

# Note on the preservational nature of ornamentation in sphaeromorphs assignable to *Tapajonites* Sommer & van Boekel, 1963 (Prasinophyta?)

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**ABSTRACT** – Assemblages of Middle Devonian (Givetian) phytoplankton from the Holy Cross Mountains include sphaeromorphs possessing blister-like ornamentation typical of the genus *Tapajonites* Sommer & van Boekel, 1963. Study of the sculptural elements under high magnification indicates the presence of patterns resembling impressions of pyrite crystals. It is suggested that ornamentation in *Tapajonites*, or at least in some sphaeromorphs assignable to that genus, is of a secondary nature. *J. Micropalaeontol.* 19(2): 159–162, December 2000.

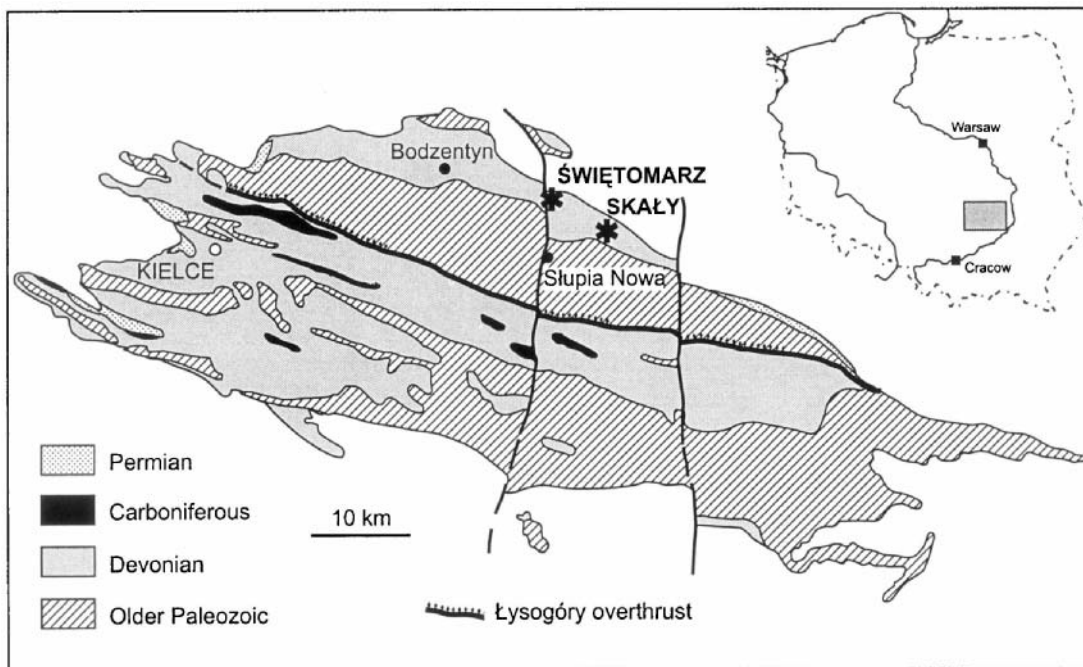
## INTRODUCTION

Abundant spores and phytoplankton have been recovered from the Middle Devonian (Givetian) shaly-marly Nieczulice Beds of the Holy Cross Mountains which outcrop between the villages of Skały and Świętomarz (Fig. 1). Miospore stratigraphy and palynofacies of these deposits were discussed in Turnau & Racki (1999), who also gave details of the sample locations.

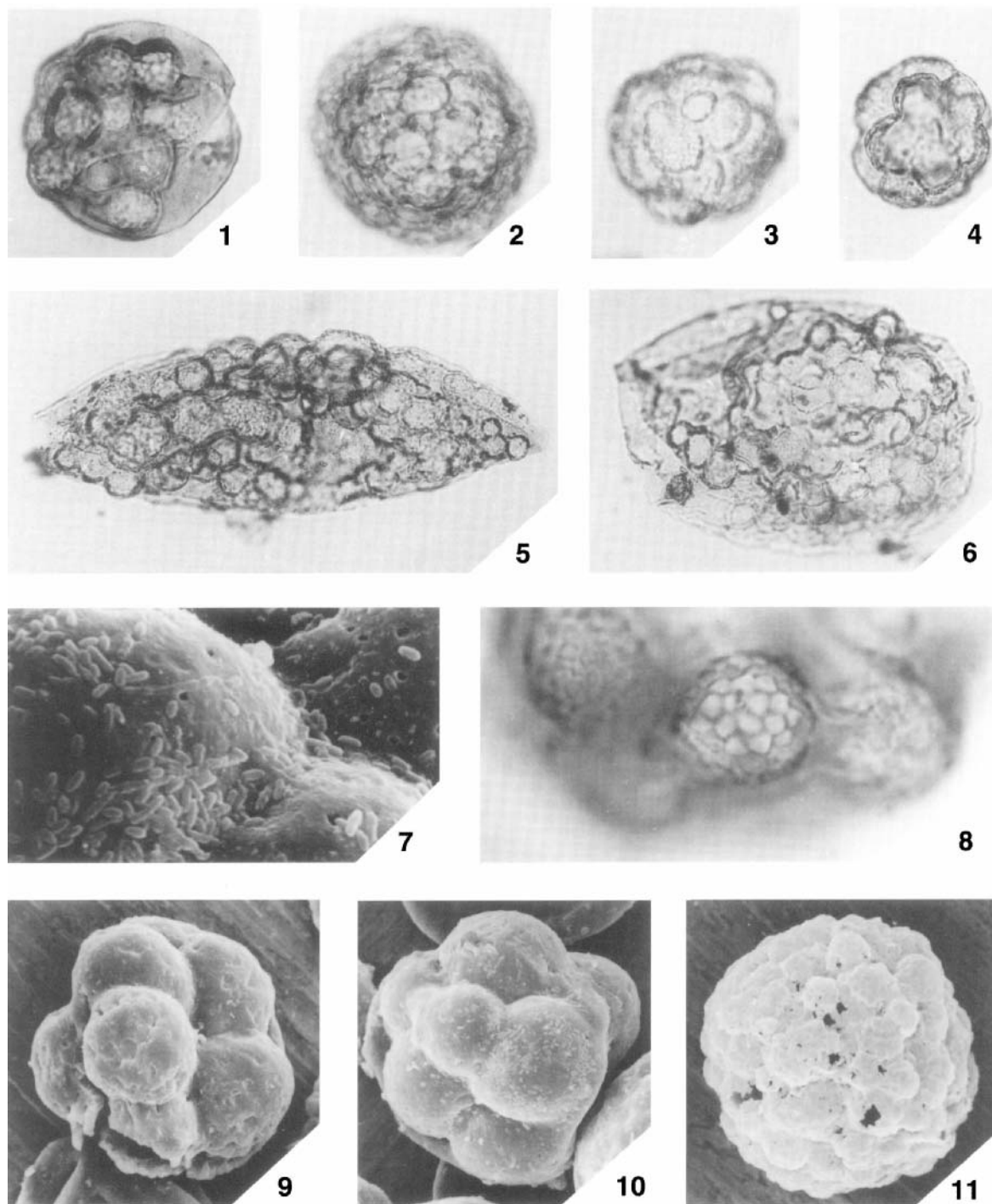
The phytoplankton assemblages studied are dominated by prasinophytes, especially *Leiosphaeridia* and some thick-walled sphaeromorphs assigned to *Hemiruptia*. In some samples, sphaeromorphs displaying blister-like ornamentation are quite common. They were initially assigned to *Tapajonites* but later the author encountered forms with identical but randomly distributed ornamentation, which led to the conclusion that the blisters were preservational features. This was confirmed by the presence of wall structures visible under oil at 1000× magnification.

## SAMPLE, MACERATION AND REPOSITORY INFORMATION

The material discussed below has been derived from the Nieczulice Beds cropping out at Skały village (samples designated Sk) and in a trench at Pokrzywianka village (samples designated Po). The Nieczulice Beds are fine-grained, dark-coloured strata deposited in an intrashelf basin (see Turnau & Racki, 1999, figs 1C, 2A). They include interbedded sets of argillaceous shales, marls and marly limestones, with shaly lithologies being dominant. Abundant fauna occurs in places, but the assemblages (mostly brachiopods, crinoids, bivalves, styliolinids and ostracods) are less diverse in comparison with the underlying, fossiliferous Skały Beds. There are sequences devoid of fauna, which may suggest recurrent low oxygen conditions. The palynological samples were grey or greenish clayey shales and marls derived from sequences or partings devoid of fauna. These samples were not enriched in marine



**Fig. 1.** Location of study area on a simplified geological map of the Holy Cross Mountains; inset, position of the Holy Cross Mountains within Poland.



#### Explanation of Plate 1

Modification of wall membranes in Givetian sphaeromorphs from the Holy Cross Mountains. Magnification  $\times 500$  except where otherwise stated. **Fig. 1.** Thick-walled sphaeromorph with one cluster of blister-like cavities; marks after pyrite appear as granulation. Sample SkIII/10, slide HCM9/60. **Figs 2–4.** Sphaeromorphs ornamented all over with blister-like cavities (a *Tapajonites* appearance): **2**, sample SkIII/10, slide HCM9/60; **3**, sample SS II/1, slide HCM17/1; **4**, sample Sk/1, slide HCM17/64,  $\times 750$ . **Figs 5–6.** Leiospheres with randomly distributed blister-like cavities. Marks after pyrite appear as distinct granulation: **5**, sample Po/3, slide HCM17/34; **6**, sample Po/3, slide HCM17/34. **Fig. 7.** SEM micrograph showing fragment of wall of specimen of Fig. 10 lacking external marks after pyrite, and displaying wall pores; bacteria on surface must be contamination. Magnification  $\times 2500$ . Sample SkIII/10. **Fig. 8.** Detail of blister-like ornamentation showing marks after pyrite on inner surface of cavity. Sample Po/3, slide HCM 17/34. Magnification  $\times 1500$ . **Fig. 9.** SEM micrograph of sphaeromorph showing wall broken by growth of pyrite framboids. Sample SkIII/10. Magnification  $\times 680$ . **Figs 10, 11.** SEM micrographs of sphaeromorphs ornamented with blister-like cavities of various sizes. Sample SkIII/10. Magnification  $\times 700$  and  $\times 850$  respectively. Sk and Po refer to Skały and Pokrzywianka villages, respectively (see text). All material is deposited in the Institute of Geological Sciences, Polish Academy of Sciences, Krakow.

organic matter, which would indicate deposition in anoxic conditions, but this may be due, at least in part, to outcrop weathering.

Palynomorphs were isolated from the rocks using standard palynological techniques. This includes HCl–HF–HCl acidification followed by heavy liquid separation and oxidation using HNO<sub>3</sub>. Residues are embedded in Cellosize and cemented to a microscope slide with Elvacite. All material is deposited in the Institute of Geological Sciences, Polish Academy of Sciences, in Kraków.

#### DESCRIPTION OF SPECIMENS AND COMPARISON WITH *TAPAJONITES*

Specimens bearing the blister-like ornamentation vary in size and appearance. The observed vesicle diameters are 40–200 µm, and the wall thickness is between 2 µm and 8 µm. In some forms, the entire wall surface is covered by roughly equidimensional blisters (Pl. 1, figs 2–4, 9–11), or the ornamentation is confined to parts of the surface (Pl. 1, figs 1, 5, 6). The observed diameter of the blisters is 6–25 µm, but their size does not appear to be related to the vesicle size. Under 400× magnification, the blister-covered surface seems to be granulate. Observation under oil at 1000×, with progressively deeper focusing shows that the blisters are cavities within the wall membrane. The margins of the cavities are scalloped and, at the highest and lowest focus, the membrane shows a pattern of angular, lighter fields measuring less than 1 µm across (Pl. 1, fig. 8). As revealed by observation under SEM, this internal pattern may not show at the vesicle surface (pl. 1, fig. 10), or may be vaguely expressed by cracks in the vesicle wall (Pl. 1, fig. 9). Wall pores c. 0.3 µm in diameter, are visible under SEM (Pl. 1, fig. 7).

The genus *Tapajonites* was erected by Sommer & van Boekel (1963) who studied Middle Devonian phytoplankton from Brazil. Two species were originally assigned to the genus: *T. roxoi* Sommer & van Boekel (designated as type species) and *T. mosesii* (Sommer). The latter species has been transferred to *Maranhites* by Brito (1967). The present paper does not apply to *M. mosesii*.

Sommer & van Boekel (1963) describe the ornamentation of *T. roxoi* in the following way. 'Ornamentation, at the margin advancing clearly beyond the outline, consisting of humps rather regularly spaced, light yellow in colour; all over the surface, irregularly distributed, are numerous little discs about 10 micra in diameter, of intense yellow colour and a more orange hue.' The light colour of the humps and discs suggests that they may be hollow. In Sommer & van Boekel (1963, pl. 1, figs 1,2), one can see that they are indeed lighter and of distinct granular texture.

Jux (1977) studied the wall structure in some tasmanitids from the Middle Devonian of Brazil, including specimens assignable to *Tapajonites*. Jux assigned his specimens to *Tapajonites mosesii*, but it is clear from the illustrations (Jux, 1977, pl. 4, figs 1–3) that, in these specimens, the distribution of protuberances on the wall surface is more like that in *T. roxoi* (the type species of *Tapajonites*), and unlike that in *T. mosesii* (now *Maranhites mosesii* (Sommer) Brito, 1967). It was demonstrated that the ornamentation elements in *Tapajonites* are cavities within the wall membrane of these fossils. They have scalloped margins (see Jux, 1977, pl. 4, fig. 4a) and are domed over the

wall surface. Canals can be seen leading from the wall surface to the cavity. Jux suggested that the cavities might have acted as some form of hydrostatic device.

#### DISCUSSION

The appearance of different forms of blister-like structures simulating spore exine ornamentation has been described by Neves & Sullivan (1964). These authors indicated the secondary nature of the structures and discussed their development, attributing their origin to the growth of pyrite crystals and aggregates within wall membranes of spores and phytoplankton. They distinguished three forms of cavities. Those described from the Holy Cross Mountains agree with the features of compound cribrate cavities of these authors.

Guy-Ohlson (1996, pl. 1, fig. 10) illustrated in a SEM micrograph a pattern appearing on the inner surface of a phycoma wall that is exactly like the pattern of angular fields described above and shown in Pl. 1, fig. 8. Guy-Ohlson suggested that these marks were the imprints of pyrite crystals.

Neves & Sullivan (1964) noted that exine deformation by pyrite growth occurred in certain morphological types of spores and their distribution was controlled by spore structural elements. The results of the present observations indicate that in phytoplankton, the described wall modification occurs primarily in prasinophytes, especially in sphaeromorphs. This is probably because these forms possess wall canals which allowed the initial penetration of bacteria, and the subsequent growth of pyrite framboids. The distribution pattern of the blisters has to be controlled, in most cases, by the distribution of the canals.

Pyrite deformation structures in palynomorphs are usually easily recognized as such, especially when occurring in spores. However, blisters distributed more or less regularly on the wall surface, occurring in sphaeromorphs which lack distinct morphological features, may be easily mistaken for sculpture. The original description and illustrations of *Tapajonites roxoi* do not permit a complete understanding of the nature of the protuberances to be formed, and the *Tapajonites* specimens showing the internal wall structure (Jux, 1977) have been described from another locality. It is, therefore, difficult to decide whether the genus should be abandoned or retained. The *Tapajonites*-like forms described above are, however, definitely deformed sphaeromorphs, and so are some other forms described in the literature as *Tapajonites*. The external morphology and the wall structure in the *Tapajonites mosesii* described by Jux (1977, pp. 6–9, pl. 4, figs 1–4) suggest the preservational nature of the wall cavities. Specimens assigned to the discussed genus also occur in abundance in Middle–Upper Frasnian deposits of the Rheinisches Schiefergebirge in Germany, from where Amirie (1984) has illustrated specimens (*op cit.* pl. 11, figs 4–9) which appear identical to the forms described here. *Tapajonites* sp. I (Martin, 1984, pp. 33–34, pl. 7, fig. 9) may also be a deformed sphaeromorph.

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