

# HEPATICAE IN THE SENONIAN OF SOUTH BOHEMIA

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## ABSTRACT

Hepaticoid dichotomizing thalli with very narrow segments resembling some *Riccia* but bearing very short stalked oval sporogons of the *Notothylas* type, containing spores, are described from the Senonian fire clays of the locality Zliv-Blana (near České Budejovice in South-Bohemia, Czechoslovakia) as *Notothylacites filiformis* gen. et sp. nov. In the same rocks, along with the impressions of these liverworts, two kinds of liverwort spores were also found, one suggesting the spores of *Notothylas* or *Phaeoceros*, the second those of *Oxymitra*. However, no *Riccia* spores have been established. The first named type of spores was also found within the sporogons of the above-mentioned thalli impressions.

**D**URING the last years a rather rich material of fossil plant remains, macrofossils (F. Němejc) as well as microfossils (B. Pacltová) has been assembled from the Senonian (Santonian) beds in the Zliv-Blana area, west of České Budejovice in South-Bohemia. The attention of the present authors was especially attracted by several specimens of some very thin and dichotomously divided liverwort thalli. They were collected at a depth of about 2-3 m. beneath the surface in a 40-50 cm. thick fossiliferous layer in the fire clays of the industrially important large loam pit, about 5m. deep, on the northern side of the road leading from Munice to Zaháji, west of České Budejovice.

The liverwort thalli occur in a rather thin layer of light greyish very fine-grained fire clay also containing many impressions of angiosperm leaves as well as various small seeds covered here and there with remains of carbonized cuticles. But all the liverwort thalli found here are mere impressions only. However, in several fertile specimens, sporogons are exceptionally preserved in a carbonized state, especially their spores. Dispersed liverwort spores were found not only in the layer containing impressions of liverwort thalli, but also elsewhere within other layers of the fire clay bed exposed in the above-mentioned loam pit (Pacltová, 1961).

All the liverwort thalli found here belong to one type; they are dichotomously divided five or six times at angles varying between 60° — rarely even more — and 30°. Their individual segments are very narrow; the basal ones measure hardly 0.8 mm. while the distal ones 0.4 mm. only. They are quite smooth without traces of any air chambers. They mostly exhibit a distinct midrib. Their tops are rounded. The whole plantules are thus sparsely and very regularly branched and of semicircular outline (12-16 mm. in diameter). In several rare specimens small and very shortly stalked sporogons are visible. They are inserted just at the point of dividing of the midrib. They are oval in shape, about 450-500  $\mu$  long and 430-450  $\mu$  wide. By maceration of the respective carbonized mass loosely affixed on their imprints numerous spores were obtained but no cuticles of the sporogon walls. In several imprints of sporogons a sign of a longitudinal slit in their wall seems to be present. No indication of any columella was established within them. The obtained spores were present within the sporogons joined together into tetrads. A close examination showed that the sporangia were oval in shape (length 450-500  $\mu$ , width 430-450  $\mu$ ). They were subjected to maceration: transferred with a preparation needle to the microscope slide, and a drop of 5% KOH was added. This caused gradual disintegration of the sporangium into tetrads, some of which further disintegrated into individual spores (see Pl. 3, Figs. 8-12). During further treatment with H<sub>2</sub>O<sub>2</sub>, progressive dissolution of the outer layer of the sporoderm-perine was observed; this surrounds the exine and displays an irregular (puckered) sculpture (Pl. 3, Figs. 10, 11). The puckered layer dissolved first, forming small heaps suggesting a "verrucate" sculpture (Pl. 3, Fig. 12). During further chemical treatment the small heaps gradually dissolved and disappeared. Under them a further, chagrenate layer appeared which slowly cracked forming irregular patterns resembling mud cracks (Pl. 4, Figs. 13, 14); this layer also disappeared. Finally, the

exine of the spore remained; its morphological structure corresponded to that of the spores found already earlier as dispersed spores (Pačtová, 1961; Pl. 3, Figs. 1-3).

The spores reacted in the same way to the action of the acetic acid ( $\text{CH}_3\text{COOH}$ ). During further maceration experiments, the spores did not change. They reacted only to further oxidation agents, e.g.  $\text{KClO}_3$ , changing their brown-yellow colour to a light yellow.

Comparing our fossil liverwort with various extant Hepaticae, we can observe a rather close similarity to some species of the genera *Riccia* and *Anthoceros* growing under extremely wet conditions, or in the genus *Riccia* even floating on a water surface. But the shape of the sporogons does not agree with any of these genera. The shape of the sporogon and the features of the spores found within it seem to agree mostly with the genus *Notothylas*. The spores also exhibit similarity to the genus *Phaeoceros*, but in the latter the sporogons are whip-like, elongated and provided inside with a typical columella as is the case with the genus *Anthoceros*. Thus, the basic features of our fossil liverwort seem to agree mostly with the genus *Notothylas*. However, the present authors have not found in the accessible botanical papers on extant Hepaticae any note whether some species of the genus *Notothylas* under special conditions also exhibit thalli with narrow filiform segments as are those known in several species of the genus *Anthoceros* or *Riccia*. The *Notothylas* thalli are always described as bearing short and rather broad segments (or lobes). And as even in paleobotanical papers (Lundblad, 1954 and J. Oberhel, 1964) no hepaticoid plants in a fossil state are mentioned, which could show such a curious combination of features, the present authors have chosen for the Senonian type under consideration a special generic name, i.e. *Notothylacites* gen. nov.; it is derived from the name *Notothylas* to show the very close relation to this genus. Future investigations may show whether this Senonian type is or is not identical with some of the extant species of *Notothylas*, representing an aberrant life form only, due to special extremely wet conditions. It is also not quite certain whether all the sterile thalli belong to the same genus, although they display the same external morphological features and all were collected at the same place.

## SYSTEMATIC DESCRIPTION

### HEPATICAE

#### Genus *Notothylacites* gen. nov.

*Type species*—*Notothylacites filiformis* gen. et sp. nov.

*Diagnosis*—As for species.

*Notothylacites filiformis* sp. nov.

Plates 1-4

*Diagnosis*—Thalli semicircular in outline dichotomizing into a system of elongated and very narrow laciniae showing a distinct midrib. Thallus laciniae dichotomizing at an angle of  $60^\circ$ - $30^\circ$  narrowing slowly from the base to their tops (0.8-0.4 mm.). The whole plantules are semicircular about 12-16 mm. in diameter.

Very short, stalked sporogon capsules (opening by a longitudinal slit (?) without a distinct columella), oval, about 450-500  $\mu$  long and 430-450  $\mu$  wide.

Spore trilete biconvex; amb convexly triangular. Equatorial diameter (47) 52 (55)  $\mu$ . Laesurae straight  $\pm 25$   $\mu$  long, extending to equator. Lips narrow, inconspicuous. Both perine and exine were observed. The perine probably consists of two layers: the outer layer puckered, dissolved during maceration; the second layer very thin, chagrenate, which during maceration first irregularly cracks and also becomes dissolved. Exine 1.5-2  $\mu$ , consists of thicker granulate sexine (ectexine) and a smooth nexine (endexine)—2:1. Three or sometimes more than three small (1-2  $\mu$ ) pore-like depressions on the exine can usually be seen in the region between laesurae.

*Derivation of name*—With regard to the similar recent genus *Notothylas*.

*Horizon*—Fossiliferous fire clay layers. Lower Senonian (Santonian).

*Locality*—Zliv-Blana, South-Bohemian basin, Czechoslovakia.

*Deposition of type specimen*—The holotype and all the macrofossils and slides are deposited in the collections of the Department of Palaeontology, Charles University, Prague 2, Albertov 6.

*Discussion*—The morphological structure of the above-mentioned spores resembles that of the spores of the genus *Notothylas* (Notothylaceae, Anthocerotales) described partly by Erdtman (1965, p. 130) and

figured by Dettmann (1933, Pl. XXVII, Figs. 12, 16). It is probable that the spores figured, showing different "sculptures" in the spores of one recent species, namely, *Notothylas breuteli* Gottsche from Cuba, also represent various maceration stages only. A certain similarity can also be observed in the spores of the genus *Phaeoceros* (Anthoceroaceae, Anthocerotales) which are distinguished especially by a thicker exine and a more marked tetrad scar. From the spores of the genus *Riccia* they substantially differ, and, therefore, it cannot be taken into consideration that the thallus of the liverwort studied belongs to the genus *Riccia*.

Spores similar to those dealt with in this paper have been described by Dettmann (1963) as dispersed spores. This author assigns them with a certain reserve to the artificial genus *Foraminisporis* Krutzsch. This problem should be discussed in a complex way, elsewhere. Pacltová (1961, Pl. 3, Figs. 1-3) has figured dispersed spores from the same locality as that considered in this paper (Zliv-Blana); they are morphologically conformable to the spores from the sporangia described here. The spectrum of spores was also investigated on a layer in which liverwort impressions had been found. In this case dispersed spores have also been established, which agree with those from the above-mentioned sporangia. The state of preservation corresponds to the state of the spores after maceration.

In addition to the spores considered here, different liverwort spores have already earlier been found at the locality Zliv-Blana. They have been described by Pacltová (1961, p. 87, Pl. II, Figs. 1-4) under the name *Zlivisporis blanensis* Pacltová. The

latter author determined their relationship to the genus *Oxymitra* (Oxymitraceae, Marchantiales and Ricciales).

### CONCLUSION

In the Lower Senonian (Santonian) fireclay of the locality Zliv-Blana (South-Bohemian basin) one type of hepaticoid thalli and two types of hepaticoid spores have been established.

The described thallus impressions are divided into narrow, dichotomizing lacinulae like in some species of *Riccia* or *Anthoceros* living under very wet conditions or floating on a water surface. The sporogons and spores bear features common in the genus *Notothylas*. As no similar combination of features has so far been known in any hitherto described fossil hepaticoid type or in any extant liverwort, a new name has been applied to the newly found Senonian type: *Notothylacites filiformis* sp. nov. and, accordingly, a new genus, i.e. *Notothylacites* was described. This genus seems to be closely related to the present *Notothylas*. In addition, it has been recognized that the studied microflora (spores and pollen grains) of the respective Senonian fire clay beds contains two types of hepaticoid spores: one type identical to the spores found within the sporogons of the described species *Notothylacites filiformis* sp. nov. and another one, described as *Zlivisporis blanensis* Pacltová, which resembles the spores of the genus *Oxymitra* (Oxymitraceae, Marchantiales and Ricciales).

The spectrum of spores (see Pacltová, 1961) contains in addition to numerous pollen grains abundant thalli of algae of the genus *Pediastrum*, which fact points to the swamp character of the sediment.

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## EXPLANATION OF PLATES

## PLATE 1

1. *Notothylicites filiformis* gen. n. et sp. n.; fertile thallus. Sporangium indicated by an arrow. Holotype ( $\times 5$ ).
  2. The same; natural size (1:1).
  3. Sporangium, positive impression ( $\times 100$ ).
  4. Negative impression of sporangium ( $\times 100$ ).
- Photographed by V. Šilhanová.

## PLATE 2

5. Sterile thallus of a liverwort ( $\times 5$ ).
  6. The same. 1:1.
  7. Sterile thallus of a liverwort ( $\times 5$ ).
- Both from the same locality and layer as *Notothylicites filiformis* sp. n.
- Photographed by V. Šilhanová

## PLATE 3

- Spores from the sporangium of *Notothylicites filiformis* sp. n.
8. Part of a sporangium. Spores without perine.

9. A tetrad of spores with perine.
  10. A spore with perine; distal view.
  11. A spore with perine; proximal view.
  12. A spore with relics of perine after short maceration with 5%  $H_2O_2$ .
- All spores  $\times 1000$

Microphotos by B. Pacltová

## PLATE 4

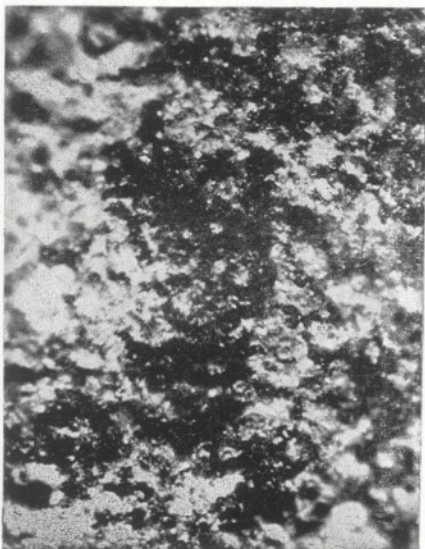
- Spores from the sporangium of *Notothylicites filiformis* sp. n. Different stages of maceration.
- 13-14. Two layers of perine; overlies the exine; the relics of the upper (puckered) layer are well visible on the lower third of the spore; the second layer chagrenate; in Fig. 1 the manner of its cracking is visible.
  - 15-16. The spores in which the exine is covered with relics of perine forming irregular small heaps. (Fig. 3 — polar view, Fig. 4 — equatorial view).
  - 17-18. Chagrenate spore without perine.
- All spores  $\times 1000$ .

Microphotos by B. Pacltová

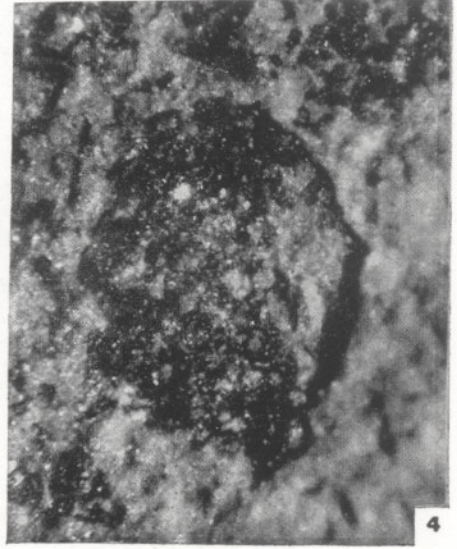


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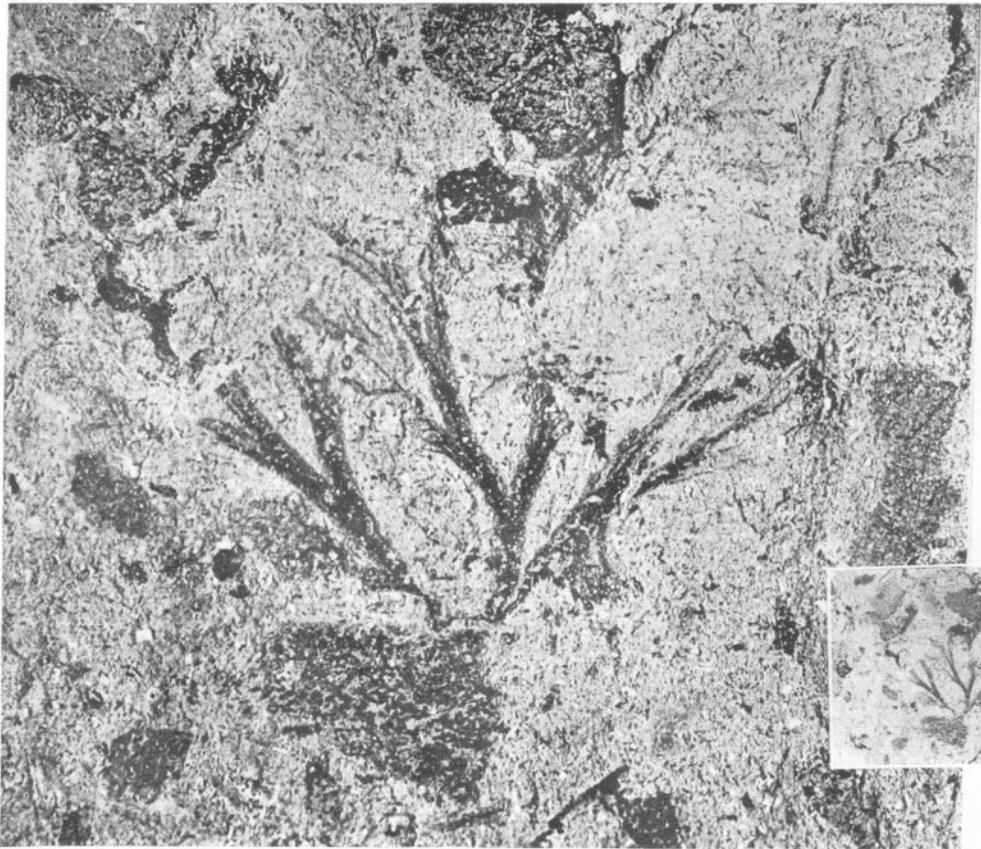
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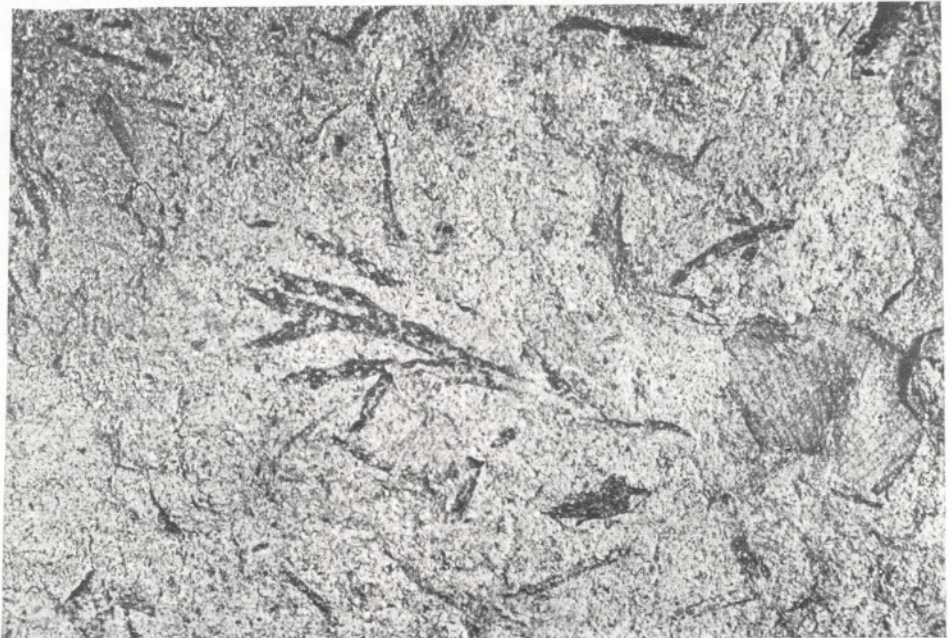
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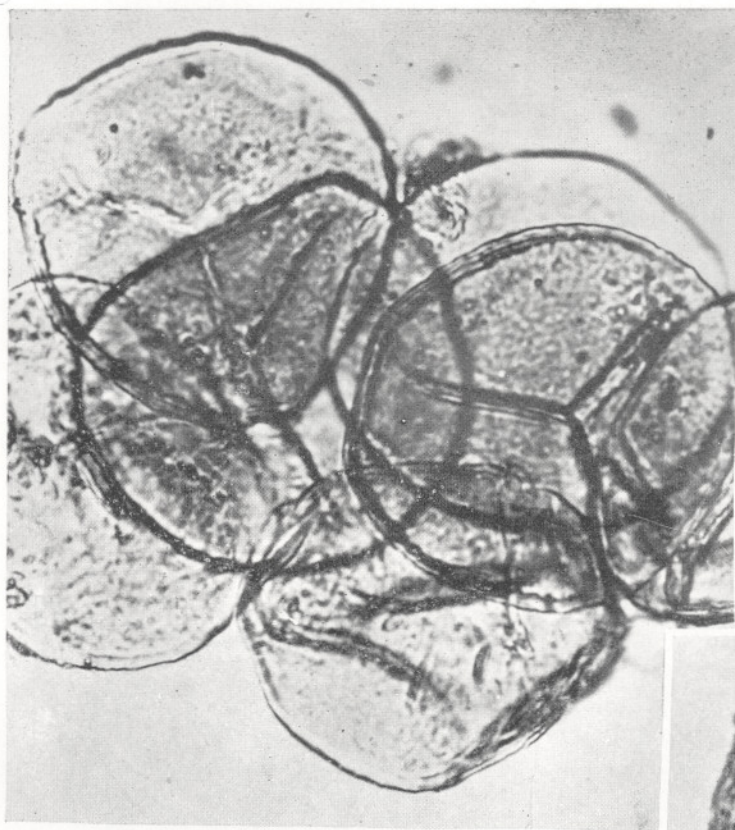
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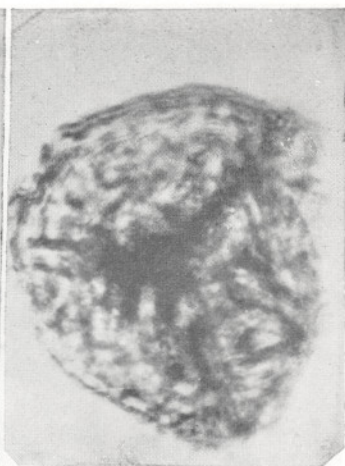
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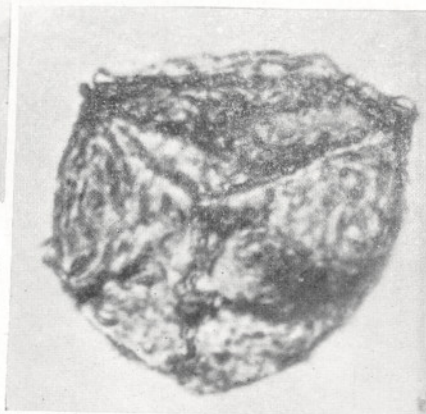
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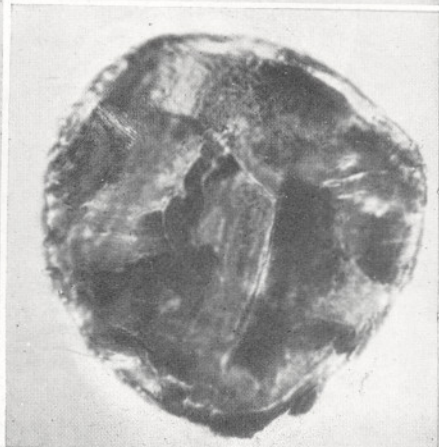
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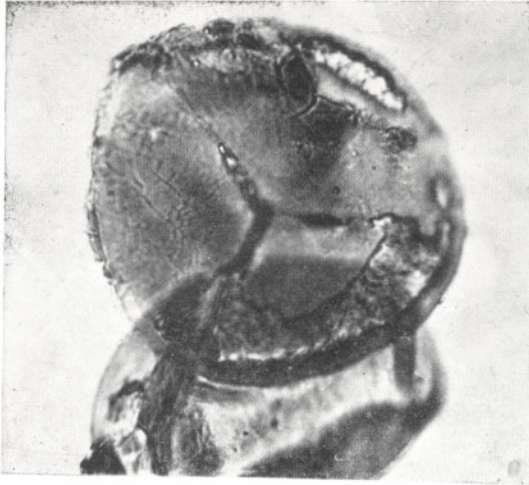
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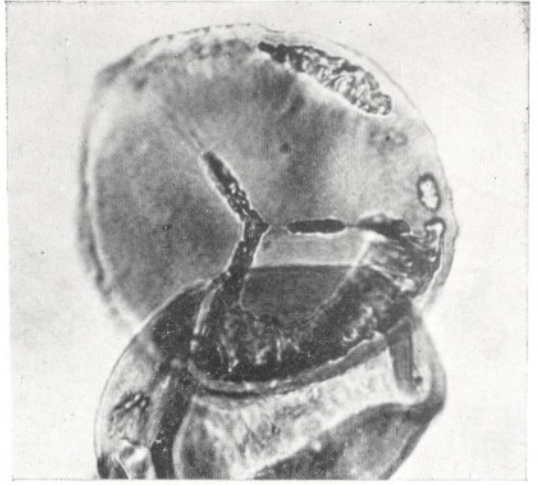
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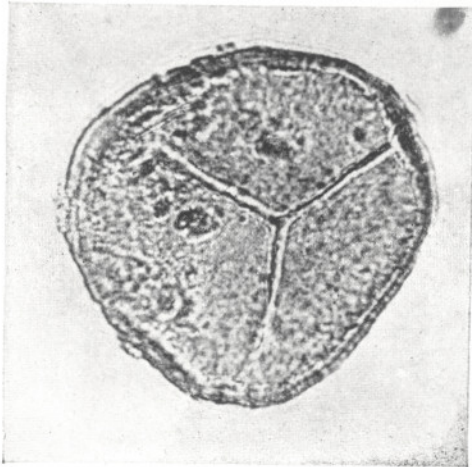
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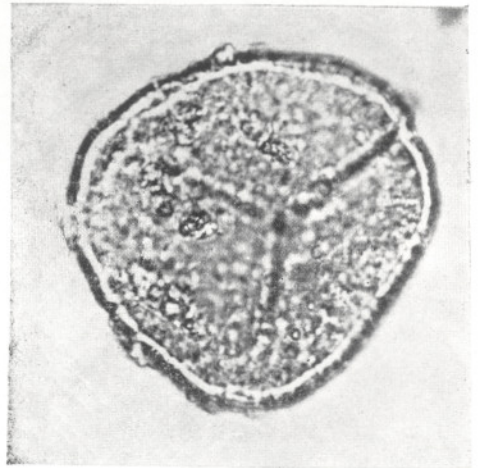
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