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Palynology of Middle Jurassic black organic shale of "Tacco di Laconi", Central Sardinia, Italy

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KEY WORDS — *Palynology, Middle Jurassic, Sardinia.*

ABSTRACT — *The black organic shale, belonging to the «Tacco di Laconi» have been palynologically investigated. The microflora, rich indeed, is similar to those known for the same formation in other partes of the Island and reflects the characters of the macroflora studied by Krasser (1920) and Edwards (1929) in the Laconi's plant deposits. Palynostratigraphically this layer may be correlated with the Ischyosporites variegatus Zone of Iran-Afghanistan Basin, dated as Bajocian-Bathonian.*

RIASSUNTO — [Palinologia delle argille a piante del Giurese medio del «Tacco di Laconi»] — *Una ricca associazione contenente 54 specie di pollini e spore è stata ritrovata nelle argille sottostanti le dolomie del «Tacco di Laconi». L'associazione è simile a quelle finora ritrovate nella medesima formazione in altre località della Sardegna.*

L'età resta ancora imprecisata Bajociano-Batoniano data la correlabilità di questa associazione con la Zona a Ischyosporites variegatus del bacino Iraniano-Afgano, che è comprensiva di tutti e due i piani.

INTRODUCTION

A black Middle Jurassic shaly layer rich in plant remains, have been palynologically investigated. The sample, very rich in pollen and spores, was collected by the author from the section exposed in the Pala Asonis Quarry (Tav. Genoni, 218 II NO), which is situated on the right of the Genoni-Laconi Road, approximately at km 6 (Text-fig. 1).

The Pala Asonis section belongs to the «Tacco di Laconi» succession which outcrops in its entirety in the same area. Except for the reduced thickness, the Pala Asonis section consists of the same lithotypes as the much thicker sequences of «Tacco di Laconi». The following lithotypes are recorded in the Pala Asonis section (from bottom to top):

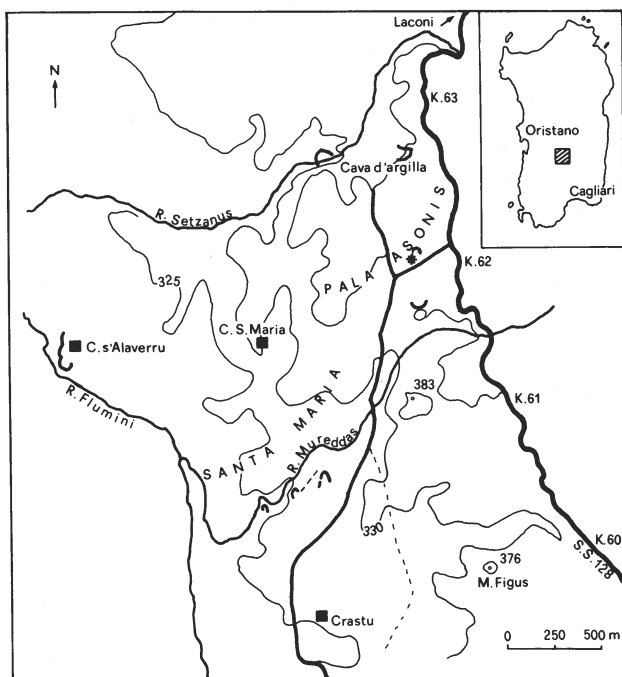
- a continental conglomerate, 3 m thick, containing prevailing white and rounded quartz pebbles whose dimensions range from few (2.3 cm) to several centimeters. The conglomerate evolves toward grey sandstone containing lenses of black organic shales with plant remains, often lignitiferous. The organic-rich shales generally occur at the base of

the «Tacchi» succession either in the Central or in the Eastern Sardinia Basin.

- About 2 m of grey and yellow sands close the continental-lacustrine cycle which may be considered equivalent to the Genna Seole Formation (Dieni *et al.*, 1983) of Central Eastern Sardinia.
- 11 m of marine dolostones in layers about 30 cm thick, interstratified with thin pelitic layers closing the section. This unit, only 11 m thick appears to be very condensed and/ or reduced by subsequent erosion in comparison with other succession where the dolostones can be from 50 to 100 m thick.

AGE

So far the age of the «Tacchi» succession is not precisely defined either with uncertainty involving both base and top of the succession. The basal conglomerate was supposed to correspond the oolitic limestone containing *Liogryphea franchi* Parona, which deposition is related to the Liassic transgression in NW Sardinia (Nurra) (Oosterban, 1936). The top sediments, generally dolomitic and unfossiliferous,



Text-fig. 1 - Location map of the Pala Asonis Quarry.

should have a generalized Middle to Early-Late Jurassic age. The latter age of the top most sediments is suggested by the very rare fossils which locally can be found in rare calcareous and dolomitic strata of the « Tacchi » succession: *Rhynchonella subsoleta*, *Terebratula lamarmorae*, *Nerinea voltzii*, *Pleurotomaria* sp. (Meneghini, 1857). Krasser (1920) and Edwards (1929) assigned to the plant-bearing shales from Sardinia a Bajocian age for the striking similarity of the macroflora with that from the Yorkshire. Moreover, Del Rio (1977) according to the palynostratigraphic scheme of Couper (1958), also established in the Yorkshire, attributed the same Bajocian age to the Central Sardinia palynomorph assemblage. Recently, Dieni *et al.* (1983) suggested a Bathonian age for the continental-lacustrine cycle of the succession (Genna Selole Formation). The mentioned authors based their assumption on the occurrence in the Genna Selole Formation of some marshy gasteropods (i.e. *Bathonella*, *Coussmeria* and *Naricopsina*) which are recorded in the Bathonian of Scotland. If the stratigraphic value of these marshy gasteropods will be confirmed, then the latter succession could be partially younger than Bathonian.

Palynostratigraphically, the Pala Asonis association is correlatable with that of the *Ischyosporites variegatus* - *Leptolepidites argenteaformis* Zone of the Iranian-Afghanistan Basin, which chronostratigraphically spans both the Bajocian and Bathonian.

The microflora assemblages reported from other Sardinian localities (Del Rio, 1977; Schneider, 1978; Salarj Cheboldaef *in* Dieni *et al.*, 1983 and Ashraf *et al.*, 1984) display large similarity. The taxa common to the various localities are plotted in Tab. 1.

LIST OF SPOROMORPHS

- Cyathidites australis* Couper, 1953
Cyathidites minor Couper, 1953
Dictyophyllidites harrisii Couper, 1958
Gleichenidites senonicus Ross, 1949
Cibotiumsporites juriensis (Balme, 1957) Filatoff, 1975
Calamospora mesozoica Couper, 1958
Todisporites minor Couper, 1958
Inaequicrassisorites inaequicrassatus D'Amato Avanzi, 1974
Concavissimisorites subgranulosus (Couper, 1958) Pocock, 1970
Leptolepidites argenteaformis (Bolkhovitina, 1953) Morbey, 1975
Converrucosporites sp.
Neoraistrickia gristhorpensis (Couper, 1958), Tralau, 1968
Neoraistrickia sp. cf. N. sp. A Filatoff, 1975
Ceratospores rotundiformis (Kara Murza, 1961) Pocock, 1970
Verrucosporites varians Volkheimer, 1972
Osmundacidites wellmanii Couper, 1953
Osmundacidites minutum Sah & Jain, 1965
Tigrisporites jonkeri Van Erve, 1977
Lycopodiacidites rugulatus (Couper, 1958) Schulz, 1967
Staplinisporites caminus (Balme, 1957) Pocock, 1962
Staplinisporites mathurii (Srivastava, 1966) Filatoff, 1975
Ischyosporites variegatus (Couper, 1958) Schulz, 1967
Matonisporites phlebopteroides Couper, 1958
Skarbysporites sp.
Densoisporites velatus Weyland & Krieger, 1953
cf. *Baculatisporites comaumensis* (Cookson, 1953) Potonié, 1956
Spore sp. a
Marattisporites scabratus Couper, 1958
Laevigatosporites ovatus Wilson & Webster, 1946
Cerebropollenites macroverrucosus (Thiergart, 1949) Schulz, 1967
Inaperturopollenites turbatus Balme, 1957
Exesipollenites scabratus (Couper, 1958) Pocock, 1970
Exesipollenites tumulus Balme, 1957
Araucariacites australis Cookson, 1947
Araucariacites fissus Reiser & Williams, 1968
Callialasporites dampieri (Balme, 1957) Suk Dev, 1961
Callialasporites microvelatus Schulz, 1966
Callialasporites minus (Tralau, 1968) Guy, 1971
Callialasporites trilobatus (Balme, 1957) Suk Dev, 1961
Monosulcites minimus Cookson, 1947
Cycadopites follicularis Wilson & Webster, 1946
Eucommiidites troedssonii Erdtman, 1948
Perinopollenites elatoides Cooper, 1958
Perinopollenites pseudosulcatus Briche, Danzé Corsin & Laveine, 1963
Corollina torosus (Reissinger, 1950) Klaus, 1960
Corollina minor (Pocock & Jansonius, 1961) Cornet & Trauerse, 1975
Podocarpidites ellipticus Cookson, 1947
Podocarpidites multicus (Bolchovitina, 1956) Pocock, 1970
Podocarpidites cf. *verrucosus* Volkheimer, 1972
Alisporites grandis (Cookson, 1947) Dettmann, 1963
Alisporites thomasi (Couper, 1958) Pocock, 1962
Platisaccus papilionis Potonié & Klaus, 1954
Vitreisporites pallidus (Reissinger, 1950) Nilsson, 1958

OTHER PAPERS	D A M A T T O	A V A N Z I	D E L R I O	S C H N E I D E R	S A L A R D C H E B O L D A E F F	A S H R A F
SPECIES (this paper)						
<i>Anaucariacites australis</i>			X	X	X	
<i>Calamospora mesozoica</i>			X			
<i>Callialasporites dampieri</i>			X			
<i>Callialasporites trilobatus</i>			X		X	
<i>Ceratosporites rotundiformis</i>			X			
<i>Cerebropollenites macroverrucosus</i>			X		X	X
<i>Concavissimisporites subgranulosus</i>						X
<i>Cyathidites australis</i>				X	X	X
<i>Cyathidites minor</i>	X		X			X
<i>Densoisporites velatus</i>					X	X
<i>Dictyophyllidites harrisii</i>	X		X	X		
<i>Eucomiidites troedssonii</i>			X		X	
<i>Exesipollenites scabratus</i>			X			
<i>Gleichenidites senonicus</i>			X			
<i>Inaequicrassisporites inaequicrassatus</i>	X				X	
<i>Ischyosporites variegatus</i>			X			X
<i>Laevigatosporites ovatus</i>						X
<i>Lycopodiacidites rugulatus</i>			X		X	X
<i>Marattisporites scabratus</i>			X			
<i>Monosulcites minimus</i>					X	
<i>Neoraistrickia gristhorpensis</i>						X
<i>Osmundacidites wellmanii</i>			X			
<i>Perinopollenites elatoides</i>			X			
<i>Perinopollenites pseudosulcatus</i>			X			
<i>Podocarpidites multicusus</i>			X			
<i>Sestrosporites pseudoalveolatus</i>			X	X	X	X
<i>Staplinisporites caminus</i>			X		X	X
<i>Todisporites minor</i>					X	X
<i>Vitreisporites pallidus</i>			X	X	X	

Tab. 1 - List of the sporomorphs found at Pala Asonis Quarry, also recorded from the same formation outcropping in Sardinia in the following localities: Tavolara Island, (D'Amato Avanzi, 1974); Central Sardinia, Nurallao, Laconi, Monte Tonneri, Seui, Perdasdefogu, Escalaplano, Tonara (Del Rio, 1977); Genna Su Ludu, Jerzu (Schneider, 1978); Genna Selole, Baunei (Salar-Chebouldaef in Dieni *et al.*, 1983) and Nurra (Ashraf in Ashraf *et al.*, 1984).

TAXONOMY

Ante Turma SPORITES H. Potonié, 1893

Turma TRILETES (Reinsch, 1881)

Potonié & Kremp, 1954

Sub Turma AZONOTRILETES Lubert, 1935

Infra Turma LAEVIGATI, QUASILAEVIGATI
(Bennie & Kidston, 1886) Potonié, 1956

Genus CYATHIDITES Couper, 1953

Type-species — *Cyathidites australis* Couper, 1953.

CYATHIDITES AUSTRALIS Couper, 1953

Pl. 1, figs. 1, 4

Remarks — Specimens with open and closed Y mark have been ranged under this species. According to this character *Cyathidites australis* and *Cyathidites mesozoicus* might be considered as possible synonymous.

Dimension — Diameter of the spore 40 to 57 μ .

Occurrence — Frequent. Also present in the Bajocian-Bathonian of Ogliastro, E Sardinia (Schneider, 1978; Salard Cheboldaef in Dieni *et al.*, 1983) and of Nurra, NW Sardinia (Ashraf *et al.*, 1984).

CYATHIDITES MINOR Couper, 1953

Pl. 1, fig. 2

Dimension — Diameter of the spore 30 to 34 μ .

Occurrence — Frequent. Also present in the Middle Jurassic of Tavolara island (D'Amato Avanzi, 1974) and in the Bajocian-Bathonian of Nurra, NW Sardinia (Ashraf *et al.*, 1984).

Genus DICTYOPHYLLIDITES Couper, 1958

Type-species — *Dictyophyllidites harrisii* Couper, 1958.

DICTYOPHYLLIDITES HARRISII Couper, 1958

Pl. 1, fig. 3

Dimension — Diameter of the spore 30 to 48 μ .

Occurrence — Very frequent. Also present in the Middle Jurassic of Tavolara island (D'Amato Avanzi, 1974), and in the Bajocian-Bathonian of Jerzu (Schneider, 1978).

Genus TODISPORITES Couper, 1958

Type-species — *Todisporites major* Couper 1958.

TODISPORITES MINOR Couper, 1958.

Dimension — Diameter of the spore 30 to 35 μ .

Occurrence — Rare. Also present in the Middle Jurassic of Tavolara island (D'Amato Avanzi, 1974), in the Bajocian-Bathonian of Nurra, NW Sardinia (Ashraf *et al.*, 1984) and of Ogliastro (Salard Cheboldaef in Dieni *et al.*, 1983).

Genus GLEICHENIDITES Ross, 1949

Type-species — *Gleichenidites senonicus* Ross, 1949.

GLEICHENIDITES SENONICUS Ross, 1949

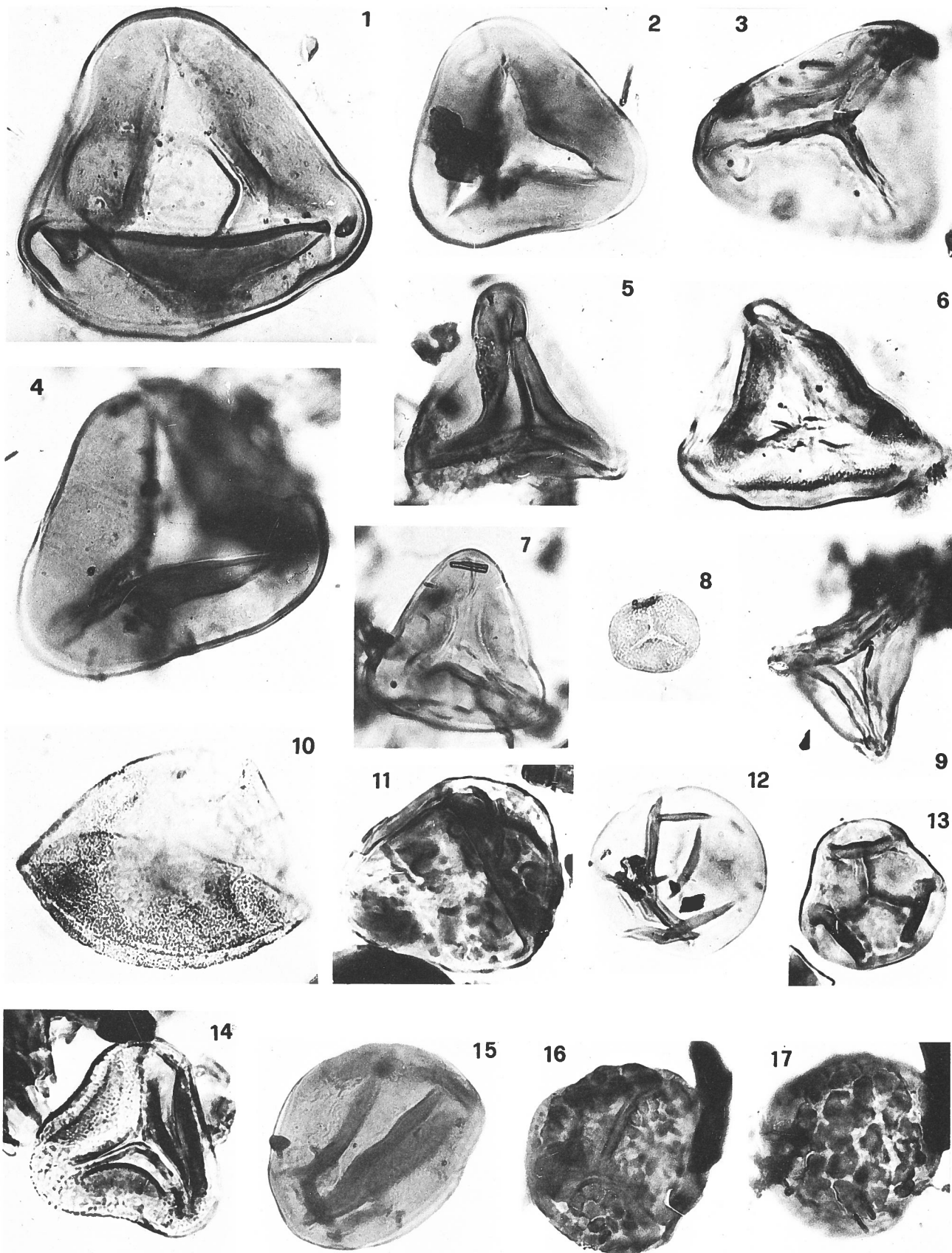
Pl. 1, fig. 7

Dimension — Diameter of the spore 20 to 33 μ .

EXPLANATION OF PLATE 1

All illustrated specimens from Pala Asonis, sample 1731.

- Figs. 1, 4 - *Cyathidites australis* Couper.
 - Fig. 2 - *Cyathidites minor* Couper.
 - Fig. 3 - *Dictyophyllidites harrisii* Couper.
 - Figs. 5, 9 - *Inaequicrassisporites inaequicrassatus* D'Amato Avanzi.
 - Fig. 6 - *Skarbysporites* sp.
 - Fig. 7 - *Gleichenidites senonicus* Ross.
 - Fig. 8 - *Osmundacidites minutum* Sah & Jain.
 - Fig. 10 - *Osmundacidites wellmanii* Couper.
 - Fig. 11 - *Converrucosisporites* sp.
 - Fig. 12 - *Calamospora mesozoica* Couper.
 - Fig. 13 - *Cibotiumspora juriensis* (Balme) Filatoff.
 - Fig. 14 - *Concavissimisporites subgranulosus* (Couper) Pocock.
 - Fig. 15 - *Laevigatosporites ovatus* Wilson & Webster.
 - Figs. 16, 17 - *Leptolepidites argentaeformis* (Bolkhovitina) Morbey.
- Magnification x 970.



Occurrence — Frequent.

Genus CIBOTIUMSPORA Chang, 1965

Type-species — *Cibotiumspora paradoxa* (Malyavkina, 1949) Chang, 1965.

CIBOTIUMSPORA JURIENSIS (Balme, 1957)
Filatoff, 1975

Pl. 1, fig. 13

Dimension — Diameter of the spore 25 to 39 μ .

Occurrence — Rare.

Genus CALAMOSPORA Schopf, Wilson & Bentall, 1944

Type-species — *Calamospora hartugiana* Schopf in Schopf, Wilson & Bentall, 1944.

CALAMOSPORA MESOZOICA Couper, 1958
Pl. 1, fig. 12

Dimension — Diameter of the spore 30 to 35 μ .

Occurrence — Rather frequent.

Genus INAEQUICRASSISPORITES
D'Amato Avanzi, 1974

Type-species — *Inaequicrassisporites inaequicrassatus* D'Amato Avanzi, 1974.

INAEQUICRASSISPORITES INAEQUICRASSATUS
D'Amato Avanzi, 1974

Pl. 1, figs. 5, 9

Dimension — Diameter of the spore 35 to 40 μ .

Occurrence — Rare. Also present in the Middle Jurassic of Tavolara island (D'Amato Avanzi, 1974) and in the Bajocian-Bathonian of Ogliastro (Salard Cheboldaëff in Dieni *et al.*, 1983).

Infra Turma APICULATI (Bennie & Kidston, 1886)
Potonié, 1956

Genus CONCAVISSIMISPORITES
(Delcourt & Sprumont, 1955)

Delcourt, Dettmann & Hughes, 1963

Type-species — *Concavissimisporites verrucosus* Delcourt & Sprumont, 1955.

CONCAVISSIMISPORITES SUBGRANULOSUS
(Couper, 1958) Pocock, 1970

Pl. 1, fig. 14

Dimension — Diameter of the spore 32 to 38 μ .

Occurrence — Very frequent. Also present in the Bajocian-Bathonian of Nurra, NW Sardinia, (Ashraf *et al.*, 1984).

Genus CONVERRUCOSISPORITES
Potonié & Kremp, 1954

Type-species — *Converrucosisporites triquetrus* (Ibrahim, 1933) Potonié & Kremp, 1954.

CONVERRUCOSISPORITES sp.

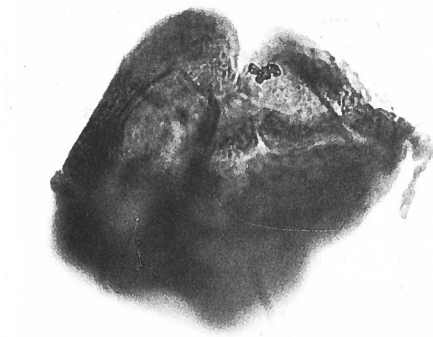
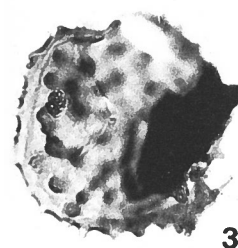
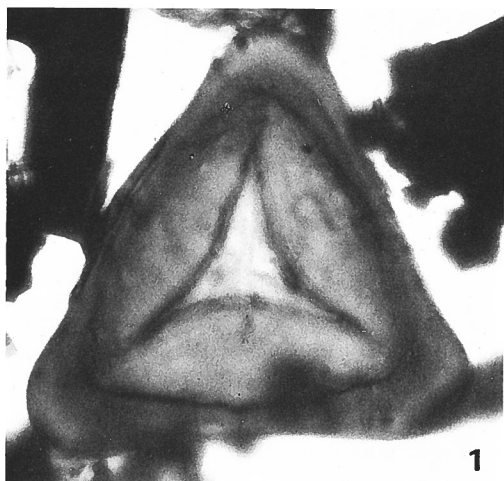
Pl. 1, fig. 11

Description — Trilete, lesurae 3/4 of the spore radius, amb triangular with concave sides and rounded apices. Esina 1,5 μ thick, sculptured with verrucae often coalescent.

EXPLANATION OF PLATE 2

All illustrated specimens from Pala Asonis, sample 1731.

- Fig. 1 - *Matonisporites phlebopteroides* Couper.
 - Fig. 2 - *Lycopodiacidites rugulatus* (Couper) Schulz.
 - Fig. 3 - *Neoraistrickia* sp. cf. *Neoraistrickia* sp. A Filatoff.
 - Figs. 4, 10 - Spore type a.
 - Fig. 5 - *Densoisporites velatus* Weiland & Krieger.
 - Fig. 6 - *Neoraistrickia gristhorpensis* (Couper) Tralau.
 - Fig. 7 - *Ceratosporites rotundiformis* (Kara Murza) Pocock.
 - Fig. 8 - *Tigrisporites jonkeri* Van Erve.
 - Fig. 9 - *Marattisporites scabratus* Couper.
 - Fig. 11 - *Verrucosisporites varians* Volkheimer.
 - Fig. 12 - cf. *Baculatisporites comaumensis* (Cookson) Potonié.
- Magnification $\times 995$.



Dimension — Diameter of the spore 40 to 43 μ .

Occurrence — Rare.

Remarks — *Converrucosisporites* sp. is similar to *Converrucosisporites* sp. A Filatoff 1975, but it is smaller.

Genus VERRUCOSISPORITES Ibrahim, 1933

Type-species — *Verrucosisporites verrucosus* Ibrahim, 1933.

VERRUCOSISPORITES VARIANS Volkeimer, 1972

Pl. 2, fig. 11

Dimension — Diameter of the spore 40 μ .

Occurrence — Rare.

Genus OSMUNDACIDITES Couper 1953

Type-species — *Osmundacidites wellmanii* Couper, 1953.

OSMUNDACIDITES WELLMANII Couper, 1953

Pl. 1, fig. 10

Dimension — Diameter of the spore 50 to 55 μ .

Occurrence — Rare.

OSMUNDACIDITES MINUTUM Sah & Jain, 1965

Pl. 1, fig. 8

Dimension — Diameter of the spore 17 μ .

Occurrence — Very rare.

Genus BACULATISPORITES Thomson & Pflug, 1953

Type-species — *Baculatisporites primarius* Thomson & Pflug, 1953.

cf. BACULATISPORITES COMAUMENSIS
(Cookson, 1953) Potonié, 1956

Pl. 2, fig. 12

Dimension — Diameter of the spore 65 to 73 μ .
Baculae 1,5 μ thick.

Occurrence — Rare.

Infra Turma MURORNATI Potonié & Kremp, 1954

Genus TIGRISPORITES (Klaus, 1960) Van Erve, 1977

Type-species — *Tigrisporites halleinis* Klaus, 1960.

TIGRISPORITES JONKERI Van Erve, 1977

Pl. 2, fig. 8

Dimension — Diameter of the spore 40 to 44 μ .

Occurrence — Rare.

Genus LEPTOLEPIDITES (Couper, 1953) Norris, 1968

Type-species — *Leptolepidites major* Couper, 1953.

LEPTOLEPIDITES ARGENTAEFORMIS
(Bolchovitina, 1953) Morbey, 1975

Pl. 1, figs. 16, 17

Dimension — Diameter of the spore 35 to 40 μ .

Occurrence — Rare.

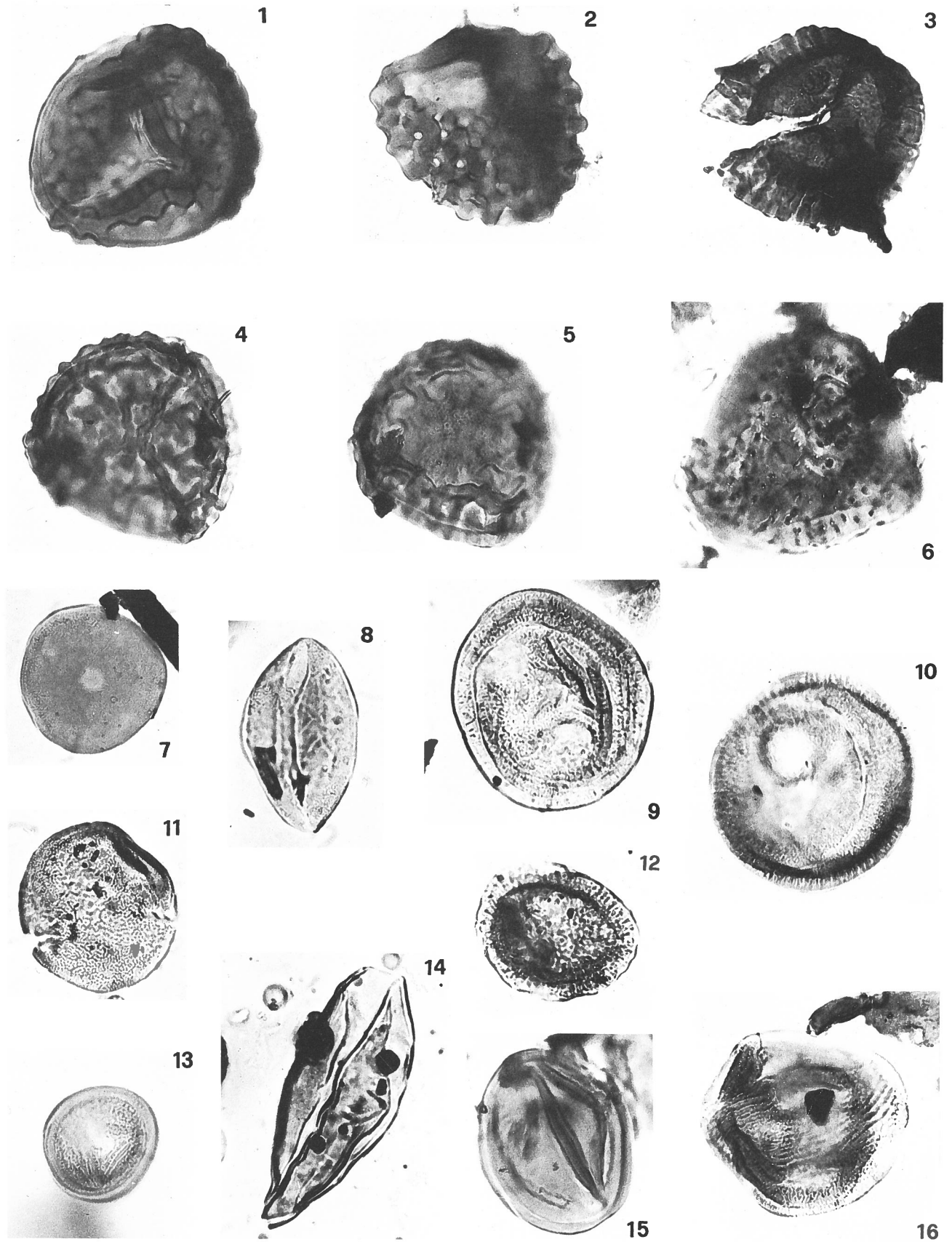
Genus NEORAISTRICKIA Potonié, 1956

Type-species — *Neoraistrickia truncata* (Couper, 1953). Potonié, 1956.

EXPLANATION OF PLATE 3

All illustrated specimens from Pala Asonis, sample 1731.

- Figs. 1, 2 - *Ischyosporites variegatus* (Couper) Schulz.
Fig. 3 - *Staplinisporites mathurii* (Srivastava) Filatoff.
Figs. 4, 5 - *Staplinisporites caminus* (Balme) Pocock.
Fig. 6 - *Sestrosporites pseudoalveolatus* (Couper) Dettmann.
Fig. 7 - *Exesipollenites tumulus* Balme.
Fig. 8 - *Monosulcites minimus* Cookson.
Figs. 9, 10, 12, 16 - *Corollina torosus* (Reissinger) Klaus.
Fig. 11 - *Exesipollenites scabratus* (Couper) Pocock.
Fig. 13 - *Corollina minor* (Pocock & Jansonius) Cornet & Traverse.
Fig. 14 - *Cycadopites follicularis* Wilson & Webster.
Fig. 15 - *Eucommiidites troedssonii* Erdtman.
Magnification $\times 975$.



NEORAISTRICKIA GRISTHORENSIS
(Couper, 1958) Tralau, 1968

Pl. 2, fig. 6

Dimension — Diameter of the spore 32 to 37 μ .

Occurrence — Rare. Also present in the Bajocian-Bathonian of Nurra, NW Sardinia (Ashraf *et al.*, 1984).

NEORAISTRICKIA sp. cf. NEORAISTRICKIA sp. A
Filatoff, 1975

Pl. 2, fig. 3

Dimension — Diameter of the spore 26 μ .

Occurrence — Very rare.

Genus CERATOSPORITES Cookson & Dettmann, 1958
Type-species — *Ceratospores equalis* Cookson & Dettmann, 1958.

CERATOSPORITES ROTUNDIFORMIS
(Kara-Murza, 1961) Pocock, 1970

Pl. 2, fig. 7

Dimension — Diameter of the spore 28 μ .

Occurrence — Rare.

Genus LYCOPODIACIDITES Couper, 1953

Types-species — *Lycopodiacidites bullerensis* Couper, 1953.

LYCOPODIACIDITES RUGULATUS
(Couper, 1953) Schulz, 1967

Pl. 2, fig. 2

Dimension — Diameter of the spore 45 to 53 μ .

Occurrence — Rather frequent. Also present in the Bajocian-Bathonian of Nurra, NW Sardinia (Ashraf *et al.*, 1984).

Genus ISCHYOSPORITES Balme, 1957

Type-species — *Ischyosporites crateris* Balme, 1957.

ISCHYOSPORITES VARIEGATUS
(Couper, 1958) Schulz, 1967

Pl. 3, figs. 1, 2

Dimension — Diameter of the spore 58 to 65 μ .

Occurrence — Abundant. Also present in the Bajocian-Bathonian of Nurra, NW Sardinia (Ashraf *et al.*, 1984).

Genus STAPLINISPORITES Pocock, 1962

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

STAPLINISPORITES CAMINUS
(Balme, 1957) Pocock, 1962

Pl. 3, figs. 4, 5

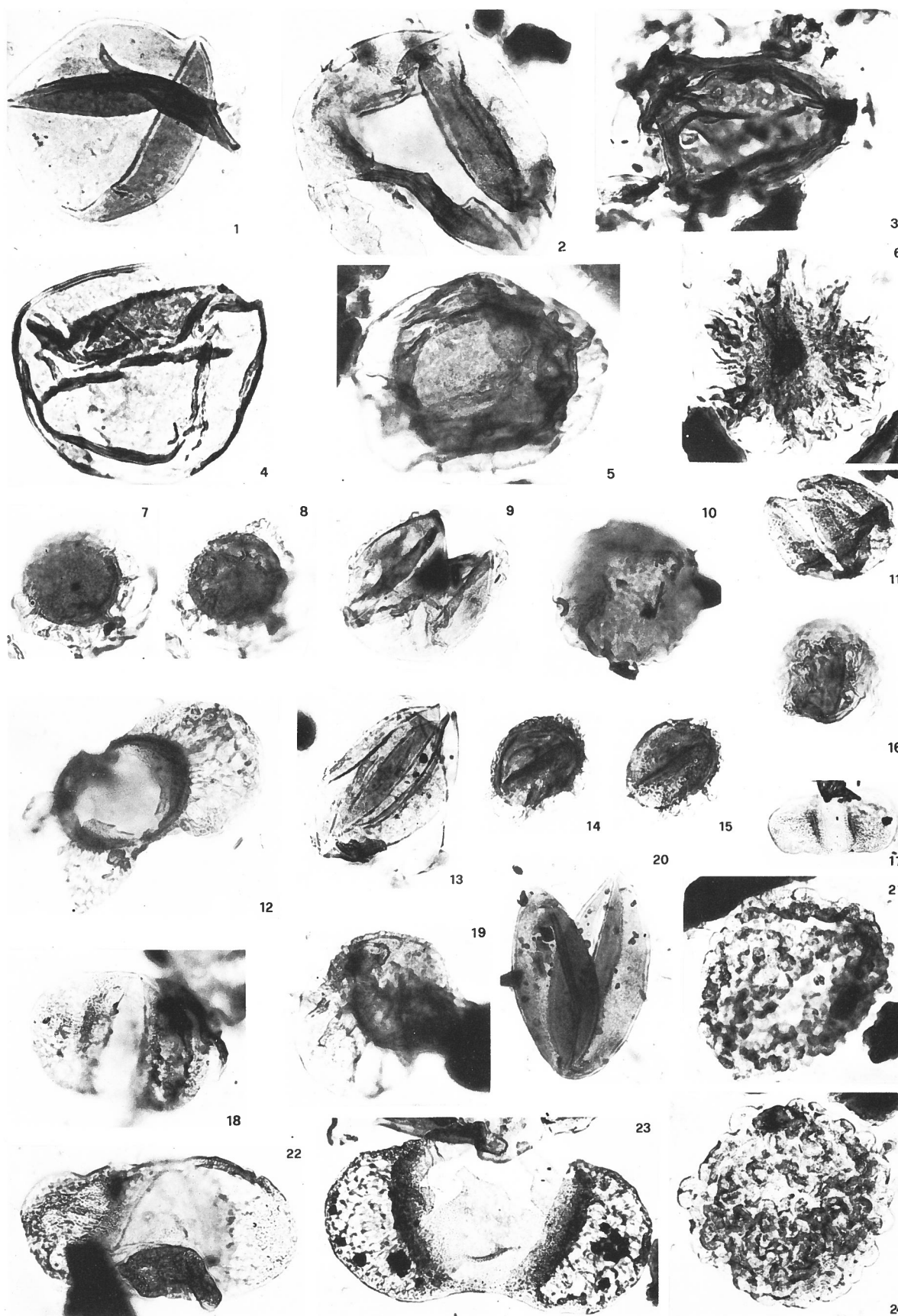
Dimension — Diameter of the spore 32 to 47 μ .

EXPLANATION OF PLATE 4

All illustrated specimens from Pala Asonis, sample 1731.

- Figs. 1, 2 - *Araucariacites australis* Cookson.
- Fig. 3 - *Callialasporites trilobatus* (Balme) Suk Dev.
- Fig. 4 - *Inaperturopollenites turbatus* Balme.
- Figs. 5, 6 - *Callialasporites dampieri* (Balme) Suk Dev.
- Figs. 7, 8, 14, 15 - *Callialasporites minus* (Tralau) Guy.
- Figs. 9, 13, 20 - *Perinopollenites pseudosulcatus* Briche, Danzé Corsin & Laveine.
- Fig. 10 - *Callialasporites microvelatus* Schulz.
- Fig. 11 - *Araucariacites fissus* Reiser & Williams.
- Fig. 12 - *Platisaccus papilionis* Potonié & Klaus.
- Fig. 16 - *Perinopollenites elatoides* Couper.
- Fig. 17 - *Vitreisporites pallidus* (Reissinger) Nilsson.
- Fig. 18 - *Alisporites thomasi* (Couper) Pocock.
- Fig. 19 - *Podocarpidites* cf. *verrucosus* Volkheimer.
- Figs. 21, 24 - *Cerebropollenites macroverrucosus* (Thiergart) Schulz.
- Fig. 22 - *Podocarpidites multicus* (Bolchovitina) Pocock.
- Fig. 23 - *Podocarpidites ellipticus* Cookson.

Magnification $\times 660$.



Occurrence — Frequent. Also present in the Bajocian-Bathonian of Nurra, NW Sardinia (Ashraf *et al.*, 1984) and of Ogliastra, E Sardinia (Salaré Cheboldaëff in Dieni *et al.*, 1983).

STAPLINISPORITES MATHURII
(Srivastava, 1966) Filatoff, 1975

Pl. 3, fig. 3

Dimension — Diameter of the spore 38 to 42 μ .

Occurrence — Frequent.

Sub Turma ZONOTRILETES Waltz, 1935
Infra Turma AURICOLATI Schopf, 1938 emend.
Dettmann, 1963

Genus MATONISPORITES Couper, 1958
Type-species — *Matonisorites phlebopteroides*
Couper, 1958.

MATONISPORITES PHLEBOTEROIDES Couper, 1958
Pl. 2, fig. 1

Dimension — Diameter of the spore 45 to 60 μ .

Occurrence — Frequent.

Infra Turma TRICRASSATI Dettmann, 1963

Genus SKARBYSPORITES Van Erve, 1977
Type-species — *Skarbysporites elsendoornii* Van
Erve, 1977.

SKARBYSPORITES sp.

Pl. 1, fig. 6

Dimension — Diameter of the spore 40 μ .

Occurrence — Rare.

Infra Turma CINGULATI Potonié & Klaus, 1954

Genus DENSOISPORITES
(Weiland & Krieger, 1953) Dettmann, 1963

Type-species — *Densoisorites velatus* Weiland &
Krieger, 1953.

DENSOISPORITES VELATUS
Weiland & Krieger, 1953

Pl. 2, fig. 5

Dimension — Diameter of the spore 45 μ .

Occurrence — Rare. Also present in the Bajocian-Bathonian of Nurra, NW Sardinia (Ashraf *et al.*, 1984) and of Ogliastra, E Sardinia (Salaré Cheboldaëff in Dieni *et al.*, 1983).

Genus SESTROSPORITES Dettmann, 1963
Type-species — *Sestrosporites (Foveotriteles) irregularatus* Couper, 1958.

SESTROSPORITES PSEUDOALVEOLATUS
(Couper, 1958) Dettmann, 1963

Pl. 3, fig. 6

Dimension — Diameter of the spore 50 μ .

Occurrence — Rare. Also present in the Bajocian-Bathonian of Nurra, NW Sardinia (Ashraf *et al.*, 1984), of Ogliastra, E Sardinia (Salaré Cheboldaëff in Dieni *et al.*, 1983), and of Jerzu (Schneider, 1978).

Turma MONOLETES Ibrahim, 1933
Sub Turma AZONOMONOLETES Lubert, 1935
Infra Turma SCULPATATOMONOLETI
Dybova & Jachowicz, 1957

Genus MARATTISPORITES Couper, 1958
Type-species — *Marattisorites scabratus* Couper,
1958.

MARATTISPORITES SCABRATUS Couper, 1958
Pl. 2, fig. 9

Dimension — Diameter of the spore 30 x 22 μ .

Occurrence — Abundant.

Infra Turma LAEVIGATOMONOLETI
Dybova & Jachowicz, 1957

Genus LAEVIGATOSPORITES Ibrahim, 1933
Type-species — *Laevigatosporites vulgaris* Ibrahim,
1933.

LAEVIGATOSPORITES OVATUS
Wilson & Webster, 1946

Pl. 1, fig. 15

Dimension — Length of the pollen 30 to 38 μ ,
breadth 30 to 33 μ .

Occurrence — Very frequent. Also present in the Bajocian-Bathonian of Nurra, NW Sardinia (Ashraf *et al.*, 1984).

Spore sp. a

Pl. 2, figs. 4, 10

Description (based on one broken specimen) — Azonotriletes (?) spore of subcircular amb. The (?) distal surface bears high ornamental structures consisting of coni or baculae with tapering or pilate tips of variable shape. Their base is generally evasate and their top is curved and pimpled; rarely some bi-horned elements may be observed. The height of these elements is 10 to 15 μ . The elements are spaced from 3 to 8 μ on the exoesinal surface. The base, not bulbous, is 4 or 5 μ wide. On the (?) proximal surface and also in the subequatorial circular strip of the distal hemisphere, the ornamental structures are of smaller sizes, more crowded and of different type: they may be baculae with pointed terminations or stout spines. Their medium height is 5 μ .

The exoesine is thick (about 3 μ) and, apparently, unilayered; the surface is chagrenate or scabrate.

Dimension — Presumed diameter of the spore 70 μ .

Remarks — The double ornamentation pattern is common to several spore genera, but only two of them have similar elements: *Porcellispora sensu* Scheuring, 1970 and *Carnisporites* Madler, 1964.

Both genera have larger elements on the distal surface and very reduced ones on the proximal one. *Carnisporites* has larger elements on the distal and partly on the proximal surface, while the Spore sp. a has larger element over a reduced area of the distal surface.

Of particular interest are the specimens figured by Van Erve (1977) of *Porcellispora longdonensis* recorded from the Noriglio Grey Limestone Formation of Italian Alps. They are very similar to spore sp. a, even in the sizes of the ornamental elements, which are higher than those described by Scheuring for the type-species. *Porcellispora longdonensis* is a Middle and Late Triassic element and Van Erve's younger finding in Late Pleinsbachian- Early Toarcian sediments is unique. Probably, considering the great variation shown in the ornamentations, a new Jurassic species related to *Porcellispora longdonensis* might be established.

The specimen of *Porcellispora longdonensis* figured by Pantic and Felber (1983) from the Bajocian of Switzerland is different in the elements from Van Erve's species.

Occurrence — Very rare.

Ante Turma POLLENITES H. Potonié, 1931
Turma SACCITES Erdtman 1947
Sub Turma MONOSACCITES (Chitaley, 1951)
Potonié & Kremp, 1954
Infra Turma ALETESACCITES Leschik, 1955

Genus CEREROPOLLENITES Nilsson, 1958
Type-species — *Pollenites macroverrucosus* Thiergart, 1949.

CEREROPOLLENITES MACROVERRUCOSUS
(Thiergart, 1949) Schulz, 1967

Pl. 4, figs. 21, 24

Dimension — Diameter of the pollen 55 to 60 μ .

Occurrence — Very frequent. Also present in the Bajocian-Bathonian of Ogliastro, E Sardinia (Salard Cheboldaëff in Dieni *et al.*, 1983) and of Nurra, NW Sardinia (Ashraf *et al.*, 1984).

Sub Turma DISACCITES Cookson, 1947
Infra Turma DISACCIATRILETI
(Leschik, 1955) Potonié, 1958

Genus PODOCARPIDITES
(Cookson, 1947) Potonié & Kremp, 1958
Type-species — *Podocarpidites ellipticus* Cookson, 1947.

PODOCARPIDITES ELLIPTICUS Cookson, 1947
P. 4, fig. 23

Dimension — Total breadth 85 μ , corpus breadth 50 μ , corpus height 50 μ .

Occurrence — Rare.

PODOCARPIDITES MULTICINUS
(Bolchovitina, 1956) Pocock, 1970

Pl. 4, fig. 22

Dimension — Total breadth 78 μ , corpus breadth 38 μ , corpus height 42 μ , saccus height 40 μ .

Occurrence — Rare.

PODOCARPIDITES cf. VERRUCOSUS
Volkheimer, 1972

Pl. 4, fig. 19

Dimension — Total breadth 70 μ , corpus breadth 30 μ , corpus height 40 μ , saccus height 45 μ .

Occurrence — Rare.

Genus ALISPORITES Daugherty, 1941 emend.

Nilsson 1958

Type-species — *Alisporites opii* Daugherty, 1941.

ALISPORITES GRANDIS (Cookson, 1947)

Dettmann, 1963

Dimension — Total breadth 95 μ , corpus breadth 53 μ , corpus height 64 μ .

Occurrence — Rare.

ALISPORITES THOMASII (Couper, 1958) Pocock, 1962

Pl. 4, fig. 18

Dimension — Total breadth 55 to 70 μ , corpus height 40 μ .

Occurrence — Frequent.

Genus PLATISACCUS Naumova, 1937

ex Potonié & Klaus, 1954

Type-species — *Platisaccus papilionis* Potonié & Klaus, 1954.

PLATISACCUS PAPILIONIS Potonié & Klaus, 1954

Pl. 4, fig. 12

Dimension — Total breadth 80 μ , saccus breadth 32 μ , corpus breadth 40 μ , corpus height 32 μ , saccus height 40 μ .

Occurrence — Rare.

Infra Turma DISACCITRILETI Leschik, 1955

Genus VITREISPORITES Leschik, 1955

Type-species — *Vitreisporites signatus* Leschik, 1955.

VITREISPORITES PALLIDUS (Reissinger, 1950)

Nilsson, 1958

Pl. 4, fig. 17

Dimension — Total breadth 26 to 36 μ , corpus breadth 10 to 15 μ , corpus height 20 μ .

Occurrence — Very frequent. Also present in the Bajocian-Bathonian of Ogliastro, E Sardinia (Schneider, 1978; Salar Cheboldaef in Dieni *et al.*, 1983).

Turma ALETES Ibrahim, 1933

Sub Turma AZONALETES (Luber, 1935)

Potonié & Kremp, 1954

Infra Turma GRANULONAPITI Cookson, 1947

Genus ARAUCARIACITES Cookson, 1947

Type-species — *Araucariacites australis* Cookson, 1947.

ARAUCARIACITES AUSTRALIS Cookson, 1947

Pl. 4, figs. 1, 2

Dimension — Total diameter of the pollen 60 to 125 μ .

Occurrence — Very frequent.

ARAUCARIACITES FISSUS

Reiser & Williams, 1964

Pl. 4, fig. 11

Dimension — Total diameter of the pollen 38 to 45 μ .

Occurrence — Very frequent.

Infra Turma PSILONAPITI Erdtman, 1947

Genus INAPERTUROPOLLENITES

Thomson & Pflug, 1953

Type-species — *Inaperturopollenites dubius* Thomson & Pflug, 1953.

INAPERTUROPOLLENITES TURBATUS Balme, 1957

Pl. 4, fig. 4

Dimension — Total diameter of the pollen 50 to 70 μ .

Occurrence — Very frequent.

Remarks — Manum's (1962) concept of *Inaperturopollenites* is here followed and *Laricoidites* is considered a junior synonym of it.

Turma POLYPLICATES Cookson, 1947

Genus MONOSULCITES Cookson, 1947

ex Couper, 1953

Lectogenotype *Monosulcites minimus* Cookson, 1947

MONOSULCITES MINIMUS Cookson, 1947

Pl. 3, fig. 8

Dimension — Length of the pollen 42 μ , breadth 20 μ .

Occurrence — Very frequent. Also present in the Bajocian-Bathonian of Ogliastra, E Sardinia (Salard Cheboldaëff in Dieni *et al.*, 1983).

Sub Turma INTORTES (Naumova, 1937)
Potonié, 1958

Genus CYCADOPITES (Wodehouse, 1933)
ex Wilson & Webster, 1946

Type-species — *Cycadopites follicularis* Wilson & Webster, 1946.

CYCADOPITES FOLLICULARIS
Wilson & Webster, 1946

Pl. 3, fig. 14

Dimension — Length of the pollen 42 μ , breadth 20 μ .

Occurrence — Frequent.

Turma PRAECOLPATES Potonié & Kremp, 1954

Genus EUCOMMIDITES Erdtman, 1948

Type-species — *Eucommiidites troedssonii* Erdtman, 1948.

EUCOMMIDITES TROEDSSONII Erdtman, 1948

Pl. 3, fig. 15

Dimension — Length of the pollen 35 μ , breadth 25 μ .

Occurrence — Frequent. Also present in the Bajocian-Bathonian of Ogliastra, E Sardinia (Salard Cheboldaëff in Dieni *et al.*, 1983).

Turma POROSSES (Naumova, 1937-1939)
Potonié 1960

Sub Turma MONOPORINES Naumova 1937 - 1939
Infra Turma MONOPORINA Naumova 1939

Genus PERINOPOLLENITES Couper, 1958

Type-species — *Perinopollenites elatoides* Couper, 1958.

PERINOPOLLENITES ELATOIDES Couper, 1958

Pl. 4, fig. 16

Dimension — Total diameter of the corpus 35 to 45 μ , saccus 5 to 7 μ .

Occurrence — Very frequent.

Remarks — As already observed by Briche *et al.* (1963), by Lund (1977) and by Achilles (1981 and 1984), any pore on the proximal or distal face was observed even in the Pala Asonis material.

PERINOPOLLENITES PSEUDOSULCATUS
Briche, Danzé Corsin & Laveine, 1963

Pl. 4, figs. 9, 13, 20

Dimension — Corpus total diameter 40 to 70 μ , saccus 5 to 8 μ .

Occurrence — Very frequent.

Infra Turma CIRCUMPOLLINI
(Pflug, 1953) Pocock & Jansonius, 1961

Genus COROLLINA Malyavkina, 1949
emend. Cornet & Traverse, 1975

Type-species — *Corollina compacta* Malyavkina, 1949.

COROLLINA TOROSUS
(Reissinger, 1950) Klaus, 1960

Pl. 3, figs. 9, 10, 12, 16

Dimension — Total diameter of the pollen 28 to 40 μ .

Occurrence — Very frequent. Also present in the Bajocian-Bathonian of Ogliastra, E Sardinia (Schneider, 1978) and of Nurra, NW Sardinia (Ashraf *et al.*, 1984) as *Classopollis torosus*.

COROLLINA MINOR (Pocock & Jansonius, 1961)
Cornet & Traverse, 1975

Pl. 3, fig. 13

Dimension — Total diameter of the pollen 22 μ .

Occurrence — Rare.

Genus EXESIPOLLENITES Balme, 1957

Type-species — *Exesipollenites tumulus* Balme, 1957.

EXESIPOLLENITES TUMULUS Balme, 1957

Pl. 3, fig. 7

Dimension — Total diameter of the pollen 26 to 30 μ , pseudopore 3 to 6 μ .

Occurrence — Very frequent.

EXESIPOLLENITES SCABRATUS (Couper, 1958)

Pocock, 1970

Pl. 3, fig. 11

Dimension — Total diameter of the pollen 30 to 35 μ .

Occurrence — Very frequent.

Sub Turma POLISACCITES Cookson, 1961

Genus CALLIALASPORITES Suk Dev, 1961

Type-Species — *Callialasporites trilobatus* (Balme, 1957) Suk Dev, 1961.

CALLIALASPORITES DAMPIERI

(Balme, 1957) Suk Dev, 1961

Pl. 4, figs. 5, 6

Dimension — Total diameter 60 to 75 μ , ratio of the corpus to total diameter 1/2 to 1/4.

Occurrence — Very frequent.

CALLIALASPORITES MINUS

(Tralau 1968) Guy, 1971

Pl. 4, figs. 7, 8, 14, 15

Dimension — Total diameter of the pollen 30 to 40 μ , ratio of the corpus to total diameter 3/4.

Occurrence — Very frequent.

CALLIALASPORITES TRILOBATUS

(Balme, 1957) Suk Dev, 1961

Pl. 4, fig. 3

Dimension — Total diameter of the pollen 70 μ , ratio of the corpus to total diameter 2/3.

Occurrence — Rare. Also present in the Bajocian-Bathonian of Ogliastro, E Sardinia (Salaré Cheboldaeff, in Dieni *et al.*, 1983).

CALLIALASPORITES MICROVELATUS Schulz, 1966

Pl. 4, fig. 10

Dimension — Total diameter of the pollen 45 μ , ratio of the corpus to total diameter 7/8.

Occurrence — Rare.

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