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Palynological characteristics of the reed sandstone in the Polish Lowland area

ABSTRACT: A description is here given of the reed sandstone microflora based on the results of palynological investigations from selected borehole profiles in the Polish Lowland area. The differences in spectra from various boreholes, even those in samples from the same borehole are discussed, accompanied by a tentative interpretation of this fact. The occurrence of reed sandstone deposits has been documented in boreholes Płońsk *IG-2* and Nidzica *IG-1*, situated outside the currently accepted range of these deposits.

INTRODUCTION

The palynological investigations of Triassic deposits undertaken by the writer have shown the presence of an abundant microflora in nearly all lithostratigraphic members of that system and the numerous spores, pollen grains, occasionally even floral microplankton encountered there are of substantial stratigraphic value.

The stratigraphy of the Keuper, one of whose lithostratigraphic members is represented by the reed sandstone here considered, is based on differences in the lithological deposits and often presents considerable difficulties in areas where the layers are tectonically disturbed or in case of sedimentary lacunae. Thanks to the relative abundance of sporomorphs in the Triassic deposits, palynological investigations are of sound assistance for the documentation of these deposits.

Over the recent years, on results of palynological analyses, reed sandstone deposits have been distinguished in borehole profiles Bobolice *3*, Jamno *IG-2*, Wudzyń *1*, Płońsk *IG-2* and Nidzica *IG-1*, situated either in the marginal area of the range of the sedimentary basin or even outside the currently accepted range of its occurrence (Fig. 1).

The collected spore-and-pollen material proved most interesting introducing new data into the knowledge of the reed sandstone microflora presented in earlier descriptions of profiles from S and SW Poland (Orłowska-Zwolińska 1972a, b; Grodzicka-Szymanko & Orłowska-Zwolińska 1972).

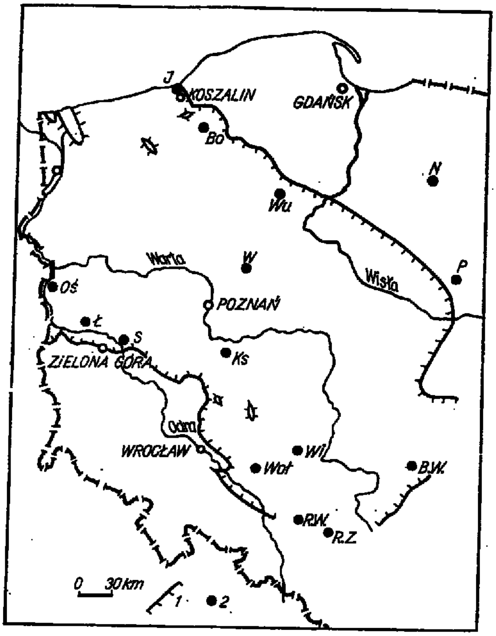


Fig. 1. Location of boreholes showing sporomorphs of the reed sandstone in the Polish Lowland

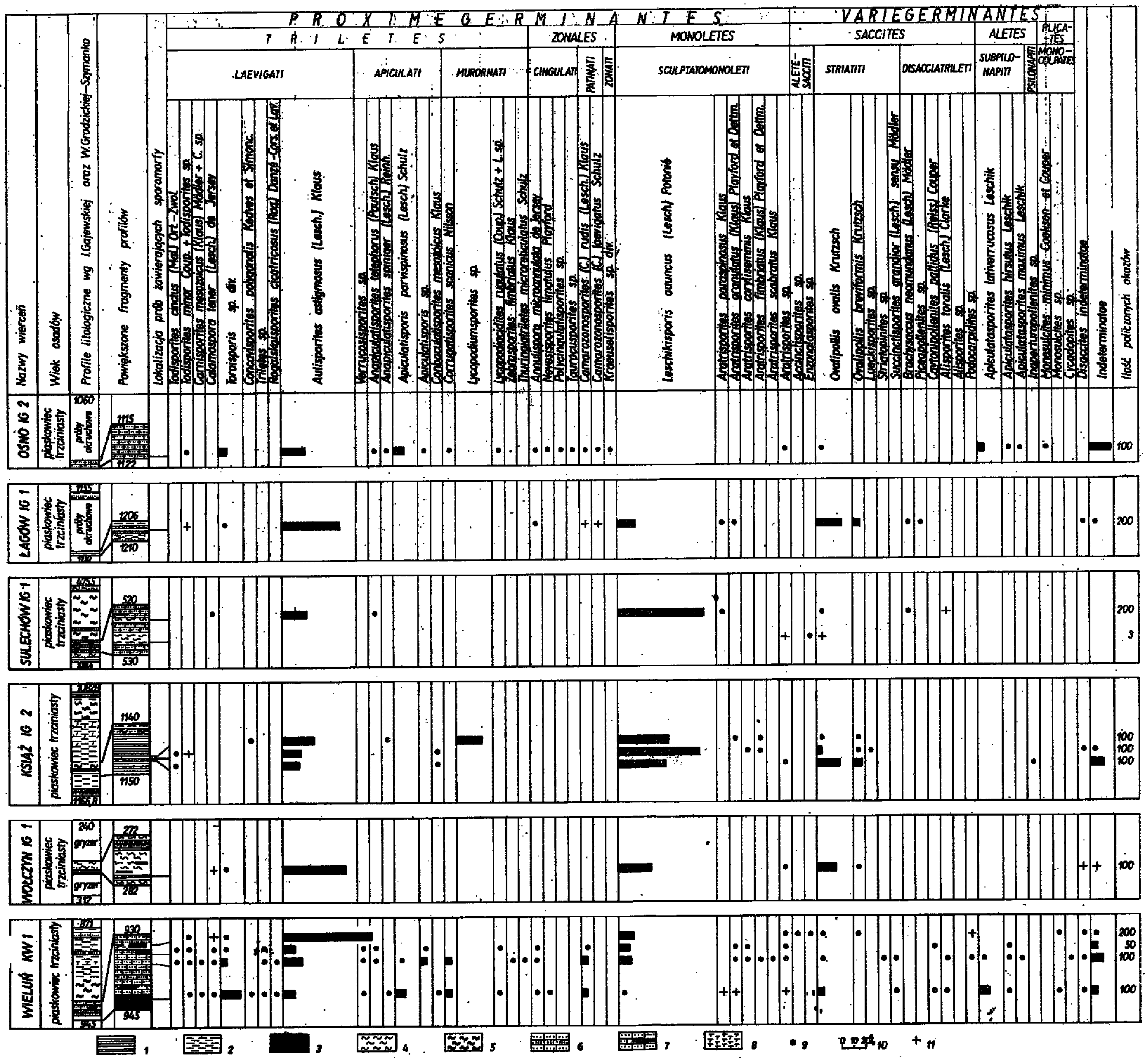
1 — Range of the reed sandstone (after Gajewska 1973); 2 — Profiles with sporomorphs of the reed sandstone: Oś — Ośno *IG-2*, Ł — Łagów Lubuski *IG-1*, S — Sulechów *IG-1*, Ks — Książ *IG-2*, Woł — Wołczyn *IG-1*, Wi — Wieluń *KW-1*, R. W. — Woźniki-Cynków region, R. Z. — Zawiercie region, B. W. — Boża Wola *IG-1*, P — Płońsk *IG-2*, N — Nidzica *IG-1*, W. Wągrowiec *IG-1*, Wu — Wudzyń *1*, Bo — Bobolice *3*, J — Jamno *IG-2*

REMARKS ON LITHOLOGY AND SEDIMENTATION

The reed sandstone deposits consist chiefly of sandy and muddy sediments. The lower parts of profiles are characterized by grey colouring and abound in microfloristic and microfaunal fossils, while the higher parts are often brown or red coloured and unfossiliferous. Gajewska (1973) when describing the characteristics of the reed sandstone emphasises the strongly variable development of the sediments even in near-by profiles. In some profiles there is a predominance of sandy deposits, in others that of mudstone-siltstone sediments. According to Gajewska's (1973) interpretation this is due to the character of the sedimentary basin which resembled a wide flat water pool. Many streams forming large deltas discharged their waters into this basin. Sandy deposits were laid down within the deltas at the river-mouths, while mudstone and silty sediments were deposited in stagnant waters. The latter were also laid down in the central part of the basin under calm sedimentary conditions.

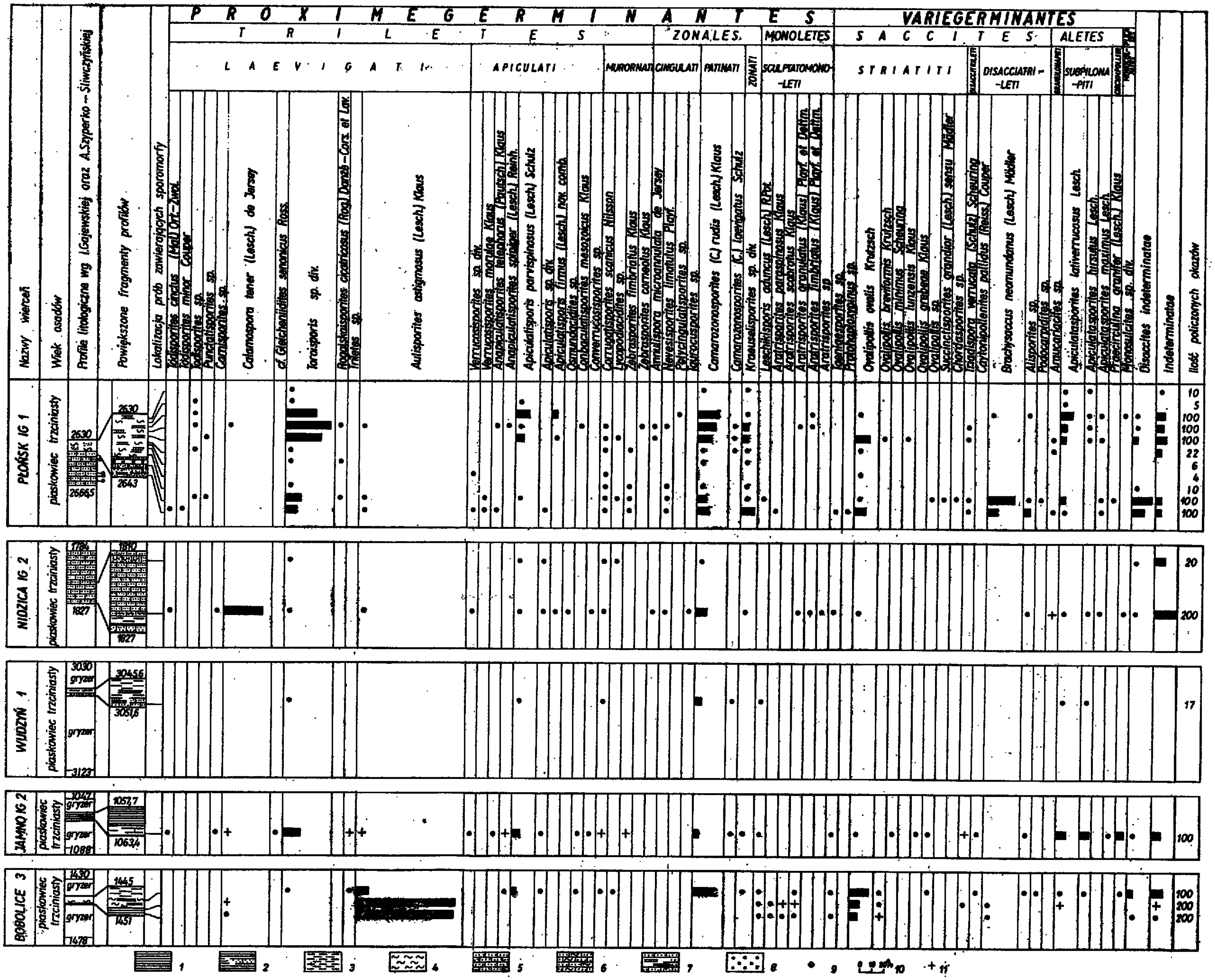
The profiles selected for the description of the reed sandstone microflora are grouped in the south-western (Fig. 2) or the north-eastern (Fig. 3) area of the basin. Use was also made of palynological data from profiles of the southern part of the basin, i.e. from the Cynków-Woźniki-Zawiercie region and the Boża Wola *IG-1* profile, as well as those from the central part of the basin — the Wągrowiec *IG-1* profile.

Percentage occurrence of sporomorphs from the reed sandstone in profiles of SW part of the basin



1 — grey and dark grey mudstones, 2 — variegated mudstones, 3 — shales, 4 — grey siltstones, 5 — variegated siltstones, 6 — grey fine-grained sandstones, 7 — sandstones with intercalations of dark grey mudstones, 8 — marls, 9 — sporomorphs in quantities of 0.5—4.0%, 10 — occurrence of sporomorphs in quantities greater than 4%, 11 — sporomorphs found beyond the quantity analysis

Percentage occurrence of sporomorphs from the reed sandstone in profiles of NE part of the basin



1 — grey and dark grey mudstones, 2 — mudstones interbedded with fine-grained sandstone, 3 — variegated mudstones, 4 — siltstones, 5 — grey fine-grained sandstones, 6 — silty sandstones, 7 — sandstones interbedded with mudstone, 8 — clay mudballs, 9 — sporomorphs in quantities of 0.5–4%, 10 — occurrence of sporomorphs in quantities greater than 4%, 11 — sporomorphs found beyond the quantity analysis

Among the diagrammatically shown profiles, those distinguished by a more sandy character of sedimentation are: Ośno *IG-2*, Wieluń *KW-1*, Nidzica *IG-1*, Płońsk *IG-2*.

The siltstone and mudstone deposits, also those with a predominance of mudstones are represented in profiles of the marginal and central parts of the basin here considered (Łagów Lubuski *IG-1*, Sulechów *IG-1*, Bobolice *3*, Książ *IG-2* and Wągrowiec *IG-1*).

CHARACTERISTICS OF MICROFLORA

The occurrence of sporomorphs of the reed sandstone have been shown in Potonié's morphological system (1956—1970) taking into account their percentage share in the spectrum.

The sporomorphs represent both groups of this system: the Proximegerminantes and the Variegerminantes. The Proximegerminantes is richer in species, moreover in most samples it also dominates numerically over the group of Variegerminantes. The most common species of the first group are: *Aulisporites astigmosus* (Lesch.) Klaus, *Leschikisporis aduncus* (Lesch.) Potonié, *Camarozonosporites rudis* (Lesch). Klaus, *Apiculatisporis parvispinosus* (Lesch.) Schulz, occassionally *Calamospora tener* (Lesch.) de Jersey, also spores of the genus *Toroisporis* Krutzsch. From among the Variegerminantes the species *Ovalipollis ovalis* Krutzsch, *O. breviformis* Krutzsch, occasionally large disaccate pollen grains of *Brachysaccus neomundanus* (Lesch.) Mädler and other, more closely indeterminate grains of *Disaccites* occur in numerical predominance. Worth mentioning are also the species *Apiculatasporites lativerucosus* Lesch. and *A. hirsutus* Lesch. so far referred to the Aletes group.

An analysis of the results of palynological investigations of the reed sandstone, diagrammatically shown in Figs 2 and 3, reveal strong differences in microflora of the various profiles, occasionally even in the particular samples from the same profile. The differences are manifested foremost by important changes in the quantitative occurrence of the various species. Some species are decidedly predominant, some represented by very few specimens. Other samples show a decrease in the numerical content or even complete lack of a formerly predominant species. In the extreme composition the reed sandstone microflora differs markedly in its spore-and-pollen assemblages.

Most noteworthy is the spectral predominance of one or two species, i.e. *Aulisporites astigmosus* (Lesch.) Klaus and *Leschikisporis aduncus* (Lesch.) Potonié. This is observable in profiles Łagów Lubuski *IG-1*, Sulechów *IG-1*, Książ *IG-2*, Wołczyn *IG-1*, partly also in the profile Wieluń *KW-1* at a depth of 932.0 m (Fig. 2) and in the Bobolice *3* profile in samples from a depth of 1449.8 and 1451.0 m. A fair abundance is also encountered of *Ovalipollis ovalis* Krutzsch, *O. breviformis* Krutzsch, the spores of Aratrisporites occur in smaller numbers while *Camarozonosporites rudis* (Lesch.) Klaus and *Annulispora microannulata* de Jersey only as single specimens. Thus, in the profiles here considered, the specific composition of microflora is distinctly meagre.

In extreme opposition to the above assemblage is, in the first place, the microflora observed in profiles Płońsk *IG-2*, Jamno *IG-2*, and Wudzyń *1*. Its index feature is a great variety of species relatively uniformly represented in the spectrum, while the species *Aulisporites astigmosus* (Lesch.) Klaus and *Leschikisporis aduncus* (Lesch.) Potonié are numerically greatly reduced or even completely absent. In the profile Płońsk *IG-2* there is a fair abundance of spores of *Camarozonosporites rudis* (Lesch.) Klaus, *Apiculatisporis parvispinosus* (Lesch.) Schulz, *Kraeuselisporites dentatus* Lesch. and *K. lituus* Lesch. emend. Scheuring, also spores from the genus *Toroisporis* and pollen grains of *Ovallipollis ovalis* Krutzsch, *Brachysaccus neomundanus* (Lesch.) Mädler and *Apiculatasporites lativerrucosus* Lesch. The following species, numerically fewer but of regular occurrence should also be noted: *Corrugatisporites scanicus* Nilsson, *Zebrasporites fimbriatus* Klaus, *Nevesisporites limatulus* Playford, *Camarozonosporites laevigatus* Schulz, *Rogalskaisporites cicatricosus* Rog. (Danzé-Cors. & Lav., *Triadispora verrucata* (Schulz) Scheuring, *Apiculatasporites hirsutus* Lesch. and *A. maximus* Lesch.

A similar character of microflora has also been observed in the profile Nidzica *IG-1*, situated to the NE of the currently accepted occurrence range of the reed sandstone deposits (Fig. 1). In a sample from the depth of 1823.0 m the most numerous spores were those of *Calamospora tener* (Lesch.) de Jersey, which, however, are not reliable age index for the sample because of its wide stratigraphic range. On the other hand, of substantial stratigraphic value are the less numerous spores *Camarozonosporites rudis* (Lesch.) Klaus, *Apiculatisporis parvispinosus* (Lesch.) Schulz, *Annulispora microannulata* de Jersey, spores from the genera *Kraeuselisporites* and *Toroisporis,* also of species *Ovalipollis ovalis* (Krutzsch), *Apiculatosporites lativerrucosus* Lesch., *A. hirsutus* Lesch. and *A. maximus* Lesch. In a sample from the depth of 1912.0 m, owing to the low frequency of sporomorphs in the sediment, the specimens were scarce. Among them are, however, the same characteristic species on which the two samples may be regarded of equal age.

Examples of profiles containing species of the spore-and-pollen spectrum with a predominance of *Aulisporites astigmosus* (Lesch.) Klaus as well as of the spectrum uniformly represented by numerous species — but without *Aulisporites astigmosus* — are as follows: Ośno *IG-2* (1122.0 m), Wągrowiec *IG-1* (1726.3 m) — sample not shown in the diagram — Wieluń *KW-1* (934.0 m, 936.0 and 943.0 m), also the Bobolice *3* profile (1448.0 m). Side by side with *Aulisporites astigmosus* (Lesch.) Klaus and *Leschikisporis aduncus* (Lesch.) Potonié samples from the above profiles also contained a fair abundance of *Apiculatisporis parvispinosus* (Lesch.) Schulz, *Camarozonosporites rudis* (Lesch.) Klaus, *Apiculataspo-rites lativerrucosus* Lesch, *A. hirsutus* Lesch, *Ovalipollis ovalis* Krutzsch and other species.

The simultaneous occurrence of species characteristic of the spore--and-pollen spectra occasionally differing from each other reliably indicates the contemporaneous age of the microflora distinguished in all the profiles here examined. A comparison with the microflora from outside of Poland shows striking resemblances, particularly with the spore-and-pollen assemblage of "Schilfsandstein" in Switzerland (Leschik 1955) and in the German Democratic Republic (Schulz 1966).

The table of the occurrence range of sporomorphs differentiated in profiles from the German Democratic Republic shows that many species make their first appearance in the reed sandstone and that some do not occur beyond its range.

On accepting the contemporaneous age of the reed sandstone microflora in all the profiles here discussed it is necessary at least tentatively to interpret the differences observed in its composition.

It seems reasonable to suppose that these cannot be explained by the regional or temporal differences in the plant assemblage of a given member. Actually, distant profiles may have a similar microfloral composition while others lying near to each other show distinct differences in that respect.

A comparison of palynological data from the profiles of Bobolice *3* and Wieluń *KW-1* does not allow to distinguish two stratigraphic horizons within the reed sandstone deposits. The quantitative changes in the microfloral composition of the above profiles are namely proportionately reversed. In the profile Wieluń *KW-1*, the number of the species *Aulisporites astimosus* (Lesch.) Klaus increases in the younger deposits while it decreases visibly in the profile Bobolice *3*.

A certain connection has however been observed of the microfloral composition with the character of the given deposits. The microflora occurring in dark-grey mudstones is characterized by a predominance of *Aulisporites astigmosus* (Lesch.) Klaus, occasionally also by that of *Leschikisporis aduncus* (Lesch.) Potonié and by the meagreness of other species.

On the other hand, microflora from the fine-grained grey sandstones abounds in kaolin dust (profile Ośno *IG-2*), or that from siltstone (Nidzica *IG-2*) as well as from clayey siltstones closely and finely laminated by fine--grained sandstones (Płońsk *IG-1*) display a richer and more varied spectrum with a subordinate percentage content or even complete lack of species *Aulisporites astigmosus* (Lesch.) Klaus. The sporomorphs are not encountered in typical coarser-grained sandstones.

In view of the variable and complex nature of processes responsible for the composition of the spore-and-pollen assemblage in the fossil deposits, it is hardly possible reliably to ascertain the factors contributing to the differentiation of microflora in the profiles here considered. Among the many potential agents one reasonably admissible is the dependence of the composition of the reed sandstone microflora on the variability of sedimentary conditions within the marginal part of the basin. The streams discharging their waters into the basin often built extensive deltoid areas. The conditions controlling the accumulation of organic materials, prevailing in these areas, varied in what time and space were concerned. The accumulation of a rich microflora probably took place to a great extent in result of strong river transport which brought sporomorphs from a relatively large continental area. It seems reasonable to suppose that river transport was here more important than the eolian.

Poorly differentiated microflora, with one or two dominant species, accumulated in stagnant waters in deltoid areas under calm sedimentary conditions. It may be reliably supposed that it derived from local plants overgrowing the shores of these water basins. The occurrence of the rich microflora in the Wągrowiec profile, situated in the central part of the basin, may possibly be interpreted as a result of the action either of water currents or of winds which brought the sporomorphs into the depressed area.

DESCRIPTIONS OF SELECTED SPOROMORPH SPECIES

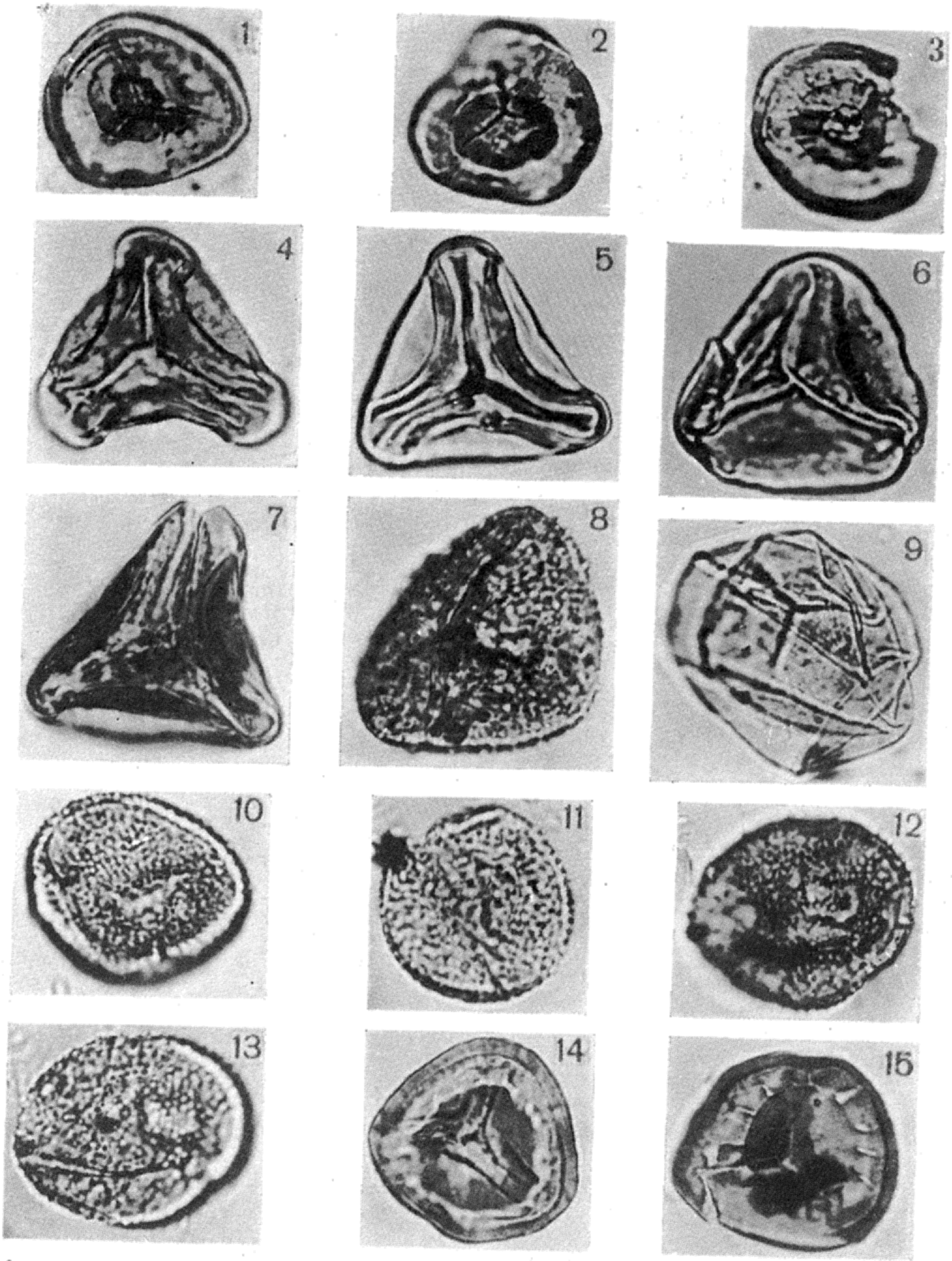
Anteturma: **Proximegerminantes** R. Potonié & Kremp 1954
Turma: **Triletes** (Reinsch 1881) Potonié & Kremp 1954
Infraturma: **Laevigati** (Bennie & Kidston, 1886) R. Potonié, 1956
Genus: *Aulisporites astigmosus* (Leschik) Klaus 1960
Aulisporites astigmosus (Leschik) Klaus 1960
(Pl. 2, figs 1–3, 5)

1955. *Calamospora astigmosus* Lesch.; G. Leschik p. 22, Pl. 2, Fig. 17.
1960. *Aulisporites astigmosus* (Lesch.) Klaus; W. Klaus p. 119, Pl. 28, Figs 2, 3.
1971. *Aulisporites astigmosus* (Lesch.) Klaus; T. Orłowska-Zwolińska pp. 640, 642, Pl. 3, Figs 1–5.

Remarks. — A detailed description of this species is contained in a paper by T. Orłowska-Zwolińska 1971.

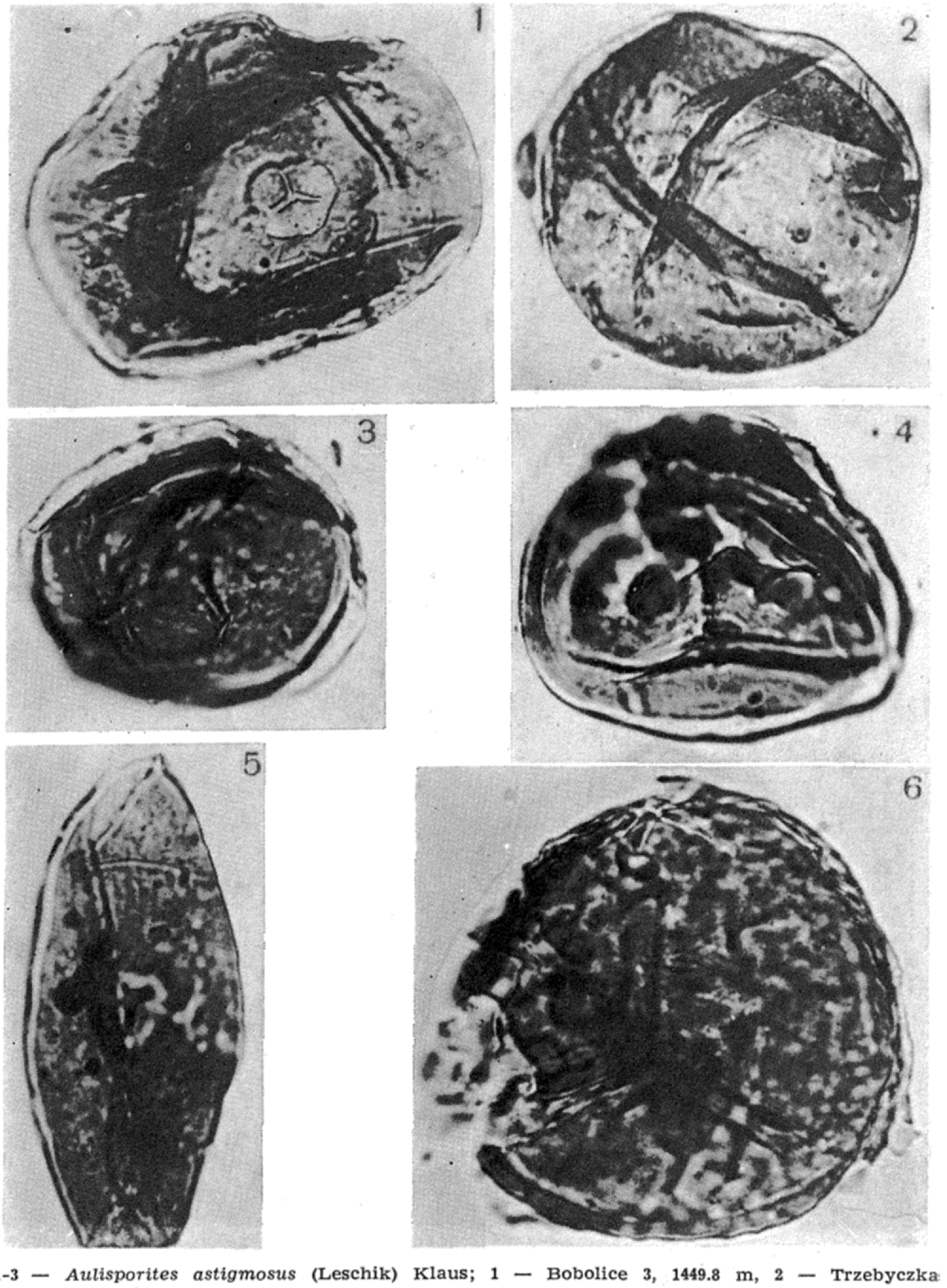
Occurrence in Poland — A species found sporadically and as single specimens in the Lower Keuper, predominant in the reed sandstone deposits in numerous Polish boreholes outside of the Carpathians, particularly in boreholes Sulechów *IG-1*, Książ *IG-2*, Łagów *IG-1*, Wołczyn *IG-1*, Wieluń *KW-1*, Boża Wola *IG-1* and Bobolice *3*.

Occurrence range outside of Poland — Reed sandstones in Switzerland — Neuewelt n/Basel (G. Leschik 1955) and in the Carnian of the Eastern Alps (W. Klaus 1960).



1-3 — *Annulispora microannulata* de Jersey; 1 — borehole Drawno *IG-2*, depth 1521.5 m; Wągrowiec *IG-1*, 1726.3 m; 3 — Płońsk *IG-2*, 2634.9 m,
4-6 — *Toroisporis* sp.; 4 — Płońsk *IG-2*, 2634.9 m; 5-6 — Płońsk *IG-2*, 2633.9 m,
7 — cf. *Gleicheniidites senonicus* Ross.; Jamno *IG-2*, 1063.0 m,
8 — *Apiculatisporis firmus* (Leschik) nov. comb.; Płońsk *IG-2*, 2634.9 m,
9 — *Calamospora tener* (Leschik) de Jersey; Nidzica *IG-1*, 1823.0 m,
10-13 — *Apiculatisporis parvispinosus* (Leschik) Schulz; 10 — Płońsk *IG-2*, 2634,9 m; 11 — Nidzica *IG-1*, 1812.0 m; 12-13 — Płońsk *IG-2*, 2641.1 m,
14-15 — *Rogalskaisporites cicatricosus* (Rog.) Danzé-Cors. et Lav.; 14 — Płońsk *IG-2*, 2641.1 m; 15 — Płońsk *IG-2*, 2636.4 m.

All figures × 1000



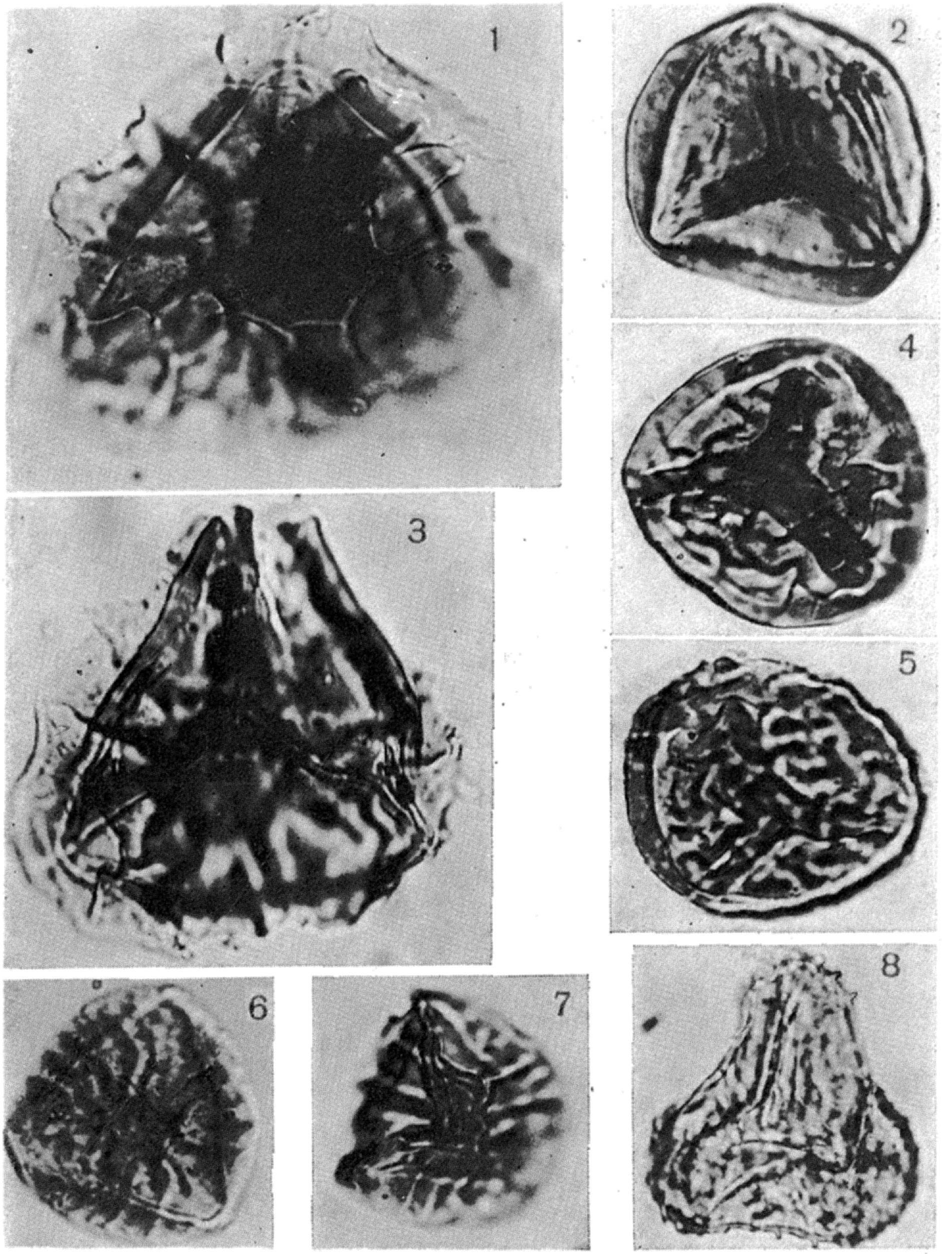
1-3 — *Aulisporites astigmosus* (Leschik) Klaus; 1 — Bobolice 3, 1449.8 m, 2 — Trzebyczka *TN-96*, 83.3-83.4 m; 3 — Płońsk *IG-2*, 2641.1 m,

4 — *Corrugatisporites scanicus* Nilsson; Płońsk *IG-2*, 2642.8 m,

5 — *Aulisporites astigmosus* (Leschik) Klaus; the specimen secondarily deformed, with trilete mark; Wągrowiec *IG-1*, 1726.3 m,

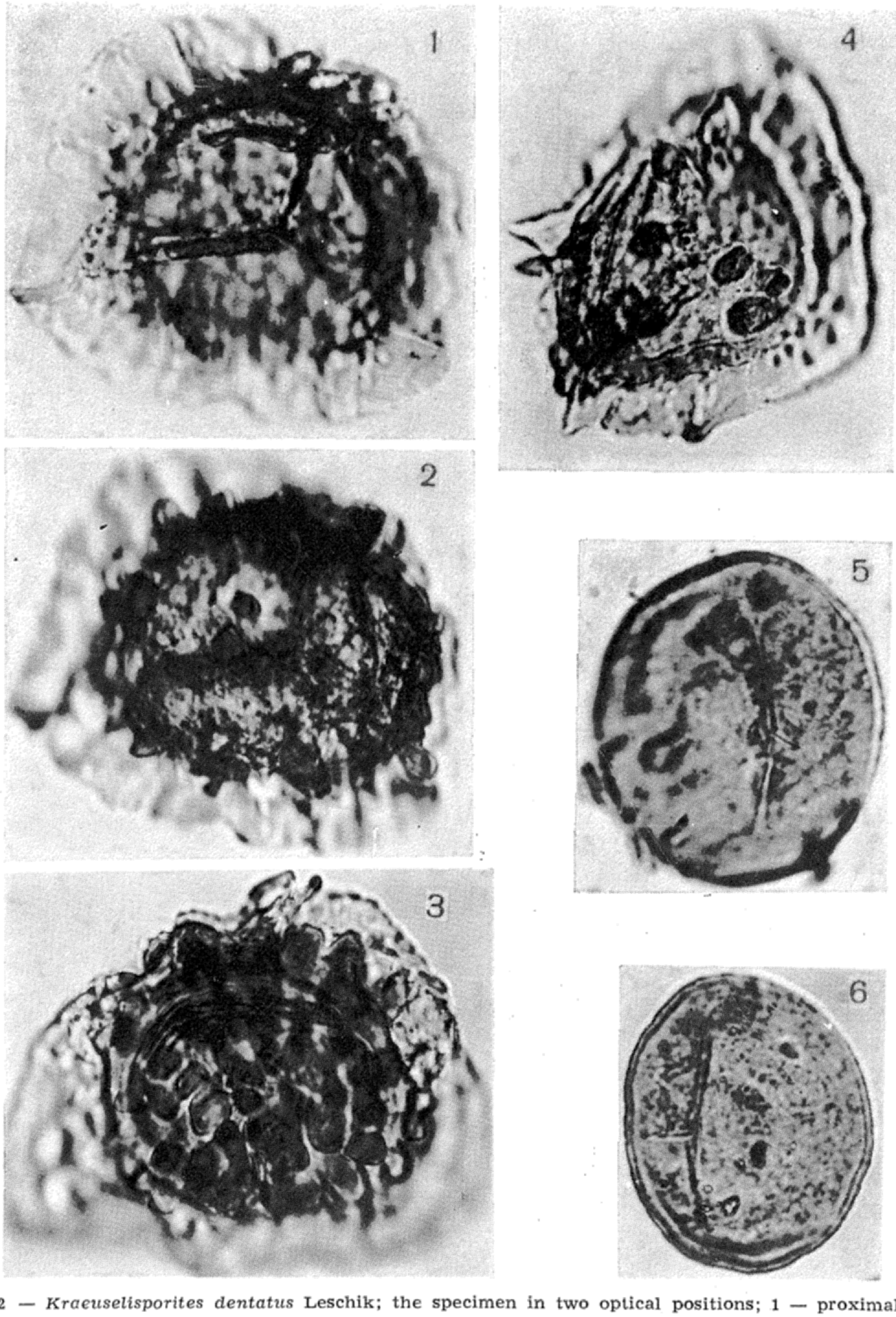
6 — *Lycopodiacidites* sp.; Płońsk *IG-2*, 2641.1 m.

All figures × 1000



1 — *Zebrasporites fimbriatus* Klaus; distal surface; Płońsk *IG-2*, 2635.9 m,
2 — *Camarozonosporites (C.) laevigatus* Schulz; Płońsk *IG-2*, 2635.9 m,
3 — *Zebrasporites fimbriatus* Klaus; proximal surface; Płońsk *IG-2*, 2635.9 m,
4-5 — *Camarozonosporites (C.) rudis* (Leschik) Klaus; Płońsk *IG-2*, 4 — 2642.8 m; 5 — 2633.9 m,
6 — *Zebrasporites kahleri* Klaus; Wągrowiec *IG-1*, 1726.3 m,
7 — *Zebrasporites corneolus* Klaus; Płońsk *IG-2*, 2633.9 m,
8 — cf. *Conbaculatisporites mesozoicus* Klaus; Jamno *IG-2*, 1036.0 m.

All figures × 1000



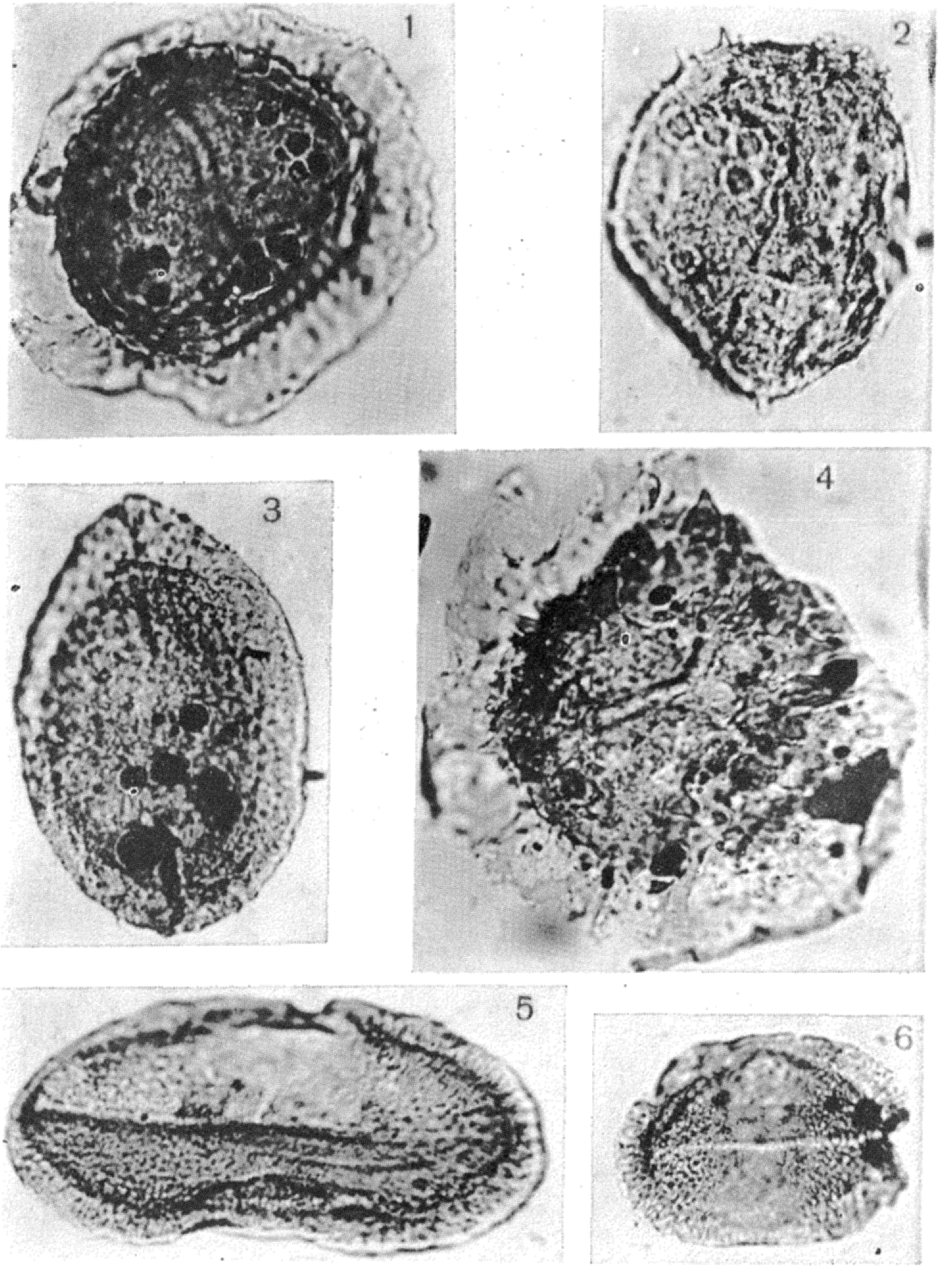
1-2 — *Kraeuselisporites dentatus* Leschik; the specimen in two optical positions; 1 — proximal surface, 2 — distal surface; Jamno *IG-2*, 1063.0 m,

3 — *Kraeuselisporites dentatus* Leschik; distal surface; Płońsk *IG-2*, 2634.9 m,

4 — *Kraeuselisporites lituus* Leschik emend. Scheuring; Płońsk *IG-2*, 2642.8 m,

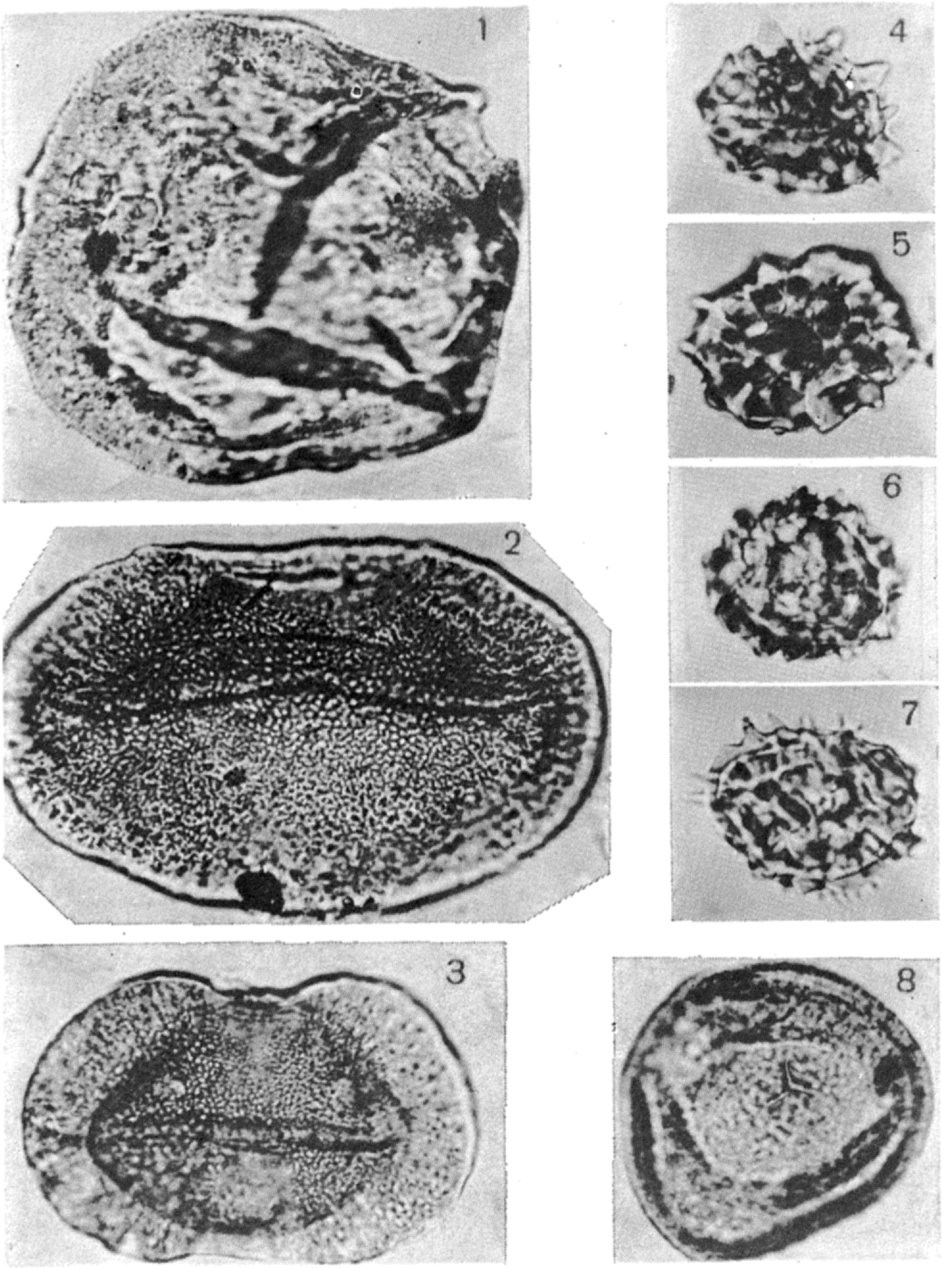
5-6 — *Leschikisporis aduncus* (Leschik) Potonié; 5 — Sulechów *IG-1*, 523.3 m; 6 — Książ *IG-2*, 1147.5 m.

All figures × 1000



1 — *Kraeuselisporites ramosus* Leschik; Płońsk *IG-2*, 2642.8 m,
2 — *Aratrisporites paraspinosus* Klaus; Łagów Lubuski *IG-1*, 1206.0—1210 m,
3 — *Aratrisporites coryliseminis* Klaus; Cynków-Winowno *CW.60*, 42.7-42.8 m,
4 — *Kraeuselisporites* sp.; Płońsk *IG-2*, 2642.8 m,
5 — *Ovalipollis* cf. *lunzensis* Klaus; Cynków-Woźniki *CW.61*, 126.5—128.0 m,
6 — *Ovalipollis grebeae* Klaus; Bobolice *3*, 1449.8 m.

All figures × 1000



1 — *Apiculatasporites maximus* Leschik; Płońsk *IG-2*, 2641.4 m,
2 — *Ovalipollis ovalis* Krutzsch; Książ *IG-2*, 1147.0 m,
3 — *Ovalipollis breviformis* Krutzsch; Wągrowiec *IG-1*, 1739.0 m,
4-6 — *Apiculatasporites lativerrucosus* Leschik; 4 — Płońsk *IG-2*, 2634.0 m, 5 — Płońsk *IG-2*, 2633.9 m; 6 — Jamno *IG-2*, 1063.0 m,
7 — *Apiculatasporites hirsutus* Leschik; Płońsk *IG-2*, 2634.9 m,
8 — *Praecirculina granifer* (Leschik) Klaus; Jamno *IG-2*, 1063.0 m.

All figures × 1000

Infraturma: **Apiculati** (Bennie & Kidston 1886) R. Potonié 1956
Genus: *Apiculatisporis* R. Potonié & Kremp, 1956
Apiculatisporis parvispinosus (Leschik) Schulz 1962
(Pl. 1, Figs 7—10)

1955. *Apiculatisporites parvispinosus* Leschik; G. Leschik, p. 17, Pl. 2, Figs 1—4.
1962. *Apiculatisporis parvispinosus* (Leschik) Schulz; E. Schulz, p. 312, Pl. 2, Figs 16—19.

Description — Size 25—31.5 μm. Equatorial outline of spores oval to circular. Thickness of exine approx. 1 μm. Sculpture of surface as densely arranged thin spines or cones, readily detectable on the margin. On the surface of the specimen here described the sculpture elements have the appearance of round grains. The triradiate tetrad mark often invisible. In most cases one delicate arm is observable resembling a monolete mark. On a few specimens there is a poorly developed arm oblique to the preceding one giving the tetrad mark the appearance of an asymmetric triradiate mark.

Occurrence in Poland — Keuper, upper reed sandstone in boreholes Płońsk *IG-2*, Nidzica *IG-1*, Wudzyń *1*, Jamno *IG-2*, Bobolice *3*, Ośno *IG-2*, Wieluń *KW-1*, Wągrowiec *IG-1*.

Occurrence range outside of Poland — Switzerland — Neuewelt n/Basel reed sandstone (Leschik 1955); German Democratic Republic, from the reed sandstone to the Lower Liassic (Schulz 1966, 1967).

Apiculatisporis firmus (Leschik) nov. comb.
(Pl. 1, Fig. 8)

1955. *Apiculatasporites firmus* Leschik; G. Leschik p. 33, Pl. 4, Fig. 12.

Description — Size 36—40 μm, triangular-circular in outline, often with secondary deformation. Exine a. 1 μm thick, covered with densely arranged small bluntly terminating spines. Triradiate tetrad mark. Arms of mark thin, reaching to 2/2 of the spore length, two of them as a nearly straight line.

Occurrence in Poland — Reed sandstone, boreholes Płońsk *IG-2* and Nidzica *IG-1*.

Occurrence range outside of Poland — Reed sandstone — Switzerland — Neuewelt n/Basel (Leschik 1955), also German Democratic Republic (Schulz 1966).

Infraturma: **Murornati** Potonié & Kremp, 1954
Genus: *Zebrasporites* Klaus, 1960
Zebrasporites fimbriatus Klaus, 1960
(Pl. 3, Figs 1, 3)

1960. *Zebrasporites fimbriatus* Klaus; W. Klaus, p. 139, Pl. 30, Fig. 22.

Description — Size 60—65 μm. Spores triangular in outline, with broadly rounded tips and triradiate tetrad mark. Exine two-layered. Outer layer thin, delicate and transparent, proximally smooth, distally with characteristic radially arranged rugae. Rugae thin, centrally transversely joined, thus occasionally as irregular large-meshed reticulum. Arms of tetrad mark reaching to the outline of the inner exine layer.

Occurrence in Poland — reed sandstone, boreholes Płońsk *IG-2*, Jamno *IG-2* and Wieluń *KW-1*.

Occurrence range outside of Poland — The Carnian of the Eastern Alps (Klaus 1960).

Turma: **Zonales** Bennie & Kidston emend. Potonié 1956
Infraturma: **Zonati** Potonié & Kremp 1954
Genus: *Kraeuselisporites Leschik* 1955 emend. Jonsonius 1962
Kraeuselisporites dentatus Leschik, 1955
(Pl. 4, Figs 1—3)

1955. *Kraeuselisporites dentatus Leschik*, G. Leschik, p. 37, Pl. 4, Fig. 2.
1974. *Kraeuselisporites dentatus* Leschik; B. Scheuring, p. 200.

Description — Size 50—60 µm. Spores triangular-circular in outline with triradiate tetrad mark. Exine two-layered, consisting of a zonate exoexine and of intexine forming the central part of the spore. Exoexine of the distal hemisphere thick, infrapunctate and ornamented with elongated verrucae or rounded-tipped cones. Sculpture elements irregularly arranged on the surface of the central part of spore, variable in shape and width. Exoexine proximally smooth with a distinct tetrad mark. Arms of mark narrow, devoided of lips, reaching to the outline of the central body of spore. Compression folds present on the zone in the elongation of arms. Zone broad, light, occasionally slightly folded.

Occurrence in Poland — reed sandstone in boreholes Płońsk *IG-2*, Nidzica *IG-1*, Jamno *IG-2*, Bobolice *3*, Ośno *IG-2*.

Occurrence range outside of Poland — Switzerland — Neuewelt n/Basel — reed sandstone (Leschik 1955); German Democratic Republic — from the uppermost part of Lower Keuper down to and including the reed sandstone (Schulz 1966).

Kraeuselisporites ramosus Leschik 1955
(Pl. 5, Fig. 1)

1955. *Kraeuselisporites ramosus* Leschik, G. Leschik, p. 36, Pl. 4, Fig. 20.

Description. — Size a. 60 µm. Spores triangular-circular in outline with triradiate tetrad mark. Distally the exoexine delicately infrapunctate and ornamented by irregularly arranged rounded verrucae on the central part of spore. A distinct proximal tetrad mark. Contact areas smooth. Zone smooth and delicate.

Remarks. — The above species differs from *K. dentatus* in smaller and less densely arranged sculpture elements.

Occurrence in Poland — Reed sandstone, borehole Płońsk *IG-2*.

Occurrence range outside of Poland — Switzerland — Neuewelt n/Basel — reed sandstone (Leschik 1955).

Kraeuselisporites lituus Leschik, 1955 emend. Scheuring, 1974
(Pl. 4, Fig. 4)

1955. *Kraeuselisporites lituus* Leschik; G. Leschik p. 37, Pl. 4, Fig. 23.
1974. *Kraeuselisporites lituus* Leschik emend. Scheuring; B. Scheuring p. 200.

Description — Size 50—55 µm. Spores triangular-circular in outline, with triradiate tetrad mark. Exine two-layered consisting of an intexine forming the central part of the spore and the surrounding zonate exoexine. Exoexine of the distal hemisphere thick, distinctly punctate and covered wtih strong spines irregularly spaced. The spines of this species are characterized in being drop-like and with a hollow cavity at the base. Exoexine of proximal side infrapunctate without any sculpture. Zone relatively narrow, a. 1/5 of the spore width. Outer margin of zone folded, denated or spinose, surface occasionally perforated.

Occurrence in Poland — Reed sandstone, boreholes *IG-2* and Jamno *IG-2*.

Occurrence range outside of Poland — Switzerland — Neuewelt n/Basel, reed sandstone (Leschik 1955).

Anteturma: **Variegerminantes** R. Potonié, 1970
Turma: **Aletes** Ibrahim, 1933
Subturma: **Azonaletes** (Luber 1935) R. Potonié & Kremp, 1954
Genus: *Apiculatasporites* Ibrahim 1933

Apiculatasporites lativerrucosus, Leschik, 1955
(Pl. 6, Figs 4—6)

1955. *Apiculatasporites lativerrucosus* Leschik; G. Leschik, p. 32, Pl. 4, Fig. 9.
?1973. *Apiculatasporites lativerrucosus* Leschik; A. Horowitz, p. 201, Pl. 7, Fig. 5.

Description — Size 21.7 × 18.2 µm — 29.4 × 23.8 µm. Spore circular or subcircular in outline. Exine thick with robust appendages. Basal width of appendages a. 5—6.3 µm, height ranging from 2.5 to 4.2 µm, coniform in shape with strongly rounded tips. No triradiate tetrad mark observable, probably owing to the rich ornamentation of the exine.

Occurrence in Poland — Reed sandstone, boreholes in the Lowland area: Płońsk *IG-2*, Nidzica *IG-1*, Wudzyń *1*, Jamno *IG-2*, Bobolice *3*, Ośno *IG-2*, Wieluń *KW-1*, Wągrowiec *IG-1*.

Occurrence range outside of Poland — Switzerland — reed sandstone (Leschik 1955); German Democratic Republic — reed sandstone (Schulz 1966). Sporomorphs referred to the above species are also reported by Horowitz (1973) from the late Triassic deposits of Southern Israel.

Apiculatasporites hirsutus Leschik, 1955
(Pl. 6, Fig. 7)

1955. *Apiculatasporites hirsutus* Leschik, G. Leschik p. 33, Pl. 4, Fig. 10.

Description — Size 21.7 × 18.3 µm — 28.7 × 21.7 µm. Broadly oval in outline. Exine a. 1.5 µm thick. Sculpture consisting of spine-like appendages. Spines subcircular at tips or sharply pointed. No triradiate tetrad mark observable. A single crack apparently a monolete mark occasionally detectable on some specimens.

Remarks — The above species differs from *A. lativerrucosus* in dimensions and shape of appendages as well as in a greater number of appendages on the margin of spores than that in *A. lativerrucosus*.

Occurrence in Poland — Reed sandstone, boreholes Płońsk *IG-2*, Nidzica *IG-1*, Wudzyń *1*, Jamno *IG-2*, Bobolice *3*, Ośno *IG-2*, Wieluń *KW-1* and Wągrowiec *IG-1*.

Occurrence range outside of Poland — Switzerland — reed sandstone (Leschik 1955), also German Democratic Republic — reed sandstone (Schulz 1966).

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CHARAKTERYSTYKA PALINOLOGICZNA PIASKOWCA TRZCINIASTEGO NA NIŻU POLSKIM

(Streszczenie)

W wyniku przeprowadzonych badań palinologicznych osadów triasu, udokumentowano w ostatnim czasie istnienie osadów piaskowca trzciniastego w wierceniach Jamno *IG-2*, Bobolice *3*, Wudzyń *1*, usytuowanych w strefie brzeżnej zbiornika sedymentacyjnego oraz w wierceniach Płońsk *IG-2*, Nidzica *IG-1*, znajdujących się już poza jego zasięgiem (fig. 1).

Otrzymany materiał sporowo-pyłkowy okazał się bardzo interesujący i wzbogacił znajomość mikroflory piaskowca trzciniastego wcześniej opracowanych wierceń południowej i południowo-zachodniej Polski (Orłowska-Zwolińska 1972 a i b, Grodzicka-Szymanko i Orłowska-Zwolińska 1972).

Analizując wyniki badań zaobserwowano dość duże zróżnicowanie w składzie ilościowym mikroflory między spektrami poszczególnych wierceń lub nawet między spektrami kolejnych próbek w jednym profilu. W profilach Sulechów *IG-1*, Książ *IG-2*, Łagów Lubuski *IG-1*, Wołczyn *IG-1* (fig. 2), a także w niektórych próbkach Wieluń *KW-1* i Bobolice *3* znamienną cechą zespołu sporowo-pyłkowego jest dominujący udział procentowy jednego lub dwóch gatunków. Są to *Aulisporites astigmosus* (Lesch.) Klaus i *Leschikisporis aduncus* (Lesch.) Potonié. Poza wymienionymi, na uwagę zasługują gatunki *Ovalipollis ovalis* Krutzsch, *O. breviformis* Krutzsch, a w dalszej kolejności spory *Aratisporites*, pojedyncze okazy *Camarozonosporites rudis* (Lesch.) Klaus i *Annulispora microannulata* de Jersey.

Przeciwieństwem powyższego zespołu jest mikroflora występująca w profilach Płońsk *IG-2* i Jamno *IG-2* (fig. 3). Cechą znamienną jest tutaj duża różnorodność gatunków reprezentowanych stosunkowo równomiernie w spektrum przy jednoczesnym wybitnie zredukowanym udziale procentowym lub nawet całkowitym braku gatunku *Aulisporites astigmosus* (Lesch.) Klaus. Na uwagę zasługują natomiast spory rodzaju *Toroisporis*, *Kraeuselisporites*, głównie reprezentowane przez *K. dentatus* Lesch. i *K. lituus* Lesch. emend. Scheuring oraz gatunki *Camarozonosporites rudis* (Lesch.) Klaus, *Apiculatisporis parvispinosus* (Lesch.) Schulz, *Zebrasporites fimbriatus* Klaus, *Rogalskaisporites cicatricosus* (Rog.) Danzé-Cors. et Lav., ziarna pyłku *Ovalipollis ovalis* Krutzsch, *Brachysaccus neomundanus* (Lesch.) Mädler, *Apiculatasporites lativerrucosus* Lesch. i *A. hirsutus* (Lesch.

Gatunki obu wyżej scharakteryzowanych zespołów sporowo-pyłkowych występują jednocześnie w profilach Ośno *IG-2*, Wągrowiec *IG-1* oraz w niektórych próbkach z profilów Wieluń *KW-1* i Bobolice *3*.

Porównanie przedstawionej mikroflory z analogiczną z osadów „Schilfsandstein" w Szwajcarii (Leschik 1955) i NRD (Schulz 1966) pozwala uznać ją za równowiekową powstaniu piaskowca trzciniastego.

Przyjmując jednakowy wiek osadów piaskowca trzciniastego we wszystkich omawianych profilach, należy wyjaśnić przyczynę zmienności w składzie mikroflory. Z uwagi na różnorodność i złożoność procesów decydujących o składzie zespołu sporowo-pyłkowego w osadzie kopalnym, trudno jednoznacznie ustalić przyczynę tego zjawiska. Spośród wielu możliwych przyczyn, szczególnie bliską wydaje się być zależność składu mikroflory piaskowca trzciniastego od zmienności warunków sedymentacyjnych w strefie przybrzeżnej zbiornika, obfitującej w rozległe obszary deltowe (Gajewska 1973). Nagromadzenie bogatej w gatunki mikroflory nastąpiło prawdopodobnie przy wydatnym udziale transportu rzecznego, który znosił sporomorfy z dużego obszaru lądu. Mikroflora uboga w gatunki, z przewagą ilościową jednego lub dwóch, nagromadziła się w wodach zastoiskowych, stanowiących miejsca spokojnej sedymentacji na obszarach deltowych. Pochodziła ona prawdopodobnie od roślinności porastającej wybrzeża tych wód.