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Miospores, megaspores and *Lepidopteris ottonis* (Goeppert) Schimper in the uppermost Triassic deposits from Poland

This article presents stratigraphic position of the deposits, containing the remains of the leaf of the seed fern *Lepidopteris ottonis* (Goeppert) Schimper. The opinion is that the range of this species comprises two miospore zones: *Corollina meyeriana* and *Ricciisporites tuberculatus* and one megaspore assemblage *Trileites pinguis*. In the profiles from Poland these zones document the epicontinental "Rhaetic" deposits, which — according to the chronostratigraphic scheme — belong to the Alpine stages: the Norian and Rhaetian.

INTRODUCTION

This paper presents the photographs of the miospores (Pl. I–III), found in the materials of the late Dr Teresa Orłowska-Zwolińska. These miospores came from one sample (depth 2125.0 m) from the borehole Gradzanowo 3, situated in the Warsaw Depression. The determination of the species content of miospores enabled the location of the studied sample in the *Ricciisporites tuberculatus* Zone, the one which defines in other areas of Poland, the deposits of the Wielichowskie Beds, refered to the upper "Rhaetic".

The significance of the materials found is enhanced by the fact that in this sample the remains of a leaf of the seed fern *Lepidopteris ottonis* (Goeppert) Schimper was also described (M. Barbacka, 1991).

The results of studies from the Gostyń area (T. Marcinkiewicz, T. Orłowska- Zwolińska, 1985) were used to complete the pattern of co-occurrence of not only the miospores and *L. ottonis* but also of the megaspores, especially in the older deposits of lower "Rhaetic".

The species *L. ottonis* (Goeppert) Schimper is an important fossil of the macroflora zone *Lepidopteris* in eastern Greenland (T. M. Harris, 1931, 1932, 1937), dated to the

"Rhaetic". In Europe this species was found in southern Sweden (B. Lundblad, 1950), in Germany (T. M. Harris, 1931, 1937), in Denmark (F. Bertelsen, O. Michelsen, 1970) and in Poland (F. Roemer *fide* J. Znosko, 1955; M. Piwocki, 1970; M. Barbacka, 1991).

STRATIGRAPHIC POSITION OF THE DEPOSITS WITH *LEPIDOPTERIS OTTONIS* (GOEPPERT) SCHIMPER IN THE RESULTS OF MIO- AND MEGASPORE INVESTIGATIONS

The palynological investigations of the epicontinental Triassic in Poland, carried out by the T. Orłowska-Zwolińska (1983, 1984, 1985) and A. Fijałkowska (1992) documented an occurrence of numerous spores and pollen grains, significant for the establishment of the biostratigraphy of these deposits and their correlation in distant areas. The registered changes of the species composition enabled T. Orłowska-Zwolińska to resolve the palynostratigraphic scheme of the Triassic deposits, which became a basis for defining the deposit stratigraphy, among others — in the borehole Gradzanowo 3. In the studied fragment of the profile (depth 2125.0 m), in addition to the miospores the seed fern remains fern *Lepidopteris ottonis* (Goeppert) Schimper were also described (M. Barbacka, 1991). The miospore assemblage noticed there (Pl. I–III) has common features with the assemblage of the *Ricciisporites tuberculatus* Zone, typical for the deposits of the Wielichowskie Beds in the profiles of western Poland. These sediments, traditionally refered in Poland to the upper "Rhaetic", correspond — according to T. Orłowska-Zwolińska (1983, 1985) — with the Rhaetian stage in the Alps. The studied assemblage does not have all species characteristic for the above mentioned zone. It probably results from the palaeoecological differences or, the assemblage from the borehole Gradzanowo 3 corresponds with the lowermost part of the *Ricciisporites tuberculatus* Zone. In this part of the zone the number of index species gradually increases upward.

The attachment of the assemblage from the borehole Gradzanowo 3 to the *Ricciisporites tuberculatus* Zone was confirmed by the occurrence of the following species: *Ricciisporites tuberculatus* Lundblad, *Triancoraesporites ancorae* (Reinhardt) Schulz, *Limbosporites lundbladii* Nilsson, *Cingulizonates rhaeticus* (Reinhardt) Schulz, *Semiretisporis gothae* Reinhardt, *Pinuspollenites minimus* (Couper) Kemp, *Rhaetipollis germanicus* Schulz, *Monosulcites punctatus* Orłowska-Zwolińska, *Classopollis classoides* (Pflug) Pocock et Jansonius, *Polypodiisporites polymicroforatus* (Orłowska-Zwolińska) Lund, *Chasmatosporites* sp. and *Araucariacites* sp.

The presence of the index species enables the comparison of this assemblage not only with the coeval mioflora from the "Rhaetic" deposits of western Poland but also with the mioflora of the *Rhaetipollis–Limbosporites* Zone, described by J. J. Lund (1977) from the middle "Rhaetic" and of the *Ricciisporites–Polypodiisporites* Zone from the upper "Rhaetic" (*sensu germanico*) of Germany and Denmark (T. Orłowska-Zwolińska, 1985).

Moreover, some of the above mentioned miospores are known from the palynological Zone 1, distinguished by K. R. Pedersen and J. J. Lund (1980) in eastern Greenland. This zone is characterized, among others, by a high content of *Ricciisporites tuberculatus* Lundblad and by an occurrence of such species as: *Rhaetipollis germanicus* Schulz, *Limbosporites lundbladii* Nilsson, *Ovalipollis ovalis* Krutsch and others. It is regarded as

an equivalent of the *Lepidopteris ottonis* Zone and the *Transitional Region* of the macroflora, known from eastern Greenland.

To complete the stratigraphic pattern the results of studies of the older, the lower "Rhaetic" deposits should be presented. Such material was obtained from the profile of borehole Gostyń 46 G (the Fore-Sudetic Monocline area). There were also found, in addition to the miospores, megaspores and fragments of epidermis. The characteristic morphological features of the epidermis, especially the structure of stomatal apparatus, allows as to suppose that it belongs to a leaf of *Lepidopteris ottonis* (Goeppert) Schimper (T. Marcinkiewicz, T. Orłowska-Zwolińska, 1985, Pl. II, Figs. 6, 7).

The miospores found in the profile of borehole Gostyń 46 G at the depths 235.0 –236.0 and 242.0–243.0 m and in the other profiles from the Gostyń region, represented the following species: *Classopollis classoides* (Pflug) Pocock et Jansonius, *Corollina meyeriana* (Klaus) Venkatachala et Góczán, *C. zwolińskai* Lund, *Brachysaccus neomundanus* (Leschik) Mädler, *Granuloperculatipollis rudis* Venkatachala et Góczán, *Labiisporites triassicus* Orłowska-Zwolińska, *Taurocusporites verrucatus* Schulz, *Heliosporites altmarkensis* Schulz, *Ovalipollis ovalis* Krutsch, *Monosulcites minimus* Cookson and *Nevesisporites limatulus* Playford (Pl. IV, V).

The presented taxons of miospores differ from the species of the assemblage, found in a sample from the borehole Gradzanowo 3. The species content in the samples from the borehole Gostyń 46 G indicates an occurrence of the subzone "b", distinguished within the *Corollina meyeriana* Zone. This subzone is characteristic for the upper part of the Jarkowskie Beds and lower part of the Zbąszyneckie Beds from the profiles of western Poland. These beds are included — in the Polish lithostratigraphic nomenclature — within the lower "Rhaethic". The studies of T. Orłowska-Zwolińska (1985) indicated that this mioflora has a distinct similarity to the one of the Steinmergelkeuper (E. Schulz, 1967) and of the Postera–Schichten in Germany as well as to the mioflora of the lower "Rhaetic" *sensu germanico* from Denmark (J. J. Lund, 1977). The miospores typical for the *Corollina meyeriana* Zone are also noticed in the Norian deposits in the Alps.

The megaspores, occurring in the epicontinental Rhaetic deposits of Poland represent the assemblage *Trileites pinguis*. The earlier studies of the author (T. Marcinkiewicz, 1969, 1971) and quite new data indicate that some species of megaspores, belonging to this assemblage, such as *Trileites pinguis* (Harris) Potonié and *Bacutriletes tylotus* (Harris) Potonié begin their range within the Jarkowskie Beds and in the lower part of the Zbąszyneckie Beds. Such a distribution pattern was noticed in the profile of borehole Gostyń 46 G at the depth 233.0–247.0 m (T. Marcinkiewicz, T. Orłowska-Zwolińska, 1985). Besides the characteristic appearance of the species *Striatriletes ramosus* Marcinkiewicz and *Talchirella granifera* Marcinkiewicz et al. was found here.

The assemblage *Trileites pinguis* in the studied profiles from Poland was also found in the upperlying deposits of the Wielichowskie Beds, where it is enriched with numerous new taxons, unknown from the older sediments. Among the most significant species are: *Tasmanitriletes pedinacron* (Harris) Jux et Kempf, *Trileites rectus* Marcinkiewicz, *Verrutriletes litchii* (Harris) Potonié, *V. utilis* (Marcinkiewicz) Marcinkiewicz, *Maexisporites misellus* Marcinkiewicz, *Horstisporites cavernatus* Marcinkiewicz, *Minerisporites ales* (Harris) Potonié and others.

Table 1

The ranges of the miospore and megaspore zones and of the species *Lepidopteris ottonis* (Goeppert) Schimper in the uppermost Triassic in Poland

Lithostratigraphy			Miospore zones/subzones		Chrono-stratigraphy	Megaspore assemblages		Macroflora
TRIASSIC	"RHAETIC"	Wielichowskie Beds	*Ricciisporites tuberculatus*	*Ricciisporites tuberculatus* *Triancoraesporites ancorae* *Limbosporites lundbladii* *Cingulizonates rhaeticus* *Semiretisporis gothae* *Rhaetipollis germanicus* *Classopollis classoides* *Monosulcites punctatus* *Pinuspollenites minimus* *Polypodiisporites polymicroforatus*	NORIAN – RHAETIAN	*Trileites pinguis*	*Trileites pinguis* *Bacutriletes tylotus* *Tasmanitriletes pedinacron* *Trileites rectus* *Verrutriletes utilis* *Maexisporites misellus* *Horstisporites cavernatus* *Horstisporites rexargenteus* *Minerisporites ales*	*Lepidopteris ottonis*
		Zbąszyneckie Beds	*Corollina meyeriana*	c *Rhaetipollis germanicus* *Corollina meyeriana* *Eucommiidites major* *Monosulcites minimus*			*Trileites pinguis* *Bacutriletes tylotus* *Striatriletes ramosus* *Talchirella granifera*	
		Jarkowskie Beds		b *Taurocusporites verrucatus* *Labiisporites triassicus* *Brachysaccus neomundanus* *Heliosporites altmarkensis* *Carnisporites granulatus*				
	KEUPER	Upper Gypsum Beds		a *Granuloperculatipollis rudis* *Corollina* sp. div. *Ovalipollis ovalis* *Classopollis classoides*	Carnian			

Data after: T. Marcinkiewicz (1969, 1971), T. Orłowska-Zwolińska (1983, 1985), T. Marcinkiewicz, T. Orłowska-Zwolińska (1985), M. Barbacka (1991)

Due to the fact that the lower range of the *Trileites pinguis* assemblage is related with the upper part of the *Corollina meyeriana* Zone but the upper range of it corresponds with the *Ricciisporites tuberculatus* Zone, it could be stated that there is a consistency between the mio- and megaspore interpretation of the stratigraphic position of the deposits, containing *Lepidopteris ottonis* (Goeppert) Schimper.

Outside Poland some taxons, characteristic for the *Trileites pinguis* assemblage are noticed in Germany in the upper part of the lower "Rhaetic" (upper member of the Postera–Schichten), mainly in the middle and upper "Rhaetic" (the Contorta–Schichten and the Trileites–Schichten (H. J. Will, 1969).

A similar megaspore assemblage, defining according to F. Bertelsen and O. Michelsen (1970) the *Trileites pinguis* Zone, is known from the middle and upper "Rhaetic" of Denmark as well as from eastern Greenland where it occurs within the *Lepidopteris* Zone (T. M. Harris, 1935).

After summarizing the presented palynological data it could be stated that within the range of *Lepidopteris ottonis* (Goeppert) Schimper two miospore zones occur: *Corollina meyeriana* and *Ricciisporites tuberculatus* as well as one megaspore assemblage *Trileites pinguis*. These zones document the Norian and Rhaetian deposits in Poland. The conclusion of such an assessment is that *Lepidopteris ottonis* (Goeppert) Schimper appeared probably in the Norian deposits, but not during the transgression with *Rhaetavicula contorta* as was assumed by T. M. Harris (1937). H. J. Will (1969) also suggested that the range of *Lepidopteris ottonis* begins earlier than in the Rhaetkeuper because it occurs up to the Steinmergelkeuper, corresponding in Poland with the deposits containing the miospore assemblage *Corollina meyeriana*.

Considering the stratigraphic position of the deposits found with remains of the leaf *Lepidopteris ottonis* (Goeppert) Schimper, resulting from the mio- and megaspore studies, it could be assumed that the vertical range of this species is contained within Norian and Rhaetian sediments.

The correlation of results of the miospore and megaspore studies with the occurrence of *Lepidopteris ottonis* (Goeppert) Schimper in the uppermost Triassic in Poland, is presented in Table 1.

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MIOSPORY, MEGASPORY I *LEPIDOPTERIS OTTONIS* (GOEPPERT) SCHIMPER W OSADACH NAJWYŻSZEGO TRIASU POLSKI

Streszczenie

W artykule przedstawiono fotografie miospor, które znaleziono w materiałach zmarłej dr Teresy Orłowskiej-Zwolińskiej. Miospory te pochodzą z jednej próbki otworu wiertniczego Gradzanowo 3 (głęb. 2125,0 m) usytuowanego w niecce warszawskiej. Skład gatunkowy miospor pozwolił na umiejscowienie badanej próbki w poziomie *Ricciisporites tuberculatus*, który na innych obszarach Polski dokumentuje warstwy wielichowskie, zaliczane do retyku jako piętra alpejskiego (T. Orłowska-Zwolińska, 1985).

Wartość znalezionych materiałów podkreśla fakt, że z tej samej próbki oznaczono również szczątki paproci nasiennej *Lepidopteris ottonis* (Goeppert) Schimper (M. Barbacka, 1991).

Dla uzyskania całości obrazu związanego z ustaleniem pozycji stratygraficznej osadów zawierających *Lepidopteris ottonis* (Goeppert) Schimper uwzględniono publikowane wyniki badań z otworu wiertniczego Gostyń 46 G, z głębokości 235,0–236,0 i 242,0–243,0 m, w którym oprócz miospor znaleziono fragmenty epidermy *L. ottonis* oraz megaspory (T. Marcinkiewicz, T. Orłowska-Zwolińska, 1985).

Zespół miosporowy z otworu wiertniczego Gostyń 46 G wykazuje inny skład gatunkowy aniżeli zespół wydzielony w próbce z otworu Gradzanowo 3. Oznaczone gatunki wskazują na obecność podzespołu "b" wyróżnionego w obrębie poziomu *Corollina meyeriana*, który w polskich profilach charakteryzuje wyższą część warstw jarkowskich i niższą część warstw zbąszyneckich. Ogniwa te określone jako „retyk" niższy odpowiadają w podziale chronostratygraficznym norykowi (T. Orłowska-Zwolińska, 1985).

Zestawienie powyższych obserwacji pozwoliło wyrazić pogląd, że w zasięgu *Lepidopteris ottonis* (Goeppert) Schimper występują dwa poziomy miosporowe: *Carollina meyeriana* i *Ricciisporites tuberculatus*. Ponadto z korelacji wyników badań biostratygraficznych wynika, że megaspory występujące w zasięgu wymienionych poziomów miosporowych reprezentują zespół *Trileites pinguis*, który — jak się wydaje — rozpoczyna swój zasięg w noryku i trwa nadal w retyku, wzbogacając się w liczne nowe gatunki (T. Marcinkiewicz, 1969, 1971; T. Marcinkiewicz, T. Orłowska-Zwolińska, 1985).

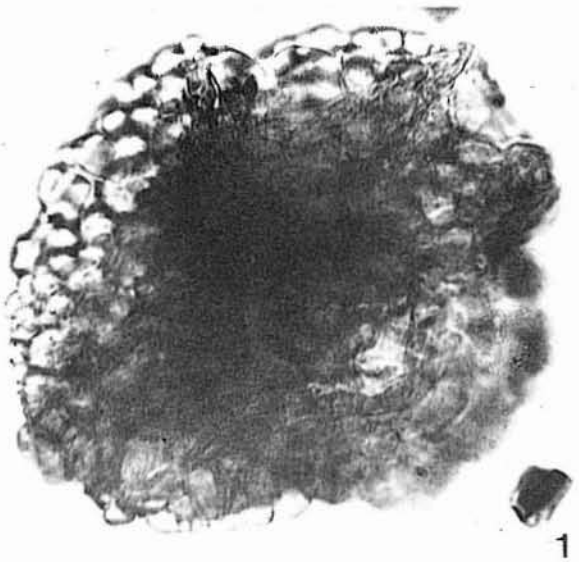
Biorąc pod uwagę ustaloną w wyniku przeprowadzonych badań mio- i megasporowych pozycję stratygraficzną badanych osadów, można przyjąć, iż pionowy zasięg *Lepidopteris ottonis* (Goeppert) Schimper jest związany z osadami noryku i retyku.

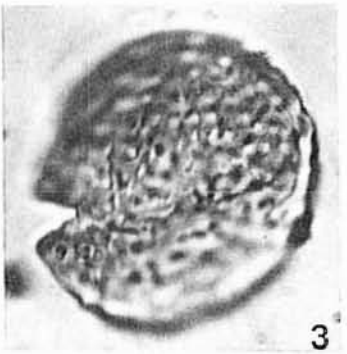
PLATE I

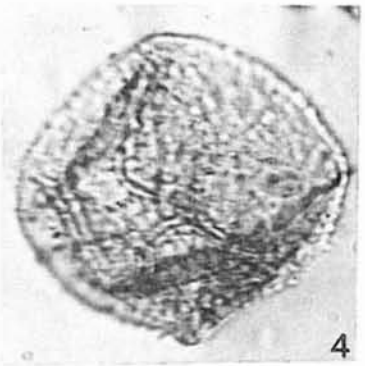
The miospore assemblage the *Ricciisporites tuberculatus* Zone (Rhaetian)
Zespół poziomu miosporowego *Ricciisporites tuberculatus* (retyk)

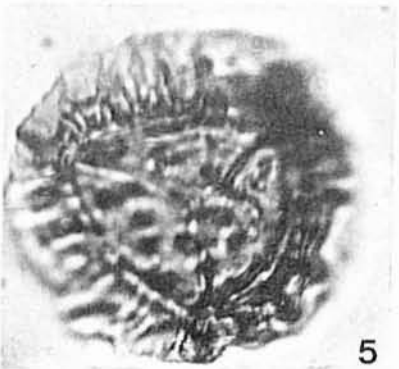
Figs. 1.6. *Ricciisporites tuberculatus* Lundblad, tetrads (tetrady), x 750
Figs. 2.3. *Polypodiisporites polymicroforatus* (Orłowska–Zwolińska) Lund
Fig. 4. *Baculatisporites* sp.
Fig. 5. *Limbosporites lundbladii* Nilsson

The miospores presented on Plate I–III are from the borehole Gradzanowo 3, depth 2125.0 m; the specimens without scale enl. x 1000
Miospory przedstawione na tabl. I–III pochodzą z otworu Gradzanowo 3, głęb. 2125,0 m; okazy, przy których nie podano skali, pow. 1000 x









Teresa MARCINKIEWICZ, Teresa ORŁOWSKA-ZWOLIŃSKA — Miospores, megaspores and *Lepidopteris ottonis* (Goeppert) Schimper in the uppermost Triassic deposits from Poland

PLATE II

The miospore assemblage of the *Ricciisporites tuberculatus* Zone (Rhaetian)
Zespół poziomu miosporowego *Ricciisporites taberculatus* (retyk)

Figs. 1–3. *Cingulizonates rhaeticus* (Reinhardt) Schulz
Fig. 4 . *Triancoraesporites ancorae* (Reinhardt) Schulz
Fig. 5. *Chasmatosporites* sp.
Fig. 6. *Araucariacites* sp.

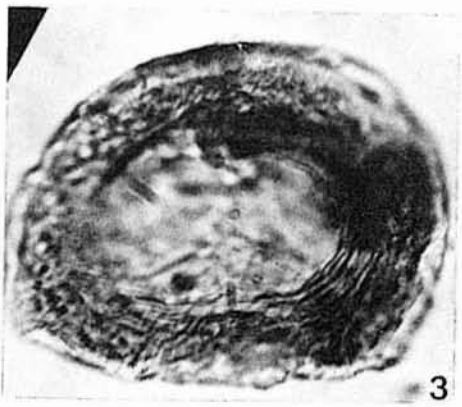


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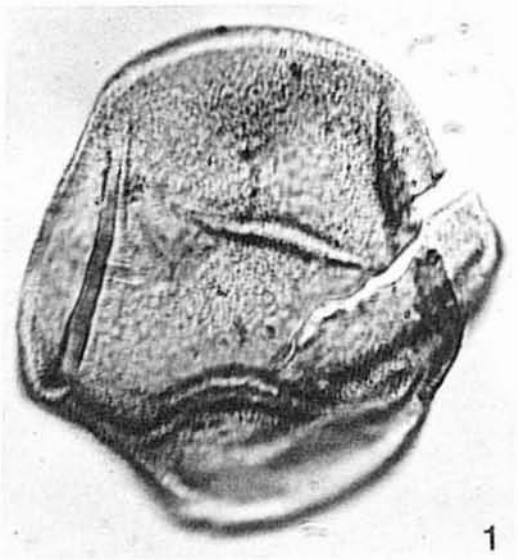
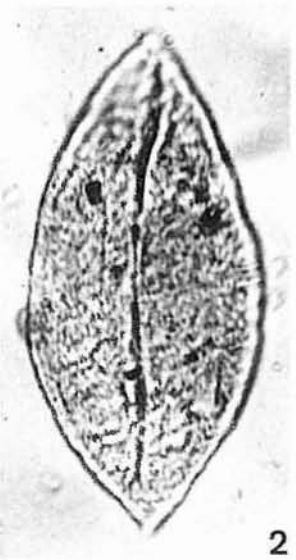
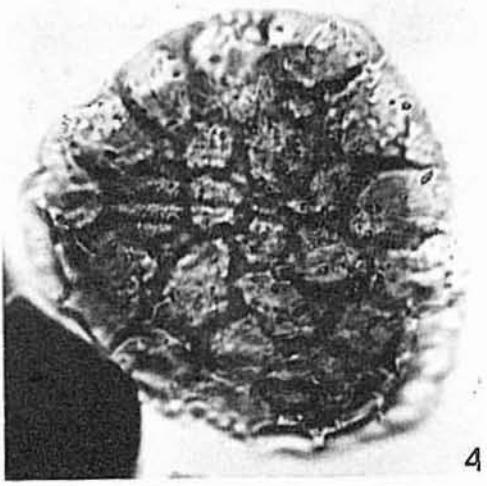
PLATE III

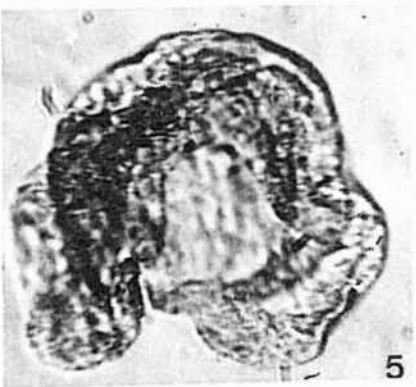
The miospore assemblage of the *Ricciisporites tuberculatus* Zone (Rhaetian)
Zespół poziomu miosporowego *Ricciisporites taberculatus* (retyk)

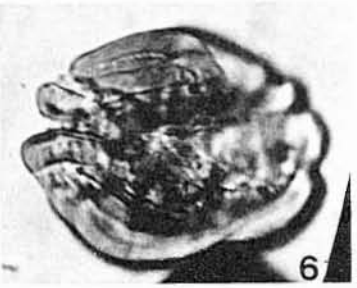
Fig. 1. *Araucariacites* sp.
Fig. 2. *Monosulcites punctatus* Orłowska–Zwolińska
Fig. 3. *Classopollis classoides* (Pflug) Pocock et Jansonius
Fig. 4. *Semiretisporis gothae* Reinhardt
Fig. 5. *Pinuspollenites minimus* (Couper) Kemp
Fig. 6. *Rhaetipollis germanicus* Schulz











Teresa MARCINKIEWICZ, Teresa ORŁOWSKA-ZWOLIŃSKA — Miospores, megaspores and *Lepidopteris ottonis* (Goeppert) Schimper in the uppermost Triassic deposits from Poland

PLATE IV

The miospore assemblage of the *Corollina meyeriana* Zone (Norian)
Zespół poziomu miosporowego *Corollina meyeriana* (noryk)

Figs. 1, 2. *Ovalipollis ovalis* Krutsch
Borehole Gostyń 5 G, depth 363.0 m
Fig. 3. *Taurocusporites verrucatus* Schulz
Borehole Gostyń 64 G, depth 235.0–236.0 m
Figs. 4–6. *Labiisporites triassicus* Orłowska-Zwolińska
4, 5 — borehole Gostyń 46 G, depth 235,0–236,0 m, 6 — borehole Gostyń 5 G, depth 363.0 m
Fig. 7. *Brachysaccus neomundanus* (Leschik) Mädler
Borehole Gostyń 5 G, depth 363.0 m
Fig. 8. *Polycingulatisporites reduncus* (Bolchovitina) Playford et Dettmann
Borehole Gostyń 46 G, depth 235.0–236.0 m

All figures on the plates IV–VI as in the article of T. Marcinkiewicz, T. Orłowska–Zwolińska (1985) except of: Pl. IV, Fig. 7, Plate V, Figs. 1, 5, 8, 9
Wszystkie figury na tabl. IV–VI jak u T. Orłowskiej-Zwolińskiej (T. Marcinkiewicz, T. Orłowska-Zwolińska, 1985) z wyjątkiem tabl. IV, fig. 7, tabl. V, fig. 1, 5, 8, 9

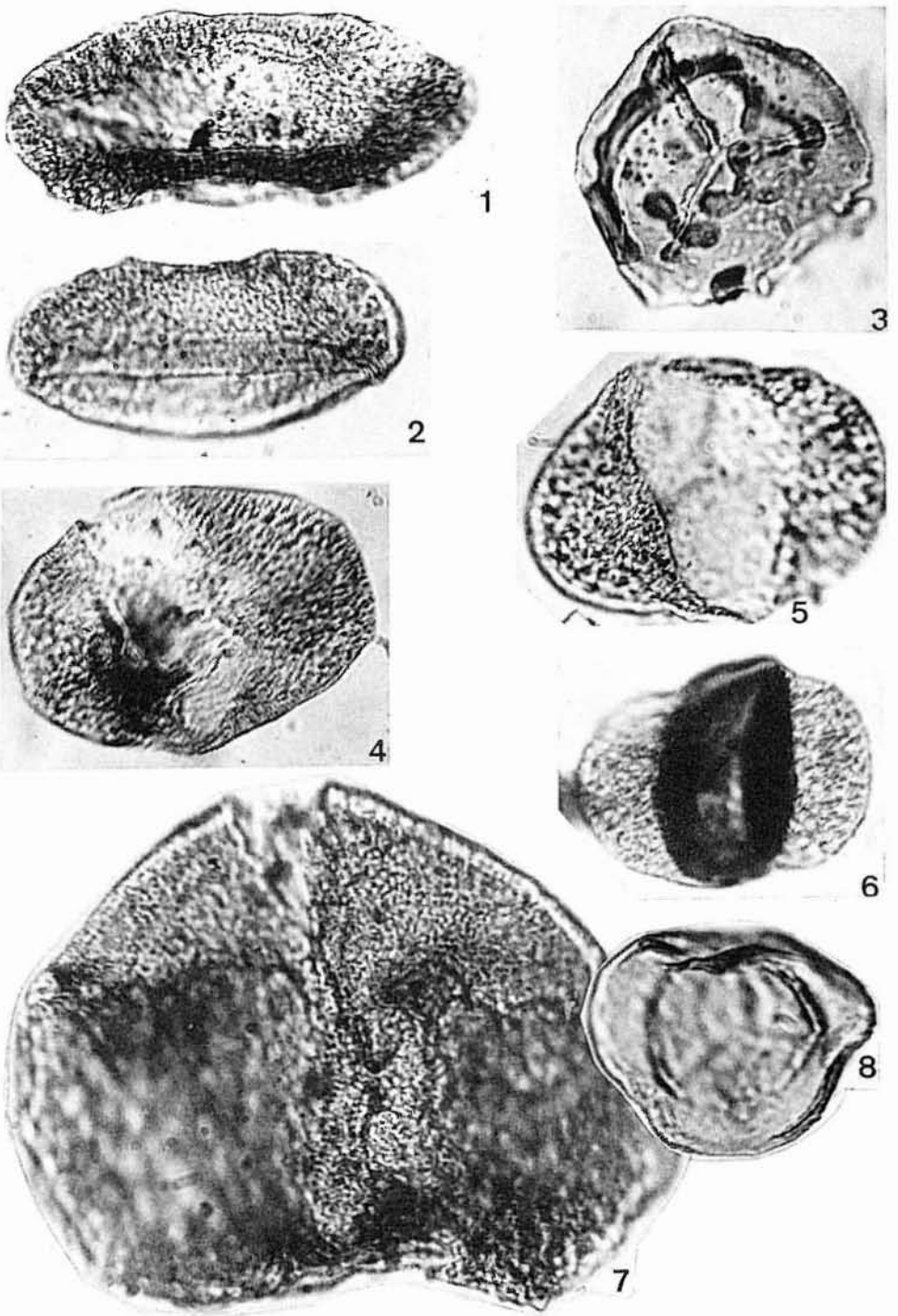


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PLATE V

The miospore assemblage of the *Corollina meyeriana* Zone (Norian)
Zespół poziomu miosporowego *Corollina meyeriana* (noryk)

Figs. 1, 2. *Granuloperculatipollis rudis* Venkatachala et Góczán
1 — borehole Gostyń 46 G, depth 242.0–243.0 m; 2 — borehole Gostyń 5 G, depth 363,0 m
Fig. 3. *Nevesisporites limatulus* Playford
Borehole Gostyń 5 G, depth 363.0 m
Fig. 4. *Heliosporites altmarkensis* Schulz
Borehole Gostyń 46 G, depth 242.0–243.0 m
Fig. 5. *Tigrisporites* sp.
Borehole Gostyń 46 G, depth 235.0–236.0 m
Figs. 6–8. *Corollina meyeriana* (Klaus) Venkatachala et Góczán
Borehole Gostyń 46 G, depth 235.0–236.0 m
Fig. 9. *Foveolatitriletes crassus* Orłowska–Zwolińska
Borehole Gostyń 27 G, depth 315.0–316.0 m; x 750
Figs. 10, 11. *Classopollis classoides* (Pflug) Pocock et Jansonius
Borehole Gostyń 46G, depth 235.0–236.0 m

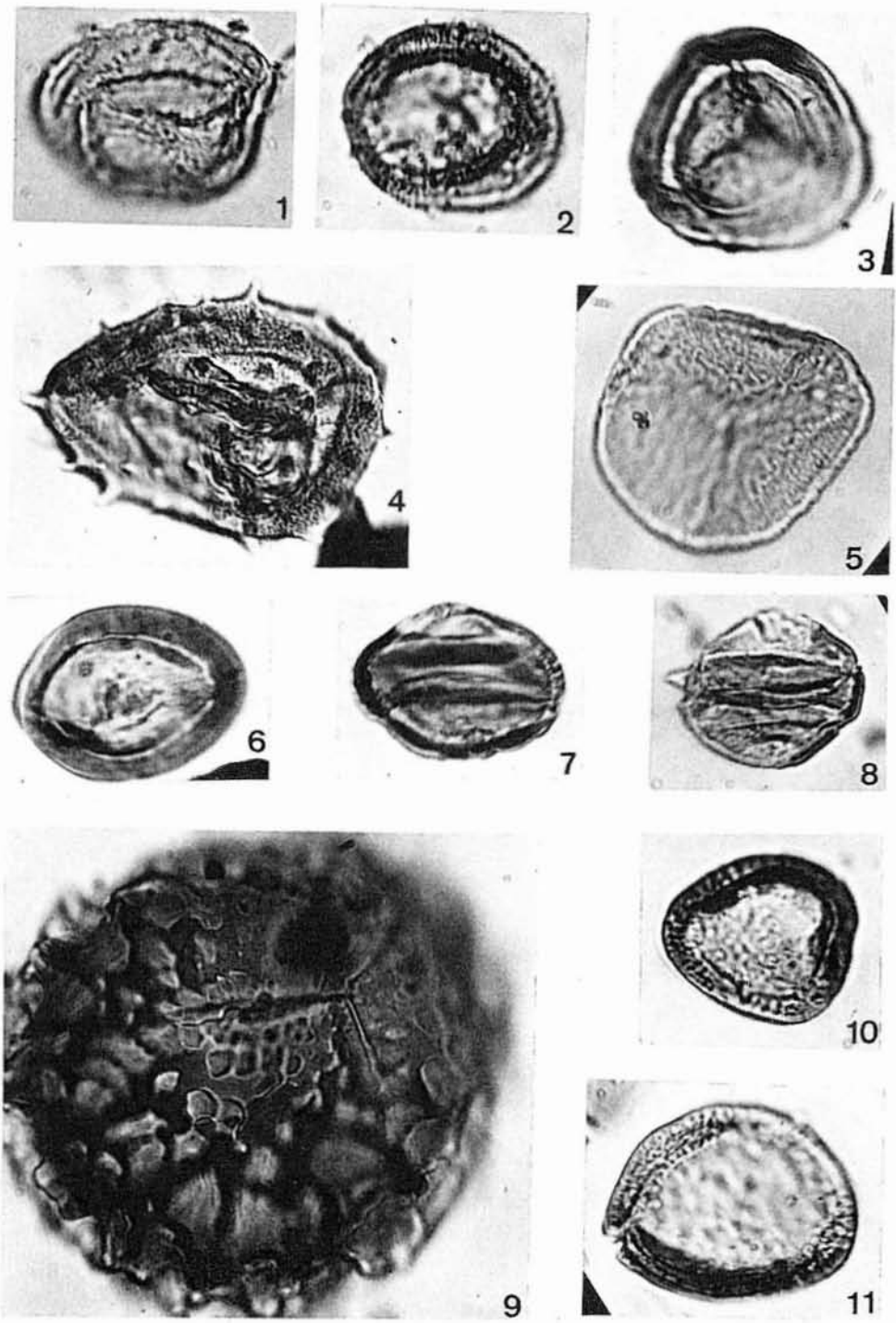

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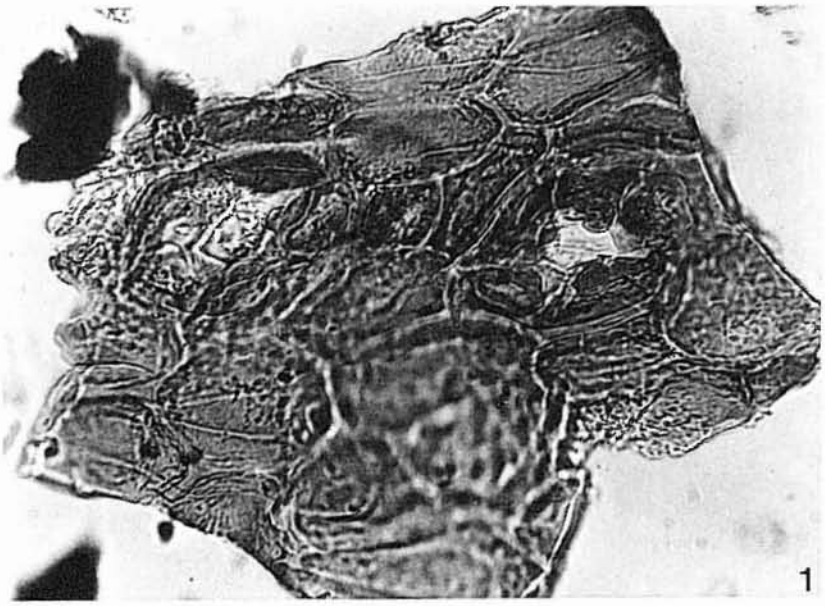
PLATE VI

Figs. 1, 2. Fragments of epidermis with the stomatal apparatus of cf. *Lepidopteris ottonis* (Goeppert) Schimper;borehole Gostyń 46 G, depth 242.0–243.0 m; Norian; x 500
Fragmenty epidermy z aparatami szparkowymi cf. *Lepidopteris ottonis* (Goeppert) Schimper; otwór Gostyń 46 G, głęb. 242,0–243,0 m; noryk; 500 x



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