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The megaspore assemblage of Capillisporites germanicus from the Middle Triassic of Poland

The megaspore studies of boundary parts of the Lower Keuper and Upper Muschelkalk profiles, developed as clayey-sandy facies, allowed to distinguish the specific megaspore assemblage with proposed name — Capillisporites germanicus. Such assemblage had some features common with the Dijkstraisporites beutleri one, described from the Lower Keuper deposits but it contained index species for the Upper Muschelkalk that dated it as an older than the Dijkstraisporites beutleri assemblage. Differences in species content between both mentioned assemblages pointed out that in some regions the boundary parts of profiles, regarded as the Lower Keuper, were the stratigraphic equivalent of the Upper Muschelkalk from other areas. Both megaspore assemblages occurred within range of the Heliosporites dimorphus Zone of Ladinian age. Here were distinguished four new species (*Maexisporites collinus* sp. n., *Verrutriletes nodosus* sp. n., *Tenellisporites ornatus* sp. n., *Polaneuletes tuberculatus* sp. n.), three new combinations (*Henrisporites capillatus* (Fuglewicz) comb. n., *Sexaneuletes clavatus* (Fuglewicz) comb. n., *Aneuletes mesotriassicus* (Kozur) comb. n.) and two new genera (*Sexaneuletes* gen. n., *Polaneuletes* gen. n.).

INTRODUCTION

The megaspore studies based on material from 23 boreholes from the Fore-Sudetic, Western Pomerania and north-eastern Poland area (Fig. 1). Samples were taken mainly from boundary parts of profiles which according lithology and wire logs had dated as the Lower Keuper or Upper Muschelkalk (Fig. 2).

These deposits have formed during rapid marine ingression on wide area of Polish Lowland when the marine carbonate-clayey sediments of the Upper Muschelkalk had been replaced by clayey-sandy deposits of deltaic-lagunal-fluvial facies of the Lower Keuper age (I. Gajewska, 1971, 1978).

On the Fore-Sudetic area, where the marine basin of the Muschelkalk had longest existed (I. Gajewska, 1964, 1983*a*), the carbonate and carbonate-clayey sediments with

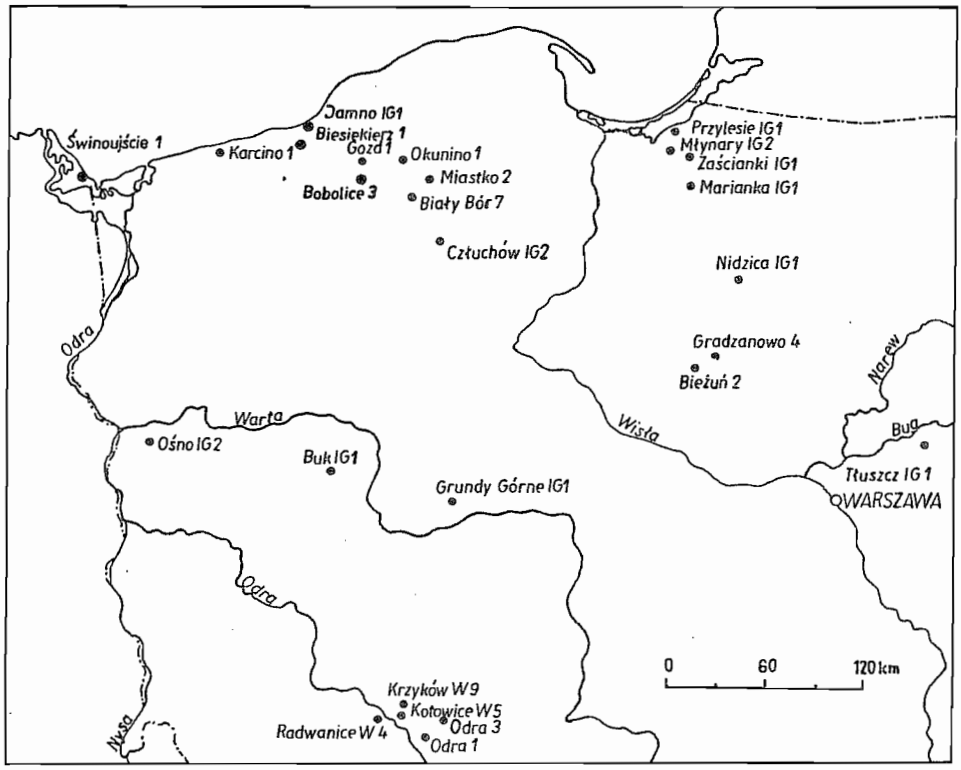

Fig. 1. Location sketch of studied profiles
Lokalizacja badanych profili

ceratites and crinoids were occurred. Megaspores were found in upper part of this series, composed of clayey-silty-sandy deposits (Ośno IG 2 borehole, depth 1298.0–1300.0 m). They made together specific and taxonomicaly variable megaspore assemblage named as Capillisporites germanicus assemblage. This one has index species for the Upper Muschelkalk which allowed to compare and correlate it with similar assemblages known outside Poland. That assemblage occurred in Ośno IG 2 profile within the range of lower part of the Heliosaccus dimorphus miospore zone. Plant microplankton of *Acritarcha* type also found here acted — according T. Orłowska-Zwolińska (1983, 1985) — as facies indicator which allowed to distinguish the marine deposits of Upper Muschelkalk from limnic sediments of the Lower Keuper. The part of profile from depth: 1298.0–1304.0 m was included — according mentioned data — to the Upper Muschelkalk. Regarding results of miospore studies of this part of profile it could be stated that the megaspore assemblage C. germanicus dates also the Upper Muschelkalk deposits.

Other distinct assemblage was noticed in profiles of several boreholes from southern part of the Fore-Sudetic Monocline (Krzyków W 9, depth 310.5–318.6 m; Rad-

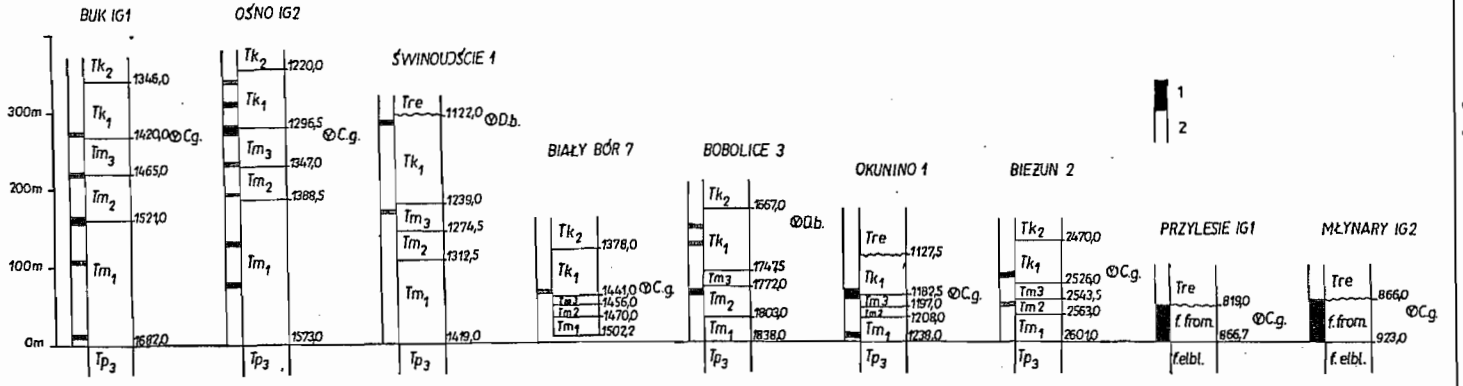

Fig. 2. Position of megaspore assemblages in selected profiles of the Muschelkalk and Lower Keuper

1 — cored parts of profiles; 2 — non-cored parts; megaspore assemblages: D.b. — Dijkstraisporites beutleri, C.g. — Capillisporites germanicus; Tp3 — Upper Buntsandstein; Tm1 — Lower Muschelkalk; Tm2 — Middle Muschelkalk; Tm3 — Upper Muschelkalk; Tk1 — Lower Keuper; Tk2 — Upper Keuper; Tre — Rhaetian; f. from. — Frombork Formation; f. elbl. — Elbląg Formation

Występowanie zespołów megasporowych w wybranych profilach wapienia muszlowego i kajpru dolnego

1 — odcinki rdzeniowane; 2 — odcinki nierdzeniowane; zespoły megasporowe: D.b. — Dijkstraisporites beutleri, C.g. — Capillisporites germanicus; Tp3 — pstry piaskowiec górny; Tm1 — wapień muszlowy dolny; Tm2 — wapień muszlowy środkowy; Tm3 — wapień muszlowy górny; Tk1 — kajper dolny; Tk2 — kajper górny; Tre — retyk; f. from. — formacja fromborska; f. elbl. — formacja elbląska

wanice W 4, depth 276.5–292.5 m; Kotowice W 5, depth 323.0 m; Odra 1, depth 196.0 m and 207.0 m; Odra 3, depth 449.5 m and Grundy Górne IG 1, depth 2122.0–2140.0 m). Its characteristic feature is significant occurrence of two species: *Dijkstraisporites beutleri* Reinhardt and *Maexisporites meditectatus* (Reinhardt) Kozur as well lack of the most of species belonged to Capillisporites germanicus assemblage. The mentioned species are widely known from the Lower Keuper deposits in Poland and allowed to identify this assemblage with Dijkstraisporites beutleri ones described earlier by author (T. Marcinkiewicz, 1978).

Fragmentary coring of the most of studied wells could not confirm stratigraphic ranges of described spore assemblages: Capillisporites germanicus and Dijkstraisporites beutleri within on borehole profile.

Western Pomerania area was northern part of the Muschelkalk sedimentary basin. Carbonate and carbonate-clayey deposits with ceratites and crinoids had origined within its deeper part (I. Gajewska, 1971, 1976) but in shallower one — the marly-carbonate sediments with sandy admixture, brownish-red in colour, lithologicaly similar to the Lower Keuper rocks. Megaspores found in some samples from these deposits form one assemblage similar — according species content — to Capillisporites germanicus one, noticed within the Upper Muschelkalk from the Fore-Sudetic Monocline.

The Upper Muschelkalk deposits from north-eastern Poland had accumulated within marginal basin zone. They consist of marly limestones with siltstone intercalations which continuously pass upward into clayey-sandy deposits of the Lower Keuper. These two stratigraphic units were not separated detaily due to lack of lithological differences between both series and index fauna (A. Szyperko-Śliwczyńska, 1967, 1973*a, b*, 1974; I. Gajewska, 1983*a, b*).

Abundant and well preserved megaspores were found in borehole profiles from north-eastern Poland. They documented typical Lower Keuper deposits (boreholes: Gradzanowo 4, Bieżuń 2, Tłuszcz IG 1) as well as series of the Frombork Formation (according data of R. Strzelecki, 1985). The species assemblage, found there, is typical for the Upper Muschelkalk and also occurs on the Fore-Sudetic Monocline area. These data suggest that studied deposits from north-eastern Poland could be regared as stratigraphic equivalent of the Upper Muschelkalk from other regions (Tab. 1).

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Described here megaspore collection is a property of Palaeobotanic Laboratory of Państwowy Instytut Geologiczny.

CHARACTERISTIC AND STRATIGRAPHIC APPRECIATION OF CAPILLISPORITES GERMANICUS ASSEMBLAGE

The description of C. germanicus assemblage based on core materials from boreholes: Biały Bór 7 (depth 1434.0–1439.0 m), Buk IG 1 (1410.0–1417.0 m), Bieżuń 2 (2514.0–2514.5 m), Człuchów IG 2 (1990.1–1996.0 m), Gozd 1 (1379.7–1386.0 m), Gradzanowo 4 (2350.5–2357.0 m), Karcino 1 (1056.5 m), Młynary IG 2 (877.5–878.5 m), Marianka IG 1 (1070.0 m), Miastko 2 (1203.5 m), Nidzica IG 1 (1845.0 m), Okunino 1 (1177.0–1183.0 m), Ośno IG 2 (1298.0–1300.0 m), Przylesie IG 1 (843.5–846.5 m), Tłuszcz IG 1 (1330.0 m), Zaścianki IG 1 (969.2 m).

Megaspore assemblages found in mentioned above profiles have some species known earlier from Dijkstraisporites beutleri assemblage which documented the limnic deposits of the Lower Keuper in Poland, Germany and Ukraine but they were noticed also in the Upper Muschelkalk (P. Reinhardt, 1963; P. Reinhardt, D. Fricke, 1969; E. Kannegieser, H. Kozur, 1972; H. Kozur, 1973; H. Kozur, E. W. Mowszowicz, 1976; T. Marcinkiewicz, 1978, 1983). Such species as: *Flabellisporites crinitus* Marcinkiewicz, *Henrisporites capillatus* (Fuglewicz) comb. n., *H. triassicus* Kozur, *Tenellisporites marcinkiewiczae* Reinhardt et Fricke and *Verrutriletes marcinkiewiczae* Kozur suggest close stratigraphic position of both assemblages but up till now such sequence has been not found in one borehole profile. Otherway, within Capillisporites germanicus assemblage are absent such species as: *Dijkstraisporites beutleri* Reinhardt and *Maexisporites meditectatus* (Reinhardt) Kozur known as most specific and index species for the Lower Keuper deposits. Lack of these species eliminates mentioned stratigraphic unit. Other new species (Tab. 2) were appeared in discussed assemblage and they allowed to distinguish individual assemblage, stratigraphicaly different from Dijkstraisporites beutleri one. Significant species in studied assemblage are such ones which were noted — after R. Fuglewicz (1977) and T. Marcinkiewicz (1983) — from deposits belonged according lithostratigraphic data to the Lower Keuper or Upper Muschelkalk. They are: *Bothriotriletes grandis* Fuglewicz, *Sexaneuletes clavatus* (Fuglewicz) comb. n., *Verrutriletes preutilis* Fuglewicz, *Nathorstisporites invenustus* Fuglewicz, *Horstisporites ?irregularis* Fuglewicz, *Narkisporites formidabilis* Marcinkiewicz, *Bacutriletes micros* Fuglewicz and *Echitriletes latispinosus* Fuglewicz. Two ones are — after author — synonyms of *Bacutriletes minimus* Kozur and *Prikaspisporites srebrodolskae* Kozur (H. Kozur, E. W. Mowszowicz, 1976).

Two significant index species occurred within studied assemblage — *Capillisporites germanicus* Kozur and *Trileites muelleri* Kozur, described earlier from Upper Muschelkalk deposits (mo_3) of Turingien (H. Kozur, 1972). Also was found *Aneuletes mesotriassicus* (Kozur) comb. n., known from the Lower Ladinian — Ceratite Beds (mo_2) of Upper Silesia (H. Kozur, 1972).

The described assemblage had some common elements with assemblage found in lower part of the Gemmanella Beds from the North-Caspian Depression (E. W. Mowszowicz, H. Kozur, 1975; H. Kozur, E. W. Mowszowicz, 1976). They are: *Bacutriletes minimus* Kozur and *Prikaspisporites srebrodolskae* Kozur. It is significant that in upper part of mentioned Gemmanella Beds occurs the assemblage with predominant species *Dijkstraisporites beutleri* Reinhardt. Age of that beds was defined as Late

Table 3

Correlation of miospore and megaspore assemblages, distinguished in the Upper Muschelkalk and Lower Keuper deposits in Poland

Lithostratigraphy	Miospore zones and subzones (T. Orłowska-Zwolińska, 1983, 1985)	Chronostratigraphy	Megaspore assemblages (T. Marcinkiewicz, 1978 and recent investigation)
Lower Keuper	*Heliosaccus dimorphus*	Ladinian	Dijkstraisporites beutleri
Upper Muschelkalk	*Tasmanites*	Anisian	Capillisporites germanicus ↓ ?

Anisian — Ladinian (see — *op. cit.*) after megaspores and ostracods[1] found in their lower part.

Additional stratigraphic indicator could be occurrence of single specimen *Erlansonisporites ?lobatus* Fuglewicz, described from uppermost Anisian – Lower Ladinian deposits in Tatra Mts (R. Fuglewicz, 1980).

New, at first time found in studied materials, species are: *Maexisporites collinus* sp. n., *Tenellisporites ornatus* sp. n., *Verrutriletes nodosus* sp. n. and *Polaneuletes tuberculatus* sp. n.

Capillisporites germanicus assemblage, although has some species common with Dijkstraisporites beutleri assemblage defining the Lower Keuper, contains index species for the Upper Muschelkalk that suggests its older age. Species, known up till now only from the Lower Keuper but found here together with species typical for the Upper Muschelkalk, have wider stratigraphic range that it was described in Polish literature. They are not index species to precise boundary between the Muschelkalk and Keuper and should be regarded as precursor species, beginning their occurrence just in top part of the Upper Muschelkalk of earlier and continuing it into overlaying deposits of the Lower Keuper.

It is interesting that Capillisporites germanicus assemblage was noticed (Tab. 3) in lower part of miospore zone Heliosaccus dimorphus, distinguished in top part of

[1] Among them was *Gemmanella (Praegemmanella) subtilis* Kozur — species as synonym *Gemmanella schweyeri* Schneider, occurred in Poland within upper part of the Middle Muschelkalk and rarely — in lower part of the Lower Keuper (O. Styk, 1982).

the Upper Muschelkalk (T. Orłowska-Zwolińska, 1983, 1985) as subzone with Tasmanites.[2] Dijkstraisporites beutleri assemblage occurs in upper part of that zone (without marine plankton) which reflects limnic conditions of the Lower Keuper sedimentation.

This Capillisporites germanicus assemblage should be connected with Lower Ladinian due to fact that microflora with index species *Heliosaccus dimorphus* is related to — after T. Orłowska-Zwolińska — Ladinian. Consequently, the Dijkstraisporites beutleri assemblage could be placed within the Upper Ladinian.

The distinguishing of Capillisporites germanicus assemblage has significant value for correlations of profiles from marginal zone of the Upper Muschelkalk sedimentary basin, in which the facies distribution could be similar as during lower part of the Lower Keuper.

SOME SPECIES DESCRIPTION AND TAXONOMIC AND STRATIGRAPHIC REMARKS

Genus *Trileites* (Erdtman 1945, 1947) Potonié, 1956
Trileites muelleri Kozur
(Pl. I, Figs 1, 2)

1973 *Trileites muelleri* Kozur; H. Kozur: Pl. 1, Figs 1, 3a, b.

Description. Megaspores rounded in outline, 600–855 μm in diameter. Rays of tetrad scar straight with relatively thin lamellae of sharp margins. Their height changes from 70 to 110 μm. Lack of arcuate ridges. Exine smooth, slightly shiny.

Occurrence. Poland: Upper Muschelkalk, lower part of the Lower Keuper; Germany: Upper Muschelkalk (m_{O3}).

Genus *Maexisporites* Potonié, 1956
Maexisporites collinus sp. n.
(Pl. I, Figs 3–5; Pl. II, Figs 1, 2)

Holotypus: MUZ PIG 507 (123), Pl. I, Fig. 4.
Locus typicus: Poland, Biały Bór 7 borehole, depth 1434.0–1439.0 m.
Stratum typicum: Upper Muschelkalk.
Derivatio nominis: *collinus* (Latin) — hummocky.

Description. Megaspores rounded-oval in outline, 340–560 μm in diameter. Rays of tetrad scar distinct, straight or slightly undulated, forming low ridges

[2]Later studies of T. Orłowska- Zwolińska (1988) documented an occurrence of *Tasmanites* in all Upper Muschelkalk.

of constant width. Rays are framed with shallow groove at both sides. Large contact faces. Arcuate ridges subtle defined. Coarse exine ornamentation.

R e m a r k s . Described megaspores are similar to *Maexisporites meditectatus* (Reinhardt) Kozur. Have larger diameter, grooves along rays of tetrad scar and other surface ornamentation.

O c c u r r e n c e . Poland: Upper Muschelkalk, lower part of the Lower Keuper, Frombork Formation.

Genus *Verrutriletes* (van der Hammen, 1954) Potonié, 1956
Verrutriletes nodosus sp. n.
(Pl. II, Fig. 4; Pl. III, Fig. 1)

H o l o t y p u s : MUZ PIG 507 (201), Pl. III, Fig. 1.
L o c u s t y p i c u s : Poland, Przylesie IG 1 borehole, depth 845.0–845.3 m.
S t r a t u m t y p i c u m : Frombork Formation.
D e r i v a t i o n o m i n i s : *nodosus* (Latin) – nodular.

D e s c r i p t i o n . Megaspores rounded-triangular in outline, 340–440 μm in diameter. Tetrad scar prominent in the form of humocky ridges, about 15–40 μm in height. Arcuate ridges distinctly marked, formed by joining of individual elements of ornamentation. All surface is covered with densely spaced tubercles. Tubercles, rounded and irregular, have height up to 20 μm and base width up 15 μm. They often join together forming elongated elements of ornamentation.

O c c u r r e n c e . Poland: Upper Muschelkalk, lower part of the Lower Keuper, Frombork Formation.

Genus *Bacutriletes* (van der Hammen, 1954) Potonié, 1956
Bacutriletes minimus Kozur
(Pl. III, Fig. 5; Pl.IV, Figs 3, 4; Pl. V, Figs 1, 2; Pl. VI, Figs 4, 5)

1976 *Bacutriletes minimus* Kozur; H. Kozur, E. W. Mowszowicz: Pl. 1, Fig. 3.
1977 *Bacutriletes micros* Fuglewicz; R. Fuglewicz: Pl. 33, Figs 1–4.
1986 *Bacutriletes micros* Fuglewicz; R. Fuglewicz: Pl. 93, Figs 1, 3.

D e s c r i p t i o n . Megaspores rounded-triangular in outline, 230–250 μm in diameter. Rays of tetrad scar long with lamellae of 20 μm height. Contact faces covered with fine conical appendages. Remaining spore surface sculptered with finger-shaped appendages. Appendages with rounded or truncated apexes have length up to 20 μm and base width about 5–10 μm.

O c c u r r e n c e . Poland: Upper Muschelkalk, lower part of the Lower Keuper, Frombork Formation; Ukraine: south-western part of the North-Caspian Margin — lower part of the Gemmanella Beds (Anisian – Ladinian).

Genus *Prikaspisporites* Kozur, 1976
Prikaspisporites srebrodolskae Kozur
(Pl. VII, Fig. 5; Pl. IX, Figs 1, 2; Pl. X, Figs 1, 2, 4)

1976 *Prikaspisporites srebrodolskae* Kozur; H. Kozur, E. W. Mowszowicz: Pl. 2, Fig. 6 a, b.
1977 *Echitriletes latispinosus* Fuglewicz; R. Fuglewicz: Pl. 34, Figs 1–2.
1986 *Echitriletes latispinosus* Fuglewicz; R. Fuglewicz: Pl. 94, Figs 1–4.

D e s c r i p t i o n . Megaspores triangular-rounded in outline, 300–400 μm in diameter. Tetrad scar distinct, in form of slightly undulated lamellae with deeply incised margins. Lamellae height up to 40 μm. Surface of contact facies with flat, conical appendages. Distal spore surface covered with flat, finger-shaped appendages, 80 μm long and 10–20 μm wide. Appendages joined at the base with low horizontal lamellae form bands of crests. On distal side visible imperfect reticulum formed due to joining of individual elements of ornamentation.

O c c u r r e n c e . Poland: Upper Muschelkalk, lower part of the Lower Keuper; Ukraine: south-western part of the North-Caspian Margin — lower part of the Gemmanella Beds (Anisian – Ladinian).

Genus *Henrisporites* (Potonié) Binda et Srivastava
Henrisporites capillatus (Fuglewicz) comb. n.
(Pl. XII, Fig. 3; Pl. XIII, Fig. 4)

1977 *Dijkstraisporites capillatus*, Fuglewicz; R. Fuglewicz : Pl. 38, Fig. 3; Pl. 39, Fig. 1 a, b; Pl. 40, Fig. 3.
1978 *Henrisporites delicatus* Marcinkiewicz; T. Marcinkiewicz : Pl. 12, Fig. 7; Pl. 8, Figs 1–3; Pl. 14, Figs 1–4.
1983 *Henrisporites delicatus* Marcinkiewicz; T. Marcinkiewicz : Pl. 7, Figs 3–4; Pl. 8, Figs 1–4; Pl. 9, Figs 1–4.
1986 *Dijkstraisporites capillatus* Fuglewicz; R. Fuglewicz: Pl. 100, Figs 4, 7.

R e m a r k s . All megaspores mentioned in synonym index have equatorial flange and ornamentation as fine capillate appendages sparsely spaced on exine surface. These megaspores were described by R. Fuglewicz (1977) as *Dijkstraisporites capillatus* Fuglewicz and by T. Marcinkiewicz (1978) as *Henrisporites delicatus* Marcinkiewicz. In this study such spores represent one species with proposed species name: *Henrisporites capillatus* (Fuglewicz) comb. n.

O c c u r r e n c e . Poland: Upper Muschelkalk and Lower Keuper, Frombork Formation.

Genus *Nathorstisporites* Jung, 1958
Nathorstisporites invenustus Fuglewicz
(Pl. XI, Fig. 4)

1977 *Nathorstisporites invenustus* Fuglewicz; R. Fuglewicz: Pl. 40, Figs 1–2.
1986 *Nathorstisporites invenustus* Fuglewicz; R. Fuglewicz: Pl. 100, Figs 2, 6.

D e s c r i p t i o n . Megaspores rounded in outline, 320–490 μm in diameter. Tetrad scar obscured by appendages of proximal side. Arcuate ridges not developed. Spore surface covered with low, irregular lamellae of 20 μm height, which are peak--shaped in adhesion points. Lamellae joined together forming irregular network.

R e m a r k s . Described specimens have great similarity to *Nathorstisporites dobruskinae* Kozur (H. Kozur, E. W. Mowszowicz, 1976) but dim specimen photos, presented in citated work, make such comparison difficult.

O c c u r r e n c e . Poland: Upper Muschelkalk, lower part of the Lower Keuper, Frombork Formation.

Genus *Tenellisporites* Potonié, 1956
Tenellisporites ornatus sp. n.
(Pl. X, Figs 3, 5; Pl. XII, Figs 1, 2)

H o l o t y p u s : MUZ PIG 507 (162), Pl. XII, Fig. 1.
L o c u s t y p i c u s : Poland, Przylesie IG 1 borehole, depth 846.5 m.
S t r a t u m t y p i c u m : Frombork Formation.
D e r i v a t i o n o m i n i s : *ornatus* (Latin) — armed.

D e s c r i p t i o n . Megaspores rounded in outline, 250–360 μm in diameter. Rays of tetrad scar long, extending to the equatorial zone, developed as low, slightly undulated lamellae. Proximal side smooth or covered with few very fine tubercles. In equatorial zone visible ribbon appendages, 30–200 μm in length, some of them have widoned ends. Appendages are densely spaced, often lateraily knited. Distal side ornamented with appendages similar to equatorial ones and also fine tubercles are visible.

R e m a r k s . This species is distinctly similar to *Tenellisporites marcinkiewiczae* Reinhardt et Fricke. It differs with other ornamentation on distal side.

O c c u r r e n c e . Poland: Upper Muschelkalk, lower part of the Lower Keuper, Frombork Formation.

Genus *Aneuletes* Harris, 1961
Synonym: *Semiornatisporites* Kozur, 1973
Aneuletes mesotriassicus (Kozur) comb. n.
(Pl. XIII, Figs 1–3)

1973 *Semiornatisporites mesotriassicus* Kozur; H. Kozur: Pl. 1, Fig. 5.

D e s c r i p t i o n . Megaspores rounded in outline, 340–500 μm in diameter, without tetrad scar. Tubercles on concave area are diagnostic feature. They are of various size, sometime they join together forming elongated elements of ornamentation.

R e m a r k s . Genus *Semiornatisporites* should be regarded as younger synonym of name *Aneuletes* (J. Jansonius, L. V. Hills, 1977).

O c c u r r e n c e . Poland: Upper Muschelkalk, lower part of the Lower Keuper, Frombork Formation; Laryszów (Upper Silesia) — Lower Ladinian — Ceratites Beds (m_{O2}).

Genus *Sexaneuletes* gen. n.
Typical species: *Sexaneuletes clavatus* (Fuglewicz) comb. n.

D e s c r i p t i o n . Megaspores without tetrad scar, 300–500 μm in diameter. They have small, shallow cavity, surrounded with exine ridge of irregularly hexagonal external outline and with six folds, radiated toward equatorial zone. Megaspore surface covered with tubercles.

R e m a r k s . Two megaspore kinds without tetrad scar are known in literature. First of them is genus *Aneuletes*, proposed by T. M. Harris (1961) for bodies resembling megaspores but without tetrad scar. These are spores are spherical in outline, with flat or slightly concave area at one side. This area is covered with tubercles. Next genus is *Carbaneuletes* (A. M. Butterworth, E. Spinner, 1967; E. Spinner, 1983, 1984) was proposed for sporomorphs, 300–600 μm in diameter, without tetrad scar. Wall of such sporomorphs consists of three layers. The outermost layer is thin and smooth. It is characterized by a small circular structure; the middle one is reticulate, the innermost layer is thin, finely granulose.

Sexaneuletes clavatus (Fuglewicz) comb. n.
(Pl. XIV, Figs 1–3)

1977 *Aneuletes clavatus* Fuglewicz; R. Fuglewicz: Pl. 41, Fig. 1a, b.
1986 *Aneuletes clavatus* Fuglewicz; R. Fuglewicz: Pl. 102, Figs 3, 5.

D e s c r i p t i o n : Megaspores rounded in outline, 350–470 μm in diameter. They have shallow and relatively small cavity surrounded with exine ridge of hexagonal external outline, with six folds, radiated toward equatorial zone. Internal cavity diameter is 80–130 μm. Exine ornamentation consists of fine tubercles, closely packed and they often join together forming irregular elements. Nearby cavity tubercles are finer and more packed than on other areas.

R e m a r k s . This species, described by R. Fuglewicz as *Aneuletes clavatus* was offered to include into genus *Sexaneuletes* due to occurring of cavity framed with exine ridge with outside folds and ornamentation consisting of tubercles. Megaspores described by R. Fuglewicz (1977) as *Aneuletes acrochordones* resemble in morphology *S. clavatus* (Fuglewicz) comb. n. and could be also classified as *Sexaneuletes*.

O c c u r r e n c e . Poland: Upper Muschelkalk, lower part of the Lower Keuper, Frombork Formation.

Genus *Polaneuletes* gen. n.
Typical species: *Polaneuletes tuberculatus* sp. n. — described lower

D e s c r i p t i o n . Megaspores without tetrad mark, 320–530 μm in diameter. Ring of closely adhered tubercles is their diagnostic feature. Ring inside slightly concave. Ornamentation of spore surface outside this ring is tubercular or net-shape.

Polaneuletes tuberculatus sp. n.
(Pl. XIII, Figs 5, 6; Pl. XIV, Figs 4–6)

H o l o t y p u s : MUZ PIG 507 (177), Pl. XIV, Fig. 6.
L o c u s t y p i c u s : Poland, Przylesie 1G 1 borehole, depth 845.5 m.
S t r a t u m t y p i c u m : Frombork Formation.
D e r i v a t i o n o m i n i s : *tuberculatus* (Latin) — covered with tubercles.

D e s c r i p t i o n . Megaspores rounded in outline, 320–470 μm in diameter, without tetrad scar. They have ring with internal diameter about 300 μm, consisting of closely joined tubercles. Surface inside this ring is slightly concave, ornamented with tubercles. Outside ring occur tubercles of irregular shapes and various size (30–35 μm). Sometimes tubercles join together forming elongated and rounded elements of ornamentation.

R e m a r k s . Studied specimens resemble in general morphology *Aneuletes pomeranus* Fuglewicz (R. Fuglewicz, 1977). Presence of this ring is their common feature but they have different ornamentation which is nodular at *P. tuberculatus* but *reticular* — at *A. pomeranus*. *A. pomeranus* Fuglewicz could be included to genus *Polaneuletes* due to presence of ring, surrounding concave spore area.

O c c u r r e n c e . Poland: Upper Muschelkalk, lower part of the Lower Keuper, Frombork Formation.

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Teresa MARCINKIEWICZ

ZESPÓŁ MEGASPOROWY CAPILLISPORITES GERMANICUS ZE ŚRODKOWEGO TRIASU POLSKI

Streszczenie

Badaniom megasporowym poddano osady ilasto-piaszczyste, zaliczane w schematach litostratygraficznych do wapienia muszlowego górnego lub do dolnych odcinków kajpru dolnego. Znalezione w tych osadach gatunki megaspor dały podstawę do wyróżnienia charakterystycznego zespołu megasporowego, który określono w obecnej pracy mianem Capillisporites germanicus.

Zespół Capillisporites germanicus wykazuje pewne cechy wspólne z zespołem Dijkstraisporites beutleri dokumentującym w polskich profilach osady kajpru dolnego, co świadczy o bliskości położenia stratygraficznego obu zespołów, chociaż nie udało się prześledzić ich następstwa w jednym profilu wiertniczym. Badany zespół wykazuje jednocześnie charakterystyczne zmiany w składzie gatunkowym, które decydują o jego odrębności. Wśród gatunków zasługujących na uwagę należy wymienić następujące: *Flabellisporites crinitus* Marcinkiewicz, *Henrisporites capillatus* (Fuglewicz) comb. n., a poza tym *Narkisporites fornidabilis* Marcinkiewicz, *Prikaspisporites srebrodolskae* Kozur, *Aneuletes mesotriassicus* (Kozur) comb. n. i *Sexaneuletes clavatus* (Fuglewicz) comb. n. i in. Zespół ten odznacza się także obecnością gatunków wskaźnikowych dla górnego wapienia muszlowego, takich jak *Capillisporites germanicus* Kozur, *Trileites muelleri* Kozur, co skłania do wniosku, iż jest to zespół starszy od wspomnianego zespołu Dijkstraisporites beutleri.

Ponadto stwierdzono, że zespół megasporowy Capillisporites germanicus pojawia się w niższej części zasięgu miosporowego poziomu Heliosaccus dimorphus obejmującego stropowy odcinek górnego wapienia muszlowego. Natomiast zespół Dijkstraisporites beutleri związany jest z górną częścią wzmiankowanego wyżej poziomu Heliosaccus dimorphus, charakteryzującego limniczne warunki tworzenia się osadów kajpru dolnego. Uwzględniając datowanie ustalone na podstawie miospor (T. Orłowska-Zwolińska, 1983, 1985) przyjęto, że megasporowy zespół Capillisporites germanicus znajduje się w obrębie niższego ladynu, a zespół Dijkstraisporites beutleri należy do wyższego ladynu.

PLATE I

Figs 1, 2. *Trileites muelleri* Kozur

1 — MUZ PIG 507 (119), 2 — MUZ PIG 507 (120); Ośno IG 2 borehole, depth 1298.0 m

Otwór Ośno IG 2, głęb. 1298,0 m

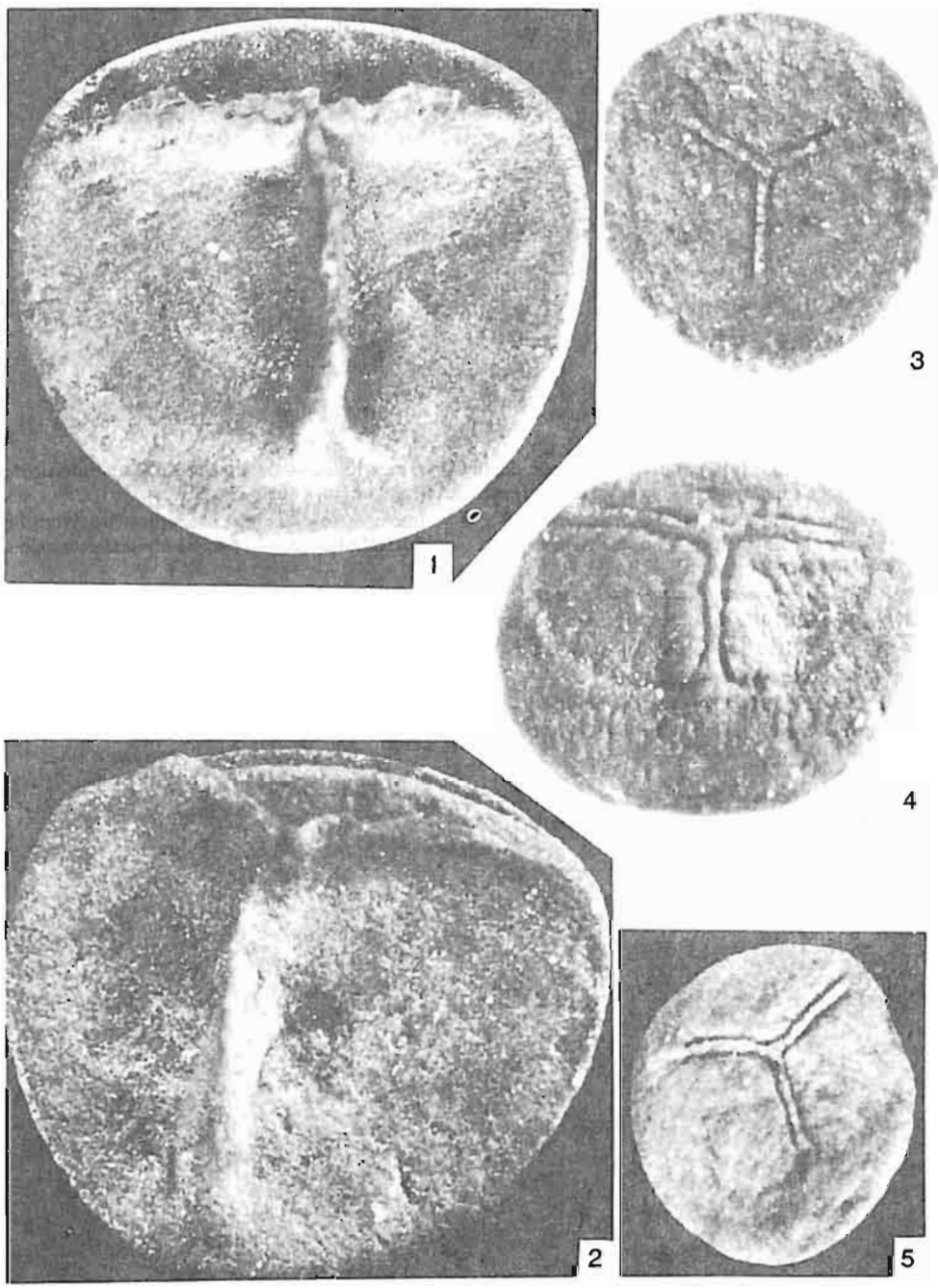
Figs 3–5. *Maexisporites collinus* sp. n.

3 — MUZ PIG 507 (125), Bieżuń 2 borehole, depth 2514.5 m; 4 — holotype, MUZ PIG 507 (123), Biały Bór 7 borehole, depth 1434.0–1439.0 m; 5 — MUZ PIG 507 (124), Biały Bór 7 borehole, depth 1439.0 m

3 — otwór Bieżuń 2, głęb. 2514,5 m; 4 — holotyp, otwór Biały Bór 7, głęb. 1434,0–1439,0 m; 5 — otwór Biały Bór, głęb. 1439,0 m

All photos (1–5) in reflected light; x 100

Wszystkie okazy (1–5) w świetle odbitym; pow. 100 x



Teresa MARCINKIEWICZ — The megaspore assemblage of Capillisporites germanicus from the Middle Triassic of Poland

PLATE II

Figs 1, 2. *Maexisporites collinus* sp. n.

1 — MUZ PIG 507 (193), Bieżuń 2 borehole, depth 2514.5 m, x 150; 2 — fragment of the same specimen, proximal side small spherules on exine surface supposed fungal origin, x 4000

1 — otwór Bieżuń 2, głęb. 2514,5 m, pow. 150 x; 2 — fragment tego samego okazu ilustrujący rzeźbę powierzchni proksymalnej; widoczne małe kuleczki na powierzchni egzyny — przypuszczalnie związane z grzybami, pow. 4000 x

Fig. 3. *Maexisporites meditectatus* (Reinhardt) Kozur

MUZ PIG 507 (191), Kotowice M 5 borehole, depth 383.0 m, x 220

Otwór Kotowice M 5, głęb. 383,0 m, pow. 220 x

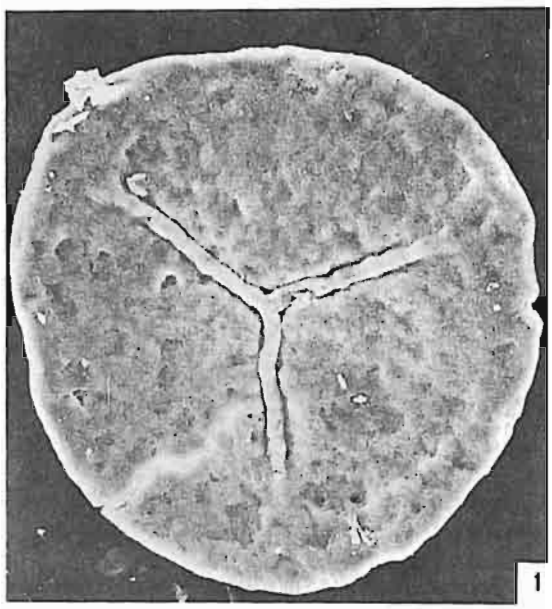
Fig. 4. *Verrutriletes nodosus* sp. n.

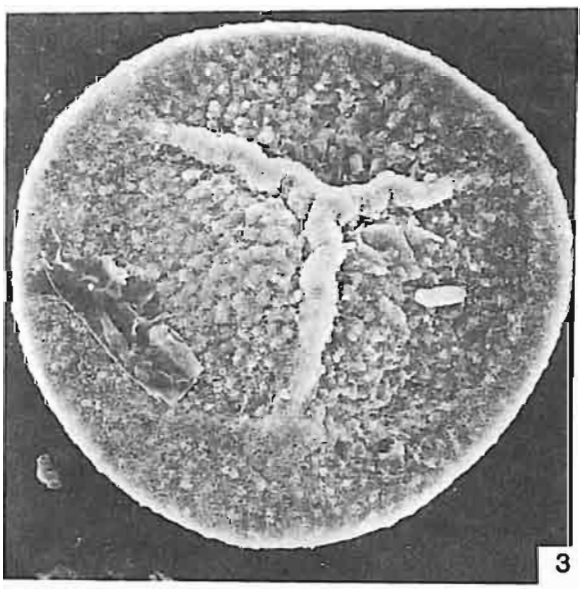
MUZ PIG 507 (234), Przylesie IG 1 borehole, depth 845.0–845. 3 m, x 100

Otwór Przylesie IG 1, głęb. 845,0–845,3 m, pow. 100 x

All photos in SEM

Wszystkie okazy w skaningowym mikroskopie elektronowym





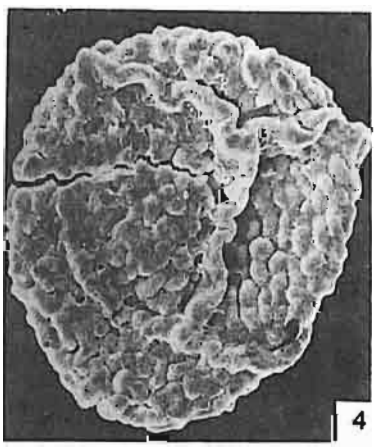


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PLATE III

Fig. 1. *Verrutriletes nodosus* sp. n.

Holotype, MUZ PIG 507 (201), Przylesie IG 1 borehole, depth 845. 3 m, x 200

Holotyp, otwór Przylesie IG 1, głęb. 845,3 m, pow. 200 x

Figs 2–4. *Verrutriletes preutilis* Fuglewicz

2 — MUZ PIG (137), proximal side, Przylesie IG 1 borehole, depth 846.5 m, x 100; 3 — the same specimen, distal side; 4 — MUZ PIG 507 (229), Przylesie IG 1 borehole, depth 845. 0–845.3 m, x 100

2 — powierzchnia proksymalna, otwór Przylesie IG 1, głęb. 846,5 m, pow. 100 x; 3 — ten sam okaz, powierzchnia dystalna, 4 — Przylesie IG 1, głęb. 845, 0–845,3 m, pow. 100 x

Fig. 5. *Bacutriletes minimus* Kozur

MUZ PIG 507 (131), Tłuszcz IG 1 borehole, depth 1330.0m, x 150

Otwór Tłuszcz IG 1, głęb. 1330,0 m, pow. 150 x

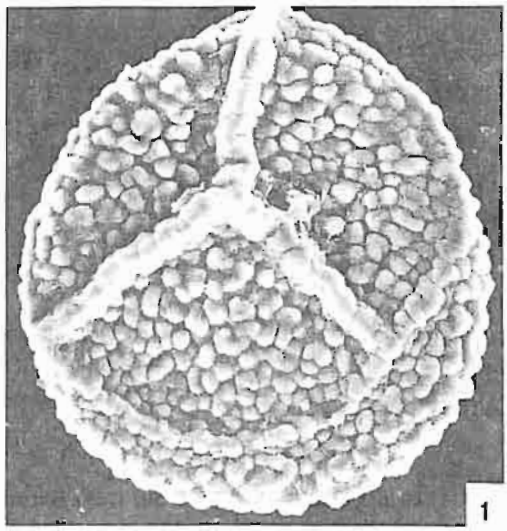
Fig. 6. *Verrutriletes marcinkiewiczae* Kozur

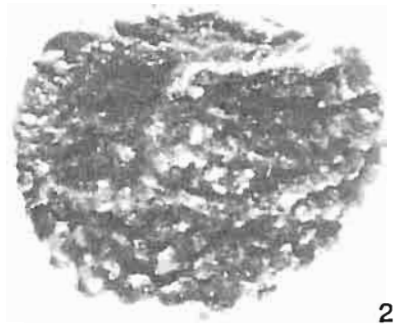
MUZ PIG 507 (197), Przylesie IG 1 borehole, depth 846.5 m, x 120

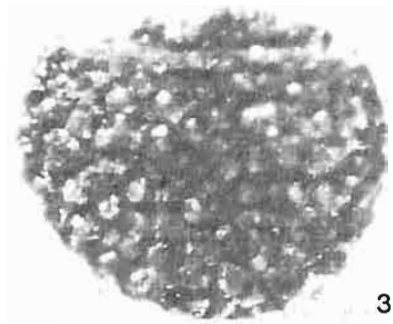
Otwór Przylesie IG 1, głęb. 846, 5 m, pow. 120 x

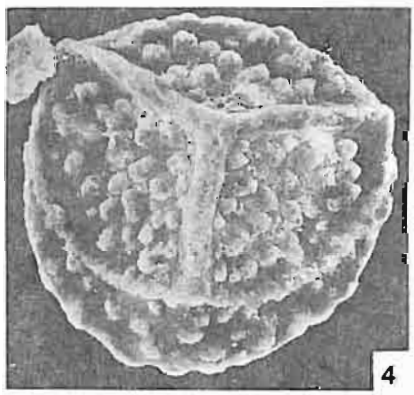
Figs 1, 4, 6 — SEM photos, Figs 2, 3, 5 — photos in reflected light

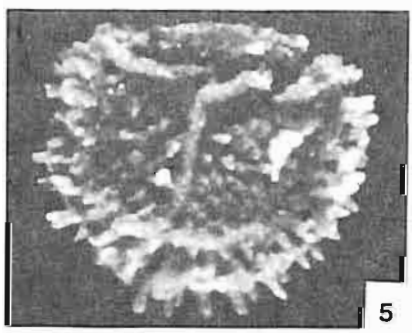
Fig. 1, 4, 6 — w skaningowym mikroskopie elektronowym, fig. 2, 3, 5 — w świetle odbitym

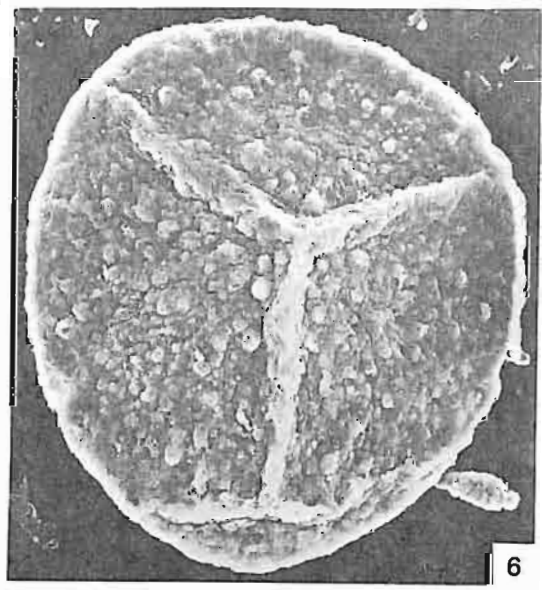












Teresa MARCINKIEWICZ — The megaspore assemblage of Capillisporites germanicus from the Middle Triassic of Poland

PLATE IV

Figs 1, 2. *Capillisporites germanicus* Kozur

1 — MUZ PIG 507 (199), Okunino 1 borehole, depth 1177.0 m, x 130; 2 — MUZ PIG 507 (139), Nidzica IG 1 borehole, depth 1845.0 m, x 100

1 — otwór Okunino 1, głęb. 1177,0 m, pow. 130 x; 2 — otwór Nidzica IG 1, głęb. 1845,0 m, pow. 100 x

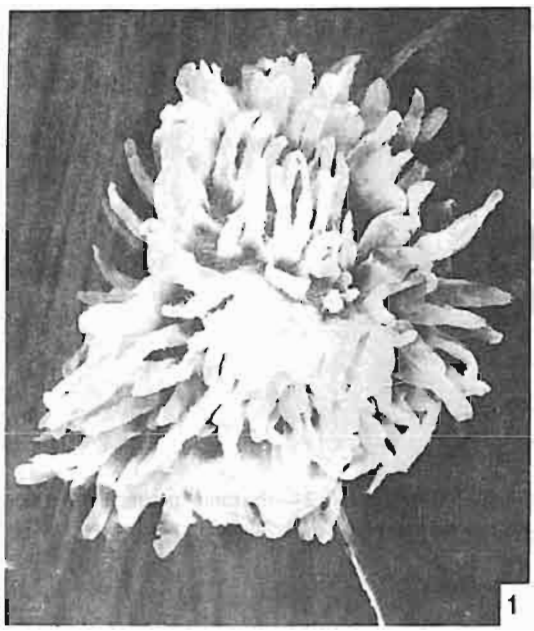
Figs 3, 4. *Bacutriletes minimus* Kozur

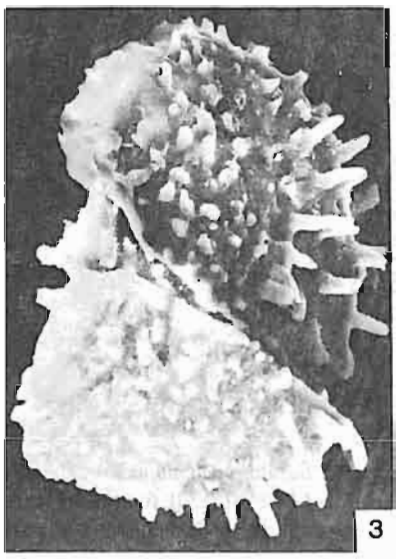
3 — MUZ PIG 507 (195), Przylesie IG 1 borehole, depth 846.5 m, x 200; 4 — fragment of the same specimen, ornamentation of distal side, x 780

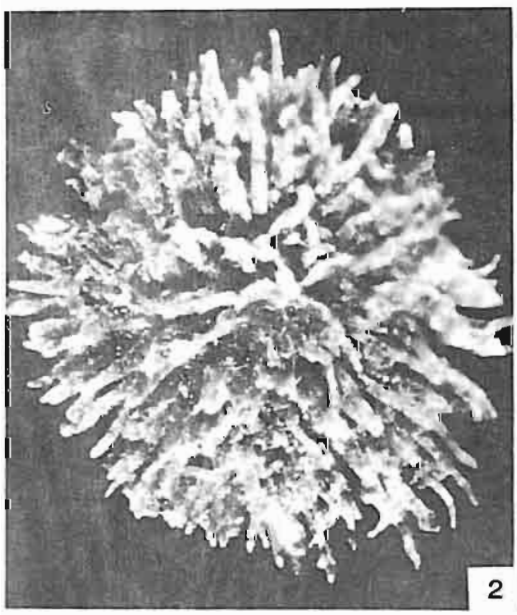
3 — otwór Przylesie IG 1, głęb. 846,5 m, pow. 200 x; 4 — fragment tego samego okazu ilustrujący urzeźbienie powierzchni dystalnej, pow. 780 x

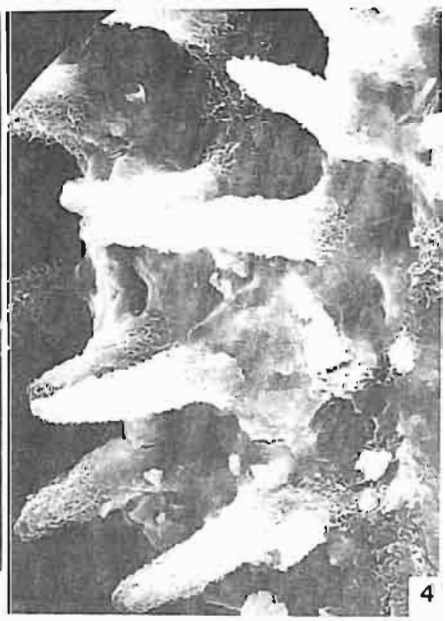
Figs 1, 3, 4 — SEM photos, Fig. 2 — photo in reflected light

Fig. 1, 3, 4 — w skaningowym mikroskopie elektronowym, fig. 2 — w świetle odbitym









Teresa MARCINKIEWICZ — The megaspore assemblage of Capillisporites germanicus from the Middle Triassic of Poland

PLATE V

Figs 1, 2. *Bacutriletes minimus* Kozur
1 — MUZ PIG 507 (130), Biały Bór 7 borehole, depth 1439.0 m, x 150; 2 — the same specimen, distal side
1 — otwór Biały Bór 7, głęb. 1439,0 m, pow. 150 x; 2 — ten sam okaz powierzchnia dystalna
Fig. 3. *Bothriotriletes grandis* Fuglewicz
MUZ PIG 507 (127), Buk IG 1 borehole, depth 1410.0 m, x 70
Otwór Buk IG 1, głęb. 1410,0 m, pow. 70 x
Fig. 4. *Capillisporites germanicus* Kozur
MUZ PIG 507 (239), Okunino 1 borehole, depth 1180.6 m, x 100
Otwór Okunino 1, głęb. 1180,6 m, pow. 100 x
Fig. 5. *Erlanosonisporites ?lobatus* Fuglewicz
MUZ PIG 507 (235), Przylesie IG 1 borehole, depth 845. 0–845.3 m, x 100
Otwór Przylesie IG 1, głęb. 845,0–845,3 m, pow. 100 x

Figs 1–3 — photos in reflected light, Figs 4, 5 — SEM photos
Fig. 1–3 — w świetle odbitym, fig. 4, 5 — w skaningowym mikroskopie elektronowym

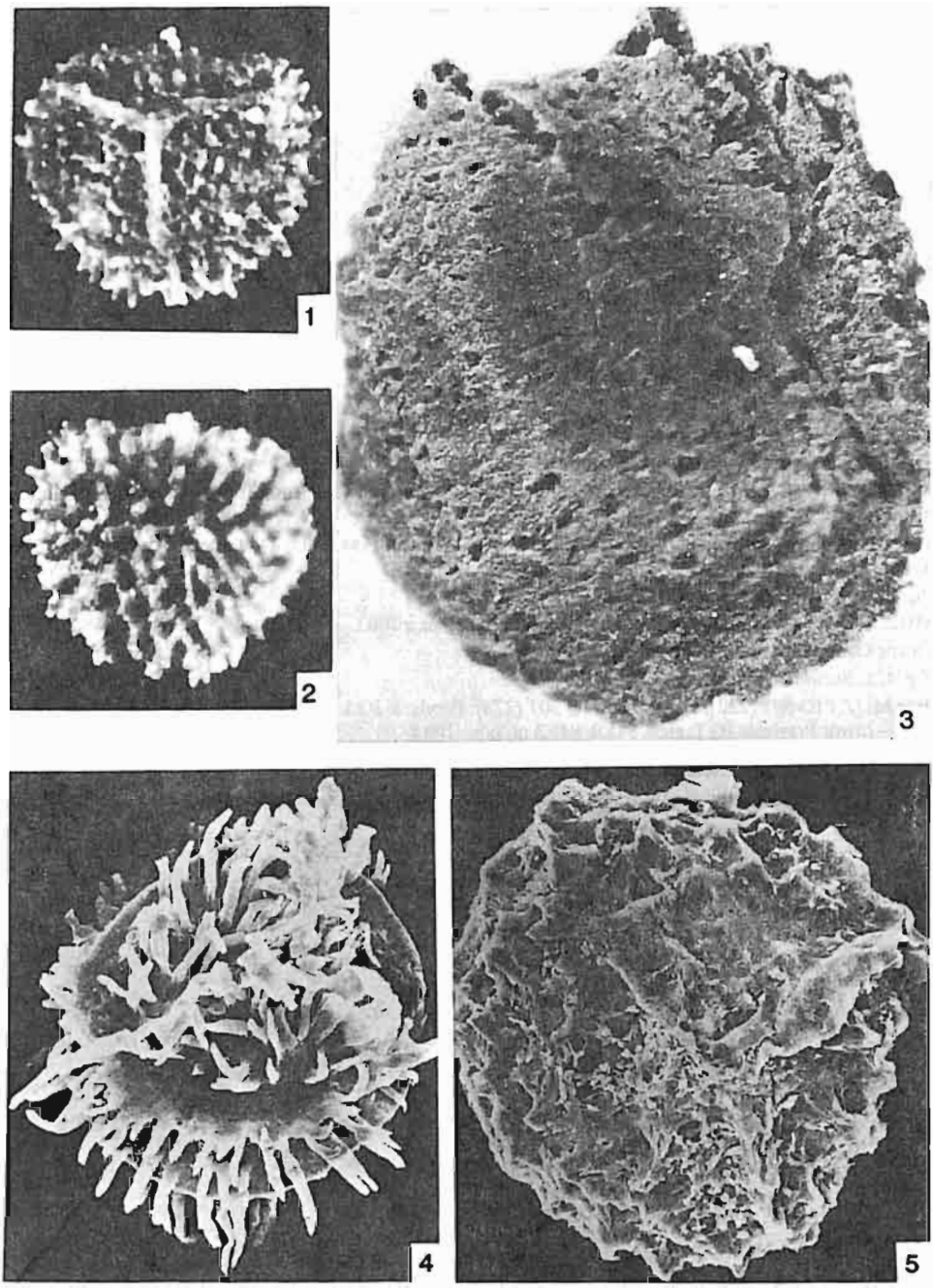


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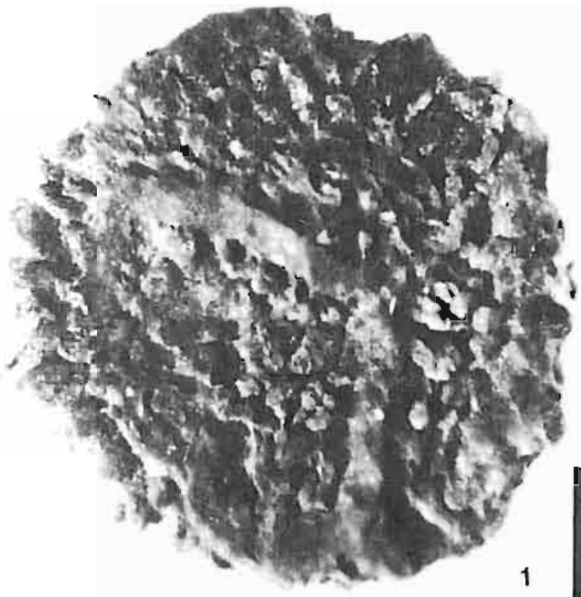
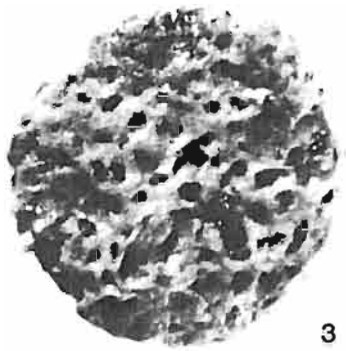
PLATE VI

Figs 1, 2. *Narkisporites fornidabilis* Marcinkiewicz
1 — MUZ PIG 507 (141), proximal side, Okunino 1 borehole, depth 1180.6 m, x 100; 2 — the same specimen, distal side
1 — powierzchnia proksymalna, otwór Okunino 1, głęb. 1180,6 m, pow. 100 x; 2 — ten sam okaz, powierzchnia dystalna
Fig. 3. *Bothriotriletes grandis* Fuglewicz
MUZ PIG 507 (128), Ośno IG 2 borehole, depth 1300.0 m, x 100
Otwór Ośno IG 2, głęb. 1300,0 m, pow. 100 x
Fig. 4, 5. *Bacutriletes minimus* Kozur
4 — MUZ PIG 507 (222), 5 — MUZ PIG 507 (223); Przylesie IG 1 borehole, depth 845.0–845.3 m, x 100
4, 5 — otwór Przylesie IG 1, głęb. 845,0–845,3 m, pow. 100 x

Figs 1–3 — photos in reflected light; Figs 4, 5 — SEM photos
Fig. 1–3 — w świetle odbitym; fig. 4, 5 — w skaningowym mikroskopie elektronowym



1



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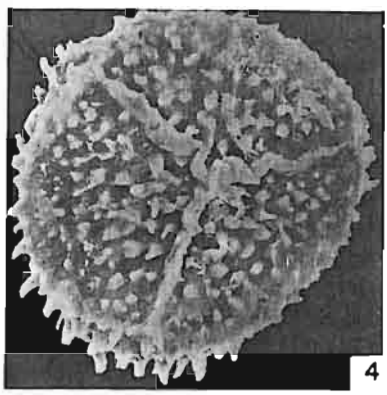

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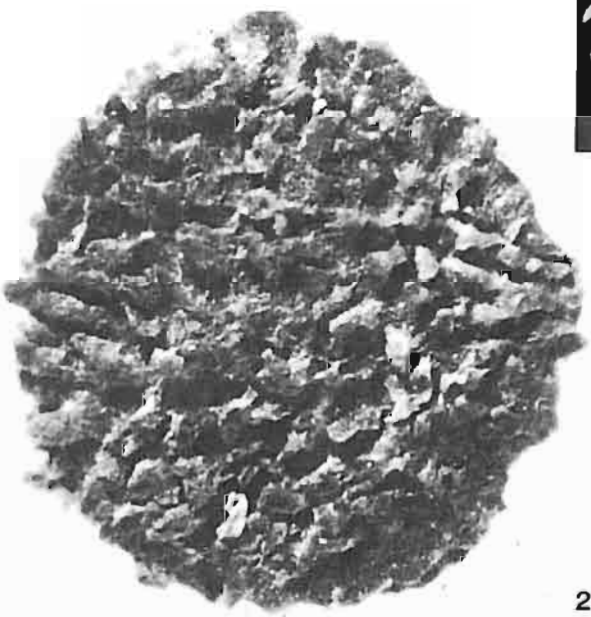

2

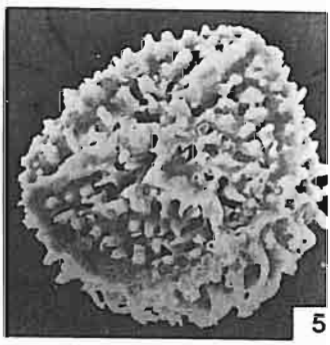

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PLATE VII

Figs 1, 2. *Verrutriletes marcinkiewiczae* Kozur
1 — MUZ PIG 507 (135), proximal side, Przylesie IG 1 borehole, depth 846.5 m, x 100; 2 — the same specimen, distal side
1 — powierzchnia proksymalna, otwór Przylesie IG 1, głęb. 846,5 m, pow. 100 x; 2 — ten sam okaz, powierzchnia dystalna
Fig. 3. *Capillisporites germanicus* Kozur
MUZ PIG 507 (138), Karcino 1 borehole, depth 1056.5 m, x 100
Otwór Karcino 1, głęb. 1056,5 m, pow. 100 x
Fig. 4. *Narkisporites formidabilis* Marcinkiewicz
MUZ PIG 507 (144), Buk IG 1 borehole, depth 1410.0 m, x 100
Otwór Buk IG 1, głęb. 1410,0 m, pow. 100 x
Fig. 5. *Prikaspisporites srebrodolskae* Kozur
MUZ PIG 507 (157), Okunino 1 borehole, depth 1180.0 m, x 100
Otwór Okunino 1, głęb. 1180,0 m, pow. 100 x

Figs 1–5 — photos in reflected light
Fig. 1–5 — w świetle odbitym

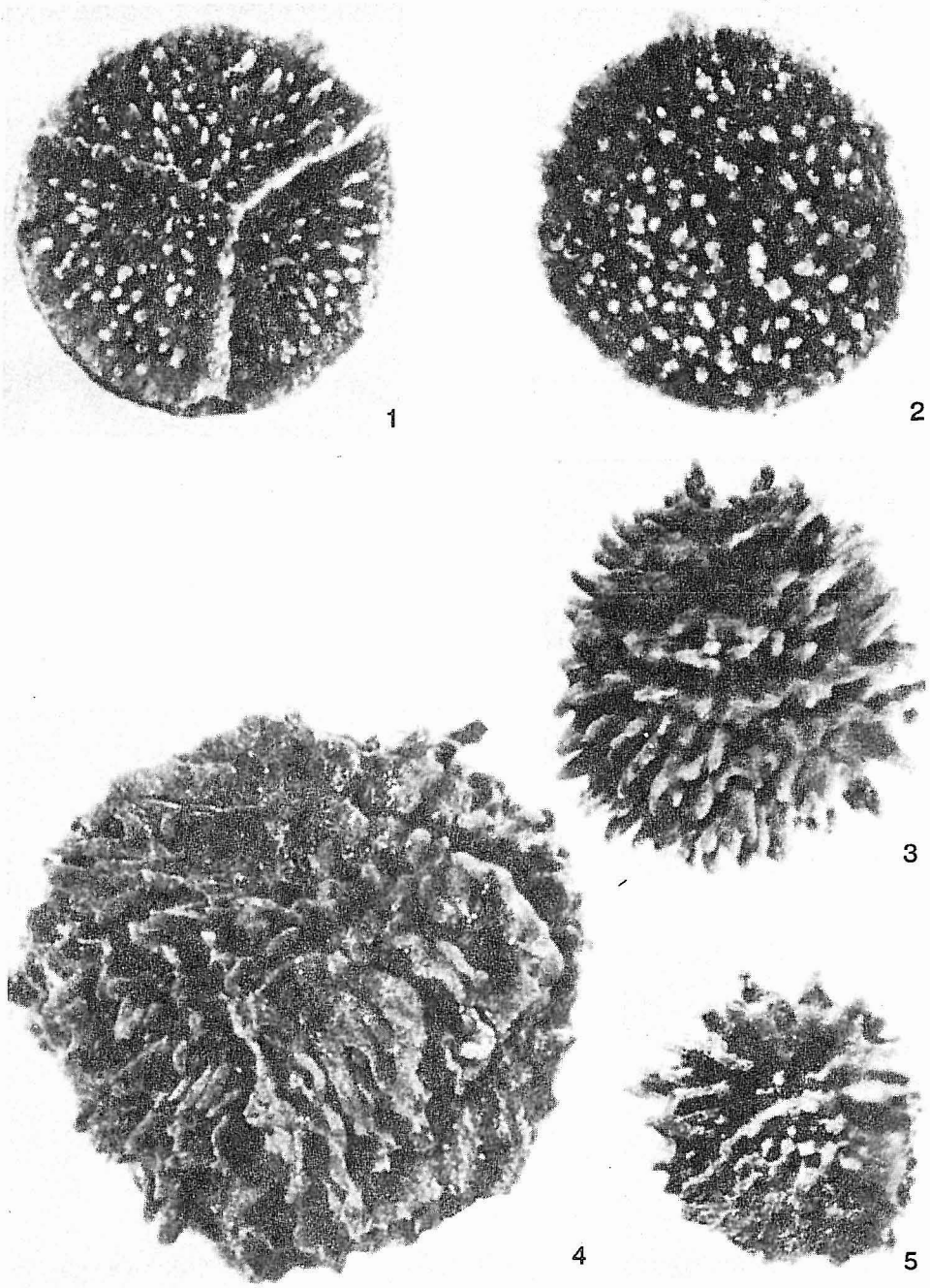

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PLATE VIII

Figs 1, 2. *Narkisporites formidabilis* Marcinkiewicz

1 — MUZ PIG 507 (142), Okunino 1 borehole, depth 1180.0 m, x 100; 2 — PIG 507 (145), Buk IG 1 borehole, depth 1410.0 m, x 100

1 — otwór Okunino 1, głęb. 1180,0 m, pow. 100 x; 2 — otwór Buk IG 1, głęb. 1410,0 m, pow. 100 x

Figs 3–5. *Tenellisporites marcinkiewiczae* Reinhardt et Fricke

3 — MUZ PIG 507 (161), proximal side, Człuchów IG 2 borehole, depth 1996.0 m, x 100; 4 — the same specimen, distal side; 5 — MUZ PIG 507 (159), Buk IG 1 borehole, depth 1412.0 m, x 100

3— powierzchnia proksymalna, otwór Człuchów IG 2, głęb. 1996,0 m, pow. 100 x; 4 — ten sam okaz, powierzchnia dystalna; 5 — otwór Buk IG 1, głęb. 1412,0 m, pow. 100 x

Figs 1–5 — photos in reflected light

Fig. 1–5 — w świetle odbitym

PLATE VIII

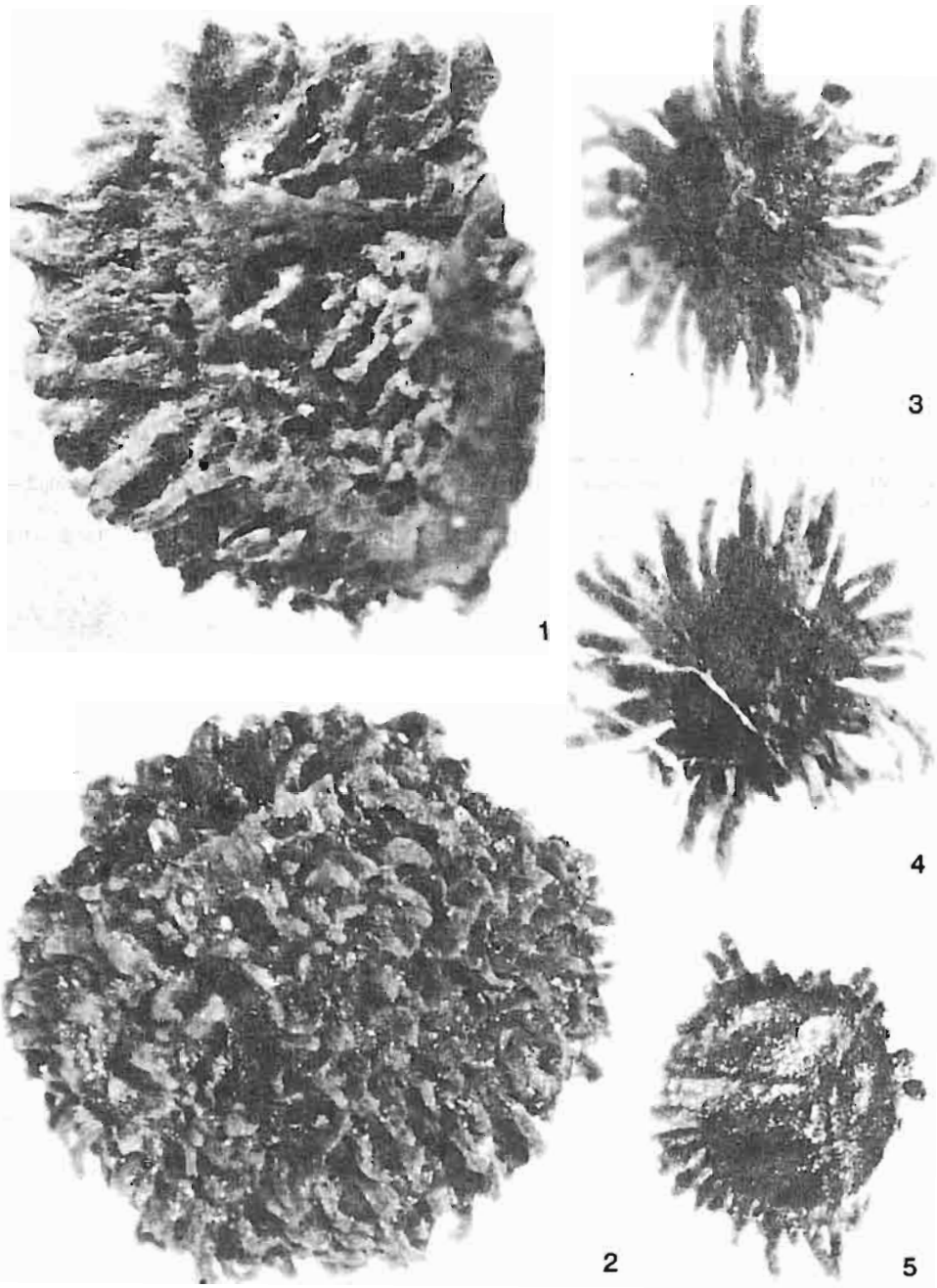

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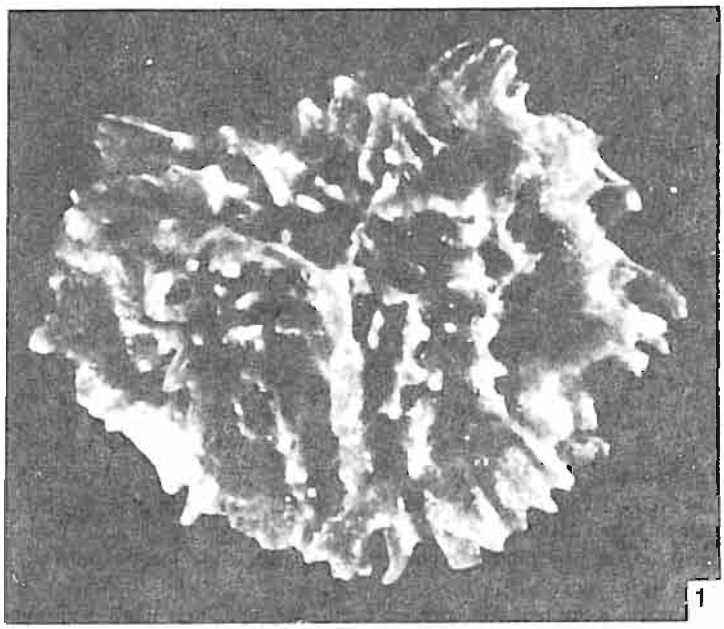
PLATE IX

Figs 1, 2. *Prikaspisporites srebrodolskae* Kozur

1 — MUZ PIG 507 (155), proximal side, reflected light, Okunino 1 borehole, depth 1180.6 m, x 150; 2 — the same specimen, distal side

1 — powierzchnia proksymalna, w świetle odbitym, otwór Okunino 1, głęb. 1180,6 m, pow. 150 x; 2 — ten sam okaz, powierzchnia dystalna



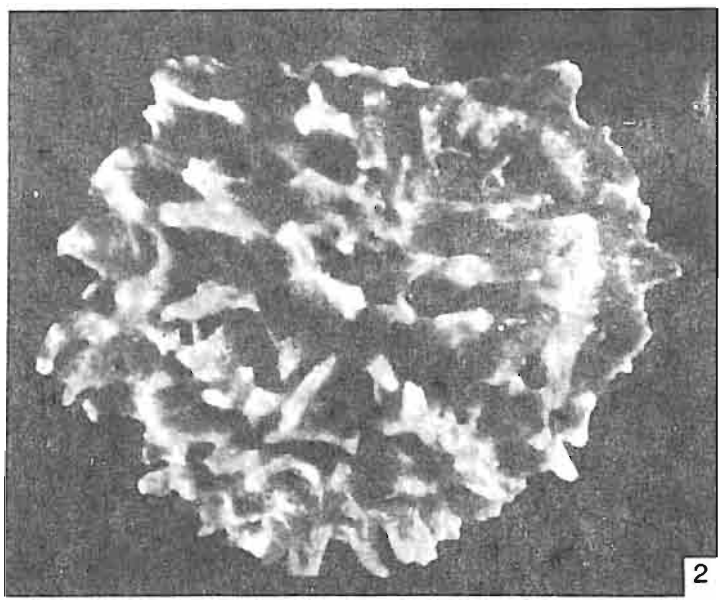


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PLATE X

Figs 1, 2, 4. *Prikaspisporites srebrodolskae* Kozur

1 — MUZ PIG 507 (156); 2 — MUZ PIG 507 (154), Okunino 1 borehole, depth 1180.6 m, x 150; 4 — MUZ PIG 507 (153), Bieżuń 2 borehole, depth 2514.5 m, x 100

1, 2 — otwór Okunino 1, głęb. 1180,6 m, pow. 150 x; 4 — otwór Bieżuń 2, głęb. 2514,5 m, pow. 100 x

Figs 3, 5. *Tenellisporites ornatus* sp. n.

3 — MUZ PIG 507 (163), proximal side, Przylesie IG 1 borehole, depth 845.0–845.3 m, x 100; 5 — the same specimen, distal side

3 — powierzchnia proksymalna, otwór Przylesie IG 1, głęb. 845,0–845,3 m, pow. 100 x; 5 — ten sam okaz, powierzchnia dystalna

Figs 1–5 — photos in reflected light

Fig. 1–5 — w świetle odbitym

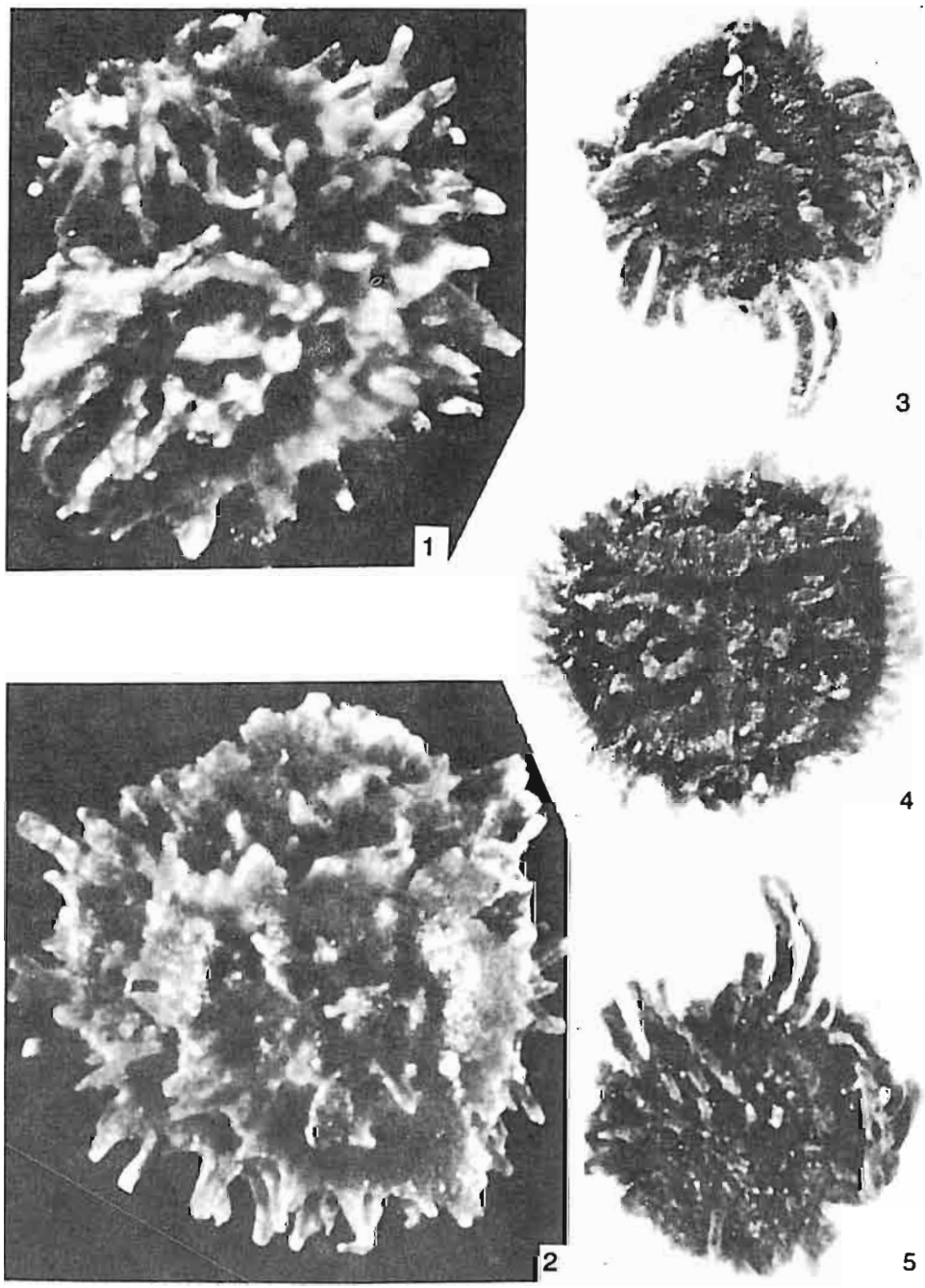

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PLATE XI

Figs 1–3. *Dijkstraisporites beutleri* Reinhardt

1— MUZ PIG 507 (188), distal side, Radwanice W 4 borehole, depth 292.5 m, x 120; 2 — MUZ PIG 507 (205), distal side, Bobolice 3 borehole, depth 1692.5 m, x 100; 3 — MUZ PIG 507 (189), proximal side, Radwanice W 4, depth 292.5 m, x 110

1 — powierzchnia dystalna, otwór Radwanice W 4, głęb. 292,5 m, pow. 120 x; 2 — powierzchnia dystalna, otwór Bobolice 3, głęb. 1692, 5 m, pow. 100 x; 3 — powierzchnia proksymalna, otwór Radwanice W 4, głęb. 292,5 m, pow. 110 x

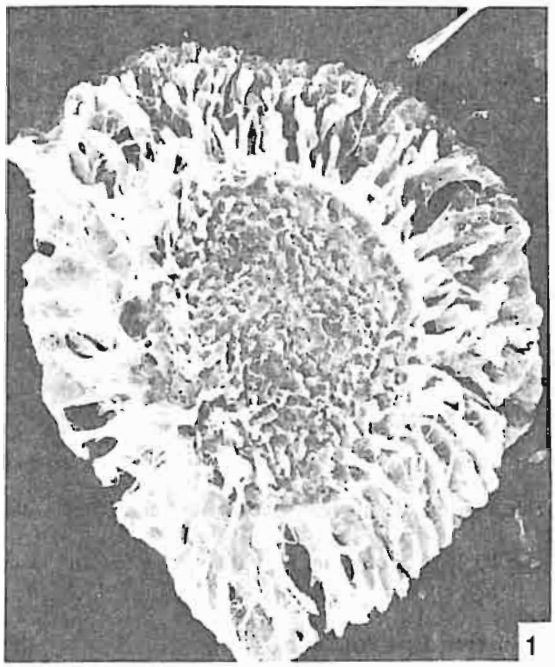
Fig. 4. *Nathorstisporites invenustus* Fuglewicz

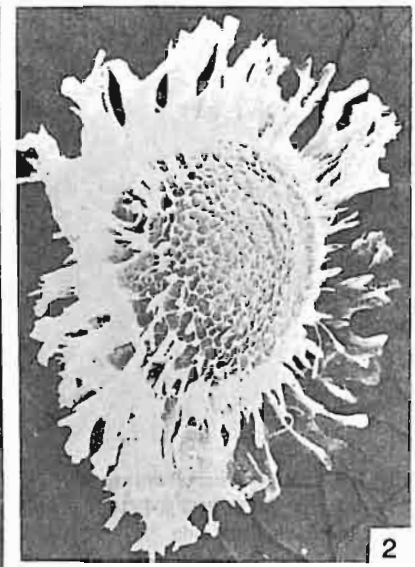
MUZ PIG 507 (200), Ośno IG 2 borehole, depth 1300.0 m, x 130

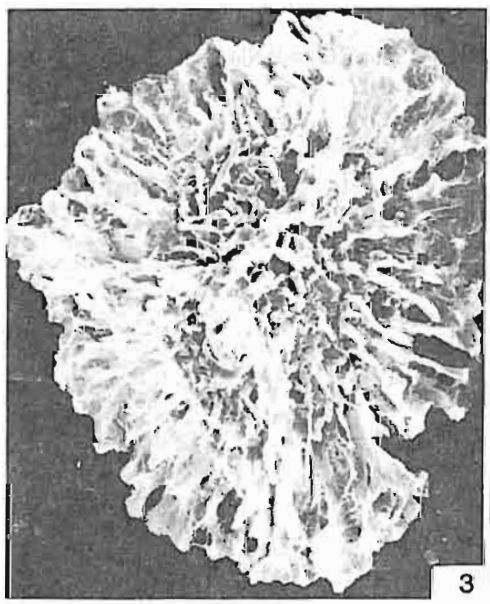
Otwór Ośno IG 2, głęb. 1300,0 m, pow. 130 x

Figs 1–4 — SEM photos

Fig. 1–4 — w skaningowym mikroskopie elektronowym







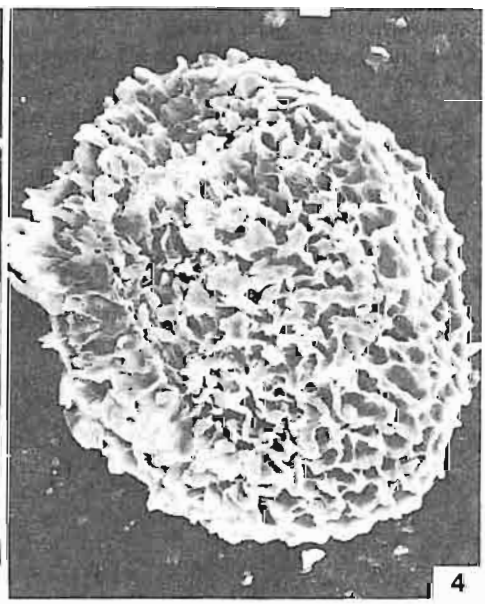


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PLATE XII

Figs 1, 2. *Tenellisporites ornatus* sp. n.

1 — holotype, MUZ PIG 507 (162), proximal side, Przylesie IG 1 borehole, depth 846.5 m, x 100; 2 — the same specimen, distal side

1 — powierzchnia proksymalna, otwór Przylesie IG 1, głęb. 846,5 m, pow. 100 x; 2 — ten sam okaz, powierzchnia dystalna

Fig. 3. *Henrisporites capillilatus* (Fuglewicz) comb. n.

MUZ PIG 507 (196), distal side, Przylesie IG 1 borehole, depth 846.5 m, x 120

Powierzchnia dystalna, otwór Przylesie IG 1, gleb. 846,5 m, pow. 120 x

Figs 4, 5. *Flabellisporites crinitus* Marcinkiewicz

4 — MUZ PIG 507 (215), in lateral view, x 100; 5 — MUZ PIG 507 (194), proximal side, Nidzica IG 1, borehole, depth 1845.0 m, x 100

4 — w położeniu bocznym, pow. 100 x; 5 — powierzchnia proksymalna, otwór Nidzica IG 1, głęb. 1845,0 m, pow. 100 x

Figs 1, 2 — photos in reflected light, Figs 3–5 — SEM photos

Fig. 1, 2 — w świetle odbitym, fig. 3–5 — w skaningowym mikroskopie elektronowym

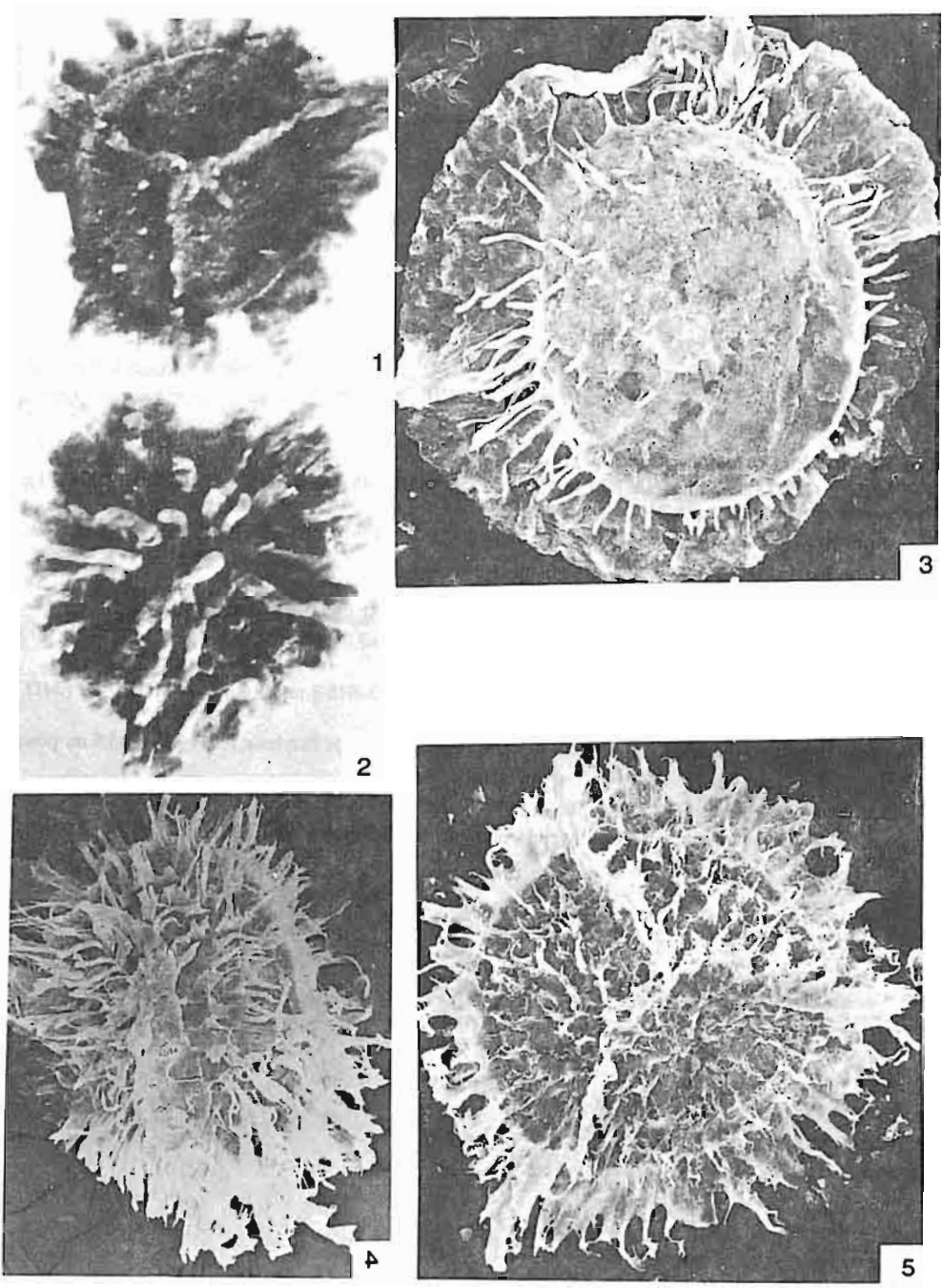

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PLATE XIII

Figs 1–3. *Aneuletes mesotriassicus* (Kozur) comb. n.

1 — MUZ PIG 507 (219), Przylesie IG 1 borehole, depth 845.0–845.3 m, x 200; 2 — MUZ PIG 507 (171), Przylesie IG 1 borehole, depth 846.5 m, x 100

1 — otwór Przylesie IG 1, głęb. 845,0–845,3 m, pow. 200 x; 2 — otwór Przylesie IG 1, głęb. 846,5 m, pow. 100 x

Fig. 4. *Henrisporites capillatus* (Fuglewicz) comb. n.

MUZ PIG 507 (242), proximal side, Przylesie IG 1 borehole, depth 845.0–845.3 m, x 100

Powierzchnia proksymalna, otwór Przylesie IG 1, głęb. 845,0–845,3 m, pow. 100 x

Figs 5, 6. *Polaneuletes tuberculatus* sp. n.

5 — MUZ PIG 507 (230), Przylesie IG 1 borehole, depth 845.0–845.3 m, x 100; 6 — MUZ PIG (241), Przylesie IG 1 borehole, depth 845.5 m, x 100

5 — otwór Przylesie IG 1, głęb. 845,0–845,3 m, pow. 100 x; 6 — otwór Przylesie IG 1, głęb. 845,5 m, pow. 100 x

Figs 1, 4–6 — SEM photos, Figs 2, 3 — photos in reflected light

Fig. 1, 4–6 — w skaningowym mikroskopie elektronowym, fig. 2, 3 — w świetle odbitym

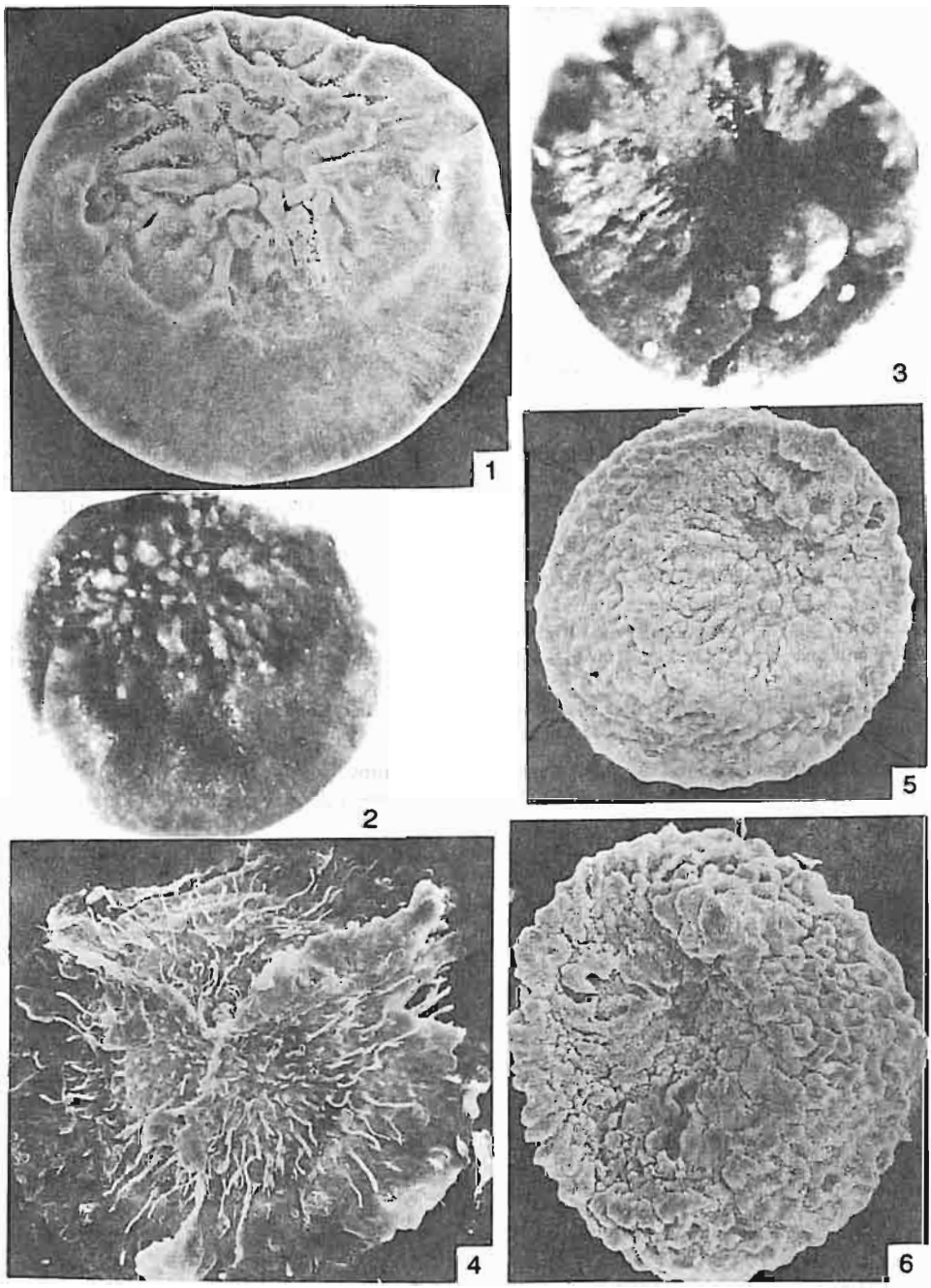

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PLATE XIV

Figs 1–3. *Sexaneuletes clavatus* (Fuglewicz) comb. n.

1 — MUZ PIG 507 (174), Przylesie IG 1 borehole, depth 845. 0–845.3 m, x 100; 2 — MUZ PIG 507 (175), Biały Bór 7 borehole, depth 1437.0 m, x 100; 3 — MUZ PIG 507 (198), Przylesie IG 1 borehole, depth 846.5 m, x 200

1 — otwór Przylesie IG 1, głęb. 845,0–845,3 m, pow. 100 x; 2 — otwór Biały Bór 7, głęb. 1437,0 m, pow. 100 x; 3 — otwór Przylesie IG 1, głęb. 846,5 m, pow. 200 x

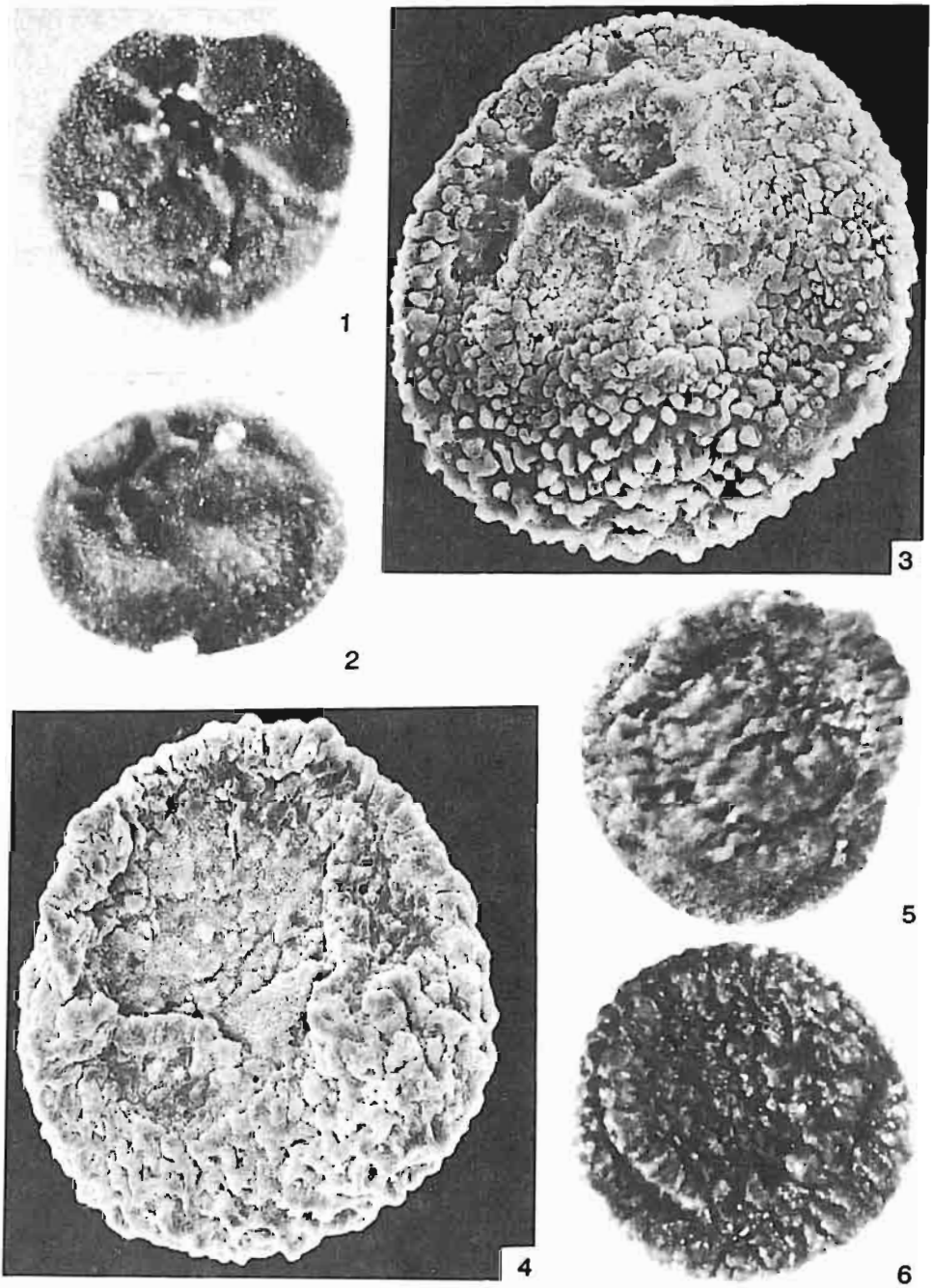
Figs 4–6. *Polaneuletes tuberculatus* sp. n.

4 — MUZ PIG 507 (221), Przylesie IG 1 borehole, depth 845.5 m, x 160; 5 — MUZ PIG 507 (176), Biały Bór 7 borehole, depth 1437.0 m, x 100; 6 — holotype, MUZ PIG 507 (177), Przylesie IG 1 borehole, depth 845.5 m, x 100

4 — otwór Przylesie IG 1, głęb. 845,5 m, pow. 160 x; 5 — otwór Biały Bór 7, głęb. 1437,0 m, pow. 100 x; 6 — holotyp, otwór Przylesie IG 1, głęb. 845,5 m, pow. 100 x

Figs 1, 2, 5, 6 — photos in reflected light, Figs 3–4 — SEM photos

Fig. 1, 2, 5, 6 — w świetle odbitym, fig. 3, 4 — w skaningowym mikroskopie elektronowym



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