A C T A P A L A E O N T O L O G I C A P O L O N I C A

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MEGASPORES OF POLISH BUNTERSANDSTEIN AND THEIR STATIGRAPHICAL SIGNIFICANCE

Abstract. — The results of investigations of the biostratigraphy of Polish Bunter sandstein, on the base of megaspores, are presented. Samples were taken from four borings, three in the North-East and one in Central Poland. 39 megaspore species belonging to 15 genera are described. Of these, 29 species and one genus are new. The aboundance and variability of megaspores in vertical profile enabled the author to distinguish three index megaspore assemblages (I, II, III). A new stratigraphic and palaeogeographic interpretation of Bunter, based on megaspores and lithological development, is given.

INTRODUCTION

The present paper is a first attempt at investigating the biostratigraphy and corellation of facially different Lower Triassic sediments, on the base of megaspores. The examined material, made available by the Geological Institute, consisted of samples from three borings in NE Poland: Nidzica IG-I, Olszyny IG-1 and Pasłęk IG-1 and one in Central Poland: Boża Wola IG-I (in the Nida basin).

Out of the 39 described species, belonging to 15 genera, one genus and 29 species are acknowledged as new. Three index megaspore assemblages (I, II, III) were distinguished. Assemblage I is characteristic for Indus (Upper-oolitic beds), II — for Olenekian, III belongs probably to Anisian.

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The described megaspore collection is housed in the Institute of Geology, Warsaw University.

MATERIAL AND METHODS OF INVESTIGATION

In all the examined borings, Bunter is usually developed as clay-mudstone or sandy sediments. Carbonate sediments are less developed while conglomerates are very scarce.

Mainly clay and mudstone samples were taken for megaspore examination. Samples from sandy intercalations were examined only when they contained rich plant debris. Grains of pollen and spore occur mostly in dark, gray or greeny rocks, being usually absent in red ones. Samples were from 1/2 to 3 kg in weight, on an average 1—2, and were taken in a continuous profile, as intercalations with rich megaspore assemblages can pass into spore free rock without changing their macroscopic appearance. Samples were dissolved in HCl, placed on a sieve and washed in water to separate particles under 0,1 mm, than dried. Next they were treated with 1:3 solution of HF for 2—3 days. Samples should be treated with HF only after the $CaCO_3$ has been completely eliminated, to prevent turbulant reaction. The samples were then decanted, treated with 10% HCl for one to separate the silica and fluorosilicates, washed with water several times, once more decanted and put through a 0.1 mm sieve. Such maceration, while enriching the organic part of the samples, eliminates, to the maximum extent, the mineral part. Megaspores were collected wet and brightened with Schulze oxiditing solution (HNO_3+KClO_3). Described megaspores were usually examined dry, in reflected light. Specimens with thin membrane were also examined in glicerogelatine preparations in transmitted light.

The megaspore systematics in this paper is based on the morphographical system of Potonié (1956).

REVIEW OF INVESTIGATIONS ON MEZOZOIC MEGASPORES

One of the first papers to be published on Triassic megaspores was that of Fitting (1907). This author described megaspores from Bunter sediments near Halle (Germany), considering them to belong to lycopod of the genus *Pleuromeia*, since only sporophils of this plant were found in the sediment. Mägdefrau (1931) presented schematic drawings of megaspores belonging to *Pleuromeia sternbergi* (Muenster) Corda. Nejburg (1960)

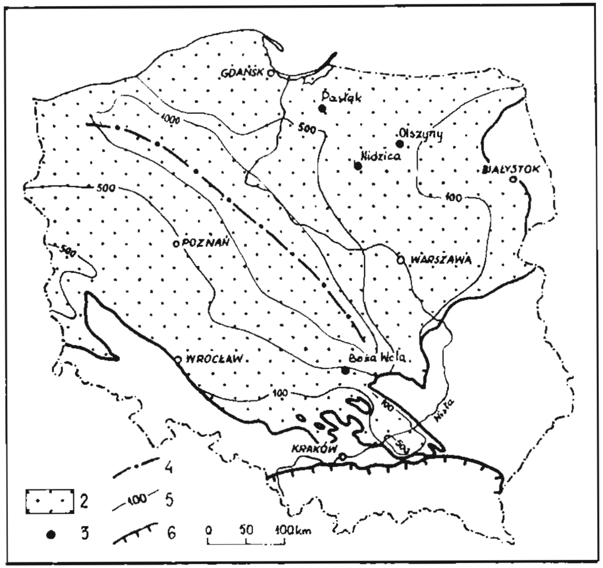


Fig. 1

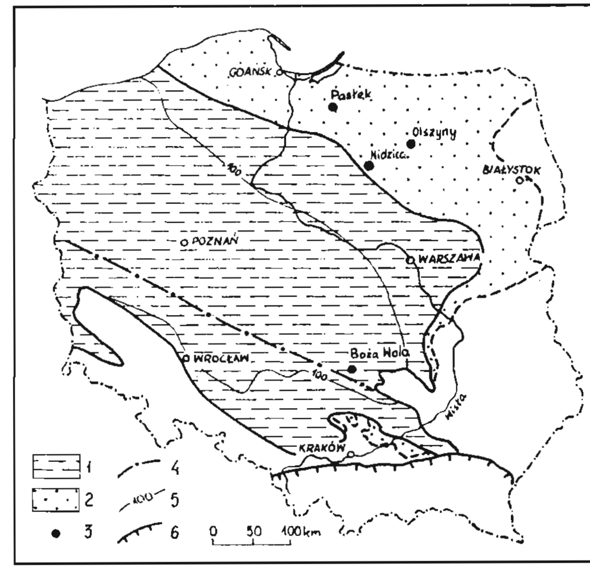


Fig. 2

Figs 1, 2. — Extension of Lower Triassic formations in Beyond-Carpathian Poland (after Senkowiczowa and Szyperko-Śliwczyńska, 1972 with introduced changes). *1* extension of Röt formations (Olenekian), *2* extension of formations of the boreal megacyclothem (Indus), *3* investigated borings, *4* axis of the basin, *5* isopachs, *6* northern boundary of the Carpathian overthrust.

described a new species, *Pleuromeia rossica*, from the Lower Triassic of the Russian platform. Besides megaspores belonging to the genus *Pleuromeia*, other Lower Triassic lycopod megaspores, belonging to the genus *Selaginellites* (Lundblad, 1948), were described.

From the Triassic sediments of Salt Range (Punjab) Sitholey (1943) examined plant fragments and magaspore interiors belonging to two species. Pant and Srivasatava (1964) reexamining Sitholey's material described five megaspore species, of these one genus and three species were new.

Dettmann (1961) elaborated megaspores from the Lower Mesozoic of Tasmania and South Australia. In the Tasmanian assemblage the author differentiated seven species, six of these being presented as new. On the base of one index species, *Banksisporites pinguis* (Harris) Dett.=/*Trileites pinguis* (Harris) Potonié/.Dettmann suggested Rhaetic age for the Tasmanian sediments. However, in the present author's opinion the forms described by Dettmann as *Banksisporites pinguis* (Harris) Dett. belong to a different species, described in the present paper as *Trileites vulgaris* n.sp. characteristic for Lower Triassic. So it is possible the Tasmanian assemblage is of the Lower Triassic age.

Middle Triassic megaspores have not been described till now. 17 megaspore species from the Lower and Middle Keuper of Germany were examined by Reinhardt, 1963; Reinhardt & Fricke, 1969; Kozur, 1971; Kannegieser & Kozur, 1972. Much more information is available on megaspores of the highest Triassic i.e. Rhaetic and Jurassic. In 1908 Nathorst prepared and described megaspores from Liassic strobilus from Scania. Great credit is due to Harris (1926, 1935) for examining Rhaetic and Liassic megaspores from E Greenland, and (1961) Middle Jurassic flora and megaspores from Yorkshire. Contemporanely with Harris, Rhaetic and Liassic megaspores were being studied by another investigator, Wicher (1938, 1939, 1951) who stated their stratigraphic importance for the Rhaetic and Liassic of NW Germany. Similar papers for the Franconian region were presented by Jung (1958, 1960), and for the Rhaetian and Liassic of Sweden by Lundblad (1950, 1956). Jurassic megaspores from the Middle Jurassic of England were described by Murray (1939) and Kendall (1942).

Among more recent authors one should mention Bogdashova (1969), who examined Jurassic megaspores from the Siberian Platform describing some new species. Gry (1969) described Jurassic megaspores from Bornholm and Bartelsen (1970) — Rhaetic-Liassic magaspores from Denmark. The papers of Marcinkiewicz (1957, 1960, 1962, 1969, 1971) and Znosko (1955) are valuable contributions to our knowledge of Polish Liassic megaspores and their use for stratigraphy.

Among Cretaceous megaspores the best known are these from Lower Cretaceous. English Weald megaspores were described by Dijkstra (1951), Hughes (1955, 1958) and Batten (1969). Australian — by Cookson and Detmann (1958). Mädler (1955) examined forms from NW Germany, and Dijkstra (1959) — from Holland.

Miner (1932), Dijkstra (1949), Vangerow (1954), Hall (1963), Hall & Peacke (1968) all described Upper Cretaceous megaspores.

MEGASPORES OF THE BUNTERSANDSTEIN OF POLAND

The Lower Triassic megaspores described in this work are very interesting not only as indices in stratigraphy but also as the oldest representatives of Mesophytic megaspores described from Europe.

The lack of Permian megaspores in Europe (the existing elaborations of these megaspores concern only the area of Gondwana) do not allow any comparison with the flora which preceed directly the Lower Triassic one. The comparison of the megaspores of the Buntersandstein with those described in the Keuper and Lower Jurassic allows the statement that the megaspores of the Bunter have a distinctly Mesophytic character. Excepting the described new genus *Pusulosporites* all the genera of megaspores described in the Bunter are known in the younger Mesozoic formations.

As concerns the megaspores described by the author, they represent mostly new species. What ought to be emphasized is the broad geographic extension of following Lower Triassic species: *Trileites vulgaris* n.sp., *Trileites sinuosus* (Dett.) n.comb., *Horstisporites microlumenus* Dett., *Hughesisporites variabilis* Dett., common with the area of Tasmania (Dettmann, 1961).

Four described in this work species of megaspores: *Dijkstraisporites beutleri* Reinh., *Narkisporites harrisi* (Reinh. & Fricke) Kozur, *Tenellisporites* cf. *marcinkiewiczae* Reinh. & Fricke and *Echitriletes multispinosus* n.sp. occur also in the formations of Lower and Middle Keuper in Germany (Reinhardt, 1963; Reinhardt & Fricke, 1969; Kozur, 1971; Kennegieser & Kozur, 1972) and in Poland.

SHORT CHARACTERISTIC OF THE MEGASPORE ASSEMBLAGES

In the investigated sediments of the Bunter, the author stated an abundant occurrence of megaspores in beds separated as Upper-oolitic Beds of the boreal megacyclothem, and in the lower part of the non differentiated formations of the meridional megacyclothem (Olenekian and probably Lower Anisian). A detailed analysis of megaspores demonstrated that most megaspores have a short vertical extension. Basing upon this observation several megaspore assemblages of various specific composition were differentiated, and designated with provisional marks: I, II, III. The I megaspore assemblage is characteristic for the Upper-oolitic Beds (Indus), the II for the Olenekian, the III belongs probably already to the Anisian.

Assemblage 1

The assemblage in question is composed of 17 species, the occurrence of which depends upon the lithologic character of the sediments. The occurrence in boring of North-Eastern Poland (Nidzica IG-1 and Olszyny IG-1) of interlayered oolitic beds which register the marine influences and argillaceous intercalations with megaspores which reflect the lacustrine conditions, proves that this complex was deposited in a paralic environment. In the boring of Central Poland (Boża Wola IG-1) the oolitic intercalations do not occur and here the argillaceous siltstones correspond to the oolitic beds in question. The occurrence of carbonized plant detritus in these sediments and sometimes very abundant and well preserved megaspores may prove their limnic provenance. Different megaspore species occur in the Upper-oolitic Beds on the areas of North-Eastern Poland and Central Poland. On the area of North-Eastern Poland in the assemblage of megaspores in question, 14 megaspore species occur (Table 2) which are mostly small and have a thin exine. The most abundant are here: *Trileites polonicus* n.sp., *Trileites vulgaris* n.sp., and *Pusulosporites marginatus* n.sp. As sporadic species occur: *Trileites sinuosus* (Dett.) n.comb., *Pusulosporites crassus* n.sp., *Bacutriletes globosus* n.sp., *Horstisporites heteroreticulatus* n.sp., *Horstisporites spinosus* n.sp. *Horstisporites elegans* n.sp., *Erlansonisporites* sp. and *Triletes* sp.

In the boring of Central Poland the megaspopore assemblage in question is less differentiated and represented by 7 species (Table 2). These megaspores are mostly large and their exine is much thicker than in megaspores of North-Eastern Poland. Only 3 species are common in both areas: *Trileites vulgaris* n.sp., *Pusulosporites inflatus* n.sp. and *Pusulosporites marginatus* n.sp. In the boring in question occur abundantly: *Trileites vulgaris* n.sp., *Pusulosporites populosus* n.sp., *Echitriletes echinatus* n.sp. and *Hughesisporites variabilis* Dett. Sporadically occur: *Pusulosporites marginatus* n.sp.

On the area of North-Eastern Poland as well as in the Central Poland the megaspores are best developed and occur most abundantly in the higher part of the Upper-oolitic Beds (see Table 5). In the lower parts of these beds the megaspores are mostly smaller and not so well preserved. A very characteristic feature of this assemblage is that no species passes higher towards the assemblage II. This allows an exact and precise defining of the upper boundary of the assemblage I.

Assemblage II

The megaspores belonging to this assemblage were stated in the uppermost part of the Röt in the Central Poland (Boża Wola IG-1) and in the base of the inland formations in the borings of North-Eastern Poland (Nidzica IG-1, Olszyny IG-1, Pasłęk IG-1), which sediments were assigned till now to the Middle Bunter (Szyperko-Śliwczyńska 1961, 1962, 1964, 1967).

The assemblage discussed here is characterized by occurrence of 14 new species, 10 of which occur only in this assemblage, and 4 pass higher towards the assemblage III (Table 1). The most abundant are: *Trileites validus* n.sp., *Maexisporites pyramidalis* n.sp. Sporadically occur *Macrosporites makowskii* n.sp. Three species: *Maexisporites rotundus* n.sp., *Bacutriletes asaphus* n.sp. and *Aneuletes rotundus* n.sp. are common in the investigated material. It ought to be emphasized that differently as the megaspores from North-Eastern Poland which show mostly a high degree of destruction (which is probably a result of water transportation) the specimens occurring in the Röt in Central Poland are excellently preserved and occur abundantly. One may suppose that they occur in situ.

Among the megaspores of the Röt assemblage in the boring Boża Wola IG-1 a special attention deserves *Trileites validus* n.sp. which occurs exclusively in this boring. The lack of this megaspore on the area of North-Eastern Poland and abundant occurrence exclusively in the Röt formations may prove that the plant producing this megaspore grew in the vicinity of the sea.

Assemblage III

The presence of megaspores belonging to this assemblage was stated exclusively in the North-Eastern Poland (Nidzica IG-1, Olszyny IG-1, Pasłęk IG-1). They occur in the younger part of the overmentioned complex of the inland formation.

The assemblage in question is composed of 12 species of megaspores, 8 of which are characteristic only for this assemblage (Table 3), and the following 4 are common with the assemblage II: *Verrutriletes fragilis* n.sp., *Bacutriletes asaphus* n.sp., *Horstisporites microlumenus* Dett. and *Dijkstraisporites beutleri* Reinh.

The most abundant are: *Trileites grandis* n.sp., *Narkisporites insignis* n.sp. and *Echitriletes multispinosus* n.sp. Sporadically occur *Echitriletes*? sp. 1 and *Tenellisporites* cf. *marcinkiewiczae* Reinh. & Fricke.

A special attention deserves the occurrence of such megaspores as: *Tenellisporites* cf. *marcinkiewiczae* Reinh. & Fricke, *Dijkstraisporites beutleri* Reinh., *Narkisporites harrisi* (Reinh. & Fricke) Kozur and *Echitriletes multispinosus* n.sp. The first two species are treated as index fossils for the Lower Keuper of Germany (Reinh. & Fricke, 1969; Kanneg. & Kozur,

Table 1. Extensions of the megaspore species in the formations of the Buntersandstein in borings: Nidzica IG-I, Olszyny IG-I, Pasłęk IG-I and Boża Wola IG-I

T R I A S S I C							Age / Megaspore species
I N D U S					OLE-NEKIAN	ANISIAN?	
B U N T E R							
Sub-oolitic Beds	Lower-oolitic Beds	Inter-oolitic Beds	Upper-oolitic Beds	Supra-oolitic Beds	RÖT		
						—	*Trileites grandis* n.sp.
						—	*Narkisporites brevispinosus* n.sp.
						—	*Narkisporites harrisi* (Reinh. & Fricke) Kozur
						—	*Narkisporites insignis* n.sp.
						—	*Echitriletes gracilis* n.sp.
						—	*Echitriletes multispinosus* n.sp.
						—	*Echitriletes*? sp. 1
					—	—	*Tenellisporites* cf. *marcinkiewiczae* Reinh. & Fricke
					—	—	*Verrutriletes fragilis* n.sp.
					—	—	*Bacutriletes asaphus* n.sp.
					—	—	*Horstisporites microlumenus* Dett.
					—	—	*Dijkstraisporites beutleri* Reinh.
					—		*Trileites levis* n.sp.
					—		*Trileites tenellus* n.sp.
					—		*Trileites validus* n.sp.
					—		*Maexisporites parvus* n.sp.
					—		*Maexisporites pyramidalis* n.sp.
					—		*Maexisporites rotundus* n.sp.
					—		*Bacutriletes insolitus* n.sp.
					—		*Echitriletes*? sp. 2
					—		*Macrosporites makowskii* n.sp.
					—		*Aneuletes rotundus* n.sp.
			—				*Trileites polonicus* n.sp.
			—				*Trileites sinuosus* (Dett.) n. comb.
			—				*Trileites vulgaris* n.sp.
			—				*Pusulosporites crassus* n.gen., n.sp.
			—				*Pusulosporites populosus* n.sp.
			—				*Pusulosporites inflatus* n.sp.
			—				*Pusulosporites marginatus* n.sp.
			—				*Bacutriletes globosus* n.sp.
			—				*Echitriletes echinatus* n.sp.
			—				*Horstisporites heteroreticulatus* n.sp.
			—				*Horstisporites spinosus* n.sp.
			—				*Horstisporites sulcatus* n.sp.
			—				*Horstisporites elegans* n.sp.
			—				*Erlansonisporites* sp.
			—				*Hughesisporites inflatus* n.sp.
			—				*Hughesisporites variabilis* Dett.
			—				*Triletes* sp.
			I		II	III	Megaspore assemblage

Table 2

Occurrence of megaspores in the formations of the Buntersandstein in borings: Nidzica IG-I, Olszyny IG-I, Pasłęk IG-I and Boża Wola IG-I

Locality	Age	Depth (in metres)	*Trileites grandis* n.sp.	*Narkisporites brevispinosus* n.sp.	*Narkisporites harrisi* (Reinh. & Fricke) Kozur	*Narkisporites insignis* n.sp.	*Echitriletes gracilis* n.sp.	*Echitriletes multisponosus* n.sp.	*Echitriletes*? sp. I	*Tenellisporites* cf. *marcinkiewiczae* Reinh. & Fricke	*Verrutriletes fragilis* n.sp.	*Bacutriletes asaphus* n.sp.	*Horstisporites microlumenus* Dett.	*Dijkstraisporites beutleri* Reinh.	*Trileites levis* n.sp.	*Trileites tenellus* n.sp.	*Trileites validus* n.sp.	*Maexisporites parvus* n.sp.	*Maexisporites piramidalis* n.sp.	*Maexisporites rotundus* n.sp.	*Bacutriletes insolitus* n.sp.	*Echitriletes*? sp. 2	*Macrosporites makowskii* n.sp.	*Aneuletes rotundus* n.sp.	*Trileites polonicus* n.sp.	*Trileites sinuosus* (Dett.) n. comb.	*Trileites vulgaris* n.sp.	*Pusulosporites crassus* n.gen., n.sp.	*Pusulosporites populosus* n.sp.	*Pusulosporites inflatus* n.sp.	*Pusulosporites marginatus* n.sp.	*Bacutriletes globosus* n.sp.	*Echitriletes echinatus* n.sp.	*Horstisporites heteroreticulatus* n.sp.	*Horstisporites spinosus* n.sp.	*Horstisporites sulcatus* n.sp.	*Horstisporites elegans* n.sp.	*Erlansonisporites* sp.	*Hughesisporites inflatus* n.sp.	*Hughesisporites variabilis* Dett.	*Triletes* sp.	Megaspore assemblage
Nidzica IG-I, Bunter	Anisian?	1896,5	+			△																																					III
		1898,4												+																													
		1927,5									+																																
		1935,2	△	●	○		▲	▲	+		+	+	▲	+																													
	Olenekian	1940									+	+	+						+																								II
		1943													+																												
		1948									○	+	△		▲	+		▲	○	○	▲			+																			
		1955									+				+			+																									
		1961,5												+	+									+																			
	Indus	2012																							○	+	▲			+	△			+	+	+							I
		2018																							●	+	○	+		▲	○	+		+	+	▲	+	+				+	
		2038																												△													
		2048																									○																
		2051,8																									▲																
		2052																									○																
Olszyny IG-I, Bunter	Anisian?	1345		+			+																																				III
	Olenekian	1355									+	+	+					△	△	+	+			+																			II
	Indus	1410																							●		▲			△	+					+							I
		1425																												+													
		1436																									△																
Pasłęk IG-I, Bunter	Anisian?	1138	+			△				+																																	III
		1145	+			△																																					
	Olenekian	1156											+		+			+						+																			II
		1158										+	+		+			+		+																							
		1163													+				+																								
Boża Wola IG-I, Bunter	Olenekian, Röt	1841										+				●	□					+	+	+																			II
		1842										+		△		●	□			+			+																				
		1842,5															□						+																				
		1843												+			□																										
	Indus, Upper-oolitic Beds	2000																									+						+							+		I
		2002																									○		□	▲			○						○	●		
		2020																									+		△	+			+							+		
		2031,5																											●	▲			▲									
		2041,5																											△	△	+		△									
		2073,5																									△		▲				+									
		2096																									△		+													

+ 1—5 specimens, △ 6—10 specimens, ▲ 11—20 specimens
○ 21—50 specimens, ● 51—100 specimens, □ > 100 specimens

1972). *Narkisporites harrisi* (Reinh. & Fricke) Kozur was described from the Middle Keuper of Germany (Reinh. & Fricke, 1969; Kozur, 1971; Kannegieser & Kozur, 1972). *Echitriletes multispinosus* n.sp. was stated by the author in comparative materials in Lower Keuper formations of Upper Silesia.

The fact that most of the megaspore species of the assemblage in question do not occur lower, but some occur also in the Keuper, allows the conclusion that the assemblage III characterizes a new stage on the development of the Triassic flora and belong perhaps already to the Middle Triassic.

STRATIGRAPHY AND PALAEOGEOGRAPHIC CONCLUSIONS

The Lower Triassic sediments of the Polish-German depression form the great part of the over 3000 m thick complex of Triassic deposits filling up this depression. The largest thickness, exceeding 1000 m, these sediments attain in the central part of the depression, gradually thinning towards its border. Differentiated epeirogenic movements provoked remarkable differences in the facies amidst the sediments of this age, which, in connection with an exceptional scantiness in fossils does not allow to elaborate a uniform stratigraphic scheme. The Lower Triassic sediments are till now best known in Germany, because on this area they are well developed, they outcrop in many localities and were since a long time of interest for many investigators.

BUNTERSANDSTEIN ON THE AREA OF GERMANY

Basing upon changes in the lithologic character of the sediments, the Lower Triassic (Bunter) was divided into the Lower, Middle and Upper one, and the lagunal-marine sediments of the Upper Bunter were called Röt. At the same time a series of local lithostratigraphic schemes were elaborated for different areas of the German trough, as it is presented in the table underneath.

The lack of index-fossils and the uncertainty of lithologic criteria did not allow any detailed correlation of distant profiles. Especially large difficulties concern the comparison of the Lower Triassic profile on the central part of the German trough with the profiles of the marginal zone. The correlation of both areas is further object of discussion (Rusitzka, 1967; Backhaus, 1971).

The oldest link in the complete profile of the Lower Triassic formations of the German trough is represented by brick-coloured argillaceous siltstones (Bröckelschiefer, Übergangsfolge) which rest often in conformity over the Zechstein sediments. A continuous transition of the Permian into the Triassic and the sometimes very similar lithologic character, does not allow to define strictly the position of the boundary between both systems (Boigk, 1957 Rusitzka, 1967). Above these formations there occur on the whole German trough a characteristic complex of interlayered beds of oolitic limestones and argillaceous sediments with intercalations of gypsum and anhydrite. The oolitic layers form two characteristic horizons: the lower one (Unterer Rogenstein) and the upper one (Oberer Rogenstein). The upper oolitic series reposes in many places with a gap in relation to the older substratum. The argillaceous intercalations in the oolitic complex have often grey or greenish color, and the petrographic character of these sediments testifies to a variable environmental conditions: lacustrine, lagunal and marine (Langbein, 1970; Schulze, 1970).

BUNTERSANDSTEIN

Triassic trough of the Rhein (Wurster, 1965)		Trough of Thuringia (Jungwirth; 1969) Langbein 1970)
Upper	Röt Solling-Folge	Röt Solling-Folge
Middle	Spessart-Folge Rhön-Folge Eichsfeld-Folge	Hardegsen-Folge Detfurth-Folge Volpriehausen Folge
Lower	Oberer Rogenstein Unterer Rogenstein Bröckelschiefer	Obere Folge Untere Folge Übergangsfolge

The Middle Buntersandstein was differentiated basing upon a larger share of coarse-grained clastic sediments, and a weaker development of chemical sediments (gypsum and anhydrite) (Boigk, 1957, 1959, 1961; Rusitzka, 1967). Between the Lower and Middle Bunter a continuous sedimentation proceeded, and the lower link of the Lower Bunter namely the Volpriehausen-Folge and Detfurth-Folge contain further oolitic beds (Rusitzka, 1967; Langbein, 1970). Probably these two series form one marine sedimentary cycle with the lower one. This supposition is confirmed by the investigations of Usdowski (1963) who demonstrated that the oolitic limestones of the Bunter were deposited in the littoral marine zone.

In the marine intercalations of the Middle Bunter, especially in the Volpriehausen-Folge occur abundantly *Avicula murchisoni* Gein. (Boigk, 1961; Herrmann, 1964). In the upper part of the Middle Bunter the area of sedimentation sprinks and the sedimentary basin was disrupted into a series of smaller basins (Herrmann, 1964). In these conditions most of the brownish-red sediments of the younger Middle Bunter (Hardegsen-Folge), devoid of oolites, were deposited (Herrmann, 1964).

The oldest link of the Upper Bunter is the Solling-Folge, the sediments of which are characterised by a remarkable variation of facies (Herrmann, 1964). They are transgressing the older sediments of various age, and their petrographic character as well as their environmental conditions are completely different from those of the lower formations (Herrmann, 1964). The upper part of the Upper Bunter is developed as lagunal-marine sediments of the Röt.

THE BUNTERSANDSTEIN ON THE AREA OF POLAND

In Poland as in Germany a threefold division of Lower Triassic was accepted. The Triassic of the area of North-East Poland was subject of investigations of Szyperko-Śliwczyńska (1961, 1962, 1964, 1967) and of Dadlez and Szyperko-Śliwczyńska (1965). The stratigraphy of the Lower Triassic was based by these authors mainly upon the lithological character and also upon the occurrence of ostracods and phyllopods. In three borings (Nidzica IG-1, Olszyny IG-1 and Pasłęk IG-1) Szyperko-Śliwczyńska distinguished amidst the Lower Triassic formations the Lower and Middle Bunter, and in the boring Nidzica IG-1 she supposed the presence of Röt.

The Bunter of the boring Boża Wola IG-1 was elaborated by Jurkiewicz (1965). This author distinguished the upper part of the Bunter with *Myophoria costata* Zenk. as the Röt, and the boundary between the not differentiated older Bunter and the Röt established in the base of the marine sediments.

The analysis of the present author's materials and the study of other profiles of the Triassic of the Polish-German depression, allow to express different stratigraphic and palaeogeographic conclusions. The proposed division of the Bunter and its comparison with the division of German geologists (in a synthetic conception) is presented on Table 3.

Basing upon the lithologic character of the sediments, their colour and also upon the organic remains, the author distinguished in the Bunter and in the Muschelkalk two separate megacyclothems: a boreal one and a meridional one. The formations of the boreal megacyclothem on the Polish-German depression were deposited in paleogeographic and tectonic conditions similar to those in the Zechstein. The deposition of sediments of this cyclothem was depending from the junction of the Polish-German basin with the boreal sea. Inside this cyclothem smaller cyclothems may be distinguished: cylothem Ia and Ib, each of them beginning with sediments of a closed inland basin, and coming to a close with oolitic formations, registering the junction of the Polish-German basin with the boreal sea. The third cyclothem (Ic) is not complete.

The meridional megacyclothem began with a structural reconstruction

Table 3

Proposed division of the Buntersandstein of Poland and its comparison with the German division

TRIASSIC	ANISIAN	Muschelkalk	Megacyclothem meridional			Muschelkalk	
	OLENEKIAN	Röt				Röt Solling-Folge	Oberer Buntsandstein
	INDUS	Bunter	Megacyclothem boreal	Cycl. Ic (incompl.)	Supra-oolitic Beds	Hardegsen-Folge	Mittlerer Buntsandstein
				Cyclothem Ib	Upper-oolitic Beds	Detfurth-Folge Volpriehausen-Folge Oberer Rogenstein	
					Inter-oolitic Beds		Unterer Buntsandstein
				Cyclothem Ia	Lower-oolitic Beds	Unterer Rogenstein	
					Sub-oolitic Beds	Bröckelschiefer	

of the marginal zone of the Polish-German basin. The deposition of sediments of this megacyclothem (Röt and Muschelkalk) depended upon the junction of the Polish-German basin with the Tethys ocean.

THE BOREAL MEGACYCLOTHEM

Cyclothem Ia

1. **Sub-oolitic Beds** — they are most fully developed in these localities where they present a continuation of the Zechstein sedimentation (Pasłęk IG-1). They are mostly composed of mudstones and brick-coloured siltstones with abundant intercalations of gypsum and anhydrite and scanty thin intercalations of limestones. These sediments contain only a few grains of pollen. The lower boundary of the strata in question was determined by the author after Szyperko-Śliwczyńska (1962, 1964).
2. **Lower-oolitic Beds** — they appear as argillaceous siltstones with inter-

calations of oolitic limestones which form the first oolitic horizon in the Lower Triassic. The argillaceous interlayerings are often of a grey and greenish colour. The beds in question contain rather abundant organic remains: scales and teeth of fishes, phyllopods and ostracods, rich assemblages of pollen and rare megaspores.

Cyclothem Ib

1. **Inter-oolitic Beds** — they resemble to the suboolitic Beds in their lithologic character. They are mostly composed of brick-coloured mudstones and siltstones with abundant intercalations of gypsum and anhydryte and they contain also interlayerings of sandstones and limestones. A poor fauna of ostracods and phyllopods is found in these sediments. No plant remains were stated.
2. **Upper-oolitic Beds** — they present a most characteristic link in the boreal megacyclothem. They are composed of interlayered argillaceous deposits and oolitic limestones which form a second horizon in Lower Triassic. In the boring Boża Wola IG-1 these beds are replaced by argillaceous siltstones in which no oolitic intercalations are observed, though these intercalations occur on neighbouring areas (boring Radoszyce, Przedbórz, Wygwizdów), and also in outcrops on the margin of Holy Cross Mountains (Senkowiczowa, 1970). In comparison with older beds of the boreal megacyclothem the Upper-oolitic Beds contain the most abundant organic remains. There occur teeth and scales of fishes, fragments of vertebrate bones and also phyllopods and ostracods. In the youngest oolitic beds of the Bunter in Germany (Volpriehausen-Folge and Detfurth-Folge) which correspond probably to the Upper-oolitic Beds in question, there occur abundantly *Avicula murchisoni* Gein., species known also from the Bunter of the Holy Cross Mountains (Senkowiczowa, 1970) and probably also from the area of the Polish Lowland (an oral communication from Mrs A. Szyperko-Śliwczyńska). The three elaborated borings (Nidzica IG-1, Olszyny IG-1 and Boża Wola IG-1) in the argillaceous formations of the Upper-oolitic Beds, the present author stated the occurrence of very abundant megaspores. Only in one boring Pasłęk IG-1 no megaspores were found in the beds in question.

Cyclothem Ic (incomplete)

Supra-oolitic Beds — they occur in all investigated borings and are rather uniform in their character. The lower boundary of these beds is well marked because in all the investigated borings they begin with sandstones or conglomerates overlaying argillaceous or oolitic sediments of the Upper-oolitic Beds. Higher prevail brick-coloured argillaceous mudstones. Small amounts of phyllopods and ostracods occur in the beds in question. Plant remains are lacking.

THE MERIDIONAL MEGACYCLOTHEM

Investigated was the lower part of this megacyclothem comprising the Röt (Boża Wola IG-1) from Central Poland and the continental sediments from the area of North-Eastern Poland, belonging after Szyperko-Śliwczyńska (1961, 1962, 1964, 1967) to the Middle Bunter (Pasłęk IG-1, Olszyny IG-1) and to the Middle Bunter and Röt (Nidzica IG-1). The sediments belonging to this megacyclothem appear in a very differentiated facies. In the North-Eastern Poland they occur as interlayered complexes of conglomerates, sandstones and argillaceous siltstones. Especially abundant intercalations of conglomerates occur in the lower part of these beds (Table 4, 5). In the beds in question grey and greenish colours prevail and a rich plant detritus occur in form of carbonized plant remains and abundant megaspores. Remains of fauna were not stated. These sediments are overlain by marine formations with fauna of Muschelkalk (Nidzica IG-1, Olszyny IG-1) (Szyperko-Śliwczyńska, 1967) with exception of the boring Pasłęk IG-1 in which the age of the overlaying sediments is problematic. After Szyperko-Śliwczyńska (1967) thesy may belong to the Lower Muschelkalk.

Sediments of this age have a different character in Central Poland. In the boring Boża Wola IG-1 they begin with conglomerates, passing upwards into brown argillaceous sandstones. These formations correspond probably to the sediments widely known in Germany and occurring also in other areas of Poland, namely to the Chirotherian sandstones. The occurrence of *Myophoria costata* Zenk. in similar formations on the area of the fore-Sudetic Monocline (Gajewska, 1964) proves that these formations mark the beginning of the marine cycle of the Röt and Muschelkalk. Higher repose the sediments of Röt developed as dark grey and greenish marls with *Myophoria costata* Zenk. (Jurkiewicz, 1965) and limestones with intercalations of gypsum and anhydrite. In the topmost part of these formations scanty intercalations occur containing a rich plant detritus in form of well preserved imprints of leaves and stalks and very abundant megaspores differentiated as the II megaspore assemblage.

The occurrence of the II megaspore assemblage on the top of the Röt by a continuous transition of this link into the Muschelkalk proves that in the profiles, in wich besides the assemblage II occurs the overlying assemblage III, this part of the sediments corresponds probably to the older Anisian.

A consequent applying of the diastrophic criterion suggests a reckoning of the Muschelkalk to the upper megacyclothem, determined as the meridional one, because the Muschelkalk is a continuation of the marine cycle beginning with the deposition of the Röt. Therefore the upper boundary of the meridional megacyclothem ought to be placed over the youngest marine sediments of the Muschelkalk. The upper boundary of the meridional megacyclothem defined in this manner would in a general aspect correspond to the boundary between the Lower and Upper Triassic, distinguished by means of macrofloristic investigations (Dobruskina, 1970). After Dobruskina the Triassic has in a floristic aspect an expressively twofold character: the flora of the Anisian has an early Triassic character, whereas the flora of the Ladinian is very approached to the Late Triassic flora.

PALAEOGEOGRAPHIC CONCLUSIONS

The investigated formations of the Buntersandstein were deposited in the littoral eastern part of the Polish-German basin, which was formed on the foreground of the Hercynides as result of subsiding movements beginning already before the Zechstein. Bordered on the South with Hercynian massifs of the Vindelician-Beskid continent and on the North with the Baltic continent, this basin was untill the Röt periodically joined in the north-western part with the boreal sea. The marine and lagunal facies of the older Bunter are better developed on the north-western and central part of this depression. In the littoral zone these facies are reduced or pass into continental deposits, often coarse-grained clastic rocks. Only near the close of the Lower Triassic (Röt) the "Hercynian barrier" is broken through on the South, in result of which the Polish-German basin is joined with the Thetis basin.

The uplifting movements which were marked near the close of the Permian produced a disruption of the junction between the Zechstein basin with the boreal sea. In result of the after-Permian tectonic movements the Lower Triassic series of the same age reposes on different stratigraphic elements (from Precambrian untill Zechstein) of the older substratum. However in some depressions of the terrain the inland basins outlast and a stable uninterrupted sedimentation proceeded (Pasłęk IG-1). In conditions of a dry and hot climate strongly calcareous brick-coloured argillaceous siltstones were deposited (Sub-oolitic Beds) with scanty thin intercalations of limestones. This basin was probably submitted to an intensive evaporation, and in result of a poor influx of fresh-waters, abundant precipitations of anhydrite proceeded.

In the higher part of the Lower Triassic (Lower-oolitic Beds) the conditions are changed. In result of subsiding epeirogenic movements the Polish-German basin was joined with the boreal sea. This junction brought about on the whole area of the depression a deposition of characteristic argillaceous sediments with intercalation of oolitic limestones. The argillaceous sediments contain often intercalations of a greenish colour with grains of pollen and rare megaspores. The appearance of plant remains (especially of megaspores) may prove a change towards a more humid climate.

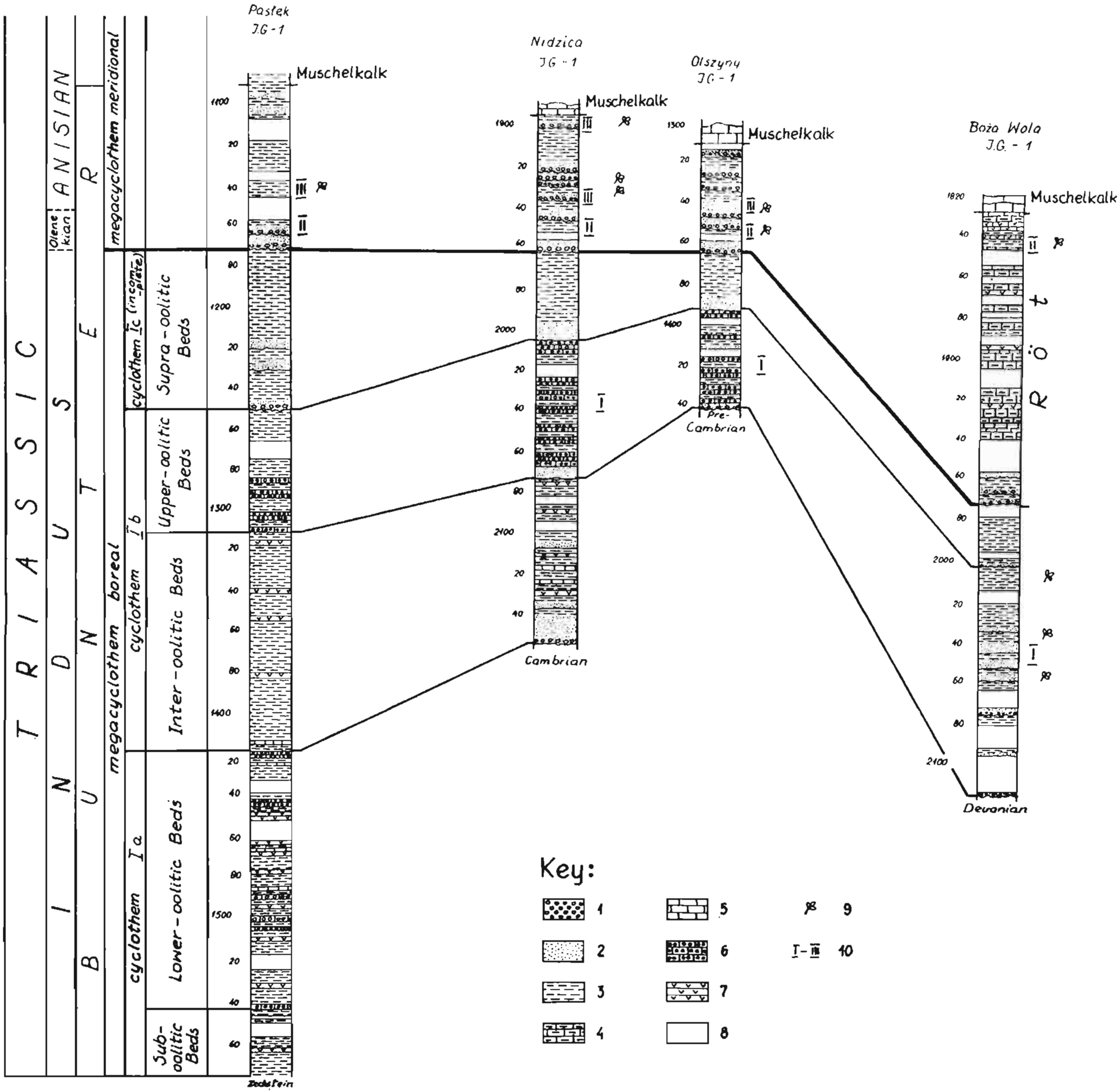
The next stage (Inter-oolitic Beds) is characterized by a new disruption of the junction between the basin in question and the boreal sea, in result of which the conditions prevailing during the sedimentation of the Sub-oolitic Beds turned back again. In this time mudstones and siltstones mostly brick-coloured were deposited with abundant intercalations of gypsum and anhydrite. In the littoral zone (Nidzica IG-1) occur often numerous sandy intercalations. The Inter-oolitic Beds contain scanty fossils, and the lack of plant remains may testify to a change towards a more dry climate.

In the upper part of the older Lower Triassic (Upper-oolitic Beds) the Polish-German basin joins once more the boreal sea and at the same time it increases remarkably its extension. In this time the most characteristic for the Lower Triassic complex was deposited, composed of interlayered beds of oolitic limestones and mudstones, encroaching often on the older substratum. In comparison with the Lower-oolitic Beds this complex is characterized by a better development of the oolitic limestone intercalations, the thickness of which attain sometimes several meters. These intercalations are best developed in the peripheral parts of the basin (Nidzica IG-1) and considerably weaker in deeper places or more distant from the shore (Pasłęk IG-1). The oolitic formations were probably deposited in a shallow marine basin in conditions of high temperature and higher salinity. As investigations of recent oolites demonstrate also presently a large amount of oolites is formed in shallow tropical basins of higher salinity (Shepard, 1963). The colour of rocks of this series differs of those occurring lower. Here grey and greenish coloured sediments prevail and only subordinately red-coloured intercalations occur. The argillaceous intercalations contain numerous megaspores. Such a character of sediments and especially the abundance of well preserved megaspores the origin of which require a large amount of humidity, testifies to a humid climate. The abundance of megaspores and the state of their conservation is interpreted as an index of lacustrine conditions. The interlayering of the described lithologic types (oolitic limestones and argillaceous intercalations with megaspores) allow the conclusion that the basin in question was relatively shallow and even slight uplifting movements produced a temporary return towards lacustrine conditions.

The sedimentation of the deposits described above was interrupted by emerging movements which produced again an isolation of the Polish-German basin. In the same time a drying of the climate and the disappearance of the plant cover took place. In these conditions in the inland basin mostly brick-coloured argillaceous sandstones were deposited, belonging to the Supra-oolitic Beds devoid of organic remains of the boreal megacyclothem.

Table 4

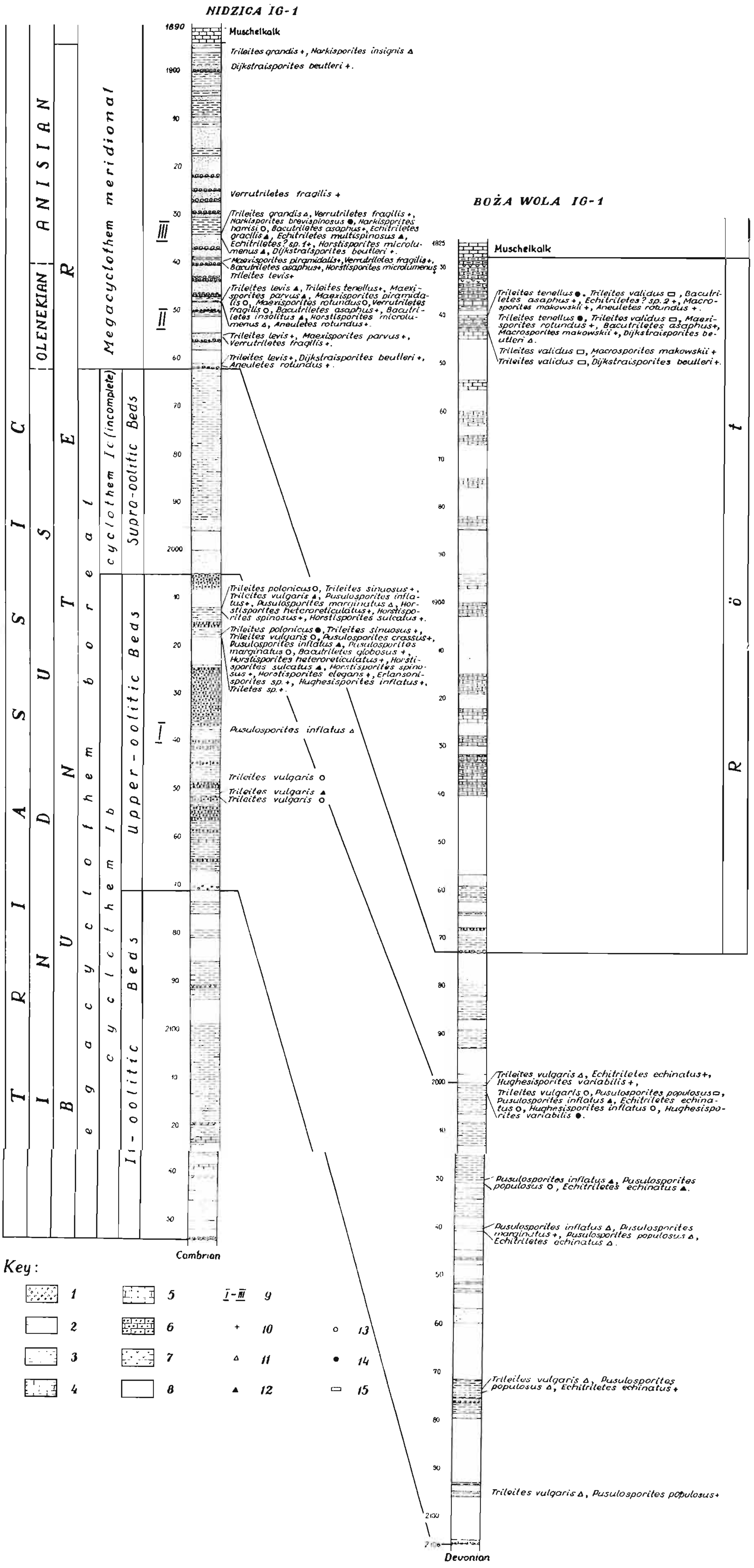
Correlation of profiles of the Buntersandstein of the investigated borings basing upon megaspores and lithologic character



1 — conglomerates, 2 — sandstones, 3 — mudstones and siltstones, 4 — marls, 5 — limestones, 6 — oolitic limestones, 7 — gypsum and anhydrite, 8 — lack of bore-hole core, 9 — macroflora, 10 — megaspore assemblages.

Table 5

Stratigraphic division and occurrence of megaspores in profiles of the Buntersandstein in borings Nidzica IG-I and Boża Wola IG-I



1 — conglomerates, 2 — sandstones, 3 — mudstones and siltstones, 4 — marls 5 — limestones, 6 — oolitic limestones, 7 — gypsum and anhydrite, 8 — lack of bore-hole core, 9 — megaspore assemblages, 10 — 1-5 specimens, 11 — 6-10 specimens, 12 — 11-20 specimens, 13 — 21-50 specimens, 14 — 51-100 specimens, 15 — over 100 specimens.

Tectonic movements which were marked near the end of the Lower Triassic produced a reconstruction of the marginal zone of the area in question and a change of the palaeogeographic picture. In result of the subsidence in the southern part of the area, the Polish-German depression was occupied by the transgression of the Tethys encroaching from the South. This transgression proceeded in separate stages. The oldest marine sediments (Röt) appear at first in the southern part of the depression, and extend further to the West and North. Inside the marine or lagunal formations there occur intercalations of argillaceous sandy lacustrine sediments, containing abundant micro and macroscopic plant remains.

On areas not invaded by the sea of Röt the sedimentation had a different character. The area of North-Eastern Poland was a continent. Lacustrine formations of this area containing very aboundant plant remains, correspond to the marine or lagunal sediments of the Röt. The prevalence of coarse-grained clastic material in these formations allows to suppose that simultaneously with the subsiding movements in the southern and western part of the Polish-German depression, the area of North-Eastern Poland was submitted to an intensive uplifting. In association with tectonic movements which produced physiographic changes, remarkable climatic changes proceeded again, with which an abundant occurrence of plant detritus and numerous megaspores is connected. Probably this area was invaded by the sea only in the younger Middle Triassic.

DESCRIPTIONS OF MEGASPORES

Anteturma **Sporites** H. Potonié, 1893

Turma **Triletes** (Reinsch, 1881) Potonié & Kremp, 1954

Subturma **Azonotriletes** Luber, 1935

Infraturma **Laevigati** (Bennie & Kidston, 1886) Potonié, 1956

Genus *Trileites* (Erdtmann, 1945, 1947) Potonié, 1956

Trileites grandis n. sp.

(Pl. XIX, Fig. 9)

Holotypus: Specimen No. 2; Pl. XIX, Fig. 9.
Stratum typicum: Anisian? III megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 1935 m.

Material. — 19 well preserved specimens.
Dimensions (in microns):

Diameter of megaspores 638—1040 (usually 750—800)
Length of Y-rays = 0,7R—0,9R
Width of Y-rays 15—25
Height of Y-rays 30—35
Thickness of exine 10—20

Descriptions. — Megaspore oval to rounded. Trilete rays developed as rather high, slightly undulated ridges or narrow bands. Curvature lacking. Spore surface usually smooth, lustrous. Surface of specimens with big diameters uneven, with cavities.

Remarks. — The described species resembles *Trileites pedinacron* (Harris) Potonié, but differs from the latter in having more developed trilete rays, usually bigger diameters and thinner exine.

Occurrence. — Nidzica IG-I, depth 1896,5—1935,2 m, Pasłęk IG-I depth 1138—1145 m, Bunter (Anisian?), meridional megacyclothem.

Trileites levis n. sp.
(Pl. XIX, Fig. 8)

Holotypus: Specimen No. 4; Pl. XIX, Fig. 8.
Stratum typicum: Olenekian, II megaspore assemblage.
Locus typicus: Nidzica IG—I, depth 1943 m.
Derivatio nominis: Lat. *levis* — smooth.

Material. — 19 well preserved specimens.
Dimensions (in microns):

Diameter of megaspores 230—400 (usually 350)
Length of Y-rays = 0,6R—0,7R
Width of Y-rays 8—12
Height of Y-rays ca 20
Thickness of exine ca 10

Description. — Megaspore rounded or round in outline. Trilete rays developed as rather narrow, slightly undulating strips. Spore surface smooth, usually lustrous. Lack of curvature.

Remarks. — The described species differs from *Trileites tenellus* n. sp. in having a thicker exine and smoother surface.

Occurrence. — Nidzica IG-I, depth 1943—1961,5 m, Pasłęk IG-I, depth 1156—1163 m, Bunter (Olenekian), meridional megacyclothem.

Trileites polonicus n. sp
(Pl. XX, Figs 3, 5, 6)

Holotypus: Specimen No. 6; Pl. XX, Fig. 3.
Stratum typicus: Indus, Upper-oolitic Beds, I megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 2018 m.
Derivatio nominis: first found in Poland.

Material. — A few hundred well preserved specimens.
Dimensions (in microns):

Diameter of megaspores 380—540/usually abouth 450
Length of Y-rays = 0,85R
Width of Y-rays about 12

Height of Y-rays 18—30
Width of curvature 12—15
Thickness of exine 15—20

Descriptions. — Megaspores flat, round, usually compressed proximo — distally. Trilete rays very well developed in the form of straight bands or ridges. Curvature well developed as a ridge. Contact areas well marked. Spore surface usually smooth, more rarely finely granulated.

Remarks. — *Trileites polonicus* n. sp. resembles megaspores identified as *Pleuromeia Sternbergi* (Muenst.) Corda and illustrated, but not described, by Mägdefrau (1931). It is also similar to the forms described (but not illustrated) under the latter name by Fitting (1907). *Trileites polonicus* n. sp. differs from the mentioned forms in its smaller diameter.

Occurrence. — Nidzica IG-I, depth 1943—1961,5 m, Pasłęk IG-I, depth depth 1410 m, Bunter (Indus), Upper-oolitic Beds, boreal megacyclothem.

Trileites sinuosus (Dettmann) n. comb.
(Pl. XX, Fig. 4)

1961. *Banksisporites sinuosus* Dettmann; M. E. Dettmann, Lower Mesozoic... p. 74—75, Pl. 1, Figs. 9—14

Material. — 5 well preserved specimens.
Dimensions (in microns):

Diameter of megaspores 270—420
Length of Y-rays = 0,65R—0,75R
Width of Y-rays 15—20
Height of Y-rays 20—35
Thickness of exine 10—15

Description. — Megaspore rounded or round in outline; flattened proximo — distally. Trilete rays well developed as undulate ridges or bands. Lack of curvature. Spore surface smooth or finely grained.

Remarks. — Dettmann (1961) differenciated the genus *Banksisporites* on the base of the presence of mesosporium and lack of verrucae in contact areas accompanying trilete rays. The present author agrees with Fitting (1900) and Potonié (1966) that the inner structure of megaspores can not be taken as a base for the erection of a genus as both specimens with verrucae accompanying trilete rays and those without these features of internal structure can be found within one genus. From the point of view of morphology, the described species corresponds to the genus *Trileites* (Erdtman) Potonié 1956.

Occurrence. — Poland: Nidzica IG-I, depth 2012 m — 2018 m, Bunter (Indus), Upper-oolitic Beds, boreal megacyclothem. Tasmania — Triassic.

Trileites tenellus n. sp.
(Pl. XIX, Fig. 4)

Holotypus: Specimen No. 7; Pl. XIX, Fig. 4.
Stratum typicum: Olenekian, II megaspore assemblage.
Locus typicus: Boża Wola IG-I, depth 1841 m.
Derivatio nominis: lat. *tenellus* — thin.

Material. — Over 100 well preserved specimens.
Dimensions (in microns):

Diameter of megaspores 250—460 (usually 350)
Length of Y-rays = 0,6R—0,7R
Width of Y-rays ca 12
Height of Y-rays ca 15
Thickness of exine 5—6

Description. — Megaspores subtriangular to rounded in outline. Trilete rays developed usually as straight or slightly undulate ridges. Curvature usually lacking, but on a few specimens it is poorly developed as a narrow (about 9 microns in width) elevation. Spore surface microgranulate.

Remarks. — The described species differs from *Trileites vulgaris* n. sp. in having shorter trilete rays and a more microgranulate surface.

Occurrence. — Nidzica IG-I, depth 1948 m, Boża Wola IG-I, depth 1841—1842 m, Bunter (Olenekian), meridional megacyclothem.

Trileites validus n. sp.
(Pl. XXI, Figs 4, 6)

Holotypus: Specimen No. 9; Pl. XXI, Fig. 6,
Stratum typicum: Olenekian (Röt), II megaspore assemblage.
Locus typicus: Boża Wola IG-I, depth 1842.5 m.
Derivatio nominis: Lat. *validus* — strong.

Material. — Over 150 very well preserved specimens.
Dimensions (in microns):

Diameter of megaspores 460—812
Length of Y-rays 0,8R—0,95R
Width of Y-rays (at the base) ca 60
Height of Y-rays up to 180
Thickness of exine 35

Descriptions. — Megaspores subtriangular (smaller specimens) to round (larger specimens), compressed proximo — distally. Apex of subtriangular specimens rounded, sides convex and trilete rays more raised. Trilete rays developed as straight bands, wider at the base and narrowing upwards. These bands sometimes are delicately grooved. Curvature usually lacking. On a few specimens it is poorly developed as an elevation 10—23 microns in width. Surface of distal side of megaspore smooth, lustrous. Proximal side mat, sometimes delicately grooved.

Remarks. — Described species is closest to *Trileites altotectatus* Kanneg. & Kozur, from which it differs in its narrower trilete rays and granulate surface on proximal side.

Occurrence. — Boża Wola IG-I, depth 1841 m — 1843 m, Bunter (Olenekian), meridional megacyclothem.

Trileites vulgaris n. sp.

(Pl. XX, Figs 1, 2, 7, 8; Pl. XXXI, Figs 2, 8)

1961. *Banksisporites pinguis* (Harris) Dettmann; M. E. Dettmann, Lower Mesozoic..., p. 74, Pl. 1, Figs 1—8, Text-figure 1*a*.

Holotypus: Specimen No. 10; Pl. XX, Fig. 7.
Stratum typicum: Indus, Upper-oolitic Beds, I megaspore assemblage.
Locus typicus: Boża Wola IG-I, depth 2002 m
Derivatio nominis: lat. *vulgaris* — common.

Material. — Several hundreds of well preserved specimens.

Dimensions (in microns):

Diameter of megaspores 230—640
Length of Y-rays = 0,75R—R
Width of Y-rays 5—15
Height of Y-rays 15—35
Thickness of exine 4—15

Description. — Megaspore rounded or round, usually proximo — distally flattened. Trilete rays well developed as straight bands or ridges. As a rule curvature lacking. Spore surface smooth, lustrous (especially on smaller specimens).

Remarks. — Dettmann (1961) described megaspores from Tasmania corresponding to *Trileites vulgaris* n. sp. under the name of *Banksisporites pinguis* (Harris) Dettmann and on that base defined the age of Tasmanian sediments as Rhaetian. Both the Polish specimens and those described by Dettmann differ from the *Trileites pinguis* (Harris) Potonié in having lower and narrower trilete rays.

Occurrence. — Poland: Nidzica IG-I, depth 2012 m — 2052 m, Olszyny IG-I, depth 1410 m — 1436 m, Boża Wola IG-I depth 2002 m — 2096 m, Bunter (Indus), Upper-oolitic Beds, boreal megacyclothem. Tasmania — Triassic.

Infraturma **Apiculati** (Bennie & Kidston, 1886) Potonié, 1956

Genus *Maexisporites* Potonié, 1956

Maexisporites parvus n. sp.

(Pl. XXI, Figs 3*a*, 3*b*)

Holotypus: Specimen No. 11; Pl. XXI, Figs 3*a*, 3*b*.
Stratum typicum: Olenekian, II megaspore assemblage.

Locus typicus: Nidzica IG-I, depth 1948 m.
Derivatio nominis: Lat. *parvus* — small.

Material. — 36 mostly well preserved specimens
Dimensions (in microns):

Diameter of megaspores 174—270
Length of Y-rays = 0,8R-R
Width of Y-rays 10—15
Height of Y-rays ca 15
Thickness of exine 6—10

Description. — Megaspore rounded or round, seldom subtriangular. Majority of specimens flattened proximo — distally. Trilete rays developed as straight or slightly undulate ridges. Curvature rarely visible. On some laterally flattened specimes it occurs as a ridge 8—13 μ in thickness. Spore surface granulated.

Remarks. — Described species differs from *Maexisporites pyramidalis* n. sp. in having lower trilete rays and flat contact area.

Occurrence. — Nidzica IG-I, depth 1948 m — 1955 m, Olszyny IG-I, depth 1355 m, Pasłęk IG-I, depth 1156 m — 1158 m, Bunter (Olenekian), meridional megacyclothem.

Maexisporites pyramidalis n. sp.

(Pl. XXI, Figs 2*a*, 2*b*; Pl. XXXI, Fig. 6)

Holotypus: Specimen No. 12; Pl. XXI, Figs 2*a*, 2*b*.
Stratum typicum: Olenekian, II megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 1948 m.
Derivatio nominis: Lat. *pyramidalis* — pyramidal.

Material. — 50 well preserved specimens.
Dimensions (in microns):

Diameter of megaspores 190—290 (usually ca. 200)
Length of Y-rays = 0,8R-R
Width of Y-rays 12—18
Height of Y-rays 20—30
Thickness of exine 8—10

Description. — Megaspore subtriangular, occasionally triangular, with rounded apex, convex sides, usually flattened proximo — distally. Trilete rays well developed as straight ridges or slightly undulating, sometimes jagged bands. Contact fields, covering only a part of proximal side, are elevated, sometimes swollen. In some specimens the contact areas are separated from the rest of the spore by a groove 15 μ in width. Curvature usually lacking. When present, it occurs as a poorly developed ridge. Spore surface grainy.

Remarks. — Transmitted light exposes, in described species, the presence of "mesosporium" devoid of verrucae, accompanying trilete rays. *Maexisporites pyramidalis* n. sp. differs from other species, belonging to the same genus in having elevated contact fields.

Occurrence. — Nidzica IG-I, depth 1940 m — 1948 m, Olszyny IG-I, depth 1355 m, Bunter (Olenekian), meridional megacyclothem.

Maexisporites rotundus n. sp.
(Pl. XXI, Figs 5*a*, 5*b*)

Holotypus: Specimen No. 13; Pl. XXI, Figs 5*a*, 5*b*.
Stratum typicum: Olenekian, II megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 1948.
Derivatio nominis: lat. *rotundus* — rotund.

Material. — 31 specimens, usually well preserved.
Dimensions (in microns):

Diameter of megaspores 270—380 (usually 300—350)
Length of Y-rays = 0,65R—0,75R
Width of Y-rays 12—20
Height of Y-rays 15—25
Thickness of exine 10—12

Descriptions. — Megaspore rounded or round, usually flattened proximo — distally. Trilete rays well developed as more or less wavy bands. Curvature lacking. Spore surface granulated.

Remarks. — Described species differs from *Maexisporites meditectatus* (Reinhardt, 1963) Kozur 1971 in its lack of curvature and evenly granulated surface.

Occurrence. — Nidzica IG-I, depth 1948 m, Olszyny IG-I, depth 1355 m, Pasłęk IG-I, depth 1158 m, Boża Wola IG-I, depth 1842 m, Bunter (Olenekian), meridional megacyclothem.

Genus *Verrutriletes* (van der Hammen, 1954) Potonié, 1956

Verrutriletes fragilis n. sp.
(Pl. XXI, Figs 1*a*, 1*b*)

Holotypus: Specimen No. 15; Pl. XXI, Figs 1*a*, 1*b*.
Stratum typicum: Olenekian — Anisian?, II and III megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 1948 m.
Derivatio nominis: lat. *fragilis* — brittle, fragile.

Material. — 36 well preserved specimens.
Dimensions (in microns):

Diameter of megaspores 210—260
Length of Y-rays = 0,75R-R

Width of Y-rays 12—18
Height of Y-rays 18—23
Height of appendages up to 10 (usually 6—8)
Diameter of appendages 4—12
Thickness of exine ca. 8

Description. — Megaspore flat, subtriangular to rounded; compressed proximo — distally. Trilete rays well developed as almost straight, sometimes slightly undulate ridges. Curvature usually lacking. Numerous short appendages with rounded apexes are more or less evenly distributed over the whole spore surface. They are also present on trilete rays.

Remarks. — Described species is closest to *Verrutriletes schulzi* Kannegieser & Kozur, 1972. Differences consist in the former having a smaller diameter, narrower trilete rays as well as smaller appendages of equal diameter on both surfaces of megaspore.

Occurrence. — Nidzica IG-I, depth 1927.5 m — 1955 m, Olszyny IG-I, depth 1355 m, Bunter (Olenekian — Anisian?), meridional megacyclothem.

Genus *Pusulosporites* n. gen.

Type species: Pusulosporites populosus n. sp.
Derivatio nominis: lat. *pusulosus* — covered with pimpels.
Species assigned: P. crassus n. sp., *P. inflatus* n. sp., *P. marginatus* n. sp., *P. populosus* n. sp.
Stratigraphical and geographical range: Indus, Upper-oolitic Beds, I megaspore assemblage, NE and Central Poland.

Diagnosis. — Megaspore rounded or round, more rarely subtriangular. Trilete rays very well developed. Curvature usually lacking. The whole surface covered with numerous, short, very small, glassy appendages with rounded apexes, more rarely sharp.

Remarks. — Described genus resembles *Verrutriletes* (van der Hammen, 1954) Potonié, 1956, differing from it in shape and very small size of appendages. Appendages of *Pusulosporites* n. gen. are variable in shape — from sharply ended to verrucose. On macerated specimens, these appendages are, in contrast to granulated exine, completely smooth, with glassy shine, light-yellow or dark-brown in colour.

Within some species, individual specimens can vary from smooth forms to those with above described ornamentation. This can also be observed in some species, similarly ornamentated, but of different genera like: *Maexisporites, Verrutriletes.* Absence of appendages is probably due to their having been destroyed (Marcinkiewicz, 1971).

Pusulosporites populosus n. sp.
(Pl. XXII, Figs 5*a*, *b*, 6, 7; Pl. XXXII, Figs. 2)

Holotypus: Specimen No. 19; Pl. XXII, Figs 5*a*, 5*b*.
Stratum typicum: Indus, Upper-oolitic Beds, I megaspore assemblage.
Locus typicus: Boża Wola I G-I, depth 2002 m.
Derivatio nominis. Lat. *populosus* — frequent.

Material. — A few hundred well preserved specimens.
Dimensions (in microns):

Diameter of megaspores 440—710 (usually 500)
Length of Y-rays = 0,75R
Width of Y-rays 23—29
Height of Y-rays ca. 18
Height of appendages to 4
Distances between appendages 6—10
Thickness of exine ca. 25

Description. — Megaspore round, usually proximo — distally compressed. Trilete rays well developed in the form of straight, rounded ridges. Curvature usually lacking. On specimens laterally flattened it is marked as a poorly developed ridge. Spore surface covered with numerous, short appendages ended by sharp or rounded apexes. Specimens with a smooth surface are also present.

Occurrence. — Boża Wola IG-I, depth 2002 m — 2096 m, Bunter (Indus), Upper-oolitic Beds, boreal megacyclothem.

Pusulosporites crassus n. sp.
(Pl. XXIII, Figs 3*a*, 3*b*, 4)

Holotypus: Specimen No. 17; Pl. XXIII, Figs 3*a*, 3*b*.
Stratum typicum: Indus, Upper-oolitic Beds, I megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 2018 m.
Derivatio nominis: Lat. *crassus* — thick.

Material. — 4 well preserved specimens.
Dimensions (in microns):

Diameter of megaspores 530—672
Length of Y-rays = R
Width of Y-rays 35—45
Height of Y-rays 60—70
Width of curvature 25—35
Height of appendages 3—5
Diameter of appendages 5—10
Thickness of exine 40—60

Description. — Megaspore round, laterally flattened. Trilete rays very well developed as thick, straight ridges or bands, narrowing upwards, sometimes transversely grooved. Curvature well developed in the form of a ridge. Spore exine granulated, uneven its surface covered with numerous appendages. These latter have usually rounded apexes, a glassy shine and are yellow or brown in colour.

Remarks. — *Pusulosporites crassus* n. sp. differs from other species of this genus in its thicker exine and well developed curvature.

Occurrence. — Nidzica — IG-I, depth 2018 m, Bunter (Indus), Upper-oolitic Beds, boreal megacyclothem.

Pusulosporites marginatus n. sp.
(Pl. XIX, Fig. 6)

Holotypus: Specimen No. 1; Pl. XIX, Fig. 6.
Stratum typicum: Indus, Upper-oolitic Beds, I megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 2018 m.
Derivatio nominis: Lat. *marginatus* — marginate.

Material. — Some tens of well preserved specimens.

Dimensions (in microns):

Diameter of megaspores 313—540
Length of Y-rays = 0,7 R (more rarely to 0,9 R)
Width of Y-rays 12—23
Height of Y-rays 15—28
Height of appendages ca. 5
Thickness of exine 12—25

Description. — Megaspores subtriangular or round, flattened proximo-distally. Trilete rays well developed, usually as straight ridges or bands. Contact areas slightly depressed (more rarely slightly elevated). A ridge (34—60 microns in thickness) occurs between contact areas and spore equator. It is separated from contact areas by a poorly developed groove. Sometimes curvature is present as an indistinct ridge. Small appendages, with rounded or pointed apexes occur on spore surface. Megaspore with granulated surface but without appendages also present.

Remarks. — Described species is closest to *Zeillerisporites sitholeyi* Pant & Sriv., differing from it in lack of "zone", occurrence of a ridge surrounding contact areas and shorter trilete rays.

Occurrence. — Nidzica IG-I, depth 2012 m — 2018 m, Olszyny IG-I, depth 1410 m, Gorzów Wielkopolski IG-I, Środa IG-II, Subsudeten Monocline, Boża Wola IG-I, depth 2041,5 m, Bunter (Indus), Upper-oolitic Beds, boreal megacyclothem.

Pusulosporites inflatus n. sp.
Pl. XIX, Figs 1, 3, 7; Pl. XXXI, Figs 1, 3)

Holotypus: Specimen No. 21; Pl. XIX, Fig. 1.
Stratum typicum: Indus, Upper-oolitic Beds, I megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 2038 m.
Derivatio nominis: Lat. *inflatus* — swollen.

Material. — Some tens of well preserved specimens.

Dimensions (in microns):

Diameter of megaspores 240—550 (usually 300—400)
Length of Y-rays = 0,65 R-R
Width of Y-rays 8—23
Height of Y-rays 20—30
Height of appendages 3—6
Diameter of mesosporium ca. 0,65R
Thickness of exine 6—25

Descriptions. — Megaspores subtriangular or round, compressed proximo-distally. Trilete rays well developed as straight or undulating ridges, or more rarely bands, which nearing the spore margin become flatter and wider, up to 35 microns. Contact areas swollen and elevated in comparison to the rest of the spore, forming a "zone". A shallow, poorly developed groove between contact areas and "zone" can be observed on some specimens. Curvature sometimes present as a ridge 15—20 microns in thickness. Present in spore interior is a mesosporoid, attached to the exine by numerous verrucae, which accompany trilete rays. Mesosporoid of specimens with thick exine can be observed only by breaking spore and extracting it. Small appendages with rounded or pointed apexes, glassy shine, dark-brown or black in colour appear on spore surface. Also present are specimens with a granulated surface.

Remarks. — *Pusulosporites inflatus* n. sp. includes specimens which, depending on the litological character of sediments, are very variable as to thickness of exine and development of appendages on spore surface. Specimens of described species have a thin exine (usually 10—15 microns) when occurrent in paralic type sediment built from alternating layers of oolite limestones, registering marine activity, and megaspore bearing clayey-mudstone intercalations, (boring Nidzica IG-I and Olszyny IG-I).

On the other hand specimens of *Pusulosporites inflatus* n. sp. have a thick (usually 15—20 microns) exine and more distinct appendages when they occur in clayey-mudstone complexes without oolite intercalations, (boring Boża Wola IG-I).

Specimens with a thin exine are very similar to the megaspores of the lycopode *Selaginellites polaris* from the Lower Triassic of East Greenland (Lundblad, 1948). *Pusulosporites inflatus* n. sp. differs from latter in the presence of verrucae accompanying trilete rays.

Magaspores *Pusulosporites inflatus* n. sp. with a thicker exine, resemble forms described from India as *Zeillerisporites sitholeyi* Pant & Sriv. (Pant & Srivastava, 1964). Differences consist in Polish specimens having heigher trilete rays and appendages present on spore surface. It should be stated, that genus *Zeillerisporites* Pant & Srivastava 1964 was erected on the base of features of internal structure.

Occurrence — Nidzica IG-I, depth 2012 m — 2038 m, Olszyny IG-I, depth 1410—1425 m, Boża Wola IG-I, depth 2002 m — 2041,5 m, Bunter (Indus), Upper-oolitic Beds, boreal megacyclothem.

Genus *Narkisporites* Kannegieser & Kozur 1972

Narkisporites brevispinosus n. sp.

(Pl. XXV, Figs 2*a*, 2*b*)

pars 1972. *Narkisporites harrisi* (Reinhardt & Fricke 1969) Kozur 1971; E. Kannegieser & H. Kozur, Zur Mikropaläontologie..., p. 189—190.

Holotypus: Specimen No. 27; Pl. XXV, Figs 2*a*, 2*b*.
Stratum typicum: Anisian? III megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 1935.2 m.
Derivatio nominis: Lat. *brevispinosus* — with short spines.

Material. — 34 well preserved specimens.

Dimensions (in microns):

Diameter of megaspores (without spines) 280—640
Length of Y-rays = R
Width of Y-rays 15—23
Height of Y-rays 15—30
Width of curvature 12—20
Length of spines 18—30
Thickness of spines (at the base) 10—22
Thickness of exine 15—18

Description. — Megaspores rounded or round, usually flattened proximo-distally. Trilete rays and curvature well developed as straight, sometimes slightly undulating ridges or bands. The whole spore surface covered by numerous, short, sometimes flattened spines with rounded or pointed ends. The best developed spines are on the distal side of a spore.

Remarks. — Described species corresponds to some forms included in genus *Narkisporites harrisi* (Reinhardt & Fricke) Kozur. In this author's opinion they are not a variant of the latter genus as they are characterised by stable morphological features (length of spines to 30 microns). They also occur in samples where other forms belonging to *Narkisporites harrisi* (Reinhardt & Fricke) Kozur are absent.

Occurrence — Poland: Nidzica IG-I, depth 1935.2 m, Olszyny IG-I, depth 1345 m, Bunter (Anisian?), meridional megacyclothem. Germany — Schilfsandstein (Jui).

Narkisporites harrisi (Reinhardt & Fricke 1969) Kozur 1971

(Pl. XXV, Figs 3*a*, 3*b*, 4, 5)

1963. *Biharisporites myrmecodes* (Harris) Potonié 1956; P. Reinhardt, Megasporen..., p. 120, Pl. 2, Figs 7, 10.

1969. *Biharisporites harrisi* n. sp.; P. Reinhardt & D. Fricke Megasporen..., p. 404, Pl. 1, Fig. 1.
pars 1972. *Narkisporites harrisi* (Reinhardt & Fricke 1969) Kozur 1971; E. Kannegieser & H. Kozur, Zur Mikropaläontologie..., p. 189—190.

Material. — 25 well preserved specimens.
Dimensions (in microns):

Diameter of megaspores (without spines) 300—600 (usually 450—500).
Length of Y-rays = R
Width of Y-rays 10—20
Height of Y-rays 25—70
Width of curvature 20—40
Length of spines 30—70
Thickness of spines (at the base) 15—25
Thickness of exine 12—18

Description. — Megaspores rounded or round. Some specimens with a small diameter are subtriangular. Majority of megaspores flattened proximo-distally. Trilete rays very well developed as straight ridges or bands. Curvature well developed in the form of a jagged band with the edge often composed of single spines conected only at the base. Numerous spines, usually sharply ended, sometimes rounded, are loosely dispersed over the whole spore surface, sometimes in small groupings. They are best developed on distal side. In contact areas of some specimens, spines are numerous by the spore pole, but disappear by the equator.

Remarks. — Kozur (1971) attributes too wide a range to *Narkisporites harrisi* (Reinhardt & Fricke 1969) Kozur 1971. According to the present author, forms belonging to diferent species have been included. See remarks and comparisons for *Narkisporites brevispinosus* n. sp. and *Narkisporites insignis* n. sp.

Occurrence. — Nidzica IG-I, depth 1935.2 m, Olszyny IG-I, depth 1345 m, Bunter (Anisian?), meridional megacyclothem. Germany — Middle Keuper.

Narkisporites insignis n. sp.
(Pl. XXIX, Figs 1, 3*a*, 3*b*, 4)

Holotypus: Specimen No. 37; Pl. XXIX, Fig. 4.
Stratum typicum: Anisian? III megaspore assemblage.
Locus typicus: Pasłęk IG-I, depth 1138 m.
Derivatio nominis: Lat. *insignis* — marked.

Material. — 27 well preserved specimens.
Dimensions (in microns):

Diameter of megaspores (without spines) 394—638 (usually about 450)
Length of Y-rays = R
Width of Y-rays 10—20
Height of Y-rays to 45

Width of curvature to 50
Length of spines to 25 (usually 18—20)
Thickness of spines (at the base) 8—20
Thickness of exine 12—20

Description. — Megaspores subtriangular or rounded. Trilete rays very well developed as straight bands. Contact areas delimited with a well developed, usually uniform band, often transversally grooved, sometimes with slightly jagged edges. Spore surface covered by numerous densely arranged spines with apexes usually sharp, occasionally rounded.

Remarks. — Described species is closest to *Triletes myrmecodes* Harris, differing from it in slightly longer trilete rays and more numerous and more densly arranged spines. According to the present author, *Narkisporites insignis* n. sp. is not just a variant of *Narkisporites harrisi* (Reinh. & Fricke) Kozur since it differs from it in shorter (to 25 μ) and more pointed spines and a curvature developed as a practically uniform, slightly jagged band. The described species characterized by its stable morphological features and time of occurrence differs from that of other forms of *Narkisporites harrisi* (Reinh. & Fricke) Kozur.

Occurrence. — Nidzica IG-I, depth 1896,5 m, Pasłęk IG-I, depth 1138 m—1145 m, Bunter (Anisian?), meridional megacyclothem.

Genus *Bacutriletes* (van der Hammen 1954) Potonié 1956

Bacutriletes asaphus n. sp.

(Pl. XXII, Figs 1—4)

Holotypus: Specimen No. 22; Pl. XXII, Fig. 3.
Locus typicus: Nidzica IG-I, depth 1948 m.
Stratum typicum: Olenekian-Anisian?, II and III megaspore assemblages.
Derivatio nominis: Gr. *asaphus* — undistinct.

Material. — 15 usually well preserved specimens.
Dimensions (in microns):

Diameter of megaspores = 250—480 (usually 300—350)
Length of Y-rays = R
Width of Y-rays 10—15
Height of Y-rays 15—20
Width of curvature ca 15
Height of appendages 8—15
Thickness of appendages ca 15
Thickness of exine 12—15

Description. — Megaspores rounded, rarely subtriangular, usually flattened lateraly. Trilete rays developed as a straight, usually jagged, band. Spore surface densly covered with appendages, their apexes more or less rounded or flattened. Appendages are best developed on distal side of spores. On most specimens the appendages are joined to form a faintly marked reticulum.

Remarks. — Described species is closest to *Bacutriletes reticuliferus* Bertelsen, differing from it in longer and better developed trilete rays and in the presence of a curvature.

Occurrence. — Nidzica IG-I, depth 1935.2 m — 1948 m, Olszyny IG-I, depth 1355 m, Pasłęk IG-I, depth 1158 m, Boża Wola IG-I, depth 1841 m — 1842 m, Bunter (Olenekian-Anisian?), meridional megacyclothem.

Bacutriletes globosus n. sp.
(Pl. XXIII, Fig. 1; Pl. XXXII, Fig. 1)

Holotypus: Specimen No. 23; Pl. XXIII, Fig. 1.
Stratum typicum: Indus, Upper-oolitic Beds, I megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 2018 m.
Derivatio nominis: Lat. *globosus* — spherical.

Material. — 2 slightly damaged specimens.
Dimensions (in microns):

Diameter of megaspores 556, 580
Length of Y-rays = R
Width of Y-rays (at the base) 25
Height of Y-rays ca 20
Width of curvature ca 23
Length of appendages up to 25
Thickness of appendages 5—6 (rarely ca 10)
Thickness of appendage tops 18—25
Thickness of exine 50—65

Description. — Megaspores spherical. Trilete rays very vell developed as straight bands, narrowing upwards. Curvature well developed in the form of a ridge. Exine granulated, covered with unevenly destributed appendages. Appendages straight, usually ending in a rounded top.

Remarks. — *Bacutriletes globosus* n. sp. differs from other species of this genus in its more developed curvature and thicker exine.

Occurrence. — Nidzica IG-I, depth 2018 m, Bunter (Indus), Upper-oolitic Beds, boreal megacyclothem.

Bacutriletes insolitus n. sp.
(Pl. XXIII, Figs 2*a*, 2*b*; Pl. XXIV, Fig. 3; Pl. XXXI, Fig. 7)

Holotypus: Specimen No. 24; Pl. XXIII, Figs 2*a*, 2*b*.
Stratum typicum: Olenekian, II megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 1948 m.
Derivatio nominis: Lat. *insolitus* — uncommon.

Material. — 20 well preserved specimens.
Dimensions (in microns):

Diameter of megaspores (without spines) 320—450
Length of Y-rays = 0,8R-R
Width of Y-rays 8—10
Height of Y-rays 15—20
Length of appendages to 25
Thickness of appendages (at the base) 4—6
Thickness of exine 5—8

Description. — Megaspores subtriangular or round, usually flattened proximo-distally. Trilete rays developed as fairly high, straight or undulated bands. Curvature in the form of a poorly developed ridge. Whole spore surface covered by both straight spinelike appendages and appendages with apexes cut of, flattened and wider at the ends.

Remarks. — *Bacutriletes insolitus* n. sp. differs from other species of the genus in the shape of appendages.

Occurrence. — Nidzica IG-I, depth 1948 m, Olszyny IG-I, depth 1355 m, Bunter (Olenekian), meridional megacyclothem.

Genus *Echitriletes* (van der Hammen, 1954) Potonié, 1956

Echitriletes echinatus n. sp.

(Pl. XXIV, Figs 4, 5*a*, 5*b*, 6; Pl. XXXII, Fig. 3)

Holotypus: Specimen No. 25; Pl. XXIV, Figs 5*a*, 5*b*.
Stratum typicum: Indus, Upper-oolitic Beds, I megaspore assemblage.
Locus typicus: Boża Wola IG-I, depth 2031,5 m.
Derivatio nominis: Lat. *echinatus* — bristled.

Material. — Some tens of well preserved specimens.

Dimensions (in microns):

Diameter of megaspores (without spines) 320—980 (usually 500—600)
Length of Y-rays = 0,8R-R
Width of Y-rays 14—18
Height of Y-rays 25—70
Width of curvature 15—20
Length of spines to 90
Thickness of spines (at the base) ca 10
Thickness of exine 10—18

Description. — Megaspores rounded or round. Trilete rays well developed as high bands. Curvature well developed in the form of a ridge. Spines long, thin pointed, straight or bent, sometimes cohering, cover the whole spore surface.

Remarks. — Described species differs from *Echitriletes lanatus* (Dijkstra, 1951) Potonié, 1956 in narrower trilete rays, well developed curvature and short spinelike appendages on the spore surface. From *Echitriletes mangardahensis* (Srivastava in Surange, Singh & Srivastava, 1953)

Potonié, 1956 it differs in its longer appendages and round or rounded outline.

Occurrence. — Boża Wola IG-I, depth 2000 m — 2073.5 m, Bunter, (Indus) Upper-oolitic Beds, boreal megacyclothem.

Echitriletes gracilis n. sp.
(Pl. XXIV, Figs 1*a*, 1*b*, 2)

Holotypus: Specimen No. 29, Pl. XXIV, Fig. 1*a*, 1*b*.
Stratum typicum: Anisian? III megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 1935,2 m.
Derivatio nominis: Lat. *gracilis* — slender.

Material. — 19 mostly deformed specimens.
Dimensions (in microns):

Diameters of megaspores (with spines) 320—450 (usually 350—400)
Length of Y-rays = R
Width of Y-rays 10—18
Height of Y-rays 20—55
Length of spines on proximal side up to 45
Length of spines on distal side up to 110 (usually 50—75)
Thickness of spines (at base) 8—23 (usually 15—20)
Width of curvature 20—70
Thickness of exine 10—12

Descriptions. — Megaspore subtriangular. Almost all specimens laterally flattened. Trilete rays well developed, usually as high, straight or undulating, sometimes jagged bands. Contact areas usually pyramidally raised in comparison to the rest of the spore. Curvature well developed as a very jagged band or as numerous spines cohering at their base. Spines numerous, straight or slightly bent, cover the spore surface, being longer and more numerous on distal side.

Remarks. — Described species differs from other species of this genus in having en elevated contact area and different length of spines on the proximal and distal surface.

Occurrence. — Nidzica IG-I, depth 1935,2 m, Olszyny IG-I, depth 1345 m, Bunter (Anisian), meridional megacyclothem.

Echitriletes multispinosus n. sp.
(Pl. XXVI, Figs 2*a*, 2*b*, 4*a*, 4*b*)

Holotypus: Specimen No. 30; Pl. XXVI, Figs 4*a*, 4*b*.
Stratum typicum: Anisian?, III megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 1935.2 m.
Derivatio nominis: Lat. *multispinosus* — having numerous spines.

Material. — Some tens of well preserved specimens.
Dimensions (in microns):

Diameters of megaspores (with appendages) 420—645
Length of Y-rays = R
Width of Y-rays 6—10
Height of Y-rays 20—40
Lenght of appendages on the spore surface up to 120
Thickness of appendages (at base) 8—15
Thickness of exine 10—18

Description. — Megaspores rounded or round. Trilete rays developed as straight or slightly undulated, usually strongly jagged bands. Curvature present but sometimes not visible. Contact areas poorly marked. Very numerous, well developed appendages, usually straight, sometimes bent, cover the whole spore surface.

Remarks. — The described species differs from others of this genus in its numerous, strongly developed appendages.

Occurrence. — Nidzica IG-I, depth 1935.2 m, Bunter (Anisian?), meridional megacyclothem, Upper Silesia — Lower Keuper.

Echitriletes? sp. 1
(Pl. XXVII, Figs 1*a*, 1*b*)

Material. — One well preserved specimen.
Dimensions (in microns):

Diameter of megaspores (without spines) 900
Length of Y-rays = 0,85R
Width of Y-rays (at base) 20—25
Height of Y-rays 35
Lenght of spines 100
Thickness of spines (at base) 45

Descriptions. — Megaspore rounded, flattened proximo-distally. Trilete rays in the form of straight ridges passing into bands. Curvature lacking. Numerous massive spines, usually pointed, sometimes rounded at the end, cover the whole spore surface. Spines more numerous on proximal side of spore.

Occurrence. — Nidzica IG-I, depth 1935.2 m, Bunter (Anisian?), meridional megacyclothem.

Echitriletes? sp. 2
(Pl. XXVIII, Figs 4*a*, 4*b*)

Material. — One well preserved specimen.
Dimensions (in microns):

Diameter of megaspore (without spines) 400
Length of Y-rays = R
Width of Y-rays 24

Height of Y-rays 13
Lenght of spines 75
Thickness of spines (at base) 15—20

Description. — Megaspore rounded, flattened proximo-distally. Trilete rays developed as low ridges. Numerous, sharply pointed spines, cover the whole spore surface.

Remarks. — The described specimen differ from *Echitriletes*? sp. 1 in having a smaller diameter and densely distributed, sharply pointed spines. Both *Echitriletes*? sp. 1 and *Echitriletes*? sp. 2 differ from *Biharisporites* Potonié, 1956, *Echitriletes* (van der Hammen, 1954) Potonié, 1956 and *Narkisporites* Kannegieser & Kozur (1972) in their well developed, massive spines.

Occurrence. — Boża Wola IG-I, depth 1841 m, Bunter (Olenekian (Röt)), meridional megacyclothem.

Genus *Horstisporites* Potonié, 1956

Horstisporites heteroretiuilatus n. sp.

(Pl. XXVIII, Figs 2*a*, 2*b*)

Holotypus: Specimen No. 34; Pl. XXVIII, Figs 2*a*, 2*b*.
Stratum typicum: Indus, Upper-oolitic Beds, I megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 2012 m.
Derivatio nominis: Gr. *heteros* — different, Lat. *reticulum* — net.

Material. — 3 specimens.

Dimensions (in microns):

Diameters of megaspores 400—464
Length of Y-rays = R
Width of Y-rays 6—8
Height of Y-rays 6—12
Diameter of lumina of reticilum on proximal side 12—16
Diameter of lumina of reticulum on distal side 23—46
Thickness of reticulum walls 3—5
Height of reticulum walls 15—20
Thickness of exine 8—10

Description. — Megaspores rounded, trilete rays poorly developed as narrow jagged bands. Curvature not well developed, visible only on specimens laterally flattened. A characteristic reticulum covers the whole spores surface. Diameters of lumina of reticulum much bigger distally than proximally. Luminae multilateral with walls strongly jagged.

Remarks. — *Horstisporites heteroreticulatus* n. sp. differs from other species of this genus in its unequal lumina diameters which are smaller proximally and larger distally.

Occurrence. — Nidzica IG-I, depth 2012 m — 2018 m, Bunter (Indus), Upper-oolitic Beds, boreal megacyclothem.

Horstisporites microlumenus Dettmann, 1961
(Pl. XXVIII, Figs 1*a*, 1*b*)

1961. *Horstisporites microlumenus* Dettmann; Dettmann, p. 75—76. Pl. 2, Figs 8—13.

Material. — 18 well preserved specimens.

Dimensions (in microns):

Diameters of megaspores 290—460 (usually 350—400)
Length of Y-rays = 0.8R-R
Width of Y-rays 6—10
Height of Y-rays 15—23
Diameters of luminae of reticulum 6—15
Height of reticulum walls 6—10
Thickness of reticulum walls 3—5
Thickness of exine 10—15

Description. — Megaspores rounded or round. Most specimens flattened proximo-distally. Trilete rays developed as narrow bands. Curvature not well developed. A weakly marked recticulum present on spore surface. Luminae of reticulum irregular with walls often jagged.

Remarks. — Specimens from Poland differ from those described by Dettmann (1961) in longer trilete rays and slightly higher reticulum walls.

Occurrence. — Poland: Nidzica IG-I, depth 1935.2 m — 1948 m, Olszyny IG-I, depth 1355 m, Pasłęk IG-I, depth 1156 m — 1158 m, Bunter: (Olenekian-Anisian?), meridional megacyclothem. Tasmania — Triassic.

Horstisporites spinosus n. sp.
(Pl. XXVI, Figs 1*a*, 1*b*)

Holotypus: Specimen No. 35; Pl. XXVI, Figs 1*a*, 1*b*.
Stratum typicum: Indus, Upper-oolitic Beds, I megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 2012 m.
Derivatio nominis: Lat. *spinosus* — spiny.

Material. — 7 specimen (5 well preserved).

Dimensions (in microns):

Diameters of megaspores (without spines) 302—383
Length of Y-rays = 0.9R-R
Width of Y-rays 6—10
Height of Y-rays 20—35
Diameter of luminae of reticulum 15—23
Thickness of reticulum walls 4—8
Length of spines 15—23
Thickness of spines (at base) ca 5
Thickness of exine 6—10

Description. — Megaspores subtriangular or round, usually flattened proximo-distally. Trilete rays well developed as narrow, straight, sometimes very jagged bands. Curvature usually lacking, when present it is expressed as a weakly marked ridge. In this case the contact areas are slightly elevated in comparison to the rest of the spore. A reticulum present on the spore surface with numerous spines developed on its walls. In some specimens, similar spines also occur on trilete rays. Reticulum better developed distally.

Remarks. — The described species is very variable as to outline, development of curvature and contact areas. It differs from other species of this genus in the presence of spines on the reticular spore surface.

Occurrence. — Nidzica IG-I, depth 2012 m — 2018 m, Bunter (Indus), Upper-oolitic Beds, boreal megacyclothem.

Horstisporites sulcatus n. sp.
(Pl. XXX, Figs 3, 4)

Holotypus: Specimen No. 36; Pl. XXX, Fig. 3.
Stratum typicum: Indus, Upper-oolitic Beds, I megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 2018 m.
Derivatio nominis: Lat. *sulcatus* — grooved.

Material. — 28 specimens, of these 18 well preserved.
Dimensions (in microns):

Diameters of megaspores 350—520 (usually 400—450)
Length of Y-rays = R
Width of Y-rays (at base) 20—35
Height of Y-rays up to 100
Width of curvature 35—40
Width of ridges on spores surface up to 10—12
Diameter of reticulum luminae on distal side ca 23
Height of appendages 2—4
Diameter of appendages 2—3
Thickness of exine 12—25

Description. — Megaspores rounded or round. Trilete rays expressed as very well developed bands, high, straight or undulated, sometimes jagged. They are not smooth but with transverse grooves and ridges. Curvature well developed in the form of a rather thick ridge. Contact area much swollen and elevated above the rest of the spore. Narrow, shallow grooves or small ridges lie meridionally on spore sides and often cohere to form an indistinctly marked reticulum. The reticular character of the spore surface is most visible distally. Also covering the spore surface are numerous small yellow appendages, mostly with rounded ends and a glassy shine.

Remarks. — The described species is closest in surface sculpture to *Horstisporites harrisi* (Murray) Pot. described by Bertelsen (1970). *Horstisporites sulcatus* n. sp. differs from the latter in its swollen contact areas, longer and higher trilete rays, more developed curvature and presence of appendages on spore surface.

Occurrence. — Nidzica IG-I, depth 2012 m — 2018 m, Olszyny IG-I, depth 1410 m, Bunter (Indus), Upper-oolitic Beds, boreal megacyclothem.

Horstisporites elegans n. sp.

(Pl. XXX, Figs *6a*, *6b*)

Holotypus: Specimen No. 43; Pl. XXX, Figs *6a*, *6b*.
Stratum typicum: Indus, Upper-oolitic Beds, I megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 2018 m.
Derivatio nominis: Lat. *elegans* — graceful.

Material. — 10 well preserved specimens.
Dimensions (in microns):

Diameter of megaspores 370-550
Length of Y-rays = R
Width of Y-rays (at base) ca 25
Height of Y-rays 60
Width of ridges on spores surface 6—12
Diameter of reticulum luminae on distal side 20—30
Height of appendages 8—12
Diameter of appendages 8—10

Description. — Megaspores round. Trilete rays well developed as straight transversely grooved bands. Curvature not well developed but distinctly marked. Distal side of the spore covered by delicate numerous grooves, separated by small ridges, irregularly undulated and directed meridionally. Grooves and ridges join in places to form a weakly developed reticulum. Direction of grooves and ridges less clear on distal side, where ornamentation has the character of a better developed reticulum Numerous brown verrucose appendages, randomly distributed and with a glassy shine occur on the whole spore surface, mostly in concavities.

Remarks. — Described species is similar to *Horstisporites harrisi* (Murray) Pot., from which it differs in length of trilete rays and presence of appendages on spore surface. *Horstisporites elegans* n. sp differs from *Horstisporites sulcatus* n. sp. in having flat contact areas.

Occurrence. — Nidzica IG-I, depth — 2018 m, Gorzów Wielkopolski IG-I, Subsudetian monocline, Bunter (Indus), boreal megacyclothem.

Genus *Erlansonisporites* Potonié, 1956

Erlansonisporites sp.

(Pl. XXVIII, Figs *3a*, *3b*)

Material. — One damaged specimen.
Dimensions (in microns):

Diameter of megaspore 440
Length of Y-rays = 0.8R
Width of Y-rays 10
Height of Y-rays 60
Width of bands 6—10
Height of bands 10—30
Height of megaspore 130
Thickness of exine ca 15

Description. — Megaspore rounded, flattened proximo-distally. Trilete rays well developed as high, slightly undulated bands. Curvature lacking. Numerous irregular bands form a labyrinth on spore surface. These bands are strongly bent, branching in different directions and cover the whole of the distal side, crossing over to the proximal side to disappear in contact areas.

Occurence. — Nidzica IG-I, depth 2018 m, Bunter (Indus), Upper-oolitic Beds, boreal megacyclothem.

Genus *Macrosporites* Renault, 1899

Macrosporites makowskii n. sp.

(Pl. XXIX, Figs 5*a*, 5*b*; Pl. XXXI, Fig. 5)

pars 1969. *Macrosporites beutleri* (Reinhardt, 1963) n. comb.; P. Reinhardt & D. Fricke, Megasporen..., p. 408, Abb. 5.

Holotypus: Specimen No. 38; Pl. XXIX, Figs 5*a*, 5*b*; Pl. XXXI, Fig. 5.
Stratum typicum: Olenekian, II megaspore assemblage.
Locus typicus: Boża Wola IG-I, depth 1842.5 m.
Derivatio nominis: in honour of Prof. Dr H. Makowski.

Material. — 7 specimen; 3 of them well preserved.
Dimensions (in microns):

Diameters of megaspores (without zone) 400—540
Length of Y-rays = R
Width of Y-rays 10—15
Height of Y-rays up to 40
Width of zone up to 110
Diameter of luminae of reticulum ca 20
Thickness of exine 3—4

Description. — Megaspores usually subtriangular or round; flattened proximo-distally. Trilete rays well marked as uneven narrow bands or delicate ridges. In equatorial part occurs a dense zone composed of a thin transparent membrane with a slightly perforated edge and a few radial delicate veins. Spores surface covered by a fine reticulum with narrow low walls.

Remarks. — The above described spores correspond to some forms included by Reinhardt & Fricke (1969) within the range of variability of *Macrosporites beutleri*. According to the present author, Reinhardt &

Fricke attributed too wide arange to this species, joining together forms with the typical features of genus *Macrosporites* Renault 1899 and *Dijkstraisporites* Potonié, 1956.

Occurrence. — Poland: Boża Wola IG-I, depth 1841 m — 1842,5 m, Bunter (Olenekian (Röt)), meridional megacyclothem. Germany — Lower Keuper.

Genus *Dijkstraisporites* Potonié, 1956
Dijkstraisporites beutleri Reinhardt, 1963
(Pl. XXVI, Figs 3*a*, 3*b*)

1963. *Dijkstraisporites beutleri* n. sp.; P. Reinhardt, Megasporen... — p. 120—121, Pl. 2, Fig. 6.
pars 1969. *Macrosporites beutleri* (Reinhardt 1963) n. comb.; P. Reinhardt & D. Fricke, Megasporen..., p. 408, Pl. 2, Fig. 5, non Abb. 5, p. 408.
1972. *Dijkstraisporites beutleri* Reinhardt; E. Kannegieser & H. Kozur, Zur Mikropalä ontologie..., Pl. 8, Fig. 7.

Material. — 11 specimens, 7 being well preserved.

Dimensions (in microns):

Diameters of megaspore 406—530
Length of Y-rays = R
Width of Y-rays 10—15
Height of Y-rays 45—60
Width of zone 60—100
Diameter of luminae of reticulum 35—45
Thickness of reticulum walls 3—5
Length of appendages ca 60
Thickness of exine ca 4

Description. — Megaspores subtriangular or round. Trilete rays well developed as a high band, to a greater or lesser degree jagged. A zone composed of numerous well marked radial veins and a membrane with its sides strongly fringed occurs in the equatorial part of the spore. A reticulum with appendages present on walls occurs on spore sides. These appendages are free or entwined, often cohering at their base. Reticulum is most distinct on worse preserved specimens where appendages have been damaged.

Remarks. — Polish specimens differ from those described by Reinhardt & Fricke (1969) in a narrower zone, thinner reticular walls and bigger luminae diameter. Nevertheless the present author considers, on the base of a comparison with new and rich material, that these differences fall within the range of variability within the species.

Occurrence. — Poland: Nidzica IG-I, depth 1898.4 m — 1961.5 m, Boża Wola IG-I- depth 1842 m — 1843 m, Bunter (Olenekian-Anisian?), meridional megacyclothem. Germany — Lower Keuper.

Genus *Tenellisporites* Potonié, 1956

Tenellisporites cf. *marcinkiewiczae* Reinhardt & Fricke, 1969

(Pl. XXIX, Figs 2*a*, 2*b*)

Material. — Two specimens (1 lacking a rim).

Dimensions (in microns):

Diameter of megaspores 371.380 (excluding rim)
Length of Y-rays = R
Width of Y-rays (at base) 23
Height of Y-rays ca 35
Length of appendages on the rim 60
Width of single appendages on the rim (at base) 15—35
Length of appendages on proximal side up to 23
Length of appendages on distal side up to 35
Thickness of appendages (at base) 10—20

Description. — Megaspores rounded or round, flattened proximo-distally. Trilete rays very well developed as straight bands with sharp edges. On one specimen, a rim occurs in equatorial zone. It is composed of a few appendages, free or cohering at the base and usually flattened. Appendages poorly developed with pointed or rounded ends also present on spore surface. They are best developed on distal side where the ends are usually rounded.

Remarks. — Described specimens are closest to *Tenellisporites marcinkiewiczae* Reinhardt, from which they differ in shorter rim appendages. Scarcity of specimens and their bad state of preservation prevents a closer identification.

Occurrence. — Poland: Pasłęk IG-I, depth 1138 m Bunter (Anisian?), meridional megacyclothem. Germany — Lower Keuper.

Genus *Hughesisporites* Potonié, 1956

Hughesisporites inflatus n. sp.

(Pl. XXX, Figs 1, 2)

Holotypus: Specimen No. 40, Pl. XXX, Fig. 1.
Stratum typicum: Indus, Upper-oolitic Beds, I megaspore assemblage.
Locus typicus: Boża Wola IG-I, depth 2002 m.
Derivatio nominis: Lat. *inflatus* — swollen.

Material. — Some tens of well preserved specimens.

Dimensions (in microns):

Diameters of megaspores 260—420 (usually ca 370)
Length of Y-rays 0,7R—0,9R
Width of Y-rays 15—23
Height of Y-rays 20—45
Height of megaspores up to 114
Thickness of exine 10—15

Description. — Megaspores subtriangular with rounded apexes and convex sides. All specimens flattened proximo-distally. Trilete rays very well developed in the form of ridges or bands, which in equatorial zone form characteristic swellings. Curvature lacking. Contact areas cover about 2/3 of proximal side being usually swollen and elevated in relation to the rest of the spore, which is flat. Sometimes a shallow groove separates contact areas from the rest of the spore. Spore surface smooth, with the exception of the contact areas, which have numerous ridges and grooves similar to those in *Hughesisporites variabilis* Dett. Grooves also present on the trilete rays of some specimens.

Remarks. — *Hughesisporites inflatus* n. sp. differs from other species belonging to the genus in its elevated contact areas.

Occurrence. — Boża Wola IG-I, depth 2002 m, Bunter (Indus), Upper-oolitic Beds, boreal megacyclothem.

Hughesisporites variabilis Dettmann, 1961
(Pl. XXX, Figs 5*a*, 5*b*)

1961. *Hughesisporites variabilis* Dettmann, M. E. Dettmann, Lower Mesozoic..., p. 76, Pl. 1, Figs 15—20; Pl. 2, Fig. 1.

Material. — Over a 100 well preserved specimens.
Dimensions (in microns):

Diameters of megaspores 290—600 (usually 450—500)
Length of Y-rays 0,75R—0,8R
Width of Y-rays 18—23
Height of Y-rays 20—40
Thickness of exine 10—18

Description. — Megaspores rounded or round, flattened proximo-distally. Trilete rays very well developed as rather high, usually straight bands or ridges. Curvature lacking. Spore surface smooth, with exception of contact area where numerous ridges and grooves of varying width and length occur. Width of ridges range from 12 to 20 microns, their maximal length — to a 100 microns. They are usually undulated, radially arranged, often connected with one another.

Remarks. — *Hughesisporites variabilis* Dett. differs from *Hughesisporites inflatus* n. sp in having flat contact areas.

Occurrence. — Poland: Boża Wola IG-I, depth 2000 m — 2020 m, Bunter (Indus), Upper-oolitic Beds, boreal megacyclothem. Tasmania — Triassic.

Genus *Aneuletes* Harris, 1961

Aneuletes rotundus n. sp.

(Pl. XIX, Figs 2, 5*a*, 5*b*; Pl. XXXI, Fig. 4)

Holotypus: Specimen No. 42, Pl. XIX, Fig. 2.
Stratum typicum: Olenekian, II megaspore assemblage.
Locus typicus: Nidzica IG-I, depth 1948.
Derivatio nominis: Lat. *rotundus* — round.

Material. — 14 well preserved specimens.
Dimensions (in microns):

Diameters of spores 220—450
Thickness of ridgelike swellings 12—24
Thickness of exine 8—15

Description. — Spores usually round. Trilete rays lacking. On one side of the spore occurs a delicate concavity, sometimes separated from the rest of the spore by a faintly marked ridge. Present in this concavity are elongated ridgelike swellings, irregularly undulate. Spore surface smooth, lustrous.

Remarks. — Described species differs from *Aneuletes patera* Harris (1961) in having a small diameter, absence of knobs in concavity and lack of small pits on spore surface. *Aneuletes rotundus* n. sp. differs from specimens described by Marcinkiewicz (1971) in the lacks of knobs in the concavity.

Occurrence. — Nidzica IG-I, depth 1948 m — 1961,5 m, Olszyny IG-I, depth 1355 m, Pasłęk IG-I, depth 1156 m, Boża Wola IG-I, depth 1841 m, Bunter (Olenekian), meridional megacyclothem.

Megaspores incertae sedis

Triletes sp.

(Pl. XXV, Figs 1*a*, 1*b*)

Material. — One well preserved specimen.
Dimensions (in microns):

Diameter of megaspore 400
Length of Y-rays 0,8R
Width of Y-rays 15
Height of Y-rays ca 12
Width of curvature 14
Diameter of concavities on spore surface ca 10

Description. — Megaspore round in outline. Trilete rays well developed in the form of straight ridges. Curvature developed as an unevenly indented ridge, which in places passes into densely arranged round knobs. The whole spore surface covered by numerous unevenly spaced small hollows.

Occurrence. — Nidzica IG-I, depth 2018 m, Bunter (Indus) Upper-oolitic Beds, boreal megacyclothem.

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RYSZARD FUGLEWICZ

MEGASPORY PSTREGO PIASKOWCA POLSKI I ICH ZNACZENIE STRATYGRAFICZNE

Streszczenie

Przedmiotem pracy jest próba przedstawienia biostratygrafii utworów dolnego triasu oraz korelacja różnych facjalnie osadów tego wieku na podstawie megaspor. Materiał do badań stanowiły próby z czterech wierceń z obszaru Polski Północno-Wschodniej (Nidzica IG-1, Olszyny IG-1, Pasłęk IG-1) oraz Polski Centralnej (Boża Wola IG-1). Do opracowania pobierano głównie próby ilaste i mułowcowe o zabarwieniu ciemnym bądź zielonkawym. Próby rozpuszczano w kwasie solnym i następnie przemywano wodą na sicie, celem usunięcia cząstek poniżej 0,1 mm. Po wysuszeniu osadu próbę poddawano działaniu kwasu fluorowodorowego w stosunku 1:3. Po 2—3 dobach do próby po uprzednim zdekantowaniu dolewano ponownie 10% HCl i pozostawiano na jedną dobę celem usunięcia koloidalnej krzemionki i fluorokrzemianów. Następnie po kilkakrotnym przemyciu wodą i zdekantowaniu ponownie próbę przemywano na sicie o średnicy oczek 0,1 mm. Megaspory wybierano na mokro z wody pipetką pod binokularem. Dla ich rozjaśnienia stosowano mieszaninę utleniającą Schulzego (HNO_3+KClO_3).

W obecnej pracy megaspory opracowywane były przeważnie w stanie suchym, w świetle odbitym. Niektóre okazy badano w świetle przechodzącym w preparatach z gliceróżelatyny. Systematykę megaspor oparto na morfograficznym systemie Potoniégo (1956).

Opisano 39 gatunków megaspor należących do 15 rodzajów, w tym 1 rodzaj oraz 29 gatunków uznano za nowe.

Porównanie megaspor pstrego piaskowca z megasporami opisanymi z kajpru i jury dolnej (megaspory permskie nie są znane z obszaru Europy) pozwala na stwierdzenie, że megaspory pstrego piaskowca mają charakter w pełni mezofityczny. Z wyjątkiem opisanego nowego rodzaju *Pusulosporites* n.gen wszystkie rodzaje megaspor opisane z pstrego piaskowca znane są z młodszych utworów mezozoicznych. Pod względem gatunkowym opisane megaspory w większości przedstawiają gatunki nowe. Na podkreślenie zasługuje szeroki zasięg geograficzny takich gatunków jak: *Trileites vulgaris* n.sp., *Trileites sinuosus* (Dett.) comb.n., *Horstisporites microlumenus* Dett., *Hughesisporites variabilis* Dett., opisanych z obszaru Tasmanii przez Dettmann (1961).

Szczegółowa analiza megasporowa wykazała, że większość gatunków ma stosunkowo krótki zasięg pionowy. Na tej podstawie wyróżniono 3 zespoły megasporowe o odmiennym składzie gatunkowym (I, II, III), (Tabela 3). I zespół megasporowy jest charakterystyczny dla górnej części indu (warstwy oolitowe górne), II-gi dla oleneku, a III-ci najprawdopodobniej należy już do anizyku.

Na podstawie korelacji utworów retu (wiercenie Boża Wola IG-1) z osadami pstrego piaskowca z obszaru Polski NE w oparciu o megaspory wykazano, że osady zaliczane dotychczas do środkowego pstrego piaskowca (Szyperko-Śliwczyńska, 1961, 1962, 1964) w rzeczywistości odpowiadają retowi i prawdopodobnie dolnemu wapieniowi muszlowemu.

W oparciu o zespoły megasporowe oraz o cykliczne następstwo kompleksów litologicznych wypracowano nowy podział stratygraficzny pstrego piaskowca (Tabela 1). Dotychczasowy podział stratygraficzny pstrego piaskowca, opracowany na obszarze niecki germańskiej, opierał się na litologii. Brak skamieniałości przewodnich oraz zawodność kryteriów litologicznych uniemożliwiały dokładną korelację oddalonych od siebie profili.

Analiza materiałów własnych oraz zapoznanie się z innymi profilami triasu obniżenia polsko-niemieckiego pozwoliły autorowi na wyciągnięcie nowych wniosków stratygraficznych i paleogeograficznych.

Na podstawie wykształcenia litologicznego osadów, ich zabarwienia i występowania w nich szczątków organicznych wyróżniono w obrębie badanych utworów dwa odrębne megacyklotemy: borealny i meridionalny. Utwory megacyklotemu borealnego osadziły się w podobnych do cechsztyńskich warunkach paleogeograficznych i tektonicznych. Charakter sedymentacji osadów tego megacyklotemu związany był z istnieniem bądź brakiem połączenia basenu polsko-niemieckiego z morzem borealnym. W obrębie tego megacyklotemu wyróżniono dwa mniejsze cyklotemy, z których każdy zaczyna się osadami zamkniętego zbiornika śródlądowego (warstwy podoolitowe i warstwy międzyoolitowe), a kończy utworami oolitowymi (warstwy oolitowe dolne i warstwy oolitowe górne), rejestrującymi połączenie się basenu polsko-niemieckiego z morzem borealnym. Trzeci cyklotem (warstwy nadoolitowe) jest niepełny.

Megacyklotem meridionalny zapoczątkowany został przebudową strukturalną basenu polsko-niemieckiego. Sedymentacja osadów tego megacyklotemu (ret i wapień muszlowy) uzależniona była od połączenia basenu polsko-niemieckiego z oceanem Tetydy.

W oparciu o badane profile podano krótki zarys warunków paleogeograficznych.

РИШАРД ФУГЛЕВИЧ

МЕГАСПОРЫ ПЕСТРОГО ПЕСЧАНИКА ПОЛЬШИ И ИХ СТРАТИГРАФИЧЕСКОЕ ЗНАЧЕНИЕ

Резюме

В настоящей работе представлена попытка биостратиграфического расчленения нижнего триаса и корреляция отложений разного фациального состава на основании мегаспор. Иследования проводились на материалах четырех буровых скважин, пройденных в Северо-Восточной (Нидзица ИГ-I, Ольшины ИГ-I, Пасленк ИГ-I) и Центральной (Божа-Воля ИГ-I) Польше. Опробование производилось, главным образом в глинистых и алевритовых осадках темноцветной или зеленоватой окраски. Образцы обрабатывались соляной кислотой с последующей промывкой водой на сите с целью удаления частиц мельче 0,1 мм. После сушки осдака образцы заливались плавиковой кислотой в соотношении 1:3. После 2—3 суток к предварительно декантированным образцам добавлялась снова 10% HCl. Образцы отстаивались в течение суток для удаления коллоидного кремнезёма и фторосиликата. Затем, после мнгократной промывки водой и декантации, образцы промывались на сите 0,1 мм. Мегаспоры извлекались из мокрого образца с помощью пипетки под бинокуляром. С целью их просветления применялась окислительная смесь Шульце.

В данной работе мегаспоры исследовались, как правило, в сухом состоянии, в отраженном свете. Некоторые экземпляры изучались в проходящем свете в препаратах с глицерин-желатином. Классификация мегаспор проведена согласно морфографической системе Потонье (1956).

Описание охватывает 39 видов мегаспор, принадлежащих к 15 родам, в том числе 1 род и 29 видов признаны новыми.

Сопоставление мегаспор пестрого песчаника с мегаспорами, которые были описаны из кейпера и нижней юры (пермские мегаспоры на территории Европы не известны), позволяет отметить, что мегаспоры, приуроченные к пестрому песчанику, отличаются полностью мезофитным характером. За исключением описанного здесь нового рода *Pusulosporites* n. gen., все остальные роды пестрого песчаника распространены также в младших мезозойский отложениях. В видовом отношении подавляющая часть описанных мегаспор относится к новым видам. Внимание привлекает широкое географическое распространение таких видов как: *Trileites vulgaris* n. sp., *Trileites sinuosus* (Dett.) comb. n., *Horstisporites microlumenus* Dett., *Hughesisporites variabilis* Dett., описанных с территории Тасмании (Деттманн, 1961).

Детальный мегаспоровый анализ выявил, что большинство видов характеризуется узким интервалом вертикального распространения. На этом основании выделены три сообщества мегаспор разного видового состава (I, II, III), представленные на таблице 3. I мегаспоровое сообщество характеризует верхний интервал инда (верхние оолитовые слои), II — оленекские слои, а III — вероятнее всего, относится уже к анизийскому ярусу.

На основании корреляции пород рёта (скважина Божа-Воля ИГ-I) с породами пестрого песчаника Северо-Восточной Польши, проведенной по мегаспорам, доказано, что отложения, относимые до сих пор к среднему пестрому песчанику (Шиперко-Сливчиньска, 1961, 1962, 1964), в действительности соответствуют рёту и, вероятно, нижнему раковинному известняку.

Мегаспоровые сообщества и циклическая последовательность литологических комплексов послужили основой разработки нового стратиграфического расчленения пестрого песчаника (фиг. 1). Существующая до сих пор схема расчленения пестрого песчаника, составленная для территории Германской мульды, основывалась на литологических критериях. Отсутствие руководящих окаменелостей и ненадежность литологических критериев не позволяли проводить детальную корреляцию разрезов в отдаленных друг от друга районах.

Анализ собранных автором материалов, а также ознакомление с другими разрезами триаса Польско-Германской низменности, предоставили возможность сделать ряд новых стратиграфических и палеогеографических заключений.

На основании литологического состава и окраски осадков, а также их органического содержимого, исследованные отложения подразделяются на две мегациклотемы — бореальную и меридиональную. Осадки бореальной меза-циклотемы образовались в сходных с цехштейновыми палеогеографических и тектонических условиях. Осадконакопление этой мегациклотемы проходило в зависимости от наличия или отсутствия соединения польско- германского бассейна с бореальным морем. Эта мегациклотема подразделяется на две меньших циклотемы, каждая из которых начинается с осадков изолированного континентального водоема (подоолитовые слои и межоолитовые слои) и завершается оолитовыми отложениями (нижние оолитовые слои и верхние оолитовые слои), знаменующими соединение польско-германского бассейна с бореальным морем. Третья циклотема (надоолитовые слои) развита в неполном виде.

Меридиональная мегациклотема началась со структурной перестройки польско-германского бассейна. Осадконакопление этой мегациклотемы (рёт и раковинный известняк) определялось соединением польско-германского бассейна с Тетисом.

На сновании изученных разрезов в работе представлен краткий очерк палеогеографических условий.

EXPLANATION OF PLATES

Photographs in Plates XIX—XXXI taken in reflected light:
Figures in Plates XIX—XXX enlarged ×100
On all Plates: *a* — proximal side; *b* — distal side

Plate XIX

Fig. 1.	*Pusulosporites inflatus* n.gen., n.sp.
Figs 2, 5*a*, 5*b*.	*Aneuletes rotundus* n.sp.
Figs 3, 6, 7.	*Pusulosporites inflatus* n.sp.
Fig. 4.	*Trileites tenellus* n.sp.
Fig. 8.	*Trileites levis* n.sp.
Fig. 9.	*Trileites grandis* n.sp.

Plate XX

Figs 1, 2, 7, 8.	*Trileites vulgaris* n. sp.
Figs 3, 5, 6.	*Trileites polonicus* n. sp.
Fig. 4.	*Trileites sinuosus* (Dett.) n. comb.

Plate XXI

Figs 1*a*, 1*b*.	*Verrutriletes fragilis* n.sp.
Figs 2*a*, 2*b*.	*Maexisporites piramidalis* n.sp.
Figs 3*a*, 3*b*.	*Maexisporites pyramidalis* n.sp.
Figs 4, 6.	*Trileites validus* n.sp.
Figs 5*a*, 5*b*.	*Maexisporites rotundus* n.sp.

Plate XXII

Figs 1, 2, 3, 4.	*Bacutriletes asaphus* n.sp.
Figs 5*a*, 5*b*, 6, 7.	*Pusulosporites populosus* n.gen., n.sp.

Plate XXIII

Fig. 1.	*Bacutriletes globosus* n.sp.
Figs 2*a*, 2*b*.	*Bacutriletes insolitus* n.sp.
Figs 3*a*, 3*b*, 4.	*Pusulosporites crassus* n.gen., n.sp.

Plate XXIV

Figs 1*a*, 1*b*, 2.	*Echitriletes gracilis* n.sp.
Fig. 3.	*Bacutriletes insolitus* n.sp.
Figs 4, 5*a*, 5*b*, 6.	*Echitriletes echinatus* n.sp.

Plate XXV

Figs 1*a*, 1*b*.	*Triletes* sp.
Figs 2*a*, 2*b*.	*Narkisporites brevispinosus* n.sp.
Figs 3*a*, 3*b*, 4, 5.	*Narkisporites harrisi* (Reinh. & Fricke) Kozur

Plate XXVI

Figs 1*a*, 1*b*.	*Horstisporites spinosus* n.sp.
Figs 2*a*, 2*b*, 4*a*, 4*b*.	*Echitriletes multispinosus* n.sp.
Figs 3*a*, 3*b*.	*Dijkstraisporites beutleri* Reinh.

Plate XXVII

Figs 1*a*, 1*b*.	*Echitriletes*? sp. 1

Plate XXVIII

Figs 1*a*, 1*b*.	*Horstisporites microlumenus* Dett.
Figs 2*a*, 2*b*.	*Horstisporites heteroreticulatus* n.sp.
Figs 3*a*, 3*b*.	*Erlansonisporites* sp.
Figs 4*a*, 4*b*.	*Echitriletes*? sp. 2

Plate XXIX

Figs 1, 3*a*, 3*b*, 4.	*Narkisporites insignis* n.sp.
Figs 2*a*, 2*b*.	*Tenellisporites* cf. *marcinkiewiczae* Reinh. & Fricke
Figs 5*a*, 5*b*.	*Macrosporites makowskii* n.sp.

Plate XXX

Figs 1, 2.	*Hughesisporites inflatus* n.sp.
Figs 3, 4.	*Horstisporites sulcatus* n.sp.
Figs 5*a*, 5*b*.	*Hughesisporites variabilis* Dett.
Figs 6*a*, 6*b*.	*Horstisporites elegans* n.sp.

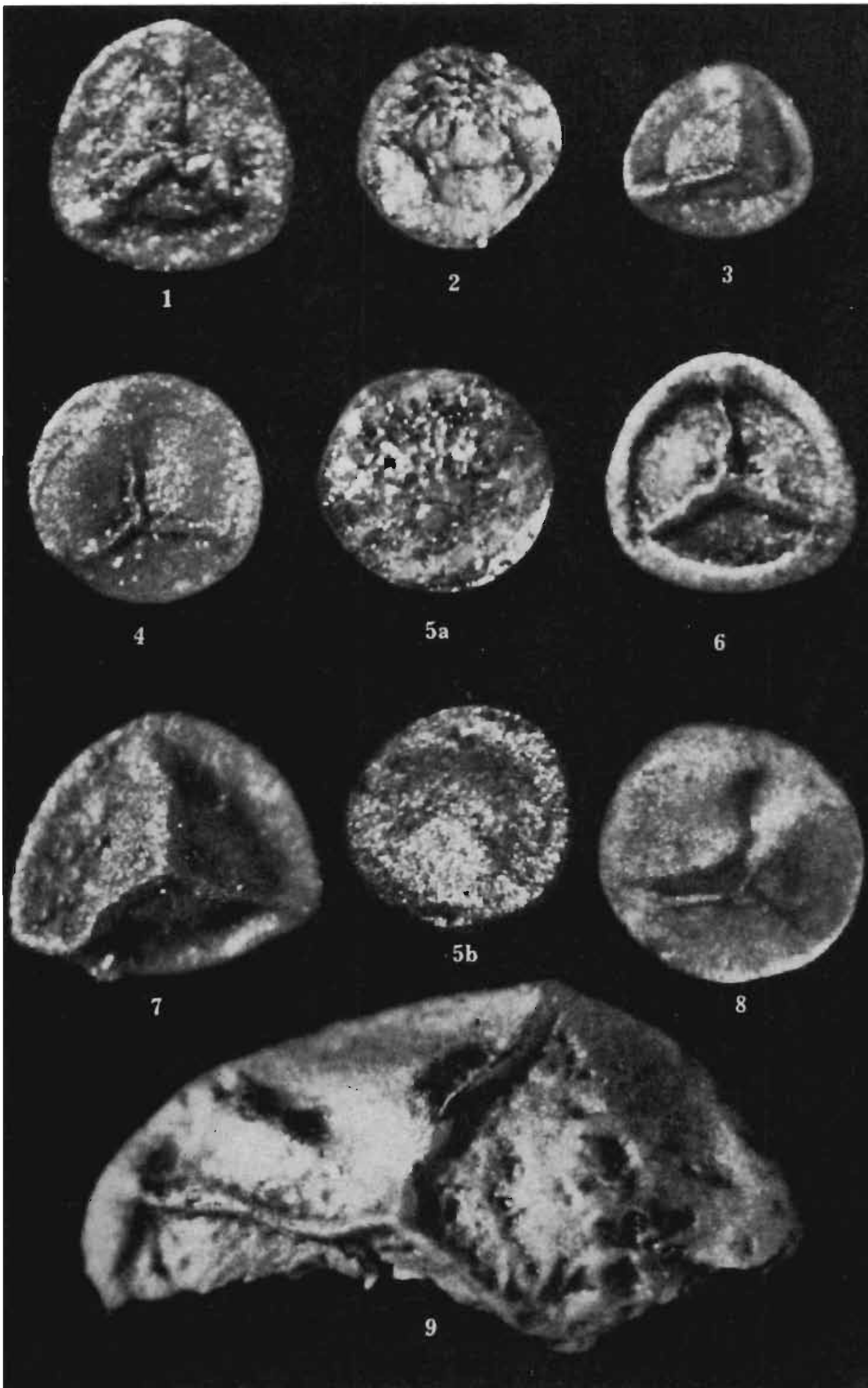
Plate XXXI

Fig. 1.	*Pusulosporites inflatus* n.sp.; mesosporoid, ×150
Figs. 2, 8.	*Trileites vulgaris* n.sp.; ×100
Fig. 3.	*Pusulosporites inflatus* n.sp., ×150
Fig. 4.	*Aneuletes rotundus* n.sp.; ×150
Fig. 5.	*Macrosporites makowskii* n.sp.; fragment of a zone; ×100
Fig. 6.	*Maexisporites pyramidalis* n.sp.; ×150
Fig. 7.	*Bacutriletes insolitus* n.sp.; fragment of exine with appendages; ×200

Plate XXXII

Fig. 1. *Bacutriletes globosus* n.sp.; fragment of exine with appendages; ×300
Fig. 2. *Pusulosporites populosus* n.sp.; fragment of exine with appendages; ×300
Fig. 3. *Echitriletes echinatus* n.sp.; fragment of exine with appendages; ×200

All photographs in transmitted light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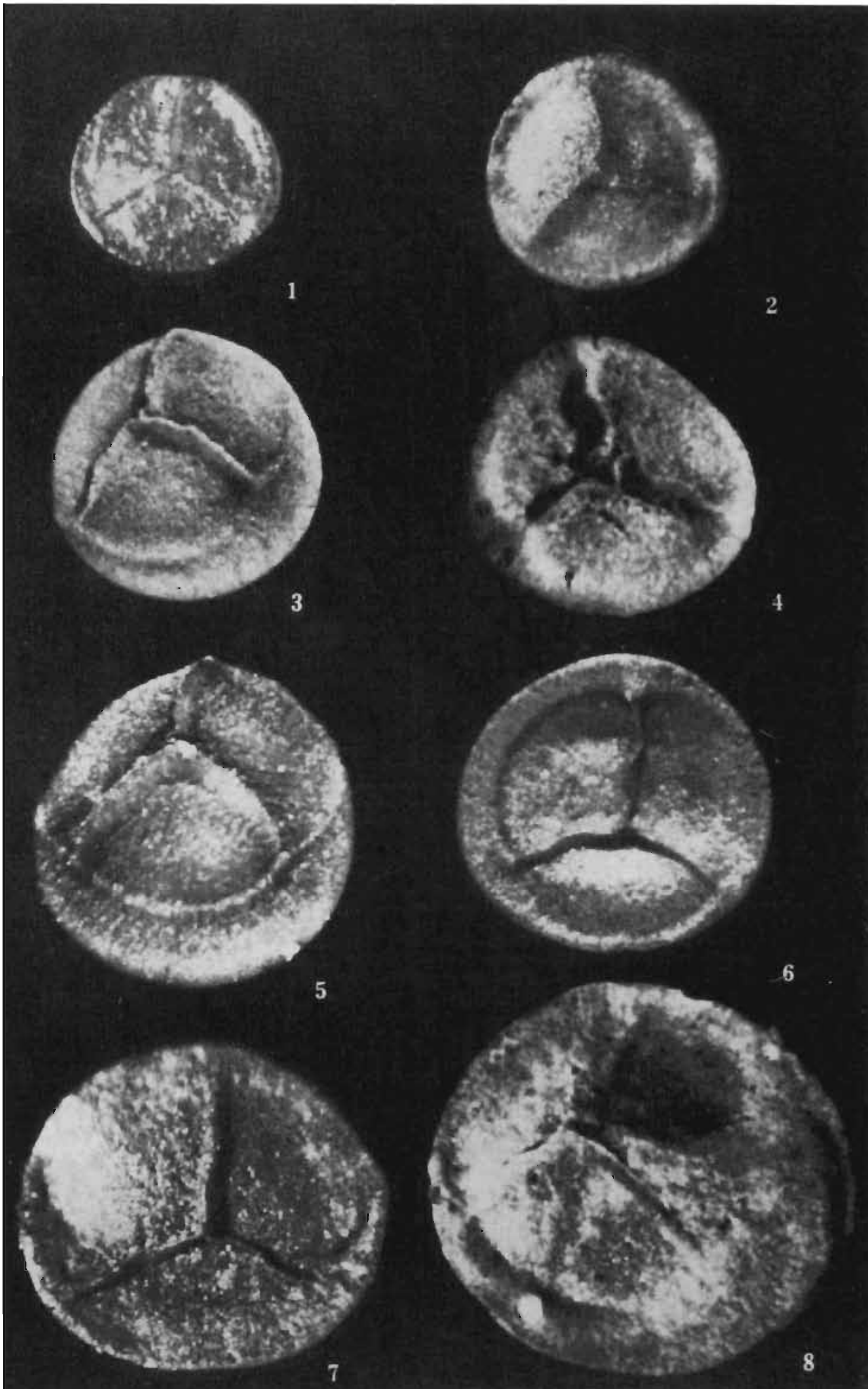
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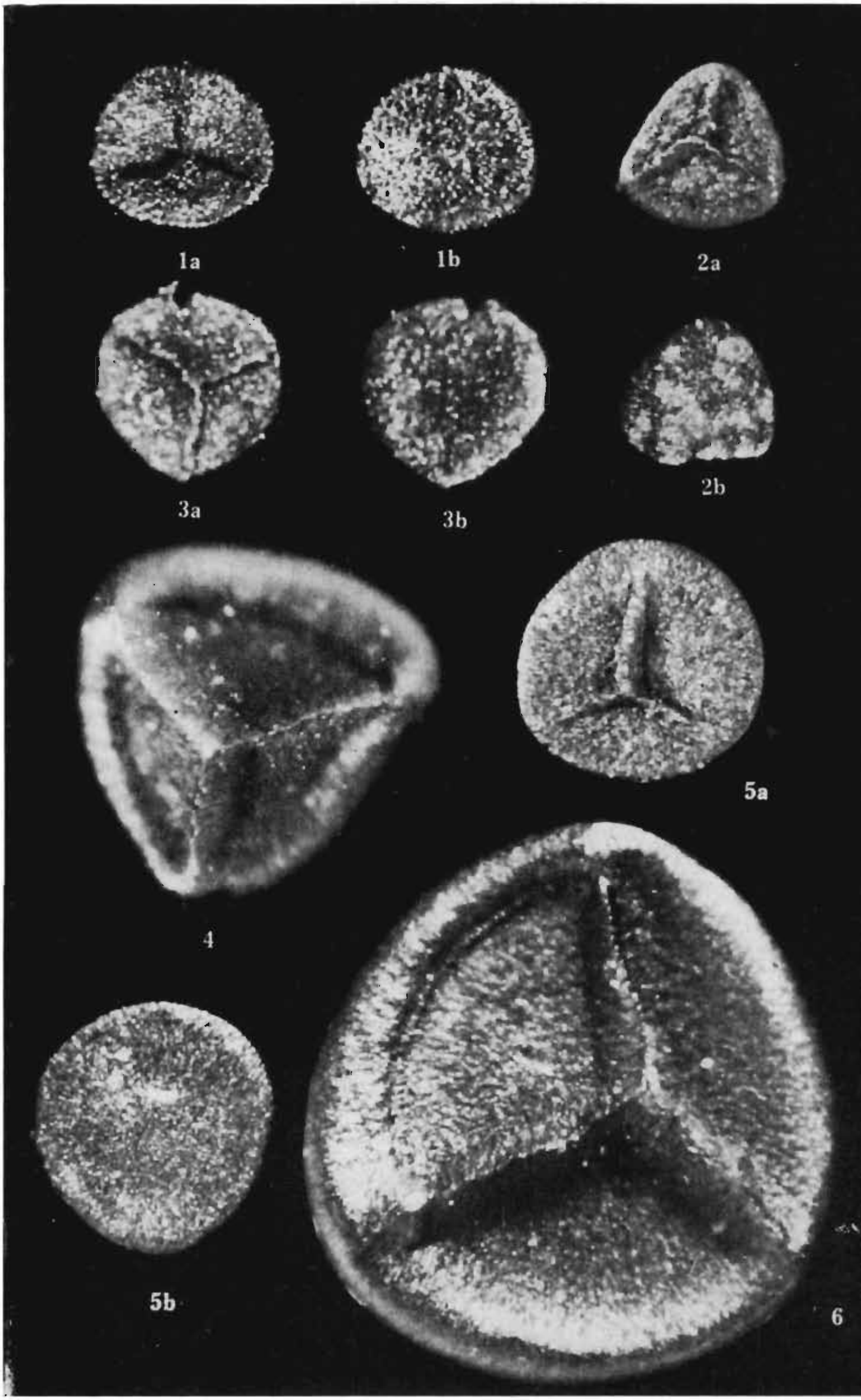
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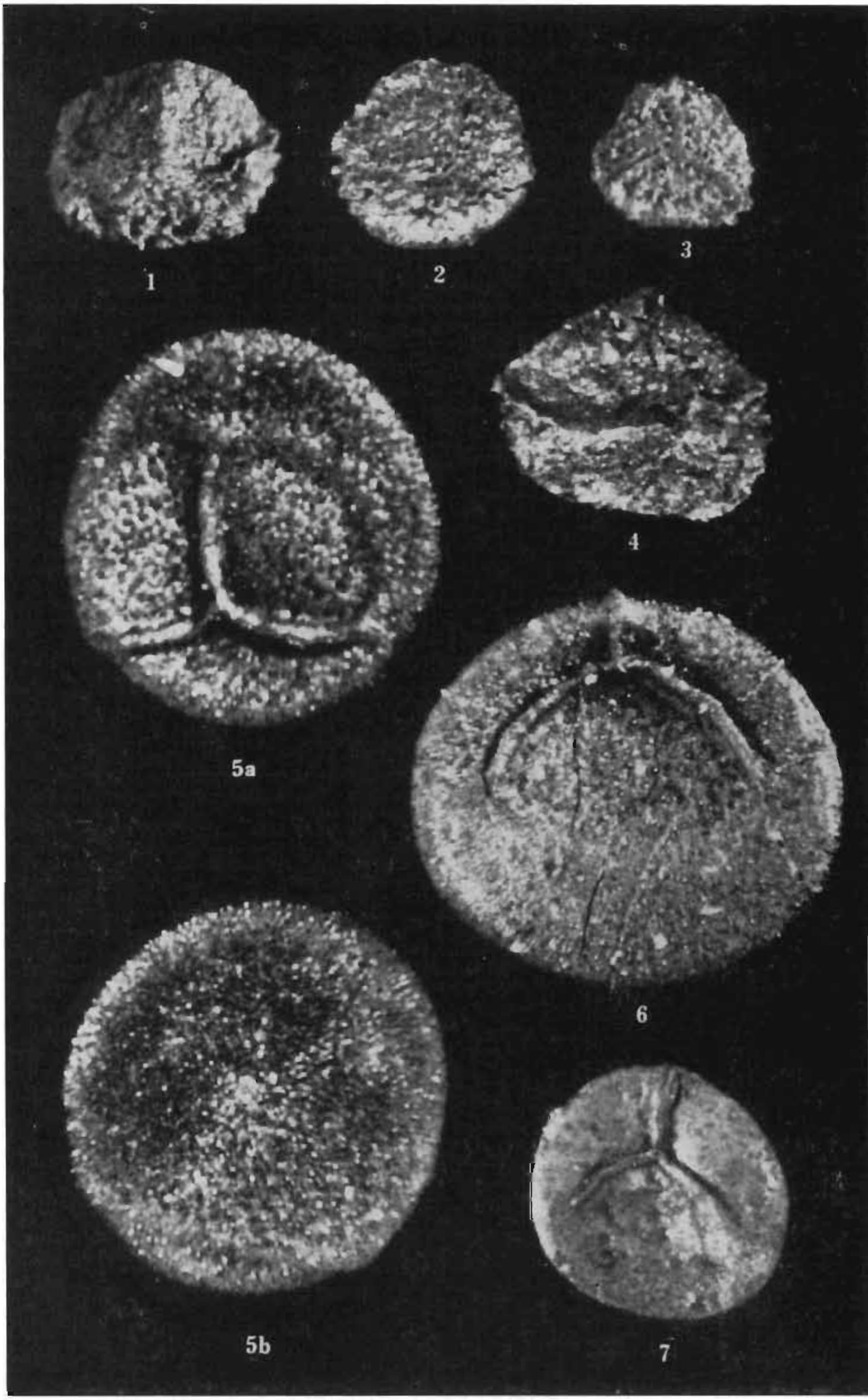
5b
6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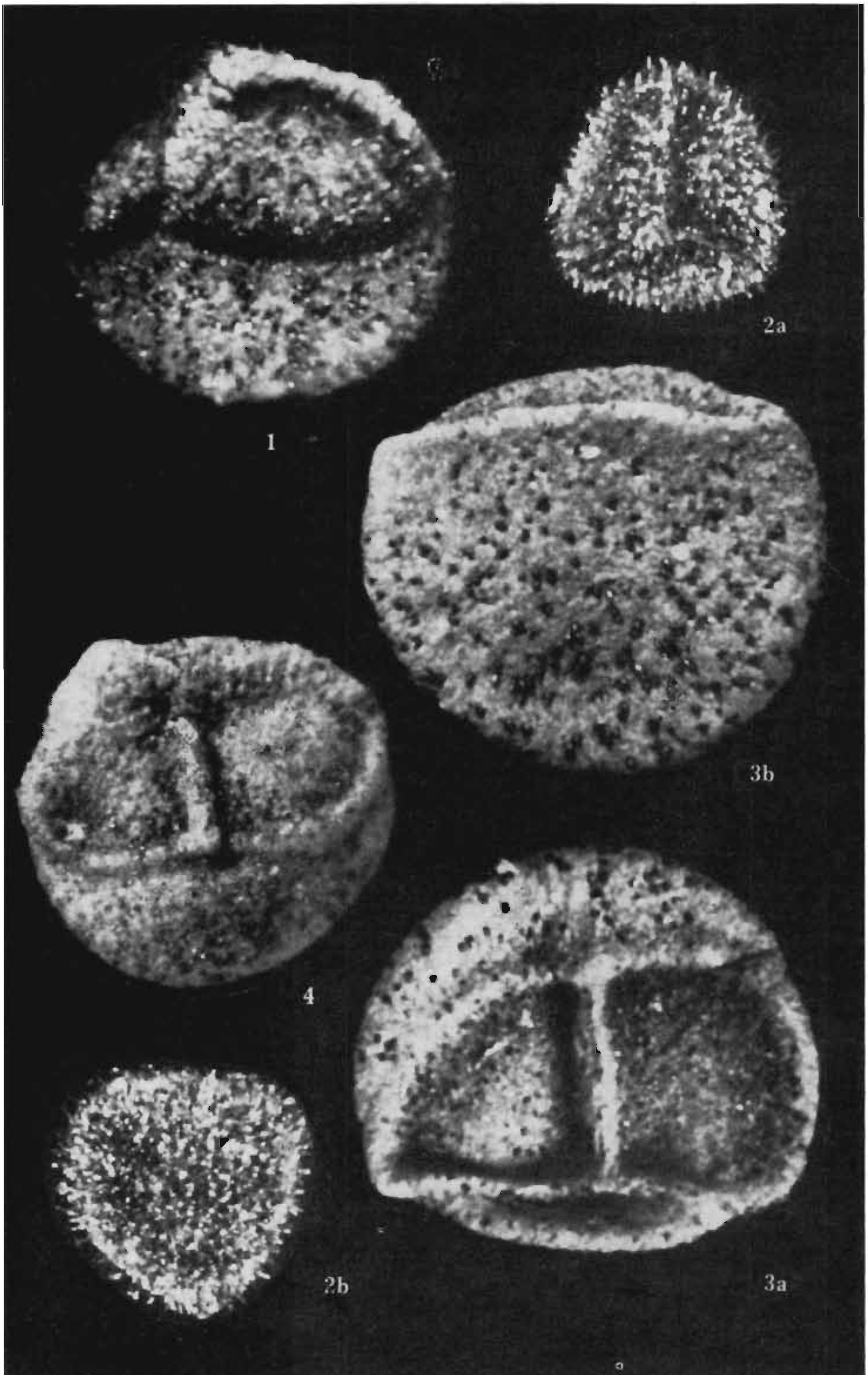

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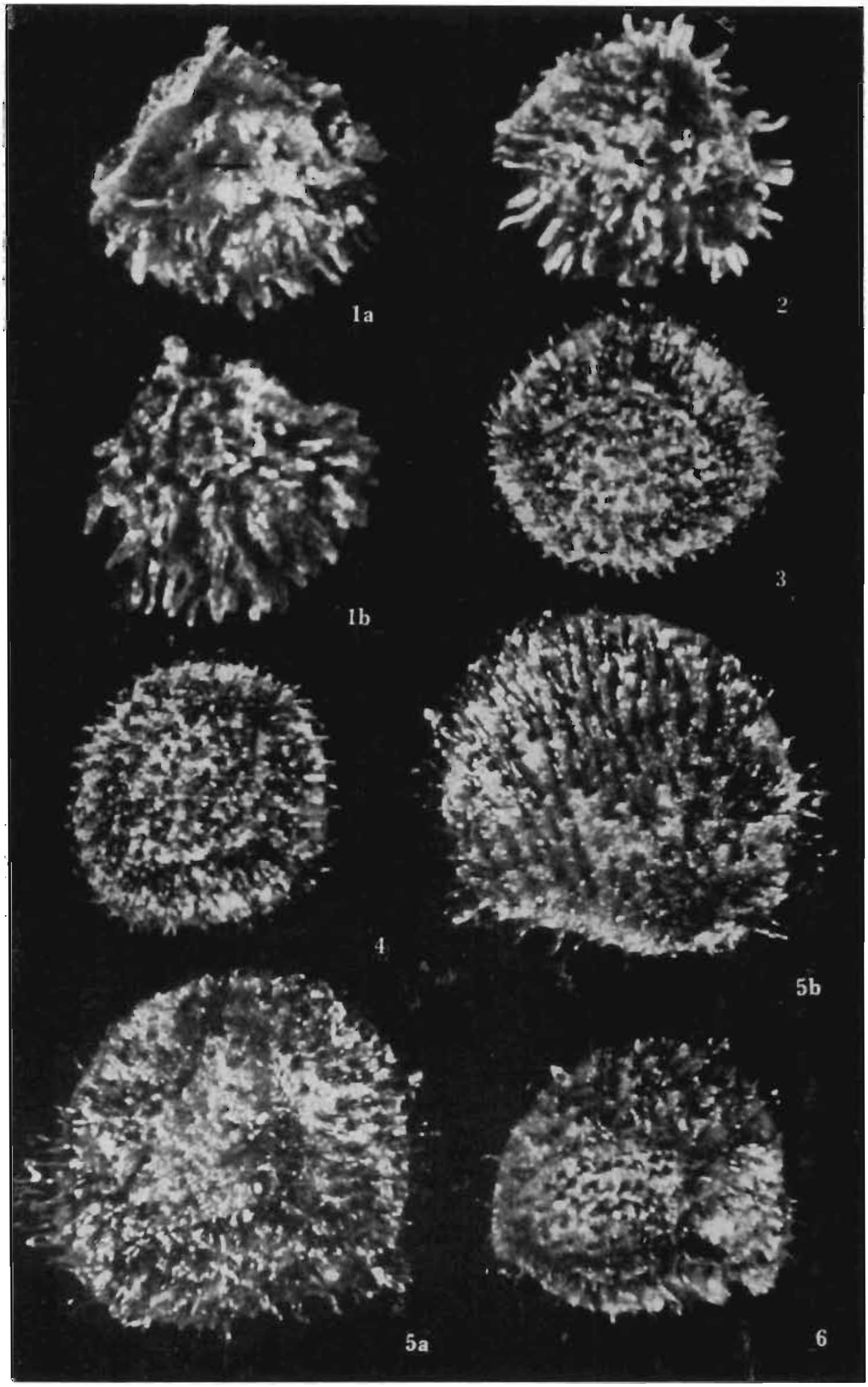
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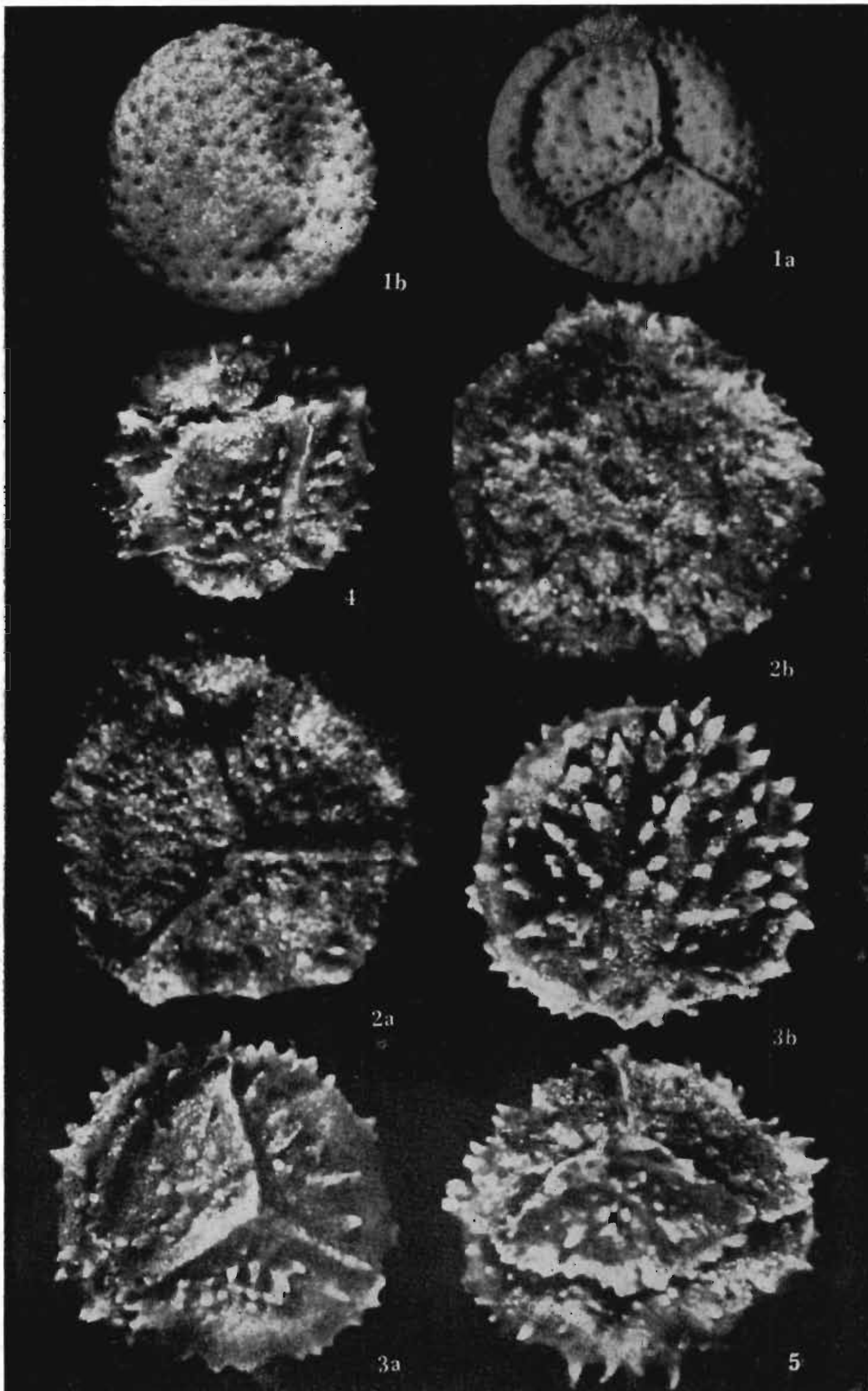
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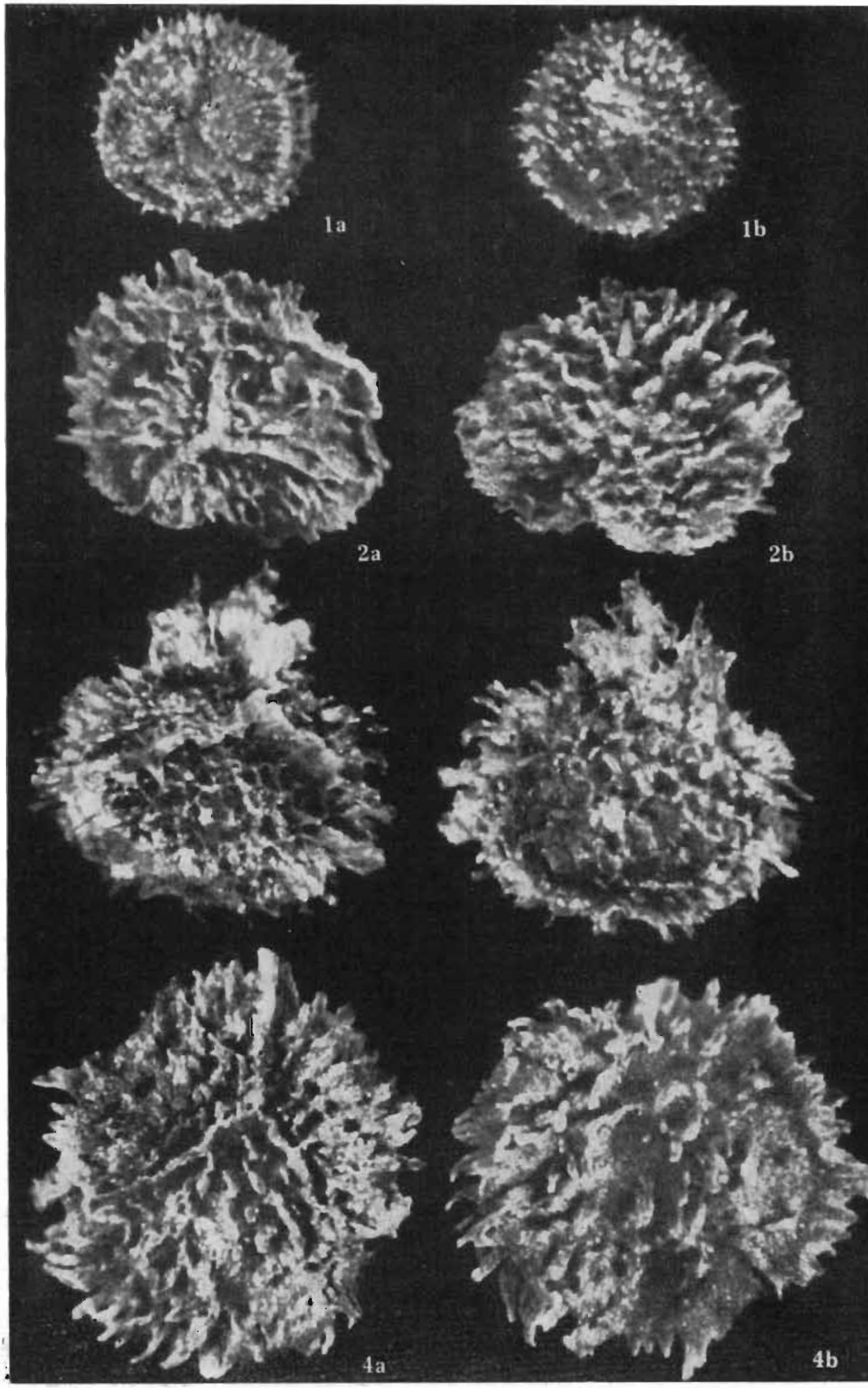
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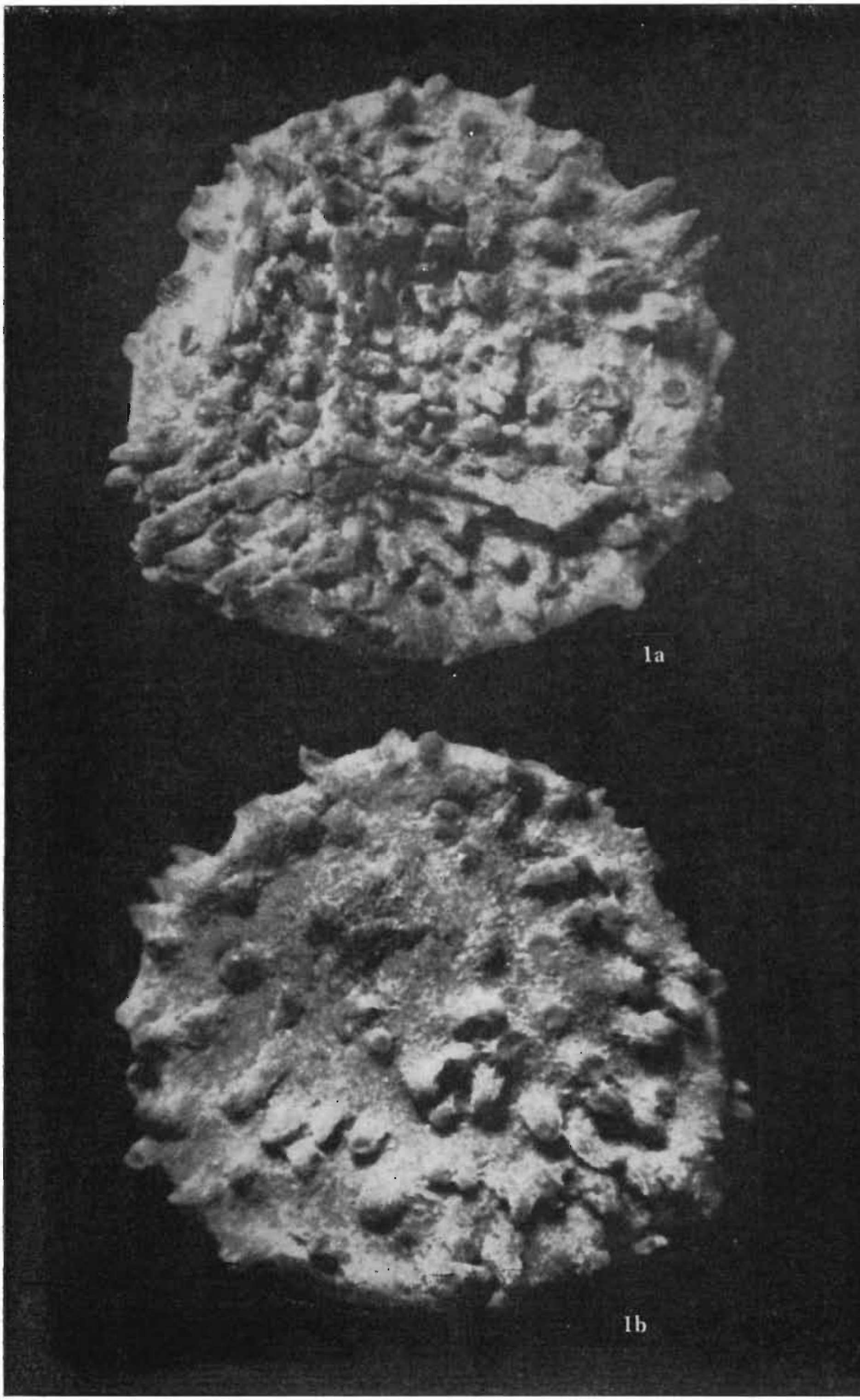
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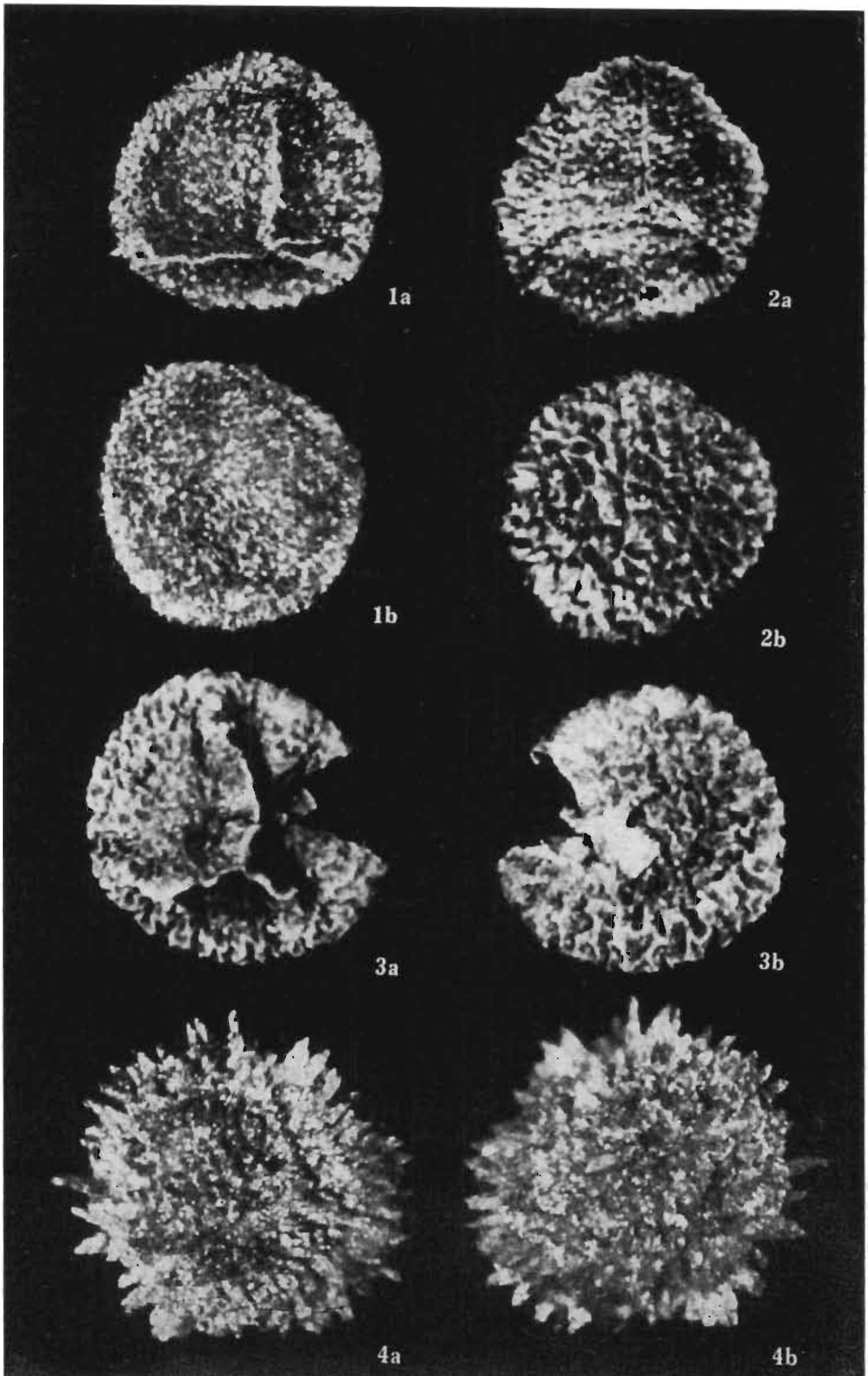
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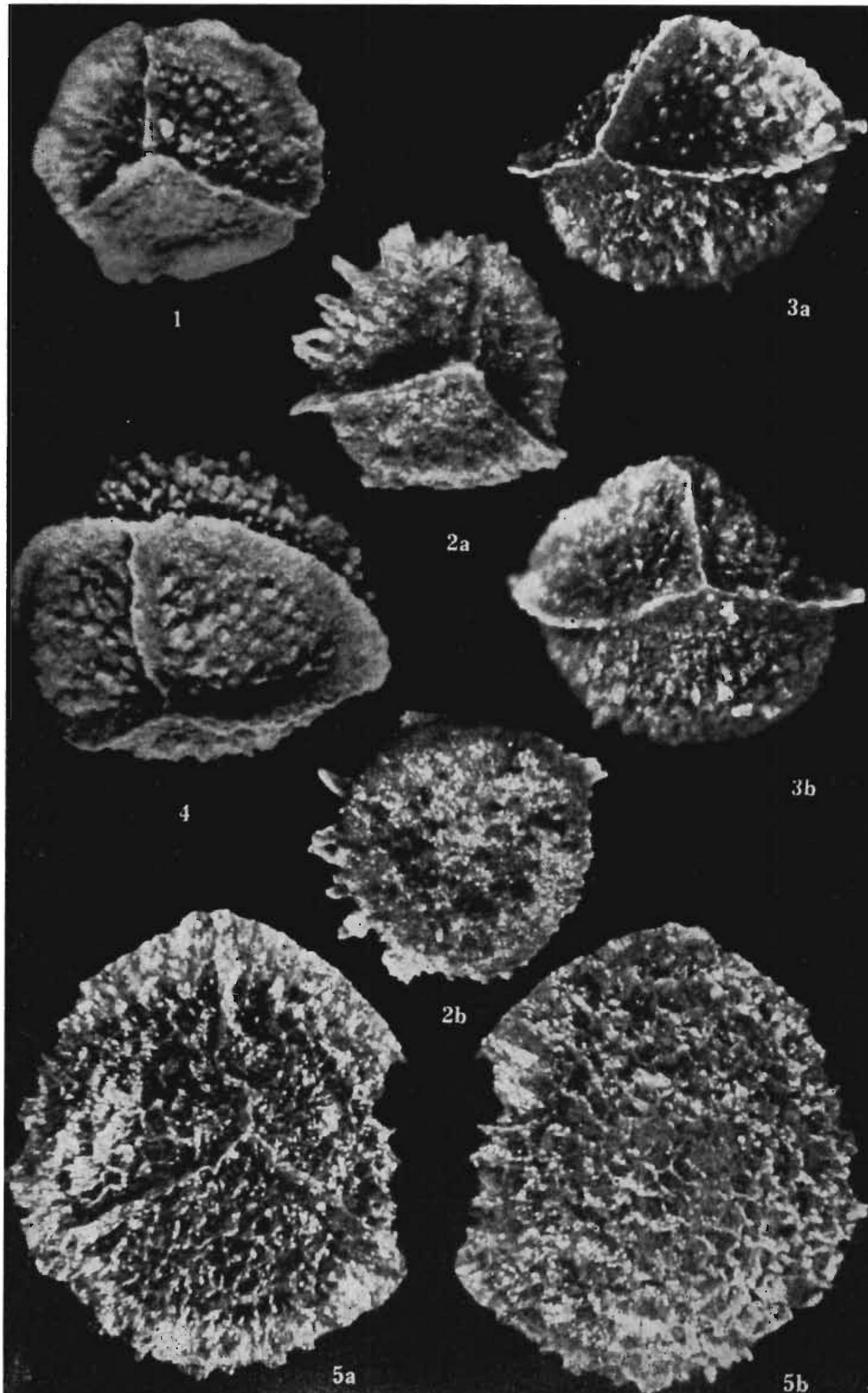
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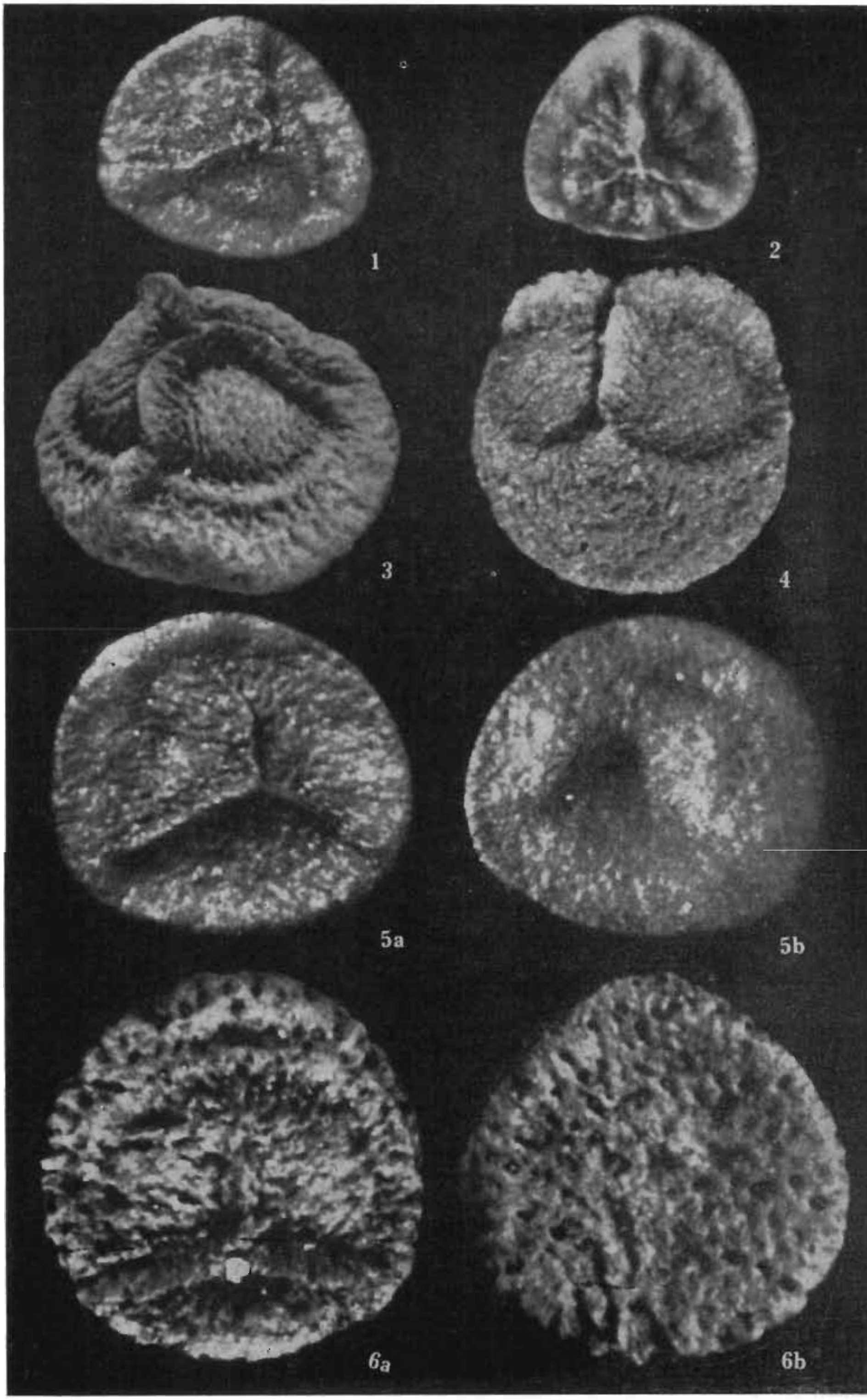
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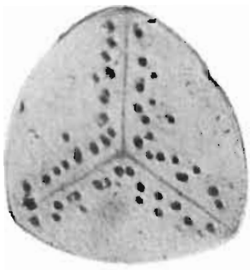
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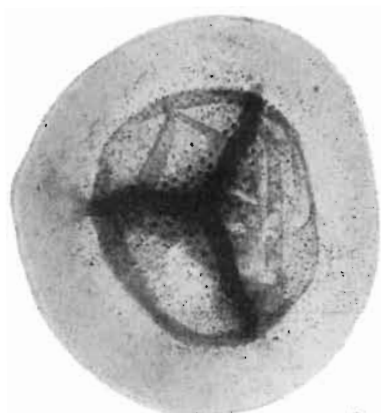
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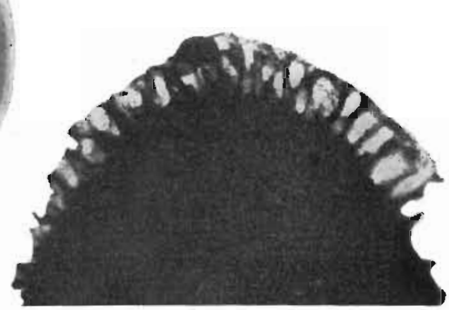
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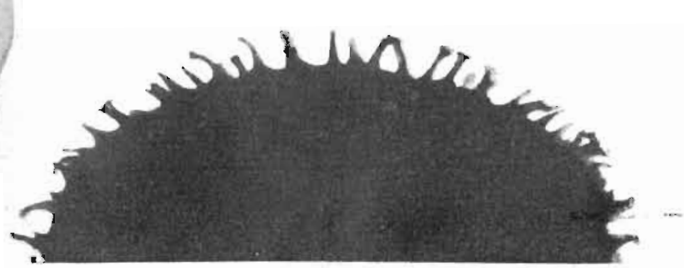
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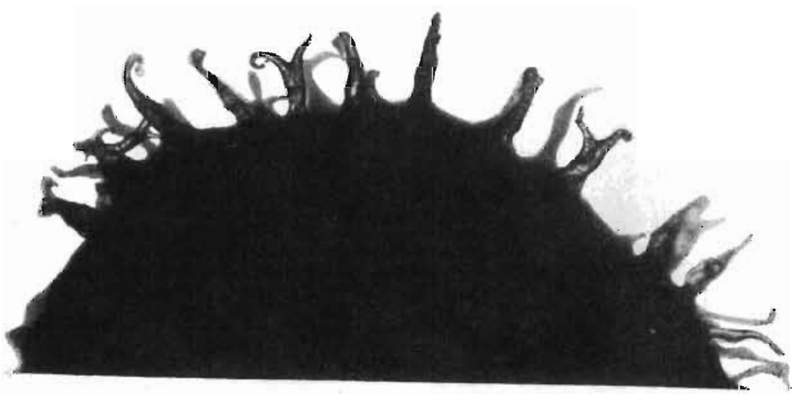

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