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Palynostratigraphy of the Keuper and Rhaetic in north-western margin of the Holy Cross Mts

Here were presented results of studies on microflora found in the Keuper and Rhaetic deposits from north-western margin of the Holy Cross Mts. Studied material came from 6 boreholes: Radwanów IG 1, Eugeniów-Korytków IG 1, Mniszków IG 1, Studzianna IG 2, Nieświn PIG 1 and Opoczno PIG 2. Seven spore-pollen assemblages were distinguished and 94 species of microspores from 54 genera as well as 7 species of *Acritarcha* from 3 genera were recognized.

INTRODUCTION

Palynological studies of the Upper Triassic deposits from north-western margin of the Holy Cross Mts were done in 1987–1990. Samples for them were taken from boreholes: Radwanów IG 1, Eugeniów-Korytków IG 1, Mniszków IG 1, Studzianna IG 2, Nieświn PIG 1 and Opoczno PIG 2 (Fig. 1).

Main aim of this work was microflora characteristics, distinguishing of spore-pollen assemblages and analysis — first time — of palynostratigraphy of the Keuper and Rhaetic deposits from mentioned area. Relatively complete scheme of such stratigraphy was prepared (Tab. 2), correlable with palynological zones found in the Upper Triassic from north-western Poland by T. Orłowska-Zwolińska (1983, 1985).

First data about occurrence of Late Triassic miospores in the Holy Cross Mts were presented by T. Orłowska-Zwolińska (1972, 1981, 1983). They refered to three boreholes: Boża Wola IG 1, Solec 60 and Gacki 1, located in southern and south-western part of studied region. Other informations about microplankton foundings of *Acritarcha* group in the Lower Keuper deposits from Bukowie — NE part of the Holy Cross

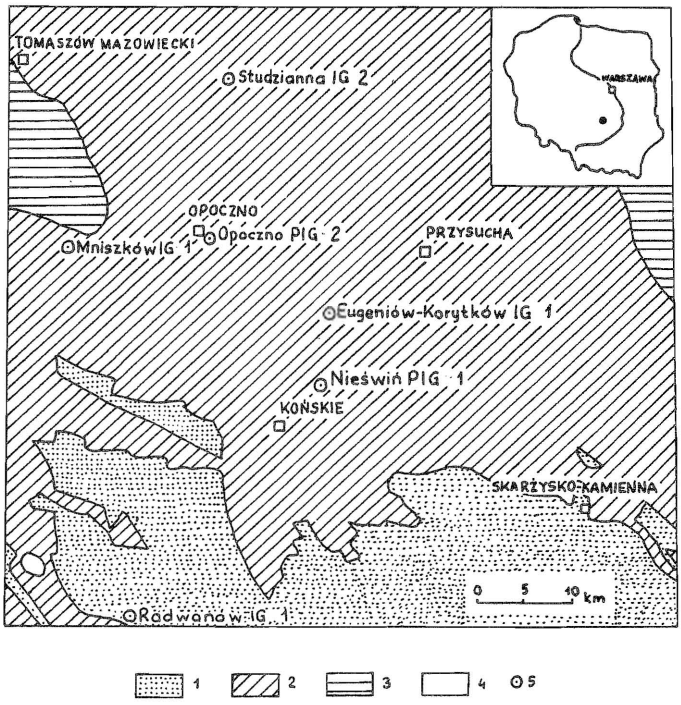

Fig. 1. Location of studied boreholes on the geological map of NW margin of the Holy Cross Mts (without Quaternary)

1 — Triassic; 2 — Jurassic; 3 — Cretaceous; 4 — Tertiary; 5 — boreholes

Lokalizacja badanych otworów wiertniczych na tle mapy geologicznej odkrytej NW obrzeżenia Gór Świętokrzyskich

1 — trias; 2 — jura; 3 — kreda; 4 — trzeciorzęd; 5 — otwory wiertnicze

Mts — were supplied by K. Rdzanek (1981). Author as a first has done such microfloristic studies of the Upper Triassic from north-western margin of the Holy Cross Mts and their preliminary results were presented in earlier works (A. Fijałkowska, 1988*a*, *b*, 1989, 1991; A. Fijałkowska, A. Trzepierczyńska, 1990).

Described miospores were classified according systematics for dispersed spores, elaborated by R. Potonié (1956, 1958, 1960, 1966, 1970), supplemented and enlarged with such works as: R.A. Couper (1958), R.F.A. Clarke (1965), S. Dybova, A. Jachowicz (1957), W. Klaus (1960, 1964), G. Leschik (1955), J. Lund (1975, 1977), K. Mädler (1964*a*, *b*), T. Orłowska-Zwolińska (1972, 1983), M. Pautsch (1958, 1971, 1973), B.W. Scheuring (1970), E. Schultz (1965, 1966, 1967), G. Warrington (1973, 1978). For studies of *Acritarcha* were used systematics, elaborated by: G. Deflandre (1935, 1937), I. Deunff (1958), C. Downie, W.A.S. Sarjeant (1963), C. Downie et al. (1963), A. Eisenack (1955, 1959), W.R. Evitt (1963), D. Wall (1965), D. Wall, C. Downie (1963).

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GENERAL CHARACTERISTICS OF STUDIED LITHOSTRATIGRAPHICAL COMPLEXES

THE KEUPER LITHOSTRATIGRAPHY

The Keuper lithostratigraphy from mentioned area was elaborated by H. Jurkiewicz (H. Jurkiewicz, 1980; H. Jurkiewicz et al., 1973*a*, *b*, 1976) and refered to similar scheme proposed by A. Szyperko-Śliwczyńska (1960) and I. Gajewska (1978) for Polish Lowland. H. Jurkiewicz distinguished the Lower and Upper Keuper, the last one included: Boundary Dolomite, Lower Gypsum Beds, Reedy Sandstone and Upper Gypsum Beds (Tab. 1).

The Lower Keuper deposits were found in four borehole profiles: Radwanów IG 1 — depth 25.0–219.0 m (H. Jurkiewicz, 1980; H. Jurkiewicz et al., 1976), Studzianna IG 2 — depth: 1574.0–1696.0 m (H. Jurkiewicz et al., 1973*a*), Nieświń PIG 1 — depth: 887.0–1042.0 m (Z. Kowalczewski ed., 1991) and Opoczno PIG 2 — depth: 940.3–1059.5 m (Z. Kowalczewski ed., 1991, 1992). In their bottom part occurred intercalations of dark siltstones, sandy siltstones and light-grey, fine sandstones. Flora detritus was abundant there. In upper part of Lower Keuper profile these deposits transformed into grey-greenish claystones with marly interbeds. In the Radwanów IG 1 borehole some laminae and imprints of gypsum were found. The top of described complex was series of claystones, 70 m thick.

The Boundary Dolomite deposits were documented in three boreholes: Eugeniów-Korytków IG 1 — depth: 314.2–318.2 m but the bottom of series was not reached (Z. Kozydra, 1962), Mniszków IG 1 — depth: 2516.0–2619.3 m (H. Jurkiewicz et al., 1973*b*) and Opoczno PIG 2 — depth: ?930.6–940.3 m. They consisted of light-grey dolomites, locally contained fauna remains and intercalated with grey dolomitic claystones or siltstones.

The Lower Gypsum Beds deposits were found in five boreholes: Eugeniów-Korytków IG 1 — depth: ?267.0–314.2 m, Mniszków IG 1 — depth: 2372.5–2516.0 m, Studzianna IG 2 — depth: ?1484.2–1574.0 m, Nieświń PIG 1 — depth: ?750.2–887.0 m, and Opoczno PIG 2 — depth: ?776.8–930.6 m. The bottom part of them consisted of dark-grey claystones with thin marl interbeds and of dolomites with laminae and imprints of gypsum and anhydrite. In upper part these deposits passed into sandy siltstones laminated with claystones or marls.

The Reedy Sandstone deposits were noticed only in one borehole Mniszków IG 1 at the depth: 2267.0–2372.5 m. They formed homogenous complex of light-grey, fine sandstones. In its top occurred siltstones layer with flora remains. In other studied boreholes — except the Radwanów IG 1 profile — the described deposits continuously passed into the Upper Gypsum Beds series. It was difficult to define precisely the boundary between them.

Table 1

Stratigraphic position of the microfloristic assemblages, distinguished by author, in lithostratigraphic scheme of the Upper Triassic of NW part of the Holy Cross Mts (scheme after: H. Jurkiewicz, 1980; H. Jurkiewicz et al., 1973*a, b*; J. Kopik, 1970, 1973; Z. Kozydra, 1962)

Lithostratigraphy				Microfloristic assemblages							
				I	IIa	IIb	III	IV	V	VI	VII
Rhaetic	Upper		motley claystone								S
	Lower		intraformational conglomerate grey-greenish and motley siltstone and claystone							E, O	
Keuper	Upper	Upper Gypsum Beds	motley claystones and siltstones grey siltstones, localy dolomitic green-grey dolomitic siltstones with dolomite interbeds and sulphates						E, M, N, O		
		Reedy Sandstone	grey sandy siltstones light-grey, fine-grained sandstones					M			
		Lower Gypsum Beds	grey sandy siltstones dark-grey siltstones with interbeds of marls and dolomites and with sulphates			E, M, N, O, S	E, M				
		Boundary Dolomite	light-grey dolomites intercalated with claystones or dolomitic siltstones		E, O						
	Lower		grey claystones with gypsum grey siltstones and sandstones	N, O, R, S							

E — Eugeniów-Korytków IG 1, M — Mniszków IG 1, N — Nieświn PIG 1, O — Opoczno PIG 2, R — Radwanów IG 1, S — Studzianna IG 2

The Upper Gypsum Beds deposits were described from boreholes: Mniszków IG 1 — depth: 2032.4–2267.0 m, Eugeniów-Korytków IG 1 — depth: 213.0–?267.0 m, Studzianna IG 2 — depth: 1304.7–?1484.2 m, Nieświń PIG 1 — depth: 585.0–?750.2 m, and Opoczno PIG 2 — depth: 708.0–?776.8 m. At the complex bottom occurred green-grey dolomitic claystones with thin dolomite interbeds, contained gypsum and anhydrite. To the top they transformed into silty deposits but sulphate content gradually decreased. In the top of the Eugeniów-Korytków IG 1 profile the cherry-red and motley claystones were noted.

THE RHAETIC LITHOSTRATIGRAPHY

The Rhaetic lithostratigraphy from studied area was elaborated by J. Kopik (1970, 1973). The Rhaetic deposits were noticed in five boreholes: Eugeniów-Korytków IG 1 — depth: 120.7–231.0 m, Mniszków IG 1 — depth: 1483.0–2032.4 m, Studzianna IG 2 — depth: 1081.0—1304.7 m, Nieświń PIG 1 — depth: 380.0—585.0 m, and Opoczno PIG 2 — depth: 560.5—708.0 m. In the Eugeniów-Korytków IG 1 borehole these deposits began with dark-grey, cherry-red spotted, dolomitic claystones, passing into motley claystones with single bivalve shells and fish scales. There occurred fine, several dcm thick, interbeds of limestones. Top of complex consisted of motley claystones with fine calcareous sphaerolithes. In other boreholes the Rhaetic series were composed of grey-greenish and motley siltstones and claystones with intercalations of light-grey sandstones. In the Mniszków IG 1 borehole, at the depth 1694.0 m, occurred 1.5 m thick bed of intraformational conglomerate. In all studied profiles the deposits of the Zagaje Series of Lower Liassic laied on the Rhaetic rocks.

THE CHARACTERISTIC OF MICROFLORISTIC ASSEMBLAGES

Author has distinguished within Keuper and Rhaetic deposits seven microfloristic assemblages (Tab. 1, 2), basing on such criterions:

— stratigraphic ranges of described species, particulary their first occurrence;
— maximum and minimum content of miospores within spectrum;
— general taxonomic composition of spectrum;
— occurrence of microplankton from *Acritarcha* group.

I ASSEMBLAGE

This assemblage occurred in the Lower Keuper deposits from four boreholes: Radwanów IG 1 — depth: 152.5 m and 261.5–218.2 m (A. Fijałkowska, 1989; A. Fijałkowska, A. Trzepierczyńska, 1990), Studzianna IG 2 — depth: 1641.8–1644.6 m (A. Fijałkowska, 1988*b*), Nieświń PIG 1 — depth: 970.3–978.3 m (A. Fijałkowska, 1991), and Opoczno PIG 2 — depth: 1030.3 m. It contained index species *Heliosaccus dimorphus* Mädler (Pl. III, Fig. 11). The dominant element of the I assemblage was pollen grains — 56.9% of all miospores there — among which the most frequent were forms possessing two sacci — Disaccites, 45.7% of assemblage — of genera: *Succinc-*

tisporites and *Triadispora*. Less numerous were genera: *Brachysaccus* — with species *B. neomundanus* (Leschik) Mädler (Pl. IV, Fig. 11) — and *Angustisulcites*.

Among grains with one saccus — *Monosaccites*, 1.3% of assemblage — dominated the specimens from species *H. dimorphus* Mädler, but among grains from subturma *Praecolpates*, 9.9% of assemblage — specimens of genus *Monosulcites*.

Spores consisted 43.1% of all assemblage. Among them dominated taxons from subturma *Azonomonoletes* — 26.1% of assemblage. Most frequent genus was *Aratrisporites* — 23.0% — with species: *A. coryliseminis* Klaus (Pl. III, Fig. 6) and *A. scabratus* Klaus (Pl. III, Fig. 13). Less numerous were specimens of species *Leschikisporis aduncus* (Leschik) Potonié (Pl. II, Fig. 6). Among spores of subturma *Azonotriletes* — 14.0% of assemblage — dominated genus *Todisporites* with species: *T. cinctus* (Maliavkina) Orłowska-Zwolińska (Pl. I, Fig. 5) and *T. minor* Couper (Pl. I, Fig. 1). In minor amount occurred there specimens of species: *Cyclotriletes granulatus* Mädler (Pl. I, Fig. 3) and *Microreticulatisporites opacus* (Leschik) Klaus (P. II, Fig. 9).

II ASSEMBLAGE

The assemblage II was subdivided into two subassemblages: IIa and IIb.

The subassemblage IIa was found in deposits of the Boundary Dolomite in two boreholes: Eugeniów-Korytków IG 1 — depth: 318.2 m, and Opoczno PIG 2 — depth: 939.8–939.9 m. It differed from subassemblage IIb, described lower, with occurrence of *Acritarcha*, consisting 10.5% of all spectrum.

The subassemblage IIb was documented in lower part of the Lower Gypsum Beds in boreholes: Eugeniów-Korytków IG 1 — depth: 291.0–314.0 m (A. Fijałkowska, 1989), Mniszków IG 1 — depth: 2464.0 m (A. Fijałkowska, 1988*a*), Studzianna IG 2 — depth: 1524.0–1527.0 m (A. Fijałkowska, 1988*b*), Nieświń PIG 1 — depth: 751.0–873.3 m (A. Fijałkowska, 1991), and Opoczno PIG 2 — depth: 879.5–884.6 m. There occurred index species: *Porcellispora longdonensis* (Clarke) Scheuring (Pl. II, Fig. 10) and *Echinitosporites iliacoides* Schulz et Krutzsch (Pl. III, Fig. 8). The dominant element of this assemblage was pollen grains, consisting 70.9% of all miospores. *Disaccites* content was 59.1%. Among them dominated specimens of genus *Ovalipollis* — 18.3% of assemblage — with species: *O. ovalis* Krutzsch (Pl. IV, Fig. 2), *O. minimus* (Scheuring) Orłowska-Zwolińska (Pl. IV, Fig. 4), *O. grebeae* Klaus (Pl. IV, Fig. 3). Also genus *Triodispora* — 13.1% of assemblage — was frequent, with species: *T. keuperiana* Orłowska-Zwolińska (Pl. IV, Fig. 8) and *T. plicata* Klaus (Pl. IV, Fig. 13). Less numerous were specimens of genera: *Minutosaccus* — *M. potoniei* Mädler (Pl. IV, Fig. 9), *M. schizeatus* Mädler (Pl. IV, Fig. 10) — and *Infernopollenites*.

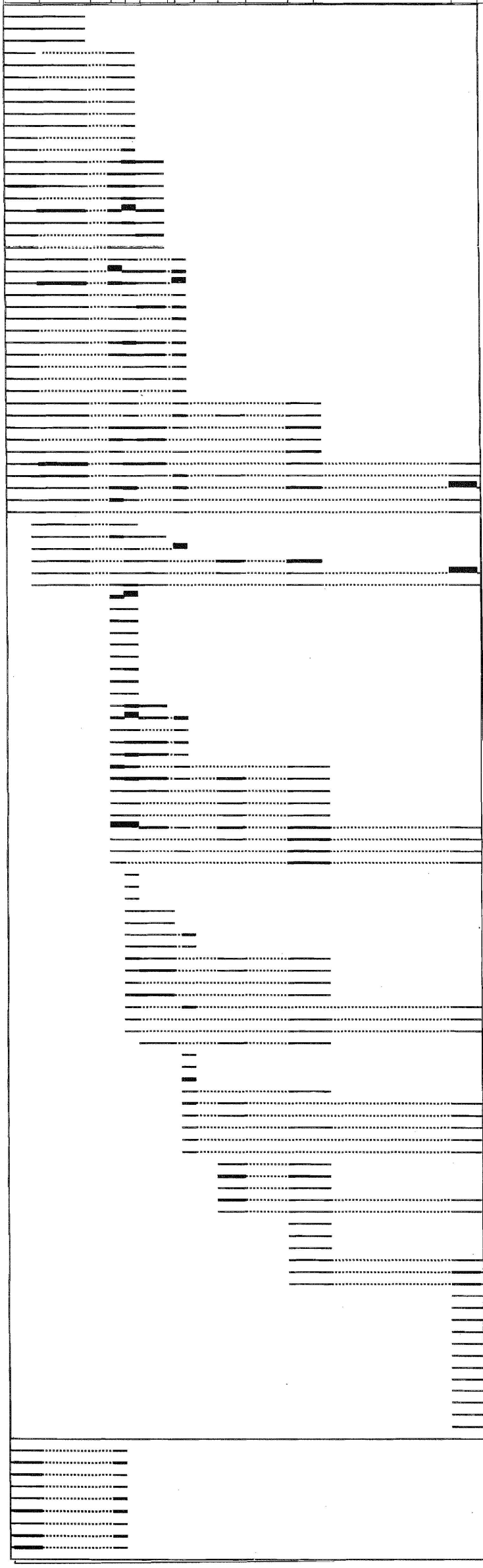
Monosaccites — 0.5% of assemblage — were represented mainly by species *Accinctisporites ligatus* Leschik (Pl. III, Fig. 9). Among Azonales — 4.3% of assemblage — dominated taxons of genera: *Paracirculina* and *Duplicisporites*. Among Praecolpates — 7.0% of assemblage — prevailed specimens of genera: *Eucommiidites* and *Cycadopides*.

Spores consisted 29.1% of all spectrum. There dominated species of subturma *Azonomonoletes* — 14.7% of assemblage — belonged to genus *Aratrisporites*. Among *Azonotriletes*, consisting 6.3% of all miospores, prevailed specimens of genus *Todis-*

Table 2

Stratigraphic position of sporomorphs in the Upper Triassic deposits from NW border of the Holy Cross Mountains

MIDDLE TRIASSIC		UPPER TRIASSIC						CHRONOSTRATIGRAPHY
LADINIAN		KARNIAN				NORIAN	RHAETIC	
longobardian		korde-wol		jul	tuwal			
Mus-chel-kalk	KEUPER					RHAETIC		LITOSTRATIGRAPHY (after H. Jurkiewicz, 1980; H. Jurkiewicz et al., 1973a, 1973 b, 1976; J. Kopik, 1970, 1973)
	Lower	Upper				Lower	Upper	
		B. Dol.	Lower Gypsum Beds	R. San.	Upper Gypsum Beds			
dimorphus		longdo-nensis		asti-gmo-sus	meyeriana		tuberculatus	PALYNOLOGICAL ZONES AND SUBZONES (after T. Orłowska-Zwolińska, 1985)
T.		i.	v.		a	b	c	
	I	II a	II b	III	IV	V	VI	VII



SPORE-POLLEN ASSEMBLAGES

Cyclotriletes granulatus Mädler
Heliosaccus dimorphus Mädler
Microreticulatisporites opacus (Leschik) Klaus
Accinctisporites ligatus Leschik
Infernopollenites sulcatus Pautsch
Platysaccus cf. *niger* Mädler
Lophotriletes triplanus Mädler
Verrucosisporites marginatus (Mädler) Orłowska-Zwolińska
Verrucosisporites morulae Visscher
Converrucosisporites cf. *conferteornatus* Pautsch
Aratrisporites crassitectatus Reinhardt
Angustisulcites klausi Freudenthal
Leschikisporis aduncus (Leschik) Potonié
Protohaploxypinus sp.
Striatoabietites aytugii Visscher
Triadispora crassa Klaus
Minutosaccus potoniei Mädler
Minutosaccus gracilis Scheuring
Minutosaccus schizeatus Mädler
Verrucosisporites pseudomorulae Visscher
Krauselisporites sp.
Aratrisporites coryliseminis Klaus
Aratrisporites granulatus (Klaus) Playford et Dettmann
Aratrisporites paraspinosus Klaus
Aratrisporites fimbriatus (Klaus) Playford et Dettmann
Aratrisporites scabratus Klaus
Aratrisporites paenulatus Playford et Dettmann
Succinctisporites grandior Leschik sensu Mädler
Striatoabietites balmei Klaus
Lunatisporites alatus (Klaus) Fijałkowska
Triadispora plicata Klaus
Falcisporites sp.
Calamospora tener (Leschik) Mädler
Anapiculatisporites telephorus (Pautsch) Klaus
Brachysaccus neomundanus (Leschik) Mädler
Alisporites toralis (Leschik) Clarke
Carnisporites cf. *mesozoicus* (Klaus) Mädler
Todisporites cinctus (Maliavkina) Orłowska-Zwolińska
Todisporites minor Couper
Cycadopites sp.
Lunatisporites noviaulensis (Leschik) Scheuring
Corrugatisporites scanicus Nilsson
Conosmundacidites othmari Klaus
Triadispora stabilis Scheuring
Aratrisporites flexibilis Playford et Dettmann
Labiisporites triassicus Orłowska-Zwolińska
Pinuspollenites sp.
Monosulcites perforatus Mädler
Echinitosporites iliacoides Schulz et Krutzsch
Triadispora delicata Orłowska-Zwolińska
Praecirculina granifer (Leschik) Klaus
Paracirculina maljavkinae Klaus
Sphagnumsporites sp.
Apiculatisporis parvispinosus (Leschik) Schulz
Camarozonosporites secatus (Leschik) Fijałkowska
Ellipsovelatisporites plicatus Klaus
Apiculatisporites parvispinosus (Leschik) Schulz
Eucommiidites microgranulatus Scheuring
Porcellispora longdonensis (Clarke) Scheuring
Triadispora cf. *bolchii* Scheuring
Triadispora keuperiana Orłowska-Zwolińska
Duplicisporites granulatus (Leschik) Klaus
Ovalipollis lunzensis Klaus
Ovalipollis minimus (Scheuring) Orłowska-Zwolińska
Ovalipollis breviformis Krutzsch
Enzonalasporites vigens Leschik
Enzonalasporites manifestus (Leschik) Schulz
Ovalipollis ovallis Krutzsch
Monosulcites minimus Cookson
Classopollis classoides (Pflug) Pocock et Jansonius
Podocarpites sp.
Triadispora suspecta Scheuring
Parallinites varus Scheuring
Navesisporites lubricus Orłowska-Zwolińska
Paracirculina cf. *tenebrosa* Scheuring
Verrucosisporites cf. *contactus* Clarke
Auliesporites astigmosus (Leschik) Klaus
Triadispora falcata Klaus
Monosulcites punctatus Orłowska-Zwolińska
Triadispora verrucata (Schulz) Scheuring
Verrucosisporites redactus Orłowska-Zwolińska
Ovalipollis gretae Klaus
Cedripites sp.
Densosporites cavernatus Orłowska-Zwolińska
Heliosporites altmarkensis Schulz
Ovalipollis rarus Klaus
Lycopodiumsporites keuperi Nilsson
Carnisporites ornatus Mädler
Chasmatosporites apertus (Rogalska) Nilsson
Carnisporites granulatus Schulz
Cyathidites minor Couper
Camarozonasporites rudis (Leschik) Klaus
Equisetumsporites sp.
Coniopteris sp.
Gleicheniidites senonicus (Ross) Skarby
Cingulizonates sp.
Granuloperculatipollis rudis Venkatachala et Góczán
Corollina zwolinskai Lund
Corollina meyeriana (Klaus) Venkatachala et Góczán
Lunatisporites rhaeticus (Schulz) Fijałkowska
Foveolatitriletes sp.
Densosporites cf. *fissus* (Reinhardt) Schulz
Nevesisporites limatulus Playford et Dettmann
Osmundacidites sp.
Riccisporites tuberculatus Lundblad
Cyathidites australis Couper
Dictyophyllidites mortoni (de Jersey) Playford et Dettmann
Acanthotriletes varius Nilsson
Trachysporites fuscus Nilsson
Lycopodiumsporites reticulumsporites (Rouse) Dettmann
Lycopodiumsporites semimuris Danzé-Corsin et Laveine
Lycopodiumsporites annotinum (Linn.) Fijałkowska
Lycopodiumsporites cf. *gristhopensis* Couper
Marattisporites scabratus Couper
Podozamites sp.
Chasmatosporites rimatus Nilsson
Concavisporites juriensis Balme
Concavisporites junctum (Kara-Murza) Semenova

Baltisphaeridium longispinosum (Eisenack) Eisenack
Baltisphaeridium aciculatum Orłowska-Zwolińska
Baltisphaeridium debilispinum Wall et Downie
Michrystridium recurvatum Valensi
Michrystridium inconspicuum (Deflandre) Deflandre
Veryhachium reductum (Deflandre) Jekhowsky
Veryhachium hyalodermum (Cookson) Schaarschmidt
Leiosphaeridia sp.
Tasmanites sp.

— a, — b, — c, — d
Frequency of sporomorph occurrence: a - ocasionally, b - less than 5%, c - 5-15%, d - over 15%
B. Dol. - Boundary Dolomite, R. San. - Reedy Sandstone

porites. Less numerous was genus *Verrucosisporites* with species: *V. morulae* Klaus (Pl. II, Fig. 1) and *V.* cf. *contactus* Clarke (Pl. II, Fig. 2).

III ASSEMBLAGE

The III assemblage was found in upper part of the Lower Gypsum Beds in two boreholes: Eugeniów-Korytków IG 1 — depth: 272.0–272.3 m (A. Fijałkowska, 1989) and Mniszków IG 1 — depth: 2425.5–2427.0 m (A. Fijałkowska, 1988*a*). Except of *P. longdonensis* (Clarke) Scheuring occurred there the second index species: *Triadispora verrucata* (Schulz) Scheuring (Pl. IV, Fig. 12). Content of pollen grains in this assemblage was 55.0%. There prevailed *Disaccites* — 37.3% — among which, similary as in II assemblage, dominated specimens of genera: *Ovalipollis* — 15.5% of spectrum — and *Triadispora* — 5.5%. Relatively frequent was genus *Minutosaccus*. The rest of grains occurred in amount similar as in II assemblage.

Spores consisted 45.0% of the assemblage and they represented mainly genus *Aratrisporites*.

IV ASSEMBLAGE

The IV assemblage was documented in deposits of Reedy Sandstone only in one borehole Mniszków IG 1 at the depth 232.0 m (A. Fijałkowska, 1988*a*). It contained index species *Aulisporites astigmosus* (Leschik) Klaus (Pl. I, Fig. 9). Content of pollen grains in the assemblage was 55.2%. There prevailed *Disaccites* — 33.6% of spectrum — belonging mainly to genera: *Lunatisporites, Stratoabietites* and *Triadispora*. Less numerous were Azonaletes — 4.2% of assemblage — with genera: *Equisetosporites* and *Praecolpates* (11.2%).

Spores consisted 44.8% of spectrum. Among them dominated specimens of Azonomonoletes — 19.6% of assemblage — from species *Leschikisporis aduncus* (Leschik) Potonié. Genus *Aratrisporites* was numerous. Among Azonotriletes — 15.4% prevailed taxons of genus *Calamospora*. Less numerous were specimens of genera; *Anapiculatisporites* and *Todisporites*. Within subturma *Auritotriletes* — 9.8% of spectrum — dominated specimens of genus *Carnisporites*: *C. granulatus* Schulz (Pl. III, Fig. 3), *C. ornatus* Mädler (Pl. III, Fig. 1) and *C.* cf. *mesozoicus* (Klaus) Mädler (Pl. III, Fig. 2).

V ASSEMBLAGE

The V assemblage was found in the Upper Gypsum Beds in boreholes: Eugeniów-Korytków IG 1 — depth: 218.4–221.5 m (A. Fijałkowska, 1989), Mniszków IG 1 — depth: 2086.4 m (A. Fijałkowska, 1988*a*), Nieświń PIG 1 — depth: 605.5 m (A. Fijałkowska, 1991), and Opoczno PIG 2 — depth: 771.2–775.5 m. Its quantitative and taxonomic composition was impoverished. There dominated pollen grains of genus *Corollina* with index species *C. meyeriana* (Klaus) Venkatachala et Góczán (Pl. V, Fig. 1). Less numerous were specimens of genera: *Ovalipollis, Enzonalasporites* and *Monosulcites* which could suggest the Subzone a from lower part of C. meyeriana Zone,

distinguished by T. Orłowska-Zwolińska in the Upper Gypsum Beds. That opinion was confirmed with lithological characteristics of deposit.

VI ASSEMBLAGE

The VI assemblage was documented in the Rhaetic deposits in two boreholes: Eugeniów-Korytków IG 1 — depth: 195.0–196.0 m (A. Fijałkowska, 1989) and Opoczno PIG 2 — depth: 578.8 m. It contained the index species *C. meyeriana* (Klaus) Venkatachala et Góczán. Pollen grains content was 81.2% of all assemblage. Among Disaccites — 36.7% of spectrum — dominated specimens of genus *Ovalipollis*. Frequent were specimens of genera: *Pinuspollenites* and *Triadispora*. Among Azonaletes — 3.0% of assemblage — prevailed taxons of genus *Corollina*: *C. meyeriana* (Klaus) Venkatachala et Góczán, *C. zwolinskai* Lund (Pl. IV, Fig. 7) and *Granuloperculatipollis*. Relatively numerous were grains of Praecolpates — 23.0% of assemblage — belonged mainly to genus *Monosulcites*.

Spores consisted 20.1% of spectrum. There dominated specimens of genus *Todisporites* and *Lycopodiumsporites*.

Described assemblage belonged to Subzone b from C. meyeriana Zone, distinguished by T. Orłowska-Zwolińska within Drawno Beds, Jarkowo Beds and lower part of Zbąszynek Beds (Lower Rhaetic).

VII ASSEMBLAGE

The VII assemblage was noticed only in one borehole Studzianna IG 2 at the depth 1108.0–1123.0 m (A. Fijałkowska, 1988*b*). It was poor. There dominated spores — 66.0% of spectrum — from subturma *Azonotriletes*, belonged to genera: *Cyathidites, Concavisporites, Todisporites* and *Lycopodiumsporites*. Among pollen grains — 34.0% of assemblage — prevailed Disaccites — 18.7% — from genus *Pinuspollenites*. Plicates consisted 12.0% of all assemblage. Frequent were species: *Eucommiidites, Monosulcites* and *Cycadopites*.

CONCLUSIONS

This work was the first detail study of palynostratigraphy of the Upper Triassic deposits from NW margin of the Holy Cross Mts. Basing on the stratigraphic ranges of miospores and their quantitative content within spectra seven microfloristic assemblages were distinguished within Keuper and Rhaetic series.

The I assemblage represented upper part of Helisaccus dimorphus Zone. The II assemblage included two subassemblages: IIa and IIb, belonged to Echinitosporites iliacoides Subzone from Porcellispora longdonensis Zone. The III assemblage belonged to Triadispora verrucata Subzone from upper part of P. longdonensis Zone. The IV assemblages was refered to Aulisporites astigmosus Zone. The V one represented the Subzone a from Corollina meyeriana Zone but the VI — Subzone b of the

same zone. The VII assemblage could be correlated with Riccisporites tuberculatus Zone.

Comparison of the assemblages found in the Holy Cross Mts with the other ones, described from other regions of Poland by T. Orłowska-Zwolińska (1983), documented large similarity to microflora from NE margin of the Upper Silesian Coal Basin. Within the Lower Gypsum Beds was found the assemblage belonged to Porcellispora longdonensis Zone of very similar taxonomic composition to subassemblage IIb, described here by author. Also the spectrum from the Reedy Sandstone indicated high similarity to the assemblage IV from the Holy Cross Mts, having high content of miospores from genera: *Ovalipollis* and *Aratrisporites*. More significant quantitative differences were visible in the early Rhaetic assemblages (Subzone b from Corollina meyeriana Zone) because on the Upper Silesian area prevailed grains of genera: *Corollina* and *Classopollis*.

Considerable analogies were noted in comparison of the I assemblage from the Holy Cross Mts with the spectrum, described by M. Pautsch (1971, 1973) from the Lower Keuper deposits of the Carpathian Foreland. The characteristic feature of the last one was occurrence of microplankton in form of species *Michrystridium*. Acritarcha of the same age were known in the Holy Cross Mts only in north-eastern part of this region (K. Rdzanek, 1981).

T. Orłowska-Zwolińska identified on area of north-eastern Poland the spectrum of the Lower Keuper with varied species composition, similar as was noted, in the I assemblage from the Holy Cross Mts. Second spectrum, found in the upper part of the Lower Gypsum Beds, resembled the III assemblage. Also the assemblages, distinguished within the Reedy Sandstone, had similar taxonomic composition. More significant differences were visible in younger assemblages of early and late Rhaetic age (Subzone b of Corollina meyeriana Zone and Riccisporites tuberculatus Zone), because the microflora from NW Poland had more taxons.

Relatively most significant differences were noticed during correlation of assemblages from the Holy Cross Mts and north-eastern Poland, where individual spectra were more rich and where the Upper Rhaetic deposits were good palynologically documented. Such differences resulted from other basin development during late Triassic, when area of the Holy Cross Mts was more marginal zone.

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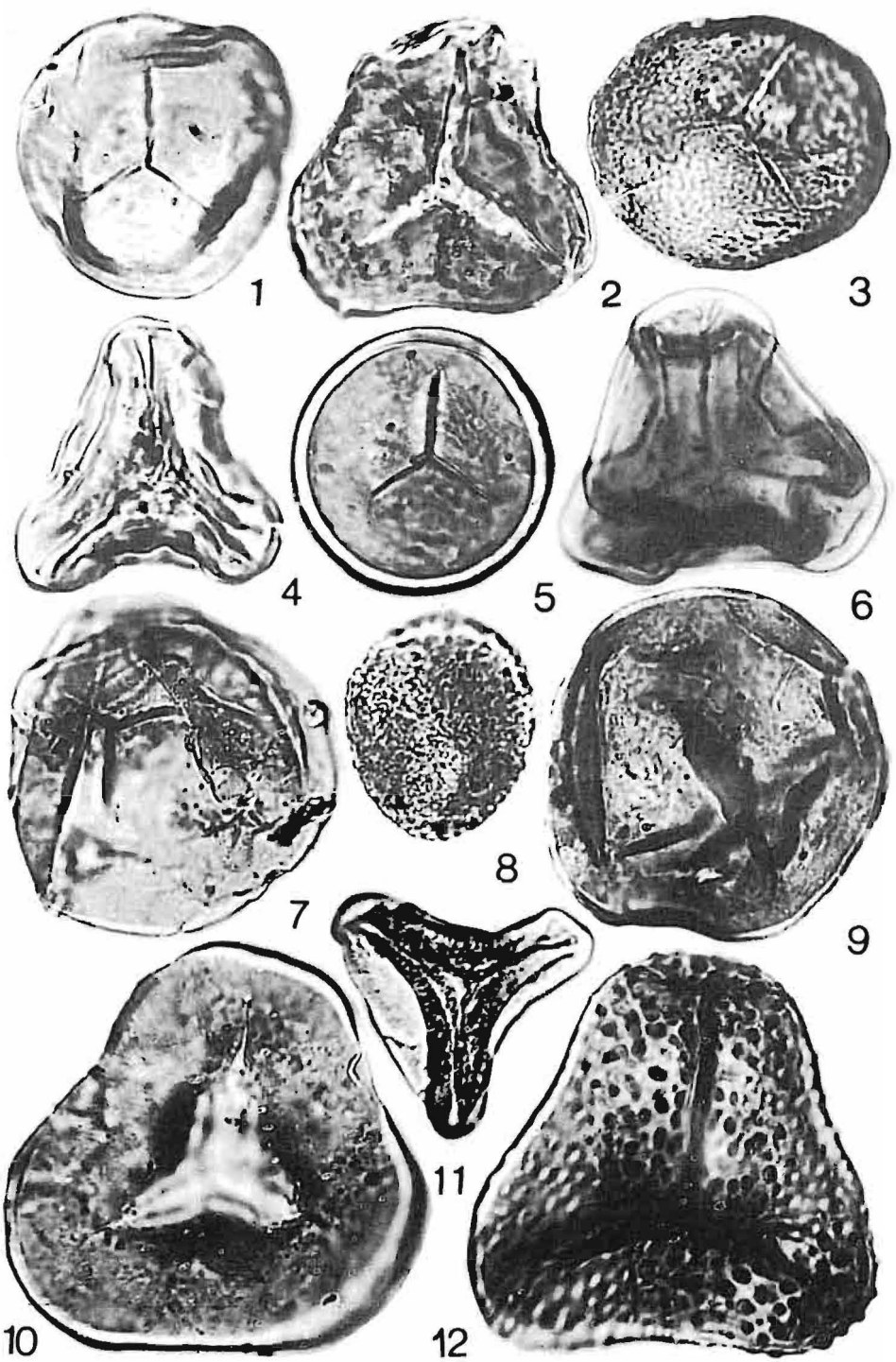
PALINOSTRATYGRAFIA KAJPRU I RETYKU W NW OBRZEŻENIU GÓR ŚWIĘTOKRZYSKICH

Streszczenie

W pracy przedstawiono wyniki badań mikroflory z osadów kajpru i retyku północno-zachodniego obrzeżenia Gór Świętokrzyskich. Materiał do badań pochodził z sześciu otworów wiertniczych. Wyróżniono 7 zespołów sporowo-pyłkowych.

Zespół I, reprezentujący zonę Heliosaccus dimorphus, zidentyfikowano w skałach dolnego kajpru. Zespół II obejmuje podzespół IIa należący do niższej części podzony Echinitosporites iliacoides wchodzącej w skład zony Porcellispora longdonensis, który został wydzielony w osadach dolomitu granicznego, oraz podzespół IIb korelowany z wyższą częścią podzony E. iliacoides, stwierdzony w niższej części dolnych warstw gipsowych. Zespół III należy do podzony Triadispora verrucata zony P. longdonensis i został zidentyfikowany w wyższej części dolnych warstw gipsowych. Zespół IV, należący do zony Aulisporites astigmosus, wyróżniono w piaskowcu trzcinowym. Zespół V reprezentuje podzonę a zony Corollina meyeriana i został stwierdzony w górnych warstwach gipsowych. Zespół VI, charakteryzujący podzonę b zony C. meyeriana, zidentyfikowano w utworach dolnego retyku. Zespół VII prawdopodobnie należy do zony Riccisporites tuberculatus wyróżnianej w osadach górnego retyku.

Ogółem oznaczono 94 gatunki miospor należące do 54 rodzajów oraz 7 gatunków *Acritarcha* reprezentujących 3 rodzaje.



Anna FIJAŁKOWSKA — Palynostratigraphy of the Keuper and Rhaetic in north-western margin of the Holy Cross Mts

PLATE I

Fig. 1. *Todisporites minor* Couper
Mniszków IG 1 borehole, depth 2320.0 m; Upper Keuper (Reedy Sandstone)
Otwór wiert. Mniszków IG 1, głęb. 2320,0 m; górny kajper (piaskowiec trzcinowy)
Fig. 2. *Cyathidites minor* Couper
Eugeniów-Korytków IG 1 borehole, depth 195.0–196.0 m; Lower Rhaetic
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 195,0–196,0 m; dolny retyk
Fig. 3. *Cyclotriletes granulatus* Mädler
Radwanów IG 1 borehole, depth 216.5 m; Lower Keuper
Otwór wiert. Radwanów IG 1, głęb. 216,5 m; dolny kajper
Fig. 4. *Gleicheniidites senonicus* (Ross) Skarby
Studzianna IG 2 borehole, depth 1123.0 m; ?Upper Rhaetic
Otwór wiert. Studzianna IG 2, głęb. 1123,0 m; ?górny retyk
Fig. 5. *Todisporites cinctus* (Maljavkina) Orłowska-Zwolińska
Radwanów IG 1 borehole, depth 216.5 m; Lower Keuper
Otwór wiert. Radwanów IG 1, głęb. 216,5 m; dolny kajper
Fig. 6. *Concavisporites juriensis* Balme
Studzianna IG 2 borehole, depth 1108.0 m; ?Upper Rhaetic
Otwór wiert. Studzianna IG 2, głęb. 1108,0 m; ?górny retyk
Fig. 7. *Calamospora tener* (Leschik) de Jersey
Eugeniów-Korytków IG 1 borehole, depth 318.2 m, Upper Keuper (Border Dolomite)
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 318,2 m; górny kajper (dolomit graniczny)
Fig. 8. *Apiculatisporites parvispinosus* (Leschik) Schulz
Studzianna IG 2 borehole, depth 1524.0 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Studzianna IG 2, głęb. 1524,0 m; górny kajper (dolne warstwy gipsowe)
Fig. 9. *Aulisporites astigmosus* (Leschik) Klaus
Mniszków IG 1 borehole, depth 2320.0 m; Upper Keuper (Reedy Sandstone)
Otwór wiert. Mniszków IG 1, głęb. 2320,0 m; górny kajper (piaskowiec trzcinowy)
Fig. 10. *Cyathidites australis* Couper
Eugeniów-Korytków IG 1 borehole, depth 195.0–196.0 m; Lower Rhaetic
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 195,0–196,0 m; dolny retyk
Fig. 11. *Dictyophyllidites mortoni* (de Jersey) Playford et Dettman
Studzianna IG 2 borehole, depth 1123.0 m; ?Upper Rhaetic
Otwór wiert. Studzianna IG 2, głęb. 1123,0 m; ?górny retyk
Fig. 12. *Converrucosisporites* cf. *conferteornatus* Pautsch
Mniszków IG 1 borehole, depth 2464.0 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Mniszków IG 1, głęb. 2464,0 m; górny kajper (dolne warstwy gipsowe)

Figs 1–12 enl. x 1000
Fig. 1–12 pow. 1000 x

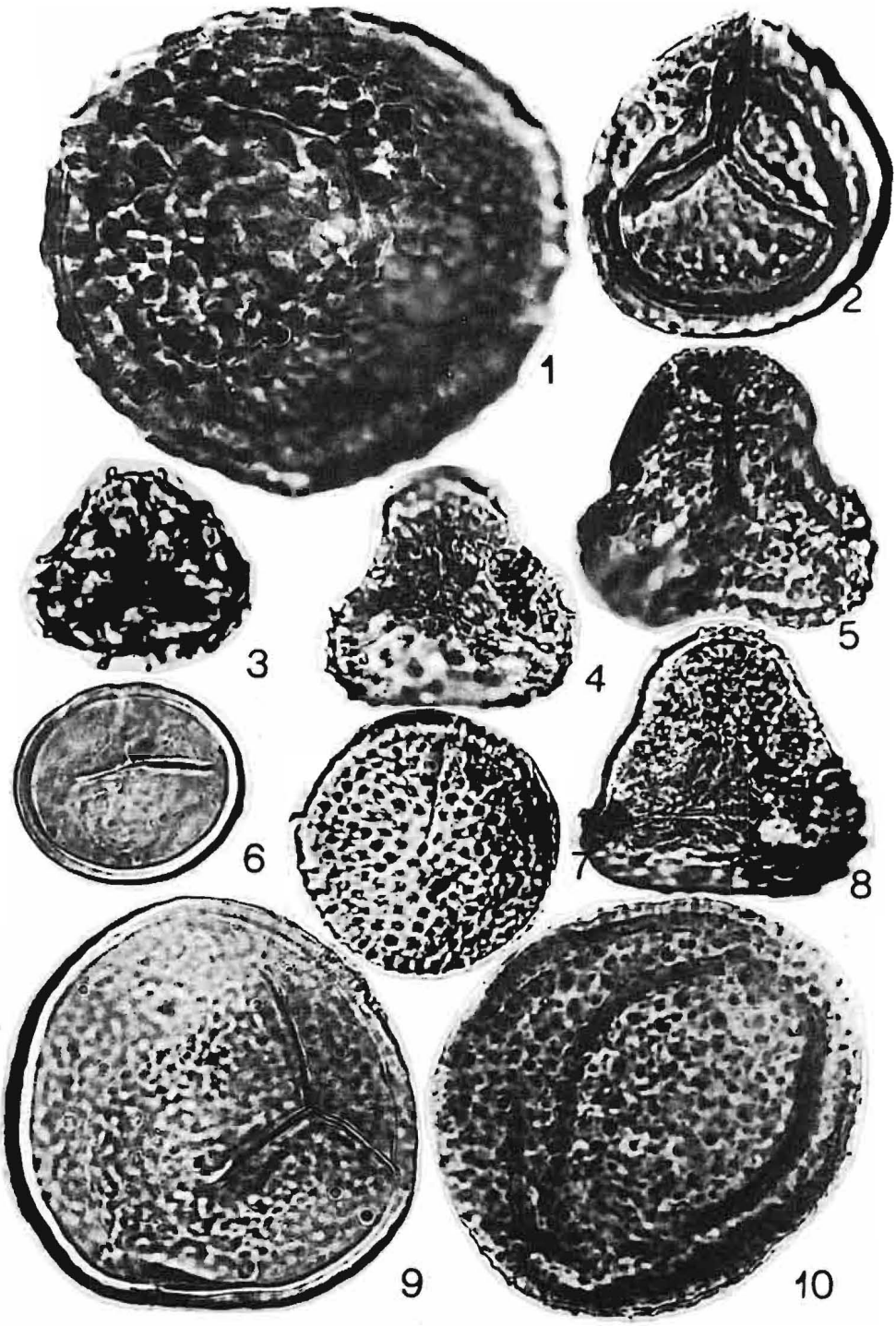


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PLATE II

Fig. 1. *Verrucosisporites morulae* Klaus
Eugeniów-Korytków IG 1 borehole, depth 318.2 m; Upper Keuper (Border Dolomite)
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 318,2 m; górny kajper (dolomit graniczny)
Fig. 2. *Verrucosisporites* cf. *contactus* Clarke
Eugeniów-Korytków IG 1 borehole, depth 272.3 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 272,3 m; górny kajper (dolne warstwy gipsowe)
Fig. 3. *Lycopodiumsporites* cf. *gristhorpensis* Couper
Studzianna IG 2 borehole, depth 1108.0 m; ?Upper Rhaetic
Otwór wiert. Studzianna IG 2, głęb. 1108,0 m; ?górny retyk
Fig. 4. *Acanthotriletes varius* Nilsson
Studzianna IG 2 borehole, depth 1108.0 m; ?Upper Rhaetic
Otwór wiert. Studzianna IG 2, głęb. 1108,0 m; ?górny retyk
Fig. 5. *Lophotriletes triplanus* Mädler
Eugeniów-Korytków IG 1 borehole, depth 291.0 m, Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 291,0 m; górny kajper (dolne warstwy gipsowe)
Fig. 6. *Leschikisporis aduncus* (Leschik) Potonié
Studzianna IG 2 borehole, depth 1641.0 m; Lower Keuper
Otwór wiert. Studzianna IG 2, głęb. 1641,0 m; dolny kajper
Fig. 7. *Anapiculatisporites telephorus* (Pautsch) Klaus
Mniszków IG 1 borehole, depth 2320.0 m; Upper Keuper (Reed Sandstone)
Otwór wiert. Mniszków IG 1, głęb. 2320,0 m; górny kajper (piaskowiec trzcinowy)
Fig. 8. *Trachysporites fuscus* Nilsson
Studzianna IG 2 borehole, depth 1108.0 m; ?Upper Rhaetic
Otwór wiert. Studzianna IG 2, głęb. 1108,0 m; ?górny retyk
Fig. 9. *Microreticulatisporites opacus* (Leschik) Klaus
Radwanów IG 1 borehole, depth 216.5 m; Lower Keuper
Otwór wiert. Radwanów IG 1, głęb. 216,5 m; dolny kajper
Fig. 10. *Porcellispora longdonensis* (Clarke) Scheuring
Eugeniów-Korytków IG 1 borehole, depth 291.0 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 291,0 m; górny kajper (dolne warstwy gipsowe)

Figs 1–10 enl. x 1000
Fig. 1–10 pow. 1000 x

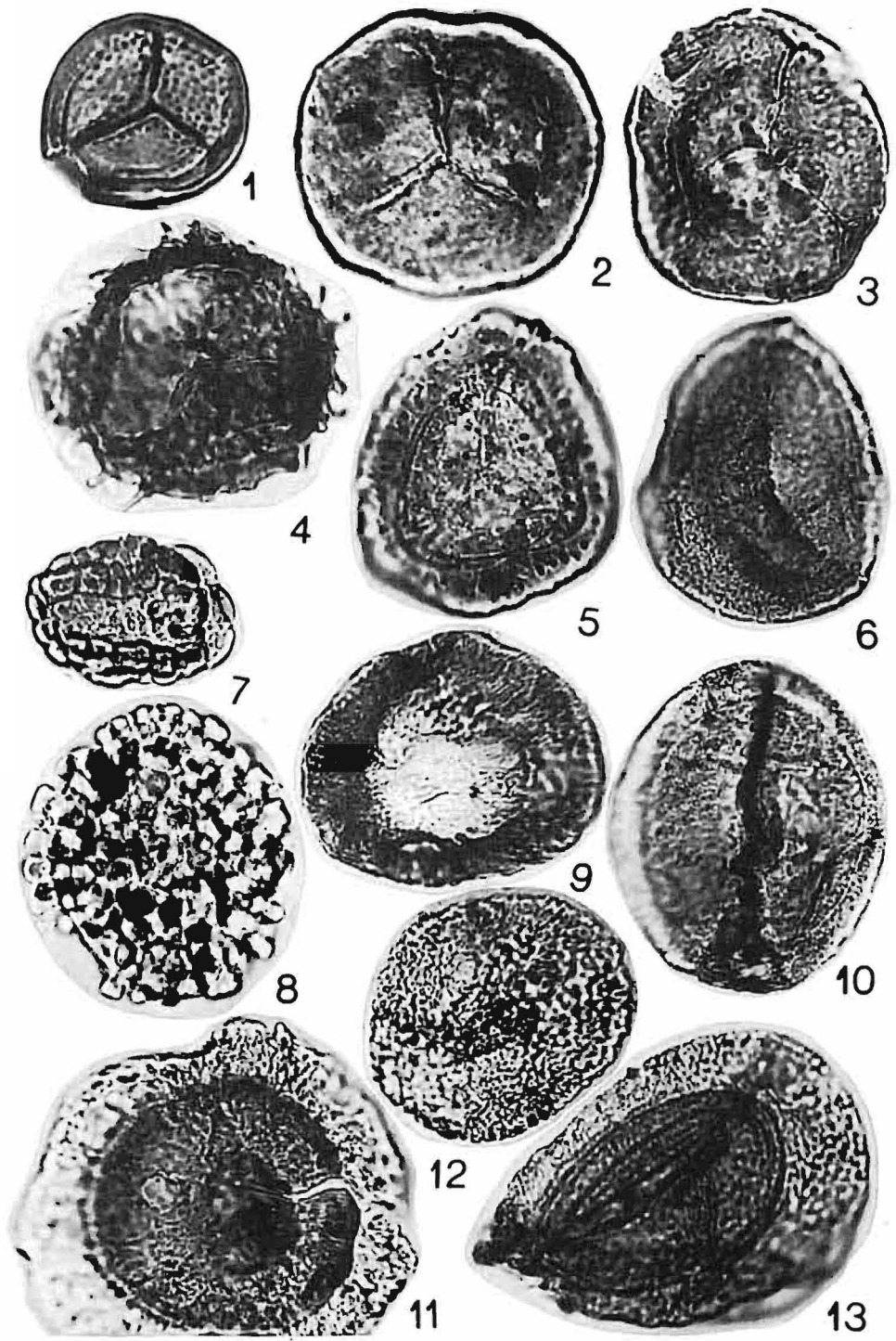

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PLATE III

Fig. 1. *Carnisporites ornatus* Mädler
Mniszków IG 1 borehole, depth 2320.0 m; Upper Keuper (Reedy Sandstone)
Otwór wiert. Mniszków IG 1, głęb. 2320,0 m; górny kajper (piaskowiec trzcinowy)
Fig. 2. *Carnisporites* cf. *mesozoicus* (Klaus) Mädler
Mniszków IG 1 borehole, depth 2320.0 m; Upper Keuper (Reedy Sandstone)
Otwór wiert. Mniszków IG 1, głęb. 2320,0 m; górny kajper (piaskowiec trzcinowy)
Fig. 3. *Carnisporites granulatus* Schulz
Mniszków IG 1 borehole, depth 2320.0 m; Upper Keuper (Reedy Sandstone)
Otwór wiert. Mniszków IG 1, głęb. 2320,0 m; górny kajper (piaskowiec trzcinowy)
Fig. 4. *Heliosporites altmarkensis* Schulz
Studzianna IG 2 borehole, depth 1123.0 m; ?Upper Rhaetic
Otwór wiert. Studzianna IG 2, głęb. 1123,0 m; ?górny retyk
Fig. 5. *Densosporites cavernatus* Orłowska-Zwolińska
Eugeniów-Korytków IG 1 borehole, depth 195.0–196.0 m; Lower Rhaetic
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 195,0–196,0 m; dolny retyk
Fig.6. *Aratrisporites coryliseminis* Klaus
Studzianna IG 2 borehole, depth 2641.8 m; Lower Keuper
Otwór wiert. Studzianna IG 2, głęb. 2641,8 m; dolny kajper
Fig. 7. *Camerosporites secatus* (Leschik) nov. comb.
Eugeniów-Korytków IG 1 borehole, depth 291.0 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Eugeniow-Korytkow IG 1, głęb. 291,0 m; górny kajper (dolne warstwy gipsowe)
Fig. 8. *Echinitosporites iliacoides* Schulz et Krutzsch
Eugeniów-Korytków IG 1 borehole, depth 291.0 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. IG 1, głęb. 291,0 m; górny kajper (dolne warstwy gipsowe)
Fig. 9. *Accinctisporites ligatus* Leschik
Radwanów IG 1 borehole, depth 216.5 m; Lower Keuper
Otwór wiert. Radwanów IG 1, głęb. 216,5 m; dolny kajper
Fig. 10. *Aratrisporites granulatus* (Klaus) Playford et Dettman
Eugeniów-Korytków IG 1 borehole, depth 291.0 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 291,0 m; górny kajper (dolne warstwy gipsowe)
Fig. 11. *Heliosaccus dimorphus* Mädler
Radwanów IG 1 borehole, depth 218.2 m; Lower Keuper
Otwór wiert. Radwanów IG 1, głęb. 218,2 m; dolny kajper
Fig. 12. *Enzonalasporites manifestus* Leschik
Eugeniów-Korytków IG 1 borehole, depth 218.4 m; Upper Keuper (Upper Gypsum Beds)
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 218,4 m; górny kajper (górne warstwy gipsowe)
Fig. 13. *Aratrisporites scabratus* Klaus
Mniszków IG 1 borehole, depth 2425.5 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Mniszków IG 1, głęb. 2425,5 m; górny kajper (dolne warstwy gipsowe)

Figs 1–13 enl. x 1000
Fig. 1–13 pow. 1000 x

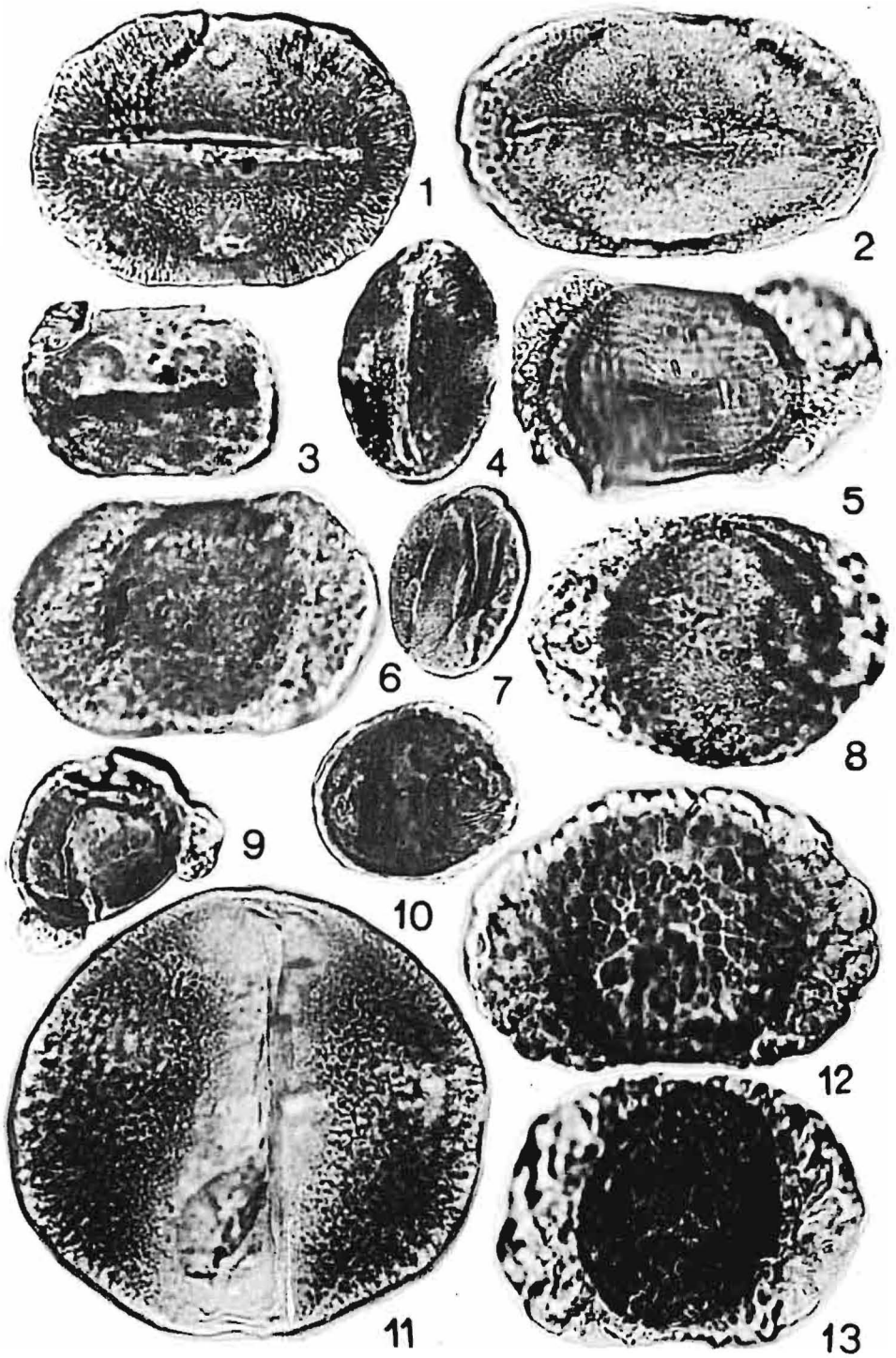

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PLATE IV

Fig. 1. *Ovalipollis rarus* Klaus
Studzianna IG 2 borehole, depth 1108.0 m; ?Upper Rhaetic
Otwór wiert. Studzianna IG 2, głęb. 1108,0 m; ?górny retyk
Fig. 2. *Ovalipollis ovalis* Krutzsch
Eugeniów-Korytków IG 1 borehole, depth 291.0 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 291,0 m; górny kajper (dolne warstwy gipsowe)
Fig. 3. *Ovalipollis grebeae* Klaus
Eugeniów-Kotytków IG 1 borehole, depth 291.0 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 291,0 m; górny kajper (dolne warstwy gipsowe)
Fig. 4. *Ovalipollis minimus* (Scheuring) Orłowska-Zwolińska
Mniszków IG 1 borehole, depth 2425.0 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Mniszków IG 1, głęb. 2425,0 m; górny kajper (dolne warstwy gipsowe)
Fig. 5. *Striatoabietites balmei* Klaus
Mniszków IG 1 borehole, depth 2464.0 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Mniszków IG 1, głęb. 2464,0 m; górny kajper (dolne warstwy gipsowe)
Fig. 6. *Lunatisporites rhaeticus* (Schulz) nov. comb.
Studzianna IG 2 borehole, depth 1108.0 m; ?Upper Rhaetic
Otwór wiert. Studzianna IG 2, głęb. 1108,0 m; ?górny retyk
Fig. 7. *Corollina zwolinskai* Lund
Eugeniów-Korytków IG 1 borehole, depth 218.4 m; Upper Keuper (Upper Gypsum Beds)
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 218,4 m; górny kajper (górne warstwy gipsowe)
Fig. 8. *Triadispora keuperiana* Orłowska-Zwolińska
Eugeniów-Korytków IG 1 borehole, depth 318.2 m; Upper Keuper (Boundary Dolomite)
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 318,2 m; górny kajper (dolomit graniczny)
Fig. 9. *Minutosaccus potoniei* Mädler
Eugeniów-Korytków IG 1 borehole, depth 318.2 m; Upper Keuper (Boundary Dolomite)
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 318,2 m; górny kajper (dolomit graniczny)
Fig. 10. *Minutosaccus schizeatus* Mädler
Radwanów IG 1 borehole, depth 216.5 m; Lower Keuper
Otwór wiert. Radwanów IG 1, głęb. 216,5 m; dolny kajper
Fig. 11. *Brachysaccus neomundanus* (Leschik) Mädler
Radwanów IG 1 borehole, depth 152.5 m; Lower Keuper
Otwór wiert. Radwanów IG 1, głęb. 152,5 m; dolny kajper
Fig. 12. *Triadispora verrucata* (Schulz) Scheuring
Eugeniów-Korytków IG 1 borehole, depth 272.0 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 272,0 m; górny kajper (dolne warstwy gipsowe)
Fig. 13. *Triadispora plicata* Klaus
Mniszków IG 1 borehole, depth 2464.0 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Mniszków IG 1, głęb. 2464,0 m; górny kajper (dolne warstwy gipsowe)

Figs 1–13 enl. x 1000
Fig. 1–13 pow. 1000 x

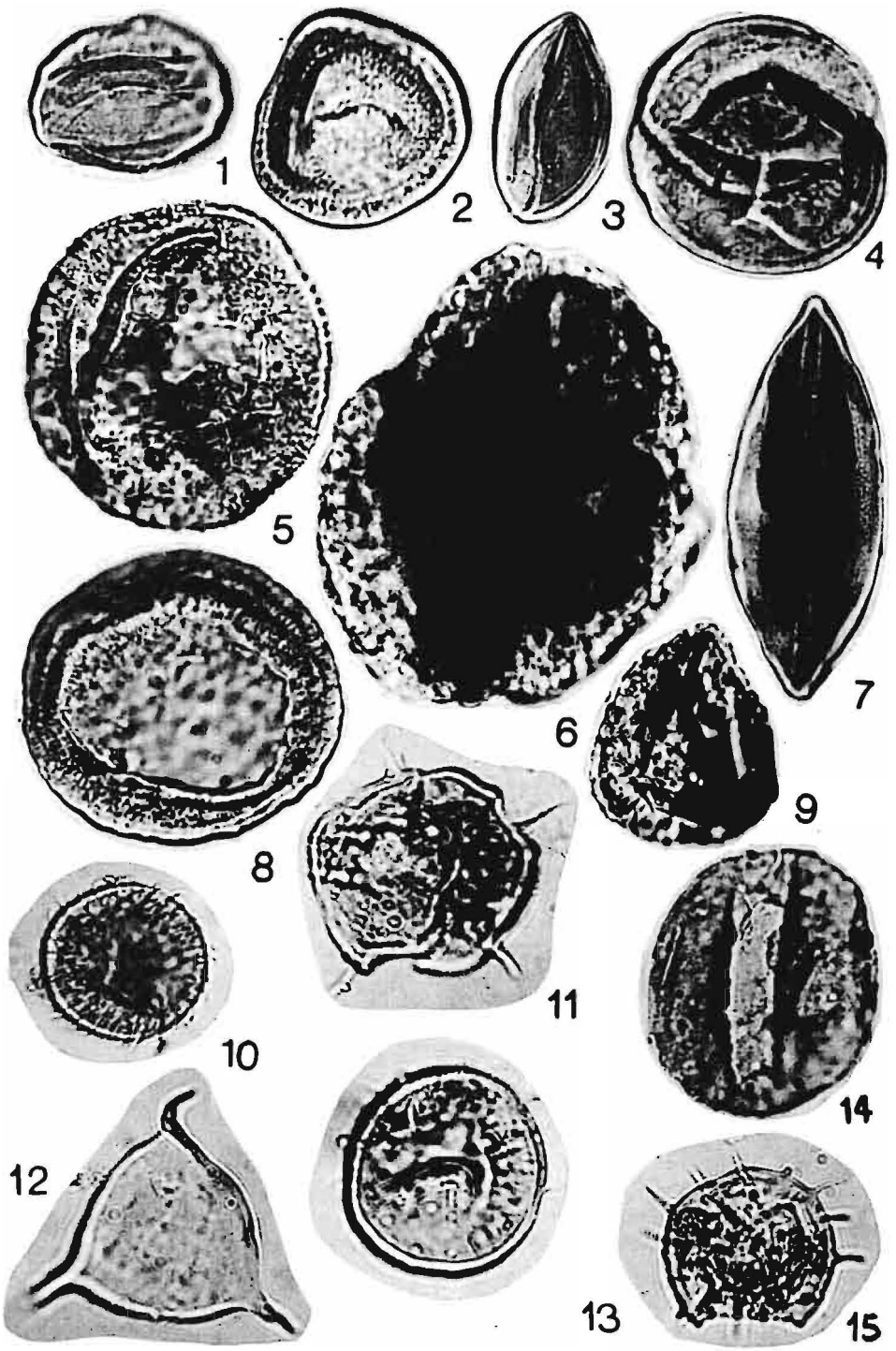

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PLATE V

Fig. 1. *Corollina meyeriana* (Klaus) Venkatachala et Góczán
Mniszków IG 1 borehole, depth 2086.4 m; Upper Keuper (Upper Gypsum Beds)
Otwór wiert. Mniszków IG 1, głęb. 2086,4 m; górny kajper (górne warstwy gipsowe)
Fig. 2. *Classopollis classoides* (Pflug) Pocock et Jansonius
Studzianna IG 2 borehole, depth 1123.0 m; ?Upper Rhaetic
Otwór wiert. Studzianna IG 2, głęb. 1123,0 m; ?górny retyk
Fig. 3. *Monosulcites minimus* Cookson et Couper
Studzianna IG 2 borehole, depth 1108.0 m; ?Upper Rhaetic
Otwór wiert. Studzianna IG 2, głęb. 1108,0 m; ?górny retyk
Fig. 4. *Paracirculina maljavkinae* Klaus
Studzianna IG 2 borehole, depth 1527.0 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Studzianna IG 2, głęb. 1527,0 m; górny kajper (dolne warstwy gipsowe)
Fig. 5. *Praecirculina granifer* (Leschik) Klaus
Studzianna IG 2 borehole, depth 1524.0 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Studzianna IG 2, głęb. 1524,0 m; górny kajper (dolne warstwy gipsowe)
Fig. 6. *Riccisporites tuberculatus* Lundblad
Studzianna IG 2 borehole, depth 1123.0 m; ?Upper Rhaetic
Otwór wiert. Studzianna IG 2, głęb. 1123,0 m; ?górny retyk
Fig. 7. *Monosulcites punctatus* Orłowska-Zwolińska
Eugeniów-Korytków IG 1 borehole, depth 195.0–196.0 m; Lower Rhaetic
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 195,0–196,0 m; dolny retyk
Fig. 8. *Chasmatosporites apertus* (Rogalska) Nilsson
Studzianna IG 2 borehole, depth 1123.0 m; ?Upper Rhaetic
Otwór wiert. Studzianna IG 2, głęb. 1123,0 m; ?górny retyk
Fig. 9. *Duplicisporites granulatus* (Leschik) Klaus
Mniszków IG 1 borehole, depth 2425.5 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Mniszków IG 1, głęb. 2425,5 m; górny kajper (dolne warstwy gipsowe)
Fig. 10. *Baltisphaeridium aciculatum* Orłowska-Zwolińska
Eugeniów-Korytków IG 1 borehole, depth 318.2 m; Upper Keuper (Boundary Dolomite)
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 318,2 m; górny kajper (dolomit graniczny)
Fig. 11. *Baltisphaeridium longispinum* (Eisenack) Eisenack
Eugeniów-Korytków IG 1 borehole, depth 318.2 m; Upper Keuper (Boundary Dolomite)
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 318,2 m; górny kajper (dolomit graniczny)
Fig. 12. *Veryhachium reductum* (Deunff) Jekhowsky
Opoczno PIG 2 borehole, depth 939.8–939.9 m; Upper Keuper (Boundary Dolomite)
Otwór wiert. Opoczno PIG 2, głęb. 939,8–939,9 m; górny kajper (dolomit graniczny)
Fig. 13. *Michrystridium recurvatum* Valensi
Opoczno PIG 2 borehole, depth 939.8–939.9 m; Upper Keuper (Boundary Dolomite)
Otwór wiert. Opoczno PIG 2, głęb. 939,8–939,9 m; górny kajper (dolomit graniczny)
Fig. 14. *Eucommiidites microgranulatus* Scheuring
Eugeniów-Korytków IG 1 borehole, depth 291.0 m; Upper Keuper (Lower Gypsum Beds)
Otwór wiert. Eugeniów-Korytków IG 1, głęb. 291,0 m; górny kajper (dolne warstwy gipsowe)
Fig. 15. *Baltisphaeridium debilispinum* Wall et Downie
Opoczno PIG 2 borehole, depth 939.8–939.9 m; Upper Keuper (Boundary Dolomite)
Otwór wiert. Opoczno PIG 2, głęb. 939,8–939,9 m; górny kajper (dolomit graniczny)

Figs 1–15 enl. x 1000
Fig. 1–15 pow. 1000 x