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TERESA ORŁOWSKA-ZWOLIŃSKA

PALYNOSTRATIGRAPHY OF THE BUNTSANDSTEIN IN SECTIONS OF WESTERN POLAND

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The palynological assemblages zones and subzones provide biostratigraphic framework for the investigated sections. The *Ludbladispora obsoleta — Protohaploxypinus pantii* zone established for the Lower Buntsandstein strata in three sections of western Poland is correlated with the *Protohaploxypinus* association, concurrent with *Otoceras* in rock of the Griesbachian stage of East Greenland. Selected miospore species are described, including two new ones: *Baculatisporites verus* sp. n. and *Ellipsovelatisporites rugulatus* sp. n., as well as one new combination: *Protohaploxypinus pantii* Jansonius comb. n.

Key words: Lower Triassic, Buntsandstein, palynostratigraphy, palynological assemblage zones, miospores, Poland.

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INTRODUCTION

Results of the author's earlier palynological investigations of the Buntsandstein (Orłowska-Zwolińska 1977) are compared with data from borehole sections Dachów M-24, Otyń IG-1, Florentyna IG-2 and Czaplinek IG-2 (fig. 1).

A microfloral assemblage, hitherto unknown from the Buntsandstein of Poland, is distinguished, which served to define a new palynological assemblage zone, named after two species abundant in it the *Lundbladispora obsoleta — Protohaploxypinus pantii* zone. The species composition of this assemblage closely resembles the composition of the *Protohaploxypinus* association distinguished in East Greenland (Balme 1979) in deposits with *Otoceras boreale* Spath and *Glyptophiceras* (*Hypophiceras*) *triviale* Spath.

The miospore assemblages of the consecutive assemblage zones are concurrent with index fauna of Early Triassic in the western Poland sections. The assemblage zone *Densoisporites nejburgii* occurs in the Middle

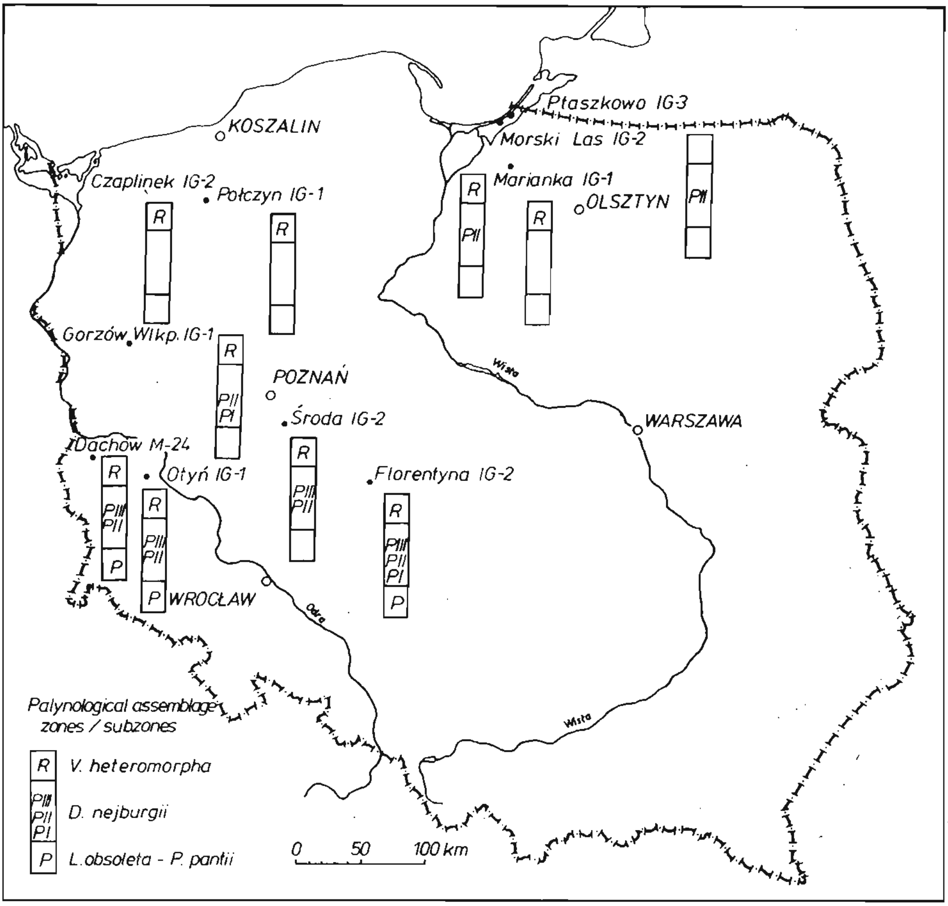

Fig. 1. Localization of borehole.

Buntsandstein strata. Its extent partly covers the extent of *Gervillia murchisoni* Geinitz, as e.g. in the section Otyń IG-1 (fig. 3). Quantitative and qualitative variations of the species composition within this zone permitted its subdivision into 3 subzones. The *Voltziaceaesporites heteromorpha* assemblage zone was distinguished in the Upper Buntsandstein strata. It has been described under the same name in an earlier paper by the author (Orłowska-Zwolińska 1977). The zone's assemblage concurs with *Costatoria costata* (Zenker) in the sections: Gorzów Wielkopolski IG-1, Dachów M-24 (Senkowiczowa 1965 and unpublished data), Środa IG-2, and Otyń IG-1 (Gajewska 1982, and unpublished data).

The miospore assemblages of the aforementioned section Otyń IG-1 could be compared with megaspore assemblages documented earlier by Fuglewicz (1979) for the same section. An age interpretation of the Lower Buntsandstein flora (p. 178) alternative to that given by Fuglewicz (1980), is presented.

Table 1

Palynological zones distinguished in three investigated regions of Poland

Fore-Sudetic area

Lithostratigr. 1982 I. Gajewska		fauna	flora: zones	subz.	flora: characteristic species
BUNTSANDSTEIN	Upper	*Costatoria costata*	*Voltziaceaesporites heteromorpha*	R	*Voltziaceaesporites heteromorpha* *Klausipollenites* sp. div. *Microcachryidites doubingeri* □ *Microcachryidites sittleri* *Microcachryidites fastidiosus* *Succinctisporites grandior* *Kraeuselisporites ullrichi* *Aratrisporites tenuispinosus* *Hexasaccites muelleri* *Brachysaccus ovalis* *Striatoabietites balmei* *Angustisulcites klausii* □ *Angustisulcites gorpii* *Triadispora crassa* ◧ *Triadispora plicata*
	Middle	*Gervillia murchisoni*	*Densoisporites nejburgii*	PIII	*Cycloverrutriletes presselensis* ◧ *Densoisporites nejburgii* ◧ & others as in: PII
				PII	*Densoisporites nejburgii* ■ *Densoisporites playfordi* ◧ *Endosporites papillatus* *Lundbladispora brevicula* *Punctatisporites trassicus* *Cyclotriletes microgranifer* *Platysaccus leschiki* *Protohaploxypinus pellucidus* □ *Taeniaesporites noviaulensis*
				PI	*Densoisporites nejburgii* *Endosporites papillatus* Acritarcha ◧
	Lower		*Lundbladispora obsoleta – Protohaploxypinus pantii*	P	*Protohaploxypinus pantii* ◧ *Taeniaesporites noviaulensis* *Protohaploxypinus pellucidus* *Protohaploxypinus samoilovichii* *Cycadopites follicularis* *Lundbladispora obsoleta* □ *Lundbladispora willmotti* *Endosporites papillatus* *Densoisporites playfordi* *Kraeuselisporites cuspidus*

West Pomerania

Lithostratigraphy 1982 A. Szyperko-Śliwczyńska			fauna	flora: zones	subz.	flora: characteristic species
BUNTSANDSTEIN	Upper	Barwice Formation		*Voltziaceaesporites heteromorpha*	R	*Voltziaceaesporites heteromorpha* *Microcachryidites doubingeri* *Microcachryidites fastidiosus* ◧ *Succinctisporites grandior* ◧ *Kraeuselisporites ullrichi* *Aratrisporites tenuispinosus* *Brachysaccus ovalis* *Striatoabietites balmei* *Angustisulcites klausii* *Angustisulcites gorpii* *Triadispora crassa* ◧ *Triadispora plicata*
	Middle	Połczyn Formation Pomerania Formation	*Gervillia murchisoni*	microflora not found		
	Lower	Baltic Formation		unstudied interval		

North-Eastern Poland

Lithostratigraphy 1979 A. Szyperko-Śliwczyńska			fauna	flora: zones	subz.	flora: characteristic species
BUNTSANDSTEIN	Upper	Elbląg Formation		*Voltziaceaesporites heteromorpha*	R	*Voltziaceaesporites heteromorpha* ◧ *Klausipollenites* sp. div. *Microcachryidites doubingeri* *Microcachryidites fastidiosus* ◧ *Succinctisporites grandior* □ *Kraeuselisporites ullrichi* *Aratrisporites tenuispinosus* *Brachysaccus ovalis* *Striatoabietites balmei* □ *Angustisulcites klausii* □ *Angustisulcites gorpii* *Triadispora crassa* (single)
	Middle	Malbork Formation				P III not distinquished
		Lidzbark Formation	*Gervillia murchisoni*	*Densoisporites nejburgii*	PII	*Densoisporites nejburgii* ◧ *Densoisporites playfordi* *Endosporites papillatus* *Lundbladispora brevicula* *Cyclotriletes microgranifer* *Platysaccus leschiki* *Protohaploxypinus pellucidus* □ *Taeniaesporites noviaulensis* □
	Lower	Baltic Formation		unstudied interval		

Explanations:
- □ relatively abundant
- ◧ abundant
- ■ very abundant

The sections of western Poland have relatively complete sequences of deposits and contain index fauna; for this reason the palynostratigraphic scheme established for them is now accepted as a base for biostratigraphic correlations of the sections of North-east Poland, and of the Peribaltic Syneclize in particular. The assemblages distinguished in the latter area are of similar composition as those of western Poland (table 1).

The present paper has been written in 1979. The data published after 1979 are introduced partly into the text.

The specimens described are stored in the Museum of the Geological Institute in Warsaw (abbreviated as Muz. IG).

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The author is indebted to Dr. B. C. Foster of Geological Survey, Queensland and Dr. G. Playford of Queensland University for their help in solving the problems related to taxonomy of some pollen grains of Striatiti.

METHODS

Samples (10—20 grammes) were crushed and treated with 10% HCl, then, for 3 days with cold 40% HF, washed with boric acid solution, heated at 70°C for 2 hours in 10% HCl, and the residues were concentrated in heavy liquid (CdI_2+KI, 2.1 g/cm^3). Oxidation was carried out on all samples using 30% HNO_3, anhydrous HNO_3, or Schultze solution, according to the degree of coalification. The residues were mounted in glycerine gelly.

Only samples bearing microflora are included in diagrams. Constituent species are recorded as percentages, based on a count of 200 specimens. At low frequency of miospores in the sample, either only 100 specimens were counted in the preparation, or only those species were noted which occurred in at least three preparations. Plankton counts are recorded as numbers of individuals per 200 or 100 microspores. Percentages of low-frequency species belonging to one genus are sometimes recorded collectively under their generic name. The species occurring sporadically, and those of little stratigraphical value, are placed together with undeterminated forms under headings *Sporites* sp. div. and *Disaccites* sp. div.

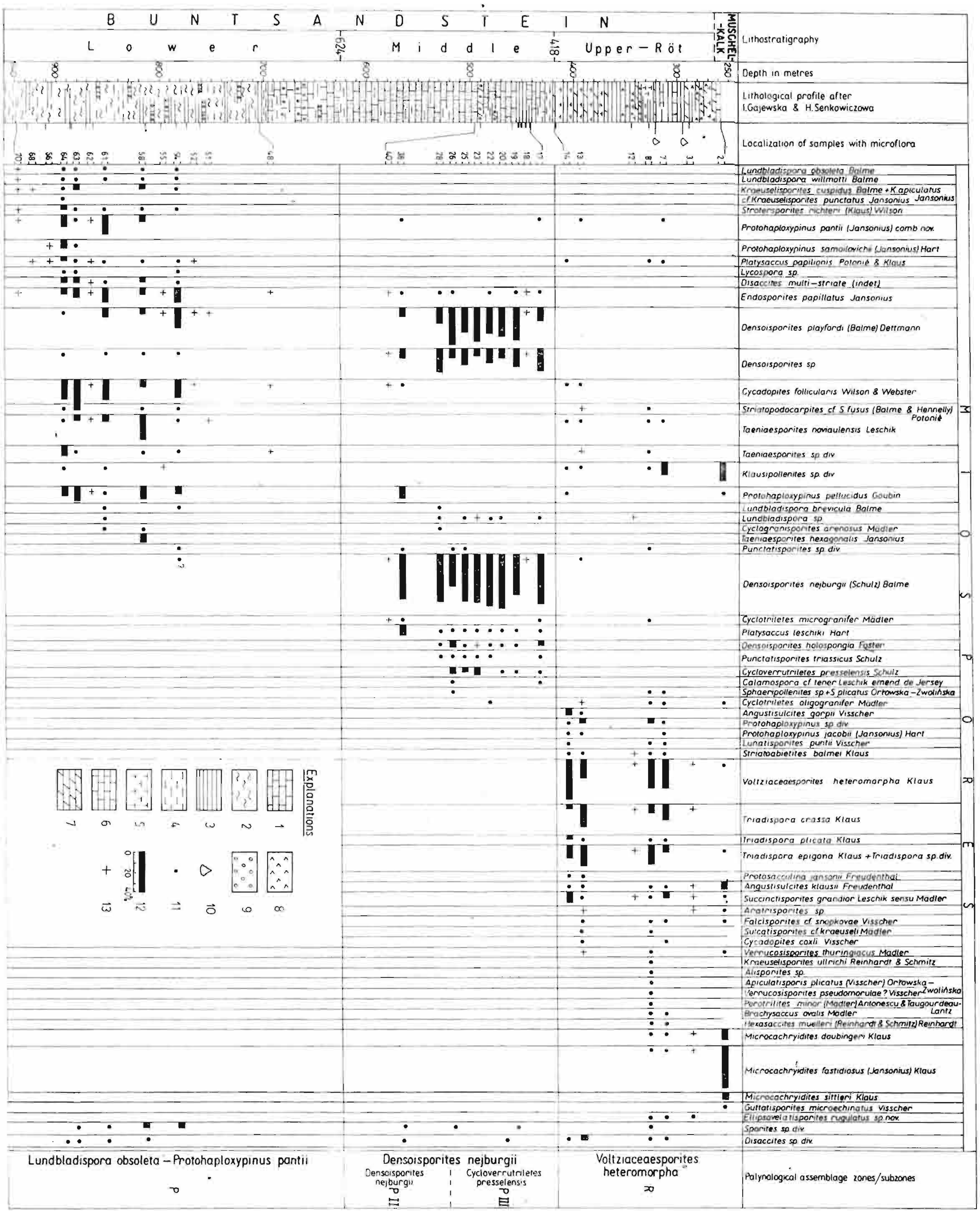

Fig. 2. Miospore occurrence in Buntsandstein deposits in the Dachów M-24 profile. 1 sandstones, 2 siltstones, 3 gray claystones, 4 *variegated* claystones, 5 marls, 6 limestones, 7 dolomites or dolomitic claystones, 8 gypsum and anhydrite, 9 oolites, 10 *Myophoria costata* (Zenker), 11 0.5–4% of miospores, 12 over 4%, 13 occurrence in samples of low microflora frequency or in additional traverses. outside the count of 200 or 100 specimens. Fauna determined by H. Senkowiczowa.

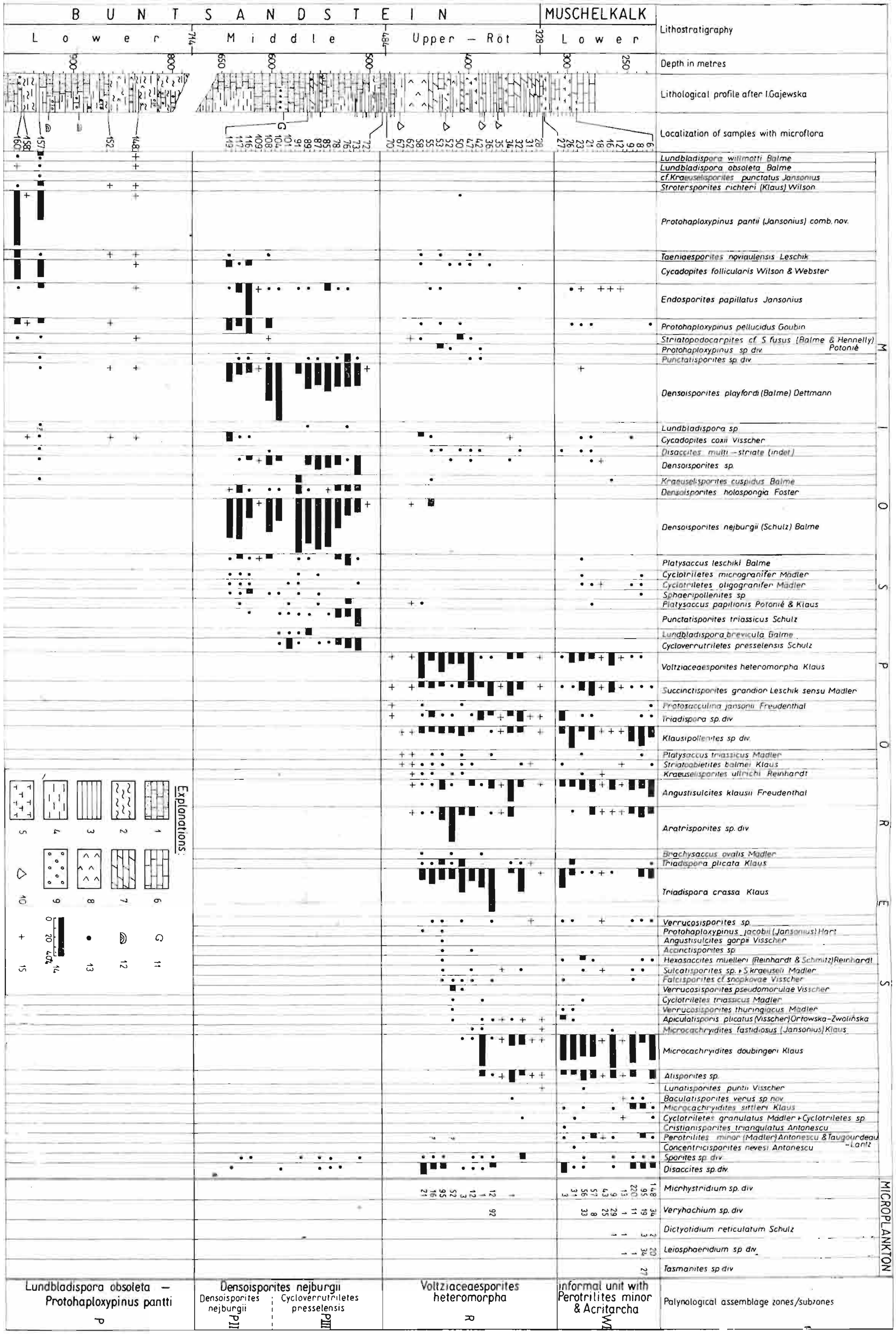

Fig. 3. Miospore and microplankton occurrence in Buntsandstein and Lower Muschelkalk deposits in the Otyń IG-1 profile, 1—10 for explanations see fig. 2; 11 *Gervillia murchisoni* Geinitz, 12 esterias, 13 0.5—4%, 14 over 4% after the presented scale, 15 occurrence in samples of low microflora frequency or in additional traverses, outside the count of 200 or 100 specimens. Fauna determined by I. Gajewska.

The determined species are arranged in a stratigraphical order and divided according to the palynological zonation proposed.

Palynological analyses were carried out with a microscope Zeiss Nfph. Microscope photographs were taken with an immersion lens.

SYSTEMATICS

LIST OF DETERMINED SPECIES

Systematics after Potonié (1956, 1958, 1960, 1970); * miospores characteristic of the unit with *Petrotrilites minor* — Acritarcha (Lower Muschelkalk).

Anteturma **Proximegerminates** Potonié, 1970
Turma **Triletes** — Azonales Potonié, 1970
Subturma **Azonotriletes** Luber, 1935
Infraturma **Laevigati** Bennie et Kidston, 1886 emend. Potonié, 1956
Genus *Punctatisporites* Ibrahim, 1933 emend. Potonié et Kremp, 1954

Punctatisporites triassicus Schulz, 1964 — pl. 17: 5
Punctatisporites sp.

Genus *Calamospora* Schopf, Wilson et Bentall, 1944

Calamospora cf. *tener* Leschik emend. de Jersey, 1962

Genus *Retusotriletes* Naumova, 1953

Retusotriletes mesozoicus Klaus, 1960

Infraturma **Apiculati** Bennié et Kidston 1886, emend. Potonié 1956
Genus *Apiculatisporis* R. Potonié et Kremp, 1956

Apiculatisporis plicatus (Visscher 1966) Orłowska-Zwolińska, 1979

Genus *Cyclotriletes* Mädler, 1964

Cyclotriletes granulatus Mädler, 1964
Cyclotriletes microgranifer Mädler, 1964 — pl. 17: 2
Cyclotriletes oligogranifer Mädler, 1964 — pl. 17: 4
Cyclotriletes triassicus Mädler, 1964 — pl. 17: 5
Cyclotriletes sp.

Genus *Cyclogranisporites* Potonié et Kremp, 1954
cf. *Cyclogranisporites arenosus* Mädler, 1964
Genus *Cycloverrutriletes* Schulz, 1964

Cycloverrutriletes presselensis Schulz, 1964 — pl. 17: 1

Genus *Verrucosisporites* Ibrahim 1933 emend. Potonié et Kremp, 1954

Verrucosisporites pseudomorulae Visscher, 1966
Verrucosisporites thuringiacus Mädler, 1964

Verrucosisporites sp.
Guttatisporites elegans Visscher, 1966 — pl. 18: 1
Guttatisporites microechinatus Visscher, 1966 — pl. 17: 6

Genus *Baculatisporites* Thomson et Pflug, 1953

Baculatisporites verus sp. n. — pl. 18: 2

Turma **Triletés — Zonales** (Bennié et Kidston, 1886) Potonié, 1970
Subturma **Zonotriletes** Waltz, 1935
Infraturma **Cingulati** Potonié et Klaus, 1954 emend. Dettmann, 1963
Genus *Densoisporites* Weyland et Krieger emend. Dettmann, 1963

Densoisporites nejburgii (Schulz, 1964) Balme, 1970 — pl. 18: 4
Densoisporites playfordi (Balme, 1963) Dettmann, 1963 — pl. 18: 6, 7
Densoisporites holospongia Foster, 1979 — pl. 18: 3
Densoisporites sp.

Genus *Lundbladispora* Balme 1963 emend. Playford, 1965

Lundbladispora brevicula Balme, 1963 — pl. 18: 5
Lundbladispora obsoleta Balme, 1970 — pl. 19: 1, 2
Lundbladispora willmotti Balme, 1963 — pl. 19: 3, 4
Lundbladispora sp.

Genus *Lycospora* Schopf, Wilson et Bentall 1944 emend. Potonié et Kremp, 1954

Lycospora sp.

Genus *Nevesisporites* de Jersey et Paten, 1964

Nevesisporites sp.

Infraturma **Zonati** Potonié et Kremp, 1954
Genus *Endosporites* Wilson et Coe, 1940

Endosporites papillatus Jansonius, 1962 — pl. 20: 3

Genus *Kraeuselisporites* Leschik, 1955 emend. Jansonius, 1962

Kraeuselisporites apiculatus Jansonius 1962 — pl. 19: 5, 6
Kraeuselisporites cuspidus Balme, 1963 — pl. 20: 1, 2
Kraeuselisporites cf. *punctatus* Jansonius, 1962
Kraeuselisporites ullrichi Reinhardt et Schmitz, 1965 — pl. 20: 5

Genus *Guthoerlisporites* Bharadwaj, 1954

Guthoerlisporites cancellosus Playford et Dettmann, 1965

Genus *Perotrilites* Couper 1953

**Perotrilites minor* (Mädler 1964) Antonescu et Taugourdeau-Lantz, 1973 — pl. 21: 4

Infraturma **Patinati** Butterworth et Williams 1958
Genus *Concentricisporites* Antonescu, 1970

**Concentricisporites nevesi* Antonescu, 1970 — pl. 21: 1, 2

Turma **Monoletes** Ibrahim, 1933
Subturma **Azonomonoletes** Luber, 1935
Infraturma **Sculptatomonoleti** Dybova et Jachowicz, 1957
Genus *Aratrisporites* Leschik emend. Playford et Dettmann, 1965

Aratrisporites granulatus (Klaus, 1960) Playford et Dettmann, 1965 — pl. 21: 4
Aratrisporites flexibilis Playford et Dettmann, 1965
Aratrisporites paenulatus Playford et Dettmann, 1965
Aratrisporites tenuispinosus Playford, 1965 — pl. 21: 5

Anteturma **Variegerminantes Potonié,** 1970
Turma **Saccites** Erdtmann, 1947
Subturma **Monosaccites** Chitalay, 1951 emend. Potonié et Kremp, 1954
Infraturma **Aletesacciti** Leschik, 1955
Genus *Accinctisporites* Leschik, 1955

Accinctisporites diversus Leschik, 1956
Accinctisporites sp. — pl. 20: 6

Genus *Ellipsovelatisporites* Klaus, 1960

Ellipsovelatisporites rugulatus sp. n. — pl. 22: 1—3.

Infraturma **Triletesacciti** Leschik, 1955
Genus *Cristianisporites* Antonescu, 1970

**Cristianisporites triangulatus* Antonescu, 1970 — pl. 22: 4

Subturma **Disaccites** Cookson, 1947
Infraturma **Striatiti** Pant, 1954
Genus *Lunatisporites* Leschik, 1956 emend. Bharadwaj, 1962

Lunatisporites puntii Visscher, 1966

Genus *Protohaploxypinus* Samoilovich, 1953 emend. Hart, 1964

Protohaploxypinus pantii (Jansonius 1962) comb. n. — pl. 23: 1—3
Protohaploxypinus samoilovichii (Jansonius, 1962) Hart, 1964 — pl. 24: 1
Protohaploxypinus jacobii (Jansonius, 1962) Hart, 1964 — pl. 25: 4
Protohaploxypinus pellucidus Goubin, 1965 — pl. 25: 3
Protohaploxypinus sp. — pl. 25: 6

Genus *Protosacculina* Maliavkina, 1953

Protosacculina jansonii Freudenthal, 1964 — pl. 22: 5, 6

Genus *Striatoabietites* Sedova, 1956

Striatoabietites balmei Klaus, 1964 — pl. 22: 7

Genus *Striatopodocarpites* Zoricheva et Sedova *ex* Sedova, 1956 emend. Hart, 1964

Striatopodocarpites cf. S. *fusus* (Balme et Hennelly, 1955) Potonié, 1958 — pl. 24: 3

Genus *Taeniaesporites* Leschik, 1956 emend. Klaus, 1963

Taeniaesporites noviaulensis Leschik, 1956 — pl. 25: 2
Taeniaesporites albertae Jansonius, 1962 — pl. 21: 6
Taeniaesporites hexagonalis Jansonius, 1962 — pl. 23: 4

Genus *Strotersporites* Wilson, 1962 emend. Klaus, 1963

Strotersporites richteri (Klaus, 1955) Wilson, 1962 — pl. 23: 5

Infraturma **Disaccitrileti** Leschik, 1955

Genus *Angustisulcites* Freudenthal, 1964 emend. Visscher, 1966

Angustisulcites gorpii Visscher, 1966
Angustisulcites klausii Freudenthal, 1964 — pl. 24: 6

Genus *Triadispora* Klaus, 1964

Triadispora crassa Klaus, 1964
Triadispora plicata Klaus, 1964 — pl. 26: 6
Triadispora epigona Klaus, 1964 — pl. 24: 4, 5

Infraturma **Disacciatrileti** Leschik, 1955 emend. Potonié, 1958

Genus *Brachysaccus* Mädler, 1964

Brachysaccus ovalis Mädler, 1964

Genus *Alisporites* Daugherty, 1941 emend. Nilsson, 1958

Alisporites cf. *A. opii* Daugherty, 1941
Alisporites sp.

Genus *Falcisporites* Leschik 1956 emend. Klaus, 1963

Falcisporites cf. *snopkovae* Visscher, 1966

Genus *Platysaccus* Naumova ex Potonié et Klaus, 1954

Platysaccus leschiki Hart, 1960
Platysaccus papilionis Potonié et Klaus, 1954
Platysaccus triassicus Mädler, 1964

Genus *Klausipollenites* Jansonius, 1962

Klausipollenites staplinii Jansonius, 1962 — pl. 24: 2
Klausipollenites decipiens Jansonius, 1962

Genus *Microcachryidites* (Cookson, 1947) ex Couper, 1953

Microcachryidites doubingeri Klaus, 1964 — pl. 26: 5
Microcachryidites sittleri Klaus, 1964 — pl. 26: 4
Microcachryidites fastidiosus (Jansonius, 1962) Klaus, 1964 — pl. 26: 7

Genus *Voltziaceaesporites* Klaus, 1964

Voltziaceaesporites heteromorpha Klaus, 1964 — pl. 25: 1

Genus *Sulcatisporites* Leschik 1955 emend. Nilsson, 1958

Sulcatisporites cf. *S. kraeuseli* Mädler, 1964
Sulcatisporites sp.

Genus *Succinctisporites* Leschik, 1955 emend. Mädler, 1964

Succinctisporites grandior Leschik, 1955 *sensu* Mädler, 1964

Genus *Colpectopollenites* Pflug, 1953 emend. Visscher, 1966

Colpectopollenites ellipsoideus Visscher, 1966

Subturma **Polysaccites** Cookson, 1947

Genus *Hexasaccites* Reinhardt, 1965

Hexasaccites muelleri (Reinhardt et Schmitz, 1964) Reinhardt, 1965 — pl. 26: 1—3

Turma **Aletes** Ibrahim, 1933

Subturma **Azonaletes** (Luber, 1935) Potonié et Kremp, 1954

Infraturma **Granulonapiti** Cookson, 1947

Genus *Sphaeripollenites* Couper, 1958 emend. Jansonius, 1962

Sphaeripollenites plicatus Orłowska-Zwolińska, 1979
Sphaeripollenites sp.

Subturma **Monocolpates** Iversen et Troels — Smith, 1950

Genus *Cycadopites* Wodehouse, 1933 *ex* Wilson et Webster, 1946

Cycadopites follicularis Wilson et Webster, 1946 — pl. 23: 6; pl. 25: 3
Cycadopites cf. *coxii* Visscher, 1966 — pl. 25: 7

DESCRIPTIONS OF SOME SPECIES

Cycloverrutriletes presselensis Schulz, 1964
(pl. 17: 1)

1964. *Cycloverrutriletes presselensis* Schulz: 601, pl. 1: 4.

Description. — Diameter 45—66 µm. Spores of circular amb. Triradiate tetrad mark distinct, with arms straight, 3/5 spore radius long, occasionally gaping. Exine thick, covered by irregularly distributed, widely spaced globules; these fall off sometimes during maceration process and can be observed in slides outside specimens. Contact areas distinctly delimited, brighter than the remaining part of exine, and lacking the globules. Diameter of globules variable between particular specimens, ranging from 1.4 µm to 4.5 µm. Bases of the globules, short and wide, may be observed occasionally at equator. Structure of exine delicate, observable at surface as a fine-luminar reticulum.

Occurrence. — West Poland, higher part of Middle Buntsandstein. GDR and Romania, Middle Buntsandstein (Schulz 1964; Venkatachala, Beju, Kar 1968). USSR — Caspian Plain and south Mangyschlak, Lower Triassic (Bogacheva and Vinogradova 1973).

Baculatisporites verus sp. n.
(pl. 18: 2)

Holotype: pl. 18: 2

Type horizon: Lower Muschelkalk.

Type locality: borehole Otyń IG-1, depth 294.8 m.

Derivation of name: Lat. *verus* — true, real — refers to sculptural elements developed as true bacula.

Diagnosis. — Amb subcircular with triradiate tetrad mark. Exine covered with bacula, more densely at distal side.

Description. — Spore diameter without processes 55 μm—65 μm. Amb circular or rounded-triangular. Arms of tetrad mark 2/3 spore radius long, thin, distinctly delineated without undulating lips. Exine thick. Sculptural elements bacular, truncated or with rounded tips, more dense on distal side. Processes 3—7 μm long. Sculpture absent in proximity of sutures.

Remarks. — By external form, exine thickness and processes distribution, the spores resemble *Spinotriletes senecioides* Mädler from the Upper Buntsandstein. They differ by form of processes, which at the later species are conical, often pointed.

Occurrence. — Poland, Upper Buntsandstein and Lower Muschelkalk.

Lundbladispora obsoleta Balme, 1970
(pl. 19: 1, 2)

1970. *Lundbladispora obsoleta* Balme: 344, pl. 5: 7—11.

Description. — Diameter of spores 52—72 μm, 60 μm on the average. Amb rounded-triangular. Triradiate tetrad mark with delicate arms, ca 3/4 spore radius long, sometimes accompanied by narrow lips. Spores with wide cingulum which becomes transparent toward the equator. Exoexine proximately detached from endoexine. Cave distinct. Exoexine spongeous on distal side and in marginal part of the proximal side, sculptured with conical processes of wide bases and pointed tips. Intexine with three large papillae at proximal pole.

Occurrence. — West Poland, Lower Buntsandstein — regularly; Middle Buntsandstein — sporadically, Pakistan — Salt Range, uppermost Permian — very rarely: Lower Triassic — abundantly (Balme 1970). East Greenland, Lower Triassic (Balme 1979).

Lundbladispora willmotti Balme, 1963
(pl. 19: 3, 4)

1963. *Lundbladispora willmotti* Balme: 22, pl. 5: 1—3.
1965. *Lundbladispora willmotti* Balme; Playford: 190, pl. 9: 7, 8.

Remarks. — This species differs from *L. obsoleta* by delicate cingulum and smaller and more delicate sculptural elements in form of short and narrow spinae.

Occurrence. — West Poland, Lower Buntsandstein — regularly. Australia, Lower Triassic (Balme 1963, Playford 1965).

Lundbladispora brevicula Balme, 1963
(pl. 18: 5)

1963. *Lundbladispora brevicula* Balme: 23—24, pl. 4: 8, 9.

Remarks. — The spores differ from the other species by their smaller diameter, distinct arms of tetrad mark accompanied by broad, sometimes undulating lips. Sculptural elements conical, distributed over distal and in marginal part of the proximal side. Described specimens differ from the holotype by more densely spaced processes and more intense spongy structure.

Occurrence. — Poland, Lower Triassic, Australia, Lower Triassic (Balme 1963, de Jersey 1979). Pakistan — Salt Range, lowermost part of Lower Triassic (Balme 1970).

Ellipsovelatisporites rugulatus sp. n.
(pl. 22: 1—3)

Holotype: pl. 22: 1, 2.
Type horizon: upper Buntsandstein (Röt).
Type locality: Poland, borehole Otyń IG-1, depth 384.1 m.
Derivation of name: Lat. *rugulatus* — describes folded exine on grain's body.

Diagnosis. — Pollen grains elliptical in outline. Exoexine loosely surrounds the body resulting in monosaccate appearance of grains. Exoexine on proximal side of the body covered with wrinkles giving it reticular appearance.

Description. — Total grain size 85—105.5 μm; body size 51—59.5 μm. Pollen grains of elliptical equatorial outline. Body outline ovate-circular. Exoexine of saccus delicate, light, devoid of any discernible infrastructure. Exoexine on proximal side of the body folded. The folds are regularly arranged into a reticulum with polygonal lumina and undulating muri.

Remarks. — Pollen grains of similar morphology, described as *Ellipsovelatisporites* sp. have been found in Permo-Triassic strata of Lybia (Kar, Kieser, Jain 1972).

Occurrence. — West Poland, upper part of the Upper Buntsandstein.

Protohaploxypinus samoilovichii (Jansonius 1962) Hart, 1964
(pl. 24: 1)

1962. *Striatites samoilovichii* Jansonius: 67, pl. 14: 9—11.
1964. *Protohaploxypinus samoilovichii* (Jansonius) Hart, Hart: 1181, text-fig. 18.
1974. (*Striatoabietites*) — *Protohaploxypinus samoilovichii* (Jansonius) Hart: Jardiné, pl. 2: 14, 16, 18.
1979. *Protohaploxypinus samoilovichii* (Jansonius) Hart; Balme: 31, pl. 3: 16.

Description. — Total grain size 72—95 μm. Pollen grains slightly diploxylonoid in outline, more frequently, however, haploxylonoid. Body outline ovate or subcircular. Exoexine on proximal side of the body separated into 8 to 13, rather broad (3—7 μm) taeniae separated by narrow striae. The taeniae are regular, parallel to one another over the whole body size. Exoexine of saccus light with infrareticulum; folded in vicinity of saccus attachments.

Remarks. — This species is distinguished by the continuous parallel exoexine taeniae on proximal body side. Specimens similar to the holotype of *Striatites samoilovichii* (Jansonius 1962: pl. 14: 9). This species is attributed to the genus *Protohaploxypinus* in conformance with the classification of bisaccated pollen grains with taeniae (Hart 1964).

Occurrence. — Poland, Lower Triassic, sporadically in Middle Triassic. Canada, Lower Triassic (Jansonius 1962). East Greenland, Upper Permian and Lower Triassic (Balme 1979). Tasmania, Lower Triassic and lower part of Middle Triassic (Playford 1965). Gabon, Upper Permian (Jardiné 1974).

Protohaploxypinus pantii (Jansonius 1962) comb. n.

(pl. 23: 1—3)

1962. *Striatites samoilovichii* var. *pantii* Jansonius: 68, pl. 14: 14, 15.
1963. ?*Taeniaesporites samoilovichii pantii* (Jansonius) Klaus; Klaus: 312, pl. 14: 71—73.
1965. *Strotersporites pantii* (Jansonius) Goubin; Goubin: 1424, pl. 2: 7, 8.
1970. *Striatopodocarpites pantii* (Jansonius) Balme; Balme: 368, pl. 12: 7—9.
1974. (*Striatoabietites*) — *Striatopodocarpites pantii* (Jansonius) Balme; Jardiné: pl. 2. 17.

Holotype: Jansonius 1962, pl. 14: 14.

Type locality: Peace River area, Canada.

Type horizon: Lower Triassic.

Description. — Total grain size 65—82 μm. Grains bisaccate, slightly diploxylonoid or nearly haploxylonoid in outline. Body of circular or ovate outline. Some specimens have undistinct monolete mark. Sacci semicircular with distal inclination. Distinct transverse folds at sacci attachments. Exoexine on proximal body side separated into taeniae. Number of taeniae 6—9, usually 7. Equatorial taeniae are continuous, while the central ones are shorter and wedge out sharply. Taeniae are separated by narrow striae devoid of exoexine. Infrastructure of sacci reticulate.

Remarks. — The specimens similar to the holotype of *Striatites samoilovichii* var. *pantii* Jansonius. According to the classification of pollen grains of infraturma Striatiti (Hart 1964) the species is included into the genus *Protohaploxypinus*. The morphological features of the variety *Striatites samoilovichii pantii* are considered sufficient for the erection of a new species, as earlier workers have already suggested. The earlier taxonomic proposals are rejected for the following reasons: *Strotersporites* — most specimens lack distinct trilete mark on the body; *Striatopodocarpites* — different mode of sacci attachment and only slightly diploxylonoid shape of the equatorial outline of grains; *Taeniaesporites* — large number (usually 7) of exoexine taeniae.

Occurrence. — West Poland, Lower Triassic, specially numerous in the Lower Buntsandstein, Canada, Lówer Triassic (Jansonius 1962). Madagascar, Upper Permian — Middle Triassic, specially numerous in the Lower Triassic (Goubin 1965). Pakistan — Salt Range, Upper Permian (Balme 1970).

Protohaploxypinus jacobii (Jansonius, 1962) Hart, 1964

(pl. 25: 4)

1962. *Striatites jacobii* Jansonius: 67, pl. 14: 16, 17.
1964. *Protohaploxypinus jacobii* (Jansonius) Hart; Hart: 31, text-fig. 67.

Remarks. — The specimens differ from *Protohaploxypinus pantii* by wider taeniae, slightly wedging out, but not splitted, and running over the whole body.

Occurrence. — Poland, Lower Triassic. England, Upper Permian (Clarke 1965). Australia, Upper Permian (Foster 1979). West Canada, Lower Triassic (Jansonius 1962). North Sea Basin, Permian — Lower Triassic (Geiger and Hopping 1968).

Protohaploxypinus pellucidus Goubin, 1965
(pl. 25: 3)

1965. *Protohaploxypinus pellucidus* Goubin: 1423, pl. 2: 4—6.
1970. *Taeniaesporites pellucidus* (Goubin) Balme; Balme: 373, pl. 13: 8—10.
1972. *Lunatisporites pellucidus* (Goubin) Helby; de Jersey: 13, pl. 3: 9.
1979. *Taeniaesporites pellucidus* (Goubin) Balme; Balme: 34, pl. 3: 13, 14.

Remarks. — The generic name *Protohaploxypinus* has been applied because of clearly haploxylonoid equatorial outline and lack of monolete mark.

Occurrence. — Poland, Lower Triassic, locally numerous in the Middle Buntsandstein. Madagascar, Lower Triassic (Goubin 1965). Australia, Triassic (Balme 1963, 1970, de Jersey 1972, 1979). Pakistan — Salt Range, Scythian abundant; in the Middle Triassic very rare (Balme 1970).

Taeniaesporites noviaulensis Leschik, 1956
(pl. 25: 2)

1956. *Taeniaesporites noviaulensis* Leschik: 134, pl. 22: 1, 2.
pars 1962. *Taeniaesporites novimundi* Jansonius: 63, pl. 13: 25.
1979. *Lunatisporites noviaulensis* (Leschik) de Jersey; de Jersey: 27, pl. 9: 5, 8.

Remarks. — The generic name *Taeniaesporites* is maintained for pollen grains of rather diploxylonoid outline with 4 exoexine taeniae and with a small monolete tetrad mark within the body intexine.

Occurrence. — Poland, Upper Permian and Lower Triassic, fairly regularly; Muschelkalk and Keuper sporadically. Elsewhere the species is commonly encountered in the Upper Permian and fairly regularly in the Lower Triassic.

Strotersporites richteri (Klaus) Wilson, 1962
(pl. 23: 5)

1955. *Lueckisporites richteri* Klaus: 778, pl. 33: 1—3.
1962. *Striatites richteri* (Klaus) Jansonius; Jansonius: 66, pl. 14: 21, 22.
1963. *Strotersporites richteri* (Klaus) Wilson; Klaus: 316, pl. 15: 76.
1964. *Striatoabietites richteri* (Klaus) Hart; Hart: 1186, text-fig. 41.
1979. *Striatoabietites richteri* (Klaus) Hart; Balme: 32, pl. 3: 19.

Remarks. — Pollen grains particularly similar to the specimens described by Balme (1979) from East Greenland as *Striatoabietites richteri* (Klaus) Hart. Some of the investigated specimens, lacking distinct transverse segmentation of exine taeniae, appear similar to *Strotersporites jansoni* Klaus.

Occurrence. — West and Central Poland, Lower Buntsandstein. Elsewhere, Upper Permian of western Europe (Klaus 1963, Clarke, 1965) and Lower Triassic of Canada (Jansonius 1962) and Greenland (Balme 1979).

Hexasaccites muelleri (Reinhardt et Schmitz) Reinhard, 1965
(pl. 26: 1—3)

1964. *Podocarpeaepollenites thiergartii* Mädler: 87, pl. 7: 11, 12.
1964. *Nuscoisporites muelleri* nov. sp. Reinhardt et Schmitz; Reinhardt: 612, pl. 1: 5.
1965. *Nuscoisporites muelleri* Reinhardt et Schmitz: 23, pl. 5: 5, 9.
1965. *Hexasaccites* n.gen. Reinhardt: Reinhardt, Schmitz: 27.
1966. *Triadispora muelleri* (Reinhardt et Schmitz) Visscher; Visscher: 352, pl. 12: 1, 2.
1969. *Hexasaccites muelleri* Reinhardt et Schmitz; Adloff and Doubinger:

Remarks. — A broad morphological variety of specimens is observed in a sample, hence it is dependent neither on age nor on the conditions of sedimentation. The variation regards the width of the equatorial zone, exoexine partition in central part of the spore and in equatorial region, and intensity of exoexine sculpture. Specimens with narrow and continuous zone (pl. 26: 2) are morphologically similar to the specimens of *Stellapollenites.* Specimens with wide and incised zone (pl. 26: 1) resemble more the specimens of *Hexasaccites.* Examination of specimens with intermediate features suggests rather the broad morphological variety than the presence of two distinct species.

Occurrence. — Poland, Röt and lowermost part of Lower Muschelkalk. GDR, Upper Buntsandstein (Reinhardt and Schmitz 1965, Schulz 1965), Lower Muschelkalk (Mädler 1964). Netherlands, Röt (Visscher 1966) and Lower Muschelkalk (Visscher and Commissaris 1968). France, Upper Buntsandstein (Adloff and Doubinger 1969).

STRATIGRAPHY

REMARKS ON LITHOSTRATIGRAPHY OF BUNTSANDSTEIN IN POLAND

Correlation of regional lithostratigraphic schemes of the Buntsandstein of Polish Lowlands causes serious difficulties (Szyperko-Śliwczyńska 1980).

Western Pomerania. — The lithostratigraphical scheme established by Szyperko-Teller (1982) for the area of western Pomerania includes Lower, Middle and Upper Buntsandstein. The Lower Buntsandstein comprises claystones and mudstones with intercalations of marly and oolitic limestones. Sandstones are present in a marked proportion. The Middle Buntsandstein includes the Pomerania and Połczyn formations. These are in great part sandstones accompanied by mudstones and claystones. The deposits are in most part red and brown and contain numerous oolitic intercalations. *Gervillia murchisoni* Geinitz occurs in the upper part of the Pomerania Formation (Szyperko-Śliwczyńska 1980). No miospores are known from these deposits. The Upper Buntsandstein (Röt) is represented by the clastic deposits of the Barwice Formation. The formation is composed of variegated sandstones, mudstones and claystones with intercalations of grey claystones and limestones with anhydrite nodules. Marly deposits dominate in the upper part of the section.

Foresudetic Monocline. — A detailed subdivision of the Lower Triassic of the Foresudetic Monocline, based on geophysical criteria, was carried out by Sokołowski (1967) who distinguished 21 well-log-lithological units.

For most sections in this area a more general division is used, comprising: Lower Buntsandstein with numerous *Esteria*, Middle Buntsandstein with *Gervillia murchisoni* Geinitz, and Upper Buntsandstein (Röt) with relatively frequent *Costatoria costata* (Zenker) (Gajewska 1964, 1982 and unpublished data). A detailed subdivision of the Röt of the Foresudetic Monocline, worked out by Senkowiczowa (1965), basing on cyclicity of evaporitic and carbonate deposits. The Röt strata of this area are quite similar to the classical Röt of the German Lowlands, but they differ markedly from coeval, more sandy deposits in western Pomerania.

Most of the sections dealt with in this paper are situated in the Foresudetic Monocline. Large proportion of grey and darkgrey claystones and mudstones suggests conditions favourable for miospore accumulation and preservation in sediments. The palynological data obtained, especially from the sections Otyń IG-1, Środa IG-2, Gorzów Wielkopolski IG-1 and Dachów M-24, allowed for construction of a relatively complete palynostratigraphical scheme of the Buntsandstein. This scheme has been then accepted as a reference base for palynostratigraphic studies of lithologically distinct Lower Triassic sequence of North-east Poland.

North-east Poland. — The lithostratigraphic scheme of the Lower Triassic of North-east Poland established by Szyperko-Śliwczyńska (1979) syntetizes earlier schemes of the same author. The lowermost, Baltic Formation comprises calcareous and marly red-brown pelitic rocks with few sandy intercalations. Only few Esteriae, individual specimens of megaspores, and more numerous ostracods and foraminifers have been hitherto found in these strata (Szyperko-Śliwczyńska 1979). Miospores have been not investigated.

Middle Buntsandstein of this lithostratigraphical scheme is divided into three formations (in ascending order): Lidzbark, Malbork and Elbląg Formations. The Lidzbark Formation comprises mudstones and claystones with intercalations of limestones, sandstones and oolitic rocks. The rocks are usually grey. Pelecypods *Gervillia murchisoni* Geinitz, ostracods and megaspores were found in lower part of the Lidzbark Formation (Szyperko-Śliwczyńska 1979, 1980). Palynological investigations revealed a numerically rich and diversified microflora correlative with the subzone *Densoisporites nejburgii* (PII) established in the sections of western Poland (table 1). The overlying Malbork Formation comprises sandstones, mudstones and claystones with intercalations of brick-red limestones. Rare ostracods occur in these sediments; miospores have been not found.

The Elbląg Formation comprises grey sandstones and conglomerates with some mudstones and claystones, increasing in proportion upwards.

There is no fauna known from the Elbląg Formation, but there occur megaspores (Fuglewicz 1973) and numerous miospores described in this paper.

Palynological investigations of the Elbląg Formation reveal a rich microflora characteristic of the *Voltziaceaesporites heteromorpha* zone (table 1). The extent of this zone matches the range of occurrence of pelecypod *Costatoria costata* (Zenker) in the section of western Poland. Fuglewicz (1973, 1980) reports occurrence of megaspores of the *Trileites validus* zone, characteristic of the Upper Buntsandstein, in the Fore-sudetic monocline. The above facts lead to a conclusion that in North-east Poland both, the limnic deposits of the Elbląg Formation determined on lithological base as Middle Buntsandstein (Szperko-Śliwczyńska 1979) and the overlying marine strata, regarded as condensed Röt, are time-equivalent of the Upper Buntsandstein.

PALYNOLOGICAL ASSEMBLAGE ZONES OF BUNTSANDSTEIN

Palynological investigations of Buntsandstein strata in boreholes Dachów M-24, Otyń IG-1, Środa IG-2, Gorzów Wielkopolski IG-1, Połczyn IG-1 and Czaplinek IG-2 in western Poland, and borehole Florentyna IG-2 in central Poland provide sufficient base to establish a palynological zonation of the Lower Triassic. The microflora comprises numerous genera and species of spores and morphologically differentiated pollen grains, the latter represented mainly by infraturmae Striatiti, Disaccitrileti and Disacciatrileti. Accumulations of acritarchs are found in lower and upper parts of the Buntsandstein sequence.

Several assemblages have been distinguished on grounds of variations in species composition and frequency of individual taxa; the assemblages were used to devise palynological assemblage zones. The zones are named after abundant and regularly occurring species.

The assemblage zone *Lundbladispora obsoleta* — *Protohaploxypinus pantii* is proposed as an index zone for the Lower Buntsandstein.

The asseemblage zone *Densoisporites nejburgii* is established for the deposits of the Middle Buntsandstein. It is subdivided into three successive subzones:

Densoisporites nejburgii — *Acritarcha* (PI)
Densoisporites nejburgii (PII)
Densoisporites nejburgii — *Cycloverrutriletes presselensis* (PIII)

The subzones correspond to the assemblages PI—PIII distinguished in an earlier paper by the author (Orłowska-Zwolińska 1977). Here they are named after their characteristic taxons.

The assemblage zone *Voltziaceaesporites heteromorpha* (R), established for the Upper Buntsandstein, is based on the assemblage labelled "R" (Orłowska-Zwolińska 1977).

A microfloral assemblage with regularly occurring *Perotrilites minor* and abundant acritarchs was observed above the last mentioned assemblage in the discussed sections. The former defines provisionally an informal unit with *Perotrilites minor* and Acritarcha, probably of a zone rank. This unit is distinguished in "marly beds" attributed by some authors to the uppermost Röt, and by others (including the author) to the lowermost Muschelkalk. At this moment this unit can be not formally established as its upper boundary remains unknown.

ASSEMBLAGE ZONE *LUNDBLADISPORA OBSOLETA — PROTOHAPLOXYPINUS PANTII*

Stratotype. — Depth interval 713.5—938.1 m of the borehole Dachów M-24 (fig. 2). The microfloral assemblage in these strata is diverse and well preserved. Similar assemblages are found in boreholes: Otyń IG-1, at depth 835.2—935,3 m (fig. 3), and Florentyna IG-2, at depth 3121.0—3122.6 m.

Characteristics of the assemblage. — The main feature of the assemblage is appearance of spore genus *Lundbladispora.* Of these, *L. obsoleta* gives the name for the zone, because of its limited vertical extent and distinct morphological features. The second taxon, *Protohaploxypinus pantii* comprising bisaccate grains with striated body is known to occur since Permian and represented regularly and numerously in the discussed zone.

The following grains of infraturma Striatiti, apart of *Protohaploxypinus pantii*, occur regularly, but in less number: *Strotersporites richteri* (Klaus) Wilson, *Taeniaesporites noviaulensis* Leschik, *Protohaploxypinus pellucidus* Goubin, *P. samoilovichii* (Jansonius) Hart, *Striatopodocarpites* sp.

Among bisaccate unstriated grains, *Platysaccus papilionis* Potonié et Klaus is of particular interest. Monocolpates pollen grains are represented in greater numbers by *Cycadopites follicularis* Wilson et Weber and *C. coxii* Visscher.

There are generally less spores than pollen grains in the assemblage. *Lundbladispora willmotti* Balme occurs regularly in all samples; *Kraeuselisporites cuspidus* Balme, *Endosporites papillatus* Jansonius, *Densoisporites playfordi* (Balme) Dettmann, *Densoisporites* sp. appear in this zone and continue to occur in younger strata.

Comparison and correlations. — The assemblage diagnostic for this zone includes partly of the floristic elements older than Triassic, mainly

Upper Permian species. These are mostly bisaccate grains with striated body of genera *Taeniaesporites*, *Strotersporites*, *Protohaploxypinus et al.* Noteworthy is the absence of *Lueckisporites virkkiae* Potonié et Klaus, generally accepted as an index species of the Upper Permian. The investigated assemblage contains neither the forms typical (norm A) for the palynodeme *Lueckisporites*, established by Visscher (1971), nor the grains (norms B and C) of the morphological evolutionary trend of this palynodeme.

On the other hand, the discussed assemblage contains already some elements of flora typical for the Triassic represented by species of the genera *Lundbladispora* and *Densoisporites*. The most significant are *L. obsoleta* and *L. willmotti*, both with narrow stratigraphic extent, and the first appearances of *D. playfordi* and *Densoisporites* sp., commonly known in the Lower Triassic strata only.

The analysis of the assemblage indicates its character transitional between the Upper Permian and the Lower Triassic.

This assemblage corresponds to the association *Protohaploxypinus* distinguished by Balme (1979) in area of Kap Stosch in East Greenland. This association concurrs there with ammonites *Otoceras woodwardi boreale* Spath, *Glyptophiceras* (*Hypophiceras*) *triviale* Spath and conodonts *Andiignathodus typicalis*. These fossils date the *Protohaploxypinus* association at the Griesbachian stage. The Griesbachian with its lower boundary marked by appearance of *Otoceras*, begins the Lower Triassic sequence, equivalent to the Scythian, in the stratigraphical scheme of Tozer (1967).

Another occurrence of similar microfloral assemblage, also concurrent with *Otoceras*, is known in the Toad-Grayling Formation, Peace River area, West Canada (Tozer 1967). Noting the close resemblance of the Greenlandian and Canadian assemblages Balme (1979) concludes that the Upper Permian elements observed do not result from local redeposition but rather reflect a normal evolutionary trend of the Early Triassic flora over vast areas of the globe. This view is corroborated by the presence of a similar assemblage in Poland.

Attention is given to the fact that the assemblage characteristic of the *Lundbladispora obsoleta* — *Protohaploxypinus pantii* zone concurrs with the megaspore assemblage *Otynisporites eotriassicus* in the Lower Triassic strata of the borehole Otyń IG-1 (Fuglewicz 1979). Fuglewicz (1980) attributes the Upper Permian age to those deposits, accepting the view of Visscher (1971) who includes the Lower Buntsandstein to the Permian System. The palynological results presented here indicate that the microflora of the Lower Buntsandstein in the Otyń IG-1 section lacks the pollen grains of palynodeme *Lueckisporites* belonging to morphological norms A, B, and C, essential for the palynological zonation of the Upper Permian. This microflora comprises, apart from still numerous pollen grains of infraturma Striatiti with their ranges extending into the Triassic, already some elements typical of the Triassic.

The close resemblance between the discussed assemblage and the *Protohaploxypinus* association implies the correlation of the Lower Buntsandstein of the investigated sections in western Poland with the Griesbachian stage of the Triassic System in Greenland.

ASSEMBLAGE ZONE *DENSOISPORITES NEJBURGII*

The name *Densoisporites nejburgii* zone is applied to the vertical extent of that species, i.e., from its first appearance, through its acme to the beginning of its decline. Development of the species is coeval with sedimentation of the Middle Buntsandstein. The extent of the zone does not include the decline of the species; this occurred during the deposition of the Upper Buntsandstein.

The *Densoisporites nejburgii* zone is subdivided into 3 subzones distinguished by changes in quantitative relations of the constituent species, including the percentage of *D. nejburgii*. These subzones are defined by three successive microfloral assemblages, distinguished by the author in an earlier paper (Orłowska-Zwolińska 1977), and labelled PI, PII, PIII.

1. Subzone *Densoisporites nejburgii* — Acritarcha (PI)

Stratotype. — Deposits from the depth interval 2172.3—2221.5 m of the borehole Gorzów Wielkopolski IG-1, attributed to the lowermost part of the Middle Buntsandstein. Another occurrence of the same assemblage in a good state of preservation is in the borehole Florentyna IG-2 at depth 2770.0 m.

Characteristics of the assemblage. — Low frequency of miospores is characteristic of this assemblage. Its most important feature is the appearance of *Densoisporites nejburgii*. Other important characteristics include: occurrence of individual specimens of *Endosporites papillatus* Jansonius and *Densoisporites playfordi* (Balme) Dettmann and abundant occurrence of acritarchs. The acritarchs are represented mainly by the genus *Micrhystridium* in the section Gorzów Wielkopolski IG-1 and by common *Veryhachium* in the section Florentyna IG-2.

2. Subzone *Densoisporites nejburgii* (PII)

Stratotype. — Deposits in the depth interval 2,100.3—2,125.3 m of the borehole Gorzów Wielkopolski IG-1 (Orłowska-Zwolińska 1977; herein figs. 2, 3). The assemblage characteristic of this subzone was also found in the borehole Środa IG-2 (Orłowska-Zwolińska 1977) and in the borehole sections Otyń IG-1 (fig. 3), Dachów M-24 (fig. 2) and Florentyna IG-2 described in this paper, as well as in North-east Poland, in the boreholes Marianka IG-1 and Ptaszkowa IG-3 (table 1).

Characteristics of the assemblage. — Its composition is dominated by *Densoisporites nejburgii* (Schulz) Balme at all localities. The main premise for the distinction of the subzone is a sudden increase in proportion of *Densoisporites nejburgii* relative to the older subzone.

The assemblage includes: *Endosporites papillatus* Jansonius, *Densoisporites playfordi* (Balme) Dettmann, *D. holospongia* Foster, *Densoisporites* sp., *Lundbladispora brevicula* Balme. The following spores are important because of their regular occurrence: *Punctatisporites triassicus* Schulz, *Cyclotriletes oligogranifer* Mädler, *C. microgranifer* Mädler. Of the pollen grains the following occur regularly: *Platysaccus leschiki* Hart, *P. papillionis* Potonié et Klaus, *Protohaploxypinus pellucidus* Goubin (locally fairly abundant), *Taeniaesporites noviaulensis* Leschik, *Cycadopites follicularis* Wilson, Webster *et al.*

3. Subzone *Densoisporites nejburgii* — *Cycloverrutriletes presselensis* (PIII)

Stratotype. — Deposits in the depth interval 484.0—562.0 m of the borehole Otyń IG-1 (fig. 3). Another occurrences are in the boreholes Środa IG-2 (Orłowska-Zwolińska 1977), Dachów M-24 (fig. 2) and Florentyna IG-2. The assemblage has been not found neither in the well Gorzów Wielkopolski IG-1 (this is related to the absence of the upper part of the Middle Buntsandstein section in this borehole — Orłowska-Zwolińska 1977) nor in the hitherto investigated sections of North-east Poland (fig. 1, table 1).

Characteristics of the assemblage. — The assemblage diagnostic for this subzone, in common with the assemblage of the *Densoisporites nejburgii* (PII) subzone, contains numerous miospores of the genera *Densoisporites* and *Lundbladispora*. It differs, however, by the appearance and regular occurrence of *Cycloverrutriletes presselensis*, unknown from the lower subzones. The general character of the assemblage indicates a continuous development of the flora of the *Densoisporites nejburgii* (PII) subzone.

Comparison and correlations of the Densoisporites nejburgii zone. — Characteristic of the discussed zone are: abundance of *Densoisporites* and *Lundbladispora* at all localities, the regional occurrence of pollen grains *Protohaploxypinus pellucidus* and the appearance of *Cycloverrutriletes presselensis* in the uppermost part of the zone. Outside the Polish territory, this microfloral assemblage is known from the Middle Buntsandstein of GDR (Schulz 1964, 1966) and from the Moesian Platform of Romania (Vankatachala, Beju and Kar 1968).

Some analogies exist between the assemblage of the discussed zone, especially its lower part (subzone PI), and the *Taeniaesporites* association, recognized in East Greenland sections above the *Protohaploxypinus* association — early Griensbachian (Balme 1979). The analogies include the increase in number of spores *Densoisporites* and *Lundbladispora* and pollen grains *Taeniaesporites pellucidus* (syn. *Protohaplaxypinus pellucidus*). Balme compares the *Taeniaesporites* association to the microfloras described from Salt Range, Pakistan (Balme 1970), Madagascar (Goubin 1965) and Australia (Balme 1963, Helby 1973, Dolby and Balme 1976), all hitherto considered to represent the earliest Lower Triassic floras. As a consequence of a succession established in the sections of East Greenland Balme (1979) corrects the age of the compared microfloras to early Scythian, younger than the *Protohaploxypinus* association, considered by him as the oldest Lower Triassic association.

The increase in number of *Densoisporites* and *Lundbladispora* spores is also characteristic of the assemblage II of the Triassic microfloral succession of Canadian Arctic Archipelago, considered as Dienerian in age (Fisher 1979).

The correlation between the microfloras of the *Lundbladispora obsoleta* — *Protohaploxypinus pantii* zone and the *Protohaploxypinus* association continues to the younger strata of the compared regions. It is expressed, first of all, in the increase in proportion of spores *Densoisporites* and *Lundbladispora* and pollen grains *Prototohaploxypinus pellucidus* (syn. *Taeniaesporites pellucidus*), both in the overlying *Densoisporites nejburgii* zone of the Polish sections, and in the younger floràs within the Scythian stage, e.g. in the Salt Range section in Pakistan (Balme 1970). Besides, there are premisses for correlation of the microfloras of the *Densoisporites nejburgii* assemblage zone and of the Olenekian stage in southern Mangyshlak (Bogacheva and Vinogradova 1973). Nevertheless, precise correlations of microfloras of the individual Lower Triassic stages still encounter serious impediments.

ASSEMBLAGE ZONE *VOLTZIACEAESPORITES HETEROMORPHA* (R)

Stratotype. — Upper Buntsandstein strata in the depth interval 1756.4—1881.8 m of the borehole Połczyn IG-1 (Orłowska-Zwolińska 1977: fig. 4). Microflora is abundant and well preserved. Assemblages characteristic of this zone are found also in the following boreholes of western Poland: Czaplinek IG-2, Gorzów Wielkopolski IG-1, Środa IG-2, Dachów M-24 (fig. 2), Otyń IG-1 (fig. 3), Florentyna IG-2 and in North-east Poland in wells Morski Las IG-2 and Marianka IG-1 (fig. 1, table 1).

Characteristics of the assemblage. — It differs from the assemblage of the *Densoisporites nejburgii* zone by its quite different species composition, with pollen grains dominating over spores. The pollen grains, apart of *V. heteromorpha*, include mainly the following species: *Succinctisporites grandior* Leschik *sensu* Mädler, *Angustisulcites klausii* Freudenthal, *A. gorpii* Visscher (singular specimens), *Striatoabietites balmei* Klaus, *Platysaccus triassicus* Mädler, *Brachysaccus ovalis* Mädler, *Hexasaccites mulleri* (Reinhardt et Schmitz) Reinhardt. The genus *Triadispora* is represented in greatest numbers by *T. crassa* and *T. plicata* Klaus.

The particular attention is given to the occurrence, in the upper part of the zone, of pollen grains *Microcachryidites* with following species: *M. fastidiosus* (Jansonius) Klaus, *M. doubingeri* Klaus and *M. sittleri* Klaus.

The following spore species occur regularly: *Aratrisporites tenuispinosus* Plyford, *A. granulatus* (Klaus) Playford et Dettmann — locally abundant, *Cyclotriletes triassicus* Mädler, *Kraeuselisporites ullrichi* Reinhardt et Schmitz, *Verrucosisporites thuringiacus* Mädler, *V. pseudomorulae* Visscher.

The spores *Densoisporites nejburgii* are either absent or rare (section Otyń IG-1 — fig. 3) in the investigated sections of the Upper Buntsandstein. The only exception is the borehole section Czaplinek IG-2, where an assemblage with typical features of the *Voltziaceaesporites heteromorpha* assemblage zone still comprises 15% of specimens of *Densoisporites nejburgii.*

A gradual change of microfloral assemblage is observed within this zone. It consists in appearance of new elements and change in proportion of some others. For instance the pollen grains *Microcachryidites* increase, and *Triadispora* decrease in number, etc. This trend was noted earlier in the sections Połczyn IG-1 and Gorzów Wielkopolski IG-1 (Orłowska-Zwolińska 1977) and recently in the sections Dachów M-24 (fig. 2) and Otyń IG-1 (fig. 3). Being these observations further confirmed, two subzones could be distinguished within this zone.

Comparison and correlation of the assemblage. — The microflora of the assemblage zone *Voltziaceaesporites heteromorpha* bears features typical of the Upper Buntsandstein in territory of Poland (Dybova-Jachowicz and Laszko 1980, Laszko 1977) and in other European countries, especially GDR (Schulz 1965, 1966, Mädler 1964, Reinhardt and Schmitz 1965), West Germany (Doubinger and Büchman 1981), Netherlands (Freudenthal 1964, Visscher 1966), France (Adloff and Doubinger 1969) and Great Britain (Smith and Warrington 1973). A similar assemblage has been described by Klaus (1964) from the Upper Werfenian shales of the Alps.

Out of Europe a similar assemblage has been described by Fisher (1979) from the Canadian Arctic Archipelago as an assemblage IV in a succession of Triassic microfloral assemblages of this area. The age of the assemblage IV is described as possibly Spathian, according to the chronostratigraphic scale of Tozer (1969). This assemblage is dominated by bisaccate grains (among which striated bisaccate grains are important), and the appearance of *Aratrisporites tenuispinosus* Playford, *Illinites chitonoides* Klaus (syn. *Succinctisporites grandior* Leschik *sensu* Mädler), *Protodiploxypinus doubingeri* (Klaus) Warrington (syn. *Microcachryidites doubingeri* Klaus), *P. sittleri* (Klaus) Scheuring (syn. *Microcachryidites sittleri* Klaus) and *Triadispora falcata* Klaus, which make this assemblage comparable to the microflora of Upper Buntsandstein (Röt) strata of the north-western Europe. The same characteristics are displayed by the *Voltziaceaesporites heteromorpha* distinguished in the sections discussed herein.

Some elements, characteristic of the *Voltziaceaesporites heteromorpha* assemblage, as spores *Aratrisporites*, pollen grains *Angustisulcites*, *Triadispora* and *Voltziaceaesporites heteromorpha* are reported also from south Mangyshlak assemblages (Bogacheva and Vinogradova 1973), implying a possible correlation of the Olenekian stage with the Middle Buntsandstein as well as possibly with the lower part of the Röt of the Polish sections.

The age of the *Voltziaceaesporites heteromorpha* assemblage distinguished in the Upper Buntsandstein (Röt) is determined conventionally as the Upper Scythian. This is confirmed by the similarity of this flora to that of Upper Werfenian strata of the Alps (Klaus 1964) and to the assemblage IV of the microfloral succession described by Fisher (1979) and dated as the Upper Scythian — Spathian stage.

A different conclusion from the reference of the *Voltziaceaesporites heteromorpha* assemblage to the scheme of Visscher and Brügman (1981). The Spathian stage (Upper Scythian) in this scheme is characterized by the species *Densoisporites nejburgii* (Schulz) Balme and *Cycloverrutriletes presselensis* Schulz. The same species in the Polish scheme determine an assemblage older than *Voltziaceaesporites heteromorpha*. Thus, the latter would correspond to the Anisian microflora in the scheme of Visscher and Brügman (1981).

When the microflora *Voltziaceaesporites heteromorpha* is further compared with the microflora of the Röt, studied by Doubinger and Bühmann (1981), a possibility arises that the microflora of the lower part of this zone corresponds to the association I dated as Upper Scythian, whilst its upper part, with *Microcachryidites* pollen grains, corresponds to the association II, dated as Anisian.

The problem of the Scythian-Anisian boundary is not solved here, because the chronostratigraphic position of this boundary is not fixed yet, and because of diverging interpretations of palynological results. It is possible that the boundary between the Scythian and Anisian stages lies at the begining of the Röt or within Upper Buntsandstein deposits, and is reflected in the microfloristic succession by the appearance of the pollen grains *Microcachryidites*.

MICROFLORA OF LOWER MUSCHELKALK

A microfloral assemblage with characteristics comparable to the assemblage WII distinguished earlier in the borehole section Gorzów Wielkopolski IG-1 (Orłowska-Zwolińska 1977), but considerably more numerous and diversified, was found in the section Otyń IG-1, above the *Voltziaceaesporites heteromorpha* zone (fig. 3). The lower boundary of this assemblage is determined by the regular occurrence of *Perotrilites minor* (Mädler) Antonescu and Taugourdeau-Lantz and increase in percentage of microplankton represented by genera *Micrhystridium*, *Veryhachium*, *Leiosphaeridia* and *Tasmanites*. The limit of the upward extent of this microflora has been not recognized, thus requirements for establishment of a formal unit are not satisfied. For this reason the assemblage is provisionally described as defining an informal unit with *Perotrilites minor* and Acritarcha. The unit is distinguished in marly beds assigned lithostratigraphically either to the uppermost Röt (Gajewska 1964) or to the Lower Muschelkalk (Senkowiczowa 1965, 1979, Kotański 1977, Fuglewicz 1979). The species composition of the assemblage diagnostic for this unit includes a significant percentage of the species persisting from the *Voltziaceaesporites heteromorpha* zone. The distinction of the unit is accentuated by increase in microplankton content, regular appearance of *Perotrilites minor*, and appearance of *Cristianisporites triangulatus* Antonescu and *Concentricisporites nevesi* Antonescu, for the first time in the Triassic section. These species are well documented palaeontologically as belonging to the Anisian and have a wide geographic distribution. *Perotrilites minor* was discovered in the Lower Muschelkalk of GDR (Mädler 1964), and later found in Guttenstein limestone horizon (Anisian), Cristian valley, Roumanian East Carpathians (Antonescu 1979). *Cristianisporites triangulatus* Antonescu and *Aequitriradites minor* Mädler (syn. *Perotrilites minor*) have been considered characteristic for Lower Muschelkalk strata of South-east France by Taugourdeau-Lantz (1974). They occur together with the index fossil *Myophoria vulgaris* (Schlotheim). Thus, the microflora distinguished in the borehole Otyń IG-1 at the depth interval 290.0—327.0 m (the unit with *Perotrilites minor* and Acritarcha) can be correlated with the Muschelkalk microfloras of GDR and France, as well as with the Anisian microflora of the East Carpathians.

THE PROBLEM OF PERMIAN-TRIASSIC BOUNDARY

The problem of the boundary between the Permian and the Triassic is recently subject to animated discussion in palynological literature. The strata in the boundary zone between the two systems are frequently devoid of fauna. Plant microfossils, represented by spores, pollen grains, megaspores and sometimes acritarchs are relatively numerous in these strata. Palynological investigations have demonstrated that the litho-stratigraphical boundary between the sediments of Zechstein and Bunt-sandstein is diachronous. This can be documented due to the existence of characteristic microfloral assemblages. The Upper Permian assemblage in West and Central Europe is distinguishable by presence of characteristic species, of which specially important is pollen *Lueckisporites virkkiae* Potonié et Klaus. Visscher (1971) used this species as a base for creating a palynodeme, with consecutive main norms A, B, C, D, illustrating evolutionary modifications of the pollen grains within the palynodeme. The norms have been accepted as a base for detailed palynological zonation of the Upper Permian, and for separation of the Lower Triassic strata. Palynological zones A, B, C are more detailed subdivisions of the microfloristic assemblage I in the sections studied by Visscher (1971) in Kingscourt area, Ireland. Visscher (1971) correlates his assemblage I, as well as other assemblages of similar composition described from the "Zechstein" strata of Europe, with microflora of the Tatarian stage of the Russian platform. In consequence an Upper Permian age is assigned to his palynological zones A, B, C.

The assemblage II is characteristic for the next zone (D) in Kingscourt area. On grounds of numerous occurrence of spores *Lundbladispora* sp. in this assemblage, Visscher compares it to the microflora of the Middle Buntsandstein of the German basin, and to the microflora of the Vetlugian stage of the Russian platform. He includes the Vetlugian stage into the lowermost Triassic.

The Upper Permian assemblages distinguished at territory of Poland are comparable to the assemblages mentioned above. Detailed palynological studies by Dybova-Jachowicz (1974) and Dybova-Jachowicz and Laszko (1980) provide framework for the detailed correlation with the palynozones A (Aa—Ac) and B (Bc) of the Visscher's scheme. The same authors have recently distinguished the palynozone C in the section Radwanów, the Holy Cross Mountains (Góry Świętokrzyskie) (personal communication).

Triassic microfloras have been hitherto described in Poland from the Middle Buntsandstein and Röt of the western part of the country (Orłowska-Zwolińska 1977), and in Piekoszów syncline of the Holy Cross Mountains (Dybova-Jachowicz and Laszko 1980). The spore-pollen spectrum of Buntsandstein strata of the Holy Cross Mountains is restricted to the upper part of the Middle Buntsandstein and the Röt as suggests its correlation with the microflora of the sections of western Poland (table 2).

In this paper a microfloral assemblage is described, for the first time from Polish territory, which is younger than the assemblage of the Upper Permian and older than the assemblage of the Middle Buntsandstein. This assemblage is characteristic for the *Lundbladispora obsoleta — Pro-*

Table 2
Correlation of palynological zones of the Permian/Triassic boundary

Permian-Triassic Boundary (Tozer 1967, 1978)	Palynological assemblage zones in the boreholes of western Poland (distinguished in this paper): stage	substage	unit	part	zone	subzones	Microfossil associations in the section of Kap Stosch area, East Greenland (Balme 1979): system	stage	associations	Spore-pollen spectrum in the boreholes of Piekoszów syncline, Świętokrzyskie Mts. (Dybova-Jachowicz & Laszko 1980)		Palynological zones in the boreholes of Kingscourt area, Ireland (Visscher 1971): system	stage	palynodeme	zones	assemblages
TRIASSIC	ANISIAN		MUSCHELKALK	Lower	informal unit with *Perotrilites minor* & Acritarcha					spectrum of Muschelkalk		TRIASSIC				
TRIASSIC	ANISIAN		BUNTSANDSTEIN	Upper	*Voltziaceaesporites heteromorpha*					spectrum of Röt		TRIASSIC				
TRIASSIC	? SCYTHIAN	? Olenekian	BUNTSANDSTEIN	Middle	*Densoisporites nejburgii*	P III, P II, P I	TRIASSIC	Griesbachian	*Taeniaesporites* *Protohaploxypinus*	spectrum of Lower & Middle Buntsandstein		TRIASSIC	? Veltungian	*Lueckisporites* palynodeme	? *Lundbladispora* issp. dominate zone D	II
TRIASSIC	SCYTHIAN	1) Induan (Griesb.)	BUNTSANDSTEIN	Lower	*Lundbladispora obsoleta-Protohaploxypinus pantii*		TRIASSIC	Griesbachian	*Taeniaesporites* *Protohaploxypinus*	spectrum of Lower & Middle Buntsandstein		TRIASSIC	Veltungian	*Lueckisporites* palynodeme		
PERMIAN							PERMIAN		*Viitatina* (*Lueckisporites virkkiae* is present)	spectrum of Upper Permian	*Lueckisporites* palynodeme C 2), B, A	PERMIAN	Thuringian	*Lueckisporites* palynodeme	zone C, zone B, zone A	I

tohaploxypinus pantii zone. *Lueckisporites virkkiae* is already absent from this assemblage, though some other species persist from the Upper Permian. They are accompanied by genera *Lundbladispora* and *Densoisporites*, characteristic of the Triassic. The microflora of this zone is intermediate in character between the Upper Permian and Triassic microfloras. The distinctive composition of the assemblage permits its correlation with similar ones found elsewhere. Of special importance is the apparent correlation of this microflora with the *Protohaploxypinus* association described from the lower part of the Griesbachian stage in East Greenland. Though the Griesbachian stage is not unanimously classified in various stratigraphic schemes, it should be pointed out that it is the lowermost stage of the Triassic system in the scheme established for northern Canada by reference to the ammonite zonation (Tozer 1967, 1978). The strata corresponding to the lower part of the Griesbachian stage are described as the Gangetian substage by Kozur (1973), and are included by him into the uppermost Permian.

It is also important that the *Protohaploxypinus* association in East Greenland occurs above the *Vittatina* association found in the *Productus* Beds. Balme (1979) accentuates analogies between the *Vittatina* association and the Tatarian stage, at the north of the European part of the USSR, containing abundant specimens of genus *Vittatina* and relatively scarce *Lueckisporites virkkiae*.

The facts presented above suggest the following succession of microfloral assemblages across the Permian-Triassic boundary:

The Upper Permian microflora of Poland, in spite of some differences, can be correlated with the *Vittatina* association of the Upper Permian *Productus* Beds of Greenland, and with assemblages of the palynological zones A, B, C (assemblage I) of Ireland (Thuringian).

The microflora of the *Lundbladispora obsoleta* — *Protohaploxypinus pantii* zone, distinguished in the Lower Buntsandstein of western Poland, is comparable to the *Protohaploxypinus* association of Greenland, concurrent with *Otoceras* and *Glyptophiceras* (*Hypophiceras*) fauna, and assigned to the lower Griesbachian, the lowermost stage of the Lower Triassic in Tozer's scheme.

The next assemblage, diagnostic for the *Densoisporites nejburgii* zone in the Middle Buntsandstein of western Poland correlates with the microfloras of coeval strata in GDR and with the microflora of the palynozone D (assemblage II) of Ireland.

←

1) On the base of the data of USSR area (Yaroshenko, Golubieva 1981) *Lundbladispora obsoleta* — *Protohaploxypinus pantii* assemblage zone has been correlated with I miospore assemblage zone which is characteristic for Induan stage, and *Densoisportes nejburgii* assemblage zone with II assemblage characteristic for Olenekian stage.
2) zone C distinguished by S. Dybova-Jachowicz and D. Laszko in the Radwanów section — personal information.

The newly described assemblage of the *Lundbladispora obsoleta* — *Protohaploxypinus pantii* zone fills the gap in the microfloral succession at the Permian-Triassic boundary in Europe (table 2). This assemblage is younger than the zone C, and older than the zone D of the Visscher's (1979) scheme.

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TERESA ORŁOWSKA-ZWOLIŃSKA

PALINOSTRATYGRAFIA PSTREGO PIASKOWCA W PROFILACH ZACHODNIEJ POLSKI

Streszczenie

Wyniki badań palinologicznych pstrego piaskowca przedstawione we wcześniejszej pracy autorki (Orłowska-Zwolińska 1977) zostały skonfrontowane z wynikami obecnie zbadanych profili następujących wierceń: Dachów M-24, Otyń IG-1, Florentyna IG-2, Czaplinek IG-2 (fig. 1). Na podstawie wyróżnionych zespołów ustalono palinologiczne poziomy i podpoziomy (figury 1, 2, 3).

Na uwagę zasługuje wyróżnienie zespołu mikroflory triasowej dotychczas nie znanego na obszarze Polski. Zespół ten jest starszy od mikroflory środkowego pstrego piaskowca i stanowi podstawę do ustalenia poziomu palinologicznego *Lundbladispora obsoleta* — *Protohaploxypinus pantii* w osadach dolnego pstrego piaskowca w trzech profilach na obszarze Polski. Mikroflora tego poziomu wykazuje cechy wspólne z asocjacją „*Protohaploxypinus*" wyróżnioną we wschodniej Grenlandii (Balme 1979) w osadach datowanych na podstawie fauny *Otoceras* jako dolny griesbach a zaklasyfikowanych zgodnie ze schematem Tozera (1967, 1978) do dolnego triasu. Mikroflora tego poziomu stanowi przy tym ogniwo uzupełniające w dotychczas poznanej sukcesji mikroflory z pogranicza permu i triasu w Europie (tabela 2). Jest ona młodsza od najwyższej zony górnego permu (zona C) a starsza od zony dolnotriasowej (zona D) według schematu Visschera (1971).

Następny poziom palinologiczny, *Densoisporites nejburgii*, wyróżniono w zasięgu środkowego pstrego piaskowca. Obejmuje on trzy kolejne podpoziomy: *Den-*

soisporites nejburgii — Acritarcha (PI), *Densoisporites nejburgii* (PII), *Cycloverrutriletes presselensis* (PIII). Podpoziomy te jak również niżej wymieniony poziom *Voltziaceaesporites heteromorpha*, ustalono na podstawie zespołów mikroflory (PI, PII, PIII, R) wyróżnionych przez autorkę (Orłowska-Zwolińska 1977). Obecnie nadano im nazwy pochodzące od nazw charakterystycznych taksonów.

Poziom *Voltziaceaesporites heteromorpha* (R) obejmuje mikroflorę wyróżnioną w osadach górnego pstrego piaskowca, która w profilach obszaru przedsudeckiego współwystępuje z *Costatoria costata*. W profilach północno-wschodniej Polski zespół ten został stwierdzony w limnicznych osadach formacji elbląskiej, zaliczanej dotychczas na podstawie litologii do środkowego pstrego piaskowca (Szyperko-Śliwczyńska 1979), i w wyżej leżących osadach retu (tabela 1).

Mikroflora znaleziona powyżej poziomu *Voltziaceasporites heteromorpha* w warstwach marglistych zaliczanych, bądź do najwyższego retu, bądź do dolnego wapienia muszlowego, zawiera wiele elementów wspólnych z tym poziomem. Wyróżnia się regularnym występowaniem *Perotrilites minor*, pojawieniem się gatunków charakterystycznych dla niewątpliwego anizyku z dużym udziałem Acritarcha.

Opisano wybrane gatunki miospor w tym 2 nowe: *Baculatisporites verus* sp. nov. i *Ellipsovelatisporites rugulatus* sp. nov. oraz jedną nową kombinację gatunku: *Protohaploxypinus pantii* (Jansonius) comb. nov. Zilustrowano ważne dla stratygrafii gatunki miospor (plansze 17—26).

EXPLANATION OF PLATES 17—26

Plate 17

1. *Cycloverrutriletes presselensis* Schulz: borehole Dachów M-24, depth 451.0 m, Muz. IG 688/43.
2. *Cyclotriletes microgranifer* Mädler: Otyń IG-1, 561.9 m, Muz. IG 482/40.
3. *Cyclotriletes triassicus* Mädler: Otyń IG-1, 386.1 m, Muz. IG 482/137.
4. *Cyclotriletes oligogranifer* Mädler: Otyń IG-1, 294.8 m, Muz. IG 482/59.
5. *Punctatisporites triassicus* Schulz: Dachów M-24, 435.5 m, Muz. IG 688/45.
6. *Guttatisporites microechinatus* Visscher: Otyń IG-1, 338.2 m, Muz. IG 482/104.

Figures *1*—*5*×1000, *6*×750

Plate 18

1. *Guttatisporites elegans* Visscher: Środa IG-2, 2384.0 m, Muz. IG 492/68.
2. *Baculatisporites verus* sp. n.: Otyń IG-1, 294.8 m, Muz. IG 482/59 — holotype.
3. *Densoisporites holospongia* Foster: Otyń IG-1, 507.0 m, Muz. IG 482/176.

4. *Densoisporites nejburgii* (Schulz) Balme: Dachów M-24, 447.0 m, Muz. IG 688/36.
5. cf. *Lundbladispora brevicula* Balme: Dachów M-24, 484.2 m, Muz. IG 688/87.
6—7. *Densoisporites playfordi* (Balme) Dettmann: Dachów M-24, 814.5 m, Muz. IG 688/82.

All figures ×1000

Plate 19

1—2. *Lundbladispora obsoleta* Balme: *1* Dachów M-24, 887.2 m, Muz. IG 688/111; *2* Dachów M-24, 885.0 m, Muz. IG 688/107.
3—4. *Lundbladispora willmotti* Balme: *3* Dachów M-24, 784.2 m, Muz. IG 688/85; *4* lateral view, Dachów M-24, 887.2 m, Muz. IG 688/112.
5—6. *Kraeuselisporites apiculatus* Jansonius: Dachów M-24, 938.4 m, *5* Muz. IG 688/119; *6* Muz. IG 688/120.

All figures ×1000

Plate 20

1—2. *Kraeuselisporites cuspidus* Balme: Otyń IG-1, 416.3 m, Muz. IG 482/147; *1* proximal focus, *2* distal focus showing sculptural elements.
3. *Endosporites papillatus* Jansonius: Środa IG-2, 2609.0 m, Muz. IG 492/134.
4. *Perotrilites minor* (Mädler) Antonescu et Taugourdeau — Lantz: Otyń IG-1, 314.6 m, Muz. IG 482/78.
5. *Kraeuselisporites ullrichi* Reinhardt et Schmitz: Otyń IG-1, 386.1 m, Muz. IG 482/137.
6. *Accinctisporites* sp.: Otyń IG-1, 375.2 m, Muz. IG 482/126.

Figures *1—4*, *6*×1000, *5*×750

Plate 21

1, 2. *Concentricisporites nevesi* Antonescu: Otyń IG-1, 332.5 m, Muz. IG 482/86.
3. *Angustisulcites gorpii* Visscher: Dachów M-24, 418.4 m, Muz. IG 688/23.
4. *Aratrisporites granulatus* (Klaus) Playford et Dettmann: Otyń IG-1, 375.2 m, Muz. IG 482/128.
5. *Aratrisporites tenuispinosus* Playford: Połczyn IG-1, 1867.5 m, Muz. IG 483/140.
6. *Taeniaesporites albertae* Jansonius: Dachów M-24, 814.5 m; ×1000, Muz. IG 688/93.

Figure *1*×750, *2—6*×1000

Plate 22

1—3. *Ellipsovelatisporites rugulatus* sp. n.: *1—2* Otyń IG-1, 384.1 m, Muz. IG 482/131, proximal (*1*) and distal foci (*2*); *3* proximal focus, Dachów M-24, 319.5 m, Muz. IG 688/11. ×750.
4. *Cristianisporites triangulatus* Antonescu: Otyń IG-1, 323.7 m, Muz. IG 482/87. ×600.
5, 6. *Protosacculina jansonii* Freudenthal: Dachów M-24, 418.4 m, *5* Muz. IG 688/22, *6* Muz. IG 688/21. ×1000.
7. *Striatoabietites balmei* Klaus: Otyń IG-1, 384.1 m, Muz. IG 482/131. ×1000.

Plate 23

1—3. *Protohaploxypinus pantii* (Jansonius) comb. n.: *1* Dachów M-24, 864.4 m, Muz. IG 688/97; *2* proximal taeniae, Otyń IG-1, 935.6 m, Muz. IG 482/204; *3* Dachów M-24, 887.2 m, Muz. IG 688/111.
4. *Taeniaesporites hexagonalis* Jansonius: Dachów M-24, 814.5 m, Muz. IG 688/92.
5. *Strotersporites richteri* (Wilson) Klaus: Dachów M-24, 938.1 m, Muz. IG 688/119.
6. *Cycadopites follicularis* Wilson et Webster: Dachów M-24, 784.2 m, Muz. IG 688/87.

Figures *1—4*, *6*×1000, *5*×750

Plate 24

1. *Protohaploxypinus samoilovichii* (Jansonius) Hart: Otyń IG-1, 384.1 m, Muz. IG 482/132.
2. *Klausipollenites staplini* Jansonius: Otyń IG-1, 384.1 m, Muz. IG 482/131.
3. *Striatopodocarpites* cf. *fusus* (Balme et Hennelly) Potonié: Otyń IG-1, 384.1 m, Muz. IG 482/131.
4, 5. *Triadispora* sp., cf. *T. epigona* Klaus: Dachów M-24, 419.1 m, Muz. IG 688/24.
6. *Angustisulcites klausii* Freudenthal: Otyń IG-1, 342.5 m, Muz. IG 482/113.
7. *Triadispora* sp.: Otyń IG-1, 416.9 m, Muz. IG 482/144.

All figures ×1000

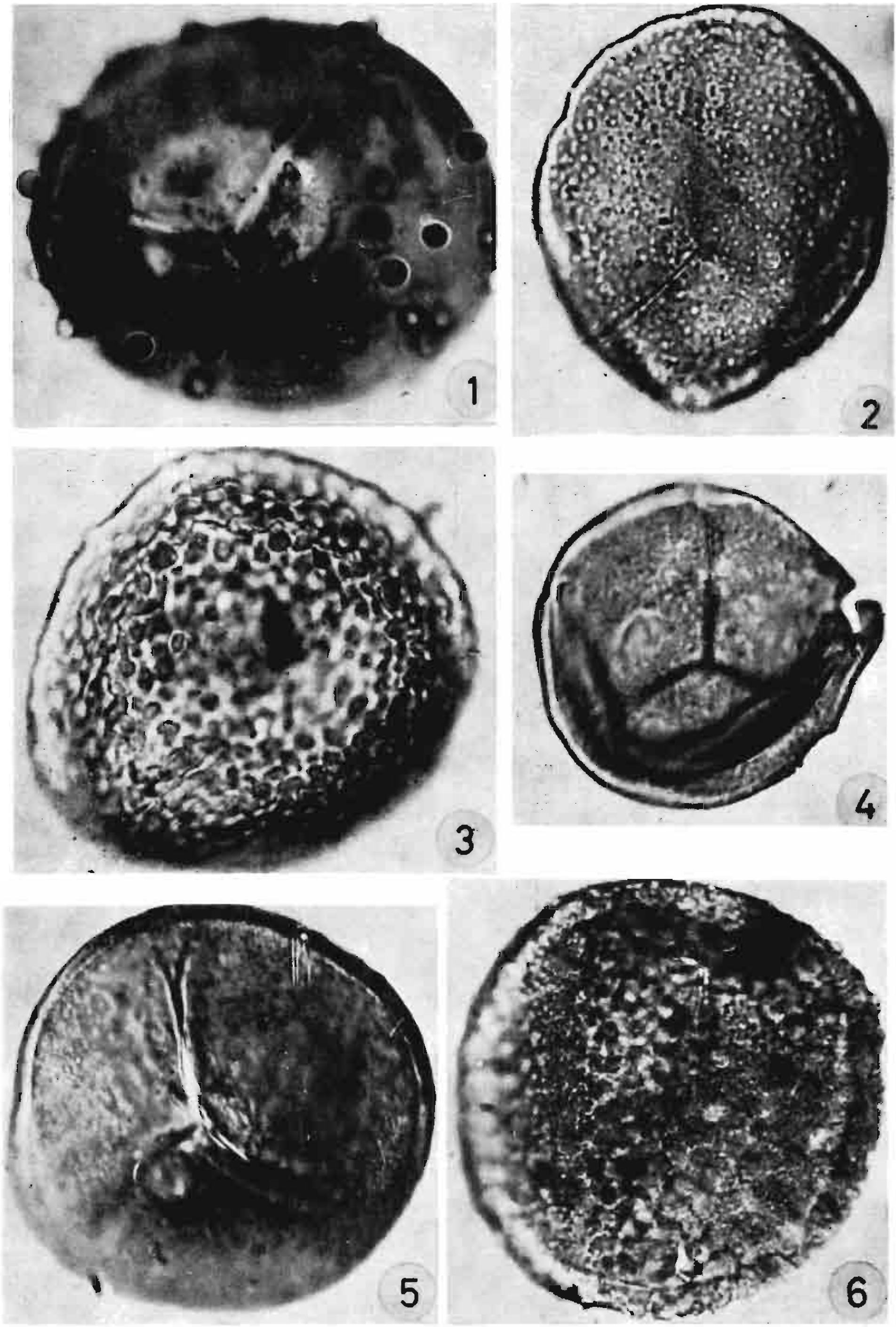
Plate 25

1. *Voltziaceaesporites heteromorpha* Klaus: Połczyn IG-1, 1756.0 m, Muz. IG 483/127.
2. *Taeniaesporites noviaulensis* Leschik: Dachów M-24, 814.5 m, Muz. IG 688/92.
3. *Protohaploxypinus pellucidus* Goubin: Dachów M-24, 814.5 m, Muz. IG 688/82.
4. *Protohaploxypinus jacobii* (Jansonius) Hart: Dachów M-24, 419.1 m, Muz. IG 688/24.
5. *Cycadopites follicularis* Wilson et Webster: Dachów M-24, 784.2 m, Muz. IG 688/87.
6. *Protohaploxypinus* sp.: Dachów M-24, 418.3 m, Muz. IG 688/22.
7. cf. *Cycadopites coxii* Visscher: Dachów M-24, 784.2 m, Muz. IG 688/87.

Figure *1*×1000, *2—7*×1000

Plate 26

1—3. *Hexasaccites muelleri* (Reinhard et Schmitz) Reinhardt: *1* wide equatorial zone, Otyń IG-1, 291.3 m, Muz. IG 482/53; *2* narrow equatorial zone, Dachów M-24, 327.3 m, Muz. IG 688/15; *3* fragment of specimen with smooth intexine, Dachów M-24, 327.3 m, Muz. IG 688/15.
4. *Microcachryidites sittleri* Klaus: Dachów M-24, 257.4 m, Muz. IG 688/4.
5. *Microcachryidites doubingeri* Klaus: Dachów M-24, 257.5 m, Muz. IG 688/1.
6. *Triadispora plicata* Klaus: Dachów M-24, 419.1 m, Muz. IG 688/24.
7. *Microcachryidites fastidosus* (Jansonius) Klaus: Połczyn IG-1, 1757.5 m, Muz. IG 483/13.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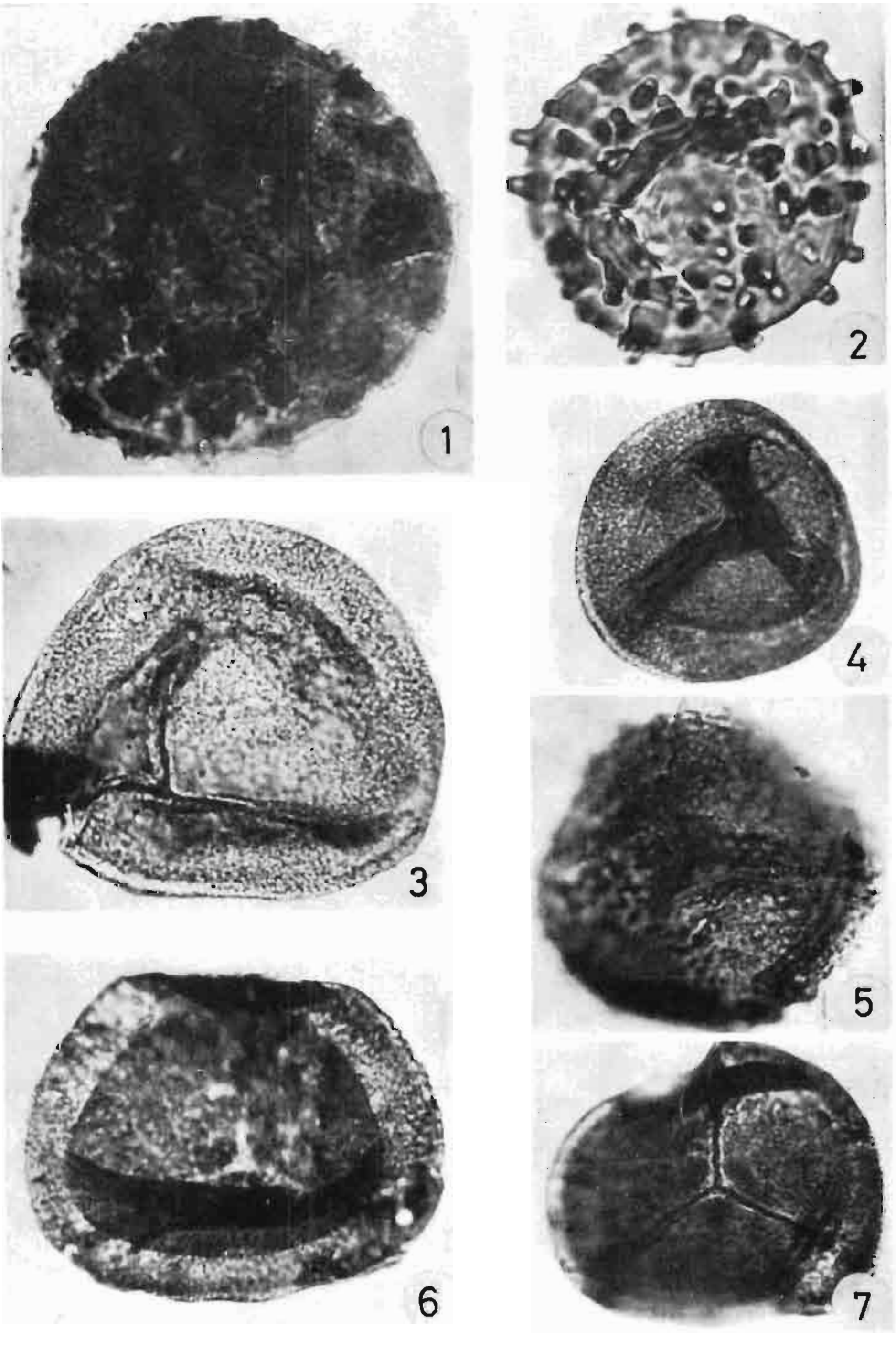
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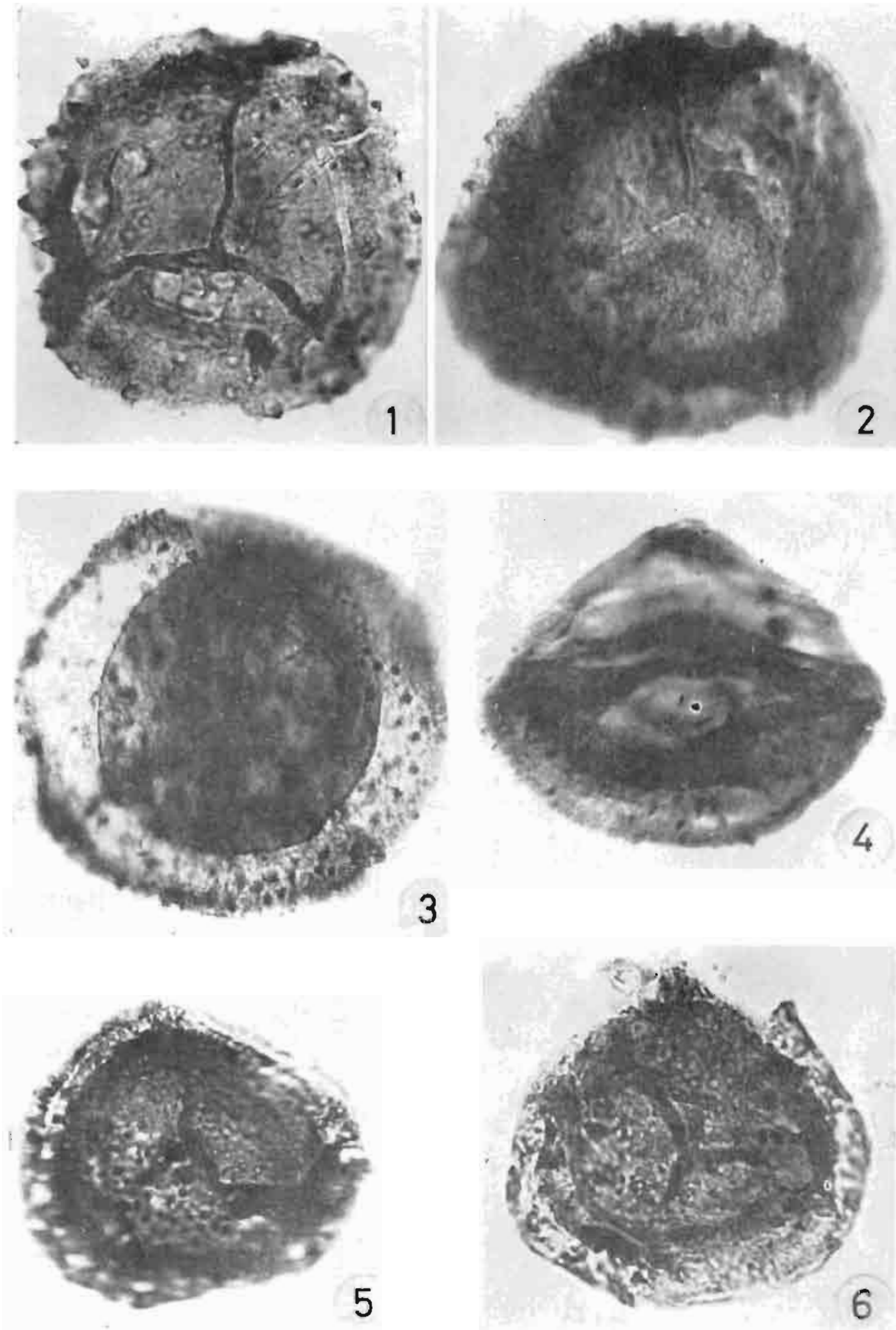
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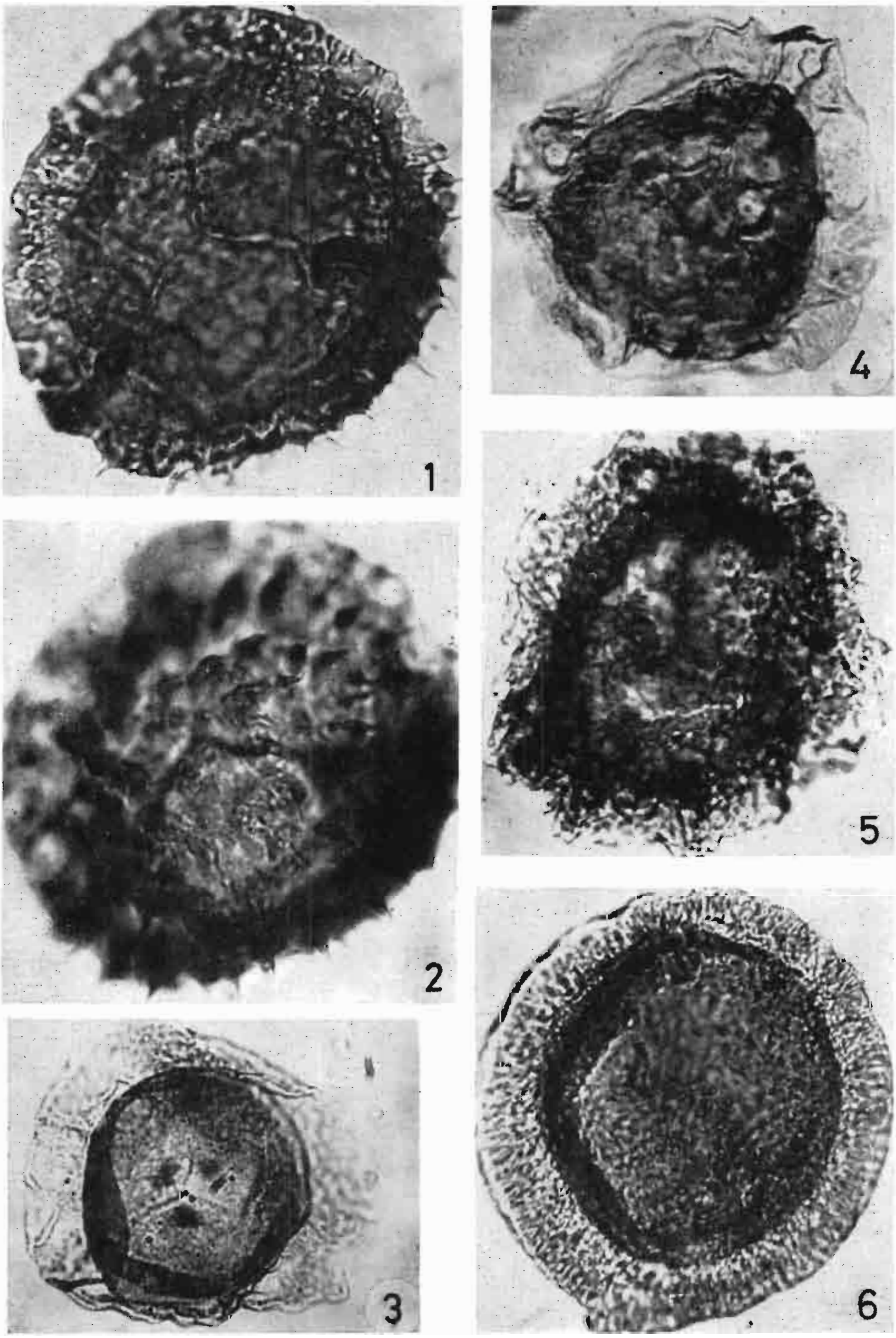
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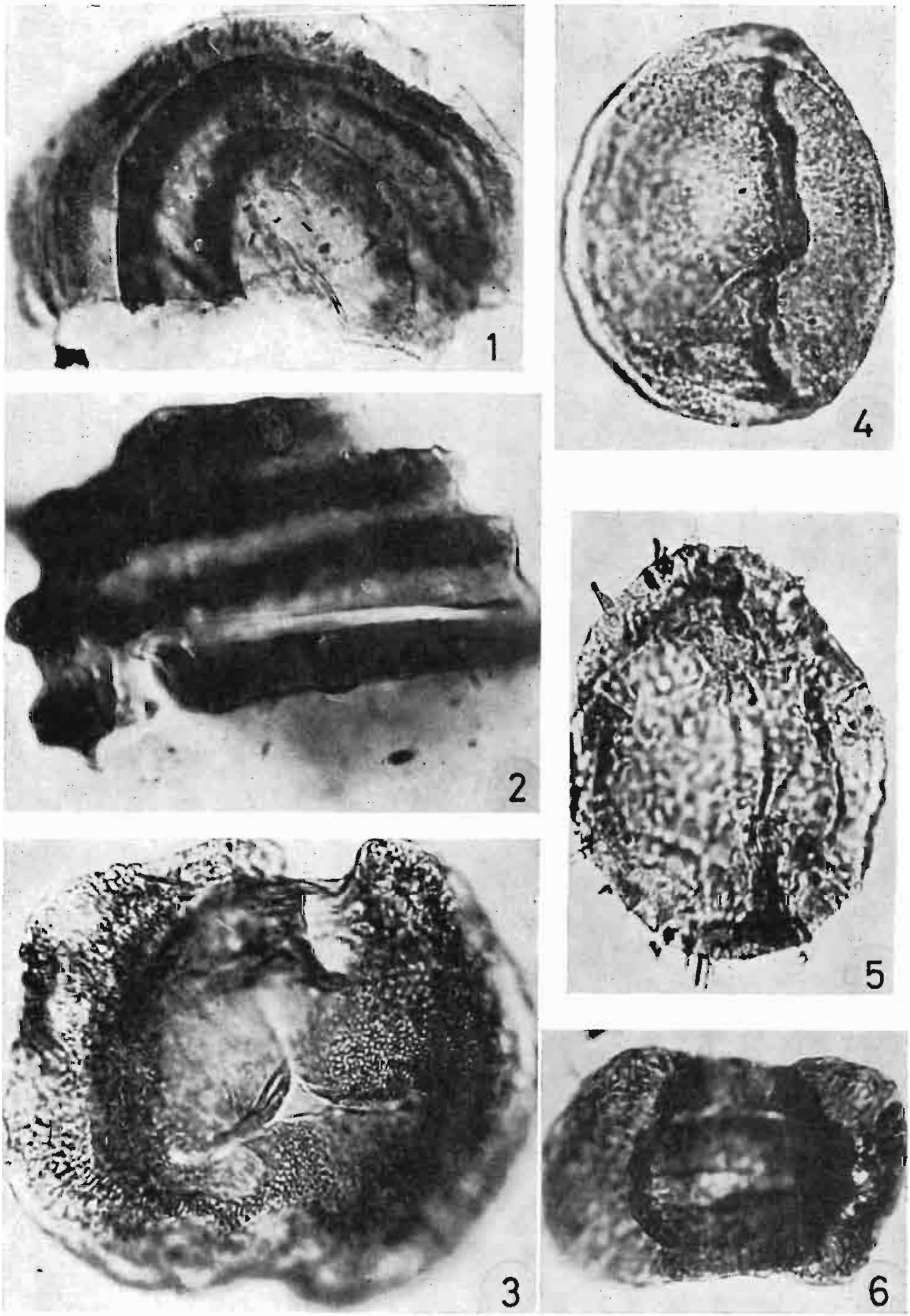
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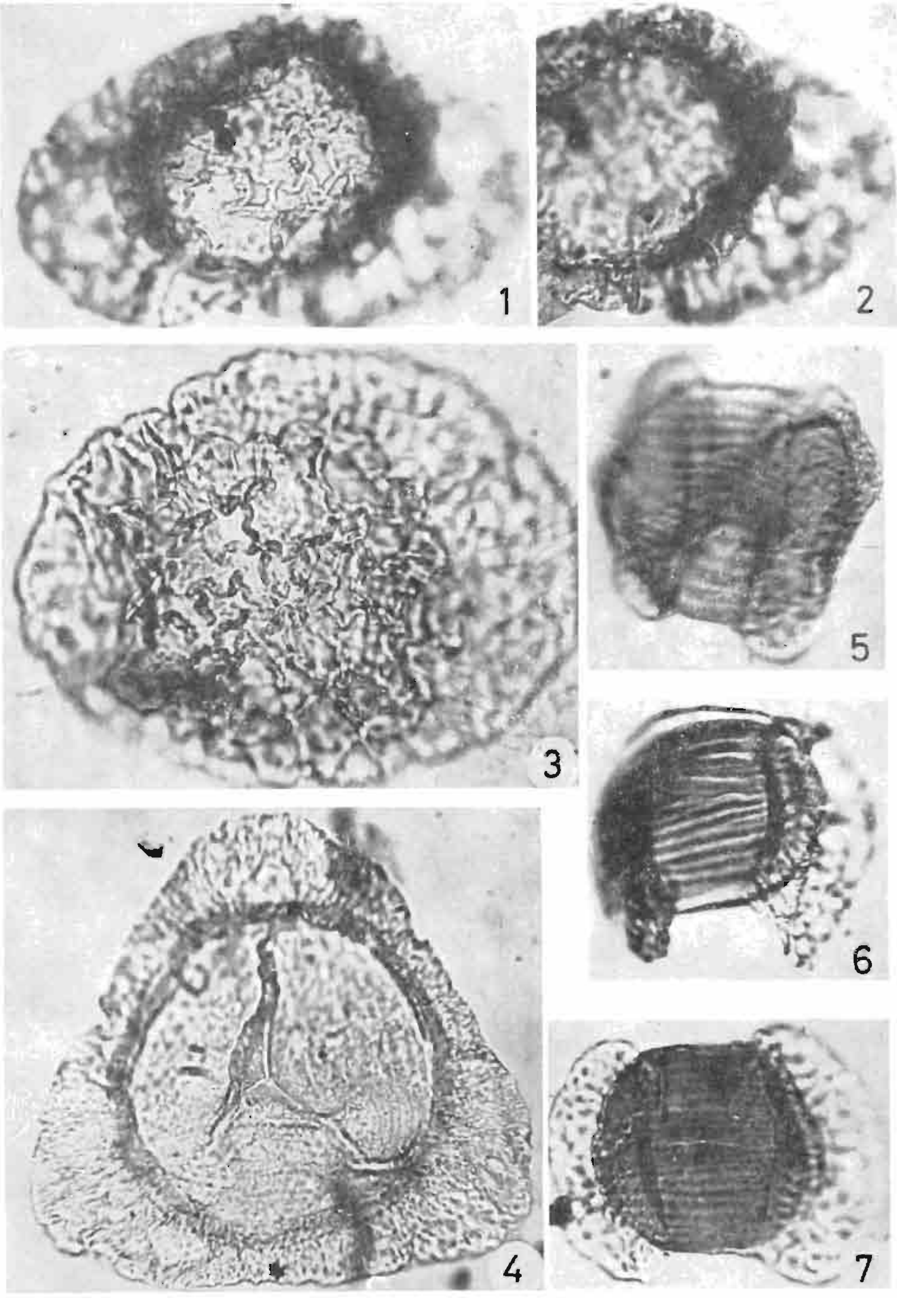
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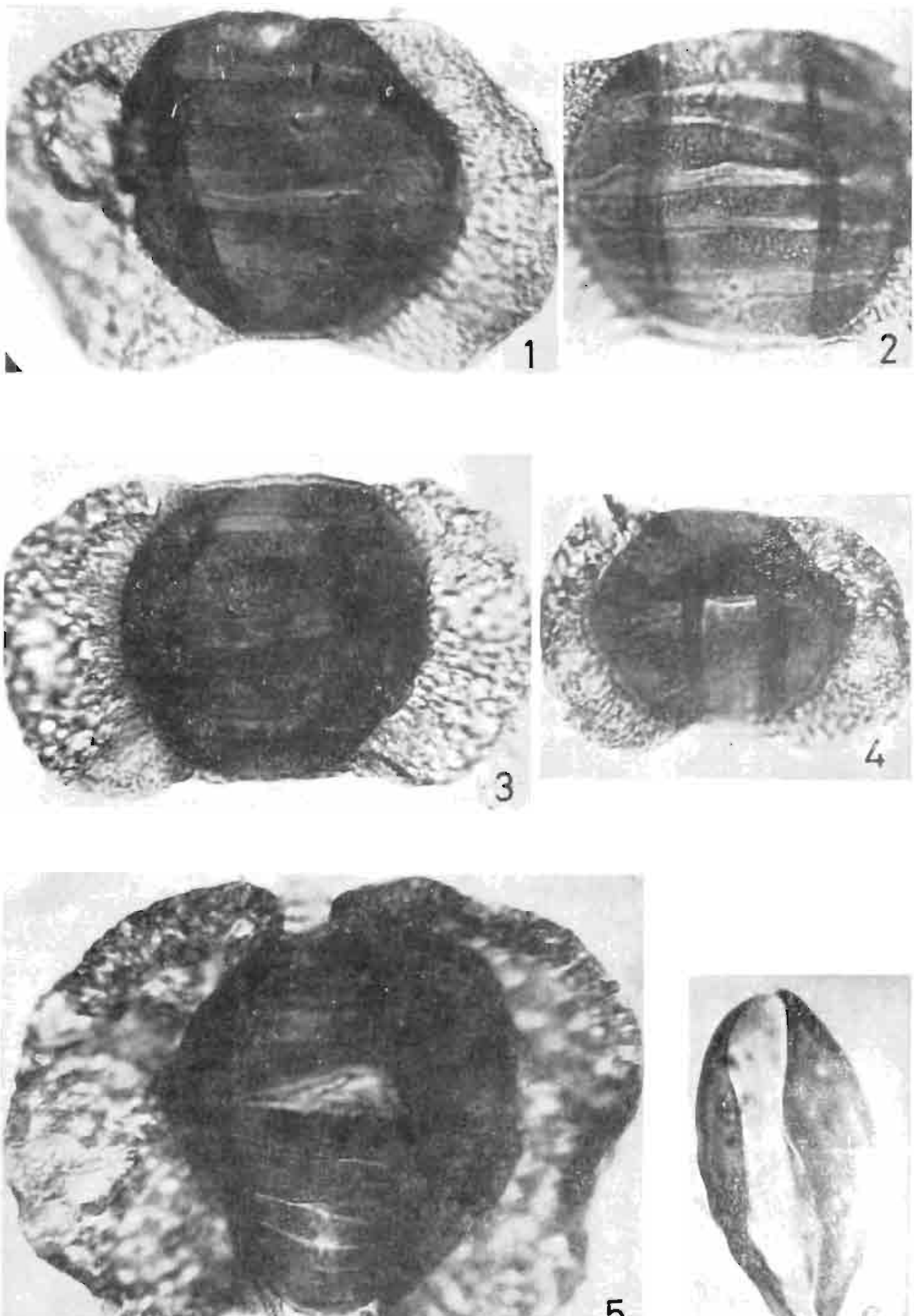
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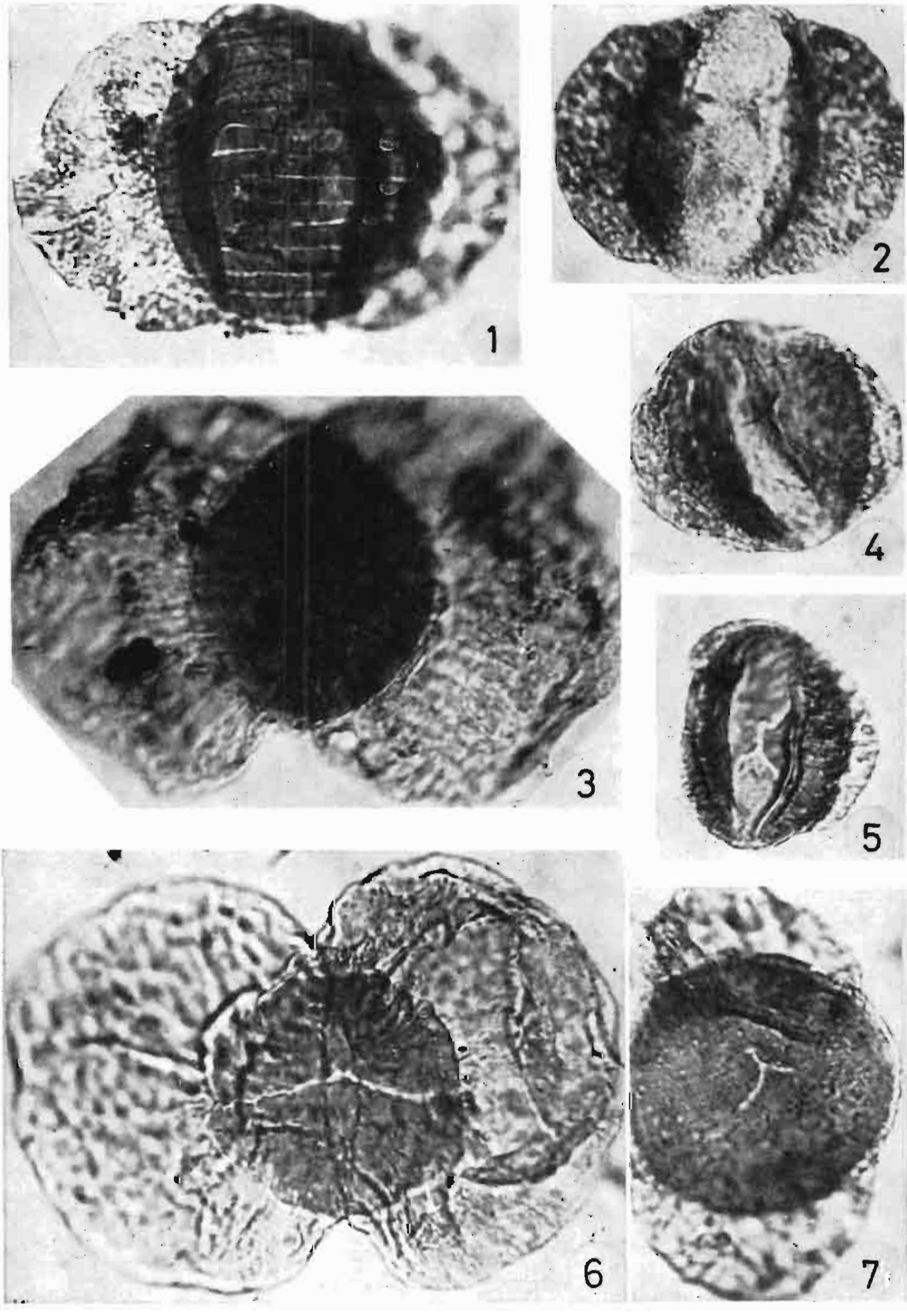
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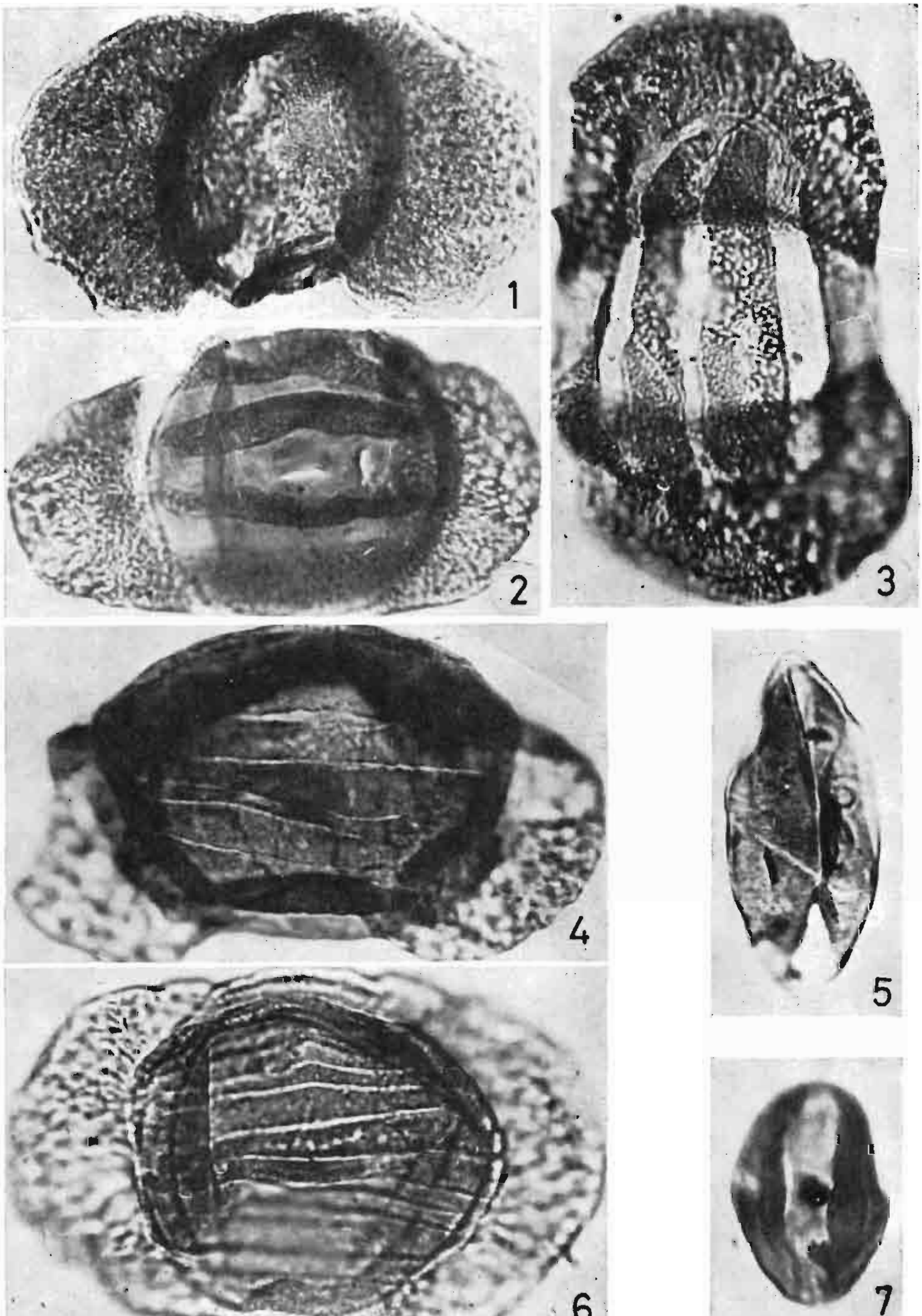
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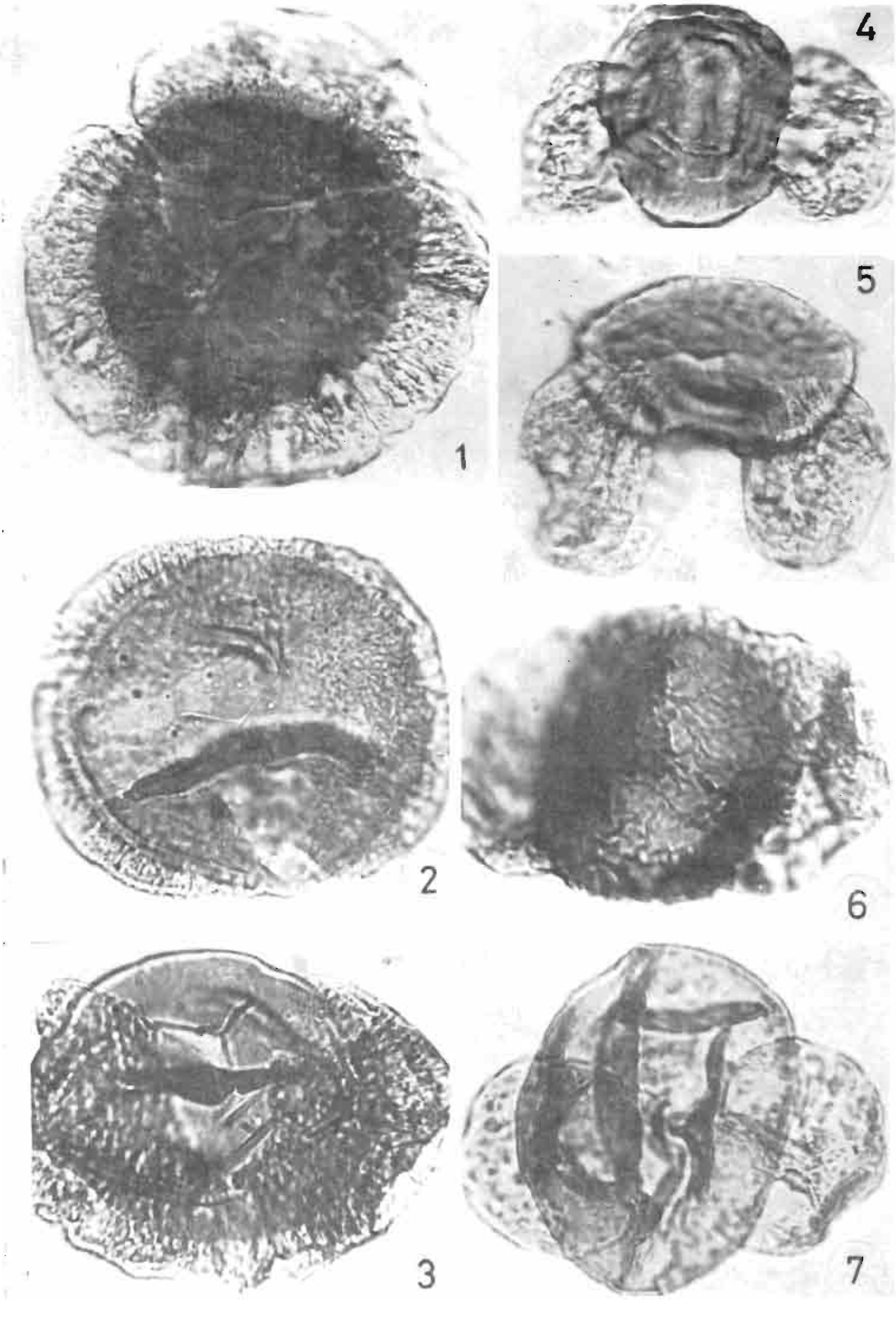
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