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JURASSIC MEGASPORES FROM GROJEC NEAR KRAKÓW

Megaspory jurajskie z Grojca koło Krakowa

ABSTRACT. The present paper deals with megaspores occurring in fire-clays at Grojec near Kraków. They represent an assemblage in which the species described earlier from the Middle Jurassic Deltaic Series in England form a considerable part. The discovery of new species, *Trileites arcuatus* n. sp. and *Erlansonisporites cerebratus* n.sp., in the Grojec flora indicates that it differs to a certain extent from the English flora compared with it.

The results of studies on megaspores, combined with the observations made by geologists as regards the stratigraphic position of the clays, constitute the basis for the opinion that the time of the origin of the clays and the plant remains contained in them was directly preceded by the development of the transgression of the uppermost Bathonian.

INTRODUCTION

The megaspores described in this paper come from fire-clays at Grojec near Kraków. These clays lie disconformably on older strata of Carboniferous or Triassic age and are covered by the transgressive Dogger formations. For more than 100 years the stratigraphic position of the clays has been the subject of controversies of many scientists. In general, the opinion of their Liassic origin prevails, although the hypothesis on the Middle Jurassic age of the Grojec Clays has recently been put forward. The purpose of the present study has been to determine the age of the Grojec Clays on the basis of the megaspores occurring in them.

I owe the information about finding some megaspores in the fire-clays to Dr. M. Reymanówna of the Institute of Botany, Polish Academy of Sciences, in Kraków. In June 1964 by her courtesy I received several specimens of megaspores obtained from the clays on the premises of the inactive mine "Stella" at Grojec. Somewhat later I received about 6 kg clay gathered by her from a dump in the mine "Bernard" at Grojec.

According to the information given by Dr. M. Reymanówna, this material designated "Grojec 4" by her, came from the eastern side of the upper part of the dump, where the clay was slightly darker and contained abundant plant detritus. It seems to have been derived from one and the same layer of the profile, for the composition of the flora is nearly the same in a large number of samples taken there. Some plants from the site "Grojec 4" have already been described, e.g. *Allicospermum retemirum* Harris, *Caytonia harrisii* Reymanówna, *C. sewardi* Thomas and *Caytonanthus* sp. (Reymanówna 1968, 1973); at this locality there are in addition *Pachypteris major* (Raciborski) Reymanówna, *Nilssonia* sp., *Ctenis* sp., *Pterophyllum cycadites* Harris & Rest, *Pseudotorellia* sp. and *Brachyphyllum* sp.

This paper presents the results of studies carried out on the material obtained only from the dump mentioned.

Diluted in perhydrol and rinsed with running water on a sieve with meshes 0·1 mm in diameter, this material provided many well preserved megaspores, which have been used for the present study. The megaspores were treated with HF to clear them of dirt. Some specimens were also macerated in HNO_3+KClO_3 and then mounted in glycerine-gelatin between slides and cover slips.

In this paper I present a further attempt to determine the stratigraphic position of the Grojec Clays on the basis of the results of studies on megaspores. The determination of the age of the clays and the flora contained in them was based on a comparison of the data concerning the area of Europe (England, Bornholm, Poland). Out of the localities of Jurassic megaspores known from different parts of the world, a few more finds of megaspores should be mentioned from the Middle Jurassic deposits of Asia and Australia (Faddeeva 1961, 1965; Bogdašowa, Odincowa & Gutowa 1967; Bogdašowa 1969; Dev 1961; Vishnu-Mittre 1954; Sah & Jain 1968; Arjang 1976; Filatoff 1975). However, they are of no major importance to the dating of the Grojec Clays and only confirm the value of some megaspore species as fossils useful in determining the Jurassic stratigraphy, at the same time giving evidence of their wide geographic distribution in the world.

The results obtained in investigations of the megaspore flora of the Grojec Clays can be used in studies of the megaspores and biostratigraphy of the Middle Jurassic intracontinental deposits in the Kraków region and in other parts of Poland.

The megaspores designated I.G.590 (1—50) 77M and I.G.590 (a-1—a-31) 77Mp and used in the present work are stored in the Palaeobotanical Laboratory, Institute of Geology, in Warsaw.

THE VIEWS HELD SO FAR ON THE AGE OF THE GROJEC CLAYS

It is difficult to establish the stratigraphic position of the so-called Grojec fire-clays in the Kraków region because of their situation. These deposits of limnic origin occur disconformably on various older layers of the Carboniferous and Triassic. In the Grojec area they lie on Muschelkalk and melaphyre and are covered by the deposits of the transgressive Dogger.

For more than 100 years various authors have been interested in the Grojec Clays and have dealt, respectively, with the problems of their genesis, age and range, as well as with the flora occurring in them.

Apart from the hints on this subject in works by Zeuszner (1847) and Roemer (1878) — vide Raciborski (1894) — the first fairly exact data about the flora of Grojec are given by Stur (1888), who regarded it as a Dogger one and compared it with the flora ot Scarborough.

Raciborski was the next to concern oneself with the flora of these clays, hitherto considered to be one of the most beautiful in the world. At first he (1889) thought it to be an Upper Rhaetic one, later (1894, p. 4) stated that the flora of the Grojec Clays is, to be sure, younger than that of the Lower Lias with *Ammonites angulatus*, but seems to be somewhat older than the flora of Scarborough, which resembles it.

Having taken into consideration Raciborski's opinion given above, Samsonowicz (1923) declared himself for referring the Grojec flora to the Upper Lias.

Różycki's (1953) observations suggest that the Grojec fire-clays are a lower member of a well-developed estuarine-continental sandy series of Lias-Dogger age. He states, in addition, that in the Kraków region there are no older transgressive deposits than those of the Lower Callovian.

Znosko (1955) also took interest in this problem and in his work given to the Rhaethic and Liassic of the Kraków-Wieluń area he analyses in detail, among other things, the stratigraphic position of the Grojec Clays. He arrives at the conclusion that all the horizons with clays in the Kraków-Częstochowa area, coming from the same sedimentation period, are the same age. As a result, he regards the Grojec Clays of the Kraków region, like the Helenów Clays distinguished in the north of the Kraków-Częstochowa area, as Lower Liassic. In his later work of 1959 Znosko upholds his conception of the Lower Liassic origin of the fire-clays despite the revision — carried out in it — of his opinion on the stratigraphy of particular lithological series distinguished in the Liassic.

Mossoczy (1961) and Jurkiewiczowa (1967) take a completely different view of the origin of the fire-clays. If Mossoczy refers it to the transformation of clayey rocks at their outcrops, Jurkiewiczowa suggests that they may have come into existence during the weathering processes occurring in the Lias at the time of emergences and hiatuses. They agree in their conclusions that the clays may have been formed in different periods and thus they may vary in age.

In the latest years Reymanówna (1963) has occupied herself with studying the flora from the Grojec Clays. In the material gathered from the dumps of the mine "Stella" she found both species widely distributed in the Lower Liassic (*Thaumatopteris* zone), like *Phlebopteris angustiloba* (Presl) Hirmer et Hoerhammer and *Pterophyllum subaequale* Hartz, and those belonging to the genera that occur in English Oolite, e. g. *Pachypteris* Brognart and *Marskea* Florin. Having analysed the specific composition of the flora of Grojec, she expressed her opinion that "it belongs to the middle zone of the Liassic".

In considering the stratigraphic position of the Chmielów Clays in the Świętokrzyski region, Karaszewski (1968) noticed a poor relationship between their flora and that of the Grojec Clays. This fact is indicated by the presence of scarcely 11 common species in 67 species described from Grojec and 31 from Chmielów. The determination of the Middle Liassic age of the Chmielów flora on the basis — among other things — of megaspores inclined Karaszewski to assume that the Grojec flora is decidedly younger than the flora from the Chmielów Clays and therefore may be of Upper Liassic age.

Having collected more specimens of the Grojec flora, among them a number of further species they have in common with the flora of the English Oolite, Reymanówna (1968, 1973) inclines to Karaszewski's conclusion and refers the Grojec flora to the Upper Lias, the Aalenian. Besides, she still emphasizes the presence of species known from the Lower Liassic (*Thaumatopteris schenki* zone) in the Grojec flora, mentioning *Phlebopteris angustiloba*, *P. muensteri* and *Pterophyllum subaequale* among them. In his paper on two ferns described by Raciborski, Harris (1977) expresses his opinion that the plants of the Grojec flora indicate its Middle Jurassic age (Upper Lias or Bajocian).

Observations made by Jurkiewiczowa (1974) throw new light on the process of transgression of the Middle Jurassic in the Kraków region and permit a somewhat more precise determination of the age of the fresh-water deposits of the "lower complex", underlying the marine deposits of the "middle complex" acknowledged to be of Upper Bathonian age. The fresh-water deposits and the Grojec Clays correlated with them by Jurkiewiczowa "are therefore older than those marine deposits and come presumably from the Vezulian-Bathonian period or rather, most probably, from the Lower Bathonian".

Taking into consideration the foregoing suggestions concerning the development of the Bathonian transgression and assuming that the time of formation of the Grojec Clays was short and that they gradually passed into deposits containing the marine fauna of the Middle and Upper Bathonian, Kopik (in Dayczak-Calikowska & Kopik 1973, p. 248) infers that the Grojec Clays can be referred exclusively to the Lower or Middle Bathonian.

CHARACTERISTICS OF THE ASSEMBLAGE OF MEGASPORES OCCURRING IN THE GROJEC CLAYS

The assemblage of megaspores occurring in the fire-clays at the site "Grojec 4", i.e. the dump of the mine "Bernard" at Grojec near Kraków (Fig. 1), is differentiated both specifically and quantitatively and its main part consists of species already known from the deposits of the Lower and Middle Jurassic of Europe (Murray 1939; Kendall 1942; Harris 1961; Gry 1969; Bertelsen & Michelsen 1970; Marcinkiewicz 1962, 1971).

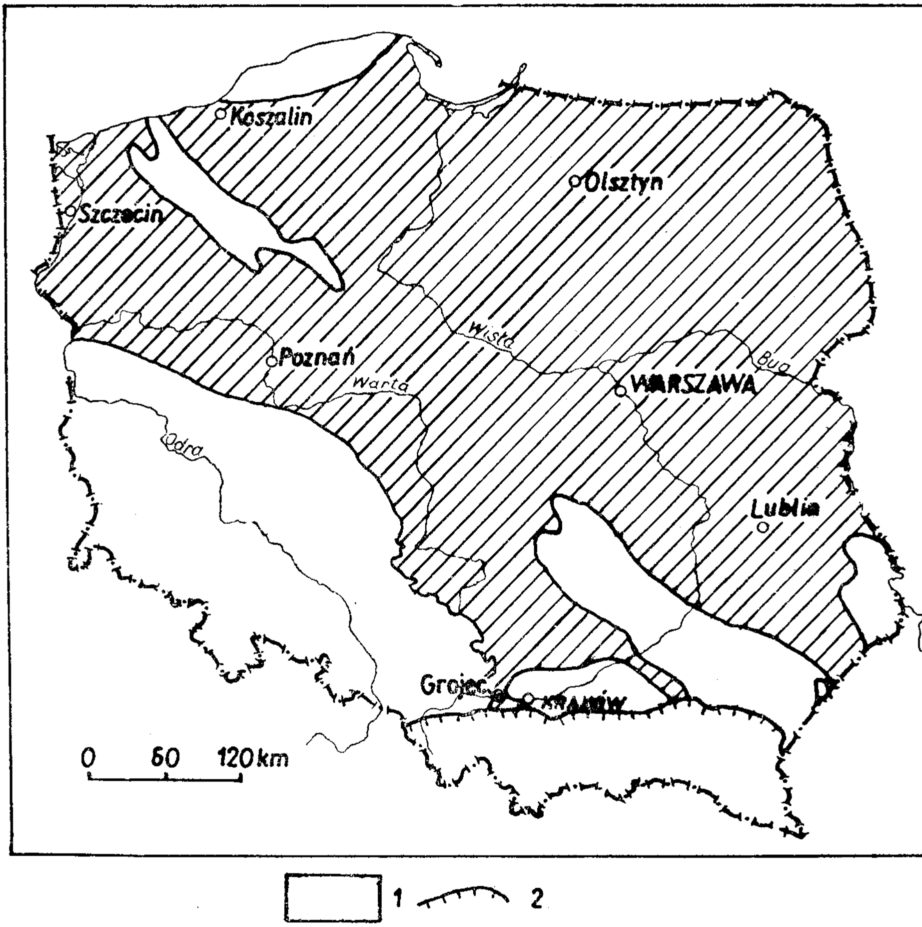

Fig. 1. The distribution of epicontinental deposits of the Upper Bathonian in Poland, after Dayczak-Calikowska (1973)
1. Regions now devoid of deposits of the Upper Bathonian. 2. Line of the Carpathian overthrust

Considered as a whole, this assemblage is in addition characterized by the presence of new species which deserve special attention for both palaeobotanic and stratigraphic reasons.

The more or less abundant occurrence of the following species * of megaspores is characteristic of the Grojec Clays:

Trileites murrayi (Harris 1961) Marcinkiewicz 1971
Trileites arcuatus n. sp.
Bacutriletes tonodios (Harris 1961) Marcinkiewicz 1971
Horstisporites harrisi (Murray 1939) Potonié 1956

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* Changes in the nomenclature of the species listed result from their being placed in other, appropriate genera in accordance with the generally accepted artificial system of Potonié (1956, 1970).

Horstisporites kendalli (Harris 1961) Marcinkiewicz 1971
Horstisporites casses (Harris 1961) Marcinkiewicz 1971
Erlansonisporites sparassis (Murray 1939) Potonié 1956
Erlansonisporites cerebratus n. sp.
Paxillitriletes phyllicus (Murray 1939) Hall et Nicolson 1973

The maximum frequency of the spores defined as *Horstisporites harrisi* (Murray) Potonié comes to the fore, *Paxillitriletes phyllicus* (Murray) Hall et Nicolson, *Trileites murrayi* (Harris) Marcinkiewicz and *Erlansonisporites sparassis* (Murray) Potonié also occurring in large numbers. *Horstisporites casses* (Harris) Marcinkiewicz appears in somewhat smaller numbers. *Bacutriletes ?onodios* (Harris) Marcinkiewicz and *Horstisporites kendalli* (Harris) Marcinkiewicz are secondary elements of the assemblage, represented by only a few specimens each.

The assemblage contains also two new species, *Trileites arcuatus* n. sp. and *Erlansonisporites cerebratus* n. sp., which give it a significant character, although their stratigraphic value has not, as yet, been examined closely. A palaeozoic megaspore identified as *Setosisporites hirsutus* (Loose) Ibrahim and fragments of *Dictyothylakos* sp. have besides been found in this material. It also appeared that numerous specimens of spores of *Trileites murrayi* (Harris) Marcinkiewicz and single specimens of the species *T. arcuatus* n. sp. show the presence of shiny spherules on the surface, which spherules, in my opinion, were due to the action of saprophytic organisms.

THE AGE OF THE GROJEC CLAYS IN THE LIGHT OF STUDIES ON MEGASPORES

1. A comparison of the assemblage of megaspores from the Grojec Clays with the assemblages of the Lower Jurassic of Europe (Poland, GDR, GFR, Denmark, Sweden).

On comparing the Jurassic megaspore assemblages known from Europe, it may be stated that the Grojec Clays lack species (e.g. *Nathorstisporites hopliticus* Jung) characteristic of the Lower Liassic deposits (GDR — Dreyer 1967; Rusbült & Petzka 1964; GFR — Jung 1960; Denmark — Bertelsen & Michelsen 1970; Gry 1969; Sweden — Lundblad 1956; Poland — Marcinkiewicz 1962, 1971), which most certainly permits the exclusion of that age.

In the light of the data published (Marcinkiewicz 1962, 1971; Rusbült & Petzka 1964; Stoermer & Wienholz 1967) there are no grounds to refer these clays to the Upper Lias, either, because only two species known from the Upper Liassic deposits, *Horstisporites harrisi* (Murray) Potonié and *Erlansonisporites sparassis* (Murray) Potonié, have been found in them.

2. A comparison of the assemblage of megaspores from the Grojec Clays with the assemblages of the Middle Jurassic of Europe.

Poland. The assemblage distinguished by Marcinkiewicz (1962) from

Table 1. The known occurrence of megaspores in the Lower and Middle Jurassic in England, Bornholm and Poland

Species of megaspores	Locality						
	England	Bornholm		Poland			
		Bagå	Levka				
	Yorkshire T. M. Harris (1961)	H. Gry (1969)		borehole, Siercza — 1 depth 856·8–880·0 m M. Brzozowska (1973)	Grojec 4	borehole Mechowo IG.1 depth 155·8–227·5 m T. Marcinkiewicz (1962, 1964)	Polish Lowland T. Marcinkiewicz (1971)
	Bajocian-Middle Bathonian	Middle Jurassic		Bajocian-Middle Bathonian	Upper part of Bathonian	(?) Aalenian (?) Bajocian	Toarcian
Trileites murrayi (Harris) Marcinkiewicz	+	+	+	+	+	+	+
Trileites turbanaeformis (Harris) Marcinkiewicz	+	—	+	—	—	—	+
Trileites arcuatus n.sp.	—	—	—	—	+	—	—
Verrutriletes pseudosquamosus Marcinkiewicz	—	—	—	—	—	+	—
Verrutriletes sp.	—	—	—	—	—	+	—
Biharisporites scaber Marcinkiewicz	—	—	—	—	—	—	+
Bacutriletes corynactis (Harris) Marcinkiewicz	+	+	+	—	—	+	—
Bacutriletes onodios (Harris) Marcinkiewicz	+	—	—	+	+	—	—
Bacutriletes clavatus Marcinkiewicz	—	+	+	—	—	—	+
Echitriletes hispidus Marcinkiewicz	+	—	+	+	—	+	+
Horstisporites harrisi (Murray) Potonié	+	+	+	+	+	+	+
Horstisporites casses (Harris) Marcinkiewicz	+	—	—	+	+	—	—
Horstisporites areolatus (Harris) Potonié	+	—	—	+	—	—	+
Horstisporites kendalli (Harris) Marcinkiewicz	+	—	—	+	+	—	—
Erlansonisporites sparassis (Murray) Potonié	+	+	+	+	+	+	+
Erlansonisporites cerebratus n.sp.	—	—	—	—	+	—	—
Erlansonisporites excavatus Marcinkiewicz	—	—	—	—	—	—	+
Minerisporites datura (Harris) nov. comb.	+	—	—	—	—	—	—
Minerisporites volucris Marcinkiewicz	—	+	—	—	—	—	+
Minerisporites institus Marcinkiewicz	—	—	—	—	—	—	+
Minerisporites richardsoni (Murray) Potonié	+	—	—	—	—	—	—
Paxillitriletes phyllicus (Murray) Hall & Nicolson	+	+	+	—	+	+	—
Paxillitriletes cf. *phyllicus* (Murray) Hall & Nicolson	+	—	—	—	—	—	+
Aneuletes patera Harris	+	+	—	—	—	—	+

borehole Mechowo IG1, from the deposits presumably of Aalenian and Bajocian age, which, according to D a d l e z (1964), constitute a sedimentational continuum with the Liassic deposits lying lower in this profile. In addition to the species listed in Table 1, this assemblage has several species in common with the assemblage from the Grojec Clays. Of these species we should mention *Trileites murrayi* (Harris) Marcinkiewicz, *Horstisporites harrisi* (Murray) Potonié, *Erlansonisporites sparassis* (Murray) Potonié and small megaspores of the species *Paxillitriletes phyllicus* (Murray) Hall et Nicolson (Pl. XIV, fig. 1-3).

Another interesting assemblage, which may be correlated with the assemblage of Grojec, is that of megaspores found by B r z o z o w s k a (1973) in the Middle Jurassic deposits of the borehole Siercza 1, situated in the Foreland of the Carpathians.

The close relationship existing between these localities (Table 1) is evidenced by as many as 6 common species, known besides from the Middle Jurassic deposits of England. These are *Horstisporites casses* (Harris) Marcinkiewicz, *H. kendalli* (Harris) Marcinkiewicz, *H. harrisi* (Murray) Potonié, *Erlansonisporites sparassis* (Murray) Potonié, *Bacutriletes tonodios* (Harris) Marcinkiewicz and *Trileites murrayi* (Harris) Marcinkiewicz.

B o r n h o l m. The megaspore flora occurring in the fresh-water deposits of Bagå and Levka on Bornholm, referred by G r y (1960, 1969) to the Middle Jurassic (Bajocian, Bathonian), is only to a small extent comparable with the Grojec flora (Table 1 *). To be sure, they have four common species — *Horstisporites harrisi* (Murray) Potonié, *Erlansonisporites sparassis* (Murray) Potonié, *Paxillitriletes phyllicus* (Murray) Hall et Nicolson and *Trileites murrayi* (Harris) Marcinkiewicz — but they form the basis only for a tentative correlation of these floras.

The lack of close data on the range and frequency of the species distinguished by G r y makes it impossible to carry out fairly detailed comparisons between Bagå and Grojec.

E n g l a n d. Some interesting and important data that facilitate comparisons and the determination of the age of the megaspore flora from the Grojec Clays are to be found in papers by M u r r a y (1939) and H a r r i s (1961) given, among other things, to the extension of megaspores in the Middle Jurassic Deltaic Series in East Midland and Yorkshire. The deltaic deposits in Yorkshire are characterized, in addition, by the occurrence of numerous macroscopic remains of plants and the presence of an ammonite fauna. For this reason the exposures of terrestrial deposits in Yorkshire belong to the most important floral localities in the world and can serve as a standard stratigraphical profile. They will also

* The assemblage from Bagå and Levka is represented by 10 megaspore species and has 7–8 species in common with the Upper Liassic assemblage known from Poland e quest on arises whether at Bagå we are actually concerned with a megaspore flora of the same age as the Middle Jurassic flora of Yorkshire, as suggested by Gry (1969), or whether it is somewhat older and perhaps belongs to one of the border members of the Upper Lias and the Lowest Dogger, which seems to be indicated by the comparisons of megaspore species.

form the background for considerations as to the age of the Grojec Clays and the megaspore flora contained in them.

In Hemingway's (1948) stratigraphical division accepted by Harris (1961) the Lower, Middle and Upper Deltaic Series are distinguished within the Middle Jurassic deposits in Yorkshire. These are flora-bearing fresh-water deposits, divided by marine intercalations containing the indicator fauna pointing to their undoubtedly Bajocian-Bathonian age. Marine deposits containing species characteristic of the murchisonae zone lie below the lower deltaic series, whereas the upper fresh-water series is covered by the marine deposits of the Callovian belonging to the macrocephalus zone. The Upper Deltaic Series is underlain by limestones of Scarborough belonging to the blagdeni zone. In Harris's (1961) opinion, two Lower Deltaic Series should be referred to the Bajocian (i.e. the Aalenian and Lower Bajocian *sensu polonico*) and the Upper Deltaic Series to the Bathonian (i. e. the Upper Bajocian and Bathonian).

The megaspore flora occurring in all these Deltaic Series shows no stratigraphic differentiation and, in this connection, forms no separate assemblages, although the particular species of which it consists are fairly considerably differentiated quantitatively (Table 2).

The megaspore flora from Yorkshire, which bears characteristics of the Middle Jurassic flora, is to a large extent comparable with the Grojec flora, because it has as many as 7 common species in 9 species occurring at Grojec and 14 in Yorkshire. These are *Paxillitriletes phyllicus* (Murray) Hall et Nicolson *Horstisporites harrisi* (Murray) Potonié, *H. casses* (Harris) Marcinkiewicz, *H. kendalli* (Harris) Marcinkiewicz, *Erlansonisporites sparassis* (Murray) Potonié, *Bacutriletes ?onodios* (Harris) Marcinkiewicz and *Trileites murrayi* (Harris) Marcinkiewicz.

The foregoing data form a sufficient basis for the correlation of both floras and lead to the conclusion that the Grojec flora much resembles the megaspore flora that characterizes the deltaic deposits in Yorkshire and therefore may be referred to the same period.

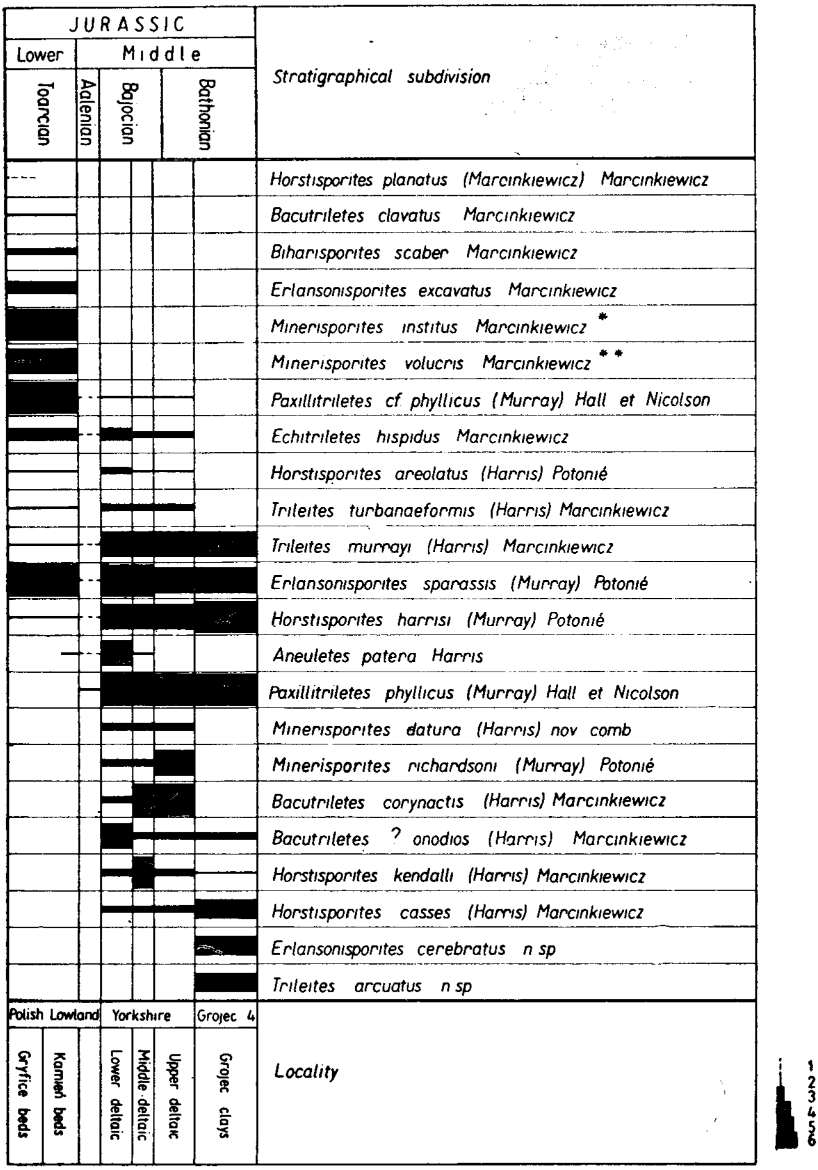
It should be remembered that as early as in 1888 Stur (vide Raciborski 1894) gave a similar age determination for these clays on the basis of a comparison of the nature of the macroflora contained in them with the analogous macroflora of England. He states that "the stratigraphic situation of the Grojec Clays is the same as that of the flora-bearing Upper, Middle and Lower Estuarine Series in Yorkshire and Scarborough and we may assume tentatively that at Grojec we are concerned with Scarborough".

Raciborski (1894), too, expressed a similar opinion, writing that "it (fossil flora from the Grojec Clays — author's note) is most closely related to the flora from Scarborough, but a vast number of its specimens belong to older species... and, as a result, it seems to be somewhat, but only slightly older than the latter flora. At any rate it is younger than the flora of the Lower Liassic horizon with *Am. angulatus*".

While analysing the results of studies on megaspores more closely, one can

Table 2

Main changes in the quantitative occurrence of megaspores in the Lower and Middle Jurassic of Poland and England



Occurrence: 1 — possible, 2 — single, 3 — rare, 4 — fairly numerous, 5 — numerous, 6 — abundant
Explanation: Lowlands of Poland; according to results obtained by Marcinkiewicz (1971). Yorkshire; on the results obtained by Harris (1961).

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* The species *Minerisporites institus* described by Marcinkiewicz (1960) from Toarcian deposits of Poland, was in the later paper of 1971 identified with the species *Triletes richardsonii* Murray which is known from the Deltaic Series of England (Murray 1939; Harris 1961). At present the authoress regards them as separate species, reserving for the Liassic spores the earlier name *M. institus* Marcinkiewicz, because they are characterized by strongly developed auricles and are considerably larger than *T. richardsonii* Murray.

** *Minerisporites volucris* Marcinkiewicz synonymized by the authoress with *Triletes datura* Harris in 1971 is now treated as a separate species, characteristic of the Upper Liassic deposits.

observe some differences between the megaspore flora from Grojec and that of the deltaic series in Yorkshire. These differences may be an additional stratigraphical indicator useful for determining the age of the Grojec Clays more exactly, for these clays have no species that are particularly characteristic of the English flora, e.g. *Minerisporites richardsoni* (Murray) Potonié, *M. datura* (Harris) nov. comb., *Bacutriletes corynactis* (Harris) Marcinkiewicz, *Echitriletes hispidus* Marcinkiewicz (= *Triletes russus* Harris), *Triletes turbanaeformis* (Harris) Marcinkiewicz and *Aneuletes patera* Harris.

On the other hand, in some cases fairly marked quantitative differences, important to the correlation of the two floras, can be seen in the common species (Table 2). This is especially true of *Horstisporites kendalli* (Harris) Marcinkiewicz, which, according to Harris (1961), is the most frequent species in the Middle Deltaic series and at Grojec is represented by scarcely two specimens.

The frequency of the remaining common specimens presents itself as follows:

Bacutriletes ?onodios (Harris) Marcinkiewicz is present in all the Deltaic series, but particularly numerous in the Lower Deltaic series. Several specimens presumably belonging to this species have been found at Grojec.

Horstisporites casses (Harris) Marcinkiewicz occurs in all the Deltaic Series, but is more often met with in the lower one. Twenty-two specimens have been taken at Grojec.

Erlansonisporites sparassis (Murray) Potonié often occurs in all the Deltaic Series, particularly abundantly in the two lower ones. It is also fairly numerous at Grojec.

Paxillitriletes phyllicus (Murray) Hall et Nicolson is, according to Harris, the commonest species in the Deltaic Series (especially in the upper one). It also occurs in large numbers at Grojec.

Horstisporites harrisi (Murray) Potonié abounds locally in the Deltaic Series. It is decidedly dominant at Grojec.

Trileites murrayi (Harris) Marcinkiewicz occurs in all the Deltaic Series, but its large numbers are observed in the upper series. The numerous specimens of this species at Grojec are worthy of noticing on account of the spherules *Reymanella globosa* Marcinkiewicz, attached to their surface, which spherules the authoress refers to fungi (Marcinkiewicz 1979).

Moreover, the Grojec Clays contain two new species, *Trileites arcuatus* n. sp. and *Erlansonisporites cerebratus* n. sp., not recorded from the Yorkshire flora. As they occur in fairly large numbers, they may be of essential importance to the determination of the nature of the megaspore flora examined and the stratigraphic position of the Grojec Clays (Tables 1 and 2).

The observation of the foregoing, fairly significant differences between the megaspore flora of the Grojec Clays and the English flora from the deposits of the Deltaic Series compared with it gives rise to the question whether the former flora corresponds entirely to the latter from the deposits regarded by Harris (1961) as of Bajocian and Bathonian age, or whether the clays represent only part of that period. Harris's opinion here presented as well as the data concerning the age of the Deltaic series given in Bate's (1967) paper, in the Stratigraphical Dictionary (Kopik 1968) and by Gignoux (1956, p. 487) indicates that the Upper Deltaic series in Yorkshire corresponds to the upper part of the Bajocian and the Lower and Middle Bathonian, there being a gap in the Upper Bathonian. In the light of these data the whole profile of deltaic deposits in Yorkshire corresponds to the Bajocian — Middle Bathonian stages.

If these assumptions are taken as the point of departure and the somewhat different specific and quantitative composition of the megaspore flora at Grojec is kept in mind, it may be supposed that the clays represent somewhat higher (?) member of the Bathonian. When Jurkiewiczowa's (1974) suggestions concerning the development of the transgression of the highest Bathonian on the Cracovian region have next been taken into consideration, it must be assumed that the origin of the clays, which make up the limnic mudstone-sandstone complex and are covered by the deposits mentioned, is probably connected with a short period of sedimentation preceding this Bathonian transgression.

It is worthy of calling to mind that Raciborski (1894, p. 7), analysing the manner of arrangement of the fossil plant remains in the clays, claimed that at Grojec "we are concerned with a bed formed within a short time, a rapid deposition of plant remains carried together with mud by the water and therefore (p. 4)... the flora of Grojec [...] cannot [...] represent the floras of several chronological stages combined together".

However, there is no evidence referring these megaspores closely to any plants that would have produced them. It may only be supposed that at the time of the formation of the deposits examined the maternal plants grew in not very distant marshy areas, situated in the proximity of gulfs, shallow water basin or at the mouths of rivers flowing into the Bathonian Sea. In such places, owing to a decrease in the water flow, the material carried by the stream could be deposited rapidly. The high rate of sedimentation, which may have taken place e.g. at the time of a great flood, is also indicated by the very good state of preservation of the megaspores, which do not show any traces of long transport.

FINAL REMARKS AND CONCLUSIONS

The foregoing considerations suggest that the megaspore assemblage associated with the Grojec Clays is characteristic of the deposits of the upper portion of the Bathonian. This conclusion is, above all, grounded on the fact that this flora, as will be seen from the comparisons made so far, has no close counterpart in the known Jurassic megaspore assemblages.

The characteristics of the megaspore assemblage ot the Grojec Clays presented in this paper and the conclusion given above reflect the present state of study. These characteristics may be modified and the conclusion may undergo a further precise definition in the future, after such new data have been obtained that they will make it possible to investigate quantitative changes and the stratigraphic range of particular species. However, these data can be provided by materials derived chiefly from boreholes.

DESCRIPTION OF MEGASPORES

Trileites (Erdtman 1945, 1947) Potonié 1956

Trileites arcuatus n. sp.

Pl. I, figs. 1, 2; Pl. II, figs. 1—3

Holotypus: IG 590/1/77 M; Pl. II, fig. 3.
Locus typicus: Poland, Grojec near Kraków
Stratum typicum: Grojec clays (Bathonian)
Derivatio nominis: arcuatus (Lat.) — arched, provided with an arch.
Description. Spores roundish or roundish-triangular in outline, 670–895 μ in diameter (most often 840 μ). Tetrad scar short, solid, with cylindrical arms reaching half the length of the spore radius. At the place where the arms of the tetrad scar meet they are narrower and at their ends somewhat broadened; they are limited by grooves on both sides. Longitudinal swellings of exine, extending as far as the arcuate ridges, are observed in the extension of the arms and sometimes also along their base. The contact areas are large, flat and sometimes depressed. The arcuate ridges are cylindrical thickenings of exine, 30–40 μ in breadth. Exine smooth, shining, light to dark brown in colour, 30–40 μ thick.
Remarks and comparison. The species described most resembles *Triletes turbanaeformis* Harris. This resemblance refers to the general shape of spores. However, unlike *T. turbanaeformis* Harris, whose ridges of the tetrad scar have sharp edges and small and bulging contact areas, the spores defined as *T. arcuatus* n.sp. have the ridges of the tetrad scar with a rounded dorsal line and large and flat contact surfaces. In addition, the presence of fine spherules, yellow in colour, which in shape resemble the forms similar to fungi described by Marcinkiewicz (1979) as *Reymanella globosa*, has been observed on the surface of some specimens of *T. arcuatus* n.sp. (Pl. II, fig. 1).
Occurrence. Poland: Grojec Clays (Bathonian).

Trileites murrayi (Harris) Marcinkiewicz

Pl. III, figs. 1–5; Pl. IV, figs. 1, 2

1939 *Triletes* sp. "A" Murray; Murray p. 484, Text-fig. 11.
1960 *Trileites* sp. "A" (Murray) Marcinkiewicz; Marcinkiewicz p. 716, Pl. 1. fig, 3.
1960 *Trileites calvus* Marcinkiewicz: Marcinkiewicz p. 717, Pl. 2, fig. 1.
1961 *Triletes murrayi* Harris; Harris p. 64, Text-fig. 20 A-F; Text-fig. 21 A, B.
1962 *Trileites* sp. A. (Murray) Marcinkiewicz; Marcinkiewicz p. 472, Pl. 6, fig. 6; Pl. 7, figs. 1, 2.
1969 *Trileites murrayi* Harris; Gry p. 83, Text-fig. 6 (fig. 3).
1971 *Trileites murrayi* (Harris) Marcinkiewicz; Marcinkiewicz p. 31, Pl. 1, figs. 6–8.

Description. The megaspores are roundish or oval in outline, 660—1300 μm in diameter. The arms of the tetrad scar are short, they reach a third of the spore radius in length. They are low ridges with narrowed ends. Along both sides of each arm run fine grooves, which bring the tetrad scar out in relief. In the extension of the arms there are low longitudinal swellings of exine. The contact areas are flat, often sunken. The arcuate ridges are missing. At the margin of the spore there is a fairly thick fold of exine. The surface of exine is smooth, shining and light-brown, its thickness 30—40 μm. In transmitted light the macerated spores show a thin folded mesosporium.

The occurrence of smooth, glossy, sometimes rough spherules, red or rubious to almost black in colour, on the surface of spores is a characteristic of nearly all specimens examined. These spherules, up to 80 μm (100μm) in diameter, occur singly or in groups or cover the whole spore surface, not excluding the ridges of the tetrad scar.

Remarks and comparison. The specimens described have the same morphological characters as has the species *Triletes murrayi* Harris, from which they differ only in the presence of spherules on the surface of exine. These spherules, according to the authoress's observations, are not elements of the sculpture, but resemble the spherules of the genus *Annella*, included by Srivastova (1976) in fungi. On account of their size and mode of attachment to the surface of exine (Pl. IV, fig. 2b, c) they have however been described under the new name of *Reymanella globosa* (Marcinkiewicz 1979).

Occurrence. Poland: Upper Lias, Grojec Clays (Bathonian); England (Bajocian, Bathonian); Bornholm (Middle Jurassic).

Bacutriletes Potonié 1956

Bacutriletes ?onodios (Harris) Marcinkiewicz

Pl. I, figs. 3—5; Pl. II, fig. 4

1961 *Triletes onodios* Harris; Harris p. 53, Text-figs. 16 I—L, 17 A—E.
1971 *Bacutriletes onodios* (Harris) Marcinkiewicz; Marcinkiewicz in textu p. 23.

Description. Megaspores roundish to oval in outline, 300-400 μm in diameter (8 specimens); arms of tetrad scar equal to 0·7 length of spore radius, in the form of low ridges (25 μm) with dentate edges; no arcuate ridges; exine densely covered with finger-shaped appendages, up to 55 μm in height and 7-15 μm in width at base, with blunt, rounded or slightly pointed ends. Some appendages are joined along their sides to form one broader element. Their tops are never joined and do not form a vault. On the contact areas the appendages are shorter than on the distal surface. Exine about 10 μm thick, yellow to brown in colour. Folded mesosporium, exospore and appendages, with fine- and medium-grained surface, visible in macerated specimens.

Remarks and comparison. The spores from Grojec, determined with reservations, in the type of appendages most resemble the spores described by Harris as *Triletes onodios*. They however differ from the holotype of this species (Text-fig. 16/J, K) in their markedly longer appendages. The specimen given by Harris in Text-fig. 17c seems to correspond to the megaspores under study but the lack of data as to the length of the appendages in the description of the species *T. onodios* Harris makes it difficult to compare them closely. However, if great variation in the sculpture of exine in *T. onodios* is kept in mind, and this is suggested by both the description and the drawings given in Harris's paper, the specimens from Grojec may be regarded as the same species.

The species described is also similar to *Bacutriletes corynactis* (Harris) Marcinkiewicz, from which it differs in the lack of appendages with tops broadened in the form of a head, whereas from *Echitriletes polysceles* (Murray) Potonié it differs in the lack of sharply pointed appendages.

Occurrence. Poland: Grojec Clays (Bathonian); England (Bajocian, Bathonian).

Horstisporites Potonié 1956

Horstisporites casses (Harris) Marcinkiewicz

Pl. V, figs. 1–3; Pl. VI, figs. 1, 2

1961 *Triletes casses* Harris; Harris p. 60, Text-fig. 19 D, F.
1971 *Horstisporites casses* (Harris) Marcinkiewicz; Marcinkiewicz in textu p. 23.

Description. Megaspores roundish in outline, 1400–2000 μm (oftenest 1680 μm in diameter; arms of tetrad scar up to 0·7 length of spore radius, in the form of robust ridges, 40–80 μm (sometimes 120 μm) in height, lowering towards equator. Contact areas flat or somewhat sunken. Arcuate ridges lacking, but in some specimens there are fine lines, arising from the arrangement of ridges which form a network. The polygonal network of low ridges, 10 μm in thickness, with 40–70 μm meshes, covers the whole surface of exine. Pointed, tongue--shaped elongations occur at the junctions of the ridges. Exine about 50 μm thick, its surface is yellow in colour.

Occurrence. Poland: Grojec Clays (Bathonian); England (Bajocian, Bathonian).

Horstisporites kendalli (Harris) Marcinkiewicz

Pl. VI, fig. 5

1961 *Triletes kendalli* Harris; Harris p. 63, Text-fig. 19 A—C.
1971 *Horstisporites kendalli* (Harris) Marcinkiewicz; Marcinkiewicz in textu p. 23.

Description. Spores (2 specimens) roundish in outline, 425 and 450 μm in diameter; arms of tetrad scar in the form of low ridges up to 0·8 spore radius in length. No arcuate ridges. Exine covered all over with low ridges, 10 μm thick, which form a pentagonal network with meshes about 20 μm in diameter. Exine yellow in colour.

Occurrence. Poland: Grojec Clays (Bathonian); England (Bajocian, Bathonian).

Horstisporites harrisi (Murray) Potonié

Pl. V, Figs. 4,5; Pl. VI. figs. 3,4; Pl. IX, fig. 3; Pl. XI, fig.4

1939 *Triletes harrisi* Murray; Murray, p. 480, Text-figs. 1,2.
1956 *Horstisporites harrisi* (Murray) Potonié; Potonié, p. 45.
1960 *Horstisporites semireticulatus* Jung; Jung, p. 142, Pl. 38, figs. 31—38.
1960 *Erlansonisporites reticulatus* (Zerndt) Marcinkiewicz; Marcinkiewicz, p. 720, Pl. 5, fig. 3.
1961 *Triletes harrisi* Murray; Harris, p. 60, Text-fig. 18 E,F.
1962 *Erlansonisporites reticulatus* (Zerndt) Marcinkiewicz; Marcinkiewicz, p. 477, Pl. 5, figs. 8-10.
1967 *Horstisporites semireticulatus* Jung; Dreyer, Pl. 9, fig. 10 a, b.
1967 *Horstisporites* aff. *harrisi* Murray; Stoermer & Wienholz, Pl. 10, fig. 89 a, b.
1969 *Horstisporites harrisi* Murray; Gry, p. 83, Text-fig. 6, (fig. 8).
1970 *Horstisporites harrisi* (Murray) Potonié; Bertelsen & Michelsen, p. 27, Pl. 7, figs. 3,4.
1971 *Erlansonisporites recticulatus* (Zerntd) Marcinkiewicz; Marcinkiewicz, p. 36, Pl. 13, figs. 3–6; Pl. 14, figs. 1–3.
1975 *Horstisporites harrisi* (Murray) Potonié; Arjang, p. 137, Pl. 8, figs. 1–5.

Description. Megaspores roundish-oval in outline, 350–550 μm (most frequently 475 μm) in diameter; tetrad scar often cracked; arms of tetrad scar up to 0·7–0·8 spore radius in length, in the form of marked, straight or slightly wavy ridges, 40–50 μm in height, getting lower towards equator. Distal surface of spore covered with low meandering ridges, which form an irregular network, with meshes about 25–35 μm in diameter. The arcuate ridges are marked by a change in the sculpture. Contact areas are ornamented with closely spaced nodules. Exine 40 μm thick, yellow in colour.
Occurrence. Poland: Lias, Grojec Clays (Bathonian); GFR (Lias); GDR Hettangian, Upper Aalenian); Denmark (Lias); England (Bajocian, Bathonian); Bornholm (Middle Jurassic); Central Iran: Kernan Basin (Dogger).

Erlansonisporites Potonié 1956

Erlansonisporites sparassis (Murray) Potonié

Pl. VI, fig. 6; Pl. VII, figs. 1–4; Pl. VIII, figs. 1–3; Pl. IX, figs. 1, 2, 4; Pl. X, figs. 1–3

1939 *Triletes sparassis* Murray; Murray, p. 480, Text-figs. 3, 4.
1942 *Triletes sparassis* Murray; Kendall, p. 920, Text-fig. 1 A, B.
1956 *Erlansonisporites sparassis* (Murray) Potonié; Potonié, p. 47.
1960 *Erlansonisporites tegimentus* Marcinkiewicz; Marcinkiewicz, Orłowska & Rogalska, Pl. 2, figs. 5–7.
1960 *Erlansonisporites tegimentus* Marcinkiewicz; Marcinkiewicz, p. 721, Pl. 6, figs. 1, 2.
1961 *Triletes sparassis* Murray; Harris, p. 57, Text-fig. 18 A—D.
1962 *Erlansonisporites tegimentus* Marcinkiewicz; Marcinkiewicz, p. 476, Pl. XI, fig. 7, Pl. XII, figs. 1, 2.
1967 *Erlansonisporites teqimentus* Marcinkiewicz: Stoermer & Wienholz, Pl. 10, fig. 87.

1969 *Erlansonisporites sparassis* Murray: Gry, Text-fig. 6 (fig. 11).
1971 *Erlansonisporites sparassis* (Murray) Potonié; Marcinkiewicz, p. 37, Pl. 15, figs. 5, 6; Pl. 16, figs. 1–6; Pl. 17, fig. 1.

Description. Spores roundish and roundish-oval in outline, 400-980 μm in diameter; tetrad scar often hidden by elements of sculpture; arms of tetrad scar in the form of high (about 80-120 μm), wavy ridges up to 0·7 spore radius in length. Arcuate ridges imperceptible. The whole surface of exine is covered with sinuous ridges, which join each other to form an irregular network with elongated meshes, 50-80 μm across.

In the proximal portion of the spore the ridges are higher, more wavy, often in the form of tongue-shaped extension with jagged edges. The sculpture of the spore is often obliterated and shows the lustrous surface of exine with the base of network. Exine 35 μm thick, yellow in colour.

Remarks and comparison. The megaspores included in *E. sparassis* (Murray) Potonié are characterized by great variation in sculpture. Most of the specimens examined bear a resemblance in the type of sculpture to the spores illustrated by Harris (1961) in Text-fig. 18 A and B. The specimens with feebly-developed sculpture are comparable with the spore given by Harris in Text-fig. 18 D and the spores found in the Lias of Poland (Marcinkiewicz 1971, Pl. 15, figs 5, 6 and others).

Occurrence. Poland: Upper Lias, Grojec Clays (Bathonian); England (Bajocian, Bathonian); Bornholm (Middle Jurassic); GDR (Lower Toarcian).

Erlansonisporites cerebratus n. sp.

Pl. XI, figs. 1–3, 5; Pl. XII, figs. 1–4

Holotypus: IG 590/41/77 M, Pl. XI, Fig. 2.
Locus typicus: Poland, Grojec near Kraków.
Stratum typicum: Grojec Clays (Bathonian).
Derivatio nominis: cerebratus (Lat.) — cerebral.

Description. Spores roundish in outline, 580–680 μm in diameter. Tetrad scar hard to see, often hidden among the elements of exine sculpture. Arcuate ridges lacking. Exine covered all over with solid wavy ridges, which form convolutions like those of the brain. They are better developed on the proximal side, where they have often the form of bands or large plates, up to 150 μm and sometimes even 300 μm in height. The ridges that cover the distal side are markedly lower (about 50 μm) and have a tendency to form an irregular network. In some specimens the sculpture of the spore is obliterated, showing a smooth, shiny dark-brown surface. Exine about 30 μm thick, yellow in colour.

Remarks and comparison. The species described is similar in sculpture to *Erlansonisporites sparassis* (Murray) Potonié, only that the ridges that make up the sculpture of *E. cerebratus* n.sp. are more massive and the plates on the proximal side are much higher and not jagged.

Occurrence. Poland: Grojec Clays (Bathonian).

Paxillitriletes Hall et Nicolson 1972
Paxillitriletes phyllicus (Murray) Hall et Nicolson

Pl. XIII, figs. 1–9; Pl. XIV, figs. 1–3

1939 *Triletes phyllicus* Murray; Murray, p. 482, Text-figs. 7, 8.
1956 *Thomsonia phyllicus* (Murray) Potonié; Potonié, p. 72.
1961 *Triletes phyllicus* Murray; Harris, p. 48, Text-figs. 13 I, J; 14.
1969 *Thomsonia phyllica* Murray; Gry, Text-fig. 6 (fig. 13).
1972 *Paxillitriletes phyllicus* (Murray) Hall & Nicolson; Hall & Nicolson, pp. 319, 320.
1975 *Paxillitriletes phyllicus* (Murray) Hall & Nicolson; Filatoff, p. 55, Pl. 8. figs, 8, 9.

Description. Megaspores roundish in outline, 185–255 μm in diameter, most often 255 μm. The arms of the tetrad scar are long, provided with thin-membranous, transparent lamellae, 70–100 μm in height. They are double, wavy, with a dentate edge, often rolled. The arcuate ridges present, 10–15 μm in width, and widening somewhat in the places where they join the tetrad scar ridges. Here are well-developed auricles, which reach 70 μm in height and 100 μm in width. Near the tetrad scar in the contact areas there are spines, about 80 μm long. An irregular network, built of low ridges, occurs on the distal and proximal surfaces. The ties of the network are elongated in the form of tongue-shaped spines. Exine thin, yellow in colour.

Remarks and comparison. Attention should be given to the fact that the synonymy does not embrace the spores known from the Upper Lias of Poland, determined by Marcinkiewicz (1962, 1971) as *Thomsonia* (*Triletes*) *phyllica* (Murray) Potonié. These spores are here assigned to *Paxillitriletes* cf. *phyllicus* (Murray) Hall & Nicolson.

From the typical specimens of *Triletes phyllicus* described by Murray (1939) and Harris (1961) the spores characteristic of the Lias differ in their twice as long diameter. However, on account of their general similarity both in morphology and dimensions they may be compared with the spores belonging to *T. phyllicus* giant form, which, according to Harris's (1961, p. 50; Text-fig. 14 K) suggestion, are a variety of this species, although it may well be that they form a separate species. On the other hand, the spores from Grojec correspond entirely to the typical specimens of *T. phyllicus* Murray from the Middle Jurassic of England.

Occurrence. Poland: Grojec Clays (Bathonian); borehole Mechowo IG-1, depth 155·8—173·0 (?Bajocian); England (Bajocian, Bathonian); Bornholm (Middle Jurassic); West Australia: Perth Basin (Middle Bajocian).

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STRESZCZENIE

MEGASPORY JURAJSKIE Z GROJCA KOŁO KRAKOWA

Opisane w niniejszej pracy megaspory pochodzą z glinek grojeckich, które w obszarze krakowskim leżą niezgodnie na różnych starszych ogniwach karbonu lub triasu, przykryte są natomiast utworami transgresywnego doggeru. Glinkami grojeckimi interesowali się różni autorzy od przeszło stu lat, rozpatrując zagadnienie ich genezy, wieku i zasięgu oraz występującej w nich flory. Na ogół przeważa pogląd o ich liasowym pochodzeniu, chociaż ostatnio wysuwane są hipotezy o środkowojurajskim wieku glinek. Podjęte przez autorkę badania miały na celu określenie położenia stratygraficznego glinek grojeckich na podstawie występujących w nich megaspor.

Wśród oznaczonych megaspor znaczną część stanowią gatunki znane ze środkowojurajskich serii deltowych w Yorkshire w Anglii. Są to: *Trileites murrayi* (Harris) Marcinkiewicz, *Bacutriletes ?onodios* (Harris) Marcinkiewicz, *Horstisporites casses* (Harris) Marcinkiewicz, *H. kendalli* (Harris) Marcinkiewicz, *H. harrisi* (Murray) Potonié, *Erlansonisporites sparassis* (Murray) Potonié, *Paxillitriletes phyllicus* (Murray) Hall et Nicolson.

Analizując bardziej szczegółowo wyniki badań megasporowych, można zaobserwować jednak pewne różnice pomiędzy badaną florą megasporową a florą z serii deltowych w Yorkshire, które mogą być dodatkowym wskaźnikiem stratygraficznym przy bliższym określaniu wieku glinek grojeckich. W glinkach brak jest bowiem niektórych gatunków szczególnie charakterystycznych dla flory angielskiej, a poza tym pojawiają się w nich dwa nowe gatunki określone jako *Trileites arcuatus* n.sp. i *Erlansonisporites cerebratus* n.sp.

Nasuwa się wobec tego pytanie, czy flora megasporowa charakteryzująca glinki grojeckie odpowiada całkowicie florze angielskiej, pochodzącej z osadów serii deltowych, którym Harris (1961) przypisał wiek bajosu i batonu czy też glinki reprezentują tylko część tego interwału czasu. Z przedstawionego stanowiska Harrisa oraz danych zawartych w pracy Bate (1967) i w Słowniku Stratygraficznym (Kopik 1968) dotyczącym wieku serii deltowych wynika, że seria deltowa górna z Yorkshire odpowiada wyższej części bajosu oraz dolnemu i środkowemu batonowi, a w górnym batonie jest luka. W świetle tych danych cały profil osadów deltowych w Yorkshire odpowiada piętrom bajos — baton środkowy.

Autorka, wychodząc z powyższego założenia i biorąc pod uwagę nieco odmienny skład gatunkowy i ilościowy flory megasporowej w Grojcu, wysuwa przypuszczenie, że glinki reprezentują nieco wyższe (?) ogniwo batonu. Uwzględniając następnie sugestie Jurkiewiczowej (1974) dotyczące rozwoju transgresji (?) najwyższego batonu na półwyspie krakowskim, autorka przyjmuje, że powstanie glinek — wchodzących w skład limnicznego kompleksu mułowcowo-piaskowcowego i przykrytych wspomnianymi utworami — wiąże się prawdopodobnie z krótkim okresem sedymentacji poprzedzającym tę transgresję batońską.

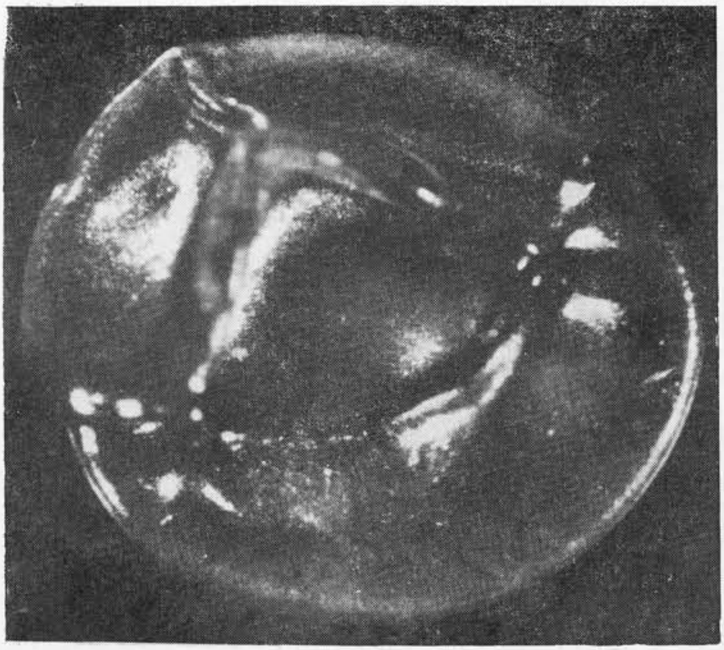
PLATES

Plate I

Trileites arcuatus sp.n.
1. IG. 590/2/77 M, × 100
2. IG. 590/3/77 M, × 100

Bacutriletes ?onodios (Harris) Marcinkiewicz

3a. Proximal side, IG. 590/17/77 M, × 100
3b. Distal side of same specimen
4. IG. 590/18/77 M, × 100
5. IG. 590/16/77 M, × 100



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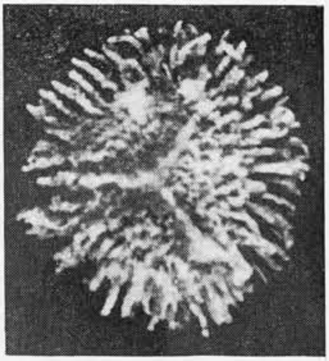

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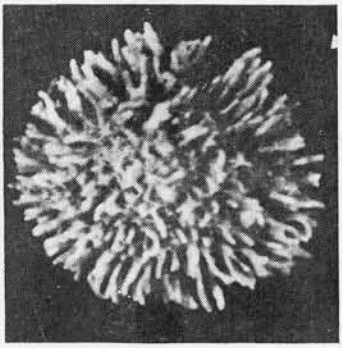

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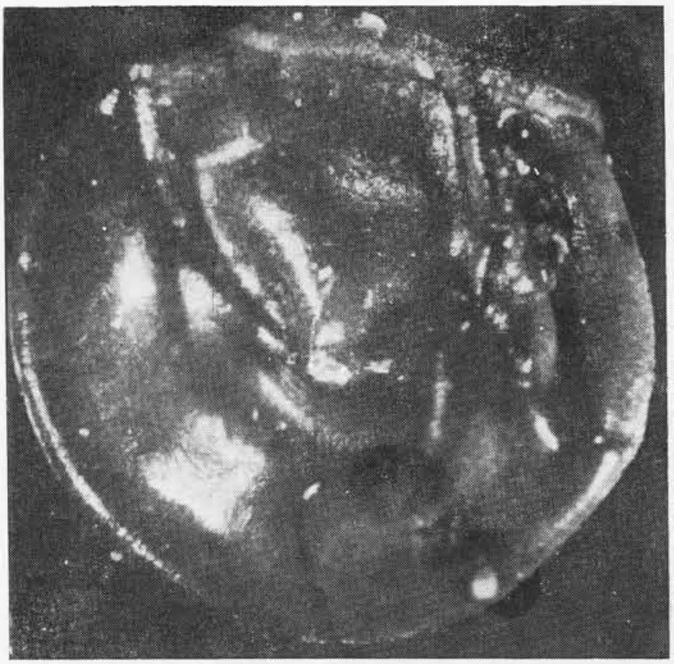

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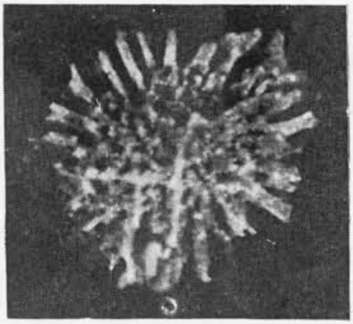

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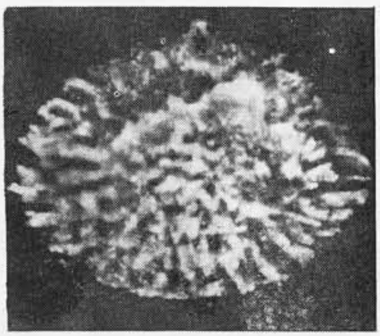

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Plate II

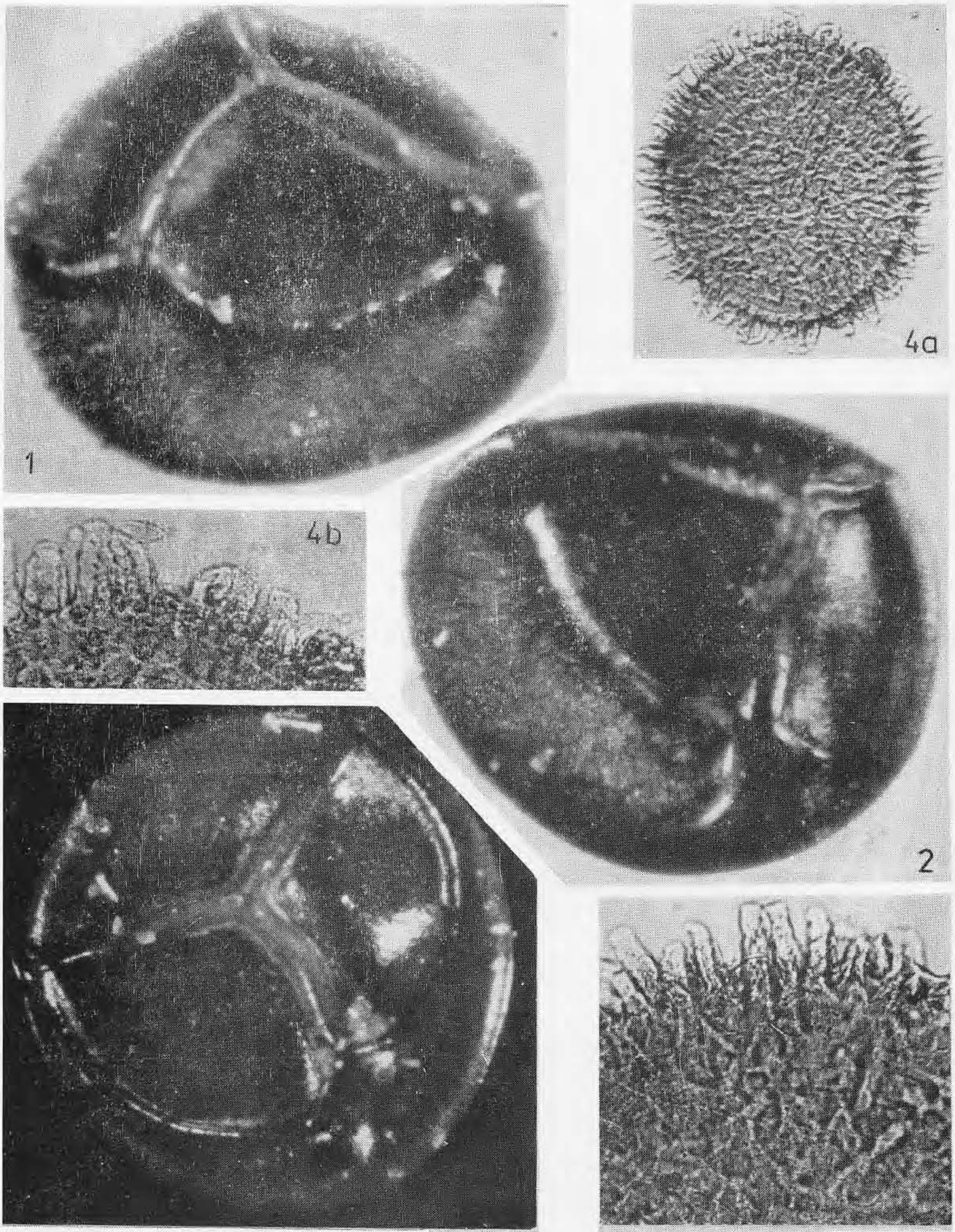
Trileites arcuatus sp.n.

1. Spherules resembling *Reymanella globosa* Marcinkiewicz visible on exine surface, IG 590/4/77 M, × 100
2. IG. 590/5/77 M, × 100
3. Holotype, IG. 590/1/77 M, × 100

Bacutriletes ?onodios (Harris) Marcinkiewicz

4a. In transmitted light, IG. 590/a—28/77 Mp, × 110

4b, c. Fragments of the same specimens, illustrating the shape of appendages, × 300



3 4c

Plate III

Trileites murrayi (Harris) Marcinkiewicz

1. A specimen with single spherules *Reymanella globosa* Marcinkiewicz, IG. 590/7/77 M, × 50
2. A specimen with groupings of spherules *Reymanella globosa* Marcinkiewicz in transmitted light, IG. 590/a—8/77 Mp, × 110
3. A specimen with spherules *Reymanella globosa* Marcinkiewicz present on the whole surface of spore exine, IG. 590/15/77 M, × 75
4. A specimen with single spherules *Reymanella globosa* Marcinkiewicz, IG. 590/8/77 M, × 50
5. A specimen with single spherules *Reymanella globosa* Marcinkiewicz, IG. 590/6/77 M, × 70

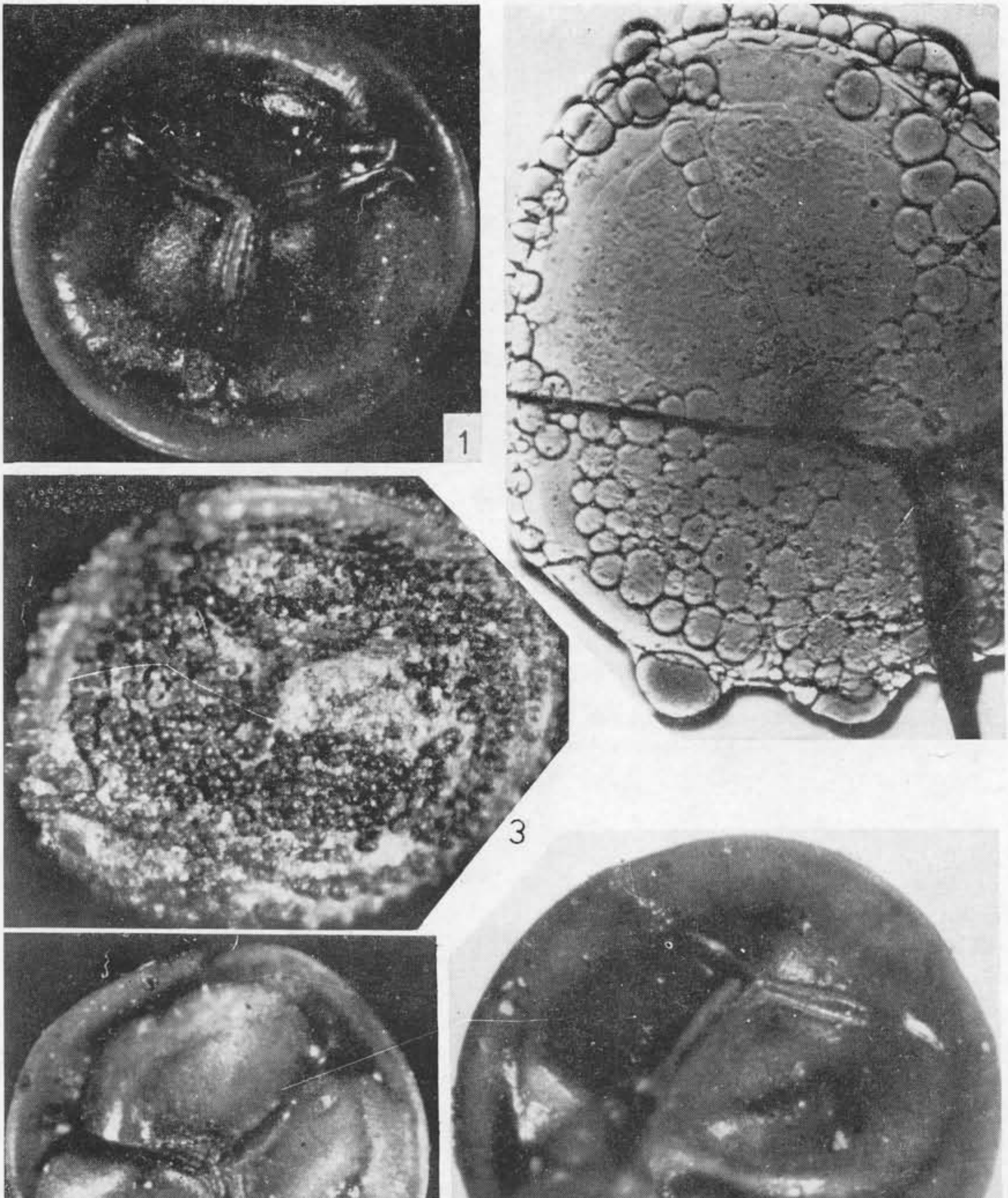

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Plate IV

Trileites murrayi (Harris) Marcinkiewicz

1a. A specimen with numerous spherules *Reymanella globosa* Marcinkiewicz; proximal side, IG. 590/11/77 M, × 75

1b. Distal side of the same specimen

2a. A specimen with numerous spherules *Reymanella globosa* Marcinkiewicz; in transmitted light, IG. 590/a—11/77 Mp, × 70

2b, c. Fragments of the same specimen, showing the attachment of spherules *Reymanella globosa* Marcinkiewicz to the surface of exine; in transmitted light, × 200

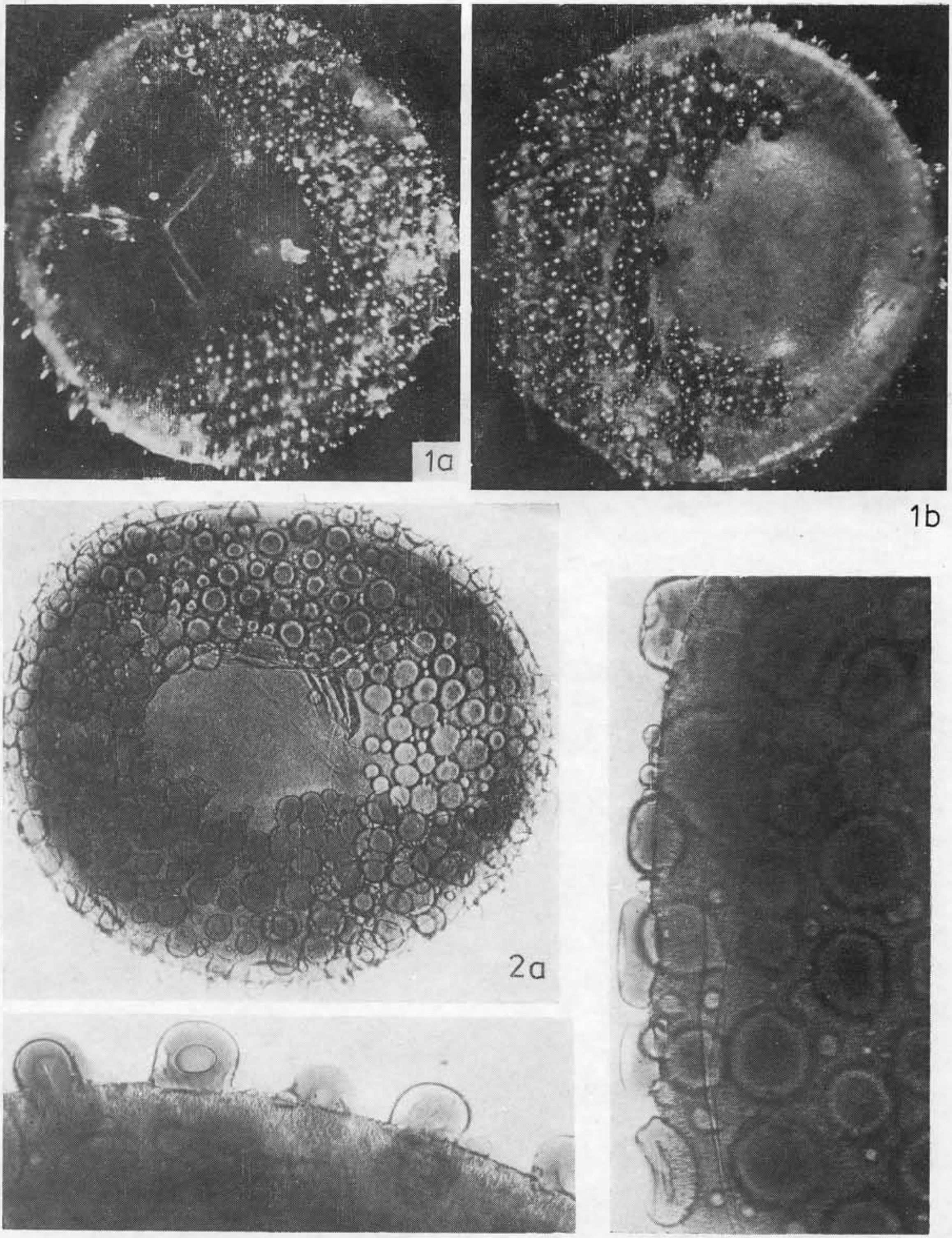

1a
1b
2a
2b
2c

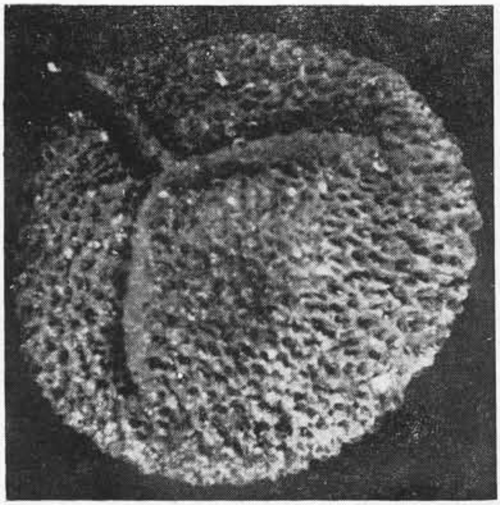
Plate V

Horstisporites casses (Harris) Marcinkiewicz

1. IG. 590/21/77 M, × 40
2. IG. 590/22/77 M, × 40
3. IG. 590/20/77 M, × 100

Horstisporites harrisi (Murray) Potonié

4. IG. 590/28/77 M, × 100
5. IG. 590/26/77 M, × 100



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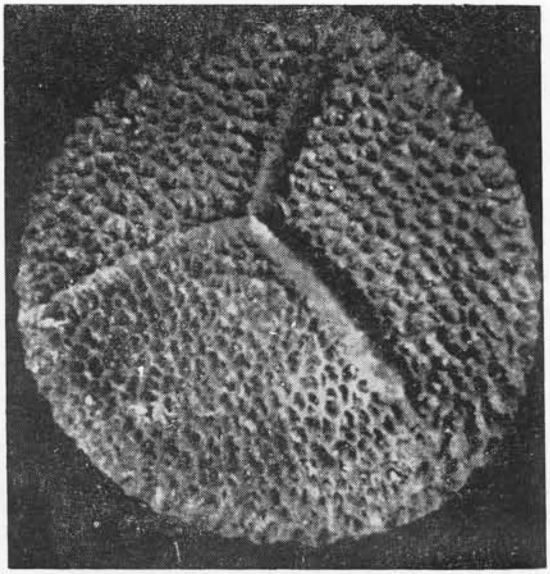

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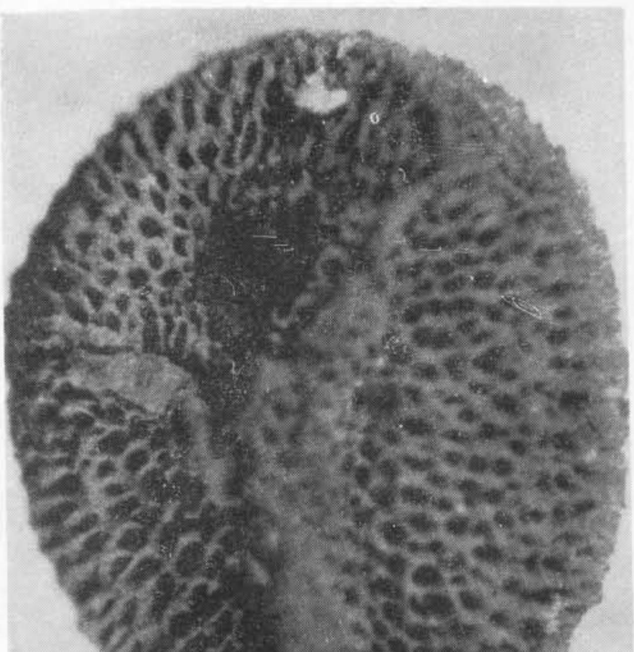

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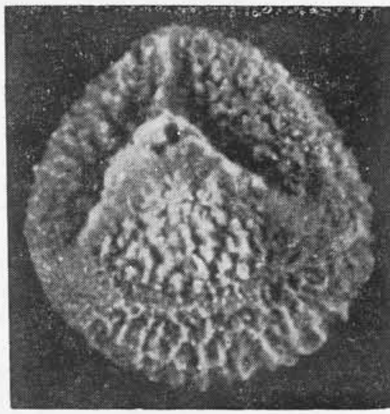


4

5

Plate VI

Horstisporites casses (Harris) Marcinkiewicz

1. IG. 590/24/77 M, × 40
2. IG. 590/23/77 M, × 40

Horstisporites harrisi (Murray) Potonié

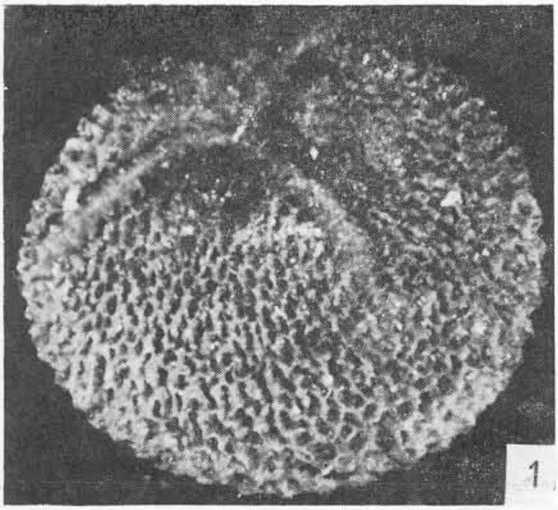
4. IG. 590/25/77 M, × 100
3. IG. 590/27/77 M, × 100

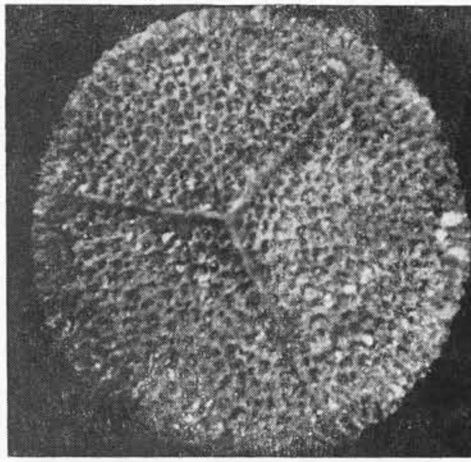
Horstisporites kendalli (Harris) Marcinkiewicz

5a. Proximal side, IG. 590/19/77 M, × 100
5b. Distal side of the same specimen

Erlansonisporites sparassis (Murray) Potonié

6. IG. 590/37/77 M, × 100





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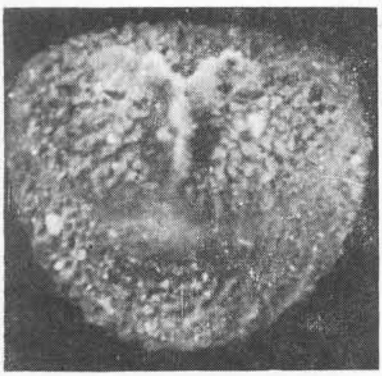

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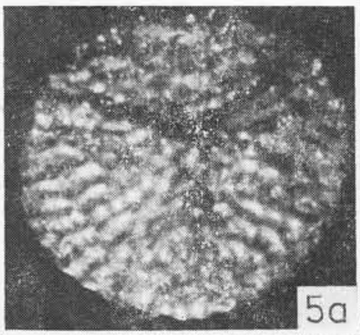

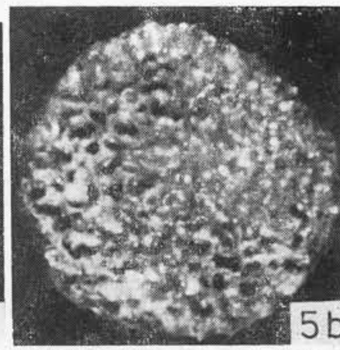

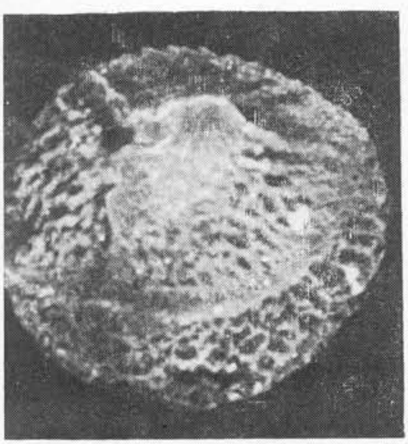

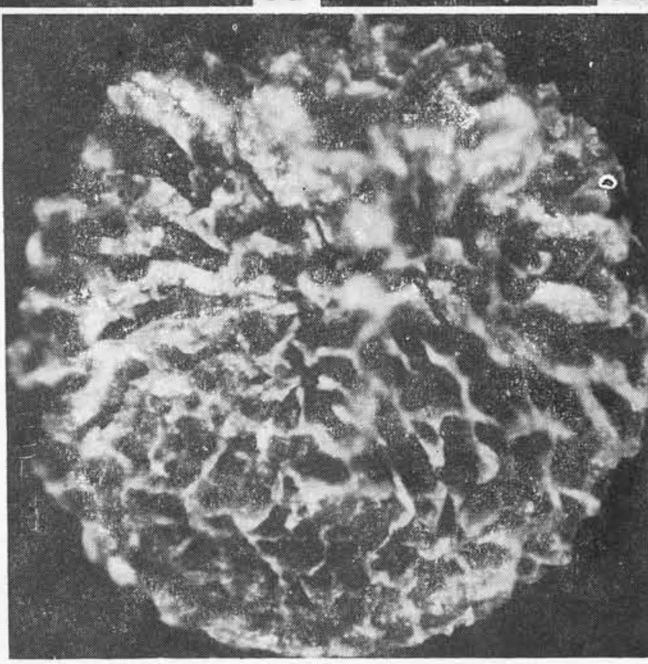

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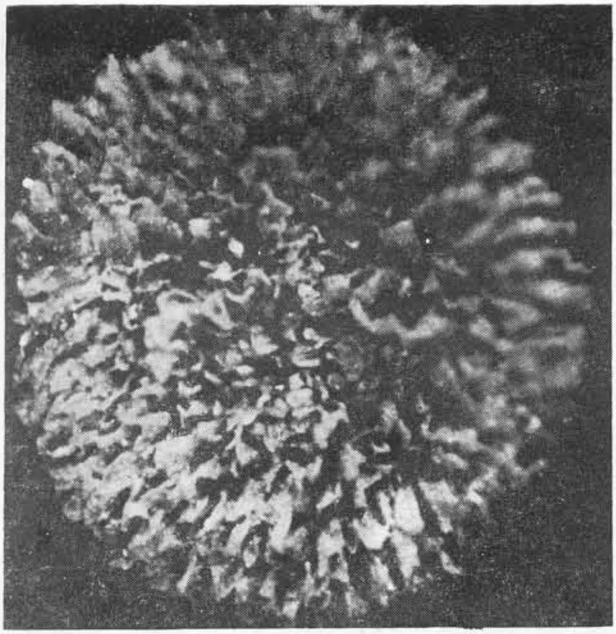
Plate VII

Erlansonisporites sparassis (Murray) Potonié

1a. Proximal side, IG. 590/30/77M, × 100
1b. Distal side of the same specimen
2. IG. 590/32/77M, × 100
3. IG. 590/33/77M, × 100
4. IG. 590/31/77M, × 100

Plate VII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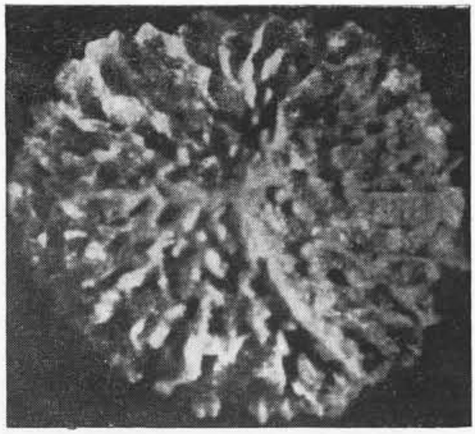
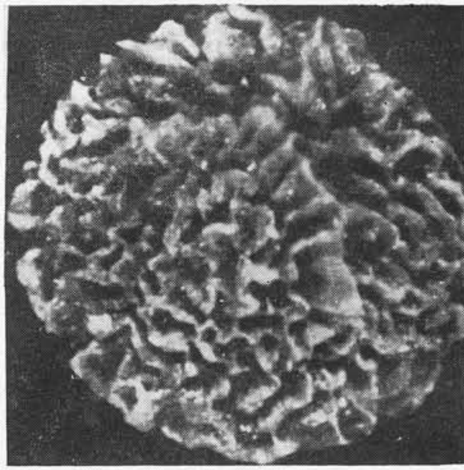

2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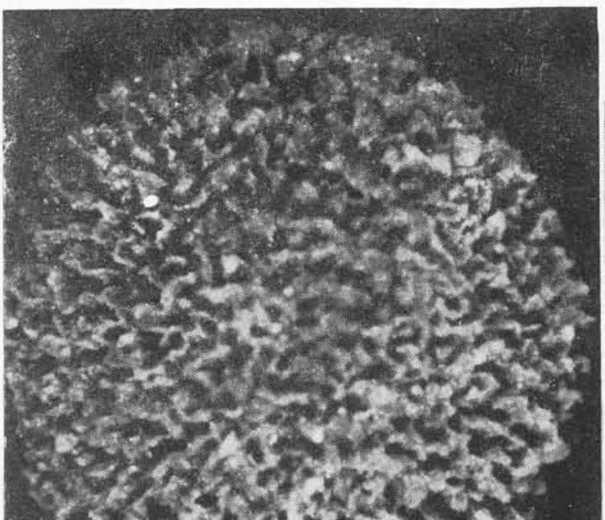
1b

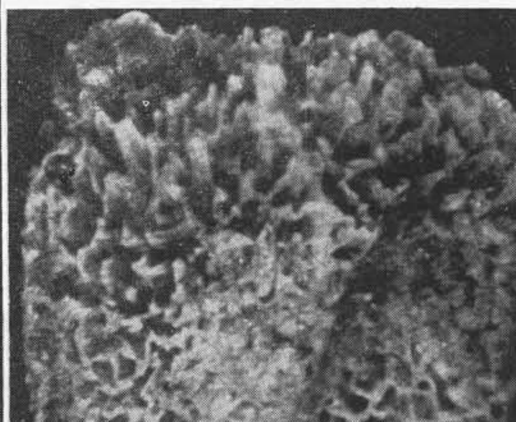
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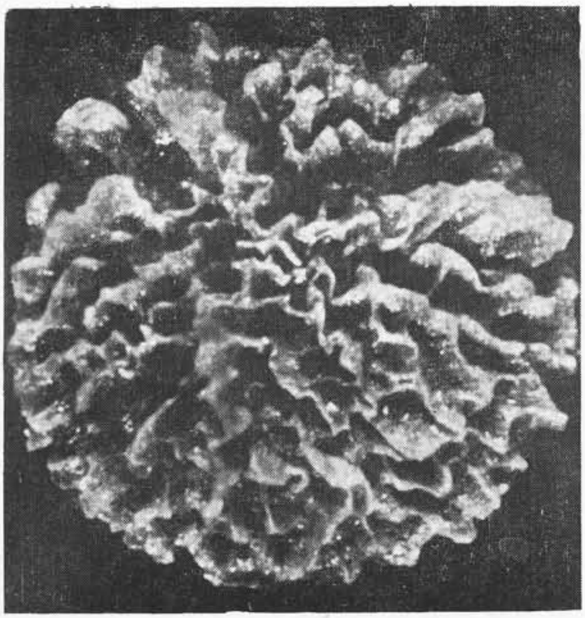
Plate VIII

Erlansonisporites sparassis (Murray) Potonié

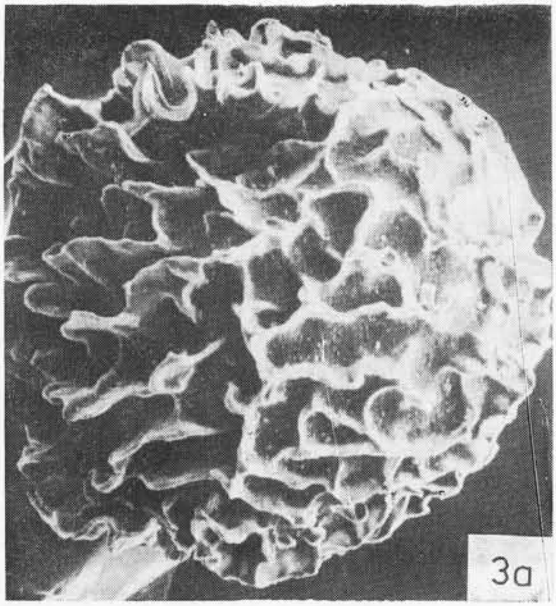
1. IG. 590/34/77 M, × 100
2. IG. 590/38/77 M, × 100

3a. Scanning electron micrograph, × 75

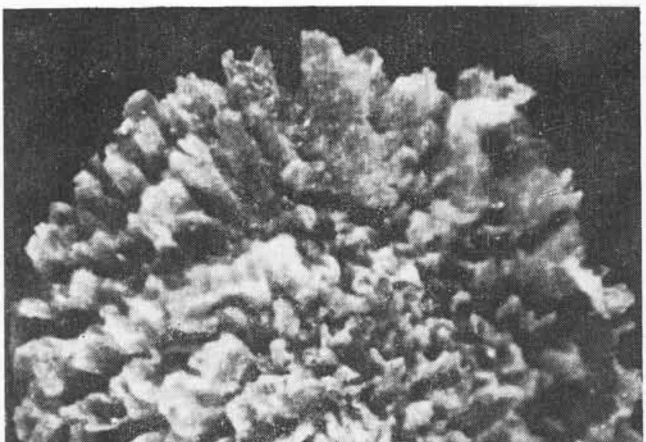
3b. A fragment of the same specimen, showing the sculpturing of the spore; scanning electron micrograph, × 150



1



3a



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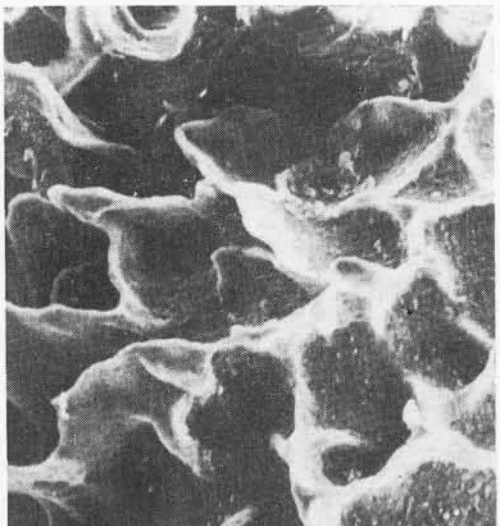


3b

Plate IX

Erlansonisporites sparassis (Murray) Potonié

1. In transmitted light, IG. 590/a—19/77 Mp, × 70
2. In transmitted light, IG. 590/a—20/77 Mp, × 110
3. *Horstisporites harrisi* (Murray) Potonié, IG. 590/29/77 M, × 100

4a. In transmitted light, IG. 590/a—18/77 Mp, × 75

4b. A fragment of the same specimen, showing the sculpture of the spore in transmitted light, × 300

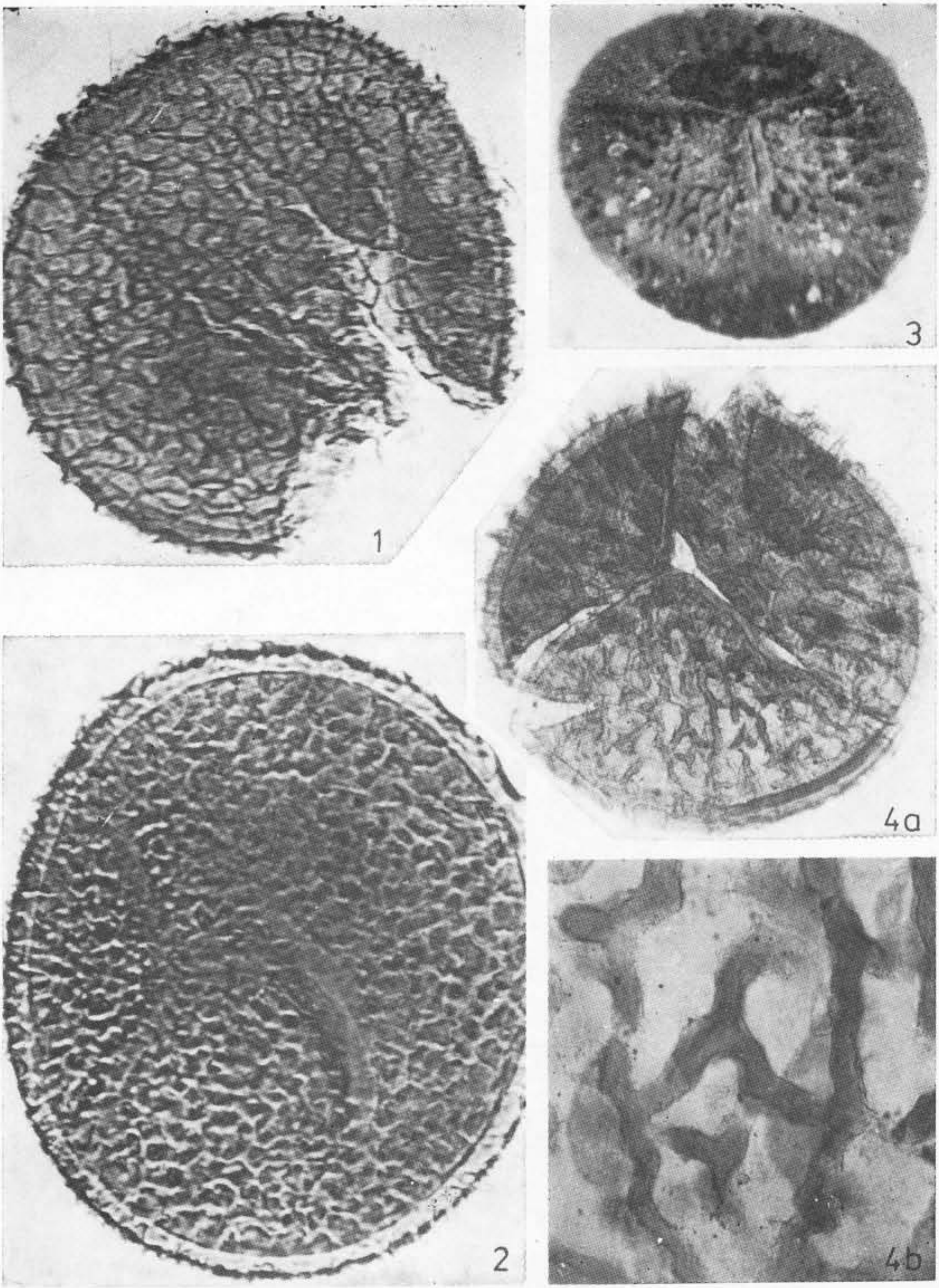


Plate X

Erlansonisporites sparassis (Murray) Potonié

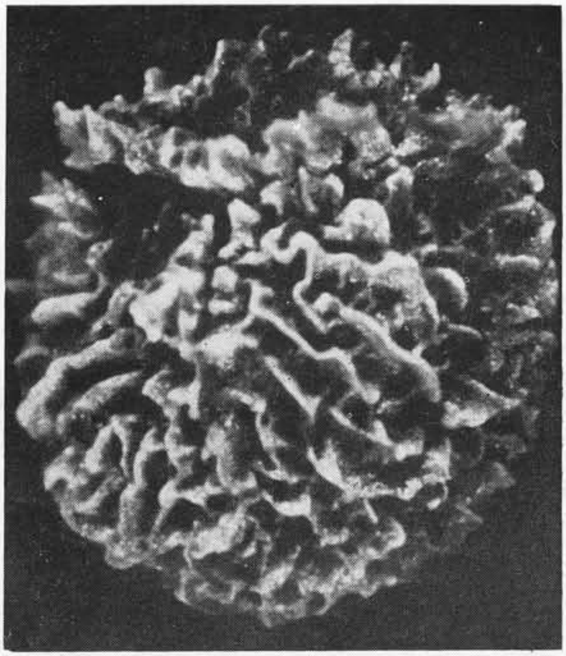
1a. A burst specimen, in transmitted light, IG. 590/a—22/77 Mp, × 75

1b. A fragment of the same specimen, showing tongue-shaped appendages, in transmitted light, × 300

2. IG. 590/36/77 M, × 100

3. IG. 590/35/77 M, × 100

1a



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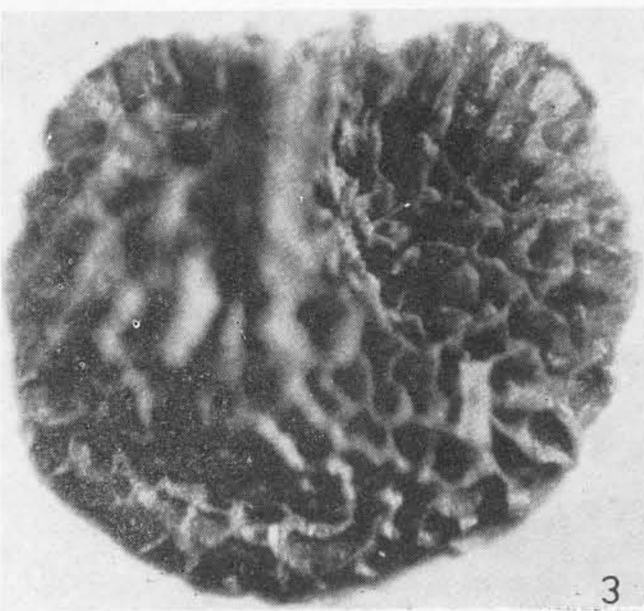

3

1b

Plate XI

Erlansonisporites cerebratus n.sp.

1. IG. 590/39/77 M, × 100
2. Holotype, IG. 590/41/77 M, × 100
3. Lost specimen, × 100
5. In transmitted light, IG. 590/a—24/77 Mp, × 110

Horstisporites harrisi (Murray) Potonié

4. In transmitted light, IG. 590/a—12/77 Mp, × 110

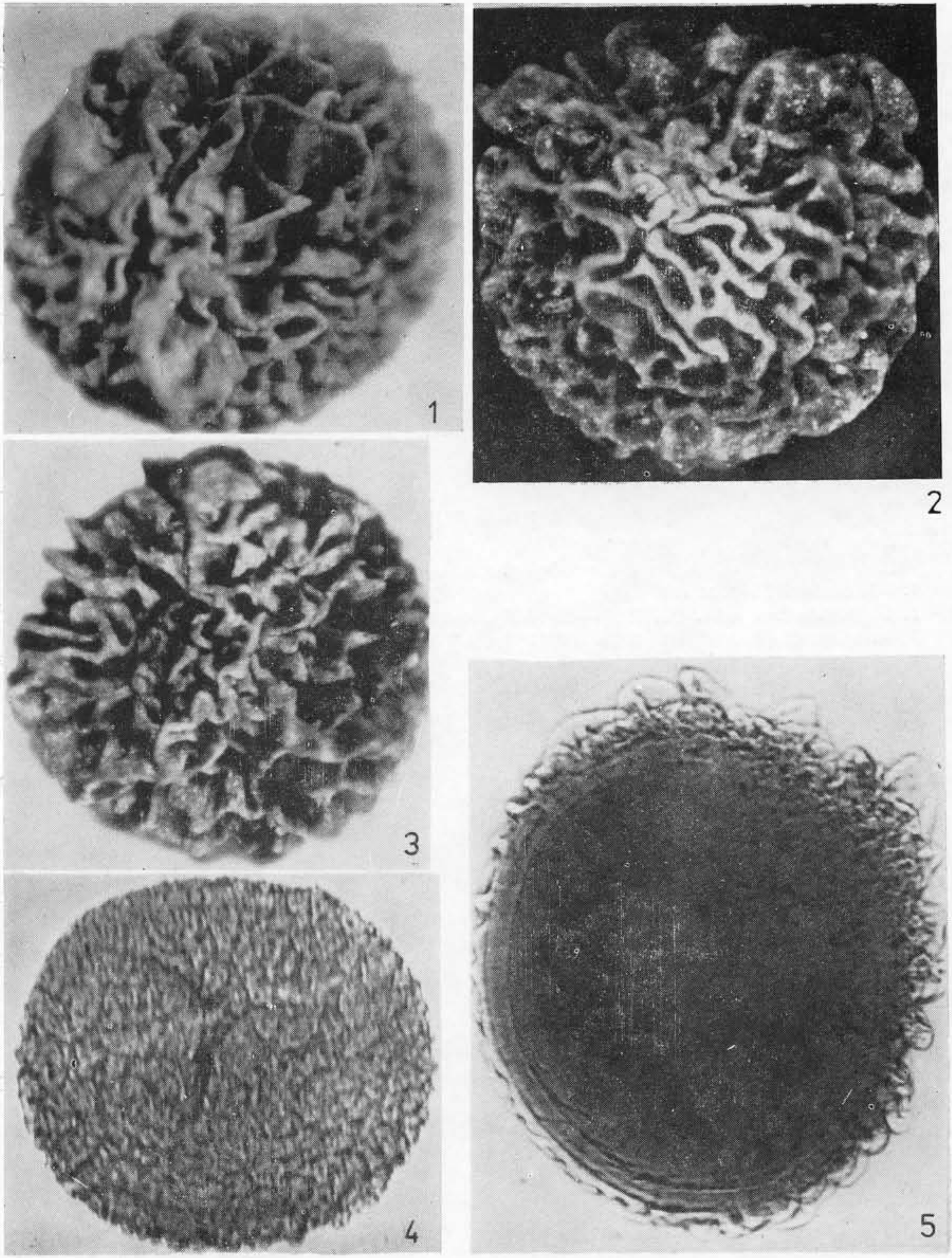
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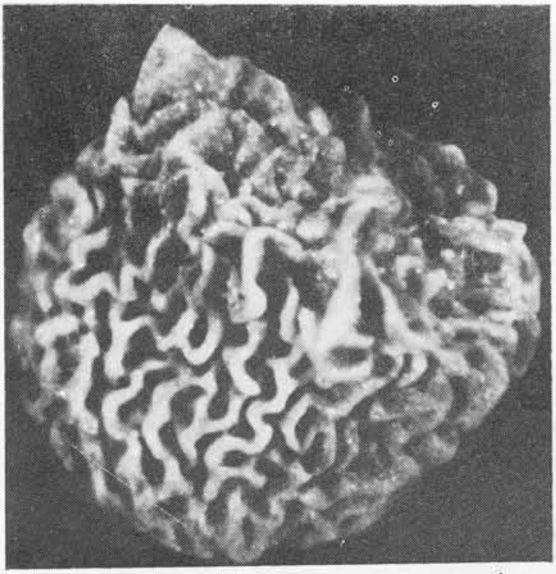
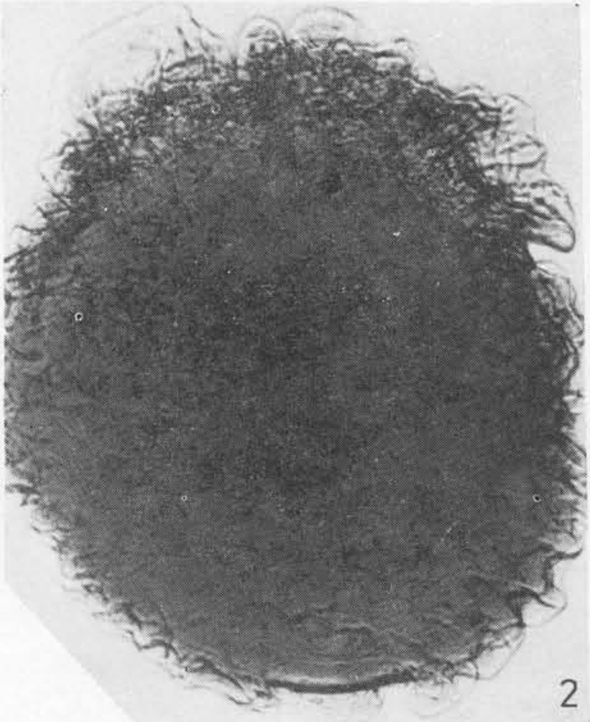
Plate XII

Erlansonisporites cerebratus n.sp.

1. IG. 590/40/77 Mp, × 100
2. In transmitted light, IG. 590/a—23/77 Mp, × 110
3. In transmitted light, IG. 590/a—26/77 Mp, × 110
4. IG. 590/42/77 M, × 100



1



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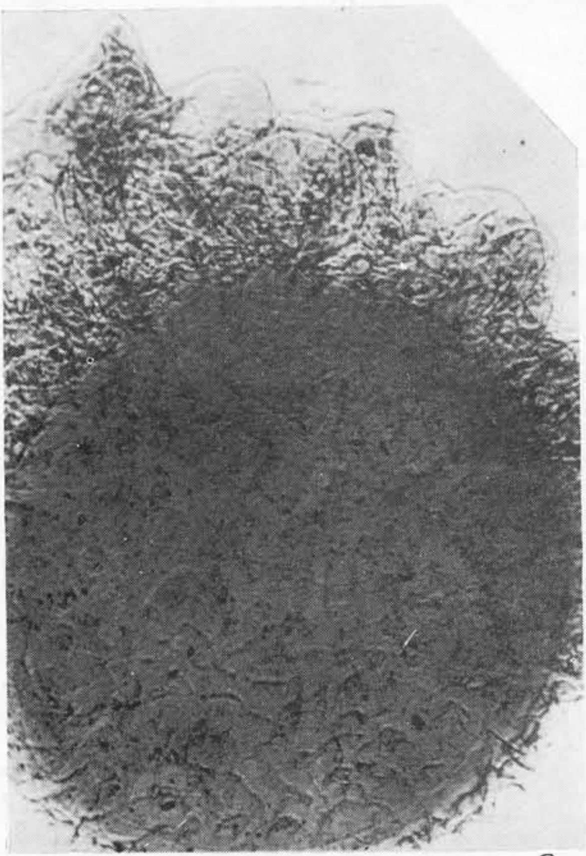

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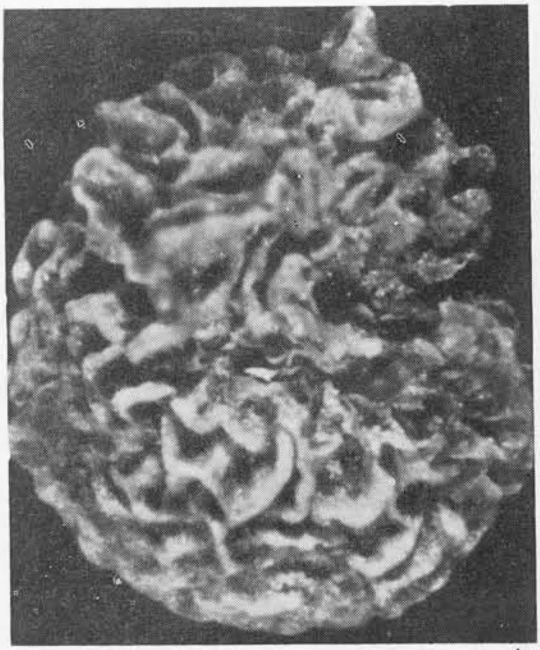

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Plate XIII

Paxillitriletes phyllicus (Murray) Hall et Nicolson

1. IG. 590/48/77 M, × 100
2. IG. 590/46/77 M, × 100
3. IG. 590/43/77 M, × 100
4. In transmitted light, IG. 590/a—31/77 Mp, × 200
5. IG. 590/49/77 M, × 100
6. IG. 590/44/77 M, × 100
7. IG. 590/45/77 M, × 100
8. IG. 590/47/77 M, × 100
9. In transmitted light, IG. 590/a—30/77 Mp, × 200
10. *Setosisporites hirsutus* (Loose) Ibrahim
    IG. 590/50/77 M, × 100

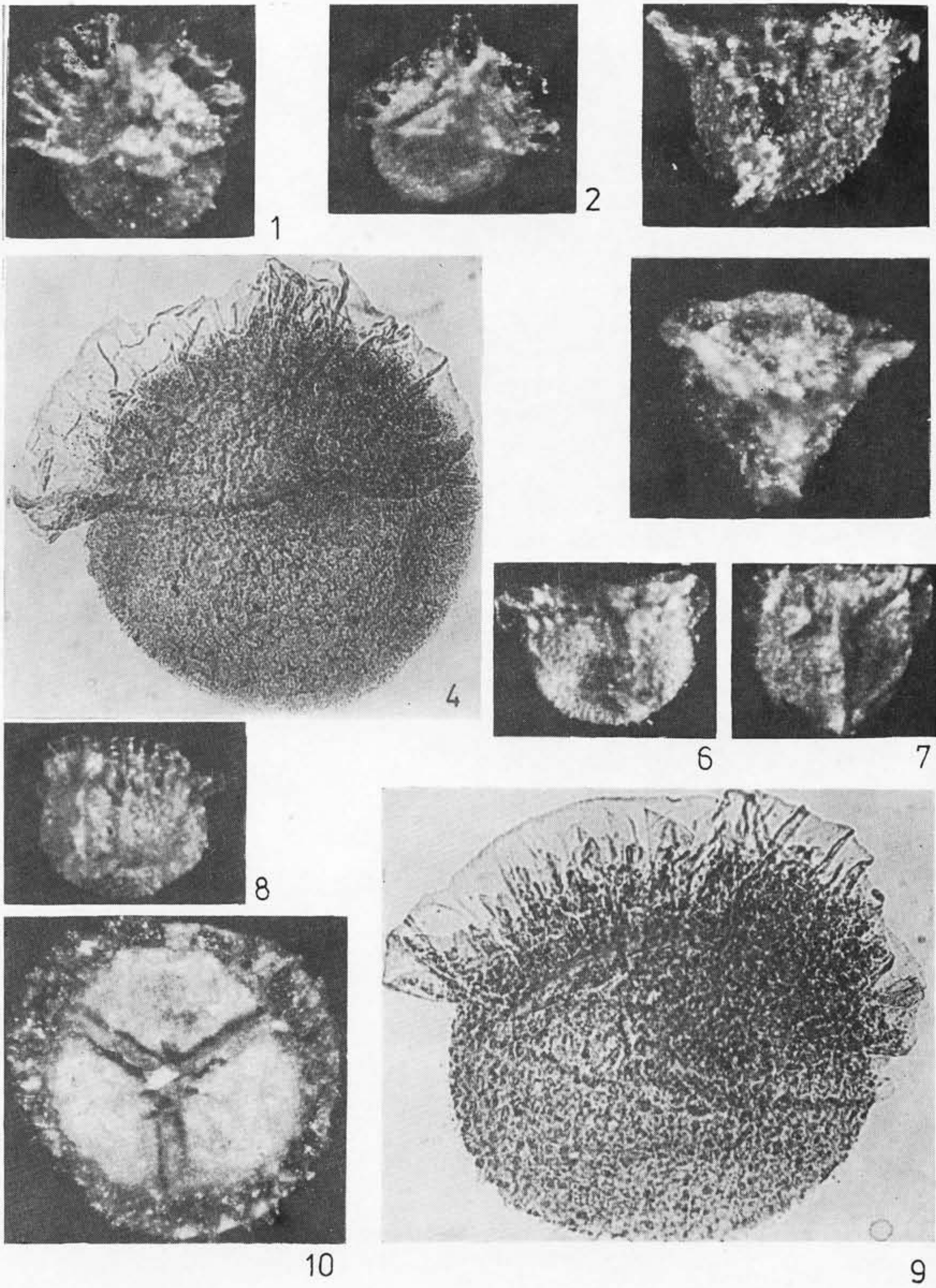
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Plate XIV

Paxillitriletes phyllicus (Murray) Hall et Nicolson

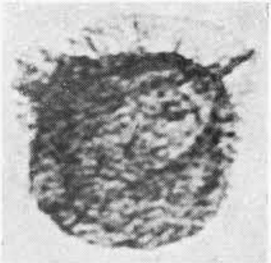
1a. In transmitted light, IG. 590/a—32/77 Mp, × 100, Mechowo IG 1 borehole, depth 155,8 m

1b. In transmitted light, IG. the same specimen, × 200

2. In transmitted light, IG. 590/a—33/77 Mp, × 200, Mechowo IG 1 borehole, depth 155,8 m

3. In transmitted light, IG. 590/a—34/77 Mp, × 200, Mechowo IG 1 borehole, depth 155,8 m

4. *Dictyothylakos* sp., × 50



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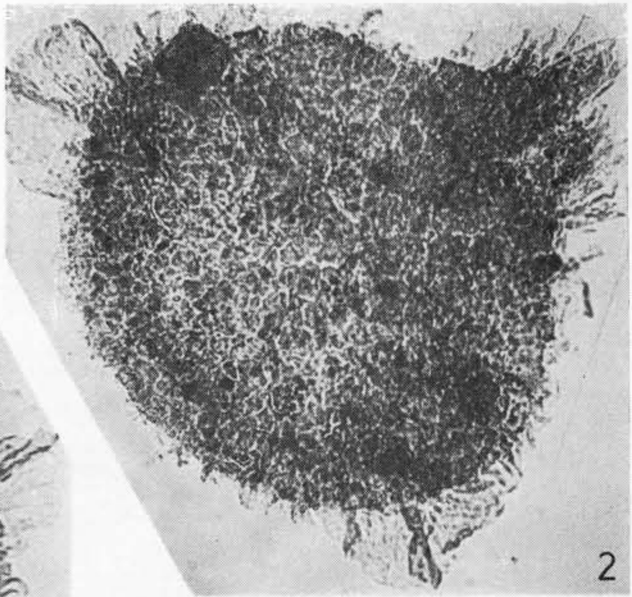

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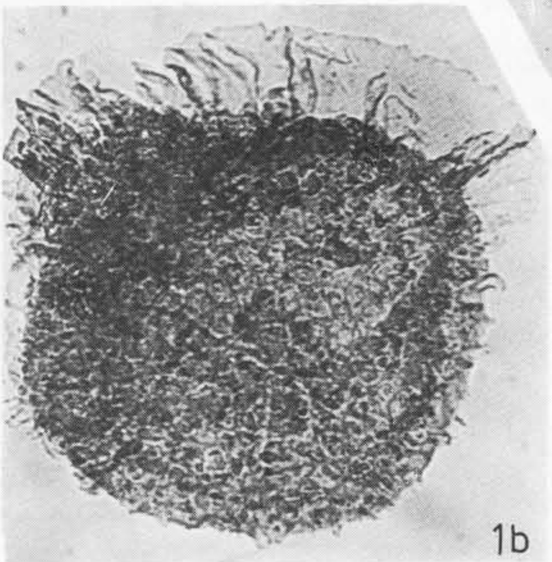
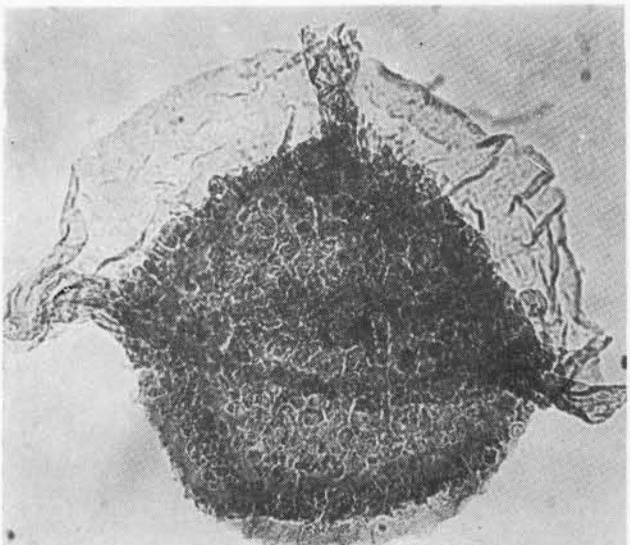


1b



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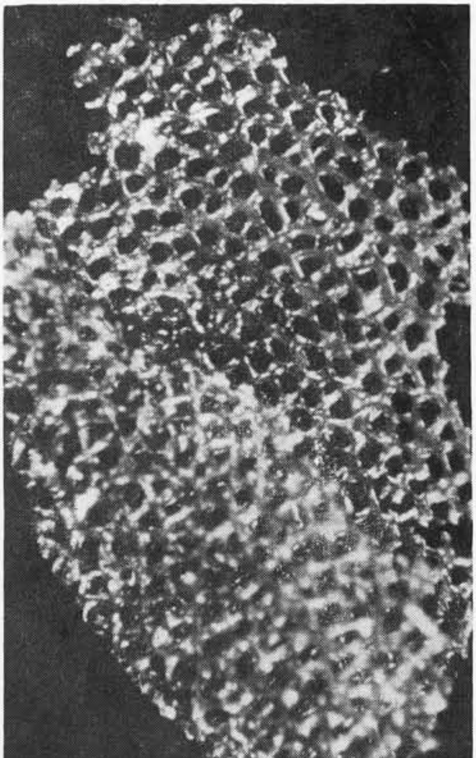

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