ON THE ORGANIZATION OF *SPENCERISPORITES* CHALONER AND *ENDOSPORITES* WILSON & COE WITH REMARKS ON THEIR SYSTEMATIC POSITION

D. C. BHARADWAJ
Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

The organisation of *Spencerisporites* and *Endosporites* has been discussed and shown to be similar to that of other zonate trilete spores but for the development of the saccus which is different from the saccus of Gymnosperms in origin and morphography. These genera and *Gondisporites* Bharad. (1962), together with their infraturma *Saccizonati* Bharadwaj (1957), have been placed in *Zonales* (B. & K.) Pot. & Kr. Emended diagnosis of *Endosporites* has been given.

INTRODUCTION

SOME years back, I (BHARDWAJ, 1957) had created a suprageneric category *Saccizonati*, to include miospores with well developed trilete mark on the proximal face and a subequatorial ridge of thickening or a membraneous flange round the bladder. In this *infraturma* I had included only *Endosporites* Wils. & Coe at that time although, as is evident from the diagnosis, another saccate spore genus, *Spencerisporites*, was also meant to be included there.

Spencerisporites and *Endosporites* are unquestionably of lycopsid affinities as has already been established by Chaloner (1951, 1953, 1958). Yet, as compared to the other known lycopsid miospores such as *Lycospora*, *Densosporites*, *Cristatisporites* and *Cirratriradites* they are saccate and hence have so far been classified, quite apart from the other related genera, among the SACCITES under POLLENITES. In view of this, I have considered it worth while to discuss the organisation of these two genera in detail here, and see how far they conform to the organization in other lycopsid spores.

Spencerisporites Chaloner 1951

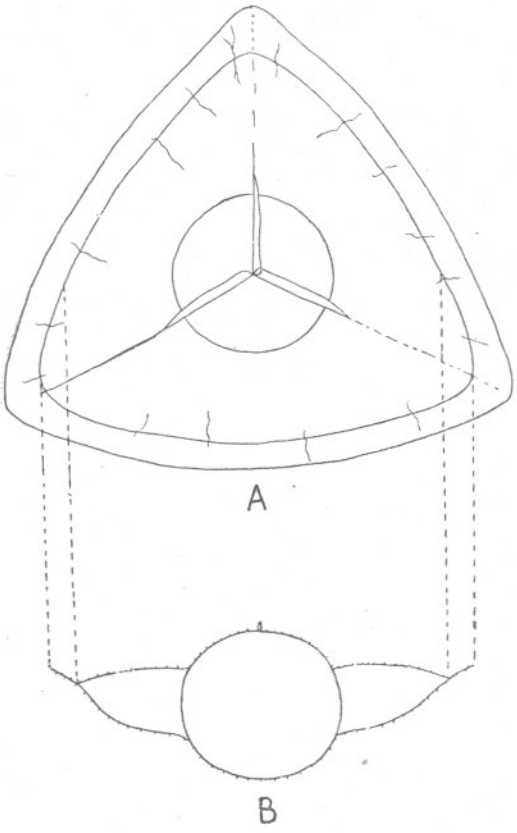
The organization in *Spencerisporites* is amply clearly and correctly understood through the researches of Chaloner (1951) and of Leisman (1962) from a study of these spores both in vertical sections as well as in surface views. The spore is always triangular in overall shape. The central body is ± circular and bears a raised trilete mark. The rays of the trilete mark usually continue beyond the central body on the saccus distinctly for a short distance (*see* FELIX & PARKS, 1959, PL. 2, FIG. 3). Beyond this, in the same alignment as the trilete rays the proximal surface of the saccus is raised like a ridge which, on equatorial flattening of the spore, gets compressed into a narrow fold as a continuation of the ray right over the marginal flange (LEISMAN, 1962). The saccus is an equatorially girdling monosaccus. Proximally as well as distally the zone of saccus attachment is equally removed from the equator of the central body i.e. a para condition of saccus attachment is prevalent in this spore. The flange is mostly uniformly broad but for the proximity of the angles where it becomes slightly broader (PL. 1, FIG. 7), the maximum width being in the line of the trilete rays.

In a vertical section through the poles of an uncompressed spore, the central body is of a circular to equatorially elongated subcircular shape. The saccus arises subequatorially and from the point of the meeting of the two saccus walls, the flange is seen to continue beyond. According to Chaloner (1951) the flange is a continuation of the proximal surface of the saccus. This is also confirmed by the continuation of the irregularly radiating network from the saccus into the flange (PL. 1, FIG. 7). Leisman (1962) has shown the network to be composed of low muri.

The organization as described above is represented in Text-fig. 1.

Endosporites Wils. & Coe 1940

As circumscribed by Wilson and Coe (1940), the organization of the genus was hardly conjecturable, especially with reference to the nature of the saccus and its



TEXT-FIG. 1 — Organization of *Spencerisporites*. A. Polar view. B. Sectional view.

attachment with the central body. It was a little later that Schopf, Wilson and Bentall (1944) elaborated the diagnosis and the description of this genus and interpreted the central body to be girdled by a monosaccus, the proximal and the distal sides of the body being freely exposed. Potonié (1952) improved upon Schopf, Wilson and Bentall's interpretation of the organization in *Endosporites*, by correctly suggesting that, but for the proximal face, the central body is covered by the saccus. Chaloner (1953) added to Potoniè's reconstruction a slight thickening between the proximal and distal walls of the saccus inside the margin. Potonié and Kremp (1954) modified Potoniè's earlier reconstruction in view of Chaloner's addition, interpreting the marginal thickening as a *limbus* i.e. a sharply defined marginal fold of the saccus in which the marginal region of proximal and distal saccus-wall lie close together or, are even fused in the form of a border.

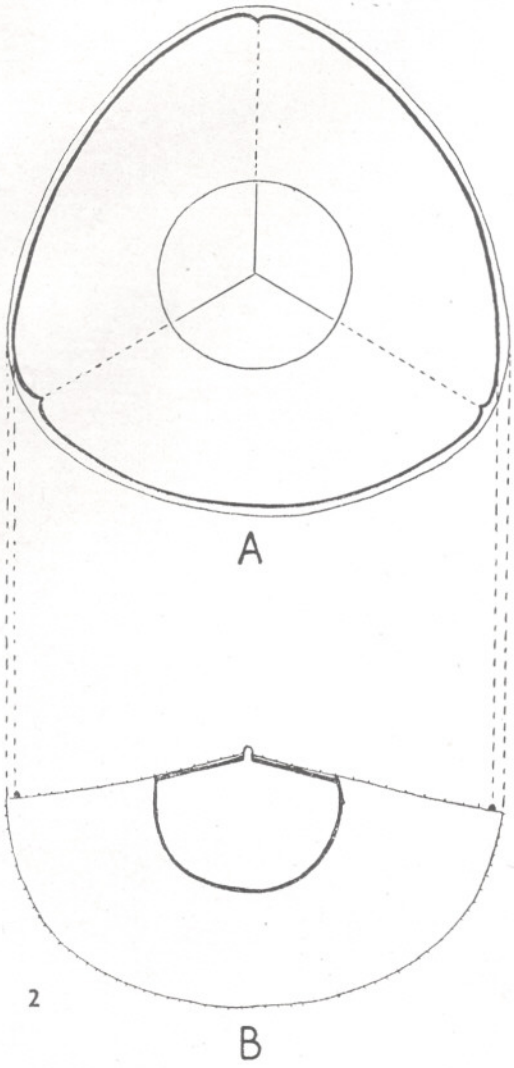
During the course of investigations of Carboniferous coals and shales from Europe, I have often observed specimens of *Endosporites* where the so called marginal limbus is really a narrowed ridge-like thickening on the proximal face of the saccus. In some cases this ridge is seen even to curve inwards to meet one of the rays or its extension on the saccus. Some specimens supporting these observations are illustrated in Pl. 1, Figs. 3, 5, 6. In view of these observations I suggest the organization in *Endosporites* to have been, as given in Text-Fig. 2.

Interpretation of the organization

I consider the thin zona in *Spencerisporites* as a modified arcuate ridge of the trilete apparatus in which the connection of the ridge with the rays has been obliterated due to stretching of the exoexine to form an air sac. It is for this reason that in unflattened specimens the proximal saccus wall is raised like a ridge in alignment with the ray on the body and the angular region of the zona is slightly broader giving an auriculate appearance much like the comparable condition in some of the *Valvisisporites* (cf. *V. nigrozonalis* (Stach & Zerndt) Pot. & Kr.) in so far as the modification of the trilete apparatus is concerned.

A situation, very much comparable to that of *Spencerisporites* is prevalent in *Endosporites* but for the fact that the arcuate ridge is unmodified here, having lost only some of its thickness due to stretching of the exoexine to form the air-sac. There is no evidence of either a marginal thickening as suggested by Chaloner or a *limbus* as interpreted by Potoniè & Kremp. Many a times the close proximity of the arcuate ridge with the margin of the saccus in obliquely flattened specimens (PL. 1, FIGS. 3, 4), is falsely suggestive of a marginal thickening.

As compared to the other monosaccate spore genera such as *Florinites*, *Potonieisporites* etc., where saccus wall is structured, the saccus of *Spencerisporites* consists of a wall which is sculptured with irregularly anastomosing and radiating, fine muri, originating on the central body and continuing over the saccus into the flange. And so is the case with *Endosporites* too. According to Schopf, Wilson and Bentall



TEXT-FIG. 2 — Organization of *Endosporites*. A Polar view. B. Sectional view.

(1944), the saccus exine in *Endosporites* is laevigate to sculptured as well as *probably* structured by fine meshed reticulation pattern. Potonie and Kremp (1955) suggest the saccus wall to be infrareticulate. However, from a detailed study, I have observed that the margin of the saccus in *Endosporites* shows very fine, uneven sculpturing consisting of low, narrow muri building up a fine reticulum (PL. 1, FIGS. 1, 2) and there is no inner structure.

DISCUSSION

The saccus of *Spencerisporites* and *Endosporites* is different in details from the saccus in *Florinites* and *Potonieisporites* etc. The reason for the differences appears to be phyletic. The spore exine in lycopsid spores is normally found not to exhibit structural differentiation i.e. the mesexine or *Isolierschicht* (POTONIÉ, 1934) is still uniformly stratified or not broken with exined and empty spaces alternating as is mostly the case among gymnospermous pollengrains where this results into intra-ornamented saccus walls.

The triangular shape, presence of trilete mark and the zonate organization in *Spencerisporites* and *Endosporites* bring these genera in line with other lycopsid spores but for their saccate nature. It seems that the development of saccus in these lycopsid spores has been an evolutionary effort comparable to that attained by some Sphenopsida (cf. *Foveolatisporites*, *Vestispora* etc.) and the Gymnosperms during the Carboniferous.

It is extremely interesting to note that the more we know about the morphological details in Lycopsida and Sphenopsida, more evidence is brought forth to establish parallel, keen efforts put up by these groups in various aspects of development, such as in the arborescent habit, secondary growth, attainment of seed habit and now the saccate miospores, to compete with Gymnosperms.

The diagnosis of *Spencerisporites* as given by Chaloner (1951) is almost complete but for the mentioning of the presence of sculpture on the saccus wall which has been elucidated only recently by Leisman (1962). This character of ornamented saccus wall is an important distinction from the structured saccus wall in gymnospermous saccate pollen grains.

The diagnosis of *Endosporites* as originally given by Wilson and Coe (1940) is rather scanty from the present standards. The elaborated diagnosis given by Schopf, Wilson and Bentall (1944) but for the organization, comes fairly close to what we now know regarding the presence of arcuate ridges and sculpture on the saccus wall in this genus although these authors did not seem to be definite about these characteristics. On the other hand Potonié and Kremp (1956) while elucidating the organization correctly introduced the occurrence of *limbus* and structured saccus wall which do not hold

good now. Hence, there is need for revision of the diagnosis of *Endosporites*.

Endosporites Wils. & Coe emend.

Diagnosis (emend.) — *Miospores nearly circular to roundly triangular in polar view, monosaccate, saccus covering the central body but for a larger part of its proximal face, saccus wall sculptured. Central body circular, bearing a trilete mark, well-developed rays extending to the margin of the central body and beyond as impressions to meet thin, arcuate ridges on the saccus.*

Gondisporites Bharadwaj (1962) is a recently created spore genus from the Lower Gondwana horizons of India. The organization of *Gondisporites* is very closely comparable to *Endosporites*, hence, the former should be placed near the latter.

Systematic position — In view of the contention expressed here the following systematic placement of *Spencerisporites Endosporites* and *Gondisporites* is suggested:

Anteturma — SPORITES H. Pot.
Turma — ZONALES (B. & K.) Pot. & Kr.
Subturma — ZONOTRILETES Waltz
Infraturma — SACCIZONATI Bhard.
Genus — *Endosporites* Wils. & Coe
,, — *Spencerisporites* Chaloner
,, — *Gondisporites* Bharadwaj

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EXPLANATION OF PLATE

PLATE 1

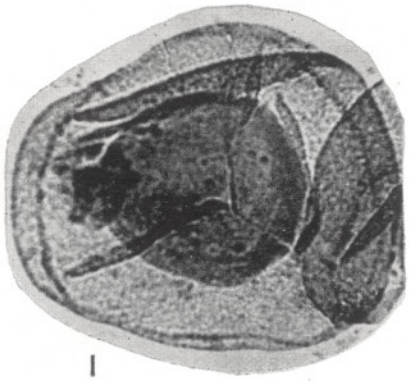
1, 2. *Endosporites formosus* Kos. (after Bhardwaj 1957, Pl. 30, Figs. 8, 7), Fig. 1 showing subequatorial ridge and Fig. 2 exhibiting the uneven *extrema lineamenta* of the saccus. × 500.

3, 4. *Endosporites*-type Spores from a microsporangium from Mazon Creek, Illinois (after Chaloner 1958, Pl. 32, Figs. 5, 6), showing contact of the ridge with one of the rays. × 500.

5. Spore from lectotype of *Polysporia mirabilis* (after Chaloner 1958, Pl. 32, Fig. 3), showing the contact of the ridge with one of the rays. × 500.

6. *Endosporites zonalis* (Loose) Knox (after Venkatachala & Bharadwaj 1964, Pl. 15, Fig. 214) showing the notched contact of the ray with the ridge. × 500.

7, 8. *Spencerites* spores (after Leisman 1962, Pl. 1, Figs. 5, 7) showing continuation of the muri from saccus to flange, extension of the trilete rays on the saccus and flange widened at the angles. × 100.



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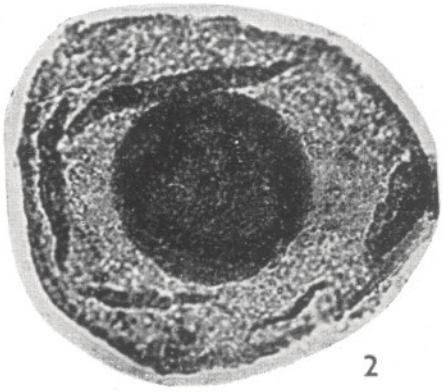

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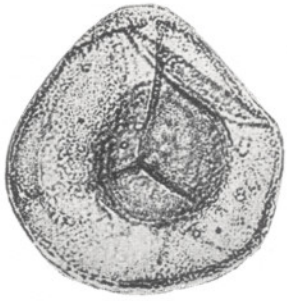

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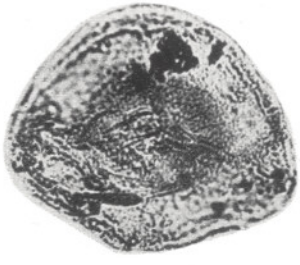

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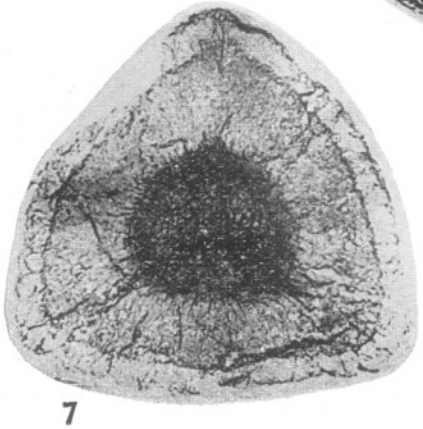

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