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MESOZOIC SPORES OF POLAND – A REVISION OF SELECTED TAXA

MEZOZOICZNE SPORY POLSKI – PRZEGLĄD WYBRANYCH TAKSONÓW

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Abstract. The study presents a taxonomic analysis of 44 taxa from the Mesozoic deposits of Poland. The spores have been ordered in a systematic way. Variability in interpretations of similar morphological or typical features of individual taxa have been presented. In case of same species the influence of the postdepositional processes on the morphological features of spores have been suggested.

Key words: Mesozoic spores, taxonomy, systematic.

Abstrakt. Analizowano taksonomicznie 44 taksony z utworów mezozoiku Polski. Uporządkowano je według sztucznej systematyki. Przy opisie niektórych taksonów spor zasugerowano wpływ czynników postdepozycyjnych na ich cechy morfologiczne.

Słowa kluczowe: spory mezozoiczne, taksonomia, systematyka.

INTRODUCTION

The aim of the work was to present the taxonomic and morphological variability of spores from the Mesozoic of Poland. The palynological material was obtained from 26 boreholes and two outcrops located in the Polish Lowland area and Holy Cross Mts as well as from three outcrops in the Tatra Mts (Fig. 1). Triassic, Lower Jurassic and Lower Cretaceous samples were analysed. In Mesozoic the Polish epicontinental basin was a connection between cool Boreal and warm Tethyan sea. Its central part – Mid-Polish Trough – is characterised by maximum subsidence and maximum thickness of deposits (6–7 km).

Lithostratigraphy of the Mesozoic deposits in the sampled boreholes was overworked by following authors: Triassic – Szyperko-Teller, 1997; Lower Jurassic–Triassic, Triassic – Niemczycka, 1997; Lower Cretaceous – Raczyńska, 1979); more detailed cyclostratigraphy has been established by Pieńkowski (1997) (Lower Jurassic) and Leszczyński (1997) (Lower Cretaceous).

Taxonomic study of the Triassic spores from Poland were performed by Pautsch (1958, 1971, 1973) in Pomerania, Kujawy and in Polish Carphatian Foreland, by Orłowska-Zwolińska (1979, 1983, 1984) in the Polish Lowlands and by Fijałkowska (1991) in the Holy Cross Mts. Jurassic spores (Lower and Middle Jurassic) from the Polish Lowlands was analysed by Rogalska (1976), and by Ziaja (2006) in the Holy Cross Mts. Upper Jurassic and Lower Cretaceous spores were studied by Mamczar (1986), and the taxonomic revision was carried out by Waksmundzka (1992).

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MATERIAL AND METHODS

Palynological material is obtained from the following deposits and boreholes of the Polish Lowlands (Fig. 1):

Triassic: Bodzanów GN 1 (Upper), Brześć Kujawski IG 1 (Lower–Upper), Byczyna IG 1 (Lower–Upper), Gronowo IG 1 (Lower–Upper), Kutno 1 (Middle–Upper), Ośno IG 2 (Middle–Upper), Poddębice PIG 2 (Upper), Różyce IG 2 (Lower–Upper), Różyce GN 1, Trześniew GN 1 (Lower–Upper), Korabiewice IG 1 (Upper);

Triassic/ **Jurassic** and **Lower Jurassic**: Kamień Pomorski IG 1, Gorzów Wielkopolski IG 1, Kłokoczyn GN 1, Korabiewice IG 1, Poddębice PIG 2;

Lower Jurassic: Mroczków, Zawada, Gliniany Las 1, Gliniany Las 2, Bartoszyce IG 1;

Jurassic: Brześć Kujawski IG 2 (Lower), Kłokoczyn GN 1 (Lower), Kutno 1 (Lower), Poddębice PIG 2 (Lower–Middle), Trześniew GN 1 (Upper);

Lower Cretaceous: Bodzanów GN 3, Klosnowo IG 1, Koło IG 2, Oświno IG 1, Pagórki IG 1, Człuchów IG 1, Tuchola IG 1, Poddębice PIG 2.

In total 498 samples were collected. They were macerated, as follows: Lower Cretaceous rocks in 7% KOH using a flotation method (CH_3COOH, H_2SO_4), Triassic and Lower Jurassic rocks in HF and HNO_3.

Three 24×24 mm glycerogelatine slides have been made from sample, for optical microscope analysis.

Problematic morphological features of some spores, observed in the optical microscope, entailed the necessity of exine analysis in optical and scanning (SEM) microscopes. To establish detailed taxonomy of spores, their poorly decipherable morphological features were analysed in SEM and transmission light and then correlated to a corresponding sedimentary environment. For comparison, intraspecies variability of recent spores was also analysed.

In this report, to sort out the morphological features and perform a detailed taxonomic study, the material was analysed according to artificial classification.

General description of spores is presented in a systematic order. In terms of morphological features. Systematic artifi-

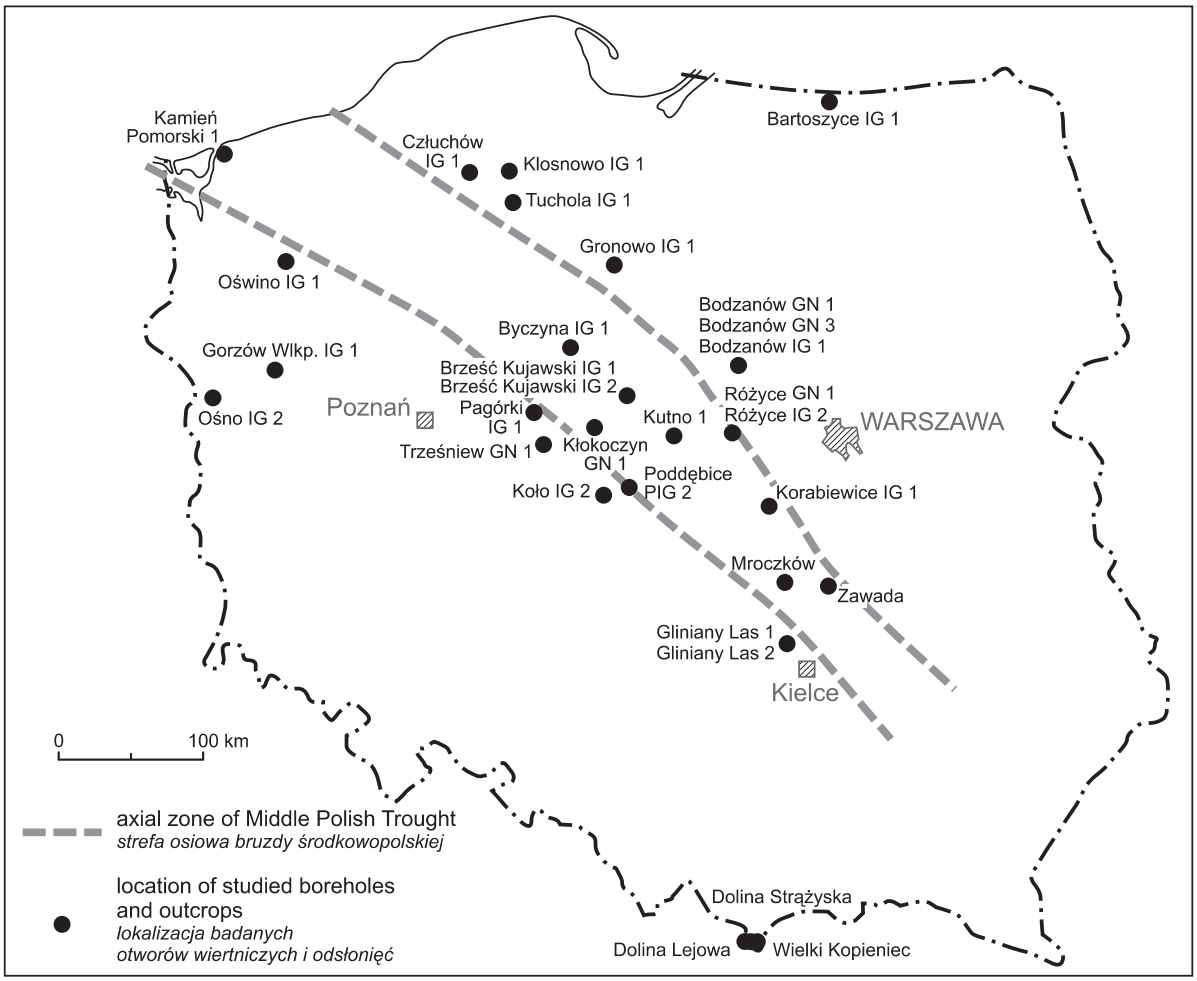

Fig. 1. Location of the studied boreholes and outcrops

Lokalizacja badanych otworów wiertniczych i odsłonięć

cial classifications for scattered spores of Potonié (1956, 1958, 1960, 1962, 1975a), Playford (1971), Pedersen and Lund (1980), and Dejax *et al.* (2007) have been used, and variability of individual taxa have been presented in relation to the characteristics of Infraturma, developed by the above-mentioned authors.

In the general description of taxa, the following sequence was applied: type species, characteristic features, diagnosis, morphological description, dimension, discussion, botanical affiliation, "species identified by authores within the genus" and criteria of the identification, analysis of species morphology.

The spores have been described according to the following sequence: outline, corners, trilete mark, additional structure and ornamentation.

For comparison of morphological features of spores morphologically similar but taxonomically variably classified, 15 illustrative tables are arranged.

The terms, which are precisely defined in Punt *et al.* (2007), were mainly used in the description of spores for comparison of morphological features.

Botanical, in addition to detailed, affiliation of spores assigned by the authors in the taxonomic description, was also compared with the analyses of Potonié (1965) and Barron *et al.* (2006).

To present the palynostratigraphic significance of taxa, the material was correlated with the taxa ranges given in literature, and with the intercontinental correlation tables of spores: Triassic – Argentina (Zavatieri, Batten, 1996); Upper Triassic, Jurassic – Northern Europe (Batten, Koppelhus, 1996); Lower Jurassic, Middle Jurassic – Denmark (Batten, 1996; Koppelhus, Batten, 1996); Upper Jurassic, Cretaceous (Batten, 1996); Cretaceous (Herngreen *et al.*, 1996).

Analysis of environmental influences on morphological features of spores was based on the following papers: Visscher, Krystyn, 1978; Herngreen, van Hocken-Klinhenberg, 1980; Parry *et al.*, 1981; Visscher, Brugman, 1981; Price, 1988; Chmura, Liu, 1990; Andriessen, Helmes, 1993; Hicks, Hyvarinen, 1999; Larocque *et al.*, 2000; Jato *et al.*, 2002; Pieńkowski, Waksmundzka, 2009.

THE SYSTEMATIC ANALYSIS (SYSTEMATICS AFTER PEDERSEN, LUND, 1980)

Taxonomic and systematic analysis of the Mesozoic spores of Poland performed for ordering the material according to artificial systematics shows more thoorughly the variability of morphological features of individual taxa. General features of the taxa are described by the characteristics of Infraturma, while additional individual features were able to be distinguished as a result of taxonomic analysis of microspores.

Anterturma: SPORITES

Turma: TRILETES (Reinsch) Dettmann

Suprasubturma: Acavatitriletes (Luber) Dettmann

Infraturma: **Laevigati** (Bennie, Kidston) Potonié

Characteristic features. – Wall more or less laevigatae.

Genus *Auritulinasporites* Nilsson, 1958

Pl. I: 1, 2

Type species: *Auritulinasporites scanicus* Nilsson, 1958.

Diagnosis. – Distinct triangular area along trilete mark arms, formed by "lips".

Description. – Triradiate spore triangular in equatorial outline, straight or concave sides, triangular corners protruding beyond the spore outline; trilete mark rays straight, *ca*. 2/3 of the spore radius of spore in length; "lips"-type thickenings along trilete mark rays, which form a distinct triangular area; structureless exine or intrapunctatae structure.

Dimensions. – 30–40 µm.

Discussion. – The genus differs from *Trachysporites* Nilsson and *Intrapunctisporis* Krutzsch by a distinctly triangular, thickened area around trilete mark rays.

Botanical affiliation. – No definated.

Species identified within the genus *A*. cf. *scanicus* and *A*. sp.; distinguished based on criterion: thickening shape:

– *A*. cf. *scanicus* (Pl. I: 1) according to Guy-Ohlson (1971) is characterised by wider laesurae due to distinct margo (zone of variable thickness), exine smooth locally slightly folded; occurrence: Mroczków (29.0, 124.6 m);

– *A*. sp. (Pl. I: 2) based on distinctly triangular corners and a thickening along trilete mark rays forming a distinct triangular area; specimen morphologically assigned by Ziaja (2006, pl. 2: 6) to *A*. sp.

Genus *Carnisporites* Mädler, 1964

Pl. I: 3

Type species: *Carnisporites mesozoicus* (Klaus, 1960) Mädler, 1964.

Diagnosis. – Curvaturae, exine scabrate, microgranulate.

Description. – Spore oval in equatorial outline with distinct outline of contact faces; trilete mark rays equal to spora radius, connected at the ends they form perfect curvaturae around equatorial outline; spore surface not smooth; exine variably ornamented, can be slightly maculatae, scabratae (variable shape ≤1 µm) and infragranulatae (slightly oval inside).

Dimensions. – 35–55 µm.

Discussion. – Specimen differs from morphologically similar genera of *Anapiculatisporites* and *Apiculatisporites* by prominent curvaturae.

Botanical affiliation. – According to Barron, species *C. megaespiniger* belongs to lycophyta (Barron *et al*., 2006).

Species identified within the genus *C. spiniger* (Leschik) Morbey; criterion: ornamentation elements:

– *C. spiniger* (Leschik) Morbey (Pl. I: 3) is characterised by ornamented distal surface spinae or coni, which also cover apices of the proximal side, acuminate or blunt-ended appendages (1–2 µm in diameter; <4 µm in length, 2.5 µm spaced; contact face smooth, locally scabratae or with appendages similar to spinae; occurrence: Gliniany Las 1 (55.2 m).

Discussion. – Morbey (1975) included many taxa to the species synonymy of *Anapiculatisporites spiniger* (Levet-Carette, 1965; Schulz, 1967; Orłowska-Zwolińska, 1972), and *Anapiculatisporites telephorus* (Levet-Carette, 1965; Schulz, 1967; Orłowska-Zwolińska, 1972).

Genus *Cibotiumspora* (Chang, 1965) Waksmundzka, 1992

Pl. I: 5

Type species: *Cibotiumspora paradoxa* (Maljavkina, 1949) ex Chang, 1965,
Tripartina paradoxa Maljavkina, 1949.

Diagnosis. – Three radial surfaces in corners of proximal and distal sides, which developed from variably thick exine.

Description. – Spore triangular in equatorial outline, straight to concave sides, corners oval to sharp; trilete mark rays straight, localy winding, equal to 1 of the spore radius or radius of the spora, spore surface smooth or finely granular, slightly reticulatae; suturae straight slender and open; thickened proximal surface, on corners of the proximal and distal sides and in the central part of the distal side; outline of exine thickening explains the formation of folds on apices and outside in corners of trilete mark rays due to variable exine thickness; it changes the previous diagnosis of the genus because the folds are not a natural structure but only a result of variable exine thickness; according to Filatoff (1975) – triradiate long and winding leasurae with wider exine kyrtome, exine smooth with rare ornamentation; according to Chang – 3 radial lobes (trilete mark rays) have equatorially similar folds, which are relatively thicker and transect suturae of the trilete mark; according to Filatoff (1975) – distal surface with folds from the smallest generally three on apices, and outside in corners of trilete mark rays.

Dimensions. – 20–40 µm.

Discussion. – Analysed literature provides various interpretations of morphological features of the taxon structure and different descriptions of the species *Cibotiumspora jurienensis* (Balme) Filatoff, according to Filatoff (1975) "with triangular apices, concave and straight to slightly convex sides, sinusoidal leasurae (*ca.* 1 µm in height, 1 µm in width), reaching the Y-mark rays, locally widened by steep folds (kyrtome), exine is 1–2 µm wide, scabratae, punctatae distal surface with steep folds across apices (forming an apex) 24–32 µm in size", according to Ziaja (2006) "characteristic thickenings of the central part of the distal side are visible, 5–6 µm wide thickening parallel to leasurae extends to 2/3 of the spore radius and ends with a fold 2–3 µm in width running across apex; exine smooth to scabratae". These various interpretations of poorly decipherable morphological features of the taxon and different descriptions of the species shows a need for further analysis of the morphological features in SEM to make a precise diagnosis of the taxon.

Botanical affiliation. – Family Dicksoniacae.

Species identified within the genus *C. jurienensis* (Balme) Filatoff; criterion: variably thick structures:

– *C. jurienensis* (Balme) Filatoff (Pl. I: 5) is characterised by proximal surface thickened on corners and in the radial part, distal surface is thickened in the central part; occurrence: Kamień Pomorski IG 1 (452.7, 475.4, 494.5, 650.0 m), Gorzów Wielkopolski IG 1 (788.9, 806.3 m), Mroczków (14.6, 43.0, 65.5 m).

Genus *Cosmosporites* Nilsson, 1958

Pl. I: 4

Type species: *Cosmosporites elegans* Nilsson, 1958.

Diagnosis. – Intexine thickened on apices of spores.

Description. – Spore triangular in equatorial outline, concave sides, round corners, trilete mark rays narrow, locally winding, equal to 1 radius of the spore, smooth surface, thickened and strongly "invaginated" intexine on apices.

Dimensions. – Type species 27 µm.

Discussion. – In the previous report (Waksmundzka, 1992) the following species were distinguished: *Cosmosporites* A, B and C based on the outline of variably thick corners and the equatorial outline of muri; *C.* A are characterised by acuminate and thickened apices and straight sides, *C.* B oval-thickend corners and oval muri, *C.* C oval-thickend corners and straight muri; the genus differs from *Cibotiumsporites* by thickened corners, while the genus *Cibotiumsporites* is characterised by folds in corners and at angles of trilete mark rays.

Botanical affiliation. – No definated.

Species identified within the genus *C. elegans* Nilsson; criterion: outline of thickened corners:

– *C. elegans* Nilsson is characterised by oval outline of corners; occurrence: Kamień Pomorski IG 1 (499.2; 503.7; 642.1 m), Gorzów Wielkopolski IG 1 (1102.6 m).

Genus *Deltoidospora* Miner, 1935

Pl. I: 6, 7; Pl. II: 1, 2

Type species: *Deltoidospora hallii* Miner, 1935.

Diagnosis. – Smooth exine, sometimes kyrtomae are present.

Description. – Spore concave-triangular to suboval in equatorial outline; straight or concave sides, oval corners; trilete mark rays straight and distinct, extends to 2/3 radius of the spore; suturae long, locally widened by folds or slightly kyrtomae (exine thickening on the proximal side of contact surfaces parallel to trilete mark line); smooth exine.

Dimensions. – 25–80 µm.

Discussion. – Naumova (1937) characterised the genus *Leiotriletes* as smooth, triradiate spores; Couper (1953) proposed to assign the spores to the genus *Cyathidites* because of similar morphological features to those observed in modern Cyathaceae; Pocock (1970), based on a general analysis and comparison of morphological features of type species of the genus *Leiotriletes* – *Leiotriletes* spherotriangulus and the species *Cyathidites australis*, pointed to a similar size of the specimens but lack of differences in morphological features between the taxa, and proposed a new synonymy of the genus *Deltoidospora*: *Deltoidospora* Miner, 1935; *Leiotriletes* Naumova, 1939; *Cyathidites australis* Couper (type species), 1953; *Leiotriletes* (Naumova) Potonié et Kremp, 1955; *Deltoidospora* (Miner) Potonié, 1956; *Deltoidospora* Miner, Pocock, 1970 (p. 27); the adopted synonymy combines the genus *Leiotriletes* with *Deltoidospora* and distinguishes numerous species; subtle or undeveloped kyrtomae distinguish this genus from the genus *Concavisporites*.

Botanical affiliation. – No definated.

Species identified within the genus: *D. auritora* (Reinhardt) Lund, *D. australis* (Couper) Pocock, *D. crassexina* (Nilsson) Lund, *D. minor* (Couper) Pocock; *D. toralis* (Leschik) Lund; criterion: shape of proximal thickening:

– *D. auritora* (Reinhardt) Lund is characterised by exine thickening on contact surfaces and around apices; occurrence: Kamień Pomorski IG 1 (287.3, 445.3, 488.4, 499.2 m), Gorzów Wielkopolski IG 1 (1096.2 m), Mroczków (51.0–100.0 m);

– *D. australis* (Couper) Pocock with triangular equatorial outline, indefinite thickening along trilete mark rays (margo); occurrence: the spores are very abundant in the studied Triassic, Jurassic and Lower Cretaceous deposits;

– *D. crassexina* (Nilsson) Lund (Pl. II: 2) is characterised by three distinct exine thickenings located semidistally between apices of the spore: thickenings are isolated from contact surfaces (according to Lund, 1977, pl. 13: 3); occurrence: Kamień Pomorski IG 1 (93.1, 140.4, 262.5, 265.5, 400.2, 407.0, 409.0, 422.1, 426.6, 428.8, 434.1, 439.1 m), Mroczków (29.0, 43.0, 51.0, 56.5, 65.5, 68.0, 75.0, 79.5, 89.0, 113.7, 121.1, 124.6, 142.2 m), Gliniany Las 1 (42.6, 59.0, 77.4, 80.8 m), Kłokoczyn GN 1 (1383.0–1388.0 m);

– *D. minor* (Couper) Pocock differs from *D. australis* by a diameter less than 57 µm; occurrence: Kamień Pomorski IG 1 (499.2 m), Mroczków (24.8, 43.0, 56.0 m);

– *D. toralis* (Leschik) Lund (Pl. I: 6, 7; Pl. II: 1) species is characterised by proximal kyrtomae of variable shape, thin smooth exine; frequent cavities between kyrtomae and contour line of the spore; dimensions: 26×46 µm (according to Dybkjær, 1988, pl. 13: 2); occurrence: Kamień Pomorski IG 1 (93.1, 140.4, 262.5, 265.4, 400.2, 407.0, 409.0, 422.1, 426.6, 428.8, 434.1, 439.1 m), Mroczków (29.0, 43.0, 51.0, 56.5, 65.5, 68.0, 75.0, 79.5, 89.0, 113.7, 121.7, 124.6, 142.2 m), Gliniany Las 1 (42.6, 59.8, 77.4, 80.8 m), Kłokoczyn GN 1 (1383.0–1388.0 m).

Genus *Dictyophyllidites* (Couper, 1958) Dettmann, 1963

Pl. II: 3–5

Type species: *Dictyophyllidites harrisii* Couper, 1958.

Diagnosis. – Thickening of exine around “leasurae”.

Description. – Spore triangular in equatorial outline, convex distal surface, proximal surface less convex; exine smooth and slightly ornamented; trilete mark rays raised at the spore’s margin, long and well visible, perpendicular to suturae; emend. Dettmann (1963) exine smooth or slightly ornamented, a thickening along the leasurae margin.

Dimensions. – 33–56 µm.

Discussion. – According to literature, Dictyo- is characterised by a thickening leasurae margin, – a thickening along outer leasurae, *Concavisporites* a thickening around leasurae.

Botanical affiliation. – *Pteridophyta* (Matoniaceae).

Species identified within the genus: *Dictyophyllidites crassexinus* (Nilsson) Tralau, *D. equiexinus* Couper, *D. harrisii* Couper, *D. mortoni* (de Jersey) Playford et Dettmann; criteria: variability of commisurae and leasurae shape:

– *D. crassexinus* (Nilsson) Tralau with straight leasurae extending to the equator and closed by a membrane of raised lips – see *Concavisporites crassexinus*; occurrence: Mroczków (65.5, 89.9 m);

– *D. equiexinus* Couper with concave muri and usually punctatae sculpture; occurrence: Kamień Pomorski IG 1 (480.4, 492.9 m);

– *D. harrisii* Couper (Pl. II: 3) with raised leasurae and parallel “margo” separated from leasurae by a shallow furrow; occurrence: Kamień Pomorski IG 1 (400.2, 420.2, 428.6, 439.1, 480.4, 488.9, 491.0, 492.9 m), Gliniany Las 1 (80.8 m);

– *D. mortoni* (de Jersey) Playford et Dettmann (Pl. II: 4) with two rays of trilete mark, parallel to the third line – line of rays; occurrence: Kamień Pomorski IG 1 (494.5, 499.2, 503.7, 518.7, 639.7 m), Gorzów Wielkopolski IG 1 (761.4, 770.7, 800.7, 804.4, 806.3, 809.7, 1003.4, 1096.2 m), Mroczków (43.0, 65.5, 89.0 m), Gliniany Las 1 (55.2, 59.3, 70.0, 77.4, 80.8, 116.4 m);

– *D.* sp. (Pl. II: 5); occurrence: no definated.

Genus *Foraminisporis* Krutzsch, 1959

Pl. III: 1, 2

Type species: *Foraminisporis foraminis* Krutzsch, 1959.

Diagnosis. – Coni, 1 to 2 µm in size.

Description. – Spore oval in equatorial outline; trilete mark rays irregular, similar in length to the spore’s radius;

muri proportional and thin; proximal and distal sides variably ornamanted; proximal side with numerous oval perforation elements ("roundish perforation"), 1 to 2 μm in diameter; distal side ornamented in contrast to variably distributed coni or elongated verrucae that extend beyond equatorial outline of the spore; in the central part they can be coalesced but they are usually isolated; outer muri of the outline bent towards proximal side.

Dimensions. – 41 μm (*F. jurassica*; not specified in literature).

Discussion. – This genus differs from the genus *Anapiculatisporites* by the shape of ornamentation elements of distal side and by perforation of proximal side; due to uncertain diagnosis of the genus, resulting from different descriptions of ornamentation elements in literature, there is a need of further analysis; SEM images explain morphological features of distal side; perforation of proximal side may result from the overlapping of images of proximal and distal sides in transmitted light; it was noted by Krutzsch (1963),who asserted that "the group of sculptury elements in the centre of interradial proximal surface, believed to be a characteristic feature, is in contrast with *foraminatae* structure which is a basis for the genus name".

Species identified within the genus *F. jurassica* Schulz; criteria: diameter and distribution of ornamentation elements:

– *F. jurassica* Schulz (Pl. III: 1) is characterised by exine covered more loosely distrubuted verrucae extending to form cones 1.0–2.4 μm in diameter at the base and 0.8–1.6 μm in height; occurrence: Gorzów Wielkopolski IG 1 (770.4, 788.9, 806.4, 817.4, 828.4 m), Mroczków (34.3 m);

– *F.* sp. (Pl. III: 2); occurrence: no definated.

Genus *Intrapunctatisporis* Krutzsch, 1959

Pl. II: 6

Type species: *Intrapunctatisporis intrapunctis* Krutzsch, 1959.

Diagnosis. – Inner sculpture of variable morphological features and three subtle folds.

Description. – Trilete spore, triangular to suboval in equatorial outline; straight to convex sides, rounded corners; trilete mark rays variable in length; smooth outer surface; morphological features of exine is characterised by infrascabratae sculpture (within the exine, beneath tectum or in a part of tectum) of variable morphological features, alveolar irregular and of variable shape, granular, collumelae with ornamentation elements less than 1 μm in size.

Dimensions. – dimensions not specified in the analysed literature.

Discussion. – In papers by Lund (1977), Filatoff (1975), Morbey (1975), Achilles (1981) the genus not distinguished. Lund (1977) recognised *I. toralis* (Leschik) Lund and *I. hians* (Leschik) Lund based on previously described taxa such as *Punctatisporites toralis* Leschik and *P. hians* Leschik, and assumes, following the diagnosis, that scabratae sculpture inside exine is their typical feature; – Dybkjær (1991) *Intrapunctatisporis toralis* (Leschik) Lund recognised, in accordance with Lund (1977), and placed in its synonymy the species *Punctatisporites toralis* Leschik; taxonomic certainty of the genus is low due to small sizes of ornamentation elements and their presence in the infra-layer taking into account that the structures, thought to be morphological features, formed under the effect of chemical and mechanical corrosion processes.

Botanical affiliation. – No definated.

After detailed taxonomical analysis and observation of morphological features in correlation with illustrative material from literature, the following species have been recognised: *I. hians* (Reissinger) Nilsson and *I. toralis* (Leschik) Lund; criteria: scabratae sculpturae and typical morphological features:

– *I. hians* (Reissinger) Nilsson is characterised by scabratae sculpturae morphological features, species *Deltoidospora crassexina*, which is conspicuous by three additional interapical-semidistal thickenings of exine; occurrence: Kamień Pomorski IG 1 (637.7 m);

– *I. toralis* (Leschik) Lund (Pl. II: 6) showing scabratae sculpturae with a thickening of contact surfaces, long suturae extending to 3/4 radius of the spore, intrafold exine between equator ambs, and a thickening of contact surfaces; occurrence: Kamień Pomorski IG 1 (180.3, 488.9, 637.7, 639.7 m), Mroczków (17.6, 43.0, 51.0, 68.0, 85.0, 98.0, 100.0, 124.6 m).

Genus *Punctatisporites* (Ibrahim, 1933) Potonié et Kremp, 1954

Pl. III: 3

Type species: *Punctatisporites punctatus* Ibrahim, 1933.

Diagnosis. – Inner sculpture of variable morphological features and three subtle folds.

Description. – Spore oval in equatorial outline, trilete mark thin and long; exine locally with subtle secondary folds and smooth or with distinct inner scabratae structure (baculum, clava, gemme, verrucae ≤1 μm), reticulatae; intra-structure suggests its lack always at the edge or outside the spore margin.

Dimensions. – 45–85 μm.

Discussion. – Lund (1977) proposed to unite the genus *Punctatisporites* previously described from Paleozoic deposits with the Mesozoic genus *Todisporites* due to their similar morphological features of type species, which are characterised by (according to Couper, 1958) "clearly oval shape, long suturae and oval equatorial outline often folded, thin and structureless exine". It is an important explanation to the use of taxonomic name of *Punctatisporites* by Schulz, Hope (1973) in Mesozoic material. This genus differs from the genus *Retusotriletes* by the lack of distinct curvaturae.

Species identified within the genus *Punctatisporites globosus* (Leschik) Lund (Pl. III: 3); criterion: comparison of illustrations in Dybkjær (1988, pl. 1: 7), because no detailed description is given in the literature for comb. nov. species

(Lund, 1977); occurrence: Gorzów Wielkopolski IG 1 (761.4, 987.5 m).

Genus *Retusotriletes* Naumova, 1953

Pl. III: 4, 5

Type species: *Retusotriletes simplex* Naumova, 1953.

Diagnosis. – Variable inner sculpture and curvaturae.

Description. – Triradiate spore, rounded, rounded-triangular, very rarely triangular in equatorial outline, trilete mark rays raised, straight or winding with developed lips, extending to 1/2–3/4 radius of the spore; exine morphologically variable; infrapunctatae structure (perforated), infragranulatae (granular inside) or infrareticulatae (intrareticular); due to commonly smooth outline of the spore, its sculpture is indistinct (invisible); rays of radial trilete mark, bounded by contact surface, extend to the marginal part of leasurae and form thickenings similar in shape to the spore shape, 1–6 µm wide curvaturae (arcuate lines bounded by contact surface); contact surface is locally variable in colour or ornamentation due to curvaturae.

Dimensions. – 15–150 µm.

Discussion. – This genus differs from the genus *Punctatisporites* by the presence of distinct curvaturae.

Botanical affiliation. – In general, species of the genus *Retusotriletes*, *e.g.*, *Retusotriletes* disticuctus, due to "polumbra" structure, are comparable with Bryophyta spores; Krasilov (1981) also morphologically compares *in situ* Bryophyta specimens with the genus *Retusotriletes* because of curvaturae and ornamentation, the following species are recognised: *R. mesozoicus* Klaus.

Species identified within the genus *R. mesozoicus* Klaus; criteria: curvatura and ornamentation:

– *R. mesozoicus* Klaus (Pl. III: 4, 5) is characterised by distinct curvaturae and variable ornamentation; occurrence: Kamień Pomorski IG 1 (414.0 m), Gorzów Wielkopolski IG 1 (806.3, 809.7, 828.4 m), Mroczków (34.8, 65.5 m).

Infraturma: **Apiculati**

Characteristic features. – Wall structurae with elongate to more or less isodiametric non-murornate positive elements.

Genus *Acanthotriletes* (Naumova, 1937) Potonié et Kremp, 1955

Pl. III: 6

Type species: *Acanthotriletes ciliotus* (Knox, 1950) Potonié et Kremp, 1955.

Diagnosis. – Longer, sharply ended ornamentation elements.

Description. – Triradiate spore, oval-triangular in equatorial outline; slightly convex sides, rounded corners; trilete mark rays, straight, extending to 1/2–3/4 radius of the spore, exine of the distal and proximal sides ornamented with longer (longer than diameter of the base), sharply ended elements; ornamentation elements are more than 1 µm in diameter and 3 µm in length (tapering spinae); ornamentation elements "closely" and irregularly spaced (nowhere greater than a diameter of the element).

Dimensions. – 20–30 µm.

Discussion. – High morphological variability within individual species of the genus is observed while analysing illustrative material (*e.g. A. various* – Morbey, 1975, pl. 3: 13–15) and the possibility of combining some species assigned to a particular genus with spores of another taxonomic position, based on the illustrative material, undermines the palynostratigraphic value of the genus; – Dybkjær (1991, p. 20) combines the species of *Apiculatisporis ovalis*, *Acanthotriletes triganus* and *A. ovalis*; Ziaja (2006, p. 21) combines *Apiculatisporis ovalis* and *Acanthotriletes ovalis* described and illustrated in Morbey (1975), Achilles (1981); – stratigraphic value is also undermined by the general description of the genus according to the catalogue (Potonié, Kremp, 1954; Singh, 1964), there is no description given in Filatoff (1975), Morbey (1975), Achilles (1981) and Dybkjær (1991), referring to the description given by Potonié, Kremp (1954); – SEM analysis suggests to interpret the longer, sharply ended ornamentation elements as major genus identifiers; it distinguishes the genus from *Apiculatisporis*.

Botanical affiliation. – According to Waksmundzka (1992) Selaginellaceae, according to Barron *et al.* (2006) *A. ovalis* – Lycophyta.

Species identified within the genus *A. levidensis* Balme and *A. various* Nilsson; on criterion comparison with illustrative material, due to lack of detailed, morphological identifiers of the species in the literature, or on the general outline of morphological features of narrowing ornamentation elements:

– *A. levidensis* Balme – identified based on comparison with illustrative material of Filatoff (1975, pl. 5: 11);

– *A. various* Nilsson is conspicuous by sharpened or blunt and oval "tapped" – spinae on distal surface and trilete mark bounded by prominent or indistinct kyrtomae (*ca.* 4 µm in width – according to Morbey, 1975, p. 15); occurrence: Kamień Pomorski IG 1 (492.9, 637.7, 639.7 m);

– *A.* sp. (Pl. III: 6); occurrence: no definated.

Genus *Anapiculatisporites* Potonié et Kremp, 1954

Pl. IV: 1

Type species: *Anapiculatisporites isselburgensis* Potonié et Kremp, 1954.

Diagnosis. – Coni, spinae.

Description. – Spore oval-triangular to rounded in equatorial outline; trilete mark rays straight, equal to the radius of the spore (or longer), extending outside the spore outline; proximal surface smooth, distal side ornamented, locally with densely spaced grana, coni or spinae; ornamentation elements gener-

ally similar in size over the whole distal side, but sometimes much larger on the distal area; ornamentation of the distal side do not extend or rarely extends beyond the equatorial outline of the spore.

Dimensions. – 50–80 µm.

Botanical affilation. – No definated.

Species identified within the genus: *A. spiniger* (Leschik) Reinhardt and *A. telephorus* (Pautsch) Klaus; criteria: the width and length of the base of ornamentation elements:

– *A. spiniger* (Leschik) Reinhardt; occurrence: Mroczków (34.8 m);

– *A. telephorus* (Pautsch) Klaus (Pl. IV: 1) is characterised by smooth to punctatae (cavities ≤1 µm in diameter) on contact surfaces, distal and equatorial sculpturae with regular spinae and coni, 1–2 µm in height, wider at the base as compared with *A. spiniger*.

Genus *Apiculatisporis* Potonié et Kremp, 1956

Pl. IV: 2

Type species: *Apiculatisporis aculeatus* (Ibrahim, 1933) Potonié, 1956.

Synonymy: *Apiculatisporites* Potonié et Kremp.

Diagnosis. – Coni, spinae, occasionally baculae.

Description. – Spore subrounded to suboval in equatorial outline; trilete mark rays indistinct, extend to 1/2 of the spora radius; proximal and distal sides ornamented by coni, spinae and locally baculae of small and equal sizes (*ca.* 0.3–1.4 µm in diameter; *ca.* 0.3–1.3 µm in height); diameter of the base of ornamentation elements is more diversified; variable density of ornamentation elements on spore surface; in case of "loosely" distributed ornamentation elements, which occurs very rarely, "free" space is covered with additional elements of sculpturae and the base of earlier-formed elements of sculpturae is locally deformed to a polygonal shape.

Dimensions. – 50–60 µm.

Discussion. – Previously accepted name *Apiculatisporites* for spores of similar morphological features was replaced by *Apiculatisporis* (Potonié, Kremp, 1956a, b) *Apiculatisporites aculeatus* Ibrahim has been included into the synonymy of species regarded as type species *Apiculatisporis aculeatus* (Ibrahim) Potonié et Kremp; acceptance of the name *Apiculatisporis* is also confirmed by including it in the palynological systematics proposed by Pedersen, Lund (1980); combining of the genera is also suggested by the description of the genus. Apiculatisporites, which is characterised by morphological features of "rather acuminate coni".

Botanical affiliation. – Balme (1995, p. 136), combines the genus *Apiculatisporis* with the Permian-Carboniferous genus *Filicopsida* on the basis of morphological comparison of "circular, simple trilete, apiculatae contae", the genus *Apiculatisporis* with *Corynepteris scotti*, Barron *et al.* (2006) *Apiculatisporites leviornatus* Levet-Carette combines it with Lycophyta.

The following have been distinguished: *A. ovalis* (Nilsson) Norris, *A. parvispinosus* (Leschik) Schulz previously described as *Apiculatisporites*, but classified into the particular taxon after comparing with illustrative material:

– *A. ovalis* (Nilsson) Norris (Pl. IV: 2) is characterised by irregular coni and spinae, occasionally baculae; sculpturae elements 0.5–1.5 µm in height; dimensions: 35–50 µm; occurrence: Kamień Pomorski IG 1 (400.2, 449.1, 642.1 m), Gorzów Wielkopolski IG 1 (800.7, 806.3 m); *A. ovalis* differs from *B. comaumensis* by the predominance of conatae sculpturae (according to Lund, 1977, p. 57); occurrence: Kamień Pomorski IG 1 (400.2, 449.1, 642.1 m), Gorzów Wielkopolski IG 1 (800.7, 806.3 m), Mroczków (68.0, 108.4 m), Gliniany Las 1 (64.4 m);

– *A. parvispinosus* (Leschik) Schulz is conspicuous by trilete – monolete mark; sculpture with conae and spinae, analysis of the material suggests problematic mixed – trilete – monolete mark as a characteristic element of the species, because this morphological features may be a secondary structure that developed due to corrosion; occurrence: Kamień Pomorski IG 1 (93.1, 112.2, 409.0, 414.0, 495.5, 499.2, 503.7 m), Gorzów Wielkopolski IG 1 (806.3 m), Mroczków (34.8, 100.0, 124.6 m), Gliniany Las 1 (59.8 m).

Genus *Baculatisporites* (Thomson et Pflug, 1953) Krutzsch, 1967

Pl. IV: 3

Type species: *Baculatisporites primarius* (Wolf) Thomson et Pflug; Thomson, Pflug (1953) considered *Rugulatisporites* and *Osmundacidites* as a younger synonymy of *Baculatisporites*.

Diagnosis. – Baculae, grana.

Description. – Spore semi-rounded in equatorial outline; trilete mark rays straight and well visible, extending to 3/4 of the spora radius of the spore; exine of distal side (or distal and proximal sides) ornamented, variously sharpened baculae, coni or granulae; sculpturae elements of various sizes, variably densely arranged on the spore surface, less densely in the margin.

Dimensions. – 35–60 µm.

Discussion. – This genus differs from the genus *Osmundacidites* by the presence of additional coni, granulae and ornamentation elements; from the genus *Conbaculatisporites* by its oval outline; from the genus *Apiculatisporites* by less conical ornamentation elements – previously, the genus *Osmundacidites* was considered a younger synonymy of the genus *Baculatisporites* (see remark on *Osmundaciidites*); – By morphology, the spore is similar to recent Osmundaceae (*O. cinnamomea*, *O. bromerifolia*, Copeland (Dettmann, 1963) and *Todea*, *Leptopteris* (Couper, 1953).

The following have been distinguished: *B. comaumensis* (Cookson) Potonié, *B. opressus* (Leschik) Lund, *B. prima-*

rius (Wolf) Thomson et Pflug; criteria: shape variability and disproportions in height and density of arrangement of sculpturae elements:

– *B. comaumensis* (Cookson) Potonié (Pl. IV: 3) is characterised by regular ornamentation, baculae according to Lund (1977) 1.5–2.0 µm in height; the species is also characterised by a twisted fold (Guy-Ohlson, 1971, p. 23); dimensions: 39–57 µm; occurrence: Kamień Pomorski IG 1 (93.1, 180.3, 273.3, 279.2 m), Gorzów Wielkopolski IG 1 (422.1, 458.7, 480.4, 499.2 m);

– *B. opressus* (Leschik) Lund with mixed sculpturae – microbaculatae (baculae ≤1 µm in size), microconae (coni ≤1 µm in size), microgranulatae (granulae ≤1 µm in size) and folds of exine in the marginal part; dimensions: 30–38 µm; occurrence: Mroczków (108.4 m);

– *B. primarius* (Wolf) Thomson et Pflug with ornamentation elements represented by baculae of different shapes; dimensions: 30–49 µm; occurrence: Gorzów Wielkopolski IG 1 (796.4 m);

– *B. wellmani* is defined as *O. wellmani* due to densely arranged ornamentation elements.

Genus *Conbaculatisporites* Klaus, 1960

Pl. IV: 4

Type species: *Conbaculatisporites mesozoicus* Klaus, 1960.

Diagnosis. – Baculae, spinae, coni, basal reticulum.

Description. – Triradiate spore, triangular in equatorial outline, never suboval or oval, straight sides, rounded corners; trilete mark rays extend to 2/3 radius of the spore or longer, straight in shape and singular; exine of distal and proximal sides variably ornamented by densely spaced baculae distributed almost parallel to thin or moderately thick exine, occasional spinae and coni; ornamentation elements constricted at the base on corners and form "basal reticulum".

Dimensions. – 30–50 µm.

Discussion. – In the literature, considerable differences in the diagnosis of ornamentation elements of morphological features are observed within the genus, which are considered as "elements devoid of baculae" (according to Dybkjær, 1988), or described as variable elements of sculpturae: baculae, spinae, coni (Lund, 1977; Schuurman, 1977, Pedersen, Lund, 1980), high variability in morphological features of specimens, which is illustrated in the analysed papers by, *e.g.*, the species of *Conbaculatisporites mesozoicus* (Lund, 1977, pl. 2: 10a, b; Pedersen, Lund, 1980, pl. 5: 1, 2; Dybkjær, 1988 pl. 2: 8, 9; Dybkjær, 1991, pl. 5: 12; cf. *mesozoicus* Filatoff 1975, pl. 5: 12, 13) also with different and inaccurate descriptions: – describing the species, Lund (1977), shows only the difference with respect to the species *C. spinosus*; this species is characterised by smaller "polar axis", and by the shape of reticulum, which is often less pronounced; – Pedersen, Lund (1980) illustrate the taxon without description; – Dybkjær (1988) describes exine with sculpturae of coni, spinae and baculae; sculpture elements are 3 µm in height and are combined at the base forming reticulum; – Dybkjær (1991), only illustrates the taxon; – Filatoff (1975) describes convex or concave sides, rounded corners, leasurae 1 µm in height, 1 µm in width; extending to 3/4 of the spora radius of the spore, separated by 2–3 µm from "margo"; – Arjang (1975) describes "konkaven, konvexen, exine baculaten, sculptura", occasional coni; Achilles (1981) gives no description, but only a photograph, and illustrates the structure; the species *C. spinosus* (Dybkjær, 1988, 1991) without description, only referring to Lund (1977); – It enabled taxonomic analysis based mainly on illustrative material. To avoid misunderstandings, the analysed material was classified according to illustrative data accompanied by descriptions of morphological features in individual illustrations, however it does not provide precise taxonomic position of the specimens, in terms of morphological features, due to considerable discrepancies observed in the literature; morphologically similar *Acanthotriletes various* Nilsson illustrated in Morbey (1975, pl. 3: 13–15) differs from *Conbaculatisporites* by the distribution of projections on distal side and on apices of proximal side, which is well explained by a correlation of the description and the illustrations; – Ziaja (2006) proposed combining the species of *Conbaculatisporites spinosus* from the paper by Dybkjær (1991, pl. 2: 10) with *Acanthotriletes varius* (Nilsson) Schuurman; – This genus differs from the genus *Apiculatisporites* of similar morphological features by triangular equatorial outline.

Botanical affiliation. – According to Ziaja (2006), Pedersen and Lund (1980) note that this type of spore is know *in situ* from *Clathopteris meniscoides* – Dipteridiaceae ferns; Potonié also links this taxon by morphological similarity with the family Dipteridiaceae.

The following have been distinguished: *C. baculatus* Bharadway et Singh, *C. mesozoicus* Klaus and *C. spinosus* (Mädler) Lund by correlation with illustrative material:

– *C. baculatus* Bharadway et Singh by correlation with illustrative material in Achilles (1981, pl. 5: 21–23); occurrence: Gorzów Wielkopolski IG 1 (1102.0 m);

– *C. mesozoicus* Klaus (Pl. IV: 4) is characterised by exine – coni, spinae, baculae *ca.* 3 µm in height, sculpture elements constricted at the base forming small, irregular "basal reticulum"; occurrence: Kamień Pomorski IG 1 (140.3, 265.4, 485.9, 637.7, 642.1 m), Gorzów Wielkopolski IG 1 (80.7, 817.4, 1096.2 m), Mroczków (29.0, 68.0, 121.1, 124.6 m), Gliniany Las 1 (55.2 m);

– *C. spinosus* (Mädler) Lund, which is characterised by greater "polar axis", smaller in size (*ca.* 25–36 µm), often less distinct "basal reticulum"; ornamentation elements characteristic of the genus: coni, spinae, baculae; occurrence: Kamień Pomorski IG 1 (476.0 m), Mroczków (34.8, 43.0, 75.0, 116.4 m), Gliniany Las 1 (64.4, 77.4 m).

Genus *Concavisporites* Pflug, 1953: Thomson et Pflug, 1953

Pl. IV: 6

Type species: *Concavisporites rugulatus* Pflug, 1953 *in*: Thomson, Pflug (1953).

Diagnosis. – Internal ornamentation and tori ornamentation.

Description. – Spore triangular in equatorial outline, with convex, slightly concave or almost straight sides; straight trilete mark rays; infragranulatae or infrareticulatae exine structure, thickening around trilete mark rays, protuberance of exine paralleling leasurae – "tori" well pronounced; "tori" within "margo" (margo – exine along trilete mark rays of variable thickness; tori – thickening of exine on the contact area).

Dimensions. – 20–40 μm.

The following have been distinguished: *C. crassexinus* Nilsson (*D. crassexinus*), *C. divisitorus* Kedves et Simoncsics; *C. hexagonalis* Kedves et Simoncsics, *C. intrastriatus* (Nilsson) Arjang, *C. raetoliassicus* Achilles, *C. reissingeri* (Kedves et Simoncsics) Arjang, *C. toralis* (Leschik) Waksmundzka, *C. tumidus* Playford, *C. umbonatus* (Bolkhovitina) Arjang; criteria: variability in the shape of protuberance – "tori" and shape of corners:

– *C. crassexinus* (Nilsson) – according to Tralau (1968, p. 36) *Dictyophyllidites crassexinus* (Nilsson) Tralau;

– *C. divisitorus* Kedves et Simoncsics "kyrtome" parallel to trilete mark, distal side "charakteristiche schleife um dii Dreieksenden Die Tecta Y Mark erreichen In leicht verlouf den Aequator" (MW: are the corners thickened on distal side");

– *C. hexagonalis* Kedves et Simoncsics is characterised by poorly developed "tori" and a thickening of exine on corners; occurrence: Kamień Pomorski IG 1 (637.7 m), Gliniany Las 1 (59.8 m);

– *C. intrastriatus* (Nilsson) Arjang have "tori" and a flattening of exine on corners; occurrence: Kamień Pomorski IG 1 (499.2, 637.7 m), Gorzów Wielkopolski IG 1 (977.6, 1096.2 m);

– *C. raetoliassicus* Achilles with flattened and narrow "tori" around trilete mark rays and a flattened widening on corners (according to Achilles, 1981); occurrence: Gorzów Wielkopolski IG 1 (770.7, 796.4 m);

– *C. reissingeri* (Kedves et Simoncsics) Arjang compared with *D. mortonii* and with my Plates (Pl. II: 4), specimens similar to those presented in Filatoff (1975) as a side view;

– *C. toralis* Leschlik (Pl. IV: 6); occcurrence: no definated;

– *C. tumidus* Playford (p. 15 *in*: Achilles, 1981) with microrugulatae (rugulae *ca*. 1 μm in size) sculpture on distal side; occurrence: Gliniany Las 1 (49.1 m);

– *C. umbonatus* (Bolkhovitina) Arjang according to Bolkhovitina (1953) (*Gleichenia umbonata*); the spore with a triangular oval, thickened on sides, with no thickenings on corners, thickenings of the oval give to the spore an irregular or trapezoidal inner outline, parallel to the oval; the greatest folds bend over, rugulae; exine smooth, triradiate mark; occurrence: Kamień Pomorski IG 1 (499.2 m).

Genus *Impardecispora* Venkatachala, Kar et Raza, 1969

Pl. IV: 5, 7

Type species: *Impardecispora apiverrucata* (Couper, 1958) Venkatachala, Kar et Raza, 1969.

Diagnosis. – Verrucae, greater diameter in apical areas.

Description. – Spore triangular to subtriangular in equatorial outline; distinctly concave sides, corners wide and oval; trilete mark rays well developed, equal to radius of the spora and extend to corners; exoexine of proximal and distal sides distal dense and ornamented with variable, mainly oval ornamentation elements – grana, verrucae, occasionally muri and rugulae; oval sculpture elements larges in size (*ca.* 3–6 μm) and densely arranged mainly on apices of proximal side, forming a natural thickening ("radial – apex"), on the remaining area of proximal and distal sides, ornamentation elements are similarly variable in shape, smaller in size, less densely distributed.

Dimensions. – 60–100 μm.

Comparison. – The genus *Trilobosporites* Potonié, with morphologically similar ornamentation elements, is characterised by additional secondary equatorial thickening of exine on apices of corners, interpreter in transmitted light as valvae, which occasionally continue in interradial sectors.

Discussion. – Illustrative material similar in morphological features with a variable taxonomic connection (according to Singh, 1964, pl. 8: 16–19) – *Trilobosporites apiverrucatus* (according to Srivastava, 1975, pl. 21: 1, 2) – *Impardecispora apiverrucata* suggests similar ornamentation of both genera; – Venkatachala *et al*. (1969, p. 124), suggest morphological diversification of these taxa; according to those authors, with similar ornamentation elements of both these genera (granulose, verrucose or "verrucae low ret"), concentrated mainly in apical-radial areas, the genus *Trilobosporites* is characterised by additional oval – "valvatae" corners and straight to slightly concave sides; – distinct morphological varability of the taxa is presented by the systematics of the genera according to Venkatachala *et al.* (1969); genus *Impardecispora* Venkatachala *et al.* (1969) – Infraturma: Apiculati, genus *Trilobosporites* (Pant) Potonié – Infraturma: Apiculati; analysis of the material in SEM and transmitted light illustrates variability of morphological features of the taxa; genus *Impardecispora* is characterised by variably oval ornamentation elements of diameters greater on corners; – the analysis allows to distinguish the genus *Trilobosporites* from this taxon based on additional ornamented thickenings in radial sectors; it well shows the morphological diversity of the taxa, however requires a very thorough analysis of morphological features in taxonomic research.

Botanical affiliation. – Pteridophytae (Waksmundzka, 1992).

The following have been distinguished: *Impardecispora apiverrucata* (Couper) Venkatachala *et al*. (1969), *I. uralensis* (Bolkhovitina) Venkatachala *et al*. (1969); criteria: spore shape, distribution of ornamentation elements and in correlation with illustrative material – Venkatachala *et al.* (1969), pl. 1: 1, 2 – *I. apiverrucata*, pl. 1: 3–5 – *I. uralensis*:

– *I. apiverrucata* (Couper) Venkatachala *et al*. (1969) (Pl. IV: 5, 7) is characterised by a clearly "trilobate" shape, granulose, verrucose, ornamentation elements 3–6 μm in diameter, generally densely arranged, of greater diameter, more concentrated in corners, less densely distributed in the remaining part of the spore; occurrence: Pagórki IG 1 (922.5–927.0, 1010.9–1097.7, 1051.2–1052.7, 1090.2–

1097.7 m), Klosnowo IG 1 (1081.0–1086.0 m), Oświno IG 1 (1301.0–1307.0, 1307.0–1313.2, 1326.4–1330.4 m);

– *I. uralensis* (Bolkhovitina) Venkatachala *et al.* less trilobate, generally oval and variable in shape, less densely distributed ornamentation elements; species not included in the list of taxa because a single specimen is identified only in correlation with illustrative material – Venkatachala *et al.* (1969, pl. 1: 3–5).

Genus *Leptolepidites* Couper, 1953

Pl. V: 1–3

Type species: *Leptolepidites verrucosus* Couper, 1953 (p. 28, pl. 2: 14).

Diagnosis. – Rugulae and verrucae protrude outside the equatorial outline of the spore.

Description. – Triradiate spore, triangular to oval in equatorial outline, straight to slightly convex sides, apices oval to slightly sharpened; rays of trilete mark extend to 4/5 radius of the spore, usually distinct; exine of proximal side smooth or slightly ornamented with irregularly distributed verrucae, commonly of smaller diameter than on distal side; exine of distal side ornamented with distinct which are variable in size and shape; the maximum diameter of verrucae is 5–6 µm; ornamentation elements distributed on the equatorial sector locally protruding outside the equatorial outline of the spore, in places they form rugulae which are locally formed due to coalescence of individual ornamentation elements of distal side.

Dimensions. – 30–35 µm.

Comparison. – This genus differs from the genus *Uvaesporites* Döring by ornamentation elements (not cingulum) that protrude beyond the equatorial outline of the spore.

Discussion. – Generally, the genus is characterised by different diagnoses, individual authors give different identifications considering previous descriptions as too general:

– Couper (1953) – thin exine, well-developed irregular sculpturae, but verrucae are oval and 5–6 µm in width, developed on proximal and distal sides; Y-mark long and indistinct;

– Potonié (1956) complement the diagnosis with a description of spore's shape "triangular to oval in shape" and includes the forms previously assigned to the genus *Gemmatriletes* into the synonymy of the taxon;

– Dettmann (1963) charaterises the taxon as: "trilete verrucae spore, subtriangular in outline, with straight to convex sides; exine thin and proximally smooth; verrucae distally and equatorially taxonomicaly distributed"; the present author includes this genus into Infraturma Apiculati, which is characterised by "acavate and azonatae spores with variably shaped sculpturae elements and appendages: verrucae, spinae, baculae and capilli; the sculptural elevation usually are discrete and their bases are less than twice as long as wide";

– Schulz (1967) assumes that sculpturae protrudes mainly on distal side and only in the margins of proximal side; sculpture elements are variable in shape, proximally locally smaller; Y-mark usually poorly visible, obscured by wart-like ornamentation elements, trilete mark rays shorter than the radius of the spore;

– Norris (1969) characterises the taxon as a "radio-symmetrical spore; subtriangular to oval in outline; leasurae singular and long; distal surface ornamented with well-developed verrucae, variable in shape and size; verrucae occasionally form rugulae, proximal surface smooth or with gentle ornamentation";

– according to Tralau (1968, p. 42), the genus includes trilete microspores with semirounded and subrounded verrucae; spores are subtriangular in outline;

– Jansonius, Hills (1976), following Jansonius (1968), include this taxon into the genus *Leptolepiidisporites* Danze-Corsin et Laveine due to identical type species of *L. verrucosus* Couper for both genera;

– Morbey (1975) and Achilles (1981) give no general description of the taxon, however make a detailed analysis of its species: *e.g.* Morbey (1975, p. 14) includes the following species into the synonymy of *Leptolepidites argenteaeformis* (Bolkhovitina) Morbey:

1953 *Stenozonotriletes argenteaeformis* Bolkhovitina.
1954 *Ophioglasaccus* (*Botrychium* cf. *lunaria*) Rogalska.
1962 *Trilites reissingeri* Reinhardt.
1965 *Trilitisporites reissingeri* (Reinhardt) Levet-Carette.
1965 *Ischyosporites paracrassacus* (Couper) Levet-Carette.
1967 *Uvaesporites argenteaeformis* (Bolkhovitina) Schulz.
1973 *Uvaesporites argenteaeformis* (Bolkhovitina) Schulz *in*: Orbell (1973).
1978 *Uvaesporites argenteaeformis* (Bolkhovitina) Schulz *in*: Schulz, Hope.

– A similar taxonomic assemblage, Ziaja (2006) includes into the synonymy of *U. argenteaeformis*.

– Achilles (1981), includes the following taxa into the synonymy of *Leptolepidites reissingeri* (Reinhardt) Lund:

1953 *Stenozonotriletes argenteaeformis* Bolkhovitina.
1954 *Ophioglasaccus* (*Botrychium* cf. *lunaria*) Rogalska.
1956 *Botrychium* cf. *lunaria* Rogalska.
1964 *Trilites reissingeri* Reinhardt.
1965 *Trilisporites reissingeri* (Reinhardt) Levet-Carette.
1965 *Ischyosporites paracrassus* Levet-Carette.
1965 *Leptolepidites verrucatus* (Couper) Levet-Carette *in*: Levet-Carette.
1967 *Uvaesporites lobatoverrucosus* Hettmann.
1967 *Uvaesporites argenteformis* (Bolkhovitina) Schulz.
1973 *Uvaesporites argenteaeformis* Schulz *in*: Schulz, Hope (1973).
1973 *Uvaesporites argenteaeformis* (Bolkhovitina) Schulz *in*: Orbell (1973).
1975 *Leptolepidites argenteaeformis* (Bolkhovitina) Morbey (*in*: Morbey, pl. 3: 7–9).
1975 *Uvaesporites argenteaeformis* (Bolkhovitina) Schulz *in*: Arjang.
1977 *Uvaesporites reissinger* (Reinhardt) Lund.
1977 *Leptolepidites argenteaeformis* (Bolkhovitina) Morbey *in*: Ashraf.
1977 *Uvaesporites argenteaeformis* (Bolkhovitina) Schulz *in*: Bjarke, Manum.

– Into the synonymy of *Leptolepidites major* Couper, Schulz, 1967 includes:

1964 *Clavatisporites clavus* Kedves et Simoncsics Guy-Ohlson (1971).
1964 *Leptolepidites major* Levet and Carette.

?1964 *Clavatisporites clavus* Kedves et Simoncsics.
?1969 *Rubinella major* Norris.

– Other authors include individual species of the genus into different taxa, *e.g.*, Dörnhofer (1977, p. 29) includes the following species into the synonymy of *Rubinella major* (Couper) Norris:

1956 *Leptolepidites major* Couper.
1963 *Leptolepidites major* Dettmann.
1966 *L. major* Burger.

The most variable species assemblage of the genus was identified by Guy-Ohlson, 1971 p. 20, who distinguished as follows:

– *L. bossus* (Couper) Schulz with proximal and distal surfaces ornament with more or less spherical verrucae, 2 µm in diameter; 40 µm in size;

– *L. equatibossus* (Couper) Tralau – with proximal and distal surfaces ornamented with verrucae, on proximal side, ornamentation elements are more closely spaced equatorially; sculpturae with more or less sperical verrucae, locally small papillae; 27–44 µm in size;

– *L. major* Couper is characterised by exine with very closely spaced verrucae, 2–7 µm in diameter; exine thick and difficult for detailed description; 42–55 µm in size;

– *L. paverus* Levet-Carette exine covered with irregular, more or less polygonal verrucae, 5–10 µm in diameter; 34–41 µm in size;

– *L. rotundus* Tralau is characterised by exine ornamented verrucae on proximal and distal surfaces; verrucae 6–9 µm in height and *ca.* 12 µm in diameter at the base; equatorial outline with sculpture; 34–43 µm in size.

It proves low resolution in the correlation of morphological features of the genus, which makes it difficult to perform its detailed taxonomic analysis, taxonomic analysis is also difficult due to morphological comparison of the genus with the genus *Uvaesporites* Döring; "ornamentation elements of the equatorial surface, which protrude beyond the outline, occasionally form rugulae", rugulae are sometimes difficult to distinguish from cingulum that formed as a result of combination of ornamentation elements typical of the genus *Uvaesporites*. It suggests performing a detailed taxonomic analysis of the genus only in correlation with illustrative material; however reduces its importance for biostratigraphic studies; a lower significance of this taxon for biostratigraphic studies is also confirmed by the presence of the following taxa in the correlation list:

- Triassic – genus *Leptolepidites* and species: *L. bossus*, *L. crassibalteus*, *L. valkheimieri*;
- Upper Triassic/ Jurassic – genus *Leptolepidites* and species *L. bossus*, *L. equatibossus*, *L. macroverrucosus*, *L. major*, *L. paerus*;
- Lower and Middle Jurassic – genus *Leptolepidites* and species *L. bossus*, *L. equatibossus*, *L. major*.

Botanical affiliation. – Tralau (1968, p. 43) suggests, due to morphological features, merging the taxon with spores of *Leptolepia novaezelandica* and *Alsophila chimborazensis* (tree-fern); Guy-Ohlson (1971) suggests to include only the species *Leptolepidites rotundus* Tralau into this group of the plant world; Dettmann (1963) combines this genus with the group of Knox – *Selaginella vaginata*; Filatoff (1975) combines this genus with *Lycopodiales*.

The following have been distinguished: – *L. major* Couper, *L. reissingeri* (Reinhardt) Lund, in Lower Cretaceous deposits – *L. tumulosus*; criterion: presence of distinct ornamentation elements – verrucae, mainly in correlation with illustrative material presented in the analysed literature:

– *L. major* Couper (Pl. V: 1–3) is characterised by ornamentation elements in the form of verrucae, 3–8 µm in diameter on distal side and 2–4 µm in diameter on proximal side; occurrence: Kamień Pomorski IG 1 (93.1, 180.3, 422.1 m), Gorzów Wielkopolski IG 1 (977.6, 1003.4 m);

– *L. reissingeri* (Reinhardt) in correlation with illustrative material of Lund (pl. 3: 14) – specimen determined as *U. reissingeri* in Lund, in later papers as *L. reissingeri*;

– *L. tumulosus* (Döring) Srivastava distinguished due to smooth surface of proximal side and verrucae 3–10 µm in diameter, 5 µm in height on distal side; M. Waksmundzka (1992) includes *Matthesisporites tumulosus* Döring, 1964 (p. 38, pl. 2: 6–8) into the synonymy; *M. plusituberosus* Döring (1964) (p. 38, pl. 2: 9, 10); occurrence: Pagórki IG 1 (1010.9– 1097.7 m), Klosnowo IG 1 (1062.2 m), Oświno IG 1 (1320.0–1326.0 m).

Genus *Microreticulatisporites* Knox, 1950

Pl. V: 5

Type species: *Microreticulatisporites lacunosus* (Ibrahim, 1938) Knox, 1950.

Diagnosis. – Rugulae or dense reticulum of polygonal luminae.

Description. – Triradiate spore, triangular to oval in equatorial outline; convex to concave sides, rounded corners, trilete mark rays distinct and well developed, extend to about 2/3 radius of the spore; exine of proximal and distal sides ornamented with irregular ornamentation elements; round-ended rugulae or dense reticulum of polygonal and irregular luminae; the luminae are commonly deeper separated from each other or connected and small (according to Knox, 1950; Potonié, Kremp, 1954 – ≤6 µm; according to Bharadway, 1956 *in*: Jansonius, Hills , 1976 – ≤3 µm), muri of reticulum locally discontinuous, oval or sharply ended; the reason for the development of discontinuous muri is suggested by locally melted at the base as well as coalesced and variable in shape ornamentation elements (grana, coni, baculae – according to Morbey, 1975, p. 17 or verrucae); equatorial outline often widened by protruding reticulum elements observed in transmitted light (according to Potonié included into Cingulati).

Dimensions. – 30–50 µm.

Discussion. – Possibility of creation of ornamentation elements in this taxon due to mechanical corrosion (melting at the base of ornamentation elements), luminae variable in shape, different descriptions of the genus (Pl. V: 5) and the inclu-

sion of species of the genus into different taxa (*e.g. M. fuscus* – *Trachysporites fuscus* – Dybkjær, 1991, p. 19) suggest a need for detailed analysis of morphological features and sedimentary environment in the taxonomic analysis;

– in contrast, the morphologically similar genus *Foveosporites* (*Foveotriletes*) Balme is characterised by irregularly distributed depressions and short channels that formed due to their coalescence;

– genus *Trachysporites* Nilsson with less pronounced reticulum characterised by protruding ornamentation elements in the central part and by the presence of single ornamentation elements outside the equatorial outline.

Botanical affiliation. – *Pteridophyta*.

The following have been distinguished: *M. fuscus* (Nilsson) Morbey and *M. uniformis* Singh:

– *M. fuscus* (Nilsson) Morbey is characterised by microreticulatae (oval muri ≤1 μm in size), microgranulatae surface of proximal side; muri discontinuous, locally formed by coalescence of the base of variable ornamentation elements, often protruding outside the equatorial outline of the spore (0.5–2.5 μm in height); luminae oval, polygonal, 0.5–3.0 μm in diameter; occurrence: Kamień Pomorski IG 1 (639.7 m);

– *M. uniformis* Singh (Pl. V: 5), material described by Singh (1964, p. 97) and illustration (pl. 13: 5–7); Singh (1971, pl. 17: 17–19);

Genus *Osmundacidites* Couper, 1953

Pl. V: 4

Type species: *Osmundacidites wellmanii* Couper, 1953.

Diagnosis. – Irregular grana.

Description. – Spore with irregularly oval or oval equatorial outline; trilete mark rays straight, approximately equal to the radius of the spore; proximal and distal sides ornamented with grana, oval to irregular in outline, 1 μm in width and 0.5–1.0 μm in height; grana irregularly distributed and spaced at 0.25–1.00 μm on distal side, reduced and more widely spaced on proximal side, tending to form rugulae (irregular rollers >1 μm in length).

Dimensions. – 40–63 μm.

Discussion. – Analysed literature (Dettmann, 1963; catalogue of Jansonius, Hills, 1976) suggests lack of the possibility of separating the *Osmundacidites* and *Baculatisporites* genera; to discriminate between *Osmundacidites* and *Baculatisporites*, Norris (1968) reexamined the description of type species *O. wellmanii* of irregular, oval, locally folded outline; leasurae straight, extends almost to the eqator; granulatae distal surface, granulae irregular or oval in outline, *ca.* 1 μm in width and 0.5–1.0 μm in height, spaced at 0.25–1.00 μm; irregular distribution; proximal surface is often granulatae probably with slightly reduced density and tendency to form "rugulae"; exine 1 μm thick; this description that the typical morphological features of the genus *Osmundacidites* are distinct granulatae without baculae or echinatae (≤1 μm in size) structures; in contrast, the genus *Baculatisporites* is characterised by predominance of single baculae, flattened (rugulatae elements of sexine >1 μm in length) and forming an irregular pattern.

Botanical affiliation. – Osmundaceae (Dettmann, 1963).

The following have been distinguished: *O. wellmanii* Couper; species distinguished; criterion: density of ornamentation elements:

– *O. wellmanii* Couper (Pl. V: 4) is characterised by closely spaced ornamentation elements; 36–76 μm in size; occurrence: Kamień Pomorski IG 1 (93.1; 112.2, 140.3, 154.6, 262.5, 265.4, 422.1, 434.1, 445.3, 447.2, 475.4, 503.7, 637.7, 642.1, 650.3 m), Gorzów Wielkopolski IG 1 (487.0, 747.9, 788.9, 800.7, 804.4, 914.5, 957.0, 960.0 m), Mroczków (112.4 m), Kłokoczyn GN 1 (1383.0–1388.0 m).

Genus *Pilosisporites* Delcourt et Sprumont, 1955

Pl. V: 6

Type species: *Pilosisporites trichopapillosus* (Thiergart, 1949) Delcourt et Spumont, 1955.

Diagnosis. – Spinae, capillae (long and winding).

Description. – Triradiate spore, triangular in equatorial outline; slightly concave, straight, or slighly convex sides, rounded corners; trilete mark rays distinct and straight, locally winding and tall (2–3 μm) extend to 3/4 radius of the spore; exine ornamented by numerous spinae, capillae, variable in length (1–10 μm) and width of the base (0.5–1.0 μm), which form echinatae sculpture; sculpture elements irregularly distributed on spore surface; locally show tendency to cluster in equatorial-radial sectors (apices).

Dimensions. – 50–85 μm.

Botanical affiliation. – According to Singh (1964) Filicales – *incertae sedis*.

The following have been distinguished: *P. trichopapillosus* (Thiergart) Delcourt et Sprumont, *P. verus* Delcourt et Sprumont; criteria: density and distribution of ornamentation elements:

– *P. trichopapillosus* (Thiergart) Delcourt et Sprumont is characterised by spinae in the outer layer of exine, regularly and densely distributed on spore surface; 50–85 μm in size; occurrence: Pagórki IG 1 (1090.2, 1097.7 m), Klosnowo IG 1 (1053.3 m), Oświno IG 1 (1301.2–1307.0 m);

– *P. verus* Delcourt et Sprumont (Pl. V: 6) is characterised by ornamentation elements concentrated in apical sectors, punctatae interradial sector on proximal and distal sides; 50–75 μm in size; occurrence: Pagórki IG 1 (1025.6–1029.6 m), Klosnowo IG 1 (1081.2–1086.0 m), Oświno IG 1 (1294.5–1301.2, 1301.2–1307.0 m).

Genus *Trachysporites* Nilsson, 1958

Pl. VI: 1

Type species: *Trachysporites fuscus* Nilsson, 1958.

Diagnosis. – Granulae, verrucae, baculae.

Description. – Triradiate spore, triangular to suboval in equatorial outline; straight to convex sides, rounded corners; trilete mark rays extend to *ca.* 3/4 radius of the spore; sculpturae represented by irregular granulae – luminae ≤1 μm in size, verrucae ≤1 μm in size, baculae, clava, short and wide spinae and muri; ridges smooth or fluted; type species is characterised by indistinct, thickened labra.

Dimensions. – 30–50 μm.

Discussion. – Analysis of descriptions of morphological features of the genera *Trachysporites* and *Microreticulatisporites*, which shows that the genus *Trachysporites* is characterised by variable ornamentation elements of sculpture (irregular granulae, ≤1 μm in size, verrucae ≤1 μm in size, baculae, clava, short and wide spines and muri), while the genus *Microreticulatisporites* is characterised by serrated reticulum of small luminae (≤6 μm in size) and discontinuous muri, irregular in outline, suggests (by analysing morphological features in transmitted light) the genera should be combined; it is confirmed by the fact that some species were included into both genera; *e.g.* Morbey (1975) includes the following species into the synonymy of the species *Microreticulatisporites fuscus*: *Trachysporites fuscus*; Achilles (1981), in a taxonomic analysis, distinguishes the species *M. fuscus* (Nilsson) Morbey with reference of Morbey, however it seems that, in well-preserved material – more regular outline of reticulum and the presence of oval ornamentation elements outside the equatorial outline of the spore allows to distinguish *Trachysporites*.

The following species have been distinguished in the analysed literature: *T. asper* Nilsson, *T. fuscus* Nilsson, *T. microclavatus* Nilsson, *T. tuberosus* Nilsson; detailed analysis of the diagnosis and illustrations of each species of the genus, in which:

– *T. asper* Nilsson is characterised according to Lund (1977) by microconi sculpture forming indistinct "crest", which creates indistinct "reticulum";

– *T. fuscus* Nilsson is characterised:

- according to van Erve (1977) by thin exine (≤1 μm) ornamented abundant and variable granulae and microgranulae sculpture (granulae ≤1 μm); trilete mark equal in length to the radius of the spore; dimensions: 42 μm;
- according to Lund (1977) – by dense granulae sculpture and coni partly melted in reticulum; according to Dybkjær (1988, p. 13) exine is 1.5–2.0 μm thick with densely spaced granulae about 1 μm in width, slightly elongated and irregularly oriented, some ornamentation elements form irregular reticulum;
- Morbey (1975) relates this taxon with the species *Microreticulatisporites fuscus* (Nilsson) Morbey due to 1.5–4.5 μm thick exine; proximal and distal surface microreticulatae to microrugulose; muri flat, oval or flattened, parallel or windinge; the base of muri often suggests coalescence of grana, coni, baculae or verrucae; ornamentation elements sometimes change the equatorial outline; folds alont trilete mark rays form kyrtomae, well or poorly deformed;
- Achilles (1981) illustrates the species without description with reference to Morbey (1975);

– *T. microclavatus* Nilsson, after Achilles (1981, fig. 27), exine with ornamentation elements of clava and granulae (≤1 μm in size), which form "rugatives microreticulum";

– *T. tuberosus* Nilsson exine according to Achilles (1981) generally shows low variability of features distinctive of this taxon, which makes it difficult to carry out precise taxonomic identification of spores of this genus, however does not preclude their identification after analysing many descriptions and illustrations, including sedimentary environmental studies.

Botanical affiliation. – *Pteridophyta* (Barron *et al*., 2006).

The following have been distinguished in the studied samples: *T. asper* Nilsson, *T. fuscus* Nilsson, *T.* cf. *sparsus* (Bharadway et Singh) Lund; criterion: variable sculpture:

– *T. asper* Nilsson (Pl. VI: 1) is characterised by loosely distributed, poorly developed microconi structure locally forming irregular reticulum; occurrence: Kamień Pomorski IG 1 (140.3, 409.0, 422.3, 424.2, 426.6, 434.1, 488.9, 492.9 m), Gorzów Wielkopolski IG 1 (637.7, 818.4, 987.5, 1070.7, 1092.2 m);

– *T. fuscus* Nilsson is characterised by dense sculpture of granulae and coni partly forming irregular reticulum; equatorial surfaces serrated (sexine surfaces separated by narrow surfaces); occurrence: Kamień Pomorski IG 1 (400.2, 452.7 m), Gorzów Wielkopolski IG 1 (1102.6 m);

– *T.* cf. *sparsus* (Bharadway et Singh) Lund is characterised by a sculpturae of scattered granulae, partly connected into small ridges forming irregular reticulum; occurrence: Kłokoczyn GN 1 (42.6 m).

Genus cf. *Trilobosporites* (Pant, 1954) Potonié, 1956

Type species: *Trilobosporites hannonicus* (Delcourt et Sprumont, 1955) Potonié, 1956.

Description. – Triradiate spore, triangular in equatorial outline; convex to distinctly concave sides, rounded corners, round in shape secondary thickened secondary proximal surface forming coni; distal surface oval-convex; trilete mark rays straight, approximately equal in length to the radius of the spore; exine variably ornamented with "granulose", distinctly verrucose or spinose; ornamentation elements variably distributed, mainly in radial sectors of the proximal surface and in the entire distal surface; densely spaced and of greater diameters, ornamentation elements in radial-apical sectors form a secondary thickening, which undermines detailed analysis of morphological features, it implies uncertain position of the taxon; in the entire proximal and distal surfaces, ornamentation elements are also variable in shape, smaller in size and more loosely distributed.

Dimensions. – 60–100 μm.

Comparison. – see *Impardecispora* Venkatachala, Karl et Raza (generally, *Impardecispora* is characterised by a thickening made of ornamentation elements of a greater diameter).

Discussion. – Poorly decipherable morphological features of the genus *Trilobosporites* in translucent light are variably interpreted by individual authors:

– Potonié (1956) with generally subtle "verrucae" assumes that "valvae" fromed by ornamentation elements are typical features of the genus;

– Dettmann (1963) considers "valvatae" morphologies as characteristic of the genus;

– Pocock (1965) distinguishes a sporoderm layer as 3-layer variably ornamented sexine;

– Burger (1966) exine verrucose, verrucae, 1 μm in height, 1–2 μm in diameter; in apical sector: 2 μm in height, 3–5 μm in diameter; exine generally 3–5 μm thick, 4–5 μm thick on corners;

– according to Venkatachala *et al*. (1969) exine thickened on corners forming ±25 μm thick valvae; exine proximally subverrucose and verrucose, distally infragranulose;

– Scott (1976) "verrucae" sculpture elements characteristic as poorly developed or absent in interradial sectors; verrucae 3 μm in width and ≤1 μm in height; well-developed verrucae on corners, more concentrated, 4 μm in width, 2 μm in height;

– Voronova (1984, p. 50) does not describe this taxon and distinguishes numerous species; the thoroughly described species differs in the following features: equatorial outline of the spore, shapes of proximal and distal surfaces; variable ornamentation;

– *T. apiverrucatus* Couper – triangular-oval equatorial outline, proximal surface conical and elevated, distal surface oval-convex; ornamentation elements (verrucae) variable in shape and size; sculpture elements of maximum diameter, located mainly around trilete mark rays and on corners; 70 μm in size;

– *T. asper* (Bolkhovitina) Voronova – oval-triangular or triangular-oval equatorial outline; convex sides, rounded corners, proximal surface conically-elevated (coni), distal surface oval-convex; ornamentation elements of proximal and distal surfaces – granular sculpture, forming a reticulate structure on both surfaces; 60 μm in size;

– *T. brenissartensis* (Delcourt et Sprumont) Potonié – equatorial outline triangular to oval, concave to slightly straight sides, rounded corners; proximal surface conical, distal surface oval-convex; secondary ornamentation elements – nexine and sexine layers forming sculpture elements; nexine thickened on corners; sculpture elements unevenly distributed and variously spaced, occurring mainly along the line of trilete mark rays, 84 μm in size;

– *T. bolkhovitinae* Voronova – without detailed description, is characterised by granulate sculpture and generally very strongly concave sides; 72 μm in size;

– *T. cavernosum* (Ivanova) Voronova – generally equatorial outline, convex sides, rounded corners, proximal surface equatorially elevated, distal surface oval-convex; exine thickened on corners, nexine of proximal and distal sides ornamented by a scabratum skin granular ornamentation; exine is thickened on corners and characterised by "scale" ornamentation, distinctly visible only in this part of the spore; 57–72 μm in size;

– *T. crassiangularis* Döring – oval-triangular equatorial outline, convex sides, rounded corners; conical-convex proximal surface, rounded-convex distal surface; scale-like exine, very well marked on corners; 50–75 μm in size;

– *T. giganteus* (Döring) Voronova – equatorial outline triangular, "sharp" and bent sides, rounded corners; conical proximal surface, oval-convex distal surface; ornamented proximal and distal surfaces; 67–97 μm in size;

– *T. grandis* (Bolkhovitina) Voronova – equatorial outline triangular-oval, straight sides, rounded corners, cone-like proximal surface, rounded-convex distal side; wart-hilly sculpture of proximal and distal sides; nexine and sexine layers; sexine layers adjoin nexine layers and form variably shaped ornamentation of „hills" with rounded apices, 3–7 μm in diameter, 1.0–2.5 μm spaced, 2.5–3.0 μm in height; 94 μm in size;

– *T. grossetuberculatum* (Bolkhovitina) Voronova – equatorial outline triangular-global, "blunt" corners, cone-like proximal surface, oval-convex distal side; wart-hilly proximal and distal sides; ornamentation elements variable in size; ornamentation elements 7 μm in diameter mainly on corners; 55 μm in size;

– *T. marylandensis* Brenner – triangular in outline, concave sides, rounded corners; hilly ornamentation (verrucae) 2.5–4.0 μm in diameter, 3.0–4.5 μm in height, 1.5 μm spaced; ornamentation elements on corners; towards the central part of the spore, the sculpture is coarsely grained; 68–83 μm in size; this species differs from T. apiverrucatus by evenly distributed ornamentation elements;

– *T. microverrucosus* (Döring) Voronova – equatorial outline oval and oval-triangular, straight, slightly concave sides, rounded corners; thin exine, broad verrucae adjoin each other forming a "reticulate-like" structure; 57–76 μm in size;

– *T. teslenkoi* Voronova – equatorial outline triangular, convex sides, rounded corners; proximal surface conditionally raised, rounded-convex distal side; proximal surface smooth or slightly finely grained; reticulate-multiangular corners, luminae *ca.* 4 μm in width, 1 μm in height; distal surface – polygonal reticulum; 47–78 μm in size;

– *T. trioreticulosus* Cookson et Dettmann – equatorial outline triangular, straight sides, wavy corners; cone-like proximal surface, exine locally thickened along the eqautor; proximal and distal sides ornamented with granular-finely granular sculpture; finely granular structure on corners, locally with concavities and alveolae; variably thickened on corners; 60 μm in size;

– *T. verrucosus* (Delcourt et Sprumont) Voronova – triangular-oval equatorial outline, conical-convex proximal surface, oval-convex distal surface formed into wart-hilly sculpture; sculpture elements realtively closely spaced, *ca.* 2 μm in height; 3–4 μm in diameter; verrucae generally with rounded apices; occasionally in the central part, the sculpture is much smaller and coarsely grained; 68 μm in size;

– *T. vialovii* Voronova – triangular in outline with concave sides, rounded corners, exine dense and granular, ornamentation elements indicate a conical shape of proximal and distal sides.

The author of the taxa – in addition to the variable ornamentation elements – points to a conical and cone-like shape of distal side or occasionally proximal side; into the synonymy of individual species, she included the following: *Lophotriletes*, *Concavissimisporites*, *Tuberaritriletes*, *Lycopodiumsporites*, *Cyathidites*, *Tuberosisporites*, *Impardecispora* (*I. merylandensis*), *Lygodium*, *Concavisporites*, *Maculatisporites*, *Cardioangulina*. The possibility of creating thickenings by the conical shape of proximal surface in radial sectors as well as the number of taxonomically variable spores in the taxon's synonymy indicates uncertain taxonomic position of the genus and does not confirm the valvatae structure characteristic of this genus (Dettmann, 1963); morphological features in correlation with illustrative material allows taxonomic identification of some specimens (thus, cf. is added); uncertain taxonomy of the genus is also confirmed by different descriptions and illustrative material of other authors, *e.g.*, *T. apiverrucatus* (Hedlund, Norris, 1968, pl. III).

Botanical affiliation. – Family Schizeaceae (according to Voronova), Filicales – *incertae sedis* (according to Singh).

The following have been distinguished: *T.* cf. *apiverrucatus* (Bolkhovitina) Voronova, *T.* cf. *asper* (Bolkhovitina) Voronova, *T.* cf. *giganteus* (Döring) Voronova, *T.* cf. *grossetuberculatum* (Bolkhovitina) Voronova, *T.* cf. *purverulentus* (Verbitskaja) Dettmann; criteria: shape of proximal and distal surfaces and ornamentation elements, due to lack of precisely defined shape of proximal surface, the material was correlated with ilustrative material for similar ornamentation elements:

– *T.* cf. *apiverrucatus* (Bolkhovitina) Voronova (Hedlund, Norris, 1968; pl. 8: 7) coll. *T. apiverrucatus*; Srivastava (1975, pl. 20: 1–7) – coll. *I. apiverrucatus*; Voronova (1984, pl. 7: 53, 53a) – coll. *T. apiverrucatus* – the genus is characterised by cone-shape, clearly convex proximal surface and wart-shaped ornamentation elements; maximum diameter of *verrucae* on corners to form thickening;

– *T.* cf. *asper* (Bolkhovitina) Voronova (Voronova, 1984, pl. 7: 53) cone-like proximal surface, oval-convex distal surface; ornamentation elements form reticulate structure on corners, corners are thickened;

– *T.* cf. *giganteus* (Döring) Voronova conical proximal surface; ornamentation elements (*verrucae*) evenly distributed on the entire surface; larger ones *ca.* 7 μm in size on corners, 3–4 μm in diameter in the central part (Voronova, 1984, pl. 8: 59);

– *T.* cf. *grossetuberculatum* (Bolkhovitina) Voronova cone-shaped proximal surface, oval-convex distal surface, proximal and distal sides with wart-hilly ornamentation (Voronova, 1984, pl. 9: 61);

– *T.* cf. *purverulentus* (Verbitskaja) Dettmann (Dettmann, 1963, pl. 13: 1–5).

Genus *Uvaesporites* Döring, 1965

Pl. VI: 2, 3

Type species: *Uvaesporites glomeratus* Döring, 1965 p. 39, pl. 9: 1–4.

Diagnosis. – Warts merge at the base in the equatorial sector.

Description. – Spore convex-triangular in equatorial outline, straight to oval sides, rounded corners; trilete mark rays commonly distinct and narrow, extending to the equator; smooth exine of proximal side, ornamented distal side; distinct sculpturae with proportional, more or less spherical (circular) ornamentation elements; ornamentation elements occasionally form cluster-shaped structures, locally distinct irregular or flattened "warts"; sometimes merging at the base to form larger structures, mainly in the equatorial sector; amalgamated ornamentation elements in the equatorial sector form cingulum-type thickenings.

Dimensions. – 40–60 μm.

Comparison. – This genus differs from the genus *Leptolepidites* Couper by the presence of a thickening in the equatorial sector (cingulum) formed by amalgamation of ornamentation elements.

Discussion. – Ziaja (2006), after a thorough taxonomic analysis of the species *Uvaesporites argenteaeformis* (Bolkhovitina) Schulz, suggests to include the following species into the synonymy of the taxon:

1953 *Stenozonotriletes argenteaeformis* Bolkhovitina.
1954 *Ophioglassacae* (*Botrychium* cf. *lunaria*) Rogalska.
1956 *Botrychium* cf. *lunaria* Rogalska.
1961 *Trilites reissingeri* sp. nov. Reinhardt.
1967 *U. argenteaeformis* (Bolkhovitina) Schulz.
1968 *U. argenteaeformis* (Bolkhovitina) Schulz *in*: Tralau.
1971 *U. argenteaeformis* (Bolkhovitina) Schulz *in*: Guy-Ohlson.
1972 *U. argenteaeformis* (Bolkhovitina) Schulz *in*: Tralau, Artturssson.
1973 *U. argenteaeformis* (Bolkhovitina) Schulz *in*: Orbell.
1974 *U. argenteaeformis* (Bolkhovitina) Schulz *in*: Herngreen, De Boer.
1974 *U. argenteaeformis* (Bolkhovitina) Schulz *in*: Arjang.
1974 *Leptolepidites argenteaeformis* (Bolkhovitina) Morbey.
1975 *Uvaesporites argenteaeformis* (Bolkhovitina) Schulz *in*: Vingen, Thusu.
1977 *Uvaesporites reissingeri* (Reinhardt) Lund.
1977 *Leptolepidites argenteaeformis* (Bolkhovitina) Morbey *in*: Ashraf.
1977 *Uvaesporites argenteaeformis* (Bolkhovitina) Schulz *in*: Bjarke, Manum.
1978 *Uvaesporites argenteaeformis* (Bolkhovitina) Schulz *in*: Guy-Ohlson.
1980 *U. reissingeri* (Reinhardt) Lund *in*: Pedersen, Lund.
1981 *U. argenteaeformis* (Bolkhovitina) Schulz *in*: Guy-Ohlson.
1984 *Leptolepidites reissingeri* (Bolkhovitina) Morbey *in*: Achilles *et al*.
1985 *Uvaesporites argenteaeformis* (Bolkhovitina) Schulz.
1989 *Leptolepidites reissingeri* (Bolkhovitina) Morbey *in*: Weiss.
1990 *Uvaesporites argenteaeformis* (Bolkhovitina) Schulz *in*: Rauscher, Schmitt.
1991 *U. argenteaeformis* (Bolkhovitina) Schulz *in*: Dybkjær.

The variable suite of species presented in the recent literature (Zhang, Grant-Mackie, 2001) is represented by:

– *U. argenteaeformis* (Bolkhovitina) Schulz with equatorial margin formed by distal and equatorial surface; sculpture elements flattened, verrucae 3–8 µm in diameter and 3–7 µm in height, forming a negative reticulum at the base; smooth proximal surface;

– *U. minisulcus* Wang is characterised by the presence of a cavity between exoexine and intexine; smooth intexine; distal and equatorial exine with verrucae, variable in shape; equatorial verrucae 1.5–2.0 µm in height, 6–7 µm at the base; exine smooth at the base;

– *U. projectus* Zhang et Grant-Mackie with cavity commonly between exoexine and inexine; distal and equatorial exoexine with "globular" or variably sized and irregular verrucae, 2–4 µm in height, 6–7 µm at the base; smooth proximal surface; the author assumes that a thickening of the equatorial sector is a patina structure (*i.e.* the thickening covers distal side and equatorial outline of proximal side);

– *U. verrucosus* (de Jersey) Helby is characterised by smaller, more irregular verrucae or clavatae – proturbances of ornamentation elements; they are larger and similar in shape around the equator; the following species are included into the synonymy of the taxon: *Discisporites verrucosus* de Jersey; *Cadorgosporites verrucosus* Reiser et Williams; *Camarozonosporites verrucosus* de Jersey; *Camarozonosporites clarhei* de Jersey 1970b; *Uvaesporites verrucosus* de Jersey 1970b;

– *U. viriesus* Zhang et Grant-Mackie with irregular and variable distal and equatorial surface created by verrucae; verrucae locally form flattened, smaller or shorter (7–8 µm) rugulae; smooth proximal surface;

and illustrates generally low intraspecies variability of the taxon (as above, probably the genus *Leptolepidites*).

Botanical affiliation. – Döring (1965) and Balme (1995) combine this taxon with Lycopsidae (Selaginellales).

The following have been distinguished in the studied samples: *U. argenteaeformis* (Bolkhovitina) Schulz, *U. glomeratus* Döring, *U. reissingeri* (Reinhardt) Lund, *U. sangenilentiformis* Sachanova et Iljana; due to poorly decipherable morphological features and different descriptions, the material was identified in comparison of description of the taxon with illustrative material.

Generally:

– *U. argenteaeformis* (Bolkhovitina) Schulz (Pl. VI: 2, 3) is characterised by verrucae ornamentation on distal side; 2–5 µm in height and 2–6 µm in diameter; proximal surface smooth (according to Tralau, 1968); occurrence: Kamień Pomorski IG 1 (400.2 m), Gorzów Wielkopolski IG 1 (788.9, 1038.8 m), Gliniany Las 1 (77.4 m);

– *U. reissingeri* (Reinhardt) Lund was determined in correlation with illustrative material Lund (1977, pl. 3: 14); Lund distinguishes the species only due to lack of *U. argenteaeformis* holotype; occurrence: Kamień Pomorski IG 1 (428.6; 642.1 m), Gorzów Wielkopolski IG 1 (828.4 m);

– *U. sanguilentiformis* Sachanova et Iljana was identified in correlation with illustrative material of Lund (1977, pl. 4: 1); occurrence: Kamień Pomorski IG 1 (180.3, 414.0, 422.1 m), Gorzów Wielkopolski IG 1 (747.9 m), Mroczków (43.0 m).

Infraturma: **Murornati**

Characteristic features. – Wall more or less reticulate to granulatae.

Genus *Cicatricosisporites* Potonié et Gelletich, 1933

Pl. VI: 4–6

Type species: *Cicatricosisporites dorogensis* Potonié et Gelletich, 1933.

Diagnosis. – Muri or ridges, forming cicatricose or canaliculatae structure.

Description. – Triradiate spore, triangular to suboval in equatorial outline; slightly concave to convex sides, rounded corners; trilete mark rays thin, wavy, long, extending from 1/2 radius to radius of the spora; exoexine of proximal and distal sides evenly ornamented with variably spaced ridges, 2–3 µm in width, of variable, flattened or convex ridges (muri); correlation of the distance between ridges and the width of ridges defines, according to Singh (1971, p. 51), the structures that characterise the taxon; ridges wider than channels form "canaliculatae", while ridges narrower than channels form – "cicatricose" morphological features; ornamentation elements of proximal and distal sides are represented by 3 sets of parallel ridges arranged obliquely, or parallel to the outline in radial sectors.

Dimensions. – 59–68 µm.

Comparison. – This genus differs from *Contignisporites*, *Striatella* and *Duplexisporites*, whose ornamentation is represented by muri, by smooth ridges in the form of muri, which form "cicatricose" or "canaliculatae" structure characteristic of the genus, with greater density in radial sectors; in addition to similar elements, ornamentation of the genus *Contignisporites* is characterised by "cingulum", the genus *Duplexisporites* – by "patella", and the genus *Costatoperforosporites* – by perforated muri.

Discussion. – According to Vakhramiejev (1988, p. 95), representatives of the genus *Cicatricosisporites* are important in terms of climatic interpretations; according to Niestierov (1987, p. 153) the taxa represent American tropical and subtropical zones, however according to Herngreen, Chlonova (1983, p. 13) – they are found in Boreal areas of America and Europe; analysis of modern plants confirms the tropical/ subtropical origin of the genera and their presence in Boreal deposits explains by sedimentary processes.

Despite decipherable morphological features of the taxon in the literature, plenty of species have been described within the genus:

– Dettmann (1963): *Cicatricosisporites australiensis* (Cookson) Potonié,

Cicatricosisporites hughesi Dettmann,
Cicatricosisporites pseudotripartites (Bolkhovitina) Dettmann,
– Kemp (1970): *Cicatricosisporites brevilaesuratus* (Couper) Kemp,
Cicatricosisporites proxiradiatus Kemp,
– Singh (1964, 1971): *C. annulatus* Archangelsky et Gamerro;
C. augustus Singh,
C. australiensis (Cookson) Potonié,
C. dorogensis (Bolkhovitina) Singh,
C. dorsostriatus (Bolkhovitina) Singh,
C. hallei Delcourt et Sprumont,
C. intricatus (Markova) Singh,
C. mediostraitus (Bolkhovitina) Pocock,
C. minor (Bolkhovitina) Pocock,
C. mohrioides Delcourt et Sprumont,
C. orbiculatus Singh,
C. perforatus (Baranov, Nemkova et Kondriatev) Singh,
C. spiralis Singh,
C. subrotundus Brenner,
C. verustus Deák,
it emphasizes the stratigraphic importance of the taxon for Lower Cretaceous deposits, however also requires very detailed analysis of morphological features of exine in taxonomic investigations.

Botanical affiliation. – Family Schizeaceae.

The following have been distinguished: *C. australiensis* (Cookson) Potonié, *C. hallei* Delcourt et Sprumont, *C. spiralis* Singh; criteria: width of ridges and channels, and the number and orientation of muri – ridges:

– *C. australiensis* (Cookson) Potonié (Pl. VI: 4, 5) is characterised by muri parallel both to each other and to the outline of the spore on proximal and distal sides; cicatricose structure; occurrence: Pagórki IG 1 (1020.3–1029.6, 1090.2–1097.7, 1137.6–1143.4, 1150.6–1167.0 m), Klosnowo IG 1 (1090.5 m), Oświno IG 1 (1294.0–1301.2, 1301.2–1307.0, 1307.0–1313.2, 1313,2–1320.8, 1361.5–1366.6 m);

– *C. hallei* Delcourt et Sprumont – ridges parallel to each other and perpendicular to trilete mark rays on proximal side; canaliculatae ornamentation; occurrence: Pagórki IG 1 (1090.2–1097.7, 1164.8–1166.6 m), Klosnowo IG 1 (1062.2 m), Oświno IG 1 (1189.5–1294.4 m);

– *C. jurassica* (Pl. VII: 4); occurrence: no definated;

– *C. spiralis* Singh (Pl. VI: 6) ridges parallel both to each other and to the outline of the spore on proximal side and distinctly triangular surfaces formed by muri on distal side; canaliculatae structure; occurrence: Klosnowo IG 1 (1062,6 m), Oświno IG 1 (1294.5–1301.2, 1301.2–1307.0, 1307.0–1313.2, 1313.2–1320.0, 1361.5–1366.5 m).

Genus *Contignisporites* Dettmann, 1963

Pl. VII: 1–3, 5

Type species: *Contignisporites glebulentus* Dettmann, 1963.

Diagnosis. – Muri, rugulae, cingulum.

Description. – Triradiate spore, oval-triangular in equatorial outline (synthetic in polar and corner views), convex sides, corners slightly sharpened; trilete mark rays equal in length to the radius of the spora, thickened and straight or slightly wavy; distinct contact areas of proximal side, structureless and with variable sculpture (in SEM), bounded by cingulum; distal exoexine with a set of parallel and variably running, occasionally branching "muri" or "rugulae"; sculpture elements form canaliculatae structure (synonymy: fossulatae irregularly elongated muri); sculpture elements locally form another oval cingulum, muri or rugulae at the junction of equatorial sector, occasionally reduced to verrucae.

Dimensions. – 40–60 μm.

Comparison. – See the following genera: *Contignisporites*, *Striatella*, *Duplexisporites*.

Discussion. – Analysed literature generally suggests poorly detailed description and synonymy of the taxon:

– Guy-Ohlson (1971), Lund (1977), Dybkjær (1988) and Ziaja (2006) do not provide detailed description;

– according to Dettmann (1963) the genus is characterised by "cingulatae" sculpture of exine with a set of nearly parallel, locally branching "muri" or "rugulae", which form cingulum at the junction of equatorial sector, and a cingulum tangent to contact surfaces in equatorial sector;

– Guy-Ohlson (1971) accepted the diagnosis of Dettmann; however including the following species into the synonymy of the taxon: *Cingulatisporites problematicus* (Couper) Levet-Carrette – *Corrugatisporites scanicus* Nilsson, 1958 and *Corrugatisporites amplectiformis* Pocock, 1970;

– Filatoff (1975, p. 65) shows only the difference of the *Contignisporites* and *Duplexisporites* genera in the presence of nearly parallel "muri" on distal surface forming "cingulum" in specimens of the genus *Contignisporites problematicus* (Couper) Döring (1965, p. 51, pl. 18: 6–8) with *Duplexisporites gyratus* Playford, Dettmann (1965, p. 141) and *Duplexisporites problematicus* (Couper) Playford et Dettmann;

– Lund (1977) illustrated the taxon only;

– Dybkjær (1988, p. 16) included *Cingulatisporites problematicus* Couper in the synonymy of *C. problematicus*, and *Conbaculatisporites problematicus* is characterised by a cingulum – like thickening; exine distally ornamented by variably oriented rugulae or verrucae;

– Ziaja (2006) included the following species into the synonymy of *Contignisporites problematicus*: *Cingulatisporites problematicus* Couper (1958), Levet-Carrete (1964), *Duplexisporites problematicus* (Couper) Playford et Dettmann – McKellar (1974), Filatoff (1975), Ashraff (1977), Achilles (1981) suggested, after Filatoff (1975), the spore be named *Contignisporites problematicus* (Couper) Döring due to outer "muri" parallel to the spore outline.

In the analysed literature, the genus is also characterised by uncertain taxonomic position; Dettmann (1963) included the taxon into Cingulati (equatorial thickenning); Lund, Pedersen (1985) – into Murornati. It is due to poorly decipherable morphological features of specimens – cingulum without

distal-equatorial "muri", considered the main feature that discriminates this genus from the genus *Duplexisporites*, can result from the following:

– natural thickenings of exine – ribs of cingulum that formed as a result of connection of "muri", or

– superimposition, in the optical microscope, of the image of "muri" (more or less parallel to the interradial line of equatorial outline), poorly developed from the equator towards distal area, where they can be reduced to small verrucae or present, which is characteristic of the genus *Duplexisporites* (according to Playford, Dettmann, 1965), and is a little detailed argument for generic identification of both these taxa;it does not preclude distinguishing of the genus, however it suggests analysis of morphologically well-preserved material in SEM. High morphological variability of the taxon, *e.g.* spiral "muri", could be connected with postdepositional processes.

Botanical affiliation. – Taxon included into Pteridiaceae; however Filatoff (1975) suggests combining the genus with Schizeaceae or Dicksoniaceae as a result of morphological comparison.

In the analysed material, the following species have been identified from the analysis of the width of cingulum and variable arrangement of ornamentation elements:

– *C. problematicus* (Couper) Döring (Pl. VII: 2), which is characterised by "cingulum" in equatorial sector, fromed by meltings of ornamentation elements; proximal surface structureless, distal surface ornamented by variably elongated verrucae; occurrence: Kamień Pomorski IG 1 (112.2, 256.4, 414.0, 452.7, 480.4, 485.9, 488.4 m), Gorzów Wielkopolski IG 1 (747.9 m), Mroczków (68.0, 98.0, 108.4, 153.0 m).

The following species hale been distinguished in correlation with illustrative material:

– *C. conbaculatus* after discussion with Guy-Ohlson (Pl. VII: 3);

– *C. cooksoni* (Balme) Dettmann,

– *C. glebelentus* Dettmann (Pl. VII: 5).

Analysis of the literature and studies of morphological features suggest the need of further morphological analysis to provide detailed taxonomy.

Genus *Costatoperforosporites* Deák, 1962

Pl. VII: 6, 7

Type species: *Costatoperforosporites fistulosus* Deák, 1962.

Diagnosis. – Perforated "ribs" wider than isolation channels.

Description. – Tetrahedral spore, oval-triangular in equatorial outline; slightly convex sides, oval corners, locally thickened; trilete mark rays unclear, approximately equal in length to the radius of the spora; locally bounded by labra; exoexine of proximal and distal sides ornamented by wide flattened perforated "ribs"; ribs (including striatae) are wider than channels and form "canaliculatae" sculpture on exine surface; perforation of the ribs in the form of regularly spaced small (*ca.* 1 μm in width) "holes" or "pits"; they form straight or slightly wavy lines on rib surfaces.

Dimensions. – 45–50 μm.

Comparison. – This genus differs from the genus *Contignisporites* Dettmann; – *Striatella* Mädler, *Duplexisporites* Deák by perforation, but ornamentation elements are generally similar, and it differs from the perforated genus *Cicatricosisporites* Potonié et Gelletich (*C. perforatus*) by wide, flattened ribs.

Botanical affiliation. – Family Schizeaceae.

The following have been distinguished: *C. fistulosus* Deák, *C. foveolatus* Deák, species identified mainly due to similar ornamentation elements – "ribs" 4–6 μm in width, channels 0.5 μm in width, and their similar arrangement – parallel to each other and to the outline; in the interradial sectors, based on additional characteristic elements:

– *C. fistulosus* Deák (Pl. VII: 6) is characterised by ornamentation elements in the form of "ribs", 4–6 μm in width, channels 0.5 μm in width; each interradial region is ornamented by 3–4 ribs parallel to each other and to the outline of the spore; distal side ornamented by 8–10 ribs in the central part; occurrence: Pagórki IG 1 (1130.5–1137.6 m);

– *C. foveolatus* Deák is also characterised by "ribs", 4–6 μm in width, channels 0.5 μm in width; each interradial region of the proximal side is ornamented by 3–4 ribs parallel to each other and to the outline; according to Singh (1971, p. 89) this species differs from *C. fistulosus* by a more triangular outline, large perforation elements on ribs, locally more frequentribs and "occasionally thickened apices"; occurrence: Pagórki IG 1 (1130.5–1137.6 m), Klosnowo IG 1 (1090.5 m), Oświno IG 1 depth (1312.3–1320.0 m);

– *C. spiralis* Singh (Pl. VII: 7) in correlation with illustrative material (Singh, 1971, pl. 10: 1–3; p. 78).

Genus *Duplexisporites* Deák, 1962

Type species: *Duplexisporites generalis* Deák, 1962.

Diagnosis. – Patella and muri more or less parallel to the outline of the spore.

Description. – Triradiate spore, triangular-oval in equatorial outline, straight-convex sides; corners sharpened; trilete mark rays widened, extend to *ca.* 3/4 of the spore radius, reaching thickenings (cingulum); exine thickened in equatorial sector, thickenings continue on distal surface ("patellae"), but invisible on traingular area; around distal area of proximal surface ornamented tangential "muri" on equatorial margin, whereas contact surface is smooth; around the equator and distally, exine is ornamented by "muri" more or less parallel to the equatorial outline of the spore; according to Deák (1962), in the centre of distal area, "muri" form continuous or discontinuous, small spirals reduced to small verrucae, or they are absent.

Dimensions. – 45–65 μm.

Comparison. – See *Contignisporites* Dettmann; – this genus differs from the genus *Asseretospora* (see Striatella) by more regular ornamentation on distal side.

Discussion. – Due to "complicated" morphological features of the taxon, like in the case of the genus *Contignisporites* Dettmann, the literature provides description of the genus and its type species, which is generally poor in details, *e.g.*:

– Norris (1969), de Jersey (1970a), Filatoff (1975), Achilles (1981) and Dybkjær (1991) do not provide description of the genus;

– according to Deák (1962), type species of the genus *Duplexisporites* is characterised by equatorial cingulum, *ca.* 5 μm in width, and central membrane of similar width, which does not cover the central part of the spore and distinguishes this genus from other Cingulati taxa; the monotype introduced by that author is also characterised by "central membrane", often triangular in outline, which is does not cover the central part of the spore.

To summarize, the general description of the taxon shows variable structures: patellae ornamented "muri"; "central membrane", or "muri" more or less parallel to interradial margin as the main identifier of the genus, which undermines its biostratigraphic significance (genus listed in the intercontinental correlation tables of Upper Jurassisc and Lower Cretaceous).

This report assumes the presence of patellae and "muri" parallel to the spore's outline, as the major typical features of the genus.

Variable interpretation of the structures of the genus, *e.g.*:

– according to Deák (1962) – trilete mark rays widened by "margo", *ca.* 1 μm in width;

– according to Playford, Dettmann (1965) – state "lipped" around trilete mark rays and possibility of secondary structures in transmitted light *e.g.* "triangular areas", "verrucae", used to describe the species, also provide the overall characteristics of morphological features of the genus.

In the species analysis:

– Playford and Dettmann (1965) distinguish between *D. gyratus* and *D. problematicus*; these authors consider wider spaced "muri" more wavy ridges as the distinguishing features of the species;

– de Jersey (1970a, p. 80), and Filatoff (1975, p. 64) taxonomically combine *D. problematicus*, *D. gyratus* and *Cingulatisporites problematicus*;

– Ziaja (2006, p. 27) includes numerous spores of the species *D. problematicus* (*e.g.* those described by Playford, Dettmann, 1965; Mc Kellar, 1974; Achilles, 1981) into the synonymy of the species *Contignisporites problematicus* (Couper) Döoring, which generally suggests combining the genera.

Botanical affiliation. – Morphological features of spores suggest botanical similarity to Schizeaceae (tree ferns, Schizaleaes of primitive sporangia) (Filatoff, 1975).

The following have been distinguished: *D. gyratus* Playford et Dettmann, *D. problematicus* (Couper) Playford et Dettmann; species identified with the presence of exine thickened in the equatorial sector and continued on distal surface, mainly in correlation with illustrative material found in the literature:

– *D. gyratus* Playford et Dettmann distinguished based on comparison with illustrative material Playford et Dettmann (1965, pl. 11: 20–22); the taxon is characterised by spirally arranged "muri"; occurrence: Mroczków (121.0 m);

– *D. problematicus* (Couper) Playford et Dettmann is characterised by proximally smooth exine, or reduced to verrucae, "muri" small, wider and sinusoidal in shape on distal exine; occurrence: Kamień Pomorski IG 1 (480.4, 639.7 m), Gorzów Wielkopolski IG 1 (770.7 m), Gliniany Las 1 (59.8 m).

Genus *Foveosporites* (Foveotriletes) Balme, 1957

Pl. VIII: 1–3

Type species: *Foveosporites canalis* Balme, 1957.

Diagnosis. – Foveo-reticulatae sculpturae.

Description. – Trilete spore, oval to oval-triangular in equatorial outline; convex sides, rounded corners; trilete mark rays straight, equal or nearly equal to the radius of the spora; exine *ca.* 2 μm thick, ornamented on proximal and distal sides by irregularly distributed small depressions variable in diameter (pits – according to Punt – synonym to foveolae), or by short channels formed due to their coalescence, which form "foveolatae" (luminae >1 μm) or "foveoreticulatae" ornamentation.

Dimensions. – 30–40 μm.

Discussion. – Van Erve (1977, p. 56) due to morphological features of the genus differently described in the literature:

– Balme (1957) – "small pits or short channels, irregular in shape";

– Playford (1971) – "vermiculatae exine defined as a depression (fossulatae), or elevation structures in rugulatae spores";

– other authors (see Jansonius, Hills, 1976) – vermiculatae – foveolatae structure of exine, characterised by straight or sinusoidal structures; they consider foveolatae or foveoreticulatae ornamentation as a characteristic feature of the genus and distinguishes the taxon from the other morphologically similar taxa of *Hymenotriletes*, *Microreticulatisporites*, *Cingulisporites* and *Foveotriletes*, which in contrast characterise the following:

- genus *Hymenozonotriletes* Naumova ex Naumova, triangular in outline, membrane zone and exine with coni or spiculae;
- genus *Microreticulatisporites* (Knox) Potonié et Kremp – exine reiculatae with small luminae;
- genus *Cingulatisporites* (Thomson) Potonié with wide "cingulatae" structure;

• genus *Foveotriletes* (van der Hammer) Potonié, triangular in outlines, coalified (coalescent) foveolae and hyaline zone of different shapes;
• thin hyaline zone that, with similar ornamentation, generally differentiates the genus *Foveosporites* from *Foveotriletes* can be considered as a weak element of the structure, which links both these genera (Waksmundzka, 1992), however it needs a more detailed analysis;
• Juhasz (Jansonius, Hills, 1976) distinguishes this taxon from *Ischyosporites* and *Klukisporites* due to lack of distinct foveolatae and foveolatae – reticulatae ornamentation on proximal side in these genera, whereas ornamentation features of distal side are represented by "muri" or "ribs".

Filatoff (1975) combines *F. multifoveolatus* with *Cingulatisporites pseudoalveolatus* (p. 45), Waksmundzka (1992) considers *C. pseudoalveolatus* as a synonym to *F. pseudoalveolatus*, which suggests combining *F. multifoveolatus* with *F. pseudoalveolatus*; SEM photographs of these two species suggest however another type of the zone in the taxa, which permits their species discrimination.

Botanical affiliation. – Knox (1950) suggests morphological similarity of this taxon to spores of the *Lycopodium verticillatum* group; Harris (1955) – to *Loxoma unninghami*, whereas Balme (1955, p. 117) compares it with modern species of *Selaginella dawsoni* (Selaginellales).

The following have been distinguished: *F. mortenensis* de Jersey, *F. multifoveolatus* Filatoff, *F. pseudofoveolatus* (Couper) Waksmundzka; criteria: foveolatae sculpture elements, outline and additional elements of the structure:

– *F. mortenensis* de Jersey (Pl. VIII: 1, 2) is characterised by foveo-reticulatae sculpture ranging from thick (Filatoff, 1975, pl. 2: 8) *ca.* 30 foveolae, through moderate to delicate (Filatoff, 1975, whereas pl. 3: 11–13) *ca.* 100 foveolae; occurrence: Kamień Pomorski IG 1 (91.3, 428.6 m);

– *F. multifoveolatus* Filatoff (Pl. VIII: 3), in addition to delicate sculpture, also distinguishes a characteristic oval outline and a cover "zone"; occurrence: Kamień Pomorski IG 1 (140.3 m), Gorzów Wielkopolski IG 1 (770.4, 788.9, 796.4, 800.7, 970.9 m);

– *F. pseudoalveolatus* (Couper) Waksmundzka has foveolae (1–2 µm in diameter; 1–2 µm spaced), and the structure with a hyaline (glass-like) zone in the equatorial sector; occurrence: Upper Cretaceous Pagórki IG 1 (922.5–927.0, 1010.9–1097.7, 1055.3–1056,3 m), Klosnowo IG 1 (1081.2–1086.0 m).

Genus *Ischyosporites* Balme, 1957

Pl. VIII: 4, 5

Type species: *Ischyosporites crateria* Balme, 1957.

Diagnosis. – Foveo-reticulatae sculpturae on distal side.

Description. – Spore triangular to oval-triangular in equatorial outline; irregular or folded outline; straight or rounded sides; corners often slightly truncated; trilete mark rays extend to 2/3 radius to radius of the spora; leasurae (suture) elevated and widened by lips; exine uniformly thickened around the equator, thicker on corners and usually on distal side; proximal side pyramidal in shape, smooth or sluightly ornamented (granulae, verrucae); exine of distal side and thickenings ornamented by thick "muri" or "ribs", which form a thick, irregular reticulatae, foveolatae, foveo – reticulatae or fossulatae (irregular walls) structure; luminae oval, rounded, polygonal, oval-polygonalne or irregular in shape; ornamentation commonly does not extend to the proximal surface.

Dimensions. – 38–50 µm.

Discussion. – Recognition of the species *Klukisporites variegatus* showing morphological features characteristic of the genus *Ischyosporites* as type species of the genus *Klukisporites* (Couper, 1958) trigerred much discussion on taxonomic combining of these two genera:

– according to Dettmann (1963) and Filatoff (1975), both these taxa were treated as two separate genera;

– according to several authors (Schulz, 1967; Tralau, 1968; Guy-Ohlson, 1971, 1986), due to the Botanical Nomenclature rule, the genus *Klukisporites* should be considered a younger synonym to *Ischyosporites*;

– Dybkjær (1991) notices two distinct morphological differences between these taxa: – regular "foveo-reticulatae" exine with a uniform equatorial thickening without valvae, very irregular "foveo – reticulatae" sculpture with elevated and folded "muri" characteristic of the genus *Klukisporites* and forming "valvate" sculpture, should be the basis for distinguishing two separate genera: *Klukisporites*/ *Ischosporites*.

Botanical affiliation. – According to Guy-Ohlson (1971), based on observation of modern spore material of Schizeaceae-Dicksoniaceae, suggest including the genus *Ischyosporites* into the family Schizeaceae.

The following have been distinguished: *I. marburgensis* de Jersey; criterion: ornamentation on distal side:

– *I. marburgensis* de Jersey (Pl. VIII: 4, 5) is characterised by smooth proximal surface, distal surface foveo-reticulatae, luminae oval to circular (3–5 µm in diameter), commonly connected inside; "muri" 2–4 µm in width, distal surface "extends" to proximal side on apices; occurrence: Kamień Pomorski IG 1 (237.1 m), Gorzów Wielkopolski IG 1 (761.4, 788.9, 796.4 m).

Genus *Klukisporites* Couper, 1958

Pl. VIII: 6, 7

Type species: *Klukisporites variegatus* Couper, 1958.

Diagnosis. – Foveolatae sculpturae, exine convolutae.

Description. – Spore oval-triangular to convex-triangular in equatorial outline; trilete mark rays extend to *ca.* 3/4 radius of the spore; commisurae widened, wider as "margo" (margin); proximal surface thin, smooth to scabratae (granular, irregular grains ≤1 µm in size); distal surface convex, exine dense,

"convolute" (extends to proximal side), foveolatae sculpture (luminae >1 μm in size); foveolatae sculpture composed of small flatenned luminae and flattened walls.

Dimensions. – 45–110 μm.

Discussion. – Pocock emended the genus including "convolute" ornamentation (extended, covering); generally according to descriptions, the range of sculpture variability is wide.

The following have been distinguished: *K. neovariegatus* Filatoff, *K. variegatus* Couper; criteria: size, density of exine and density of ornamentation elements:

– *K. neovariegatus* Filatoff are typically larger in size (45–110 μm); exine is dense, which favours rather the formation of foveolatae than reticulatae sculpture on distal side; width of luminae is 3–5 μm, slightly less than the width of "muri" (5 μm); occurrence: Gorzów Wielkoplski IG 1 (817.4);

– *K. variegatus* Couper (Pl. VIII: 6, 7), 32–51 μm in size, proximal exine ornamented by warts (verrucae), 1–3 μm in width; distal sculpture with irregular "foveo-reticulatae" elements of steep walls (5 μm in width) and suboval to irregular luminae (2–4 μm in diameter); occurrence: Gorzów Wielkopolski IG 1 (770.4, 788.9, 796.4, 809.7 m).

Genus *Neoraistrickia* Potonié, 1960

Pl. IX: 1

Type species: *Neoraistrickia truncata* (Cookson, 1953) Potonié, 1960 (*Trilites truncatus* Cookson, 1953).

Diagnosis. – Baculae flat on distal side.

Description. – Trilete spore, oval-triangular in equatorial outline; trilete mark rays straight, equal to the radius of the spora; exine ornamented by flat baculae; baculae often wider on apices, but thinner than in the genus *Raistrickia*.

Dimensions. – 31–55 μm.

Discussion. – *Raistrickia* often shows distinctly conical ornamentation elements located between baculae, commonly forming an oval amb:

– Bharadway and Kumar suggest changing the diagnosis based on reinterpretation of photographs and illustrations of previous materials; "Triradiate spore, oval-triangular in outline; trilete mark rays extend to the corners; exine dystally ornamented by 'baculae', but proximally smooth";

Botanical affiliation. – According to Tralau (1968) – morphological similarity often allows including the genus *Neoraistrickia* into the family Lycopodiaceae.

The following have been distinguished: *N. gristhorpensis* (Couper) Tralau, *N. truncata* (Cookson) Potonié; – criterion: the size of ornamentation elements:

– *N. gristhorpensis* (Couper) Tralau with ornamentation represented by baculae on proximal side; baculae 3–8 μm in width on apices; 2.0–4.5 μm in height and 2.0–3.5 μm in diameter; dimensions: 30–41 μm; occurrence: Gliniany Las 1 (55.2 m);

– *N. truncata* (Cookson) Potonié (Pl. IX: 1) (Upper Triassic/ Jurassic) with exine ornamented at the margin of proximal sideand with "strongly" flattened baculae on distal side, 2–4 μm in height and 1–2 μm in width, separated from each other or locally joined at the base; in the central part of proximal side, baculae are reduced or absent; dimensions: 28–35 μm; occurrence: Kamień Pomorski IG 1 (445.3 m).

Genus *Semiretisporis* Reinhardt, 1962

Pl. IX: 2

Type species: *Semiretisporis gothae* Reinhardt, 1962.

Diagnosis. – Flange; flange and distal side ornamented by reticulum.

Description. – Triradiate spore, triangular to subtriangular in equatorial outline; convex sides, corners oval or sharpened; trilete mark rays subtle, exine bi-layered; dark brown, relatively thick endexine forms the central part; thin and subtle ectexine covers the central part of the spore surface and forms "flange" in equatorial sector (according to the definition – equatorial stretching of the spore without accurate determination *e.g.* "copsula", "patina", "corona", "zona"); proximal side of the central area ornamented by "feign granulat"; distal side and flange ornamented by a distinct network of ectexine; luminae of the reticulum large, multiangular in shape; walls high.

Dimensions. – 65–110 μm.

Discussion. – Considerable variability in morphological features of the species *S. gothae* (Orłowska-Zwolińska, 1966, pl. III: 17; pl. IV: 22; Schulz, 1967, pl. X: 1, 2) and combining of *S. gothae* Reinhardt (Orłowska-Zwolińska, 1966, pl. 3: 17, 18) with *S. maljavkina* (Morbey, 1975, pl. 5: 6, 7; Lund, 1977) due to the only feature that discriminates these taxa – dimensions (large size of *S. maljavkinae* 130×166 μm) is due to less detailed morphological features of the taxon, which reduces its significance for palynostratigraphic studies; Dybkjær (1991) and Achilles (1981) do not give any description of the taxon.

Botanical affiliation. – Schulz (1967) suggests comparison of this genus with *Bryophyta*.

The following have been distinguished: *S. gothae* Reinhardt, based on the outline of "flage" and shape of luminae:

– *S. gothae* Reinhardt (Pl. IX: 2) is characterised by reticulatae structure of distal side continued on "flage"; luminae of reticulum large and multiangular; occurrence: Kamień Pomorski IG 1 (676.8, 677.6 m).

Genus *Staplinisporites* Pocock, 1962

Pl. IX: 3–5

Type species: *Staplinisporites caminus* (Balme, 1957) Pocock, 1962.

Diagnosis. – Thickened polar area; thickenings of exine on distal side are concentric to the outline.

Description. – Triradiate spore, convex-subtriangular to oval in equatorial outline; convex sides, corners rounded-peaked; trilete mark rays clearly equal to the radius of the spora; leasurae single or surrounded by labra; thin exine on proximal side, granulose, a thickening in the central part of distal side – "polar area"; farther in the distal side, exine is ornamented by radiate thickenings concentric to the outline of the spore (ornamentation elements – "bands").

Dimensions. – 40–42 µm.

Discussion. – This taxon is typical of Lower Jurassic deposits, in the analysed material, it abundantly occurs in Lower Cretaceous deposits.

Botanical affiliation. – Dettmann (1963) suggests morphological similarity of the taxon to modern Bryophyta, namely to *Encolypta cilista* Hear; according to Singh (1964), the spores belong to Filicales – *incertae sedis*.

The following have been distinguished: *S. caminus* (Balme) Pocock; criterion: the shape of exine thickenings:

– *S. caminus* (Balme) Pocock (Pl. IX: 3, 4) is characterised by distinctly thickened distal area, concentric to the spore outline, and radial lines of exine thickenings of distal side; occurrence: Pagórki IG 1 (1010.9–1077.7, 1047.8–1051.7, 1051.7–1052.7, 1059.0–1062.8, 1143.4–1150.0, 1150.6–1155.0, 1165.5–1167.0, 1189.7–1196.4 m), Klosnowo IG 1 (1081.2–1086.0 m), Oświno IG 1 (1294.5–1301.2, 1301.2–1304.0, 1313.2–1320.0, 1336.2–1340.2 m).

Genus *Tigrisporites* (Klaus, 1960) van Erve, 1977

Pl. X: 1

Type species: *Tigrisporites halleinis* Klaus, 1960.

Diagnosis. – Rugulae on distal side and a thickening of exine on distal area.

Description. – Spore triangular in equatorial outline, corners distinctly oval to flattened; trilete mark rays narrow, without ridges or labra, equal to the radius of the spora; straight or sinusoidal on the polar area; proximal side smooth or very slightly ornamented by faint or distinct rugulae; distal side with a smooth, granulatae or punctatae polar thickening; the remaining part of distal area ornamented by short and winding rugulae, ornamentation elements are radially arranged.

Dimensions. – 48–60 µm.

Discussion. – Different descriptions of proximal surface are presented in the analysed literature:

– smooth or slightly ornamented (Klaus, 1960; Singh, 1971);

– smooth, slightly "rugulatae" or distinctly "rugulatae" (van Erve, 1977); despite the given description, the basis for comb. nov. is its "rugulatae" sculpture and description of distal side apart from a disc-like polar thickening in the central part;

– short sinusoidal "rugae", often radialny oriented, starting at the equator causing mainly a dentate or "serrate" equatorial outline (Klaus, 1960);

– short, distinct and folded with "rugulae", variably distinct "reticulatae" sculpture or "verrucae" (Singh, 1971);

– rugulae (van Erve, 1977).

It may be due to morphological variability resulting from overlapping of the images of proximal and distal sides in transmitted light. A thickening of exine on distal side and "rugulatae" sculpture on the remaining area was previosly considered the main indicator for this genus; this genus differs from the genus *Staplinisporites* Pocock by the lack of a oval-polar ridge and the presence of only radially arranged rugulae.

Botanical affiliation. – Pteridophyta – *incertae sedis* (according to Singh, 1964).

The following have been distinguished: *T. microrugulatus* Schulz, *T. scurrandus* Norris, based on variable sizes of ornamentation elements:

– *T. microrugulatus* Schulz are characterised by larger ornamentation elements;

– *T. scurrandus* Norris (Pl. X: 1) is characterised by small, radially arranged *rugulae* on proximal surface; distal surface with a polar thickening formed by rugulae, which also cover the remaining surface; occurrence: Kamień Pomorski IG 1 (434.1; 439.1, 445.3, 453.3, 492.2, 494.5 m), Gorzów Wielkopolski IG 1 (987.5 m), Gliniany Las 1 (77.4, 80.8 m).

Infraturma: **Tricrassati**

Characteristic features: interradial crassitudae with equatorial extension thickening (corona).

Genus *Clavifera* Bolkhovitina, 1966

Pl. X: 2–5

Type species: *Clavifera triplex* Bolkhovitina, 1953.

Diagnosis. – Thickening of exine in interradial and radial-equatorial sector and in the central part of distal side.

Description. – Triradiate spore, oval-triangular in equatorial outline, straight sides, sometimes variable in shape, corners covered by a thickening; trilete mark rays straight, equal to the radius of the spora; exine of proximal and distal sides smooth; in the interradial-equatorial sector of proximal surface there is a thickening of exine (interradial crassitudae) along the walls of the spore, variable in width and shape; a thickening from a straight or wavy external line narrows towards corners and, in the radial – apical sector, it acquires an oval shape (gemma), variable in diameter; the thickening does not continue on distal side; additional thickenings of exine, triradial or triangular in shape, are visible on distal side between corners of the spore; additional folds, wart-shaped according to Bolkhovitina (1968, p. 46), occur on the surface of thickenings on distal side.

Dimensions. – 37–54 µm.

Discussion. – This genus is distinguished from the genus *Gleicheniidites* by the presence of thickenings in apical-equa-

torial sectors of proximal surface; it is distinguished from the genus *Ornamnetifera* by a smooth surface of exine on proximal and distal sides and the presence of thickenings along equatorial outline of the spore; Dettmann (1963), Burger (1966), Hedlund and Norris (1968), Kemp (1970), and Singh (1971) do not provide any description of the taxon; Playford, 1971 claims that the taxon differs from the genera *Gleicheniidites*, *Ornamnetifera* and *Plicifera* – morphologically similar – by the presence of "bulbous" or "clavate" projections in radial-apical sectors; Juhász (1977) believes that the described morphological form includes "triangular Gleicheniidites forms", which have "interradial crassitudae" and "distal crassitudae": SEM photographs (this report) more thoroughly explain the shape of distal surface and show indistinct morphological features of the genus.

Botanical affiliation. – Bolkhovitina (1968), Juhász (1977) family Gleicheniaceae.

The following have been distinguished: *Clavifera jachromiensis* Bolkhovitina, *C. rudis* Bolkhovitina (*C. tuberosa*), *C. triplex* (Bolkhovitina) Bolkhovitina; criteria: the width and outline of thickenings of exine in the equatorial sector of proximal side and the shape of thickenings on distal side:

– *C. jachromiensis* Bolkhovitina (Pl. X: 2) is characterised by a thickening in the interradial-equatorial sector of proximal surface ≤4 μm, which continues in the form of an oval thickening on corners; a thickening of the central part of distal surface is pyramidal-triangular in shape; occurrence: Pagórki IG 1 (1010.9–1097.7, 1029.9–1034.4 m), Klosnowo IG 1 (1062.2–1086.0 m), Oświno IG 1 (1301.2–1307.0, 1294.5–1301.2 m);

– *C. rudis* Bolkhovitina is characterised by a thickening in the interradial-equatorial sector of proximal side, 7–9 μm in width; central part of distal surface ornamented by verrucae – verrucae distributed sparsely, larger, irregular, high or wide (Juhász, 1977, pl. II: 17, 18);

– *C. triplex* Bolkhovitina – a trapezoidal thickening in the interradial-equatorial sector, which continues in the form of an oval thickening on corners; a thickening of the central part of distal side is pyramidal-triangular in shape; occurrence: Pagórki IG 1 (1029.9–1034.0, 1047.9–1051.7, 1055.3–1056.3, 1072.3–1079.4, 1127.1–1128.5 m), Klosnowo IG 1 (1081.2–1086.0 m).

Genus *Gleicheniidites* Ross, 1949 ex Delcourt et Sprumont, 1955 emend: Bolkhovitina, 1968

Pl. X: 6; Pl. XI: 1–4, 6

Type species: *Gleicheniidites senonicus* Ross, 1949, p. 30, pl. 1: 3.

Diagnosis. – Thickenings of exine in interradial sectors of equatorial area in the central part of distal side.

Description. – Triradial spore, subtriangular in equatorial outline; straight to slightly convex sides, rounded corners; trilete mark rays straight, equal in length to the radius of the spora; exine of proximal and distal sides smooth; "interradial crassitudae", developed as variably distinct thickenings of exine, variable in width and shape, are visible in the interradial-equatorial sector of proximal surface along the walls of the spore; thickenings do not continue on distal surface; on distal side between corners of the spore, additional thickenings of exine are visible, triangular–trilete (Y) in shape; smooth exine of the thickened side.

Dimensions. – 35–50 μm.

Discussion. – A variable set of synonymy of the genus, thoroughly discussed by Skarby (1964, p. 61) partly supplemented by:

– Tralau (1968, p. 38)

1949 *Gleicheniidites* Ross p. 31 (Jurassic – Scania).
1953 *Gleichenia* Cookson p. 464.
1955 *Gleicheniidites* Delcourt et Sprumont p. 26.
1959 *Gleicheniidites* Delcourt et Sprumont p. 34.
1961 *Gleichenia* Samoilovitsch *et al*., p. 44.
1964 *Gleicheniidites* Skarby p. 59.

– Dettmann (1963, p. 64)

1949 *Gleicheniidites* Ross (Mesozoic – Australia).
1955 *Gleicheniidites* Ross ex Delcourt et Sprumont p. 26.
1957 *Triremisporites* Delcourt et Sprumont p. 61.
1959 *Gleicheniidites* Ross Delcourt et Sprumont p. 33.
1961 *Gleichenia* Smith: Grigorieva *in*: Samoilovitch *et al*., p. 44.
1961 non *Gleicheniidites* Grigorieva *in*: Samoilovitch *et al*., p. 59.
non Ross ex Delcourt et Sprumont.

– Pocock (1970, p. 31) (Jurassic – Canada)

1949 *Gleicheniidites senonicus* Ross.
1952 *Concavisporites* Pflug.
1955 *Gleicheniidites* (Ros) Delcourt et Sprumont.
1960 *Paraconcavisporites* Klaus.
1963 *Gleicheniidisporites* Bricke: Danze-Corsin et Laveine p. 70.

– poorly detailed morphological description *e.g.* Bolkhovitina (1968) "walls of the spore more distant or closer to the equator, developed as a more or less prominent thickening on corners"; a thickening on distal side is described by that author with genus description assuming the description of Grigorievoj to be incorrect; – diversified Delcourt, Sprumont (1959); Dettmann (1963); Skarby (1964) – see the catalogue, it results from poorly decipherable morphological features of the taxon in transmitted light; SEM photographs thoroughly illustrate morphological features of the species and confirm the secondary variability of morphological features caused by the blurred image of transmitted light; it suggests to assume that the typical features of the taxon are thickenings on distal side and the specific shape of thickenings on the walls of the spore in the interradial sectors;

– the numerous species of the taxon found in the literature are as follows:

• Bolkhovitina (1968, p. 37) – after revision 1953, 1959 and Voronova (1984):

Gleicheniidites circinidites (Cookson) Dettmann and Voronova,
G compositus (Bolkhovitina) Deák,
G. delcourti Döring,
G. elegans Nagy,
G. latifolius Döring,

G. laetus (Bolkhovitina) Bolkhovitina,
G. microstellatus Nagy,
G. minor Döring,
G radiatus Bolkhovitina,
G. rara (Chlonova) Voronova,
G. rasilis (Bolkhovitina) Bolkhovitina – Voronova,
G. senonicus Ross – Voronova,
G. sp. aff *toriconcavus* Krutzsch; *G. toriconcavus* Krutzsch – Voronova,
G. umbonatus (Bolkhovitina) Bolkhovitina;

- Pocock (1970) (Jurassic Canada):
  Gleicheniidites delicatus (Bolkhovitina) Pocock:
  G. granulatus Grigorieva (*Gleichenia granulata* Bolkhovitina),
  G. nilssonii Pocock,
  G rousei Pocock,
  G. umbonatus (Bolkhovitina) Pocock (*Gleichenia umbonata* Bolkhovitina);
- Paden, Felix (1971, p. 307) – *Gleicheniidites confossus* Hedlund;
- Norvick, Burger (1975) – *G.* cf. *trijugatus* (Price) Norris et Burger (synonym: *Cingutriletes trijugatus*);
- Scott (1976) – *G. circinidites* (Cookson) Dettmann;
- Juhász (1977, p. 10) – *G. saparicus* Juhász;

specimens emphasize the palynostratigraphic significance of the genus for Lower Cretaceous deposits; however, low variability of morphological features requires comparison of the diagnosis with illustrative material and synonymy of individual taxa to perform detailed taxonomic analyses of the species.

Comparison. – This genus differs from the following genera: *Clavifera* by the lack of thickenings of the spore wall in the apical-equatorial sector of proximal surface; – *Ornamentifera* by a smooth surface of proximal and distal sides.

Botanical affiliation. – Family Gleicheniaceae (Bolkhovitina, 1968); Krasilov (1969) does not illustrate the taxon, but includes it into the families Cyathaceae or Gleicheniaceae of the recent world; Juhász (1977) accepts the taxa of the genus due to their characteristic morphological features: triangular outline, equatorial interradial thickening, "arcuate folds" on distal surface, usually smooth or ornamented exosporium – as fossil spores of "Gleicheniid".

The following have been distinguished: *G. carinatus* (Bolkhovitina) Bolkhovitina, *G. rasilis* (Bolkhovitina) Bolkhovitina, *G. senonicus* Ross as previously proposed (Waksmundzka, 1992); criteria: variability of thickenings in the interradial-equatorial sectors of proximal surface and variability in the shape of distal surface:

– *G. carinatus* (Bolkhovitina) Bolkhovitina is characterised by a trapezoidal thickening in the interradial-equatorial sector of proximal surface, 5–7 µm in height, and equatorially – triangular with concave sides of a thickening on distal side; oval-triangular outline; occurrence: Pagórki IG 1 (947.1–1002.2, 1025.6–1029.6, 1029.9–1034.0, 1055.3–1056.3, 1059.8–1062.8, 1123.4–1127.1, 1147.4–1150.5, 1164.8–1166.6 m), Klosnowo IG 1 (1081.2–1086.0, 1093.4 m), Oświno IG 1 (1289.5–1294.5, 1294.5–1301.2, 1307.0–1313.2, 1313.2–1320.0, 1320.0–1326.4, 1326.4–1330.4, 1336.2–1340.2, 1344.3–1349.2, 1349.2–1361.0, 1361.5– 1366.5 m);

– *G. rasilis* (Bolkhovitina) Bolkhovitina (Pl. XI: 6) is characterised by lens-shaped thickenings, 6–10 µm in width, with convex sides in the interradial-equatorial sector of proximal surface, and a variably outlined, Y-shaped thickening, *ca.* 7 µm in width, on distal side; occurrence: Pagórki IG 1: (941.6–947.1, 1020.3–1029.6, 1025.6–1029.9, 1029.9–1034.0, 1047.9–1051.7, 1183.7–1184.4 m);

– *G. senonicus* Ross (Pl. XI: 1–4) is characterised by trapezoidal thickening, 6–10 µm in width, in the interradial sector of proximal surface and an equatorially-triangular thickening of clearly concave sides of distal side; occurrence: Pagórki IG 1 (922.5–927.9, 941.6–947.1, 1010.9–1097.7, 1029.3–1034.0, 1041.9–1049.7, 1049.7–1051.7, 1051.7–1052.7, 1055.3–1056.3, 1059.8–1062.8, 1072.3–1079.3, 1090.2–1097.7, 1123.4–1127.1, 1127.1–1128.5, 1130.5–1137.6, 1143.4–1150.5, 1150.6–1155.0, 1164.8–1167.0, 1183.7–1184.1, 1189.7–1196.4 m), Oświno IG 1 (1289.5–1294.5, 1294.5–1301.2, 1301.2–1307.0, 1307.0–1313.2, 1313.2–1320.0, 1320.0–1326.4, 1326.4–1330.0, 1336.2–1340.2, 1344.3–1349.2, 1349.2–1361.0, 1361.5–1366.5 m), Klosnowo IG 1 (1057.5, 1062.6, 1081.2–1086,0, 1090.5, 1093.4 m).

In correlation with illustrative material, the following species have been additionally established: *G. delicatus* (Bolkhovitina) Pocock (Pocock, 1970, pl. 5: 13); *G. radiatus* (Bolkhovitina) Bolkhovitina (Bolkhovitina, 1968, pl. 11: 8–10); *G. umbonatus* (Bolkhovitina) Schulz (Bolkhovitina, 1968, pl. 9: 1–9); due to different descriptions of individual taxa in the literature, taxonomic analysis of these species needs further investigations.

Genus *Ornamentifera* Bolkhovitina, 1966

Pl. XI: 5

Type species: *Ornamentifera echinata* (Bolkhovitina, 1953) Bolkhovitina, 1968.

Diagnosis. – Thickenings of exine in the interradial sectors of equatorial area and on distal side; additional ornamentation.

Description. – Triradiate spore, triangular-oval in equatorial outline; slightly convex sides, corners oval; trilete mark rays straight, equal in length to the radius of the spora; exine of proximal and distal sides variably ornamented; according to Juhász (1977), exoexine: granulatae (small oval ornamentation elements, ≤l µm in diameter); tuberculatae (tube-shaped ornamentation elements); tuberculatae, verrucatae or echinatae (spines longer than 1 µm); in the interradial-equatorial sector of proximal surface, there ia a natural thickening of exine along the spore wall, which sometimes continues in the radial sector (*O. peregrina*), or a secondary thickening caused by a deflection of the extreme interradial distal surface on proximal surface.

Dimensions. – 36–40 µm.

Discussion. – Few authors have described the genus in the literature:

– Bolkhovitina (1968, p. 49) characterises the genus as a triangular-oval spore with an equatorial thickening and "arcuate" folds on distal side, or with a "prickly" sculpture; that author distinguished the following species: *O. echinata* (Bolkhovitina) Bolkhovitina; *O. granulata* (Grigorieva) Bolkhovitina; *O. tuberculata* (Grigorieva) Bolkhovitina; *O. peregrina* (Bolkhovitina) Bolkhovitina; *O. marginata* (Takahaski) Bolkhovitina and provides their characteristics, as follows:

- *O. echinata* (Bolkhovitina) Bolkhovitina distal side convex, proximal side denser and pyramidal, a thickening of exine between the ends of trilete mark rays along the equator; proximal side smooth, distal side ornamented by sparsely distributed short "hills", with sharp or blunt endings;
- *O. granulata* (Grigorieva) Bolkhovitina – proximal and distal sides with slightly convex or straight walls along the equator, exine ornamented by granulae uniformly and densely distributed; they extend beyond the equatorial outline of exine;
- *O. tuberculata* (Grigorieva) Bolkhovitina – proximal side flattened and pyramidal, distal side domal-shaped; thin equatorial thickening of exine, finely hilly on distal side; smooth on proximal side;
- *O. peregrina* (Bolkhovitina) Bolkhovitina – proximal side pyramidal and denser flat; distal side oval and three-part; equatorial thickening is 2.0–3.2 µm in width; exine sparsely covered with irregularly distributed flat or convex warts;
- *O. marginata* (Takahaski) Bolkhovitina – finely granular exine;

– Juhász (1977, p. 11) suggests to include the taxon into Gleichenoids group due to the presence of "interradial crassitudae" and a "distal fold", which suggests the relationship of the taxon with the family Gleicheniaceae, that author distinguished the following species: *O. granulate* (Grigorieva) Bolkhovitina, *O. peregrina* (Bolkhovitina) Bolkhovitina; *O. tuberculata* (Grigorieva) Bolkhovitina; according to Juhász, exoexine with the granulatae, tuberculatae, verrucatae and echinatae sculpture;

– Voronova (1984, p. 69) distinguished: *O. echinata* (Bolkhovitina) Bolkhovitina, *O. balsamensis*, *O. solebrose*, *O. tuberculata*, *O. peregrina*; according to that author, *e.g. O. echinata* is characterised by:

- *O. echinata* (Bolkhovitina) Bolkhovitina – triradiate spore, equatorial in outline with slightly convex sides and oval corners; piramidally thickened proximal surface, distal side convex and extend to the equator beyond the sectors of proximal part; the structure of exine is "echinatae"; trilete mark rays straight, equal in length to the radius of the spore; thin sculpture.

The descriptions of individual taxa (ornamentation elements of "echinatae" type) are poorly detailed and the descriptions should be correlated with illustrative material, after taxonomic analysis, to make a reliable establishment of the species.

Botanical affiliation. – Family: Gleicheniaceae (Juhász, 1977).

The following have been distinguished: *O.* cf. *echinata*; *O. peregrina* (Bolkhovitina) Bolkhovitina; criteria: ornamentation features and the shape of proximal and distal surfaces:

– *O.* cf. *echinata* (Bolkhovitina) Bolkhovitina (Pl. XI: 5) is characterised by ornamentation elements of "spines" type, *ca.* 1 µm in size; the specimen not determined to the species level because ornamentation elements may be corroded (in SEM); occurrence: no definated;

– *O. peregrina* (Bolkhovitina) Bolkhovitina is characterised by pyramidal and thickened proximal surface; ornamentation elements of flat verrucae, 0.8 µm in height, or convex – 1.4 µm; distal surface convex; occurrence: Pagórki IG 1 (1127.1–1128.5 m), Klosnowo IG 1 (1090.5 m), Oświno IG 1 (1326.4–1330.4 m).

Genus *Striatella* Mädler, 1964

Pl. XII: 1–3

Type species: *Striatella seebergensis* Mädler, 1964.

Diagnosis. – Muri (parallel to the inner margin of the spore); cingulum.

Description. – Spore subtriangular to oval-triangular in equatorial outline; corners convex, singular trilete mark rays are distinct, locally widened by low lips, and extend to the inner margin of cingulum; cingulum flat, formed around the equator; in interradial sectors, proximal surface ornamented by single muri arranged tangentially and parallel to the inner margin of cingulum; proximally, in contact areas exine is smooth or occasionally ornamented by single "verrucae", distal muri variable, distal-equatorial muri parallel ("parallels") and partly overlap onto cingulum; in the central part of distal side, muri bifurcated and crossed or discontinuous to form single verrucae.

Dimensions. – 50–55 µm (dimensions of type species, no dimensions in the description of the genus).

Comparison. – Morphologically similar, due to ornamentation elements, the genus *Contignisporites* is characterised by variably arranged dystal-equatorial muri and cingulum formed as a result of coalescing muri, whereas the genus *Duplexisporites* is characterised by a thickening of "patella".

Discussion. – Variously presented diagnosis of the main characteristic features of the genus:

– Mädler (1964) – "muri tangential to cingulum rather than to trilete mark";

– Filatoff, Price (1988) – "proximal muri arranged tangential to each interradial surface and parallel to the inner margin of cingulum, muri distally variable in parts".

Due to the lack of description of this taxon in many papers, the diagnosis of the taxon is poorly reliable, which reduces its biostratigraphic significance (like in the case of *Contignisporites* Dettmann and *Duplexisporites* Deák of similar morphological features).

The taxon has been variably placed: Norris (1969) includes it into Infraturma Tricrassati, which is characterised by an interradial thickening, while Dybkjær (1991) – into Infraturma

Cingulati, which is characterised by an equatorial thickening; I suggest to consider the thickenings in the interradial sector as a feature characteristic of the genus and I include it into Infraturma Tricrassati.

In the analysed material, *S. jurassica* Mädler is distinguished due to the lack of detailed species diagnosis, in correlation with general diagnosis and illustrative material in the literature;

– *S. jurassica* Mädler (Pl. XII: 1–3) compared with illustrative material of Dybkjær (1991, pl. 10); the cited work does not contain a description of this spores, the remaining papers by de Jersey (1972), Achilles (1981), Dybkjær (1988), provide neither descriptions nor illustrative material of the taxon; generally, the species is characterised by walls on proximal surface, which protrude from corners, perpendicular to the opposite walls; occurrence: Kamień Pomorski IG 1 (252.5, 488.4 m), Gorzów Wielkopolski IG 1 (746.4, 761.4, 770.4, 788.9, 800.7, 804.4, 806.3 m).

Genus *Zebrasporites* Klaus, 1960

Pl. XII: 4

Type species: *Zebrasporites kahleri* Klaus, 1960.

Diagnosis. – A zone along the spore walls; radiate folds on distal surface.

Description. – Spore triangular in equatorial outline, corners oval or flattened; trilete mark rays straight, nearly equal in length to the radius of the spore, occasionally with labra or ridges; contact surfaces clearly outlined and well developed, commonly concave, occasionally flat to slightly concave; exine widened or folded into a zone similar in structure along muri of the spore; single contact surfaces and the zone form in connection with distal side three labrum-shaped ("lobe"-shaped – lower part of the equator) interradially arranged structures characteristic of the equator; exoexine of proximal side smooth or with a subtle sculpture; distal surface smooth or with radial folds of exine ("plicate" – folds of exine *e.g.* "taeniae" etc.), which extend to the margin of the spore.

Dimensions. – 28–75 µm.

Discussion. – Taxon differently classified in the artificial systematics; according to Pedersen, Lund (1980) the specimen belongs to Infraturma Zonotriletes, while according to Dettmann (1963) – to Infraturma Tricrassati; due to interradially arranged characteristic "labrum-shaped" structures, the author of this report includes the specimen into Tricrassati, which are characterised by "interradial crassitudae" or "corona" (larger equatorial widening of exine);

Analysed literature contains inaccurate description of the interradial morphological structure:

– according to Schulz (1967), the structure widens, or is "folden out";

– according to Klaus (1960), proximal surface is smooth or with a subtle sculpture, distal surface with radial ridges around the central part, distal surface with "rugae", slightly sinusoidal in shape, "rugae" join to form more or less regular "reticulum"; that author provides no comment on the secondary structure;

– Dybkjær (1988), Achilles (1981), Filatoff (1975), Lund (1977), Morbey (1975), Pedersen and Lund (1980), Ziaja (2006) – these authors provide no description of the taxon, but only a comment on the identified species.

It suggests distinguishing of the taxon based on its characteristic morphological features, which are generally difficult for interpretation;

– genus *Diatamozonotriletes* (Naumova) Playford (deposits Carboniferous), described in the literature, generally morphologically similar, is characterised by a protruding zone zona ("corona"), which is composed of numerous, well-developed "fimbria" (long fringe-like capillae) radially arranged around equatorial margin of central body; sometimes similar to the species *Camarozonosporites rudis* (*e.g.* according to Dybkjær, 1991, pl. 8: 4) it is generalny characterised by a thickening of exine on distal surface along the equator in radial sectors, which forms a profile of convex sides, characteristic of the spores of the genus; *R. rudis* is characterised also by murornatae exine – generally convex elements separated by colpus.

Botanical affiliation. – According to Schulz (1967) *Z. interscriptus* (Thiergart) Klaus – Cyathaceae, *Z. laevigatus* Schulz – Hemitelia; Barron *et al*. (2006) does not provide the affiliation.

The following have been distinguished: *Z. interscriptus* (Thiergart) Klaus, *Z. laevigatus* (Thiergart) Klaus; criteria: generally interradially arranged "labra-shaped" structures and additionally on ornamentation features:

– *Z. interscriptus* (Thiergart) Klaus (Pl. XII: 4) is characterised by radially arranged ("plicate") thickenings of exine; occurrence: Kamień Pomorski IG 1 (300.2, 409.0, 422.1, 426.6, 434.1, 445.3, 475.4, 478.3, 488.9, 499.2, 503.7, 637.7, 639.7, 642.1, 650.3, 676.0 m), Gorzów Wielkopolski IG 1 (987.5, 1003.4, 1048.4, 1055.5, 1070.7 m), Mroczków (79.5, 116.4, 121.1 m), Gliniany Las 1 (55.2, 59.8, 64.4, 70.0, 80.8 m);

– *Z. laevigatus* (Thiergart) Klaus – smooth exine; occurrence: Kamień Pomorski IG 1 (400.2, 407.0 m).

Infraturma: **Cingulati**

Characteristic features with continuous cingulum more or less membraneous extension zona of combination of this "cingulum".

Genus *Cingulizonates* Dybova et Jachowicz, 1957

Pl. XII: 5, 6; Pl. XIII: 1–4

Type species: *Cingulizonates tuberosus* Dybova et Jachowicz, 1957.

Diagnosis. – Cingulum narrowing to form a zone of cingulizona.

Description. – Trilete spore, oval-triangular in equatorial outline; distinct central body in the central part (intexine, "central body"), oval-triangular and proximally smooth, slight-

ly granulatae, distally granulosae or verrucosae; around the central part of proximal and distal sides there is cingulum narrowing to form a cinguli zone; cingulum 5–10 µm in width, ornamented on proximal and distal sides by negative reticulum of oval and polygonal inner luminae forming a vacuolatae structure; cingulum narrows by and irregular narrowing, or passes into a translucent, wave-ended zone, 5–18 µm in width; occasionally slightly ornamented.

Dimensions. – 50–60 µm.

Discussion. – The outline of cingulum (on distal side of central body), due to considerable thickness of the cingulum when the proximal side and distal side overlap each other in transmitted light, illustrates secondary ornamentation considered by some authors to represent zone that extend into cingulum; as the result, there are different illustrations of morphological features of the taxon in the literature (Achilles, 1981, pl. 9: 6; Schulz, 1967, pl. 13: 6, 7; Dybkjær, 1991, pl. 9: 2);

– variability of morphological features of the genus, observed in transmitted light, sometimes corresponds with the variability in other taxa *e.g. Densoisporites*, and therefore: – Schulz (1967, p. 582) suggests combining the genera *Cingulizonates* and *Densoisporites*; Pocock (1970, p. 64) claims that *Cingulizonates* is a synonym to *Densosporites*; however Mädler (1964) thinks that *Densosporites* cannot occur later than in Upper Carboniferous deposits and proposes the name of *Cingulizonates* for morphologically similar specimens from younger deposits; Lund (1977) discriminates *Cingulizonates* Dybova et Jachowicz from *Densosporites* due to the presence of a zone and cingulum in *Cingulizonates* specimens.

Botanical affiliation. – According to Schulz (1967), Achilles (1981) – unknown; Lepidodendrales – *incertae sedis* (Potonié, 1970); *Lepidophyta* (Dybova, Jachowicz, 1957) but only two species out of four, 2 unknown.

The following have been distinguished: *C. delicatus* Orłowska-Zwolińska, *C. marginatus* (Mädler) Lund; *C. rhaeticus* (Reinhardt) Schulz based on variability in ornamentation of "cingulizona":

– *C. delicatus* Orłowska-Zwolińska (Orłowska-Zwolińska, 1966, pl. 7: 37) with granulate ornamentation of the central part and fibrous ornamentation of cingulum; occurrence: Mroczków (75.0 m); according to MW: this specimen can be considered morphologically corroded *C. rhaeticus*;

– *C. marginatus* (Mädler) Lund based on illustrative material (according to Lund, 1977, pl. 4: 1); Lund combines this species with the species Densosporites cingulatus Schulz; occurrence: Kamień Pomorski IG 1 (267.9, 414.0 m), Gorzów Wielkopolski IG 1 (270.9 m);

– *C. rhaeticus* (Reinhardt) Schulz (Pl. XII: 5, 6; Pl. XIII: 1–4), which is characterised by "cingulizona" with ornamentation elements of "grooves" and verrucae, and with distinct, smooth or ornamented granulae of irregular shape proximal side of the central body; this stratigraphically significant species occurs in Middle and Upper Rhaetian deposits, occasionally in the Lower Jurassic; occurrence: Kamień Pomorski IG 1 (93.1, 140.3, 642.1 m), Gorzów Wielkopolski IG 1 (788.9, 941.5, 957.6, 1070.7 m), Mroczków (43.3, 85.0 m), Gliniany Las 1 (55.2, 64.4 m).

Genus Densoisporites (Weyland et Krieger, 1953) Bharadway et Kumar, 1972

Pl. XIV: 1, 2

Type species: *Densoisporites velatus* Weyland et Krieger (1953, p. 12, pl. 4: 13, 14).

Diagnosis. – Cingulizona along the equatorial sector.

Description. – Triradiate spore, oval – triangular to oval in equatorial outline; slightly convex sides, rounded corners, locally pointed; trilete mark rays thin, slightly wavy, extend to 1/2–3/4 of the central part of the spore; wall of the spore divided, two-layered (according to Dettmann, 1963); outer layer – "perina" ("scolptina" according to Couper, 1958; Krasilov, 1981) – dystally, loosely covers the inner surface, and proximally adjoins the inner contact surfaces, occasionally forms infrequent folds; "scolptina – perina" equatorially thickened (thickening of the margin) with a subtle and variable granulosae, scabratae, reticulatae and rugulosae structure; the structure is formed by a pattern of structural – inner elements (*e.g.* according to Norris – cingulum reticulatae), the remaining surface of the spore is covered by grana or rugulae.

Dimensions. – 45–70 µm.

Comparison. – The genus *Achradosporis* Srivastava, 1975 differs by "radial fold" in the equatorial sector; the genus *Achradosporis* is characterised by "cavatae sculpturae";

– the genus *Densosporites* Barry is characterised by a *cingulum* that encircles the central part of the spore.

Botanical affiliation. – Family Selaginellacae (Waksmundzka, 1992).

The following have been distinguished: *D. erdtamanii* Guy-Ohlson, *D. laevigatus* (Pocock) Waksmundzka; *D. velatus* Weyland et Krieger; critera: thickenings – "equatorial sector around the central body" in the equatorial sector, ornamentation thickenings and the structures of the remaining part of the spore:

– *D. erdtmanii* Guy-Ohlson is characterised by a thickening, 4–7 µm in width, with ornamentation elements of granulose, and granulosae structure of the remaining part of the spore; occurrence: Klosnowo IG 1 (1090.5 m), Oświno IG 1 (1361.5–1366.5 m);

– *D. laevigatus* (Pocock) Waksmundzka is characterised by a thickening, 1–3 µm in width, with a granulosae structure; rugulatae ornamentation of the remaining part of the spore; occurrence: Pagórki IG 1 (1055.3–1056.3 m), Klosnowo IG 1 (1090.5 m), Oświno IG 1 (1360.5–1366.5 m);

– *D. velatus* Weyland et Krieger (Pl. XIV: 1, 2) characterised by a thickening, in width 5–9 µm, with a "perforatae" structure and "rugulatae" ornamentation of the remaining part of the spore; occurrence: Pagórki IG 1 (1051.7–1052.7, 1143.7–1150.5 m), Klosnowo IG 1 (1081.2–1086.0, 1090.5 m), Oświno IG 1 (1336.0–1361.5 m).

Genus *Densosporites* Berry, 1937

Pl. XIV: 3, 4

Type species: *Densosporites covensis* Barry, 1937.

Diagnosis. – Continuation of proximal surface into equatorial surface by even arching.

Description. – Triradiate spore, triangular to suboval in equatorial outline; trilete mark rays (leasurae) occasionally distinct, equal in length to the radius of central body; thin and smooth (psilatae) central body (intexine) with oval corners, central surface (central exoexine) proximal and continues around the central body, and sometimes is evenly arched into equatorial surface or extends as a slightly elevated zone (according to Orłowska-Zwolińska (1983) – elevated cingulum; according to Jachowicz – a protrusion); bending of proximal side subtly ornamented by various ornamentation elements: granulae, spines or apiculae; sculpture of the central part of distal surface in transmitted light variably ornamented from distal surface of the zone; granulosae central part of distal surface; zone of distal surface: psilatae, granulosae, spinosae, apiculosae, verrucosae etc.; inner vacuolae ("roods") rare or absent; according to Schopf *et al*. (1944) the genus is characterised by a considerable variability in colour.

Dimensions. – 58×50 µm (Jansonius, Hills, 1976).

Discussion. – Differently described elements of the structure of equatorial zone:

– "bend – zone slightly elevated above central proximal surface" (Jansonius, 1962);

– "cingulum" in a wide range of width – 2–7 µm; (Lund, 1977 – also proposed combining the genera *Densosporites* and *Cingulizonathes* without a description of the genera);

– "cingulum encircling the central part of exine" (Orłowska-Zwolińska, 1979);

– "cingulum" thick "single zoned", smooth or slightly granulosae (Bharadway, Venkatachala, 1962);

– zone (muri), with the maximum width of 6 µm (Achilles, 1981), differentiates morphological features of the zone characteristic of the genus, however does not determine precisely its morphological features;

– Schulz (1967) describes numerous species of the genus *Densosporites* and discriminates among them based on a thorough description of the characteristic zone (width, ornamentation, arrangement), the author identified the following species:

- *D. fissus* (Reinhardt) Schulz – cingulum "meridian Schmitt", 7–10 µm in width, with infrareticulatae to microfoveolatae structures;
- *D. foveocingulatus* Schulz – equatorial cingulum, 1–4 µm in width; foveolatae, reticulatae;
- *D. variabilis* (Waltz) Potonié et Kremp – cingulum, 7–11 µm in width, foveolae;
- *D. irregularis* Hacquerard et Barss – cingulum, 10 µm in width; wider on peripheries;

– Dybova, Jachowicz (1957) distinguished the following, similarly based on a thorough analysis of elements of the structure (of the zone) and morphological features of central body:

- *D. variomarginatus* Playford – a massive ring-like protrusion of variable width and very strongly serrated edge; smooth surface of the zone and central body, structure of the zone is finely dotted;
- *D. variabilis* (Walk) Potonié et Kremp – a protrusion in the equatorial plane, of nearly equal width on the whole circumference; ornamentation of the protrusion is represented by concavities, 1–3 µm in diameter;
- *D. spitsbergensis* Playford – a massive, ring-like protrusion in the equatorial plane, narrowing towards the margin of the spore, locally with cavities;
- *D. dentatus* (Weitz) Potonié et Kremp a protrusion in the equatorial plane, of regularly serrated outer edge; protrusion/central body contacts are occasionally thickened ("narrow valvae");
- *D. subcrenatus* (Weitz) Potonié et Kremp a thick protrusion in the equatorial plane, of equal or variable width, most often ragged with an uneven outer edge;
- *D. multiclavatus* (Ischenko) Jachowicz – a flat, frequently narrow protrusion in the equatorial plane, with uneven and ragged or damaged edge; smooth or granular.

These data suggest that this genus should be distinguished based on central body and a characteristic zone around the body and equatorial surface, continued by a variably ornamented bend; however, it suggests the effect of secondary factors on the shape of the zone and morphological features of the spore due to very specific characteristic special elements; it underlines the need for analysing the sedimentary environment in taxonomic analysis of the genus, it also shows the possibility of variable interpretation of structural elements and sculpture in the case of poorly decipherable morphological features.

Analysis of morphological features of the spore included into *D. cavernatus* Orłowska-Zwolińska (1983, pl. 17: 4–6) based on transmittent light shows the lack of their variability and the presence of a morphologically uniform set of elements of the structure in the equatorial sector of distal side, and illustrates the presence of elements of the structure around the central body of proximal side.

Botanical affiliation. – According to Potonié (1967) – Prododendraceae (Lycopsida).

The following have been distinguished: *D. cavernatus* Orłowska-Zwolińska, *D.* cf. *cerebralis* (Mädler) Lund, *D.* cf. *fissus* (Reinhardt) Schulz based on illustrative material of morphological features and the arrangement of elements of the structure around the central body:

– *D. cavernatus* Orłowska-Zwolińska (Pl. XIV: 3, 4) is distinguished based on comparison with illustrative material (Orłowska-Zwolińska, 1983, pl. 17: 4–6); according to Orłowska-Zwolińska, a characteristic wide cingulum of the equatorial sector and narrow oval fissures on its whole surface; SEM photographs of specimens of similar morphological features shows the arrangement of the features in the equatorial sector of proximal side that suggests the presence of

cingulum on proximal side; occurrence: Kamień Pomorski IG 1 (262.5, 265.4 m), Mroczków (34.8, 65.5, 98.2, 121.1 m);

– *D.* cf. *fissus* (Reinhardt) Schulz, compared with illustrative material of Orłowska-Zwolińska (1983); Orłowska-Zwolińska (1983) also adds cf.; occurrence: Kamień Pomorski IG 1 (149.3, 262.5, 265.4, 637.7 m), Gorzów Wielkopolski IG 1 (796.0 m), Mroczków (85.0, 98.0 m).

Genus *Limbosporites* Nilsson, 1958

Pl. XIV: 5

Type species: *Limbosporites lundblandii* Nilsson, 1958 – *Dentallisporites achimenensis* Mädler (1964, pl. 2: 13).

Diagnosis. – Narrow margin around central surface in the equatorial sector (flage).

Description. – Spore oval-triangular to multiangular in equatorial outline, distinctly convex sides; trilete mark rays straight, extend to the equatorial thickenings, exine generally dense, proximally smooth, distally foveolatae, foveolae are 2–7 µm in diameter and show various shapes (occasionally elongated) and irregularly distributed; a relatively narrow "extension" of exine ("flage") is visible around central surface in the equatorial sector, formed by a membrane that developed from thinning of the equatorial thickenings; "flage" is characterised by irregular, single-layer reticulate pattern with luminae *ca.* 9 µm in diameter; muri of luminae parallel to the outline of the spore, mainly reduced, muri of luminae perpendicular to the outline, variably thickened.

Dimensions. – 48–60 µm.

Discussion. – The only species *L. lundblandii* Nilsson of the genus, considered as type species, is rarely described in the literature – Tralau (1968), Pocock (1970), Filatoff (1975) do not identify the taxon; Achilles (1981, pl. 9: 13, 14) only illustrates the taxon, but he does not give any description; description of morphological features of type species *L. lundblandii* in the literature variably shows the structure of the equatorial zone:

– "in collar" of the spore, a thickening is visible; the thickening extends radially in the form of ribs of various thickness; some extend to the margin of the spore (Orłowska-Zwolińska, 1966);

– a zone with radially arranged ridges – a thickening of exine (Dybkjær, 1988);

– equatorial thickening with "muri", which form the inner "reticulatae" structure around the equator (Schulz, 1967);

– "equatorial foveolae", *e.g.* up to 9 µm in size, mainly oval in outline; equatorial "muri" form the apparent zone (Guy-Ohlson, 1976).

Different descriptions explains the secondary extension of exine (flage) in the equatorial zone, susceptible to the influence of sedimentary environment.

Analysis, in the investigated palynological material, of numerous spores of similar morphological features and variable colours, determined taxonomically as *L. lundblandii* due to the characteristic foveolatae structure of distal side and the presence of the extension of exine in the equatorial sector with transverse structures forming "reticulum", suggests to accept the description by Schulz (1967) and to consider the thickening that developed from the reticulate structure as natural morphological features of the taxon; it is confirmed by illustrative material provided by Guy-Ohlson (1976, pl. II: 3, 4); Dybkjær (1991, pl. 9: 4, 5) and Lund (1977, pl. 5: 2, 3), which shows morphological variability of the taxon illustrated by reduction of luminae walls;

– the genus *Semiretisporis* Reinhardt differs in two-layer exine, infragranulatae ("fein granulatae") sculpture of proximal surface and reticulatae sculpture of distal side formed by exoexine, continued on "flage";

Botanical affiliation. – Nilsson (1958) suggests affinity of the genus *Limbosporites* to Selaginellae; Schulz (1967) correlates it with Bryophyta.

The following have been distinguished: *L. lundblandii* Nilsson.

– *L. lundblandii* Nilsson (Pl. XIV: 5) is characterised by foveolatae sculpture of distal side, narrow extension of exoexine in the equatorial sector with a distinct pattern of reticulum; occurrence: Kamień Pomorski IG 1 (676.8 m), Gorzów Wielkopolski IG 1 (953.6 m), Mroczków (79.5 m), Gliniany Las 1 (42.6 m).

FINAL REMARKS

According to author, the following morphological features are taxonomically important for individual systematic units.

Anterturma: SPORITES

Turma: TRILETES

Individual Infraturmae and taxa are characterised by:

Infraturma: **Laevigati** (wall more or less laevigatae)

– *Auritulinasporites* – distinct triangular area along trilete mark rays formed by "labra";

– *Carnisporites* – curvaturae, exine, scabratae, microgranulatae;

– *Cibotiumspora* – three radial surfaces in corners of proximal and distal sides, which developed from variably thick exine;

– *Cosmosporites* – intexine thickened on apices of spores;
– *Deltoidospora* smooth exine, sometimes kyrtomae are present;
– *Dictyophyllidites* – thickening of exine around "leasurae";
– *Foraminisporis* – coni, 1 to 2 μm in size;
– *Intrapunctatisporis* – inner sculpture of variable morphological features and three subtle folds;
– *Punctatisporites* inner sculpture of variable morphological features and three subtle folds;
– *Retusotriletes* – variable inner sculpture and curvaturae; infrasculpturae of taxons without outline of the spore.

Infraturma: **Apiculati** (wall structurae with elongate to more or less isodiametric non-murornatae positive elements)

– *Acanthotriletes* – longer, sharply ended ornamentation elements;
– *Anapiculatisporites* – "spines";
– *Apiculatisporites* – the structure ornamented by coni, spinae, locally by baculae;
– *Baculatisporites* – ornamentation elements in the form of more or less sharply ended baculae or grana;
– *Conbaculatisporites* – main ornamentation in the form of baculae nearly perpendicular to exine, locally additional ornamentation elements – "spinae" and "coni";
– *Concavisporites* – ornamentated by "tori" – three thickenings between apices;
– *Impardecispora* – ornamentation elements in the form of verrucae of greater diameter in apical zones;
– *Leptolepidites* – with distal surface ornamented by verrucae;
– *Microreticulatisporites* – rugulae or dense reticulum of multiangular luminae;
– *Osmundacidites* – grana irregular in outline (according to Achilles 1981);
– *Pilosisporites* – ornamentation elements in the form of capillae (long and winding);
– *Trachysporites* – granulae, verrucae, baculae and clava sculpture;
– cf. *Trilobosporites* – conical proximal surface and variable ornamentation elements – granulosae., verrucosae;
– *Uvaesporites* – circular ornamentation elements.

Infraturma: **Murornati** (wall more or less reticulata to granulatae)

– *Cicatricosisporites* – muri, ridges 2–3 μm in width, tending to form congestions (not thickenings) in radial areas;
– *Contignisporites* – cingulum ± distally arranged; muri more or less parallel, sometimes branching;
– *Costatoperforosporites* – perforated ornamentation striatae wider than isolation channels;
– *Duplexisporites* – muri more or less parallel to the interradial line of parallel outline;
– *Foveosporites* – foveo – reticulatae sculpture;
– *Ischyosporites* – foveo-reticulatae sculpture on distal side;
– *Klukisporites* – ornamentation in the form of foveo – reticulatae structure with flattened walls; exine convolutae – proximal side arched onto distal side;
– *Neoraistrickia* – "baculae" on distal side, and smooth proximal surface;
– *Semiretisporites* – distinct "flange" formed by exoexine on proximal side; "flange" and distal side ornamented by reticulum;
– *Staplinisporites* – thickenings of exine concentric to the outline on distal side and an additional thickening on distal area;
– *Tigrisporites* – rugulae on distal side and a thickening on distal area.

Infraturma: **Tricrassati** (interradial crassitudae with interradial equatorial extension (corona) thickening)

– *Clavifera* – a thickening of exine in the radial and interradial areas of equatorial sector, and a thickening in the central part of distal side;
– *Gleicheniidites* – a thickening of exine in the interradial area of equatorial sector, and a Y-shaped thickening on distal side;
– *Ornamnetifera* – a thickening of exine in the interradial area of equatorial sector and on distal side; additional ornamentation elements in the form of foveolae, granulosae, verrucosae;
– *Striatella* – ornamented with "muri" arranged parallel to the inner margin of the spore;
– *Zebrasporites* – a zone along muri of the spore; distal exine smooth or with radial folds.

Infraturma: **Cingulati** (with continuous cingulum more or less membraneous extension zona or combination of this "cingulizona")

– *Cingulizonates* – cingulum narrowing into cingulizona;
– *Densoisporites* – "cingulum" smooth or ornamented along the "equatorial sector";
– *Densosporites* – extension of central proximal surface into equatorial surface with arched bend;
– *Limbosporites* – with a narrow ridges encircling the equatorial part of the spore and with exine of indistinct reticulum pattern.

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STRESZCZENIE

W opracowanym materiale palinologicznym mezozoiku Polski analizowano taksonomicznie zespół miospor: *Aurituli-nasporites*, *Carnisporites*, *Cibotiumspora*, *Cosmosporites*, *Deltoidospora*, *Dictyophyllidites*, *Foraminisporis*, *Intrapunctisporis*, *Punctatisporites*, *Retusotriletes*, *Acanthotriletes*, *Anapiculatisporites*, *Apiculatisporis*, *Baculatisporites*, *Conbaculatisporites*, *Concavisporites*, *Leptolepidites*, *Microreticulatisporites*, *Osmundacidites*, *Pilosisporites*, *Trachysporites*, *Uvaesporites*, *Cicatricosisporites*, *Contignisporites*, *Costatoperforosporites*, *Duplexisporites*, *Foveosporites*, *Ischyosporites*, *Klukisporites*, *Neoraistrickia*, *Semiretisporis*, *Staplinisporites*, *Tigrisporites*, *Clavifera*, *Gleicheniidites*, *Ornamentifera*, *Striatella*, *Zebrasporites*, *Cingulizonates*, *Densoisporites*, *Densosporites*, *Limbosporites*. Badane taksony uporządkowano według sztucznej systematyki. Struktury morfologiczne analizowano dodatkowo według nowej metody obserwacji morfologii miospor w świetle przechodzącym oraz SEM i przedstawiono wpływ czynników postdepozycyjnych na morfologię miospor. Ilustruje to konieczność analizy środowiska sedymentacji przy badaniach taksonomicznych.

PLATE I

Fig. 1. cf. *Auritulina scanicus* Guy-Ohlson
a – proximal side, b – distal side; Mroczków borehole, depth 124.6 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Mroczków, głęb. 124,6 m

Fig. 2. *Auritulinasporites* sp.
proximal side; Kamień Pomorski IG 1 borehole, depth 480.4 m; SEM
strona proksymalna; otwór wiertniczy Kamień Pomorski IG 1, głęb 480,4 m; SEM

Fig. 3. *Carnisporites spiniger* (Leschik) Morbey
a – proximal side, b – distal side; Gliniany Las 1 borehole, depth 55.2 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Gliniany Las 1, głęb. 55,2 m

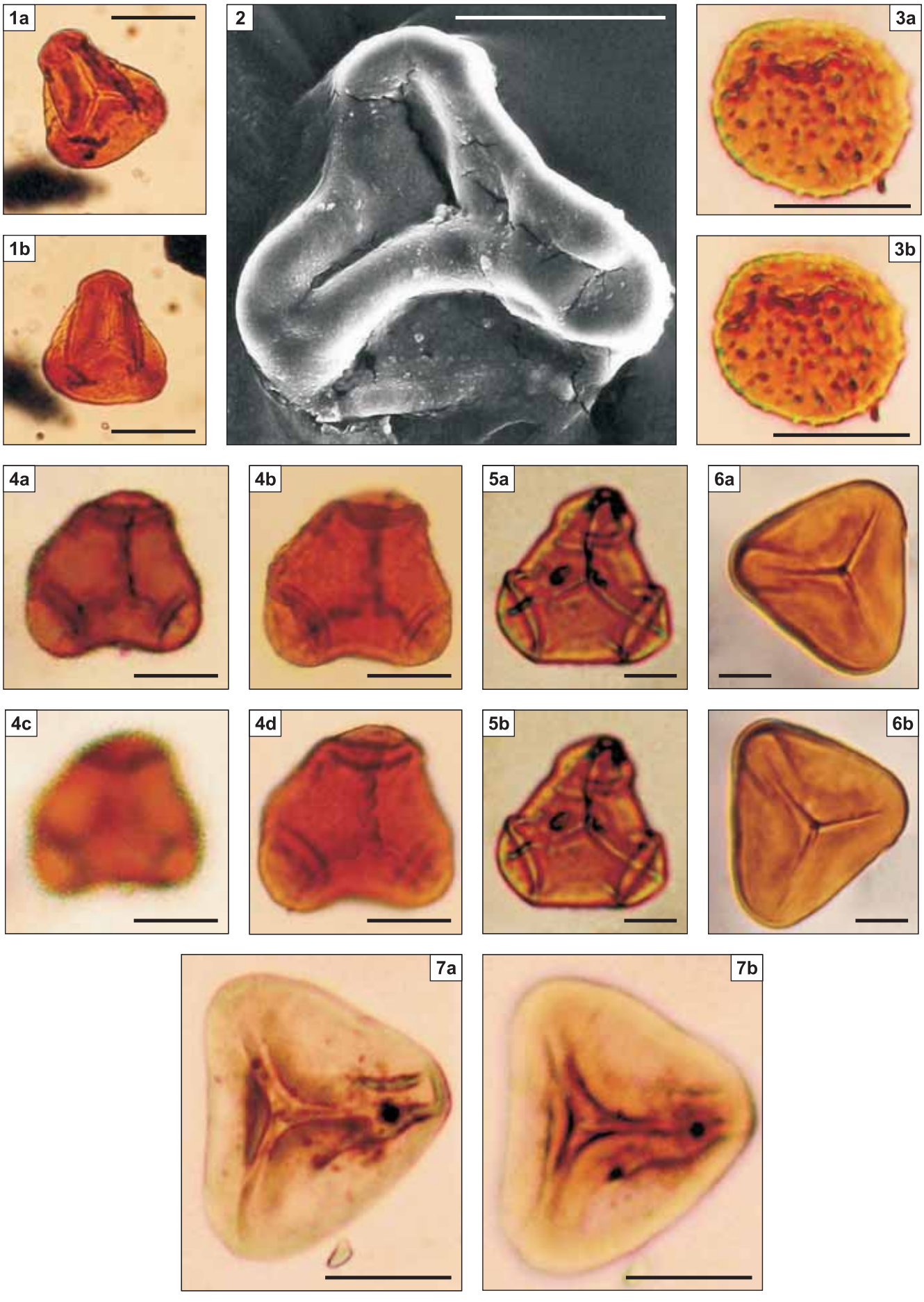
Fig. 4. *Cosmosporites elegans* Nilsson
a–d – morphology variability; Gorzów Wielkopolski IG 1 borehole, depth 1102.6 m
a–d – zmienność morfologiczna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 1102,6 m

Fig. 5. *Cibotiumspora jurienensis* (Balme) Filatoff
a – proximal side, b – distal side; Gorzów Wielkopolski IG 1 borehole, depth 788.9 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 788,9 m

Fig. 6. *Deltoidospora toralis* (Leschik) Lund
a – proximal side, b – distal side; Mroczków borehole, depth 29.0 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Mroczków, głęb. 29,0 m

Fig. 7. *Deltoidospora toralis* (Leschik) Lund
a – proximal side, b – distal side; Gliniany Las 1 borehole, depth 59.8 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Gliniany Las 1, głęb. 59,8 m

Scale bar equals 20 μm
Skala liniowa 20 μm



Marta Waksmundzka — Mesozoic spores of Poland – a revision of selected taxa

PLATE II

Fig. 1. *Deltoidospora toralis* var. *media* Lund
a – proximal side, b – distal side; Kamień Pomorski IG 1 borehole, depth 400.2 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Kamień Pomorski IG 1, głęb. 400,2 m

Fig. 2. *Deltoidospora crassexina* (Nilsson) Lund
a – proximal side, b – distal side; Mroczków borehole, depth 89.9 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Mroczków, głęb. 89,9 m

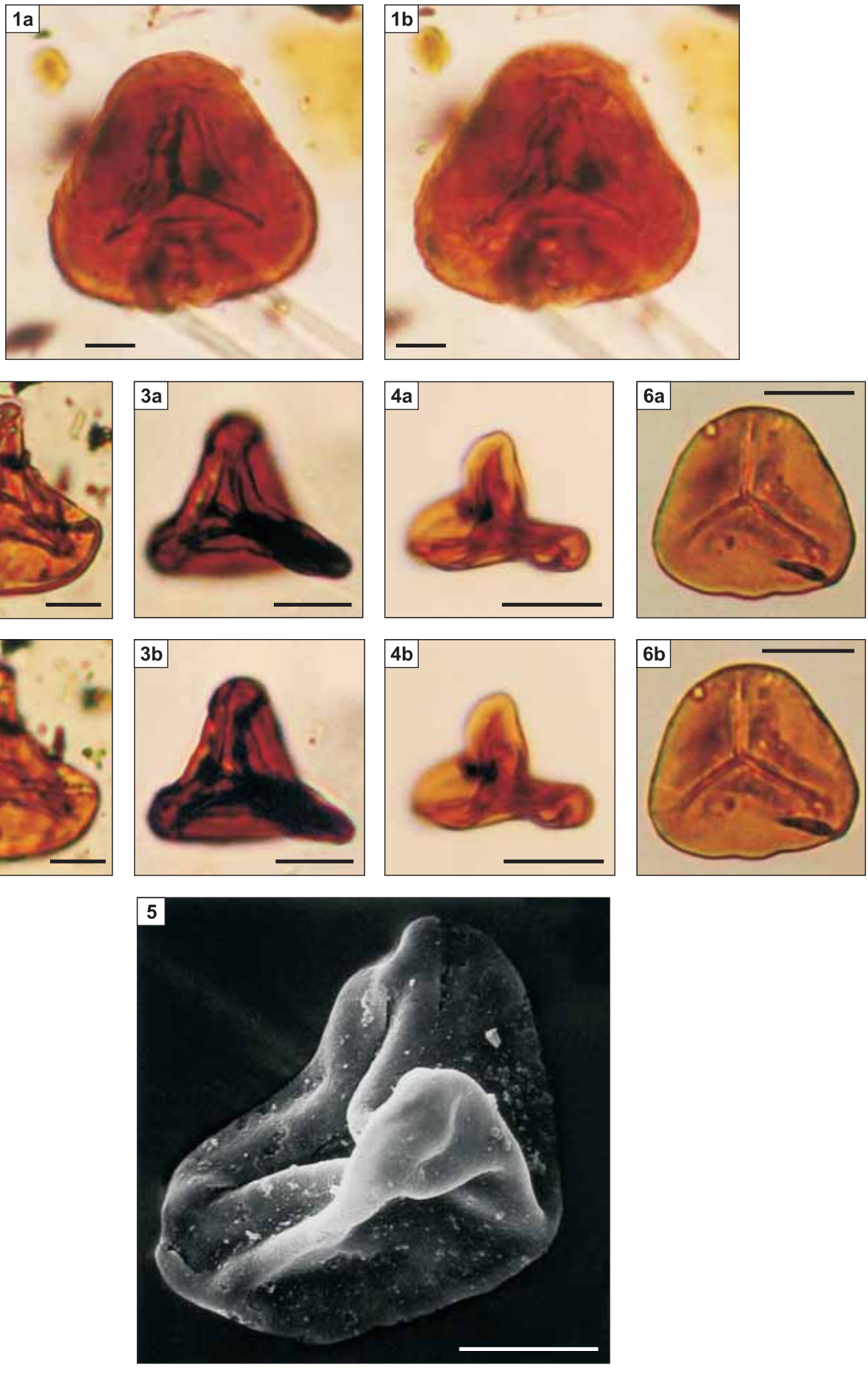
Fig. 3. *Dictyophyllidites harrisii* Couper
a – proximal side, b – distal side; Kamień Pomorski IG 1 borehole, depth 420.2 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Kamień Pomorski IG 1, głęb. 420,2 m

Fig. 4. *Dictyophyllidites mortoni* (de Jersey) Playford et Dettmann
a – proximal side, b – distal side; Gorzów Wielkopolski IG 1 borehole, depth 809.7 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 809,7 m

Fig. 5. *Dictyophyllidites* sp.
proximal side; Gorzów Wielkopolski IG 1 borehole, depth 804.4 m; SEM
strona proksymalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 804,4 m; SEM

Fig. 6. *Intrapunctisporis toralis* (Leschik) Lund
a – proximal side, b – distal side; Gorzów Wielkopolski IG 1 borehole, depth 809.7 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 809,7 m

Scale bar equals 20 μm
Skala liniowa 20 μm



Marta Waksmundzka — Mesozoic spores of Poland – a revision of selected taxa

PLATE III

Fig. 1. *Foraminisporis jurassica* Schulz
a – proximal side, b – distal side; Gorzów Wielkopolski IG 1 borehole, depth 806.4 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 806,4 m

Fig. 2. *Foraminisporis* sp.
distal side; Gorzów Wielkopolski IG 1 borehole, depth 804.4 m; SEM
strona dystalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 804,4 m; SEM

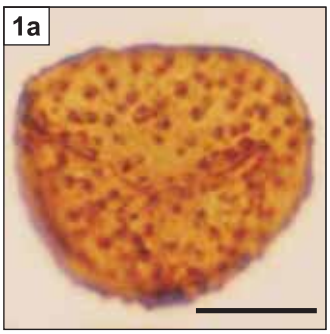
Fig. 3. *Punctatisporites globosus* (Leschik) Lund
a – proximal side, b – distal side; Gorzów Wielkopolski IG 1 borehole, depth 761.4 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 761,4 m

Fig. 4. *Retusotriletes mesozoicus* Klaus
a – proximal side, b – distal side; Gorzów Wielkopolski IG 1 borehole, depth 806.4 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 806,4 m

Fig. 4. *Retusotriletes mesozoicus* Klaus
a – proximal side, b – distal side; Kamień Pomorski IG 1 borehole, depth 414.0 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Kamień Pomorski IG 1, głęb. 414,0 m

Fig. 6. *Acanthotriletes* sp.
proximal side; Pagórki IG 1 borehole, depth 922.5–927.0 m; SEM
strona proksymalna; otwór wiertniczy Pagórki IG 1, głęb. 922,5–927,0 m; SEM

Scale bar equals 20 μm
Skala liniowa 20 μm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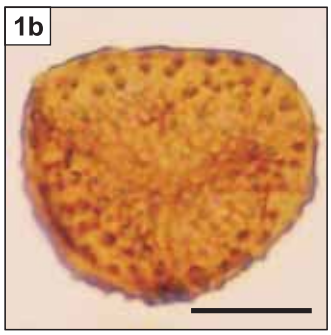
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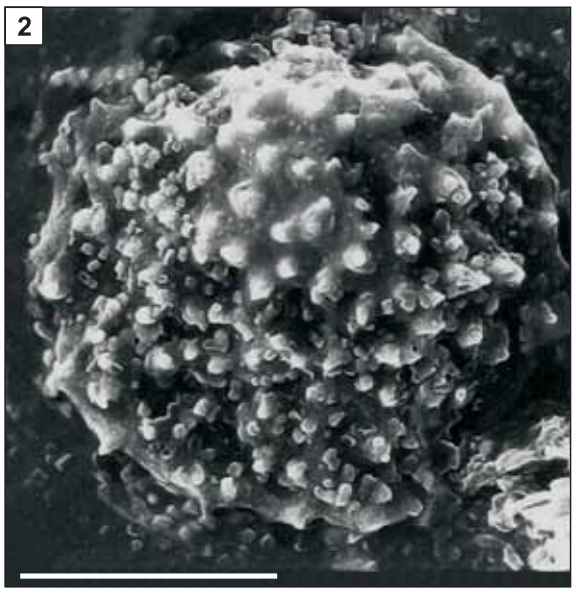
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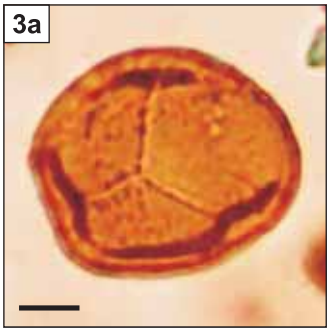
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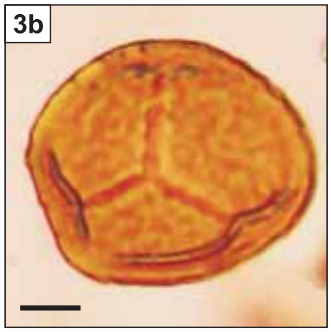
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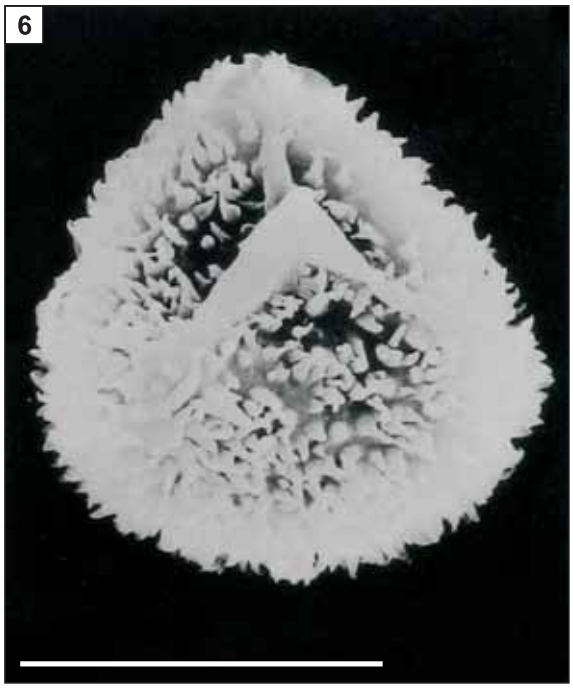
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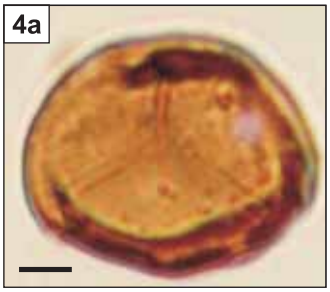
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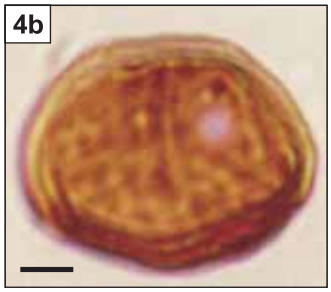
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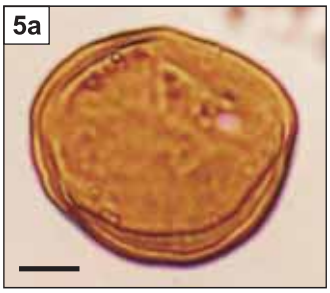
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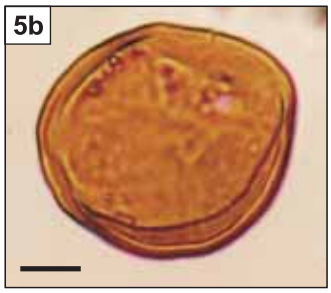

5b

PLATE IV

Fig. 1. *Anapiculatisporites telephorus* (Pautsch) Klaus
a – proximal side, b – distal side; ("spines") Dybkjær, pl. 3: 8, 9; Mroczków borehole, depth 34.8 m
a – strona proksymalna, b – strona dystalna; („igły") Dybkjær, pl. 3: 8, 9; otwór wiertniczy Mroczków, głęb. 34,8 m

Fig. 2. *Apiculatisporites ovalis* (Nilsson) Norris
a – proximal side, b – distal side; Gliniany Las 1 borehole, depth 64.4 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Gliniany Las 1, głęb. 64,4 m

Fig. 3. *Baculatisporites comaumensis* (Cookson) Potonié
a – proximal side, b – distal side; Gorzów Wielkopolski IG 1 borehole, depth 422.1 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 422,1 m

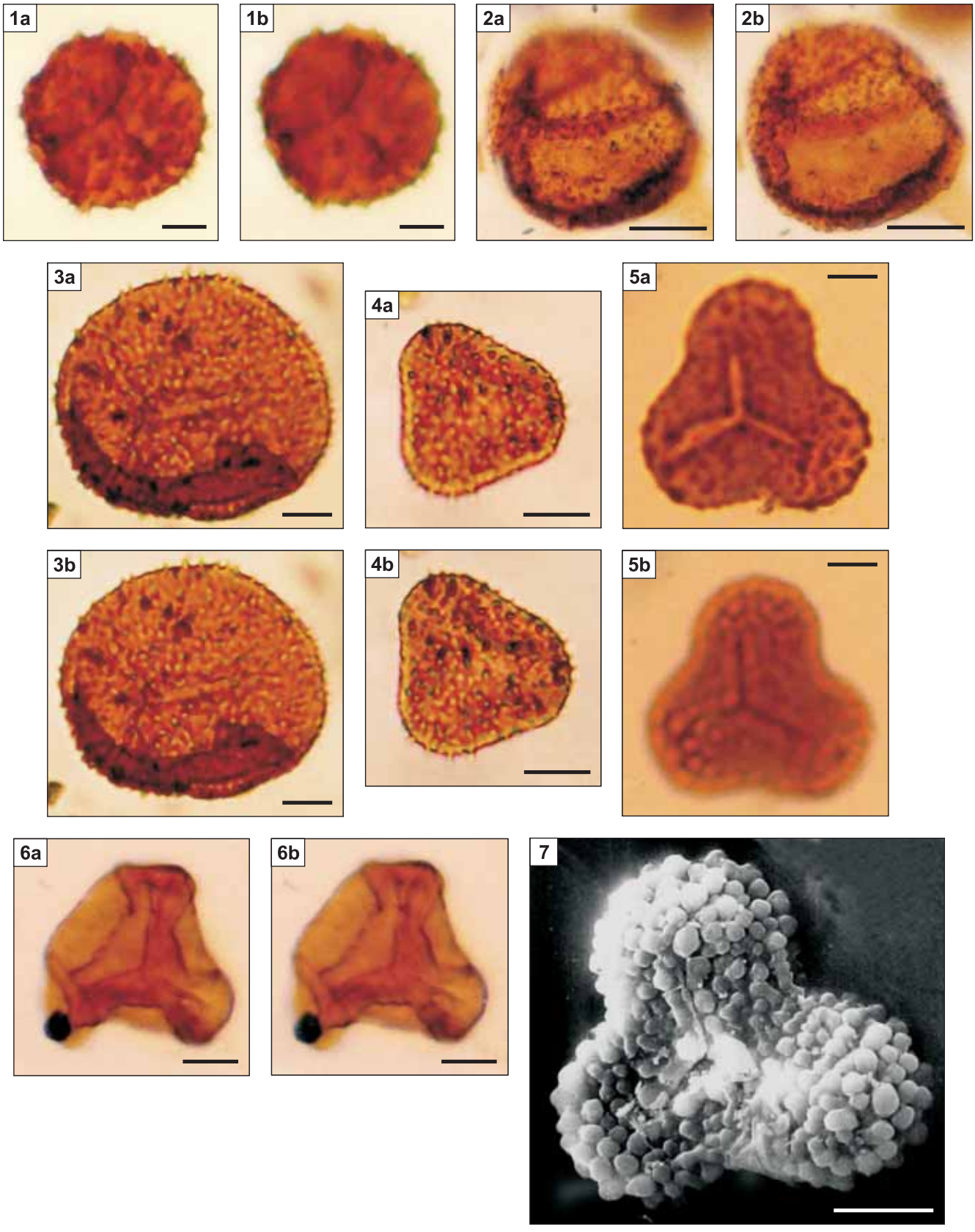
Fig. 4. *Conbaculatisporites mesozoicus* Klaus
a, b – after Lund, 1977, pl. 2: 10; Mroczków borehole, depth 29.0 m
a, b – wg Lunda, 1977, pl. 2: 10; otwór wiertniczy Mroczków, głęb. 29,0 m

Fig. 5. *Impardeispora apiverrucata* Venkatachala *et al*.
a – proximal side, b – distal side; Pagórki IG 1 borehole, depth 1051.2–1052.7 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Pagórki IG 1, głęb. 1051,2–1052,7 m

Fig. 6. *Concavisporites* sp.
a, b – after Achilles, 1981, pl. 1: 18–20, *C. toralis* Leschlik; Gorzów Wielkopolski IG 1 borehole, depth 770.7 m
a, b – wg Achillesa, 1981, pl. 1: 18–20, *C. toralis* Leschlik; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 770,7 m

Fig. 7. *Impardeispora apiverrucata* Venkatachala *et al*.
proximal side; Klosnowo IG 1 borehole, depth 1081.1–1086.1 m; SEM
strona proksymalna; otwór wiertniczy Klosnowo IG 1, głęb. 1081,1–1086,1 m; SEM

Scale bar equals 20 μm
Skala liniowa 20 μm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2b
3a
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3b
4b
5b
6a
6b
7

PLATE V

Fig. 1. *Leptolepidites major* Schulz

a, b – after Schulz, 1967, pl. II: 1–3; a – proximal side, b – distal side; Kamień Pomorski IG 1 borehole, depth 977.6 m

a, b – wg Schulza, 1967, pl. II: 1–3; a – strona proksymalna, b – strona dystalna; otwór wiertniczy Kamień Pomorski IG 1, głęb. 977,6 m

Fig. 2. *L. major* Schulz

a – proximal side, b – distal side; Kamień Pomorski IG 1 borehole, depth 977.6 m

a – strona proksymalna, b – strona dystalna; otwór wiertniczy Kamień Pomorski IG 1, głęb. 977,6 m

Fig. 3. *L. major* Schulz

a, b – after Dybkjær, 1991, pl. 9: 11–12; Gorzów Wielkopolski IG 1 borehole, depth 1003.4 m

a, b – wg Dybkjæra, 1991, pl. 9: 11–12; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 1003,4 m

Fig. 4. *Osmundacidites wellmanii* Couper

a – proximal side, b – distal side; Gorzów Wielkopolski IG 1 borehole, depth 422.1 m

a – strona proksymalna, b – strona dystalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 422,1 m

Fig. 5. *Microreticulatisporites uniformis* Singh

a, b – after Singh, 1971, pl. 17: 17–19; a – proximal side, b – distal side; Kamień Pomorski IG 1 borehole, depth 1051.2–1052.7 m

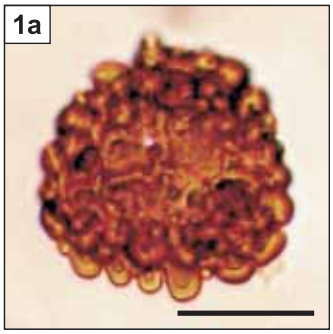
a, b – wg Singha, 1971, pl. 17: 17–19; a – strona proksymalna, b – strona dystalna; otwór wiertniczy Kamień Pomorski IG 1, głęb. 1051,2–1052,7 m

Fig. 6. *Pilosisporites verus* Delcourt et Sprumont

a – proximal side; Klosnowo IG 1 borehole, depth 1081.2–1086.0 m; SEM

a – strona proksymalna; otwór wiertniczy Klosnowo IG 1, głęb. 1081,2–1086,0 m; SEM

Scale bar equals 20 μm
Skala liniowa 20 μm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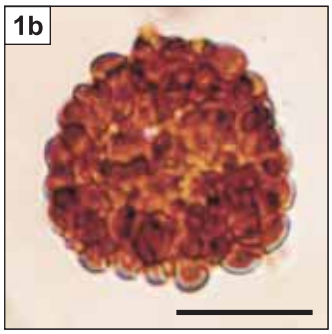
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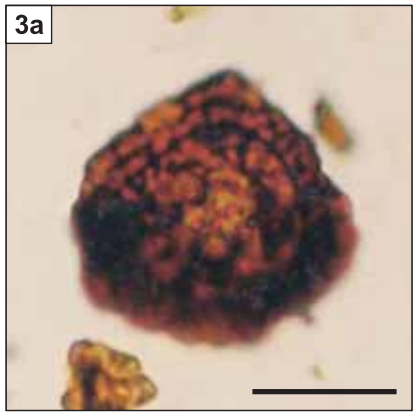
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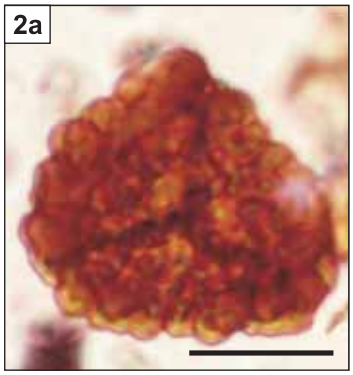
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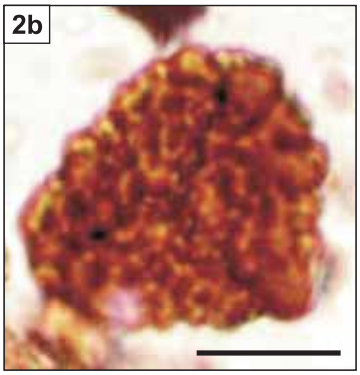
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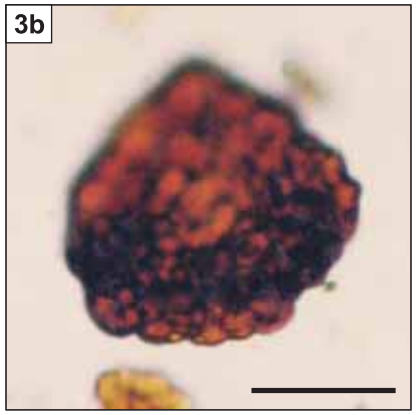
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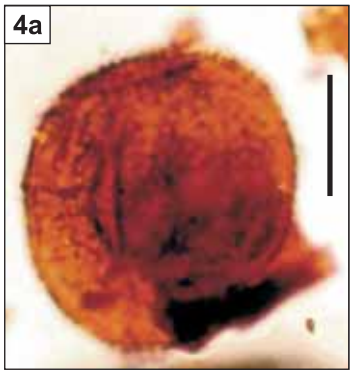
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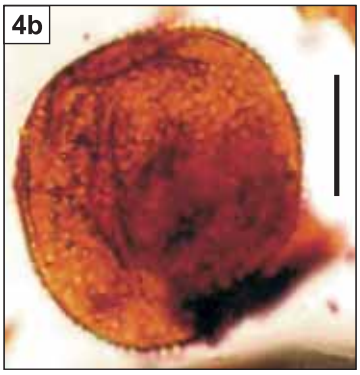
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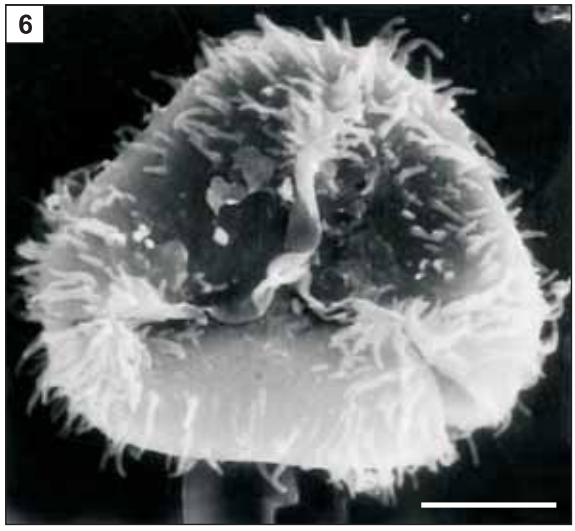
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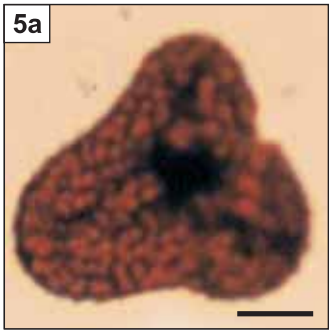
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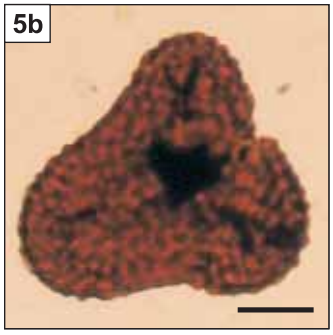
5b

PLATE VI

Fig. 1. *Trachysporites asper* Nilsson
a – proximal side, b – distal side; Gorzów Wielkopolski IG 1 borehole, depth 818.4 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 818,4 m

Fig. 2. *Uvaesporites argenteaeformis* (Bolkhovitina) Schulz
a, b – after Schulz, 1991, pl. 4: 1; Gorzów Wielkopolski IG 1 borehole, depth 788.9 m
a, b – wg Schulza, 1991, pl. 4: 1; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 788,9 m

Fig. 3. *Uvaesporites argenteaeformis* (Bolkhovitina) Schulz
a, b – after Tralau, 1968, pl. IV: 2; Gliniany Las 1 borehole, depth 77.4 m
a, b – wg Tralau, 1968, pl. IV: 2; otwór wiertniczy Gliniany Las 1, głęb. 77,4 m

Fig. 4. *Cicatricosisporites australiensis* (Cookson) Potonié
a – proximal side, b – distal side; Pagórki IG 1 borehole, depth 1050.6–1166.6 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Pagórki IG 1, głęb. 1050,6–1166,6 m

Fig. 5. *Cicatricosisporites australiensis* (Cookson) Potonié
proximal side; Klosnowo IG 1 borehole, depth 1090.5 m; SEM
strona proksymalna; otwór wiertniczy Klosnowo IG 1, głęb. 1090,5 m; SEM

Fig. 6. *Cicatricosisporites spiralis* Singh
distal side; Klosnowo IG 1 borehole, depth 1090.5 m; SEM
strona dystalna; otwór wiertniczy Klosnowo IG 1, głęb. 1090,5 m; SEM

Scale bar equals 20 μm
Skala liniowa 20 μm

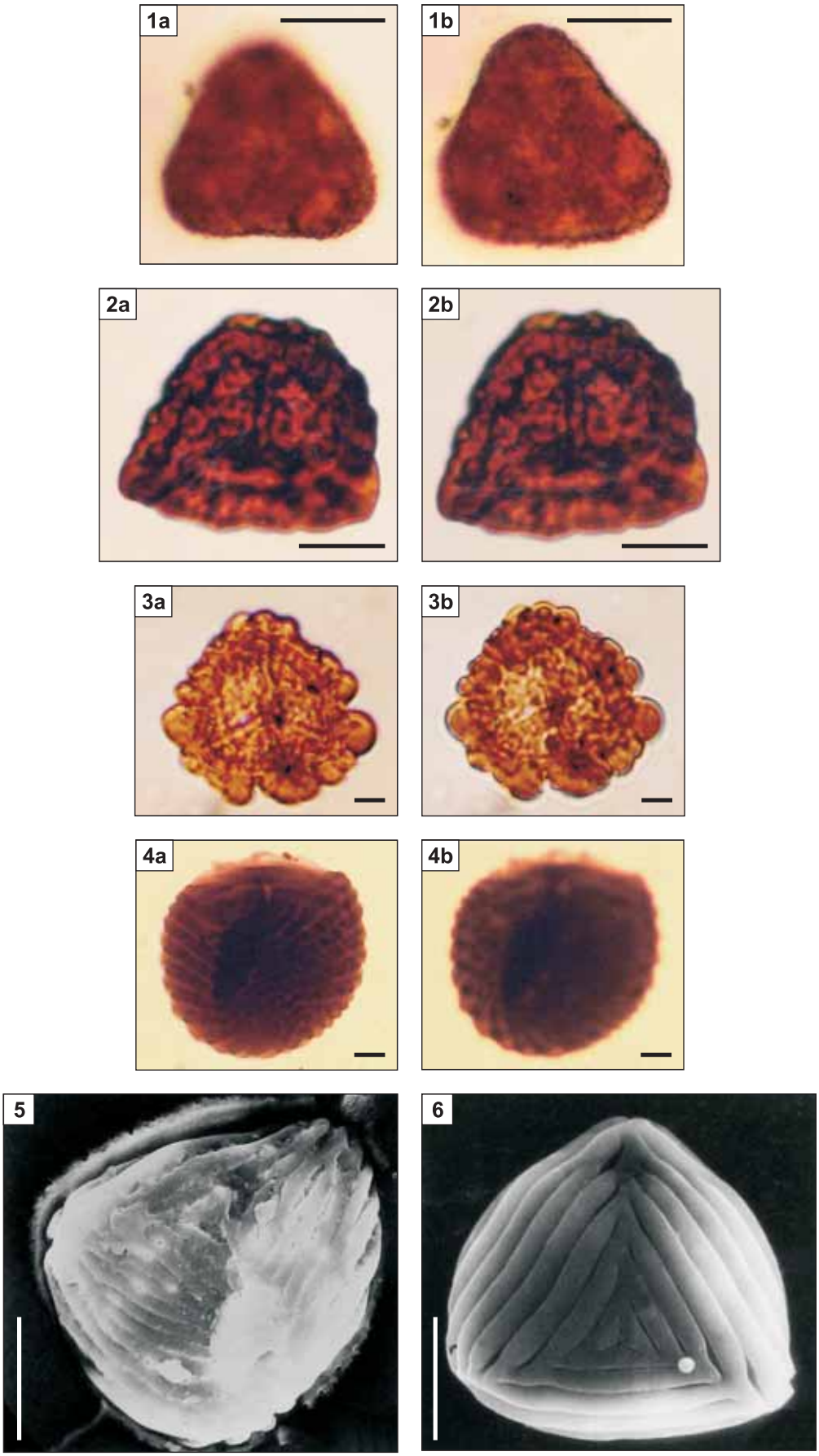
1a
1b
2a
2b
3a
3b
4a
4b
5
6

PLATE VII

Fig. 1. *Contignisporites conbaculatus* – a, b – after consultation with Guy-Ohlson; Kamień Pomorski IG 1 borehole, depth 420.2 m
Contignisporites conbaculatus – a, b – po konsultacji z Guy-Ohlson; otwór wiertniczy Kamień Pomorski IG 1, głęb. 420,2 m

Fig. 2. *C. problematicus* (Couper) Döring
a, b – Mroczków borehole, depth 108.4 m
a, b – otwór wiertniczy Mroczków, głęb. 108,4 m

Fig. 3. *Contignisporites conbaculatus*
proximal side; Gorzów Wielkopolski IG 1 borehole, depth 804.4 m; SEM
strona proksymalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 804,4 m; SEM

Fig. 4. *Cicatricosisporites* or *Contignisporites jurassica*
a, b – proximal side; Mroczków borehole, depth 68.0 m
a, b – strona proksymalna; otwór wiertniczy Mroczków, głęb. 68,0 m

Fig. 5. *Contignisporites glebelentus* Dettmann
a, b – Kamień Pomorski IG 1 borehole, depth 420.2 m
a, b – otwór wiertniczy Kamień Pomorski IG 1, głęb. 420,2 m

Fig. 6. *Costatoperforosporites fistulosus* Deák
a – proximal side, b – distal side; Pagórki IG 1 borehole, depth 1130.5–1137.6 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Pagórki IG 1, głęb. 1130,5–1137,6 m

Fig. 7. *Costatoperforosporites spiralis* Singh
side position; Klosnowo IG 1 borehole, depth 1062.2 m; SEM
położenie boczne; otwór wiertniczy Klosnowo IG 1, głęb. 1062,2 m; SEM

Scale bar equals 20 μm
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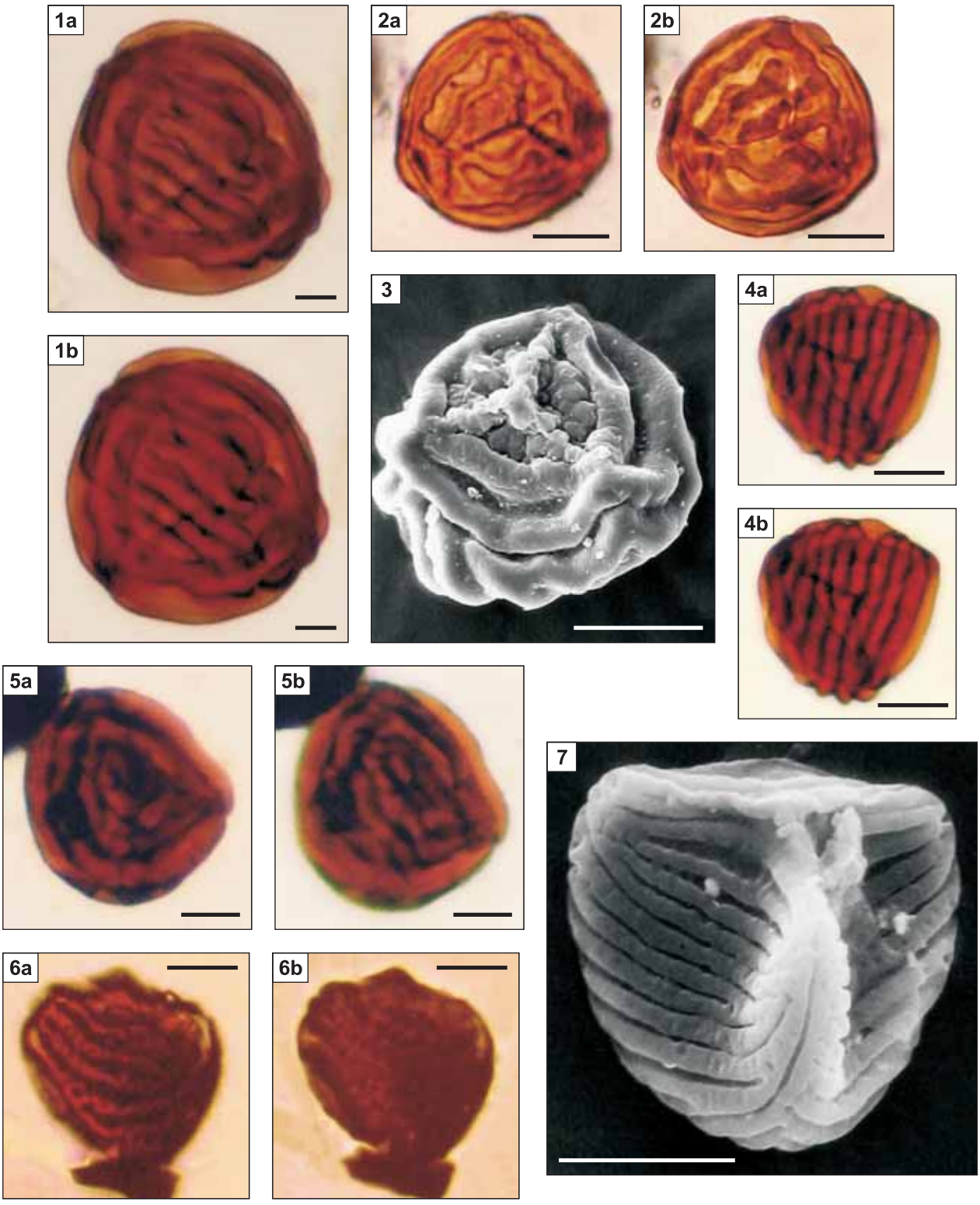
1a
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7
6a
6b

PLATE VIII

Fig. 1. *Foveosporites mortenensis* de Jersey

after Achilles, 1981, pl. 6: 3, 4; a – proximal side, b – distal side; Kamień Pomorski IG 1 borehole, depth 428.6 m

wg Achillesa, 1981, pl. 6: 3, 4; a – strona proksymalna, b – strona dystalna; otwór wiertniczy Kamień Pomorski IG 1, głęb. 428,6 m

Fig. 2. *Foveosporites mortenensis* de Jersey

a, b – taxonomically not assigned into *Klukisporites* due to irregular outline; a – proximal side, b – distal side; Kamień Pomorski IG 1 borehole, depth 428.6 m

a, b – takson niezaliczony do *Klukisporites* ze względu na nieregularny zarys; a – strona proksymalna, b – strona dystalna; otwór wiertniczy Kamień Pomorski IG 1, głęb. 428,6 m

Fig. 3. *Foveosporites multifoveolatus* Filatoff

a, b – Filatoff, 1975, pl. 3: 11–13; a – proximal side, b – distal side; Gorzów Wielkopolski IG 1 borehole, depth 770.4 m

a, b – Filatoff, 1975, pl. 3: 11–13; a – strona proksymalna, b – strona dystalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 770,4 m

Figs. 4, 5. *Ischyosporites marburgensis* de Jersey

Kamień Pomorski IG 1 borehole, depth 237.1 m

otwór wiertniczy Kamień Pomorski IG 1, głęb. 237,1 m

Fig. 6. *Klukisporites variegatus* Couper

proximal side; Gorzów Wielkopolski IG 1 borehole, depth 770.4 m

strona proksymalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 770,4 m

Fig. 7. *Klukisporites variegatus* Couper

proximal side; Gorzów Wielkopolski IG 1 borehole, depth 809.7 m; SEM

strona proksymalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 809,7 m; SEM

Scale bar equals 20 μm
Skala liniowa 20 μm

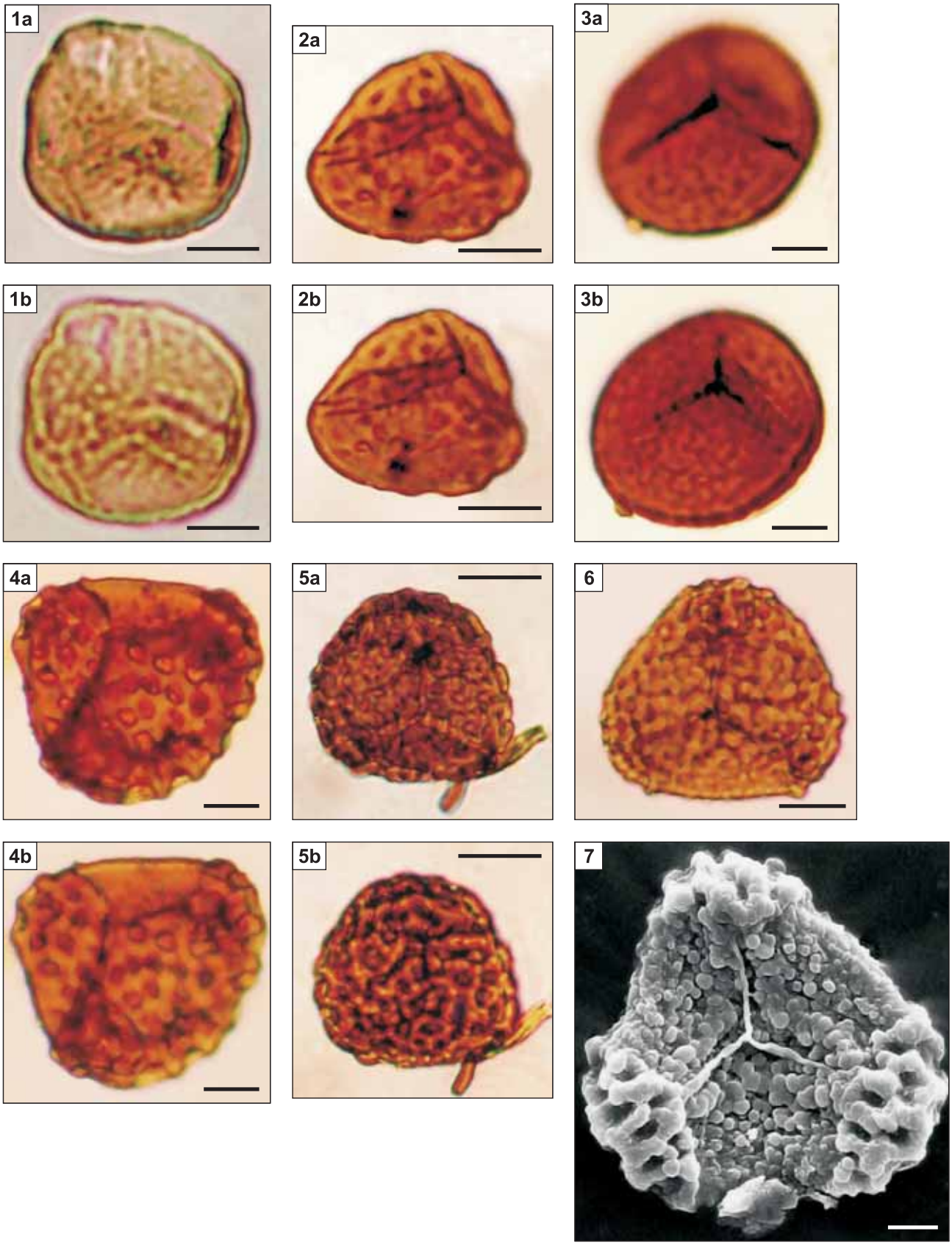

1a
2a
3a
1b
2b
3b
4a
5a
6
4b
5b
7

PLATE IX

Fig. 1. *Neoraistrickia truncata* (Cookson) Potonié

a – proximal side, b – distal side; Kamień Pomorski IG 1 borehole, depth 445.3 m

a – strona proksymalna, b – strona dystalna; otwór wiertniczy Kamień Pomorski IG 1, głęb. 445,3 m

Fig. 2. *Semiretisporites gothae* Reinhardt

a – proximal side, b – distal side; Kamień Pomorski IG 1 borehole, depth 676.8 m

a – strona proksymalna, b – strona dystalna; otwór wiertniczy Kamień Pomorski IG 1, głęb. 676,8 m

Fig. 3. *Stapliniporites caminus* (Balme) Pocock

a – proximal side, b – distal side; Oświno IG 1 borehole, depth 1294.5–1301.2 m

a – strona proksymalna, b – strona dystalna; otwór wiertniczy Oświno IG 1, głęb. 1294,5–1301,2 m

Figs. 4, 5. *Staplinisporites caminus* (Balme) Pocock

distal side; the photographys illustrates the variability thickening in the interradial area wich distinguish from genus *Staplinisporites*; Klosnowo IG 1 borehole, depth 1081.2–1086.0 m; SEM

strona dystalna; na fotografiach zilustrowano zmienność zgrubienia w interradialnej części, charakterystyczną dla rodzaju *Staplinisporites*; otwór wiertniczy Klosnowo IG 1, głęb. 1081,2–1086,0 m; SEM

Fig. 6. *Coronatispora* sp.

a – proximal side, b – distal side; the photographys illustrates the visible thickening in the interradial area which distinguish the genus from genus *Staplinisporites*; Kamień Pomorski IG 1 borehole, depth 428.6 m

a – strona proksymalna, b – strona dystalna; na fotografiach zilustrowano widoczne zgrubienie w rejonie interradialnym, które odróżnia rodzaj od rodzaju *Staplinisporites*; otwór wiertniczy Kamień Pomorski IG 1, głęb. 428,6 m

Scale bar equals 20 μm
Skala liniowa 20 μm

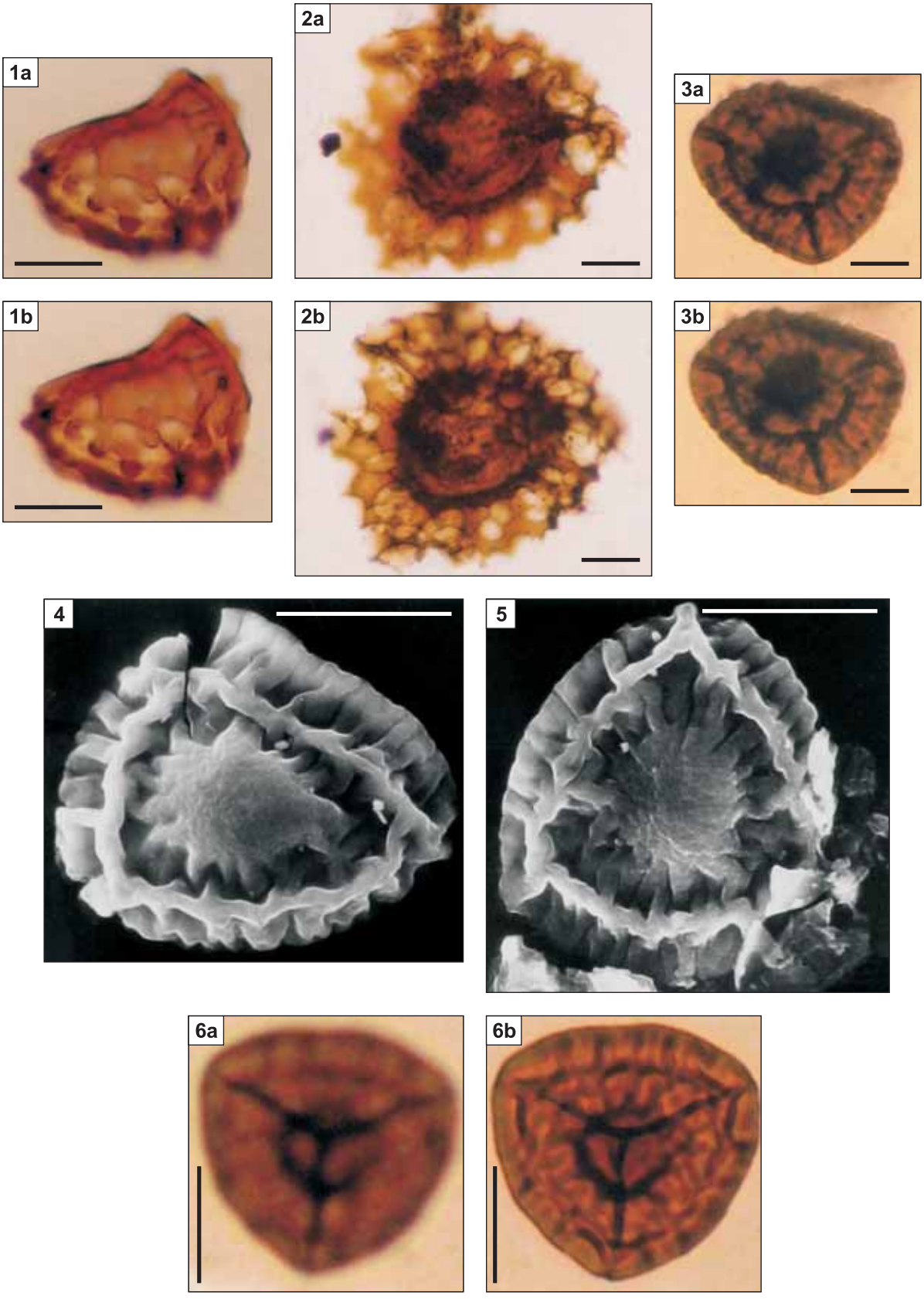

1a
2a
3a
1b
2b
3b
4
5
6a
6b

PLATE X

Fig. 1. *Tigrisporites scurrandus* Norris
a – proximal side, b – distal side; Gorzów Wielkopolski IG 1 borehole, depth 987.5 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 987,5 m

Fig. 2. *Clavifera jachromiensis* Bolkhovitina
a – proximal side, b – distal side; Pagórki IG 1 borehole, depth 1097.9–1010.9 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Pagórki IG 1, głęb. 1097,9–1010,9 m

Fig. 3. *Clavifera triplex* Bolkhovitina
a – proximal side, b – distal side; Pagórki IG 1 borehole, depth 1055.3–1056.3 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Pagórki IG 1, głęb. 1055,3–1056,3 m

Figs. 4, 5. *Clavifera triplex* Bolkhovitina
4 – proximal side, 5 – distal side; Klosnowo IG 1 borehole, depth 1081.2–1086.0 m; 4, 5 – SEM
4 – strona proksymalna, 5 – strona dystalna; otwór wiertniczy Klosnowo IG 1, głęb. 1081,2–1086,0 m; 4, 5 – SEM

Fig. 6. *Gleicheniidites senonicus* Ross
a – proximal side, b – distal side; Klosnowo IG 1 borehole, depth 1081.2–1086.1 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Klosnowo IG 1, głęb. 1081,2–1086,1 m

Scale bar equals 20 μm
Skala liniowa 20 μm

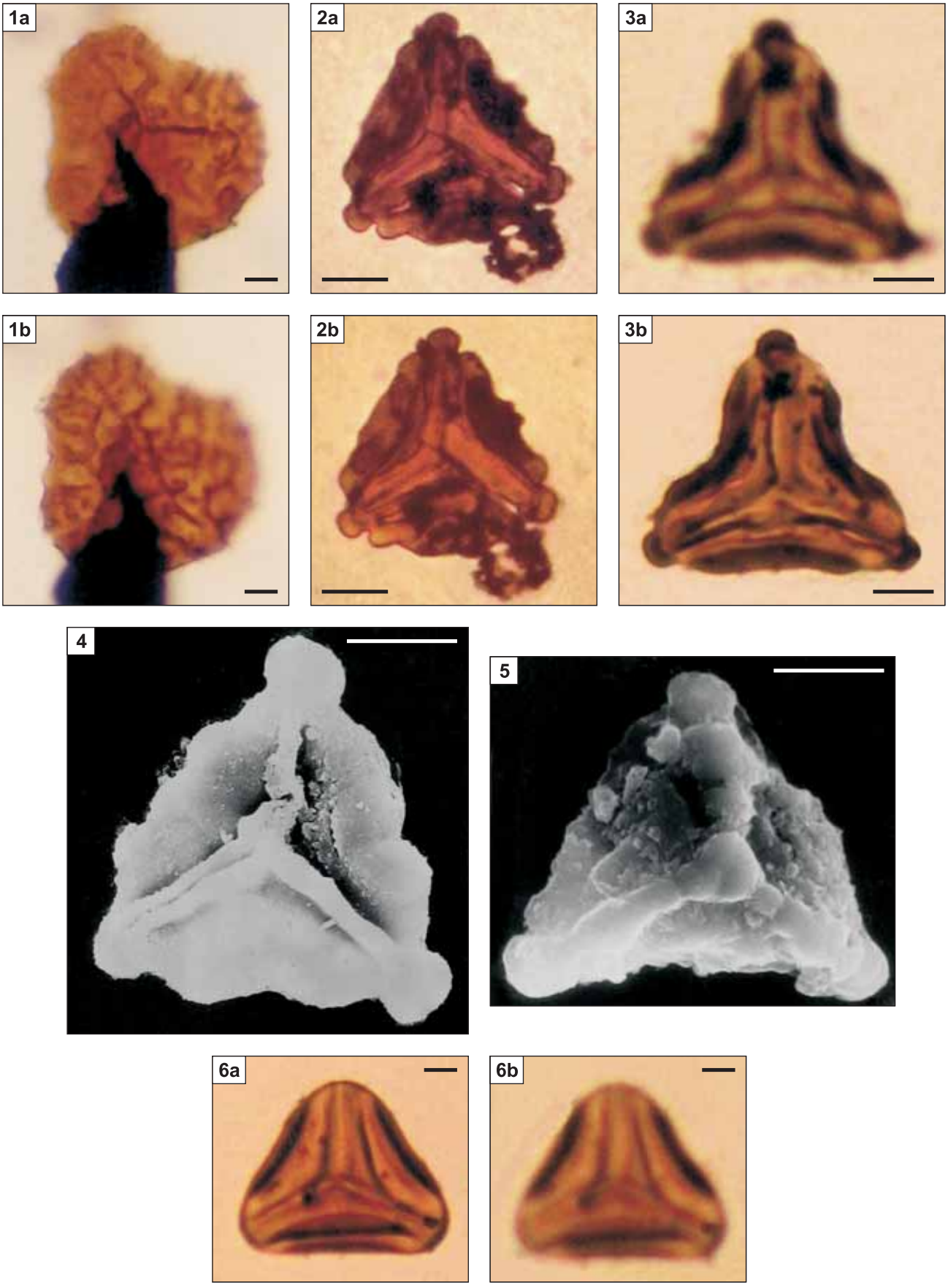

1a
2a
3a
1b
2b
3b
4
5
6a
6b

PLATE XI

Fig. 1. *Gleicheniidites senonicus* Ross
a – proximal side, b – distal side; Pagórki IG 1 borehole, depth 1130.5–1137.6 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Pagórki IG 1, głęb. 1130,5–1137,6 m

Fig. 2. *G. senonicus* Ross
distal side; Pagórki IG 1 borehole, depth 1051.7–1057.7 m; SEM
strona dystalna; otwór wiertniczy Pagórki IG 1, głęb. 1051,7–1057,7 m; SEM

Figs. 3, 4. *G. senonicus* Ross
a – proximal side, b – distal side; Pagórki IG 1 borehole, depth 1320.0–1326.4 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Pagórki IG 1, głęb. 1320,0–1326,4 m

Fig. 5. *Ornamentifera* cf. *echinata* (Bolkhovitina) Bolkhovitina
distal side; Pagórki IG 1 borehole, depth 1051.7 m; SEM
strona dystalna; otwór wiertniczy Pagórki IG 1, głęb. 1051,7 m; SEM

Fig. 6. *Gleicheniidites rasilis* (Bolkhovitina) Bolkhovitina
distal side; Pagórki IG 1 borehole, depth 1051.7–1052.7 m; SEM
strona dystalna; otwór wiertniczy Pagórki IG 1, głęb. 1051,7–1052,7 m; SEM

Scale bar equals 20 μm
Skala liniowa 20 μm

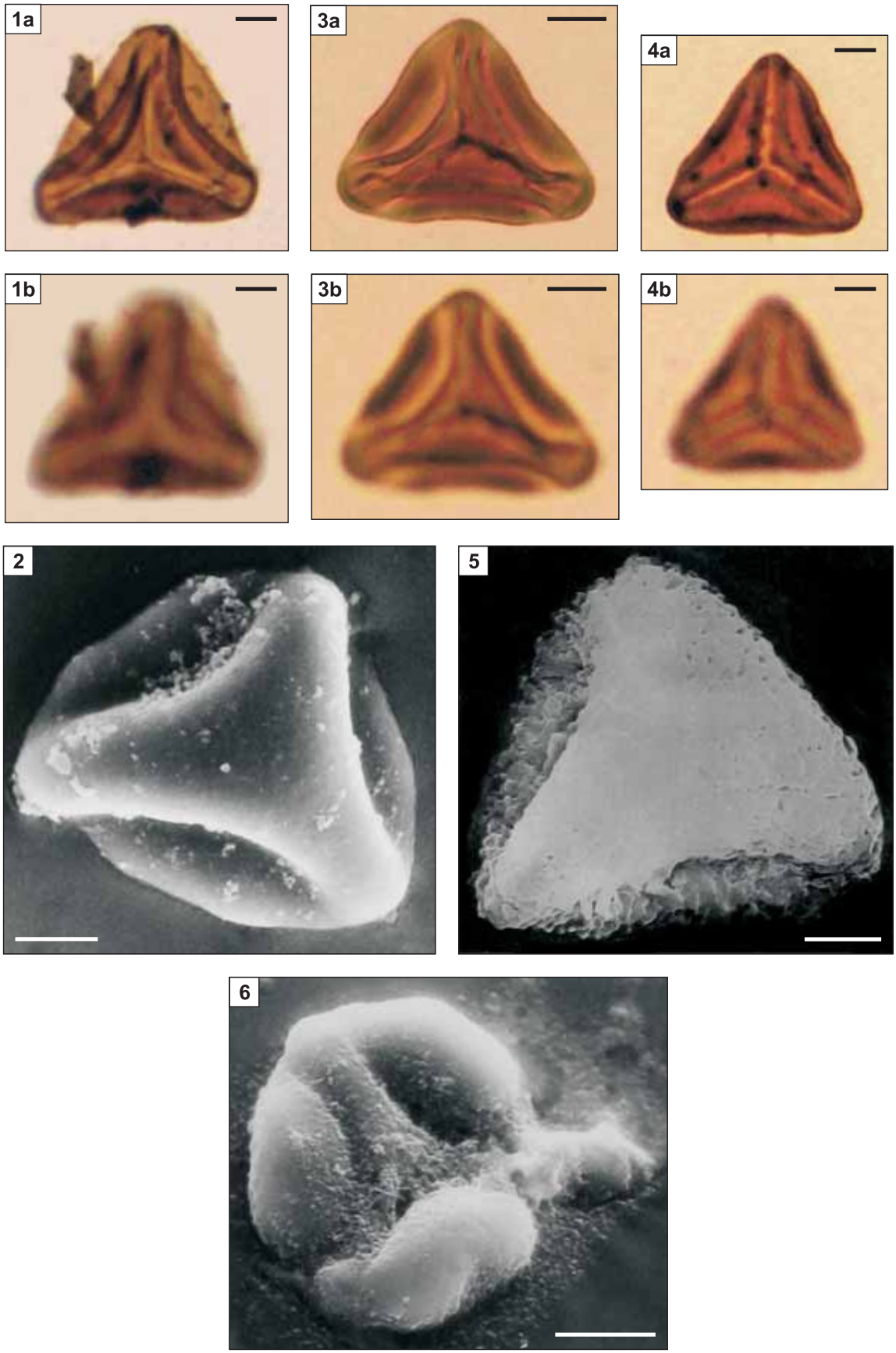

1a
3a
4a
1b
3b
4b
2
5
6

PLATE XII

Fig. 1. *Striatella jurassica* Mädler
a – proximal side, b – distal side; Gorzów Wielkopolski IG 1 borehole, depth 788.9 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 788,9 m

Figs. 2, 3. *Striatella jurassica* Mädler
2, 3a – distal side, 3b – proximal side; Gorzów Wielkopolski IG 1 borehole, depth 804.4 m; 2 – SEM
2, 3a – strona dystalna, 3b – strona proksymalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 804,4 m; 2 – SEM

Fig. 4. *Zebrasporites interscriptus* (Thiergart) Klaus
a – proximal side, b – distal side; Gliniany Las 1 borehole, depth 55.2 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Gliniany Las 1, głęb. 55,2 m

Fig. 5. *Cingulizonates rhaeticus* (Reinhardt) Schulz
a, b – proximal side, intraspecies variability; Gliniany Las 1 borehole, depth 55.2 m
a, b – strona proksymalna, zmienność wewnątrzgatunkowa; otwór wiertniczy Gliniany Las 1, głęb. 55,2 m

Fig. 6. *Cingulizonates rhaeticus* (Reinhardt) Schulz
a, b – proximal side, intraspecies variability; Gliniany Las 1 borehole, depth 64.4 m
a, b – strona proksymalna, zmienność wewnątrzgatunkowa; otwór wiertniczy Gliniany Las 1, głęb. 64,4 m

Scale bar equals 20 μm
Skala liniowa 20 μm

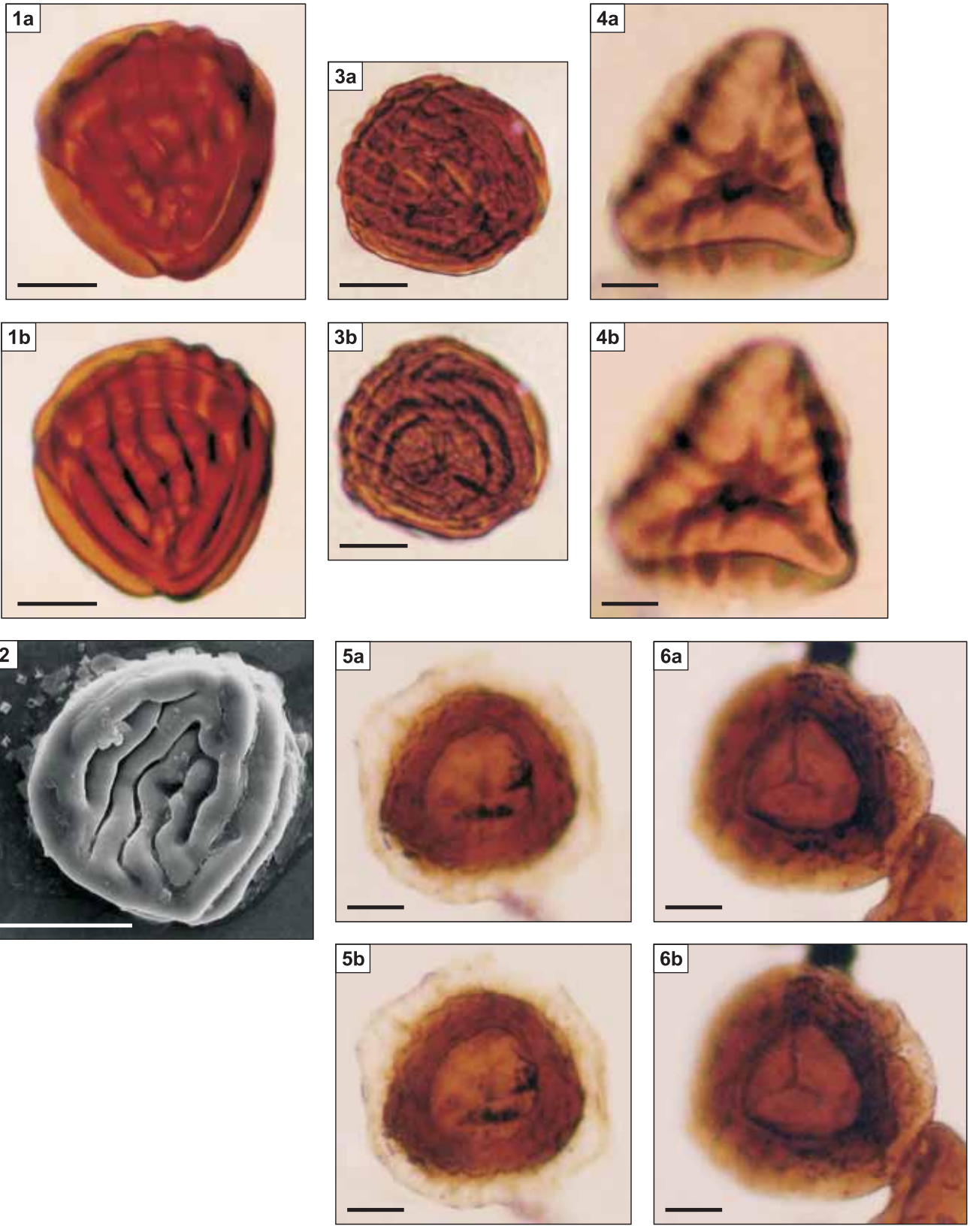

1a
3a
4a
1b
3b
4b
2
5a
6a
5b
6b

PLATE XIII

Figs. 1, 2. *Cingulizonates rhaeticus* (Reinhardt) Schulz

intraspecies variability; optical photo-micrograph; Gorzów Wielkopolski IG 1 borehole, depth 788.9 m

zmienność wewnątrzgatunkowa; światło przechodzące; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 788,9 m

Figs. 3, 4. *Cingulizonates rhaeticus* (Reinhardt) Schulz

intraspecies variability; 3 – optical photo-micrograph, 4 – proximal side; Kamień Pomorski IG 1 borehole, depth 140.3 m; 4 – SEM

zmienność wewnątrzgatunkowa; 3 – światło przechodzące, 4 – strona proksymalna; otwór wiertniczy Kamień Pomorski IG 1, głęb. 140,3 m; 4 – SEM

Scale bar equals 20 μm
Skala liniowa 20 μm

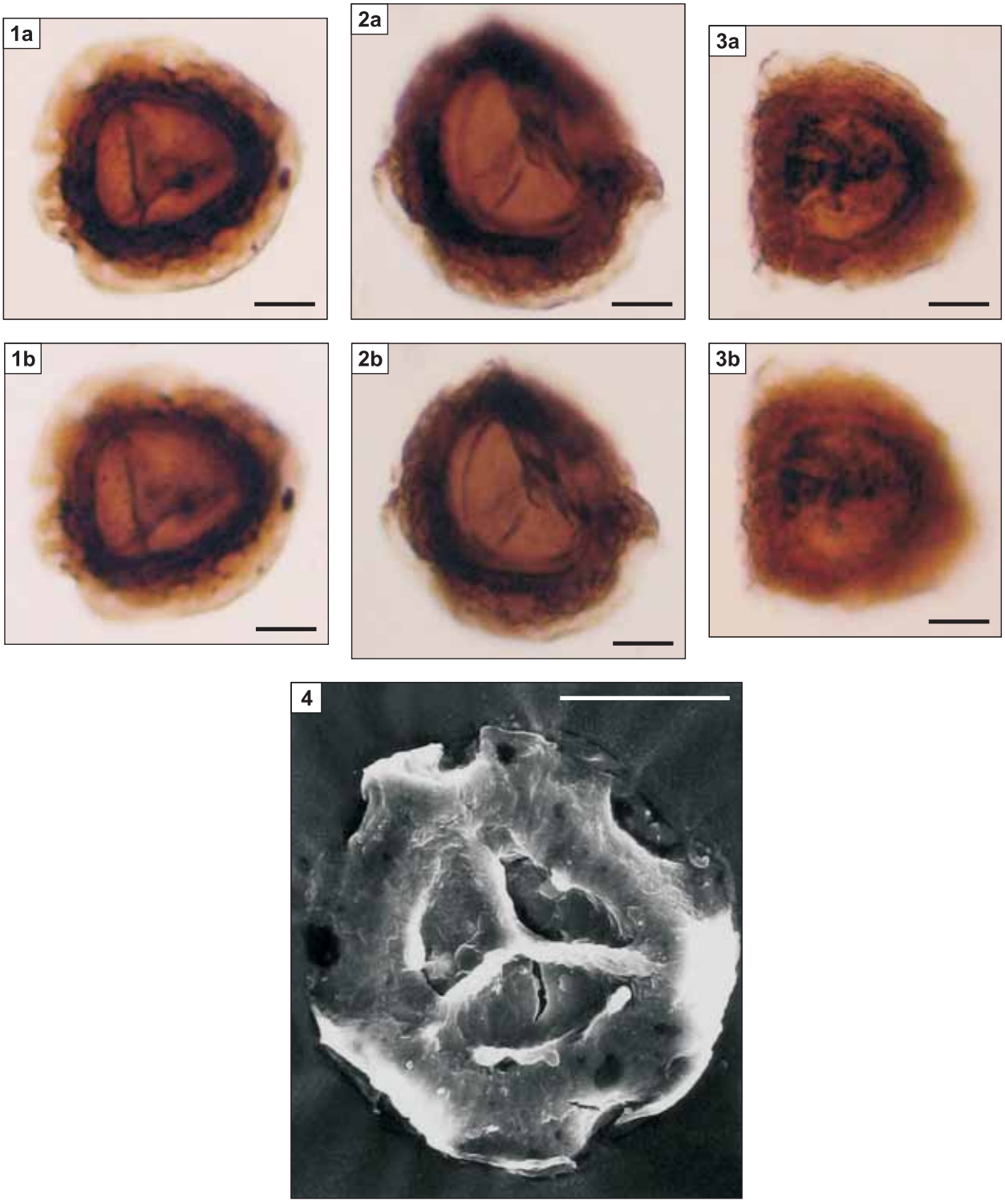

1a
2a
3a
1b
2b
3b
4

PLATE XIV

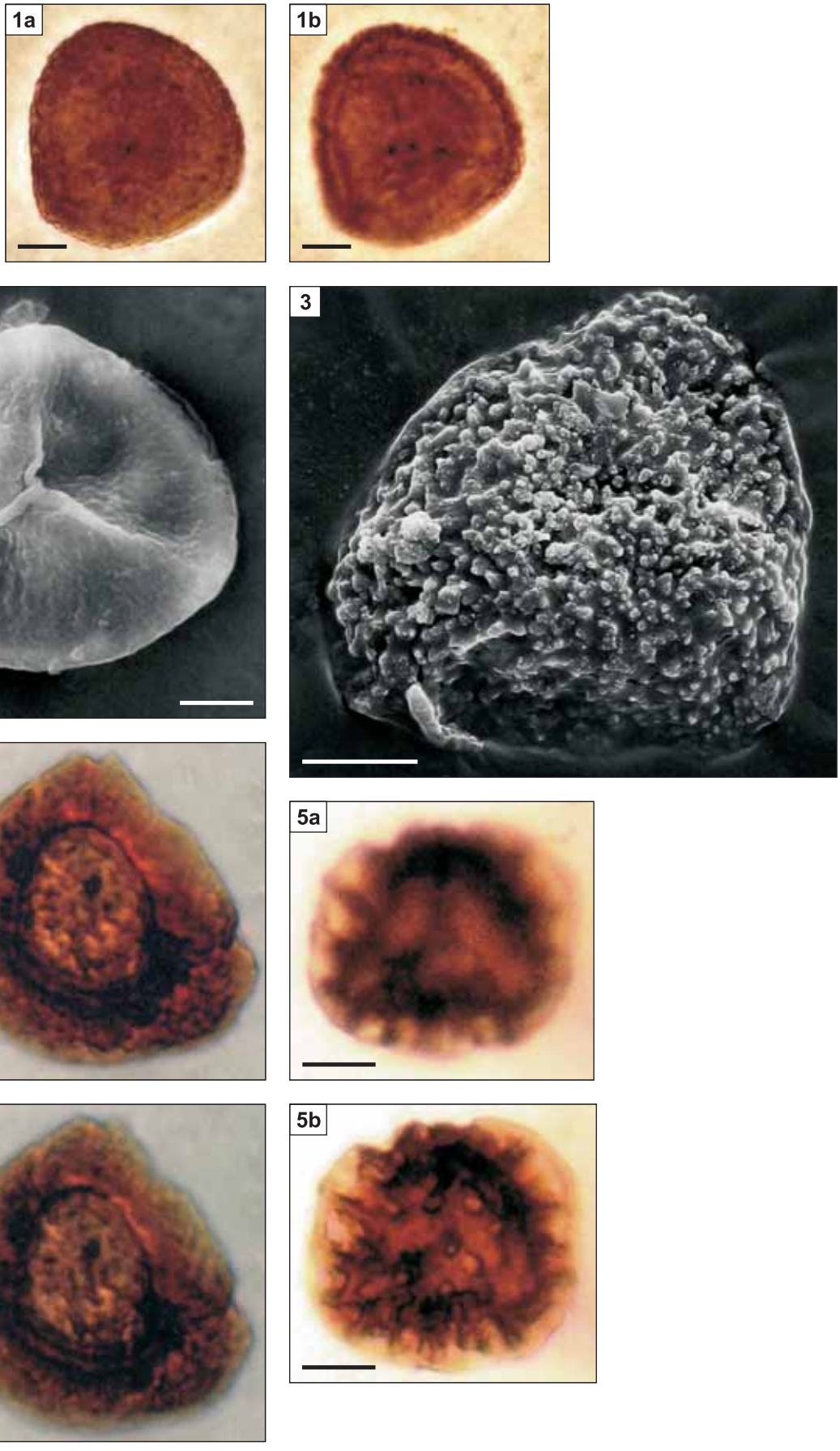
Figs. 1, 2. *Densoisporites velatus* Weyland et Krieger
1a, 2 – proximal side, 1b – distal side; Klosnowo IG 1 borehole, depth 1081.2–1086.0 m; 2 – SEM
1a, 2 – strona proksymalna, 1b – strona dystalna; otwór wiertniczy Klosnowo IG 1, głęb. 1081,2–1086,0 m; 2 – SEM

Fig. 3. *Densosporites cavernatus* Orłowska-Zwolińska
distal side; Klosnowo IG 1 borehole, depth 1090.5 m; SEM
strona dystalna; otwór wiertniczy Klosnowo IG 1, głęb. 1090,5 m; SEM

Fig. 4. *Densosporites cavernatus* Orłowska-Zwolińska
a – proximal side, b – distal side; Mroczków borehole, depth 34.8 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Mroczków, głęb. 34,8 m

Fig. 5. *Limbosporites lundblandii* Nilsson
a – proximal side, b – distal side; Gorzów Wielkopolski IG 1 borehole, depth 953.6 m
a – strona proksymalna, b – strona dystalna; otwór wiertniczy Gorzów Wielkopolski IG 1, głęb. 953,6 m

Scale bar equals 20 μm
Skala liniowa 20 μm


1a
1b
2
3
4a
5a
4b
5b