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Palynological and Stratigraphical Problems of Middle Triassic Siliciclastics from Croatian Off-shore Well Susak More-1 (Adriatic Sea) and NW Slovenia

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Key words: Palynology, Stratigraphy, Middle Triassic, Siliciclastics, Reworked Permian and Lower Triassic Palynomorphs

Abstract

The palynological assemblages from Slovenian Middle Triassic sections and Susak More-1 off-shore well always contain Permian, Scythian and Scythian-Lower Anisian palynomorphs. Middle Triassic palynomorphs were very rare (as in well SM-1) and totally absent in almost all Slovenian sections strongly suggesting the possibility that in these sections the Permian palynomorphs were reworked into the Scythian-Lower Anisian deposits. This palynostratigraphical evidence was clearly in contradiction with the age of some of these chronostratigraphically well defined Slovenian Upper Anisian-Ladinian sections.

As the siliciclastics in well SM-1 are only palynostratigraphically controlled, the correlation with Slovenian sections is entirely based on palynological analogy.

The palynological analogy of the Slovenian sections, Susak More-1 off-shore well and palynostratigraphycally controlled Middle Triassic siliciclastics from off-shore well Maja-1 (open sea side of the south Croatian Islands) indicates on a regionally extensive sedimentary realm which resulted from the aborted rifting during the Middle Triassic.

1. INTRODUCTION

Palynology is a useful tool within the field of stratigraphy. However, as with other branches of biostratigraphy, interpretation of any palynomorph assemblage must be undertaken cautiously in order to correctly define the chronostratigraphic position of the host sediments.

Many facts, including sediment reworking, preservation state and potential, sampling regimes and processing techniques combine to influence the effectiveness of palynological investigations. If perhaps only one of these, and/or other facts is overlooked it is easily possible that biostratigraphic, biochronologic and consequently chronostratigraphic paralogism will be the result.

An example of these problems was encountered by the present authors when applying palynology to the stratigraphic interpretation of the Slovenian Middle Triassic siliciclastics and the siliciclastics of the off-shore well Susak more-1.

2. HISTORY OF THE PROBLEM

In the late 1970's and early 1980's, during the production of the Basic geological map of Slovenia 1:100.000, Jelen encountered some intriguing palynostratigraphic problems in the Triassic siliciclastic rocks (Fig. 1).

In the Belca stratigraphic section (Fig. 2/1), laminated silty marl, interbedded with platy marly limestone, is overlain by variegated breccia and conglomeratic breccia. The latter is capped by dolomites containing dasycladacean alga *Diplopora annulata* SCHAFHÄULT (JELEN, 1979[3]; JURKOVŠEK, 1987a, b). From the silty marl, a poorly preserved but abundant and chronologically homogeneous palynological assemblage was recovered. The assemblage is dominated by the spore *Densoisporites nejburgii* (SCHULZ) BALME and acritarchs of *Veryhachium-Michrystridium* complex. The assemblage is of Lower Triassic, most probably Upper Scythian age, based on known stratigraphic ranges and abundance of the palynomorphs together with the absence of any younger biostratigraphic markers. In Slovenia strata containing *D. annulata* are placed within the Lower Carnian (Cordevolian) Substage (RAMOVŠ, 1973), and in Croatia within the Ladinian Stage (SOKAČ, 1973).

Later, the same Lower Triassic palynological assemblage was observed in the laminated silty to finely sandy marls at Tržič (Fig. 2/2). However, a younger biochronological marker, *Praecirculina granifer* (LESCHIK) KLAUS was also found although not in any abundance (two grains in five slides). The beginning of this species range is near the Anisian/Ladinian boundary (VISSCHER & BRUGMAN, 1981; BRUG-

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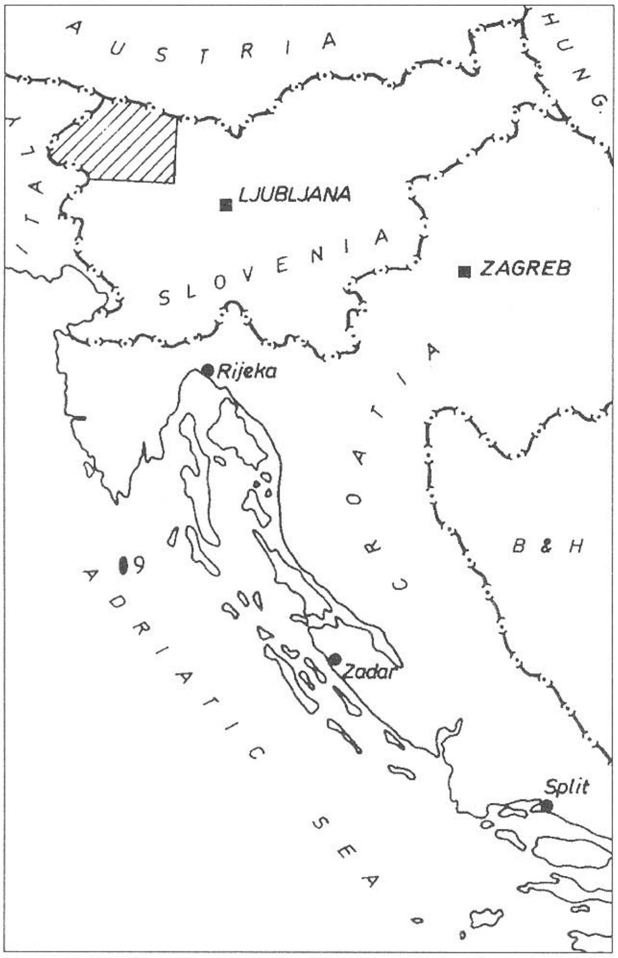
[3] JELEN, B. (1979): Triassic palynomorphs of Slovenia. Part 1.- Unpublished Internal report, Geological Survey, Ljubljana.



MAN, 1983). The marls conformably overlie Pelsonian limestone, with the ammonite *Balatonites balatonicus* (MOJSISOVICS) (RAMOVŠ, 1978; RAMOVŠ & JURKOVŠEK, 1983a). RAMOVŠ & JURKOVŠEK (1983a) also reported *Daonella sturi* (BENECKE) some tens of metres above the *Balatonites balatonicus* horizon.

In the next few years another two similar cases were encountered. At Martuljek (Fig. 2/3) thin bedded cherty limestones are interbedded with thin-bedded marls, shale, and tuffs. Calcarenite is also present. The fossil content of this formation is rather rich (JURKOVŠEK, 1987a, b; KOLAR-JURKOVŠEK, 1991; RAMOVŠ & JURKOVŠEK, 1983b), with the conodont species *Neogondolella trammeri* (KOZUR) which occurs in the Fassanian and in the lower part of the Langobardian. Also, the presence of *Daonella pichleri* MOJSISOVICS must be noted.

A similar Lower Triassic association was recorded as at the two aforementioned locations but differing in the common occurrence of a morphotype belonging to the genus *Leiosphaeridia*.

West of Kranjska Gora (Fig. 2/4) silty marls, shale, and fine grained sandstones rich in plant debris have yielded an abundant but very poorly preserved palynological assemblage. The chronostratigraphic heterogeneity of that assemblage was unambiguously demonstrated by the presence of both Lower Triassic and

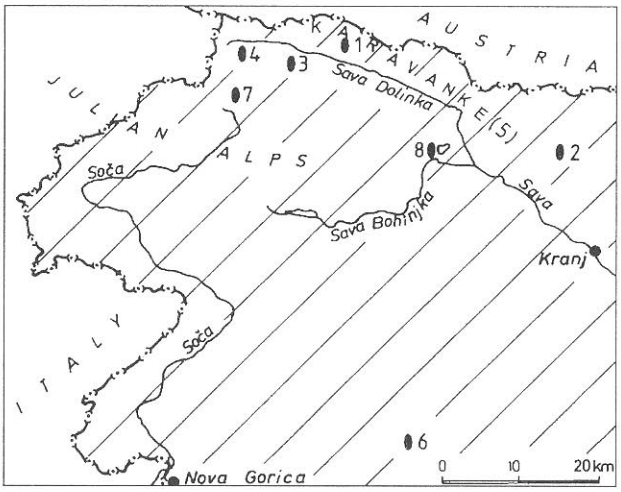


Fig. 1. Location map.

Permian spores and pollen grains. Regrettably, no younger biochronological marker was found, although it was expected because the siliciclastics are intercalated with decimetre bedded limestones containing small *Posidonia* sp. and tuffs (JURKOVŠEK, 1987a, b; RAMOVŠ, 1990).

BUSER (1974, 1979), BUSER & CAJHEN (1980) and JURKOVŠEK (1987a, b) studied a polymictic conglomeratic breccia outcropping in the Southern Karavanke Mountains from east of Tržič to the Slovenian-Italian border to the west (Fig. 2/5). They recognised Lower, Middle and Upper Permian, Scythian, Anisian and Ladinian rock fragments in the breccia. BUSER (1974), and BUSER & CAJHEN (1980) cite this breccia as a petrographic and time equivalent of the Ugovizza Breccia, which is at its type locality considered to be of Anisian age (DESIO, 1973). Up to 650 m thick conglomerates can be observed near the town of Idrija (Fig. 2/6) (ČAR, 1968, 1990; MLAKAR, 1967, 1969). Clasts were derived from rocks ranging in age from the Lower Permian to Middle Triassic, mostly from the Anisian (ČAR 1968, 1990).

Most detailed study of conglomerates was done by RAMOVŠ & KOCHANSKY-DEVIDÉ (1979) at the Vršič mountain-pass (Fig. 2/7). The age of rocks fragments was determined by foraminifers and calcareous algae. Again, Lower, Middle and Upper Permian, Anisian and Ladinian rock fragments were identified.

Breccias and conglomeratic breccias at Bled (Fig. 2/8) are characterized by boulders several metres in diameter, derived from the Neoschwagerina Limestone (BUSER, 1974; BUSER & CAJHEN, 1980). They directly overlie Anisian dolomites.

Both during and after the drilling in the late 1980's of the Susak more-1 off-shore well (Figs. 1 and 2/9), many attempts were made to determine the age of the clastics by means of micropaleontological methods (radiolarians, foraminifera, ostracode and conodonts). However, only a few samples have yielded some results. A foraminiferal assemblage containing

Reichelina media K.M. MACLAY, *Globivalvulina* cf. *graeca* (REICHEL), *Codonofusiella nana* ERK, *Pachyfloia* sp., *Tuberitina* sp. and *Ammodiscus* sp. was recognized in core J-8 (5493-5489 m), suggesting an Upper Permian age (VESELI et al., 1989[4]). It was presumed that these findings represented reworked Permian foraminifers. This was not proven until the palynological analysis was carried out which showed that the clastics contain Permian, Lower Triassic and Middle Triassic palynological assemblages (JELEN, 1987[5]; JERINIĆ, 1989). At that time, the interval 6725-5545m was interpreted to contain an autochthonous Upper Scythian palynoflora and reworked Permian palynomorphs whereas the interval 5545-5488 m contained an Anisian autochthonous palynoflora and reworked Permian palynomorphs. In the interval 5480-5348 m, interpreted as Ladinian, neither Permian, Scythian nor Anisian reworked palynomorphs were observed. JERINIĆ (1989) states that "The solution of the autochthonousness of the palynoflora of these clastics is in...the presence or the lack of palynomorphs younger than Scythian within the interval herein interpreted as Upper Scythian". Indeed, shortly afterwards, rare occurrences of some Middle Triassic palynomorphs were found within the "Scythian" interval. Rare findings of typical Scythian palynomorphs within the "Anisian" interval were also confirmed.

3. LITHOLOGICAL FEATURES

3.1. SUSAK MORE-1 WELL

According to the petrographic analysis performed by I. MESIĆ (in: VESELI et al., 1989), the siliciclastic deposits from well SM-1 can be divided into two intervals.

3.1.1. Interval 6725-5480 m

The deposits of this interval are represented by breccias, siltstones (sporadically sandy limestones, clayey dolomites, late diagenetic dolomites), silty-sandy dolomites, sandy claystones and clay shales.

Determination of the thickness and the position of the breccia of this interval and in which part of the interval the mentioned lithological members alternate could not be achieved easily by petrographic analysis alone. This is largely because the described interval is represented only by 12 metres of core and the cuttings cannot provide relevant data for determining the presence of breccias, especially if the clasts are bigger than the cuttings. However, there is no doubt that the breccias are present in some parts of the cored intervals.

The breccias are heterogeneous, composed mainly of fragments of sublithoarenitic sandstones. Fragments of quartzarenitic sandstones (core J-1, 6725-6721 m), sandy biosparites (core J-8, 5493-5489 m), recrystallized sandy ooidic limestones (core J-9, 6004-6000 m), clayey and dolomitic limestones, siltstones, clays and shales (cores J-8, 5493-5489 m; J-1, 6725-6721) are less abundant. The matrix of the breccias is heterogeneous clayey-silty-sandy-carbonate. The clasts and the matrix are often crushed and pulverized, as a result of tectonic activity. While these data suggest that these clastics are, in fact, tectonobreccias, the presence of rounded fragments in core J-1 (6725-6721 m) with transitive characteristics to breccia-conglomerates suggest that some parts of the interval consist of reworked material.

3.1.2. Interval 5480-5348 m

The deposits of this interval are represented by grayish, green-gray and brown-gray early and late diagenetic dolomites. These are in part markedly clayey or sandy and often ferruginous. Siltstones, quartzarenites and sandy claystones occur together with breccias with fragments of dolomites within the matrix.

3.2. SLOVENIAN LOCALITIES

Lithological features of the siliciclastics from Slovenian localities were not adequately studied. Only field petrographic descriptions already described (Section 2) were placed at our disposal. The lithology of the sections is schematically presented in Fig. 2, as detailed lithological sections were not produced.

4. STRATIGRAPHICAL AND TECTONIC SETTING

4.1. SUSAK MORE-1 WELL

The drilling stopped at 6725 m in the siliciclastic deposits and the nature of the underlying deposits remains unknown. However, according to seismic data a distinct marker at approximately 7000 m indicates that the total thickness of the clastics would be approximately 1600 m (ŠUŠTARČIĆ, pers. comm.). The overlying deposits are represented by carbonates and anhydrites. The Carnian age of these sabkha-type sediments was proved on the basis of palynological analysis of cores J-7 (5214-5210 m) and J-6 (5188-5184 m) (Fig. 2/9) (JELEN, 1987[5]; JERINIĆ, 1989). The *Partitisporites quadruplices* (SCHEURING) VAN DER EEM and *Corollina meyeriana* (KLAUS) VENKATACHALA & GOCZAN assemblage indicates Upper Carnian age (BRUGMAN, 1983). The contact between the clastics and the overlying carbonates and anhydrites is most probably characterized by a sedimentary hiatus. At the contact (5348 m) the presence of cavities was indicated

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[4] VESELI, V., MESIĆ, I., PREMEC-FUČEK, V., JERINIĆ, G., KALAC, K., DJAČANIN, D., BARIĆ, G. & MARIČIĆ, M. (1989): Završni izvještaj off-shore bušotine Susak more-1, 1α i 1β.- Unpublished report - INA-Naftaplin, Zagreb.

[5] JELEN, B. (1987): Preliminarni izvještaj o palinološkim analizama pučinske bušotine Susak more-1.- Unpublished report - INA-Naftaplin, Zagreb.

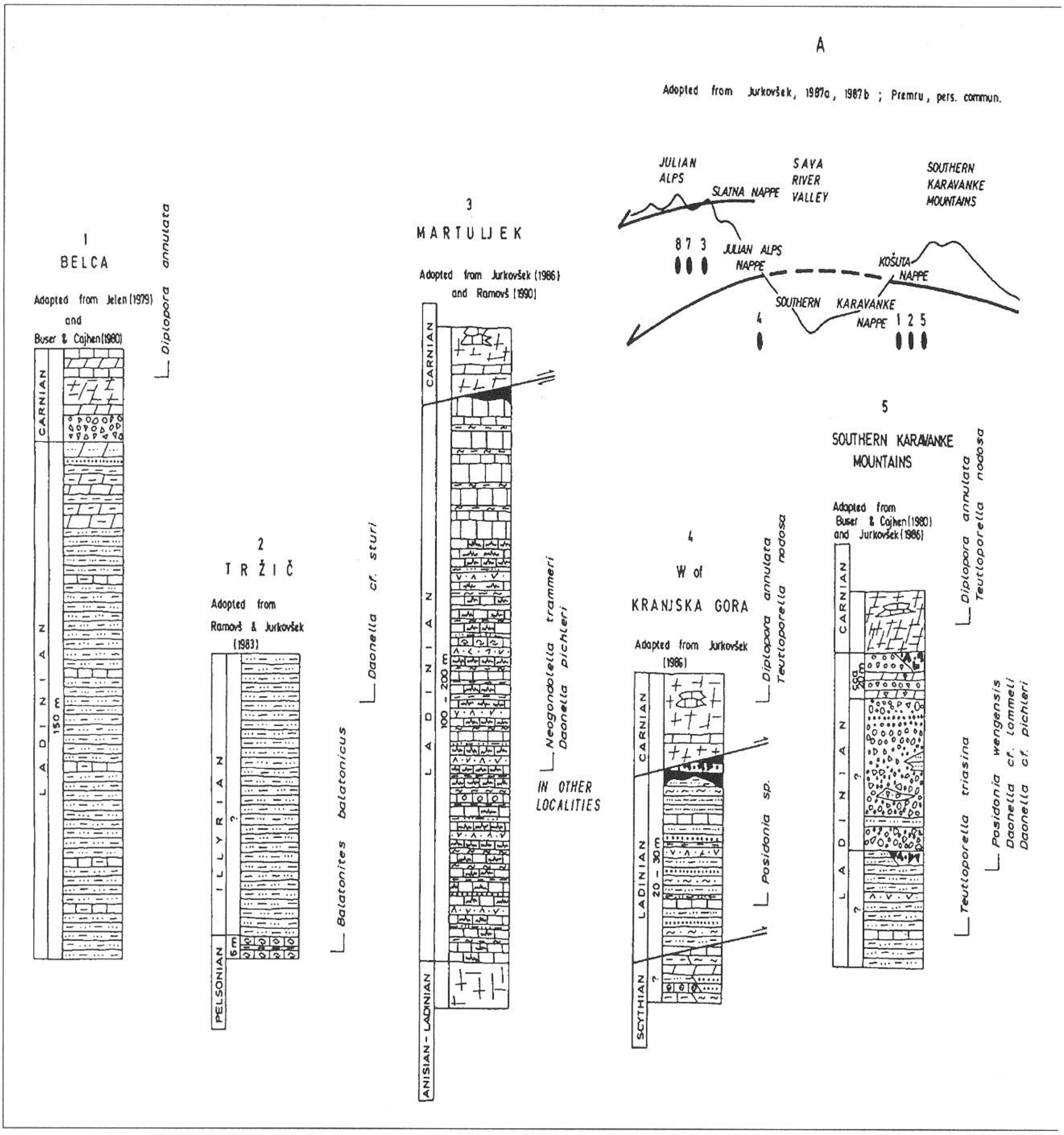
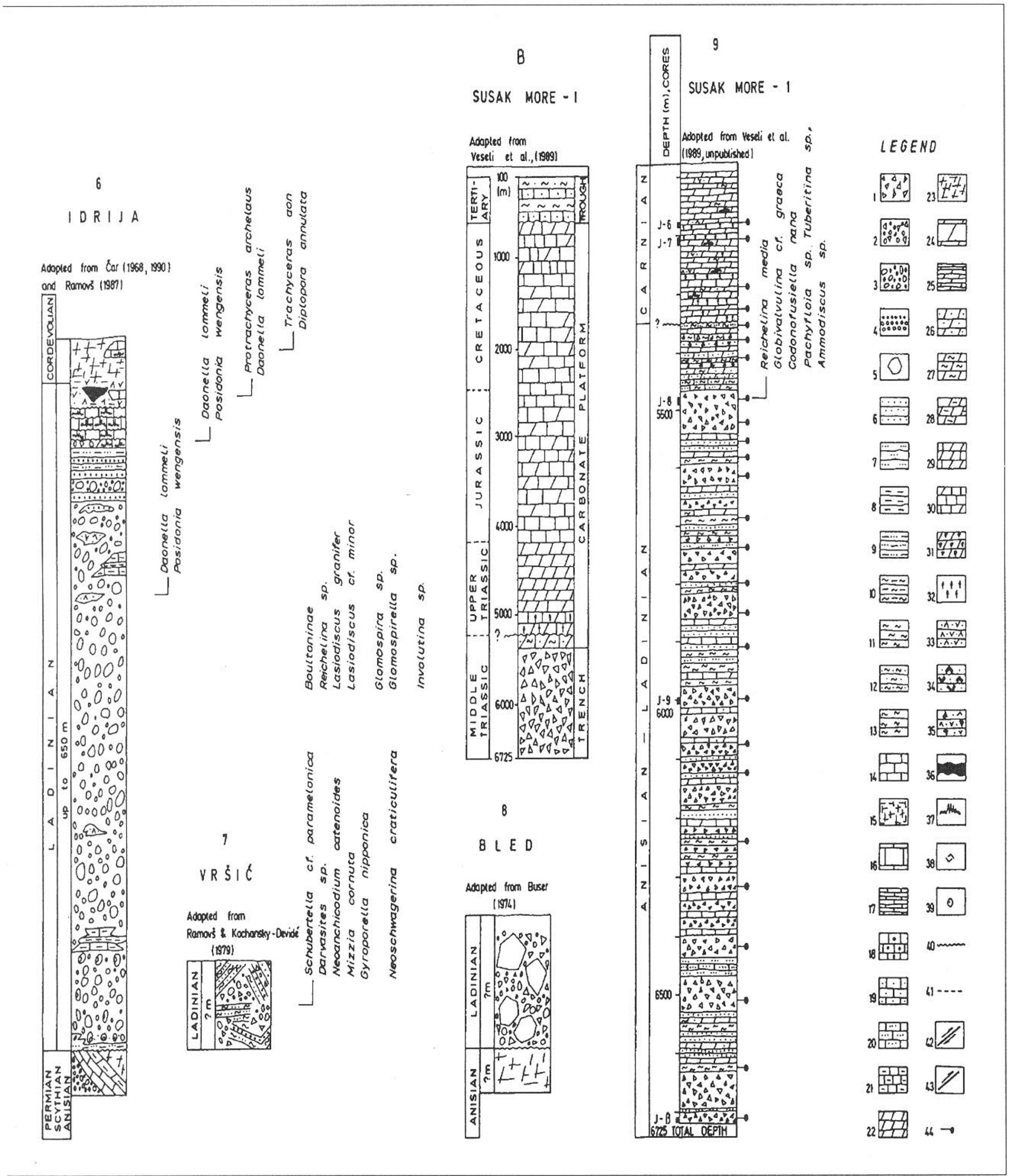


Fig. 2. Palynologically investigated sections of the Middle Triassic siliciclastics. 1-8 NW Slovenia; 9 Susak more-1 well, Croatia. Legend: 1) breccia; 2) polymictic conglomeratic breccia; 3) unsorted conglomerate; 4) graded conglomerate; 5) boulders; 6) sandstone; 7) siltstone; 8) laminated marl; 9) laminated silty marl; 10) laminated clayey marl; 11) claystone; 12) mudstone shale; 13) clay shale; 14) limestone in general; 15) massive limestone; 16) thick-bedded limestone; 17) thin-bedded limestone; 18) calcarenite; 19) sandy limestone; 20) silty limestone; 21) marly limestone; 22) dolomite in general; 23) massive dolomite; 24) thick-bedded dolomite; 25) thin-bedded dolomite; 26) sandy dolomite; 27) clayey dolomite; 28) marly dolomite; 29) dolomite with limestone relics; 30) dolomitic limestone; 31) dolorudite; 32) anhydrite; 33) tuff; 34) ignimbritic tuff; 35) volcanic breccia; 36) keratophyre; 37) chert; 38) nodular fabric; 39) ooids; 40) transgressive boundary; 41) presumed chronostratigraphic boundary; 42) fault; 43) overthrust; 44) position of palynological sampling.

by heavy loses of drilling fluids. The Carnian deposits are conformably overlain by Upper Triassic, Jurassic and Cretaceous dolomites and limestones of the carbonate platform and Tertiary clastics (Fig. 2/B).

4.2. SLOVENIAN LOCALITIES

Complete stratigraphic successions are not known from the Slovenian sections. The following conclusions regarding the geologic setting are inferred: (1) In the Southern Karavanke Mountains the siliciclastic lithostratigraphic unit is positioned within the Southern Karavanke Nappe (Fig. 2/A, JURKOVŠEK, 1987a; PREMRU, pers. comm.). It conformably overlies a deep water condensed carbonate sequence (Fig. 2/2), and terminates with the transition to shelf or platform carbonates (Figs. 2/1, 2/5); (2) The siliciclastic series at Kranjska Gora (Fig. 2/4) in the Julian Alps is possibly a



fragment of the same lithostratigraphic unit because it belongs to the same nappe structure, i.e. to the Southern Karavanke Nappe (Fig. 2/A, JURKOVŠEK, 1987a; PREMRU, pers. comm.); (3) From the spatial relationships within the Julian Alps (JURKOVŠEK, 1987b) we may conclude that the stratigraphic unit observed at the Martuljek was originally sandwiched between the shelf or platform carbonate deposits. According to JURKOVŠEK (1987a) and PREMRU (pers. comm.) this unit belongs to the Julian Alps Nappe (Fig. 2/A). The structural position of the Idrija section (Fig. 2/6) is not shown on Fig. 2/A because this represents unpublished work.

It should not be overlooked that the siliciclastics under discussion are always associated with the volcanic rocks. In the Slovenian Mesozoic, volcanic rocks have been proven to be of Ladinian age, and probably also of Carnian age (PLACER & KOLAR-JURKOVŠEK, 1990).

The faunal and floral biostratigraphy as well as the association of the Ladinian volcanism and the lithostratigraphy together have enabled us to conclude with certainty that these siliciclastics are of Upper Anisian-Ladinian age (Figs. 2/2, 2/5, 2/1, 2/4, 2/3).

5. METHODS

5.1. SAMPLING

All palynological samples from Slovenia were collected at outcrops using a systematic sampling method. The lack of detailed lithological sections prevents the true position of outcrops samples from being shown graphically. Before sampling the weathered cover was removed as much as possible and then most fresh material was taken. No samples were taken from the scree material. Tuffs were also sampled, but proved to be almost barren.

5.2. SAMPLE PREPARATION

Samples of approximately half a kilo were crushed to between 1-2 mm. Core-samples and cuttings from SM-1 were after sieved and the fraction between 0.3-3 mm was used. Subsamples of 100 g were further processed. Standard processing proceedures included HCl, then HF digestion, $ZnCl_2$ flotation, and 120 μm and 10 μm sieving (SM-1: 300 μm and 10 μm sieving). Palynomorphs were then mounted in glycerin-gelly slides. No routine oxidation was applied, except for a few samples from SM-1 rich in organic matter of different origin (lignohumic and amorphous matter) and samples with dark palynomorphs, which were treated with hot concentrated HNO_3 and 5% KOH. Due to the strong oxidative action of these chemicals the oxidation time was kept short (up to 15 min). From these organic residues slides were made both before and after oxidation.

6. SYSTEMATICS

Species lists are ordered after locations.

6.1. SUSAK MORE-1

Trilete laevigate spores
Calamospora sp. (Plate I, Figs. 1, 2)
Retusotriletes sp. (Plate I, Fig. 3)

Trilete apiculate spores
Simeinospora khlonovae BALME, 1970 (Plate I, Fig. 4)
Cyclogranitriletes arenosus MÄDLER, 1964 (Plate I, Fig. 5)
Cyclotriletes microgranifer MÄDLER, 1964 (Plate I, Fig. 6)
Cycloverrutriletes sp. (Plate I, Fig. 7)
Cycloverrutriletes presselensis SCHULZ, 1963 (Plate I, Figs. 8, 9)
Verrucosisporites sp. (Plate I, Fig. 10)
Converrucoisporites eggeri KLAUS, 1963 (Plate I, Fig. 11)

Trilete zonate spores
Triquitrites sp. (Plate I, Fig. 12)

Trilete cingulicavate spores
Densoisporites nejburgii (SCHULZ, 1964) BALME, 1970 (Plate II, Figs. 1-3)
Densoisporites playfordii (BALME, 1963) DETTMANN, 1967 (Plate II, Fig. 4)
Lundbladispora echinata REINHARDT & SCHÖN, 1967 (Plate II, Fig. 5)
Kraeuselisporites sp. (Plate II, Fig. 6)

Monopseudosaccate spores
Endosporites papillatus JANSONIUS, 1962 (Plate II, Figs. 7, 8)

Monolete cavate spores
Aratrisporites sp. (Plate II, Fig. 9)

(Proto)monosaccate pollen
Crucasaccites variousulcatus DJUPINA, 1971 (Plate II, Fig. 10)
Cordaitina gunyalensis BALME, 1970 (Plate II, Fig. 11)
Perisaccus granulatus KLAUS, 1964 (Plate II, Fig. 12)
Nuskoisporites sp. *dulhuntyi* KLAUS, 1964 (Plate II, Fig. 13)
Nuskoisporites sp. (Plate II, Fig. 14)
Dyupetalum cf. *vicentinense* BRUGMAN, 1983 (Plate II, Fig. 15)
Potonieisporites sp. (Plate III, Fig. 1)
Plicatipollenites sp. (Plate III, Fig. 2)
Doubingerispora sp. (Plate III, Figs. 3-5)

Taeniate (proto)bisaccate pollen
Lueckisporites virkkiae POTONIÉ & KLAUS, 1954 (Plate III, Figs. 6-9)
Hamiapollenites sp. (Plate III, Fig. 10)
Protohaploxypinus cf. *varius* (BHARADWAJ, 1967) BALME, 1970 (Plate IV, Fig. 1)
Strotersporites richteri (KLAUS, 1955) WILSON, 1962 (Plate IV, Fig. 2)

Trilete (proto)bisaccate pollen
Triadispora sp. (Plate IV, Figs. 3, 4)

Monolete (proto)bisaccate pollen
Angusticulccites klausii (FREUDENTHAL, 1964) VISSCHER, 1966 (Plate IV, Figs. 5, 6)
Illinites chitonoides KLAUS, 1964 (Plate IV, Fig. 7)
Jugasporites cf. *conmilvinus* KLAUS, 1964 (Plate IV, Fig. 8)
Jugasporites sp. (Plate IV, Fig. 9)
Limitisporites rectus KLAUS, 1964 (Plate IV, Fig. 10)

Alete (proto)bisaccate pollen
Vitreisporites pallidus (REISSINGER, 1950) NILSSON, 1958 (Plate IV, Fig. 11)
Klausipollenites schaubergeri (POTONIÉ & KLAUS, 1954) JANSONIUS, 1962 (Plate V, Figs. 1, 2)
Voltziaceaesporites heteromorpha KLAUS, 1964 (Plate V, Figs. 3, 4)
Alisporites cymbatus VENKATACHALA, KAR & BEJU, 1968 (Plate V, Fig. 5)
Paravesicaspora splendens KLAUS, 1963 (Plate V, Fig. 6)
Rhizomaspora cf. *divaricata* WILSON, 1962 (Plate V, Fig. 7)
Platysaccus leschikii HART, 1960 (Plate V, Fig. 8)

Polyplicate pollen
Vittatina costabilis WILSON, 1962 (Plate V, Fig. 9)
V. ovalis KLAUS, 1963 (Plate V, Figs. 10, 11)
Ephedripites primus KLAUS, 1963 (Plate V, Fig. 12)

Monosulcate pollen
Cycadopites sp. (Plate V, Figs. 13, 14)

Incertae sedis
Conaletes sp. (Plate VI, Fig. 1)
Remarks: According to Brugman (1986), *Conaletes* REINHARDT & SCHÖN, 1964 may well represent an Acritarch although originally considered as an alete spore because this taxon was found in assemblages consisting almost exclusevely of marine organisms.

Acritarcha
Scythiana spinulosa GOCZAN, 1988 (Plate VI, Fig. 2)
Metaleiofusa cf. *compresa* SCHÖN, 1967 (Plate VI, Figs. 3, 4)
Veryhachium reductum (DEFLANDRE, 1958) JEKHOWSKY, 1961 (Plate VI, Figs. 5-10)
Micrhystridium sp. div. (Plate VI, Figs. 11-13)
Brazilea sp. (Plate VI, Figs. 14-16)
Microphytoplankton gen. et sp. indet (Plate VI, Fig. 17)

Fungi
"Tympanicysta" sp. (sensu BALME, 1975) (Plate VI, Fig. 18)

Scitynasciae
Scitynasciae gen. et sp. indet (Plate VI, Fig. 19)

6.2. SLOVENIAN LOCALITIES

6.2.1. Tržič

Trilete cingulicavate spores
Densoisporites nejburgii (SCHULZ, 1964) BALME, 1970 (Plate VII, Figs. 1, 2)

Alete (proto)bisaccate pollen
Alete bisaccate gen. et sp. indet (Plate VII, Fig. 4)

Circumpolles group
Praecirculina granifer (LESCHIK, 1955) KLAUS, 1960 (Plate VII, Fig. 3)

Acritarcha
Metaleiofusa sp. (Plate VII, Fig. 5)
Veryhachium reductum (DEFLANDRE, 1958) JEKHOWSKY, 1961 (Plate VII, Fig. 6)
Veryhachium sp. (Plate VII, Fig. 7)

Prasynophiceae
Leiosphaeridia sp. (Plate VII, Fig. 8)

6.2.2. Martuljek

Trillete laevigate spores
Sporites gen. et sp. indet

Trilete cingulicavate spores
Densoisporites nejburgii (SCHULZ, 1964) BALME,

Monosulcate pollen
Cycadopites sp. (Plate VII, Fig. 11)

Acritarcha
Veryhachium sp. div.

Prasynophiceae
Leiosphaeridia sp. div. (Plate VII, Figs. 9, 10)

6.2.3. West of Kranjska Gora

Trilete laevigate spores
Sporites gen. et sp. indet

Trilete cingulicavate spores
Densoisporites nejburgii (SCHULZ, 1964) BALME, 1970 (Plate VII, Fig. 12)
Densoisporites sp.

Monopseudosaccate spores
Endosporites papillatus JANSONIUS, 1962 (Plate VII, Figs. 13-15, Plate VIII, Fig. 1)

(Proto)Monosaccate pollen
Crucisaccites variosulcatus DJUPINA, 1971 (Plate VIII, Fig. 2)

Taeniate (proto)bisaccate pollen
Lueckisporites virkkiae POTONIÉ & KLAUS, 1954 (Plate VIII, Fig. 3)

Alete (proto)bisaccate pollen
Klausipollenites schaubergeri (POTONIÉ & KLAUS, 1954) JANSONIUS, 1962 (Plate VIII, Fig. 4)
Bisaccites gen. et sp. indet.

Polyplicate pollen
Vittatina sp.

Monosulcate pollen
Cycadopites sp. (Plate VIII, Fig. 5)

Acritarcha
Veryhachium sp. (Plate VIII, Fig. 6)
Micrhystridium sp. (Plate VIII, Figs. 7, 8)

Prasynophiceae
Leiosphaeridia orbiculatum STAPLIN, 1961 (Plate VIII, Fig. 9)

Fungi
"Tympanicysta" sp. (sensu BALME, 1975) (Plate VIII, Fig. 10)

6.2.4. Belca

Trilete cingulicavate spores
Densoisporites nejburgii (SCHULZ, 1964) BALME, 1970 (Plate VIII, Figs. 11-13)

Monopseudosaccate spores
Endosporites papillatus JANSONIUS, 1962 (Plate VIII, Fig. 14)

Monosulcate pollen
Cycadopites follicularis WILSON & WEBSTER, 1964 (Plate VIII, Fig. 15)

Alete (proto)bisaccate pollen
Bisaccites gen. et sp. indet. (Plate VIII, Fig. 16)
Klausipollenites vestitus JANSONIUS, 1962 (Plate VIII, Fig. 17)

Acritarcha
Veryhacium reductum cf. *trispinosoides* JEKHOWSKY, 1961 (Plate VIII, Fig. 18)
V. longispinum HOROWITZ, 1973 (Plate VIII, Fig. 19)
V. irregularis (JEKHOWSKY, 1961) WALL & DOWNIE, 1962 (Plate VIII, Figs. 20, 21)
V. rhomboideum DOWNIE, 1965 (Plate VIII, Fig. 22)
Micrhystridium cf. *fragile* DEFLANDRE, 1947 (Plate VIII, Fig. 23)
M. cf. *stipulatum* JANSONIUS, 1963 (Plate VIII, Fig. 24)
Baltisphaeridium cf. *micropunctatum* WALL, 1965 (Plate VIII, Fig. 25)

Prasynophiceae
cf. *Leiosphaeridia*
Leiosphaeridia minutum (STAPLIN, 1961) DOWNIE & SERJEANT, 1963 (Plate VIII, Fig. 26)
L. orbiculatum STAPLIN, 1961 (Plate VIII, Fig. 27)

7. PALYNOSTRATIGRAPHY AND RELATED PROBLEMS

7.1. SUSAK MORE-1 WELL

As stated earlier, the investigated interval 6725-5348 m is lithologically divided into two parts. This division is also palynologically justified. The shift from the siliciclastics to siliciclastic shallow water carbonates occurs gradually and most probably around 5489 m, and is characterized by a significant change in the palynological assemblage. The lower, considerably thicker part contains mixed Permian, Lower Triassic and Middle Triassic palynomorphs whereas the upper part only contains palynomorphs of probable Upper Ladinian age.

7.1.1. Interval 6725-5480 m

Throughout this interval both land- and marine derived palynomorphs were recognized in each sample.

Important palynomorphs recognized within this interval allow several chronostratigraphically different assemblages to be distinguished based on known ranges of the palynomorphs in the Alpine realm (Fig. 3).

Upper Lower Permian assemblage

Only one core-sample (J-9, 6004-6000 m) of the whole interval contains *Crucisaccites variosulcatus*, *Hamiapollenites* sp. and *Lueckisporites virkkiae* which are, as an assemblage, referable to the European Upper

Lower Permian (VISSCHER, 1971, 1974; DOUBINGER, 1974; VISSCHER et al., 1974; BRUGMAN, 1983). Within this sample, Upper Carboniferous-Permian palynomorphs such as *Vittatina* sp. div., *Potonieisporites* sp. div. and *Plicatipollenites* sp. were also found. These palynomorphs were found in almost half of all samples of this interval. *Plicatipollenites* occurs very rarely.

Upper Permian assemblage

Most samples of this interval contain at least one of the following typical Upper Permian palynomorphs: *Klausipollenites schaubergeri*, *Perisaccus granulatus*, *Strotersporites richteri*, *Nuskoisporites dulhuntyi* and *Protohaploxypinus* cf. *varius*. *Lueckisporites virkkiae* is the most regular palynomorph found in all samples of this interval and throughout this interval the Norm Ab of VISSCHER is predominant, which is generally accepted as an Upper Permian (Zechstein) form in localities all over Europe (VISSCHER, 1971, 1974, 1978; DYBOVA-JACHOWICZ, 1974). The Upper Permian assemblages from the Southern Alps (KLAUS, 1963), Vicentinian Alps (CLEMENT-WESTERHOF et al., 1974), southern Dolomites (BRUGMAN, 1983) and south Croatian Dinarides (ŠUŠNJARA et al., 1992) are almost identical to the described assemblage of this interval. Common palynomorphs of the European Upper Permian assemblages such as *Limitisporites rectus*, *Paravesicaspora splendens*, *Converrucosisporites eggeri*, *Rhyzomaspora divaricata* and *Ephedripites primus* rarely occur in a few samples whereas *Potoniesporites* sp. div., and *Vittatina* sp. div. are somewhat more frequent.

Scythian - (?Lower Anisian) assemblage

The majority of the samples from this interval are characterized by the occurrence of the typical Scythian palynomorph *Endosporites papillatus*. Other Scythian palynomorphs such as *Lundbladispora echinata*, *Simeonospora khlonovae* and *Cycloverrutriletes presselensis* occur very rarely in only a few samples. *Conaletes* sp. is more abundant but was recognised in only a few samples. There is also a group of palynomorphs which range from the Scythian to the Lowermost Anisian. Among these, *Densoisporites nejburgii* is the most abundant, occurring in all samples. Others, like *Densoisporites playfordii*, *Cordaitina gunyalensis*, *Platysaccus leschiki* and *Alisporites cymbatus* occur in only a few samples and are very rare. *Jugasporites conmilvinus*, a very good Upper Scythian-Lower Anisian marker, occurs also in only a few samples and is very rare. All these palynomorphs, together with *Voltziaceaesporites heteromorpha*, *Cyclogranitriletes arenousus* and *Triadispora* sp. div. (with a wider stratigraphic range) are components of typical Lower Triassic assemblages recognized all over

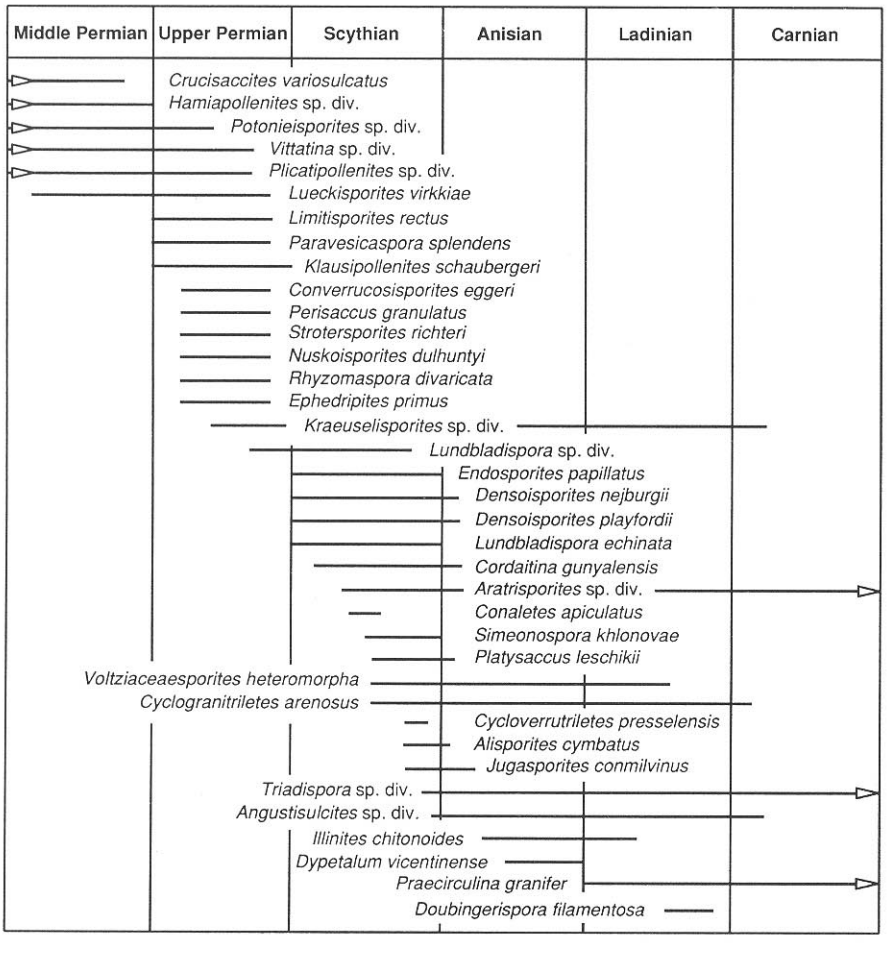


Fig. 3. Chronostratigraphic distribution of some important palynomorphs of the western Tethyan realm identified within the investigated siliciclastics (compiled after: KLAUS, 1963; VISSCHER, 1974; VISSCHER & BRUGMAN, 1981; BRUGMAN, 1983, 1986).

Europe, in both Alpine and Germanic facies, as well as in the wider Tethyan region (BALME, 1963, 1970; MÄDLER, 1964; VISSCHER, 1966, 1971, 1974; REINHARDT & SCHÖN, 1967; VISSCHER & BRUGMAN, 1981; ORLOWSKA-ZWOLINSKA, 1984; REITZ, 1985, 1988; BRUGMAN, 1983, 1986). The abundance of the *Veryhachium-Micrhystridium* complex is a regularly occurring feature in the Alpine Lower Triassic (VISSCHER & BRUGMAN, 1981; BRUGMAN, 1986). This is particularly well illustrated by sample 5550 m in which these Acritarchs are dominantly more abundant than the typical LowerTriassic sporomorph assemblage. In this sample only a few Permian palynomorphs were found. The presence of *Simeonospora khlonovae* BALME, firstly reported from the Upper Scythian of Pakistan (BALME, 1970) must be noted. The presence of this form-species was not known in Alpine region until now. This spore occurs extremly rarely (one specimen, J-1, 6725-6721 m) in well SM-1.

(?Upper) Anisian - (?Lower) Ladinian assemblage

Only a few samples contain Middle Triassic palynomorphs, some of which are also extremely rare: *Dyupetalum* cf. *vicentinense* (one specimen, J-8, 6004-6000 m) and *Illinites chitonoides* (one specimen, J-8, 5493-5489 m). *Angustisulcites klausii*/sp. div. occurs somewhat more frequently. In the Alpine region *D. vicentinense* is considered to be an Upper Anisian marker (VISSCHER & BRUGMAN, 1981; BRUGMAN, 1982, 1983, 1986). According to the same authors, *I. chitonoides* ranges from the Upper Anisian to the Lower Ladinian and *A. klausii* is a Middle Triassic marker. This type of assemblage, although scarce and limited to a few species, is comparable with Upper Anisian assemblages from the Alpine sections (VAN DER EEM, 1983; BRUGMAN, 1986). Correlation with the Germanic basin is difficult because *D. vicentinense* is only observed in the Alpine realm. Nevertheless, *I. chitonoides* is a very good Lower-Middle Muschelkalk marker and *A. klausii* occurs in Upper Bundsandstein, Lower and Middle Muschelkalk deposits (VISSCHER, 1966; ORLOWSKA-ZWOLINSKA, 1977; ADLOFF & DOUBINGER, 1978; DOUBINGER & ADLOFF, 1981; TAUGOURDEAU-LANTZ, 1983; REITZ, 1985). Within the mentioned core-samples palynomorphs with a wider chronostratigraphic range were observed such as *Voltziaceaesporites heteromorpha*, *C. arenosus*, *Triadispora* sp. div., *Aratrisporites* sp. These are the regular components of both Alpine and Germanic Middle Triassic assemblages.

7.1.2. Interval 5480-5348 m

?Upper Ladinian assemblage

This interval is characterized by an impoverished palynological assemblage represented by *Doubingerispora* sp., *Bisaccites* gen. et sp. indet. and cf. *Kuglerina*. *Doubingerispora* is abundant whereas the others are very rare. The palynomorphs are mechanically not badly preserved but due to corrosion and oxidation they are not suitable for taxonomic work. However, the majority of the globular palynomorphs show the important diagnostic feature of the triletum placed within the thickened circular zone which justifies their attribution to the form-genus *Doubingerispora*.

In the Alpine realm *Doubingerispora filamentosa* is a very good Langobardian marker (SCHEURING, 1978; BRUGMAN, 1983). *Doubingerispora* sp. was observed in Ladinian deposits in some south Croatian off-shore wells (JELEN, 1985[6]; JERINIĆ, 1989). In this interval no reworked Permian, Lower Triassic or Anisian palynomorphs were observed.

On the basis of the palynological results of the interval 6725-5480 m from well SM-1 it can be inferred that the Permian and Lower Triassic palynomorphs were reworked into Anisian-Ladinian deposits. From the palynostratigraphical point of view the scarcity and poor diversity of the isochronous, i.e. Anisian-Ladinian palynological assemblage does not allow more precise age determination of these siliciclastics. On the other hand it is very important to point out that within well SM-1 siliciclastics no traces of volcanic activities were found. As in Slovenian sections, the volcanic activities is a widely recognized feature of the Anisian and Ladinian localities of the Croatian Dinarides.

7.2. SLOVENIAN SECTIONS

Evidence from previous studies (discussed in Section 2), together with the thermal and preservation heterogeneity of the palynomorphs and probable age equivalence of the conglomeratic and Ugovizza breccias, initially suggested a conclusion that the siliciclastic series observed in the Belca section is of Lower Triassic, most probably Scythian to lowermost Anisian, age. This argument was accepted despite reservations (BUSER, pers. comm.) and incorporated into the Basic geological map of Slovenia (Beljak sheet).

However, newcoming data presented here disproved the forementioned argument. From the re-evaluation of previous evidences in the light of new observations (discussed in sections 2 and 4.2.) it followed that the siliciclastics in the Belca section also belong to the Upper Anisian-Ladinian siliciclastic succession of the Southern Karavanke nappe. From new premises a new concluding statement was made that in Belca section Lower Triassic palynomorphs were reworked together with the Permian palynomorphs into the Upper Anisian-Ladinian deposits. With the exception of the Tržič section, where extremely rare Middle Triassic

[6] JELEN, B. (1985): Izvještaj o palinološkim analizama uzoraka iz pučinske bušotine Kornati more-1.- Unpublished report, Ina-Naftaplin, Zagreb.

palynomorphs were found, all other encountered Slovenian sections (Fig. 2) contain only Permian and Scythian-lowermost Anisian palynomorphs.

The Belca section example not only illustrates how reworking in palynology, particularly in cases when isochronous palynomorphs are not present or are extremely rare, can effect chronostratigraphy but also how chronostratigraphic paralogism can occur.

7.3. QUANTITATIVE RESULTS

Based on counts of approximately 3500 grains from 31 samples it is indicated that throughout the interval 6725-5480 m Acritarchs dominate (26%), followed by cavate spores (18%), *Lueckisporites virkkiae* (13%), *Endosporites papillatus* (5%), *Klausipollenites schaubergeri* (3%) and *Conaletes* sp. (2%). With the exception of *Bisaccites* gen. et sp. indet (7%), *Monosaccites* gen. et sp. indet. (2%) and *Sporites* gen. et sp. indet (3%), almost 50 taxa are represented by approximately only 21% of all palynomorphs. These approximate percentages represent the sum of relative frequences of all samples.

The variations in vertical distribution on ages, type of palynomorphs and their quantitative relations are rather pronounced. With the exception of the regular occurrence of *L. virkkiae*, *D. nejburgii* and Acritarchs (in varying proportions), there are no regularities or trends in vertical distribution. All other palynomorphs occur scattered throughout this interval without any order. Within the samples of core J-8 (5493-5489 m) Permian palynomorphs dominate and only a few Lower and Middle Triassic palynomorphs were found. The same observation was made in the core J-1 (6725-6721 m). However, sample 5550 m (and a few others) contains many Lower Triassic sporomorphs but only a few Permian palynomorphs. The same sample also contains 60% Acritarchs whereas in sample 6700 m only a few were recognised. The most "complete" samples which contain the majority of all recognized Permian, Lower and Middle Triassic palynomorphs are those from the core J-9 (6004-6000 m).

In the interval 6725-5480 m the Permian and Lower Triassic, i.e. reworked palynomorphs are approximately equally represented and they are far more numerous than the Middle Triassic palynomorphs. Not taking into account the possibility that some of the Acritarch, as well as Sporites and Pollenites gen. et sp. indet. palynomorphs are in fact Middle Triassic in age, the percentage of the palynomorphs identified as isochronous, i.e. Middle Triassic is very low. The ratio reworked : isochronous palynomorphs is approximately 230 : 1.

The quantitative relations from the Slovenian assemblages are similar to those from SM-1 well especially regarding the general quantitative trend mentioned above.

7.4. MECHANICAL AND THERMAL PRESERVATION STATE OF THE PALYNOMORPHS

The degree of mechanical and thermal (colour) preservation of the observed Permian, Lower and Middle Triassic palynomorphs both from Slovenian localities and Susak more-1 well varies from very bad to very good both between and within thesame form species. This variation is particularly obvious in *L. virkkiae*, *E. papillatus* and especially *D. nejburgii* and the Acritarchs.

Our experience tells us that heterotypical geochemical facies affects the colour of the palynomorphs. It is also possible that some colour differences are due to reworking from places with a different thermal history as well as transportation factors. Different colours can also be explained in terms of weathering. This presumes the existence of an emersion phase.

Variation in the mechanical preservation of palynomorphs within the same formspecies with the same colour (especially Acritarchs) clearly indicates syngenetic transportation.

Size variation of the palynomorphs within the same form species is rather pronounced.

All these variations show that we are dealing with siliciclastics with a very tempestuous history. Indeed, these variations are explainable only in terms of a complex interaction of primarly heterotypical geochemical facies, syngenetic transportation and different mechanisms of re-reworking.

The quantitative estimations as well as the state of mechanical and thermal preservation suggests that the Permian palynomorphs were firstly reworked into Lower Triassic deposits. This type of reworking was found in the Lower Triassic stratotype of Muć (South Croatian Dinarides; JERINIĆ, in work) where *L. virkkiae* is rather scarce but present. Afterwards, both Permian and Lower Triassic palynomorphs were reworked into the Anisian-Ladinian deposits. The regular occurence of *L. virkkiae* and *D. nejburgii* in all samples supports this possibility because it is hard to presume conditions where synchronous Permian input was separated from Lower Triassic input.

A certain part part of all enumerated siliciclastics are represented by the Lower Triassic reworked fragments. However, a very interesting question on the provenance of the reworked Lower Triassic palynomorphs arises from the fact that the Lower Triassic in Slovenia is palynologically completely barren.

7.5. PALAEOPALYNOGEOGRAPHY

Permian, Lower Triassic and Middle Triassic palynological assemblages from the siliciclastics discussed herein show great similarities to the European localities, especially Alpine region. However, some palynomorphs do not fit into the palaeopalynogeographical picture of this region. One of these palynomorphs is the form-genus *Plicatipollenites* which occurs in well SM-

1, though it is very rare. According to BALME (1970), *Plicatipollenites* characterizes the Southern Continents and India and it was found in Iraq (SINGH, 1964) and similar forms in Russia (MEDVEDEVA, 1960). The subsurface Permian successions from Northern Gondwana have yielded *Plicatipollenites* bearing palynological assemblages, with transitional features to Laurasian assemblages (Lybia, BRUGGMAN et al., 1985; Israel, ESHET & COUSMINER, 1986; ESHET, 1990). From this point of view it is inferred that a northwards extension of *Plicatipollenites* is more likely than reworking from southern directions. This was also probably the case for the spore *Simeonospora khlonovae* BALME which was found in Salt Range, Pakistan (BALME, 1970).

7.6. TECTONICS, SEQUENCE STRATIGRAPHY AND PALAEOGEOGRAPHY

It is obvious that the reworking problem discussed herein is associated with the preliminary disintegration of the Western Tethys intracontinental platform, called by BECHSTÄDT et al., (1978) "aborted rifting" and by D'ARGENIO et al. (1980) "early continental rifting in the history of Adria".

Good consistency exists between the Triassic sequence stratigraphy of the Southern Alps (DE ZANCHE et al., 1992) and the stratigraphy of the siliciclastic facies involved. Slovenian siliciclastic facies can accordingly be assigned to the La 1-La 3 depositional sequences of DE ZANCHE et al. (1992). While not showing favour to any chronostratigraphical hypotheses related to the siliciclastic series in the SM-1 well, we also consider earlier basin formation during the Anisian. They could be either a correlative to the Slovenian Upper Anisian-Ladinian siliciclastic series or to the "Anisian flysch" of the Budva Zone (BUKOWSKY, 1913; CADET, 1978). From the palaeogeographical points of view chronostratigraphic correlation with the "Anisian flysch" is not unplausible because siliciclastics and pyroclastics older than Upper Triassic were found in off-shore wells along the open sea side of the South Croatian islands (also compare to CATI et al., 1989). Siliciclastics in the Maja-1 off-shore well, drilled south of Lastovo island, were found between depths 5942/5356 m and contained a mixed assemblage of predominant Permian, Scythian and rare Middle Triassic palynomorphs. Also, in Eastern Slovenia, Lower Triassic palynomorphs were identified most recently in the Middle Triassic clastics (JELEN, in prep.).

8. CONCLUSIONS

Studies have shown that Lower Triassic palynological assemblages in all enumerated cases have been reworked, together with Permian palynological assemblages into the Upper Anisian-Ladinian deposits. The mechanism thought to be responsible for the reworking was the so called Middle Triassic "aborted rifting" widely recognized in the western Tethyan realm. The palynological analogy of the studied Slovenian sections, Susak More-1 and Maja-1 off-shore wells indicates a regionally extensive sedimentary realm within such reworking phenomenon can be observed.

The questions of the provenance of the reworked palynomorphs (the Lower Triassic in Slovenia has been recently recognised as palynologically completely barren) and the pronounced scarcity of the isochronous, i.e. Anisian-Ladinian, pollen and spores (yet plant debris accumulation have been regularly found) remain unanswered.

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9. REFERENCES

ADLOFF, M.C. & DOUBINGER, J. (1978): Observations palynologiques dans le Muschelkalk inférieur du Sondage de Mersch, Luxembourg.- Bull. Serv. Géol. Luxembourg, 8, 1-15.

BALME, B.E. (1970): Palynology of Permian and Triassic strata in the Salt Range and Surghar Range, West pakistan.- In: KUMMEL, B. & TEICHERT, C. (eds.): Stratigraphic boundary problems: Permian and Triassic of West Pakistan.- Univ. Kans., Spec. Publ., 4, 306-454, Lawrence.

BECHSTÄDT, T., BRANDNER, R., MOSTLER, H. & SCHMIDT, K. (1978): Aborted Rifting in the Triassic of the Eastern and Southern Alps.- N. Jb. Geol. Palaont. Abh., 156/2, 157-178.

BRUGMAN, W.A. (1982): Aspects of Early and Middle Triassic palynology. 1. On *Dyupetalum vicentinense* nov. sp. from the Upper Anisian of the Southern Alps.- Rev. Palaeobot. Palynol., 37/3-4, 47-64, Amsterdam.

BRUGMAN, W.A. (1983): Permian-Triassic Palynology.- Edit. of the Lab. of Palaeobotany and Palynology, 1-129, University of Utrecht.

BRUGMAN, W.A. (1986): A palynological characterisation of the Scythian and Anisian of the Transdanubian Central Range (Hungary) and the Vicentinian Alps (Italy).- Unpublished Ph. D. Thesis, 95 p., University of Utrecht.

BUKOWSKY, G. (1913): Zur Geologie von Umgebung der Bocce die Cattaro.- Ver. Geol. R. Anst., 5, 137-142, Wien.

BUSER, S. (1974): Die Entwicklung der Triasschichten in den westlichen Karawanken.- In: ZAPFE, H. (ed.): Die Stratigraphie der alpin-mediterranen Trias, 2, 63-68, Springer-Verlag, Wien.

BUSER, S. (1979): Trias beds in Slovenia.- In: DROBNE, K. (ed.): Geological development in Slovenia and Croatia. Guide book, 16th European micropalaeontological colloquium, 17-25, Ljubljana.

BUSER, S. & CAJHEN, J. (1980): Osnovna geološka karta SFRJ 1:100.000. Tolmač lista Kranj.- Geol. Zavod Ljubljana, Zvezni geol. zavod Beograd, 1-62, Beograd.

CADET, J.P. (1978): Essai sur l'evolution Alpine d'une paleomarge continental: Les confins de la Bosnie-Herzegowine et du Montenegro (Yugoslavie).- Mem. Soc. Geol. de France, 57, Mem. 133, 1-84, Paris.

CATI, A., SARTORIO, D. & VENTURINI, S. (1987): Carbonate Platforms in the subsurface of the Northern Adriatic area.- Mem.Soc.Geol.Ital., 40, 295-308.

CHRISTOPHER, R.A. & HART, G.F. (1969): A statistical model in palynology.- Geoscience and Man, 3, 49-56.

CLEMENT-WESTERHOF, J.A., Van der EEM, J.G.L.A., Van ERVE, A.W., KLASEN, J.J., SCHUURMAN, W.M.I. & VISSCHER, H. (1974): Aspects of Permian, Triassic and Early Jurassic palynology of Western Europe.- Geologie en Mijnbouw, 53/6, 329-341.

ČAR, J. (1968): Razvoj langobardskih plasti v strukturi IV. pokrova v bližnji okoloci Idrije.- Unpublished B.Sc. Thesis, University of Ljubljana.

ČAR, J. (1990): Angular tectonic-erosional unconformity in the deposits part of the Idrija Middle Triassic tectonic structure.- Geologija, 31/32, 267-284, Ljubljana.

D'ARGENIO, B., HORVATH, F. & CHANNELL, J.E.T. (1980): Palaeotectonic evolution of Adria, the African promontory.- In: DEWEY, J. (ed.): Tethys and Plate-tectonics. 26th International Geological Congres, Theme 8, Geology of the Alpine Chains born of the Tethys, 331-351, Paris.

DESIO, A. (1973): Geologia dell Italia.- Unione Tipographica - Editrice Torinese, Torino.

DE ZANCHE, V., GIANOLLA, P., MIETTO, P. & SIORPAES, C. (1992): Triassic sequence stratigraphy in the Southern Alps.- In: Sequence stratigraphy of European basins, Abstracts, 40-41, Dijon.

DOUBINGER, J. (1974): Études palynologiques dans l'Autunien.- Rev. Palaeobot. Palynol., 17/1-2, 19-25.

DOUBINGER, J. & ADLOFF, M.C. (1981): Précisions palynologique sur l'age Anisian moyen du gisement à plantes du Trias des Lavaredes (SE de Lodeve, Sud de la France).- Sci. Géol. Bull., 34/4, 239-242, Strasbourg.

DYBOVA-JACHOWICZ, S. & LASZKO, D. (1980): Spore-pollen spectrum of Permian and Triassic rocks in the Piekszow syncline, Swietokrzyskich Mts.- Kwartalnik geologiczny, 24/3, 611-641, Warszawa.

ESHET, Y. (1990): Paleozoic-Mesozoic Palynology of Israel. I. Palynological aspects of the Permo-Triassic successions in the subsurface of Israel.- Geol. Surv. Isr. Bull., 81, 1-57.

ESHET, Y. & COUSMINER, H.L. (1986): Palynozonation and correlation in the Negev, Israel.- Micropalaeontology, 32/3, 193-215.

JERINIĆ, G. (1989): Palinološka istraživanja kao osnova stratigrafije trijaskih naslaga pučinskih bušotina Susak more-1 i Vlasta-1 (Abstract: Palynological investigation as a basis for stratigraphy of Triassic deposits in the off-shore wells Susak more-1 and Vlasta-1 in the Adriatic Sea).- Unpublished M.Sc. Thesis, 115 p., University of Zagreb.

JURKOVŠEK, B. (1987a): Osnovna geološka karta SFRJ 1:100.000. Tolmač lista Kranj.- Geol. zavod Ljubljana. Zvezni geol. zavod Beograd, 1-58, Beograd.

JURKOVŠEK, B. (1987b): Osnovna geološka karta SFRJ 1:100.000. Tolmač lista Beljak in Ponteba.- Geol. zavod Ljubljana. Zvezni geol. zavod Beograd, Beograd.

KLAUS, W. (1963): Sporen aus dem sudalpinen Perm.- Jahrb. Geol. Bundesanst. (Aust.), 106, 229-363, Wien.

KLAUS, W. (1964): Zur sporenstratigraphischen Einstufung von gipsführenden Schichten in Bohrungen.- Erdöl. Z., 80/4, 119-132.

KOLAR-JURKOVŠEK, T. (1991): Microfauna of Middle and Upper Triassic in Slovenia and its biostratigraphic significance.- Geologija, 33, 21-170, Ljubljana.

MÄDLER, K. (1964): Die geologische Verbreitung von Sporen in der deutschen Trias.- Geol.jahrb. Beih., 65, 1-147.

MLAKAR, I. (1967): Relations between the lower and the upper structure of the Idrija ore deposits.- Geologija, 10, 87-126, Ljubljana.

MLAKAR, I. (1969): Nappe structure of the Idrija. Žiri region.- Geologija, 12, 5-72, Ljubljana.

ORLOWSKA-ZWOLINSKA, T. (1977): Palynological correlation of the Bunter and Muschelkalk in selected profiles from Western Poland.- Acta Geol. Pol., 27/4, 417-430.

ORLOWSKA-ZWOLINSKA, T. (1984): Palynostratigraphy of the Bundsandstein in sections of western Poland.- Acta Palaeontologica Polonica, 29/3-4, 161-191, Warszawa.

PLACER, L. & KOLAR-JURKOVŠEK, T. (1990): O starosti pseudoziljskih skladov v vzhodnih Posavskih gubah.- Rudarsko-metalurški zbornik, 37/4, 529-534, Ljubljana.

RAMOVŠ, A. (1973): Biostratigraphische Charakteristica der Trias in Slowenien.- Geologija, 16, 378-388, Ljubljana.

RAMOVŠ, A. (1978): Geologija.- Univerza v Ljubljani, 179 p., Ljubljana.

RAMOVŠ, A. (1990): Ausbildung der Ladin-Stuffe (Mitteltrias) in den nordlichen Julischen Alpen.- Geologija, 31/32, 241-266, Ljubljana.

RAMOVŠ, A. & JURKOVŠEK, B. (1983a): Ausbildung der Anis-Schichten bei Tržič (Südkarawanken) mit besonderer Rücksicht auf die neu entdeckte "Illyr"-Unterstufe.- Geološki zbornik, 4, 37-45, Ljubljana.

RAMOVŠ, A. & JURKOVŠEK, B. (1983b): Ausbildung der Ladin-Schichten oberhalb des Šupca-Aufsichtspunktes, südlich des Vršič-Passes (Julische Alpen).- Geološki zbornik, 4, 81-91, Ljubljana.

RAMOVŠ, A., KOCHANSKY-DEVIDÉ, V. (1979): Ladinische Konglomerat-Brekzien am Vršič-Pass und deren permische und triassische Mikrofossilien.- Rud. metal. zbornik, 26, 155-165, Ljubljana.

REITZ, E. (1985): Palynologie der Triass in Nordhessen und Südniedersachsen.- Geol. Abh. Hessen, 86, 1-36, Wiesbaden.

REITZ, E. (1988): Palynostratigraphie des Bundsandsteins in Mitteleuropa.- Geol. Jb. Hessen, 116, 105-112.

SOKAČ, B. (1973): Geologija Velebita (Abstract: Geology of Mt. Velebit, Croatia).- Unpublished Ph.D. Thesis, 154 p., University of Zagreb.

TAUGOURDEAU-LANTZ, J. (1983): Associations palynologiques définies dans le Trias Languedocien (France): interpretation stratigraphique. Cah. Micropaléontol., 3, 5-20.

VAN DER EEM, J.G.L.A. (1983): Aspects of Middle and Late Triassic palynology, 6. Palynology investigations in the Ladinian and Carnian of the Western Dolomites, Italy.- Rev. Palaeobot. Palynol., 39/3-4, 189-300.

VISSCHER, H. (1966): Palaeobotany of the Mesophytic. II. Plant microfossils from the Upper Bunter of Hengelo, The Netherlands.- Acta Bot. Neerl., 15, 316-375, Utrecht.

VISSCHER, H. (1971): The Permian and Triassic of the Kingscourt outlier, Ireland.- Geol. Surv. Ireland, Spec. pap., 1, 1-114, Dublin.

VISSCHER, H. (1974): The impact of palynology on Permian and Triassic stratigraphy in Western Europe.- Rev. Palaeobot. Palynol., 17, 1-2, 5-19.

VISSCHER, H. & BRUGMAN, W.A (1981): Ranges of selected palynomorphs in the Alpine Triassic of Europe.- Rev. Palaeobot. Palynol., 34, 115-128.

VISSCHER, H., HUDDLESTON SLATER-OFFERHAUS, M.G., WONG, T.E. (1974): Palynological assemblages from "Saxonian" deposits of the Saar-Nahe basin (Germany) and the Dôme de Barrot (France) - An approach to chronostratigraphy.- Rev. Palaeobot. Palynol., 17/1-2, 39-56.

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PLATE I

SUSAK MORE-1
Magnifications: 1-7, 10-12: 1000x; 8, 9: 800x

1, 2	*Calamospora* sp.	1) J-8 (5493-5489 m), IVm vez.-1. 2) J-β (6725-6721m), Im 0,5-1.
3	*Retusotriletes* sp.	5955m-3.
4	*Simeonospora khlonovae* BALME, 1970	J-β (6725-6721), IIm 0,5-1A.
5	*Cyclogranisporites arenosus* MÄDLER, 1964	J-8 (5493-5489m), IIm frag.-1.
6	*Cyclotriletes micrograntfer* MÄDLER, 1964	J-9 (6004-6000m), Im 0,5-3
7	*Cycloverrutriletes* sp.	J-8 (5493-5489m), IVm vez.-1.
8, 9	*Cycloverrutriletes presselensis* SCHULZ, 1964	J-9 (6004-6000m), IIm 0,5-2.
10	*Verrucosisporites* sp.	J-8 (5493-5489m), IIm 0,5-3.
11	*Converrucosisporites eggeri* KLAUS, 1963	J-9 (6004-6000m), IIm vez.-2.
12	*Triquitrites* sp.	J-β (6725-6721m), IIm 0,5-2.

PLATE II

SUSAK MORE-1
Magnifications: 1-12, 14: 1000x; 13: 300x; 15: 1250x

1-3	*Densoisporites nejburgii* (SCHULZ, 1964) BALME, 1970	1) 5995m-2. 2) 5550m-2. 3) J-8 (5493-5489m), IIm frag.-1.
4	*Densoisporites playfordii* (BALME, 1963) DETTMANN, 1969; 5550m-3.	
5	*Lundbladispora echinata* REINHARDT & SCHÖN, 1962	J-9 (6004-6000m), IIIm vez.-2.
6	*Kraeuselisporites* sp.	J-β (6725-6721m), IIIm 0,1-1.
7, 8	*Endosporites papillatus* JANSONIUS, 1962	7) 5550m-1. 8) 5995m-2.
9	*Aratrisporites* sp.	J-8 (5493-5489m), IVm S-1.
10	*Crucisaccites variosulcatus* DJUPINA, 1971	J-9 (6004-6000m), IIIm vez.-2.
11	*Cordaitina gunyalensis* BALME, 1970	J-β (6725-6721m), Im 0,5-1.
12	*Perisaccus granulatus* KLAUS, 1963	J-8 (5493-5489m), IVm vez.-3.
13	*Nuskoisporites dulhuntyi* POTONIÉ& KLAUS, 1954	J-8 (5493-5489m), IVm vez.-3.
14	*Nuskoisporites* sp.	J-8 (5493-5489m), IVm vez.-3.
15	*Dyupetalum* cf. *vicentinense* BRUGMAN, 1983	J-9 (6004-6000m), IIIm vez.-1.

PLATE III

SUSAK MORE-1
Magnifications: 1-5, 8-10: 1000x; 6, 7: 1500x

1	*Potonieisporites* sp.	5730m-2.
2	*Plicatipollenites* sp.	5730m-1.
3-5	*Doubingerispora* sp.	3) 5385-IV. 4) 5385-3. 5) 540m-1.
6-9	*Lueckisporites virkkiae* POTONIÉ & KLAUS, 1954	6) J-8 (5493-5489 m), IV vez.-1. 7) J-β (6725-6721 m), Im 0,8-2. 8) J-9 (6004-6000m), Im S-3. 9) J-8 (5493-5489m), IV vez.-3.
10	*Hamiapollenites* sp.	J-β (6725-6721m), IIIm 0,1-2.

PLATE IV

SUSAK MORE-1
Magnifications: 1-11: 1000x

1	*Protohaploxypinus* cf. *varius* (BHARADWAJ, 1967) BALME, 1970	J-β (6725-6721m), IIm 0,3-3.
2	*Strotersporites richteri* KLAUS, 1963	J-9 (6004-6000m), IIIm vez.-2.
3, 4	*Triadispora* sp.	3) J-9 (6004-6000m), IIIm vez.-1. 4) J-8 (5493-5489m), IVm S-2.
5, 6	*Angustisulcites klausii* (FREUDENTHAL, 1964) VISSCHER, 1966.	5) J-8 (5493-5489m), IIIm s-4. 6) J-9 (6004-6000m), IIm S-1.
7	*Illinites chitonoides* KLAUS, 1963	J-8 (5493-5489m), IVm vez.-2.
8	*Jugasporites* cf. *conmilvinus* KLAUS, 1964	J-8 (5493-5489m), IVm vez.-2.
9	*Jugasporites* sp.	J-8 (5493-5489m), IVm vez.-1.
10	*Limitisporites rectus* KLAUS, 1956	J-9 (6004-6000m), IIIm vez.-3.
11	*Vitreisporites pallidus* (REISSINGER, 1959), NILSSON, 1958	5570m-1.

PLATE V

SUSAK MORE-1
Magnifications: 1-14: 1000x

1, 2	*Klausipollenites schaubergeri* (POTONIÉ & KLAUS, 1954) JANSONIUS, 1962	1) J-8 (5493-5489m), IVm vez.-2. 2) J-8 (5493-5489m), IVm S-1.
3, 4	*Voltziaceaesporites heteromorpha* KLAUS, 1964	J-9 (6004-6000m), IIIm vez.-1.
5	*Alisporites cymbatus* VENKATACHALA, KAR & BEJU, 1968,	5620m-3.
6	*Paravesicaspora splendens* KLAUS, 1963	J-8 (5493-5489m), IVm vez.-3.
7	*Rhizomaspora* cf. *divaricata* WILSON, 1962	6120m-2.
8	*Platysaccus leschikii* HART, 1960	J-8 (5493-5489m), IVm vez.-3.
9	*Vittatina costabilis* WILSON, 1962	J-9 (6004-6000m), IIIm vez.-3.
10, 11	*Vittatina ovalis* KLAUS, 1963	10) 5550m-3. 11) J-9 (6004-6000m), IIIm vez.-3.
12	*Ephedripites primus* KLAUS, 1963	J-8 (5493-5489m), IVm vez.-3.
13, 14	*Cycadopites coxii* VISSCHER, 1966	13) J-8 (5493-5489m), IIIm vez.-2. 14) J-9 (6004-6000m), IIIm vez.-1.

PLATE VI

SUSAK MORE-1
Magnifications: 1, 3-19: 1000x; 2 : 1950x

1	*Conaletes* sp.	5550m-2.
2	*Scythiana spinulosa* GOCZAN, 1988	J-8 (5493-5489m), IVm vez.-3.
3, 4	*Metaleiofusa compressa* SCHÖN, 1967	3) 5550m-2. 4) 5550m-3.
5-10	*Veryhachium reductum* (DEFLANDRE, 1958) JEKHOWSKY, 1961	5) J-9 (6004-6000m), IIIm vez.-1. 6-8) 5550m-1. 9) J-8 (5493-5489m), frag.-1. 10) J-8 (5493-5489m), IVm vez.-1.
11-13	*Micrhystridium* sp.	11) J-8 (5493-5489m), IVm vez.-2. 12) 5995m-1. 13) J-9 (6004-6000m), IIIm vez.-1.
14-16	*Brazilea* sp.	14) J-β (6725-6721m), IIIm 0,9-3. 15, 16) J-9 (6004-6000m), IIIm vez.-3.
17	*Microphytoplankton* gen. et sp. indet.	J-8 (5493-5489m), IVm vez.-1.
18	"*Tympanicysta*" sp.	J-8 (5493-5489m), IVm frag.-1.
19	*Scitynasceae* gen. et sp. indet.	J-8 (5493-5489m), IIm frag.-1.

PLATE VII

Magnifications: 1-15: 1000x

TRŽIČ

1, 2	*Densoisporites nejburgii* (SCHULZ, 1964) BALME, 1970; 736/1.
3	*Praecirculina granifer* (LESCHIK, 1955) KLAUS, 1960; 738/4.
4	*Bisaccites* gen. et sp. indet.; 738/4.
5	*Metaleiofusa* sp.; 738/5.
6	*Veryhachium reductum* (DEFLANDRE, 1958) JEKHOWSKY, 1961; 738/1.
7	*Veryhachium* sp.; 738/1.
8	*Leiosphaeridia* sp.; 738/2.

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9	*Leiosphaeridia* sp.; 4001/18/1.
10	*Leiosphaeridia* sp.; 4001/9/1.
11	*Cycadopites* sp.; 4003/9/1

W OF KRANJSKA GORA

12	*Densoisporites nejburgii* (SCHULZ, 1964) BALME 1970; 7135/1/1.
13-15	*Endosporites papillatus* JANSONIUS, 1962; 1896/1.

PLATE VIII

Magnifications: 1-27: 1000x

W OF KRANJSKA GORA

1	*Endosporites papillatus* JANSONIUS, 1962; 1896/1.
2	*Crucisaccites variosulcatus* DJUPINA, 1971; 7135/1/1.
3	*Lueckisporites virkkiae* POTONIÉ & KLAUS, 1954; 7135/1/2.
4	*Klausipollenites schaubergeri* (POTONIÉ & KLAUS, 1954), JANSONIUS, 1962; 1896/1.
5	*Cycadopites* sp.; 1896/1.
6	*Veryhachium* sp.; 1895/1.
7	*Micrhystridium* sp.; 1895/1.
8	*Micrhystridium* sp.; 1896/1.
9	*Leiosphaeridia orbiculatum* STAPLIN, 1961; 1855/1.
10	"*Tympanicysta*" sp.; 1896/1.

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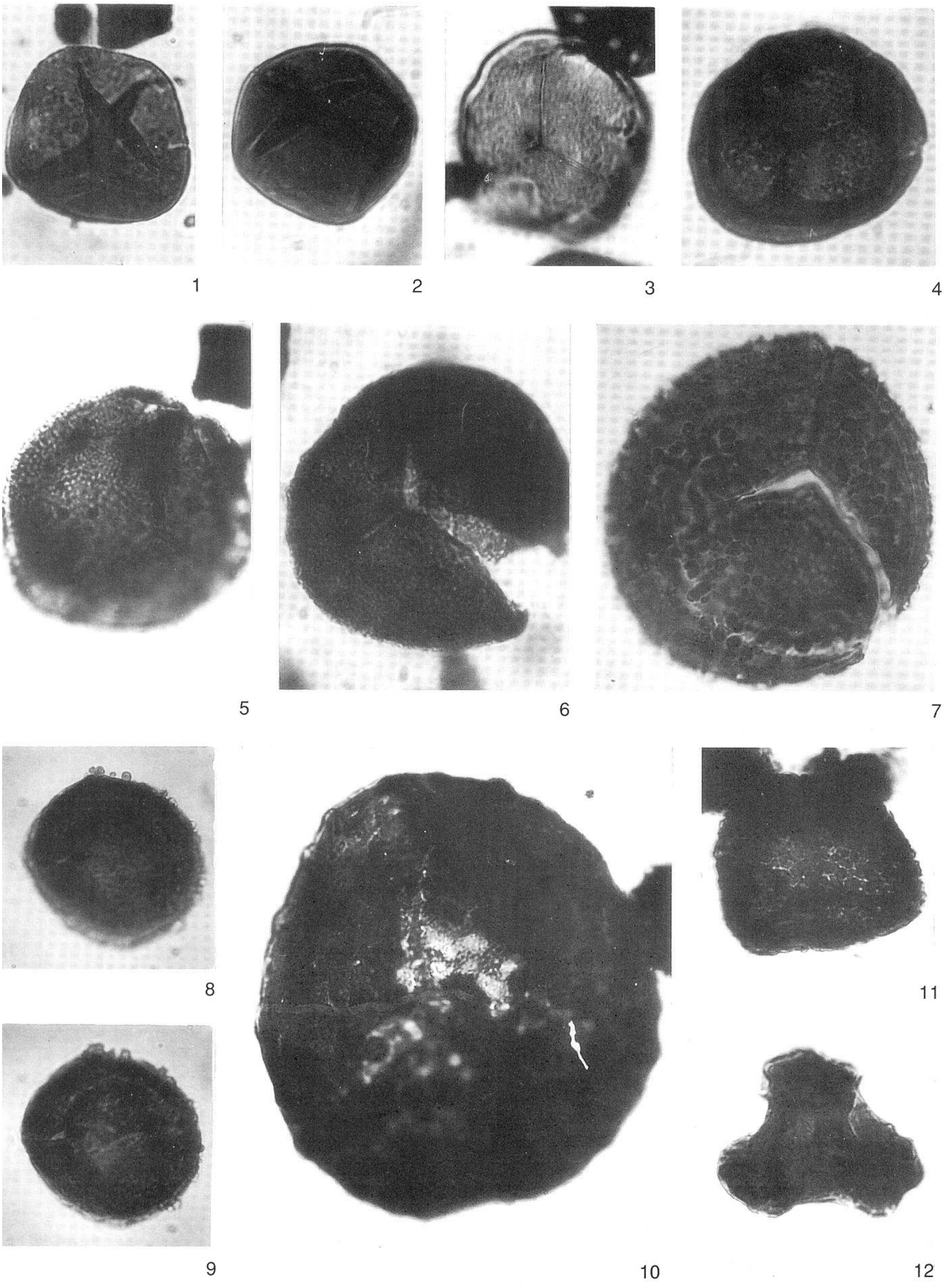
11-13	*Densoisporites nejburgii* (SCHULZ, 1964) BALME, 1970 11) B-2 12) B-4 13) B-1.
14	*Endosporites papillatus* JANSONIUS, 1962; B-13.
15	*Cycadopites* cf. *follicularis* WILSON & WEBSTER, 1946; B-5.
16	*Bisaccites* gen. et sp. indet.; B-2.
17	*Klausipollenites vestitus* JANSONIUS, 1962; B-3.
18	*Veryhachium reductum* cf. *trispinosoides* JEKHOWSKY, 1961; B-5.
19	*V. longispinum* HOROWITZ, 1973; B-13.
20, 21	*V. irregulare* (JEKHOWSKY, 1961) WALL & DOWNIE, 1962; B-7.
22	*V. rhomboideum* DOWNIE, 1955; B-13.
23	*Micrhystridium* cf. *fragile* DEFLANDRE, 1947; B-13.
24	*M.* cf. *stipulatum* JANSONIUS, 1962; B-7.
25	*Baltisphaeridium* cf. *micropunctatum* WALL, 1965; B-13
26	*Leiosphaeridia minutum* (STAPLIN, 1961) DOWNIE & SARJEANT, 1963; B-9.
27	*L. orbiculatum* STAPLIN, 1961, B-13.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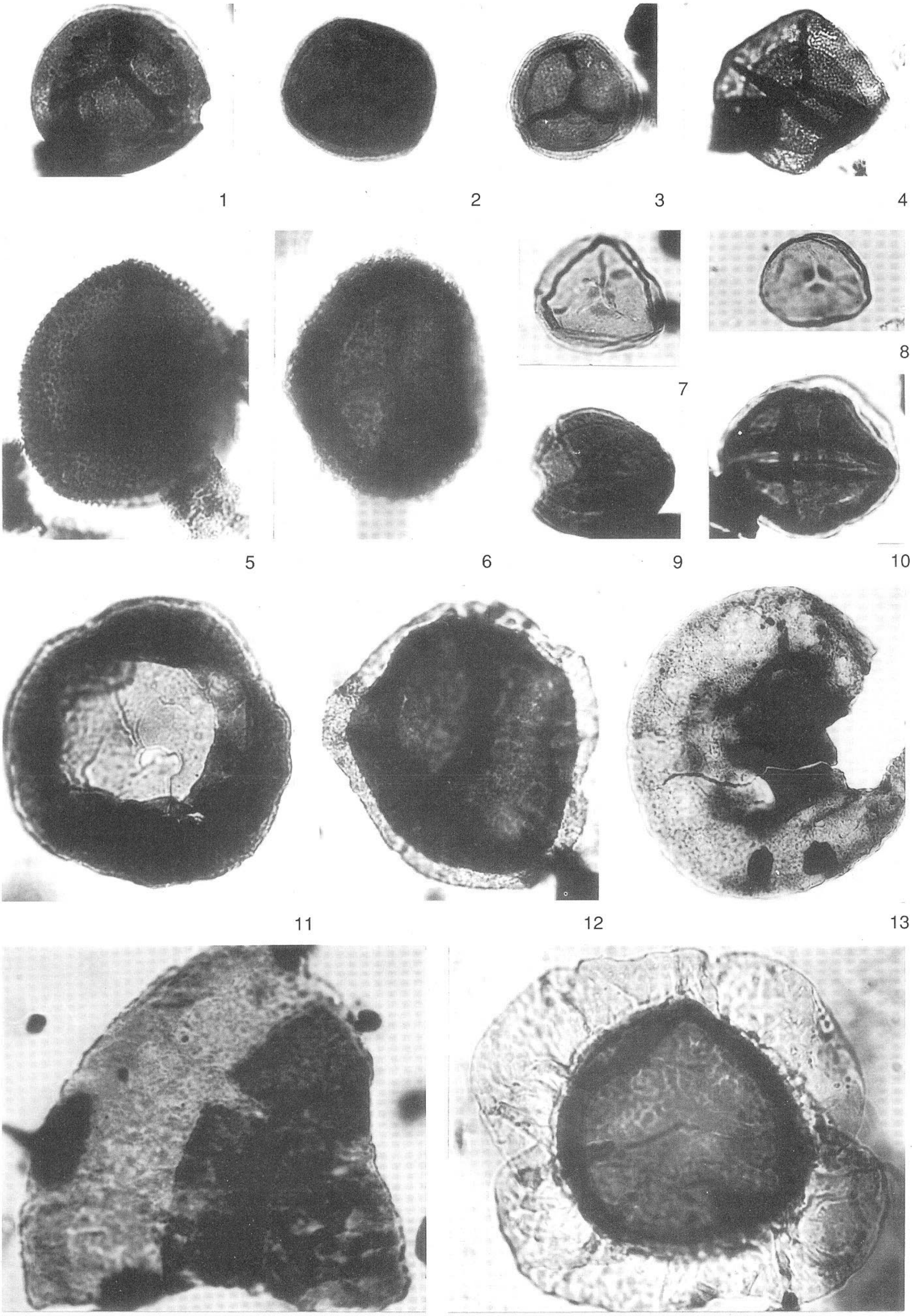
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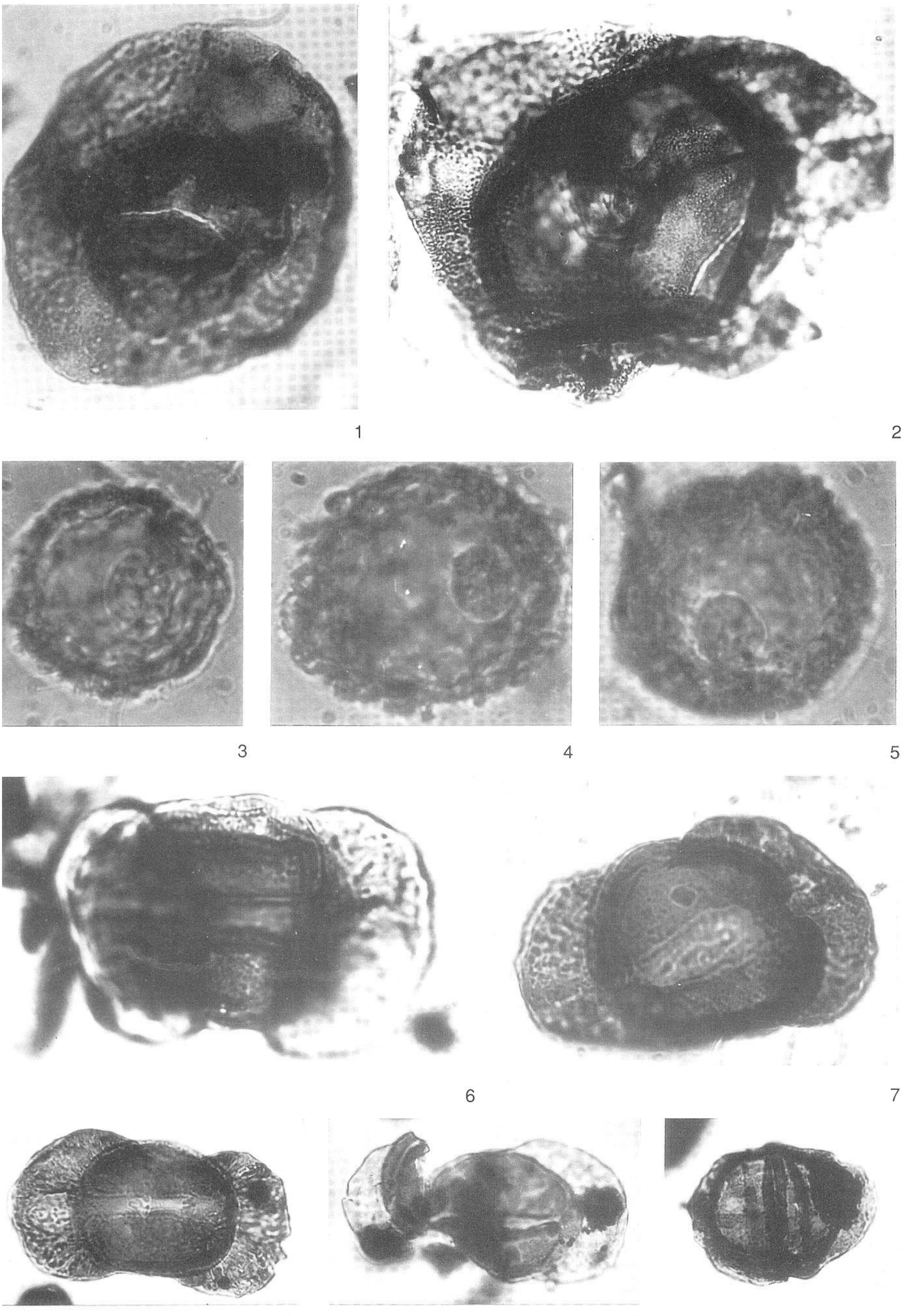
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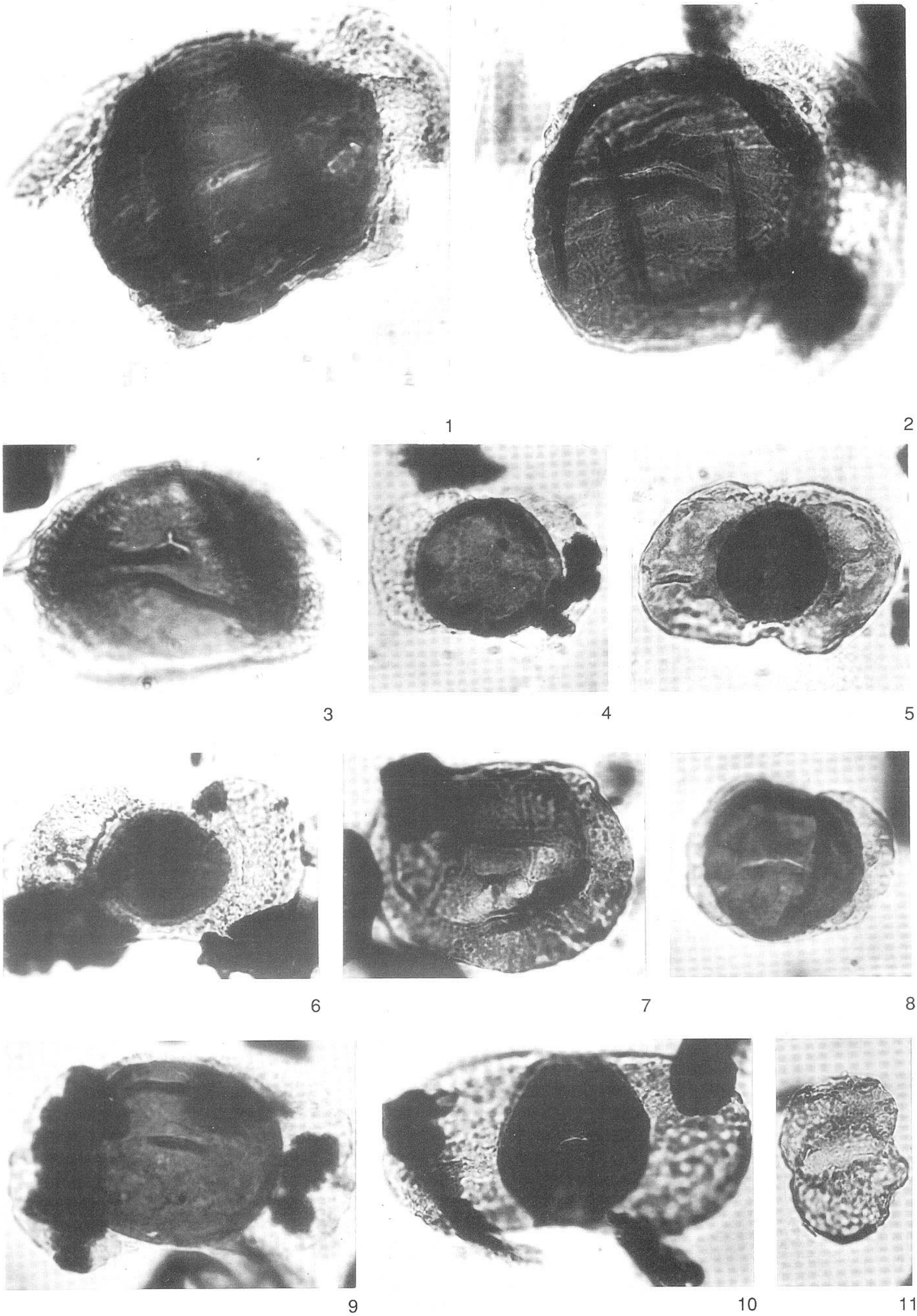
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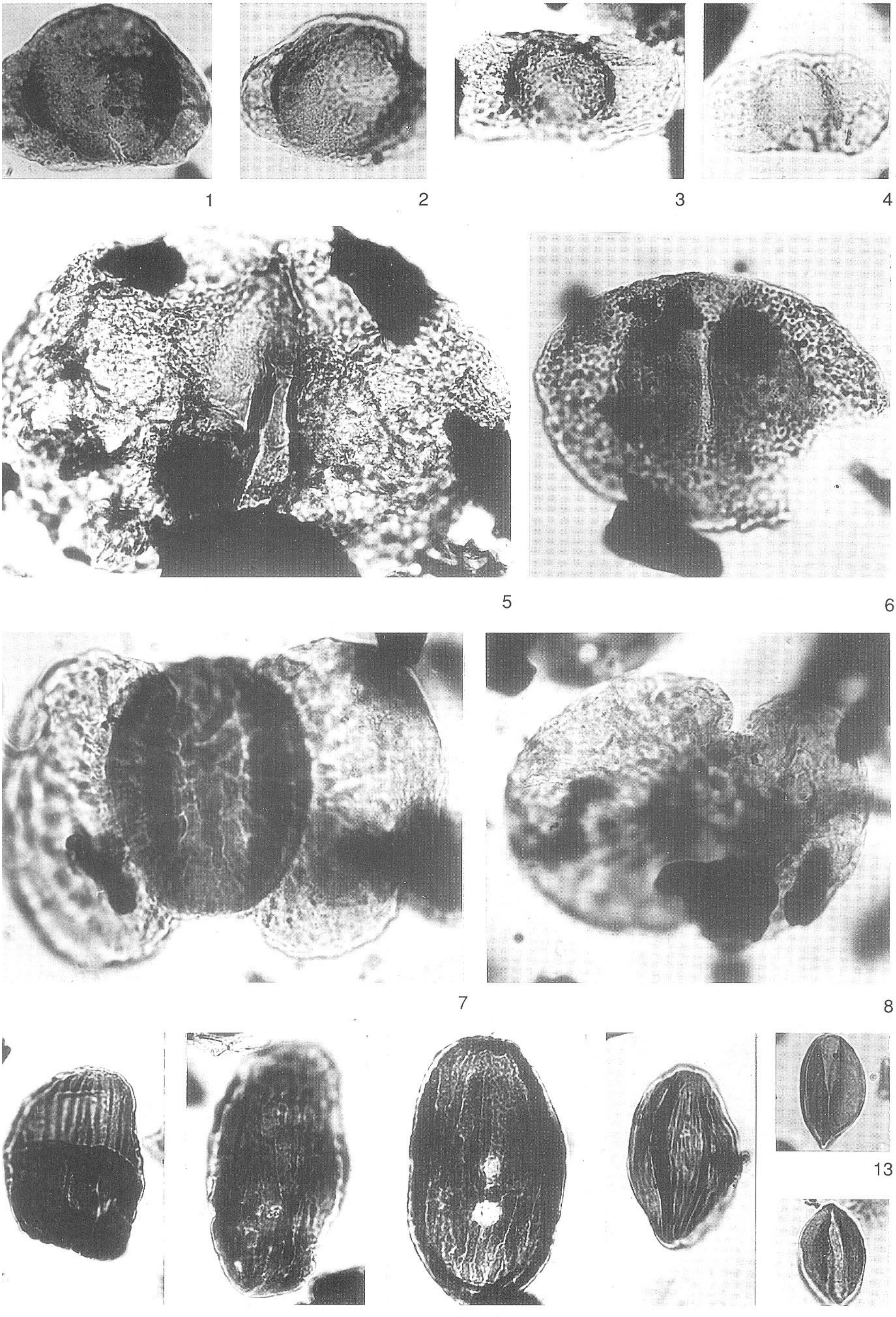
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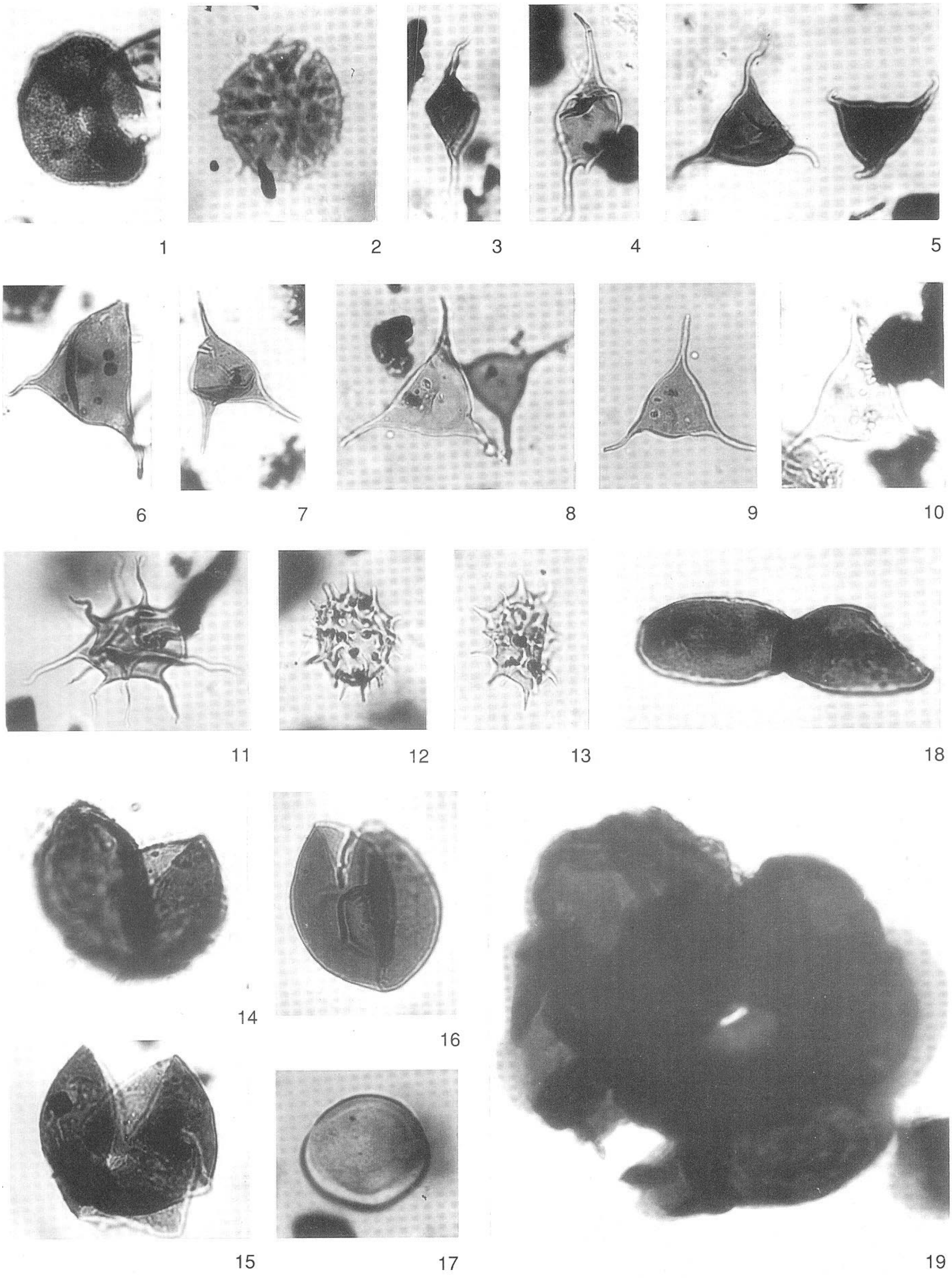
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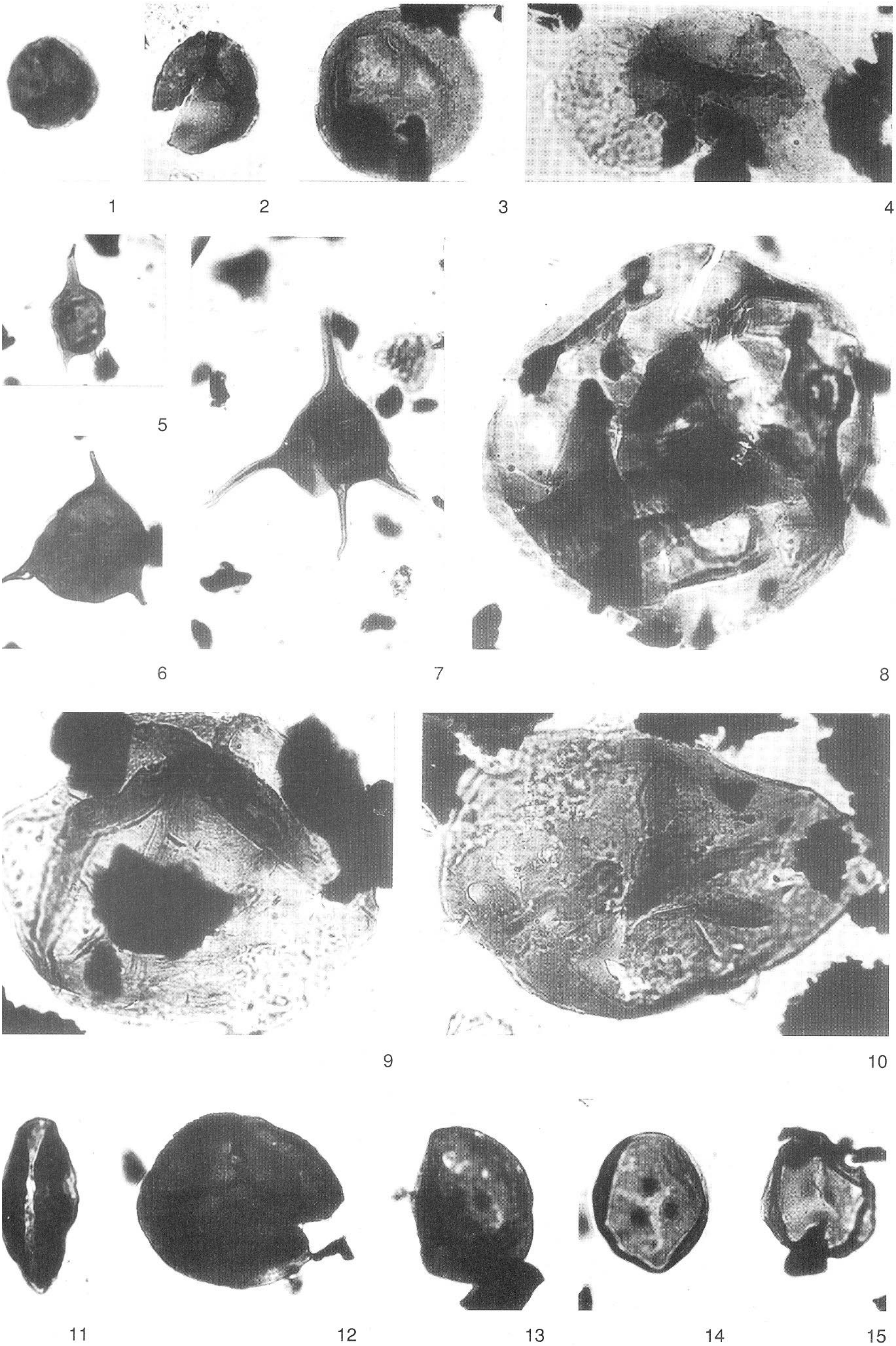
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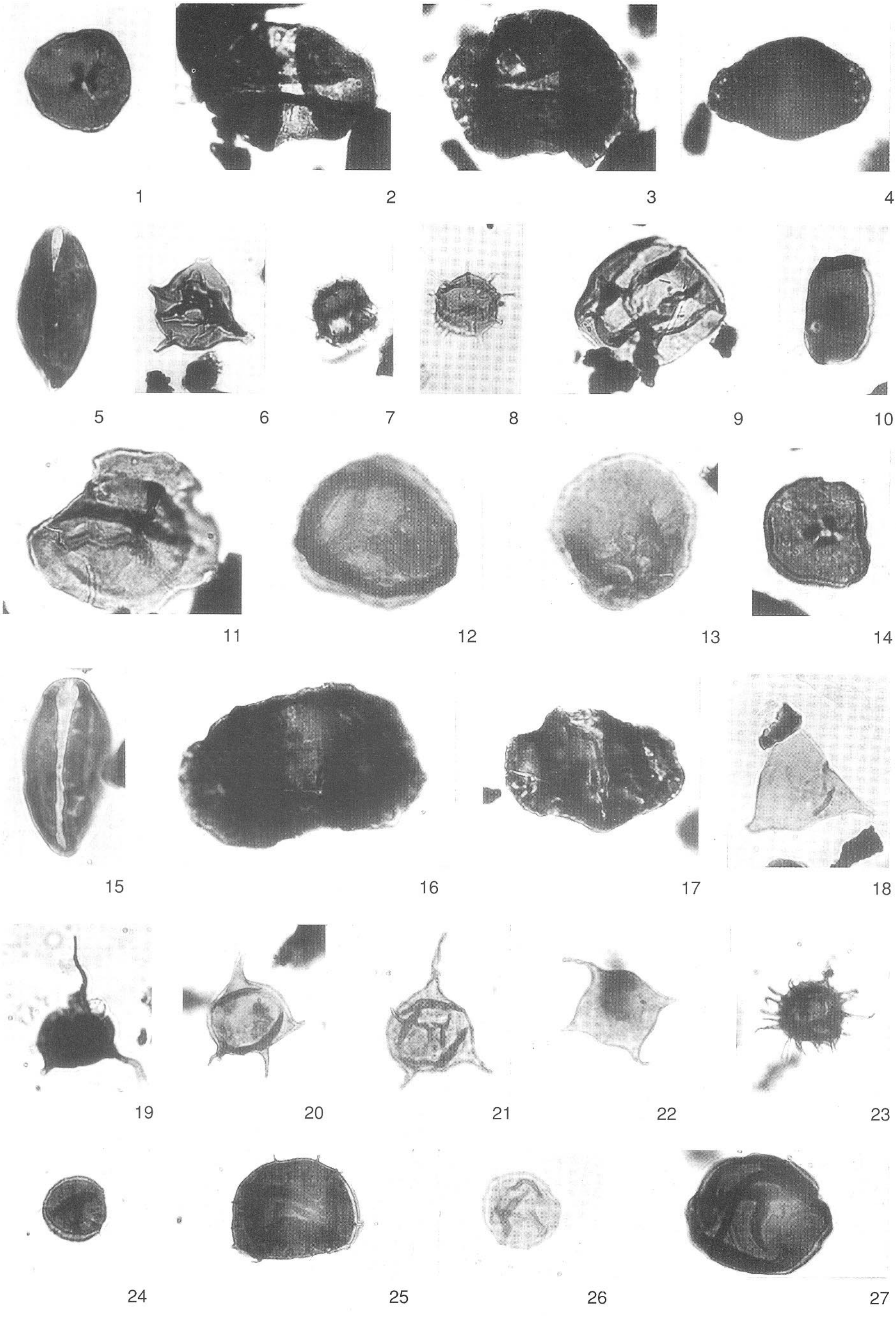
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