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The age of the Dinaride Ophiolite Belt – derived olistostrome mélange at the northern slope of Moračka Kapa (Montenegro)

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Abstract. This paper presents the first results of a palynological investigation of the Dinaride Ophiolite Belt – derived olistostrome mélange at the northern slope of Moračka Kapa (Montenegro). The analysis of microfloral association provided a reconstruction of the Late Jurassic sedimentation conditions and depositional environment in the Morača Kapa Unit. The samples (8) collected from the different parts of ophiolite matrix yielded palynomorph assemblages (fossil spores, pollen grains and dinoflagellates) of the Upper Jurassic age. The uppermost part of the ophiolite suite on the presented palynomorphs could also indicate the lowermost Lower Cretaceous. These palynological results provide a very interesting framework of these widespread, but poorly stratigraphically understood sediments. The paleoecological results suggest humid and subtropical conditions in the hinterland.

Key words: palynomorphs, age, ophiolite mélange, Upper Jurassic, Moračka Kapa, Montenegro.

Апстракт: У раду се приказују први резултати палинолошких испитивања Динаридског офиолитског појаса на простору Морачке Капе (Црна Гора). Анализа микрофлористичке асоцијације омогућила је реконструкцију услова седиментације у горњој јури у јединици Морачка Капа. Узорци (8) потичу из различитих делова офиолитског меланжа садрже асоцијацију палиноморфи (фосилне споре, полен и динофлагелате) која указује на горњојурску старост. Највиши део офиолитског стуба на основу присутних палиноморфа могао би припадати и најнижим деловима доње креде. Судећи по карактеру микрофлоре може се закључити да је клима у време горње јуре била влажна и субтропска.

Кључне речи: палиноморфе, стратиграфија, офиолитски меланж, горња јура, Морачка Капа, Црна Гора.

Introduction

The Moračka Kapa Unit is located between the Mesozoic cover overlying the Adria-derived Dalmatian-Herzegovinian composite terrane and the East Bosnian–Durmitor terrane which continues towards the southeast to the Korab terrane. It is composed of fragments to blocks (up to few decameters is size) of limestones, sandstones, basalts and serpentinites, all set in a shaly and marly matrix. It is very similar to the Jurassic olistostrome mélange of the Dinaride Ophiolite Belt, formerly named the Diabase-chert formation. The Moračka Kapa unit represents an isolated part of the detrial subduction trench assemblage of the western margin of the Dinaride Ophiolite Belt (Karamata *et al.* 2010).

The purpose of this study is to present the microfloral characteristics of the Upper Jurassic sediments (ophiolite mélange) with special emphasis on their stratigraphic position, correlation with other similar palynological assemblages in Serbia and aboard and their geodinamic implications.

The Moračka Kapa Unit was first mentioned by Kalezić *et al.* (1966). Given that the position of the unit is absolutely strange in this surrounding, its geological properties and stratigraphic position deserve a special our attention. All the field work, petrographical investigation of selected samples, paleontological investigation and trace element analysis were coordinated by S. Karamata.

Experimental

Samples

The palynological studies (spores, pollen grains and dinoflagellates) were performed on 8 representative samples collected from an outcorp in the Mora-

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ča Kapa ophiolite mélange in the valley of the Morača River (Dragovića Polje, Velje Duboko, Montenegro; Fig. 1). The samples from the matrix in Morača ophiolite mélange were collected during earlier field works by S. KARAMATA and M. PAJOVIĆ, who studied these localities in great petrological and geological detail. Figure 1 shows the location of the exposed surface, which was discovered at Dragovići Polje and the position of the investigated samples.

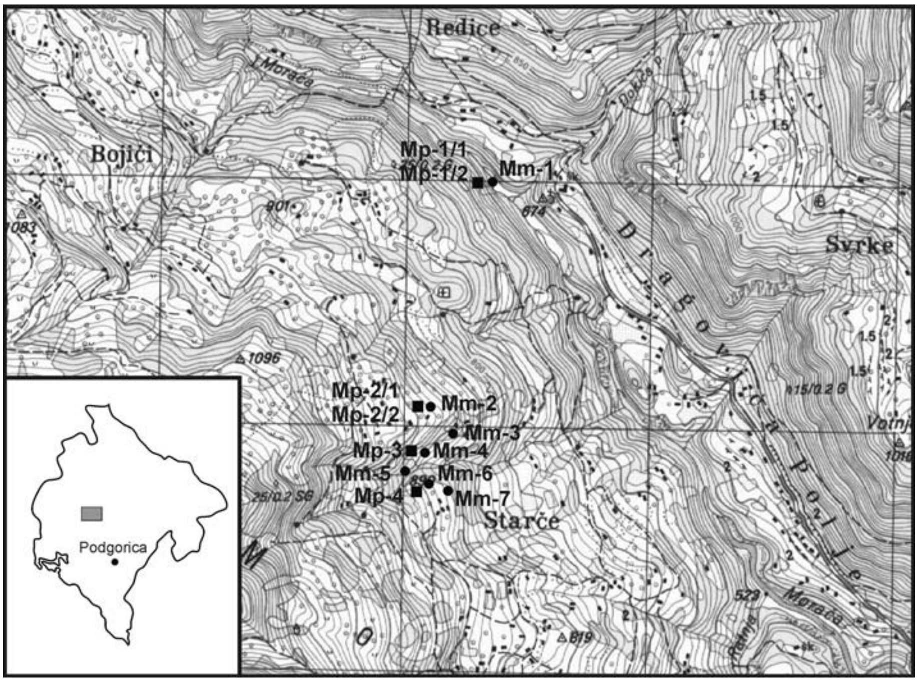

Fig. 1. The geographical position of the sampling points at Dragovići Polje.

Palynological investigations are performed on the samples that were taken from the sequences without any other microfossils. Due to the lack of ammonites and other macro-fossils, stratigraphic control was not possible for the investigated succession.

Details of the samples labeled with the numbers are as follows: 2347 (Mm-1: Morača, elevation 674, x–4 747 995, y – 6 607 355); 2348 (Mm-2: Starče, north from the elevation 890, x – 4 746 975, 6 607 180); 2349 (Mm-3: Starče, north from the elevation 890, x – 4 746 975, y – 6 607 180); 2350 (Mm-4: Starče, north from the elevation 890; x – 4 746 895, y – 6 607 095); 2351 (Mm-5: Starče, north from the elevation 890, x – 4 746 800, y – 6 607 030); 2352 (Mm-6: Starče, south from the elevation 890, x – 4 746 760, y – 6 607 130) and 2353 (Mm-7: Starče, south from the elevation 890; x – 4 746 750, y – 6 607 185, Fig. 1).

It also should be mentioned that samples for petrologic investigations, labeled as: Mp-1/1, Mp-1/2, Mp-2/1, Mp-2/2, Mp-3 and Mp-4, originated ftom the same localities. They are composed of fragments to blocks of limestones, cherts sandstones, basalts and serpentinites, all set in a shaly and matrix (KARAMATA *et al.* 2010).

Methods and aims

About 200 grams of each sample were taken for maceration. Palynomorphs were observed on isolated kerogen concentrates from different rock samples. The samples were initially treated with the classical 30 % HCL (removal of carbonate) and later with 40 % HF (3–5 days) to remove siliceous matter. Subsequently, the material was washed and submitted to separation ($ZnCl_2$; d = 1.9–2.0 g/cm^3). Occasionally, the separated kerogen concentrate was also treated to conditional acetolysis and oxidation for about three days ($NaCl+HNO_3$; $KClO_3+HNO_3$; the staining efect on exines; ERCEGOVAC, 1996). Afterwards the material was again subjected to repeated washing to remove all traces of the acids. The macerated detritus was finally treated with 10 % KOH to dissolve the humic substances and clear the palynomorphs.

Some of the most significant and well preserved palynomorphs are illustrated on the Plates I–III. The prepared slides and the original rock samples are kept in the Palynological Laboratory of the Faculty of Mining and Geology, Belgrade.

Systematic palynology and biostratigraphic character of the palynomorph association

Spores, gymnosperm pollen grain and dinoflagellate types identified in the Upper Jurassic (Kimmeridgian; the Lowermost Cretaceous is not excluded) Morača ophiolite mélange (Fig. 1) are listed below. The spores and pollen grains reported in the present paper were treated under the morphographic system of R. POTONIÉ (1956, 1958, 1960).

Anteturma SPORITES H. POTONIÉ, 1893
Turma TRILETES (REINSCH) DETTMANN, 1963
Subturma AZONOTRILETES (LUBER) DETTMANN, 1963
Infraturma LAEVIGATI (BENNIE & KIDSTON) R. POTONIÉ, 1956
Genus *Cyathidites* COUPER, 1953
Cyathidites australis COUPER, 1953 (Pl. 1, Fig. 1)
Cyathidites minor COUPER, 1953 (Pl. 1, Fig. 2)

Cyathidites cf. *mesozoicus* (Thiergarth) R. Potonié, 1956 (Pl. 1, Fig. 3)
Cythidites hausmanoides Couper, 1953 (Pl. 1, Fig. 12)
Genus *Todisporites* Couper, 1958
Todisporites minor Couper, 1958 (Pl. 1, Fig. 5)
Genus *Deltoidospora* (Miner) R. Potonié, 1956
Deltoidospora cf. *mesozoica* (Thiergart) Schurman, 1960 (Pl. 1, Fig. 4)
Genus *Biretisporites* Delcourt, Dettmann and Hughes, 1963
Biretisporites potoniaei Delcourt and Sprumont, 1955 (Pl. 1, Fig. 23)

Infraturma APICULATI (Bennie & Kidston) R. Potonié, 1956

Genus *Osmundacidites* Couper, 1953
Osmundacidites cf. *wellmanii* Couper, 1953 (Pl. 1, Fig. 6)
Osmundacidites parvus de Jersey, 1965 (Pl. 1, Fig. 24)
Genus *Acanthotriletes* (Naumova) R. Potonié and Kremp, 1955
Acanthotriletes cf. *varrispinosus* Pocock, 1962 (Pl. 1, Fig. 22)
Genus *Neoraistrickia* R. Potonié, 1956
Neoraistrickia cf. *taylorii* Playford and Dettmann, 1970 (Pl. I, Fig.19)
Neoraistrickia sp. (Pl. 1, Fig. 20)
Genus *Apiculatisporites* R. Potonié and Kremp, 1956
Apiculatisporites cf. *parvispinosus* (Leschik) E. Schulz, 1963 (Pl. 1, Fig. 18)

Infraturma MURORNATI R. Potonié and Kremp, 1954

Genus *Lycopodiumsporites* (Thiergart) Delcourt and Sprumont, 1955
Lycopodiumsporites cf. *gristhorpensis* Couper, 1958 (Pl. 1, Fig. 19)
Lycopodiumsporites cf. *clavatoides* Couper, 1958 (Pl. 1, Fig. 21)

Turma ZONALES (Bennie and Kidston) R. Potonié, 1956
Subturma AURITOTRILETES R. Potonié and Krutzch, 1954
Infraturma AURICULATI (Schopf) Dettmann, 1963

Genus *Trilites* (Cookson) Couper, 1953
Trilites cf. *distalgranulatus* Couper, 1958 (Pl. 1, Fig. 13)
Trilites cf. *verrucatus* Couper, 1958 (Pl. 1, Fig. 14)
Genus *Leptolepidites* Couper, 1953
Leptolepidites verrucatus Couper, 1958 (Pl. 1, Fig. 8)
Leptolepidites sp. (Pl. 1, Fig. 7)
Genus *Ischyosporites* Balme, 1957
Ischyosporites sp. (Pl. 1, Figs. 9, 10, 11)
Ischyosporites cf. *variegatus* (Couper) Schulz, 1967 (Pl. 1, Fig. 26)

Subturma ZONOTRILETES Waltz, 1935
Infraturma CINGULATI (R. Potonié and Klaus) Dettmann, 1963

Genus *Cingutriletes* Pierce, 1961
Cingutriletes sp. (*Pagyophyllum* cf. *connivens* Kendall, 1952 (Pl. 1, Fig. 25)
Genus *Cingulatisporites* (Thomson) R. Potonié, 1956
Cingulatisporites cf. *rigidus* Couper, 1958 (Pl. 1, Fig. 17)
Genus *Staplinisporites* Couper, 1953
Staplinisporites cf. *pocookii* Couper, 1953 (Pl. 1, Fig. 16)

Infraturma TRICRASSATI Dettmann 1963

Genus *Gleicheniidites* (Ross) Delcourt and Sprumont, 1955
Gleicheniidites cf. *senonicus* Ross, 1949 (Pl. 1, Fig. 15)
Gleicheniidites cercinidites (Cookson) Dettmann, 1963

Anteturma POLLENITES R. Potonié, 1931
Turma SACCITES Erdtman, 1947
Subturma MONOSACCITES (Chtaley) R. Potonié and Kremp, 1954
Infraturma SACCIZONATI Bhardwaj, 1957

Genus *Callialasporites* (Sukh Dev) R. Potonié, 1966
Callialasporites dampieri (Balme) Sukh Dev, 1961 (Pl. 2, Fig. 5)
Callialasporites cf. *trilobatus* (Balme) Sukh Dev, 1961 (Pl. 2, Fig. 6)

Subturma DISACCITES Cookson, 1947

Genus *Vitreisporites* Leschik, 1955
Vitreisporites cf. *pallidus* (Reissinger) Nilsson, 1958 (Pl. 2, Fig. 7)
Genus *Alisporites* Daugherty, 1941
Alisporites cf. *grandis* (Cookson) Dettmann, 1963 (Pl. 2, Fig. 1)
Genus *Abietinaepollenites* R. Potonié, 1951
Abietinaepollenites microalatus R. Pot., 1958 (Pl. 2, Fig. 2)
Genus *Podocarpidites* (Cookson) R. Potonié, 1958
Podocarpidites cf. *biformis* Rouse, 1954 (Pl. 2, Fig. 4)

Turma ALETES IBRAHIM, 1933
Subturma AZONOLETES (LUBER) R. POTONIÉ and KREMP, 1954
Infraturma GRANULONAPITI COOKSON, 1947

Genus *Araucariacites* (COOKSON) COUPER, 1953
Araucariacites australis COOKSON, 1947 (Pl. 2, Fig. 8)
Araucariacites sp. (Pl. 2, Fig. 9)
Genus *Sphaeripollenites* (COUPER) JANSONIUS, 1962
Sphaeripollenites subgranulatus COUPER, 1958 (Pl. 2, Fig. 13, 14)

Subturma ZONALETES LUBER, 1935

Genus *Perinopollenites* COUPER, 1958
Perinopollenites elatoides COUPER, 1958 (Pl. 2, Fig. 12)

Turma PLICATES (NAUMOVA) R. POTONIÉ, 1958
Subturma PRAECOLPATES R. POTONIÉ and KREMP, 1954

Genus *Eucommiidites* (ERDTMAN) HUGHES, 1961
Eucommiidites cf. *troedssonii* ERDTMAN, 1948 (Pl. 2, Fig. 10)

Subturma MONOCOLPATES IVERSEN and TROALS-SMITH, 1950

Genus *Gingocycadophytus* (SAMOILOVITCH) DE JERSEY, 1962
Gyngocycadophytus sp. (Pl. 2, Fig.19)
Genus *Cycadopites* (WODEHOUSE) WILSON and WEBSTER, 1946
Cycadopites sp. (Pl. 2, Fig. 20)
Genus *Monosulcites* (COOKSON) COUPER, 1953
Monosulcites cf. *minimus* COOKSON, 1947 (Pl. 2, Fig. 18)

Turma POROSES (NAUMOVA) R. POTONIÉ, 1960
Subturma MONOPORINES NAUMOVA, 1939

Genus *Classopollenites* (PFLUG) POCOCK and JANSONIUS, 1961
Classopollenites cf. *classoides* (PFLUG) POCOCK and JANSONIUS, 1961 (Pl. 2, Fig. 10)

DINOFLAGELLATEAE
Division PIRRHOPHYTA PASCHER, 1914
Class DINOPHYCEAE FRITSCH, 1929
Order PERIDINIALES HAECKEL, 1894
Genus *Escharisphaeridia* ERKMEN and SARJEANT, 1980
?*Escharisphaerida* sp. (Pl. 3, Fig. 5)
Genus *Pareodinia* (DEFLANDRE) STOVER and EVITT, 1978
Pareodinia ceratophora var. *pachyceras* (DEFLANDRE) GOCHT, 1970 (Pl. 3, Fig. 2)
Pareodinia cf. *arctica* WIGGINS, 1975 (Pl. 3, Fig. 4)
?*Pareodinia* cf. *imbatodinesis* VOZHENNIKOVA, 1967 (Pl. 3, Fig. 14)
Genus *Apteodinium* EISENACK, 1958
Apteodinium sp. (Pl. 3, Fig. 3)
Genus *Lepdodinium* (KLEMENT) STOVER and EVITT, 1978
Leptodinium cf. *eumorphum* (COOKSON and EISENACK) SARJEANT, 1969 (Pl. 3, Fig. 8)
Genus *Nanoceratopsis* (DEFLANDRE) PIEL and EVITT, 1980
?*Nanoceratopsis* cf. *pelludica* (DEFLANDRE) EVITT, 1961 (Pl. 3, Fig. 9)
Genus *Indodinium* KUMAR, 1986
?*Indodinium* sp. (Pl. 3, Fig. 10)

INCERTAE SEDIS
Group ACRITARCHA EVITT, 1963
?*Epiplosphaera* sp. (Pl. 3, Fig. 7)
Tasmanites cf. *tardus* EISENACK, 1958 (Pl. 3, Fig. 15)
?Membranolimbus sp. (Pl. 3, Fig. 12)
Penetetrapiites cf. *mollis* HEDLUND and NORRIS, 1973 (Pl. 3, Fig. 13)
Acritarcha gen. et. sp. indet. (Pl. 3, Fig. 6)

Informal division: “PALYNOFORAMINIFERA“
Genus *Lagenammina* RHUMBLER, 1911
?Lagenammina sp. (Pl. 3, Fig. 11)

The palynomorph association from samples 2346, 2347, 2348, 2349 and 2353 are more or less similar in floral composition. They are presented as a integral assemblage of pteridophyte spores and conifer pollen, which was used for stratigraphic and paleoecological reconstructions. General characters of the presented palynomorph association can be described as follows:

Trilete pteridophytic spores of *Cyathidites australis, Deltoidospora minor, Trilites* cf. *verrucatus* and *Apiculatisporites* sp. are relative frequent in this association. The palynomorph assemblage of the Morača area is characterized by the abundant presence of the genus *Cyathidites*. These spores correspond to the plant species *Coniopteris*, or the families Cyatheaceae and Dicksoniaceae, which is a general characteristic of the Late Jurassic, partially of the Lowermost Cretaceous deposits in North America and Europe. The shallow depositional environment is characterized with dominant ferns (*Cyathidites, Ischyosporites, Deltoidospora*, etc.).

The species *Licopodiumsporites clavatoides* and other form with typical reticulum on the distal face is quite infrequent in the presented association. Its presence, however, has certain biostratigraphic importance. The common elements of the late Jurassic in this assemblage include *Ischyosporites variegatus*, *Perinopollenites elatoides* and *Leptolepidites verrucatus*.

The absence of typically Lower Cretaceous elements (*Trilobosporites*, *Appendicisporites*, *Cicatricosisporites, Schizosporis, Plicatella, Cooksonites* and others) in investigated samples is very characteristic. VAKHRAMEEV *et al.* (1973) believe that the transition from the Volgian (Tithonian) to the Berriasian (Lowermost Cretaceous) was characterized by the first occurrence of canaliculate spores of the type *Cicatricosisporites,* whereas in the Indo–European paleofloral province the genus *Appendicisporites* occurs in the Lower Cretaceous (Valanginian). The biostratigraphicaly significant presence of the Upper Jurassic taxa such as *Klukisporites*, *Callialasporites, Concavisporites, Perinopollenites* and *Araucariacites,* indicates to a Late Upper Jurassic, probably Kimmeridgian to Tithonian age for the Morača ophiolite mélange.

The coniferous miospores are represented by nonsaccate, monosacate and bisaccate elements viz., *Araucariacites*, *Classopollis*, *Callialasporites*, *Alisporites, Abietinaepollenites*, *Vitreisporites* and *Podocarpidites.* A quantitative analysis the forms of the microflora from the integral palynological association showed the different frequencies of the various taxa. It was concluded that *A*raucariaceae, Podocarpaceae and Calliala grains among the Gymnosperms, and Cyatheaceae, Gleicheniaceae, Lycopodiaceae and Osmundaceae among the Pteridophytes represent the most important families of the Morača microfloral assemblage. A vegetation of dominating conifers from the family Araucariaceae and Classopollis *group* existed in the land habitatus in the prominent places on islands, under a then warm climate. The species *Callialasporites dampieri* is a representative element for the middle–upper part of the Mesozoic in Europe, North America, Australia, China and India.

This assemblage is also characterized by gymnospermous pollen grain among which are the forms with two sacci, such as *Quadraeculina, Abietinaepollenites, Podocarpidites,* etc. Of lower abundance are the pollen grains of the monosaccate coniferales, such as *Araucariacites*, *Callialasporites*, *Classopollenites*, etc. In addition, there are some monosaccate coniferales, such as *Cerebropollenites*, together with a few monocolpate pollen grains of *Ginkgocycadophytus nittidus*.

The species *Eucommidites troedsonii* has been also recorded from the Morača assemblages, as a characteristic species of the young Mesozoic of the North Hemisphere; *Araucariacites australis* is distributed in the Upper Jurassic and Early Cretaceous in China, in limited numbers, but it is a characteristic species occurring in great abundance in the Middle Jurassic of England, Sweden and some others countries in Northwest Europe.

The Upper Jurassic (mostly Tithonian) in most of the localities over the world contain dinoflagellates (*Gonyaulax, Pareodinia, Apteodinium*, etc.; BERGER 1986; DAVEY 1982) and specific plankton remains (Acritarcha and *Incertae sedis*). The spore-pollen association of the Morača contain a low amount of marine microplankton. Late in the Tithonian, the phytoplankton content was much lower than in the Kimmeridgian, while spores and pollen grains of terrestrial plants are higher. The dynocyst assemblage reported the Upper Jurassic age of the investigated samples. The species *Gonyaulax jurassica* and *Pareodinia ceratophora* are scare in lowermost parts of the Lower Cretaceous Unit. The depositional environment is partially marked by the different plankton forms (Dinoflagellates, Acritarchs and Palynoforaminifers). The rare appearance of the low preserved genus *Sentusidinium* most probable point to the Upper Jurassic. On the whole the presence of the dynocyst assemblage predominantly reports the Upper Jurassic age of the investigated samples.

The microflora described from the ophiolite mélange of the Morača shows a remarkable analogies with the palynological assemblage of the bauxite deposits at Biočki Stan (north of Nikšićka Župa), which are located in the southern part of the Dinaric Carbonate Platform of Montenegro. The mentioned sedimentary rocks were formed during the Upper Jurassic–Lowermost Cretaceous (mainly late Kimmeridgian; ERCEGOVAC *et al.* 1996). The assemblages examinated near the Jurassic–Cretaceous boundary from the Biočki Stan are characterized by the following: *Gleicheniidites senonicus, Allisporites bilateralis, Vitreisporites pallidus, Cerebropollenites mesozoicus, Inaperturopollenites dubius, Araucariacites australis, Perinopollenites elatoides, Classopollenites torosus, Exesipollenites scabrosus, Podocarpidites* cf. *ellipticus* and *Eucommidites troedssonii.*

The present palynomorph assemblage of the Morača Region bears significant similarities to those of England (the Sycarham Beds in Yorkshire; COUPER 1958; NORRIS 1969), Germany (Regensburg–Passau area, Bavaria; LUND & ECKE 1987), the Netherlands (BURGER 1966; HERNGREEN *et al.* 1980), Normandy (SARJEANT 1968), Sweden (TRALAU 1968), Russia (Siberia; ILYNA 1986), Egypt (El Maghara, north-central Sinai; ABOUL & ALY 1988), Algero-Tunisian Sahara (REYRE 1973), North America (SARJEANT 1979), Canada (POCOCK 1967, 1970) and India (SRIVASTAVA 1966).

Some remarks about the palynological criteria for the recognition of the Jurassic–Cretaceous boundary in western Europe

Many references were originally demonstrated that significant palynologic differences exist between the major Jurassic–Cretaceous formations. NORRIS (1969, 1973), BATEN (1973), MORGAN (1980) for example, recognized three principal microflora assemblages close to the Jurassic–Cretaceous boundary, as follow:

The microflora of Lower–Middle Thithonian is very restricted in composition containing only the following species over and above the background species: *Cyathidites minor, C. australis, Coronatispora caldensis, Dyctiophydites equiexinus, D. harrisii, Deltoidospora psilostoma, Osmundacidites wellmanii, Lycopodiumsporites austroclavatoides, Klukisporites pseudoreticulatus, Rubinella major, Callialasporites dampieri, C. obrutus, Classopollis hammenii, Abietinaepollenites minimus, Cycadopites* sp., *C. nitidus, Eucommidites minor,* etc. Some of these species were of restricted diversity as a consequence of the offshore marine environment during the Late Jurassic.

The microflora of Upper Tithonian is characterized by the incoming of *Acanthotriletes varispinosus, Cicatricosisporites purbeckensis, Plicatella abaca, Deltoidospora rafaeli,Converrucosisporites sp., Lepdolepidites psarosus, Couperisporites complexus, Parrisaccites radiatus, Sphaeripollenites subgranulatus, Cycadopites carpentieri, Schzosporites spriggii, etc.*

The microflora of Berriasian – the following species first appear: *Concavisporites juriensis, Stereisporites antiquasporites, Leptolepidites epacrornatus, Baculatisporites comaumensis, Pilosisporites trichopapillosus, Pilosisporites delicatulus, Lycopodimsporites cerniidites, Cicatricosisporites brevilaesuratus, C. angicanalis, Tripartina* sp., *Foveosporites cannalis, Contignisporites dorsostriatus, Duplexisporites problematicus, Appendicisporites potomacensis, Trilobosporites bernissartensis, T. apiverrucatus, Densoisporites perinatus, Heliosporites* sp., *Aequtriradites spinulosus, Januasporites tumulosus, Callialasporites* cf. *trilobatus, Marattisporites scabratus, Monosulcites* cf. *minimus, Schizosporis reticulatus, Sch. parvus, Sigmopollis callosus, etc.*

Paleoecological reconstruction

The analysis of spores and pollen grains, also of dinoflagellate remains, provides for the reconstruction of land vegetation on the surrounding islands.

The younger Jurassic microflora from the Morača area is representative of a typical continental flora of island archipelagos in the tropical regions of the Tethys. From the palynological assemblage two main types of land vegetation were distinguished on the islands.

a. Wet coastal regions of islands with shallow water formations were characterized with vegetation of dominant ferns (Klukisporites, Deltoidospora and Lycopodiacidites) and some seed ferns (Cycadophytes).

b. Prominent areas on the islands had more xerophyte flora which is evidenced by the abundance of conifers (mostly pollen grains of Araucaria and Classopollis). Macrofloral remains of Bracyphyllum and Pagiophyllum were not recorded. The presence of Classopollis pollen indicates their xerophitic nature. However, the presence of Classopollis pollen can be related to both arid and humid climates of high littoral areas. Its occurrence in Mesozoic rocks indicates a warm climate (VAKHRAMEEV 1970). Similar climatic conditions are suitable also for plants producing pollen of *Araucariacites* and *Callialapollenites* types; in many examples, they are found together in Jurassic and Lower Cretaceous sedimentary rocks. The presence of the families Gleicheniaceae and Schizaceae in the Uppermost Jurassic and Lower Cretaceous indicates humid climate.

c. The depositional environment is also marked by a sparse form of dinoflagellatae, acritarchs and palynoforaminifers. As has already been mentioned, the occurrence of phytoplanktonic – algal remains is associated with an aquatic environment, which indicates a great influence of marine sedimentation conditions during the formation of these sediments.

The palynological assemblage could be used for consideration concerning the paleoclimate during the sedimentation of the investigated sequences in the Morača area. Transitional tropical–subtropical climatic belts during Upper Jurassic were concluded.

In the Upper Jurassic and Lowermost Cretaceous, in the stil large Tethys, continental flora of the Tethyan phytogeographic realm existed on many archipelagos situated between the south “Laurasian Phytogeographic Realm“ (“Indo-European relm“; VAKHRAMEEV 1975) in the north and the north „Gondvana Realm“ (African continent) in the south (BRENNER 1976). Continental floras on archipelagos in the realm of the west Tethyan intraoceanic carbonate platforms, at the time were much closer to the African continent, during the Jurassic and Lower Cretaceous („separate Tethyan phytogeographic realm“; PANTIĆ *et al.* 1983).

Conclusion

Based on the first palynological investigation of the Moračka Kapa ophiolite mélange (Montenegro), the conclusions are as follows:

From the possible affinity of the palynomorphs, it may be deduced that in the Upper Jurassic, the Morača area was not rich in floras, which include Pteridophytes belonging to families such as Lycopodiaceae, Selaginellaceae, Osmundaceae, Dicksoniaceae, Cyatheaceae, etc. Among the Gymnosperms, are those plants of Cycadaceae, Ginkgoaceae, Pinaceae, Podocarpaceae and Araucariaceae. From the ecological environment of the parent plants, it was inffered that this region at that time was under a warm and humid subtropic to temperate climate.

All these paleontological data contribute to an elucidation of the characteristic late Jurassic vegetation from the Tethyan phytogeographic province. The younger Jurassic microflora from Morača area is representative of a typical continental flora of island archipelagos (near shore environment) in the subtropical–tropical regions of the Tethys. The microflora described is of special paleo- and phytogeographical interest and shows remarkable analogies with mediterranean and south-alpine floras of the Tethys, but differs from the north-pennine flora, which may belong to the Laurasian floral realm.

Although the palynomorphs assemblage is not complete, the biostratigraphical analysis of the contained pteridophyte spores, conifer pollen and the remains of the monadophytic algae Peridineae, allows the conclusions that the mentioned unit was forming during the Upper Jurassic (most probably the Kimmeridgian). The presence of some taxons from the Lowermost Cretaceous is not excluded. Taking into account all the mentioned palynological data it was concluded that the Upper Jurassic age of the Moračka Kapa Unit coresponds to late phases of the Dinaride Ophiolite Belt foramation.

The microflora of the obtained palynological investigation on the Moračka Kapa ophiolite mélange allows a new consideration in relation to Upper Jurassic–Lowermost Cretaceous boundary.

The available data concerning the age of the Moračka Kapa Unit are very important for a new interpretation of palaeogeographic and geodynamic events in this part of Tethys during the Upper Jurassic (Karamata *et al.* 2010).

Acknowledgments

I wish to thank the reviewers Polina Pavlishina (Sofia) and Platon Tchoumatchenco (Sofia) for useful discussions and comments that significantly improved the paper.

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Резиме

Старост Динаридског офиолитског појаса – меланж олистостроме на северној падини Морачке Капе (Црна Гора)

Јединица Морачка Капа налази се између мезозојског Далматинско-Херцеговачког терана и Источно Босанско-Дурмиторског терана. Овај олистостромски меланж састоји се од фрагмената и блокова кречњака, пешчара, базалта и серпентина уклопљених у глиновито-лапоровитом матриксу. Ова јединица је веома слична јурском олистостромском меланжу Динаридског офиолитског појаса, који је раније означаван као дијабаз-рожначка формација. Ова јединица представља изоловани део субдукционог рова на западној маргини Динаридског офиолитског појаса (KARAMATA *et al.* 2010)

Анализа микрофлористичког састава палиноморфа из офиолитског меланжа Морачке Капе показала је да доминира присуство спора петридофита које углавном припадају фамилијама *Lycopodiaceae, Selaginellaceae, Osmundaceae Dicksoniaceae, Cytheaceae* и друге. Полен гимносперми претежно припада фамилијама *Cycadaceae, Ginkgoaceae, Pinaceae, Podocarpaceae* и *Araucariaceae.* На основу еколошких карактеристика матичних биљака, закључено је да је овај простор у време стварања поменутих депоната био под утицајем топле и влажне субтропске до умерене климе.

Први палеонтолошки наласци доприносе упознавању карактеристика вегетације горње јуре у палеогеографској провинцији Тетиса. Млађа јурска микрофлора из Морачке Капе представља типичну континенталну флору острвских архипелага (средине близу обале) у субтропско-тропског региона Тетиса. Карактеристике ове микрофлоре показују да постоје запажене сличности са медитеранским и јужно-алписким флорама на простору Тетиса, али се разликују од северно-пенинских флора, које припадају Евроазијској флористичкој области.

Иако констатована палинолошка асоцијација није потпуна биостратиграфска анализа спора птеридофита, полена четинара и остатака монадофитних алги перидинеа омогућавају да се закључи да флористички састав ове асоцијације указује да је матрикс офиолитског меланжа настао за време горње јуре, највероватније у кимерицу. Неки присутни таксони упућују да би део испитиваних депоната могао припадати и деловима најниже креде. У сваком случају прочавања палиноморфа из офиолитског меланжа доприносе и прецизнијем утврђивању границе између горње јуре и доње креде на истраживаном простору.

Нови подаци о старости јединице Морачка Капа су веома значајни за нове интерпретације палеогеографских и геодинамичких догађаја у овом делу Тетиса за време горње јуре (KARAMATA *et al.* 2010).

Асоцијација палиноморфи из Морачке Капе показује знатне сличности са онима у Енглеској (Sycarham Beds, Yorkshire; COUPER 1958; NORRIS 1969), Немачкој (Regensburg-Passau, Bavaria; LUND & ECKE 1987), Холандији (BURGER 1966; HERNGREEN *et al.* 1980), Норвешкој (SARJEANT 1968), Шведској (TRALAU 1968), Русији (Siberia; ILYNA 1986), Египту (El Maghara, north-central Sinai; ABOUL & ALY 1988), Северној Америци (SARJEANT 1979), Канади (POCOCK 1967, 1970) и Индији (SRIVASTAVA 1966).

Plate 1

Fig. 1. *Cyathidites australis* COUPER (sample 2347/5; 13-0/7).
Fig. 2. *Cyathidites minor* COUPER (sample 2347/4; 17-6/08).
Fig. 3. *Cyathidites* cf. *mesozoicus* (Thiergart) R. Potonié (sample 2348/6; 46- 10/08).
Fig. 4. *Deltoidospora* cf. *mesozoica* (Thiergart) Schurman (sample 2348/5; 39-8/08).
Fig. 5. *Todisporites major* Couper (sample 2349/2; 3-8/08).
Fig. 6. *Osmundacidites wellmanii* Couper (sample 2349/2; 11-0/8).
Fig. 7. *Leptolepidites* sp. (sample 2353/1; 49-8/08).
Fig. 8. *Lepdolepidites verrucatus* Couper (sample 2353/1; 11-6/08).
Fig. 9. *Neochomotriletes* sp. (sample 2348/1; 53-6/08).
Fig. 10, 11. *Ischyosporites* sp. (sample 2348/3; 41-7/08 and 2348/6; 43-12/08).
Fig. 12. *Cyathidites* cf. *hausmanoides* COUPER (sample 2347/5; 23-6/08).
Fig. 13. *Trilites* cf. *distalgranulatus* COUPER (sample 2348/2; 15-7/08).
Fig. 14. *Trilites* cf. *verrucatus* COUPER (sample 2348/1; 35-6/08).
Fig. 15. *Gleicheniidites* cf. *senonicus* ROSS (sample 2348/1; 31-6/08).
Fig. 16. *Staplinisporites* cf. *pocookii* Couper (sample 2348/4; 55-7/08).
Fig. 17. *Cingulastisporites* cf. *rigidus* Couper (sample 2348/6; 50-10/08).
Fig. 18. *Apiculatisporites* cf. *parvispinosus* (Leschik) E. Schulz (sample 2348/1; 3-7/08).
Fig. 19. *Neoraistrickia* cf. *taylorii* Playford et Dettmann (sample 2348/1; 1-7/08).
Fig. 20. *Lycopodiumsporites* cf. *gristhorpensis* Couper (sample 2348/2; 35-7/08).
Fig. 21. *Lycopodiumsporites clavatoides* Couper (sample 2348/1; 45-6/08).
Fig. 22. *Acanthotriletes* cf. *varrispinosus* Pocock (sample 2348/4; 59-7/08).
Fig. 23. *Biretisporites potoniaei* Delcourt et Sprumont (sample 2348/2; 23-12/08).
Fig. 24. *Osmundacidites parvus* de Jersey (sample 2348/6; 54-10/08).
Fig. 25. *Cingutriletes* sp.; *Pagiophyllum* cf. *connivens* Kendall (sample 2348/6; 37-6/08).
Fig. 26. *Ischyosporites* cf. *variegatus* Couper (sample 2348/5; 47-8/08).

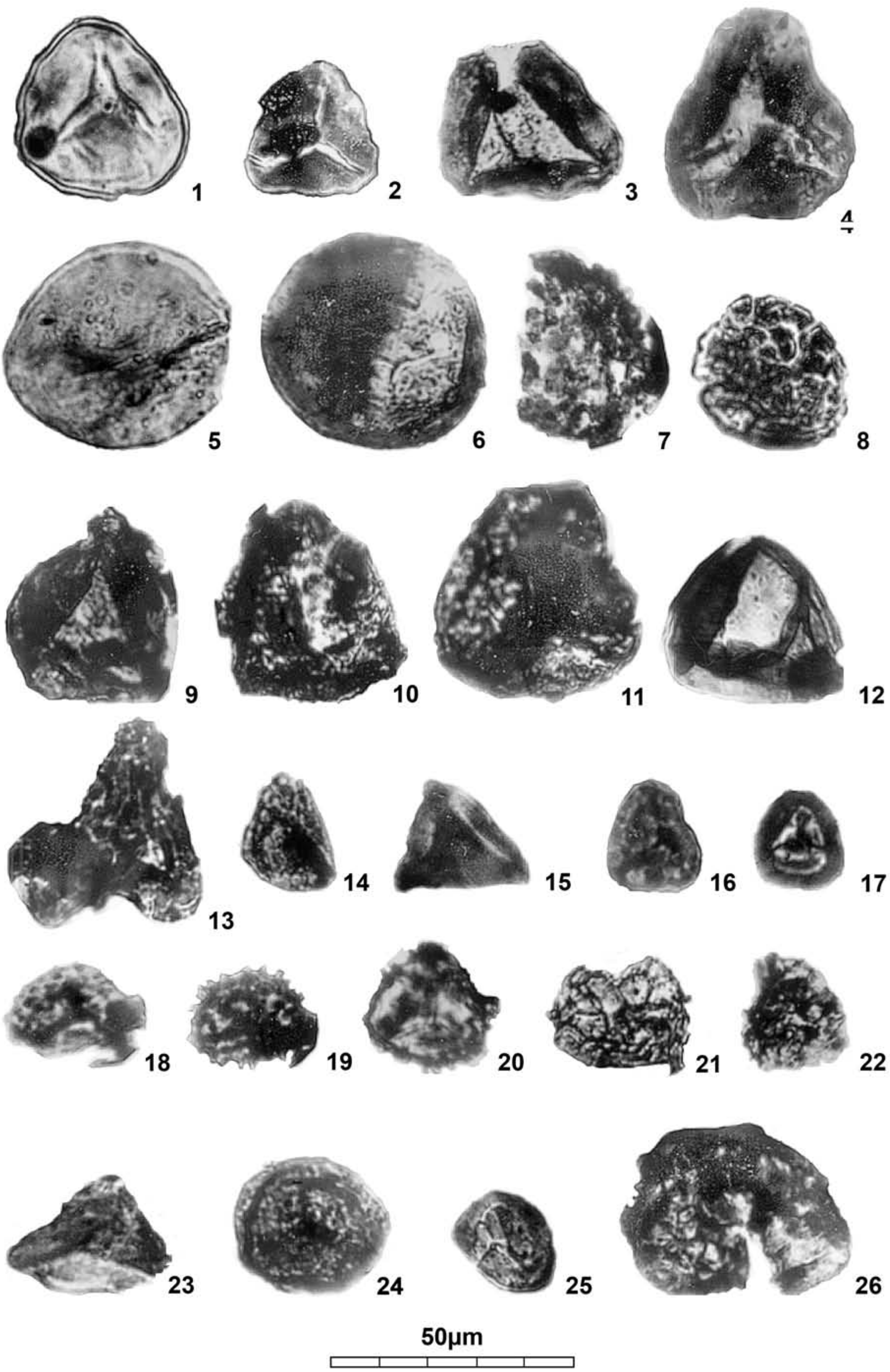
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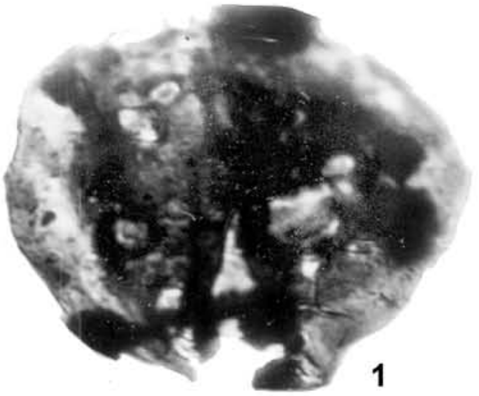
Plate 2

Fig. 1.	*Alisporites* sp. (sample 2347/7; 85-6/08).
Fig. 2.	*Abietinaepollenites microalatus* R. Potonié (sample 2347/2; 5-6/08).
Fig. 3.	*Podocarpidites* sp. (sample 2348/1; 27-6/08).
Fig. 4.	*Podocarpidites* cf. *biformis* Rouse (sample 2348/1; 55-6/08).
Fig. 5.	*Callialasporites dampieri* (Balme) Sukh Dev (sample 2348/2: 39-7/08).
Fig. 6.	*Callialasporites* cf. *trilobatus* (Balme) Dev (sample 2347/10; 58-10/08).
Fig. 7.	*Vitreisporites* cf. *pallidus* (Reissinger) Nilsson (sample 2348/2; 9-7/08).
Fig. 8.	*Araucariacites australis* Cookson (sample 2347/10; 56-10/08).
Fig. 9.	*Araucariacites* sp. (sample 2347/4; 15-6/08).
Fig. 10.	*Classopollenites* cf. *classoides* (Pflug) Pocock & Jansonius (sample 2347/1; 3-6/08).
Fig. 11.	? *Sequoiapollenites* sp. (sample 2348/1; 39-6/08).
Fig. 12.	*Perinopollenites* cf. *elatoides* Couper (sample 2348/2; 25-7/08).
Fig. 13, 14.	*Sphaeripollenites subgranulatus* Couper (sample 2348/1; 51, 61-6/08).
Fig. 15.	*Eucommidites* cf. *troedssonii* Erdtman (sample 2348/6; 66-10/08).
Fig. 16.	*Eucommidites* sp. (sample 2352/2; 55- 8/08).
Fig. 17.	*Quadraeculina* cf. *limbata* Pocook (sample 2347/3; 9-6/08).
Fig. 18.	*Monosulcites carpentieri* Delcourt & Sprumont (sample 2348/6; 64-10/08).
Fig. 19.	*Ginkgocycadophytus* cf. *nitidus* (Balme) de Jersey (sample 2348/1; 85-7/08).
Fig. 20.	*Cycadopites* cf. *follicularis* Wilson & Webster (sample 2347/7; 19-6/08).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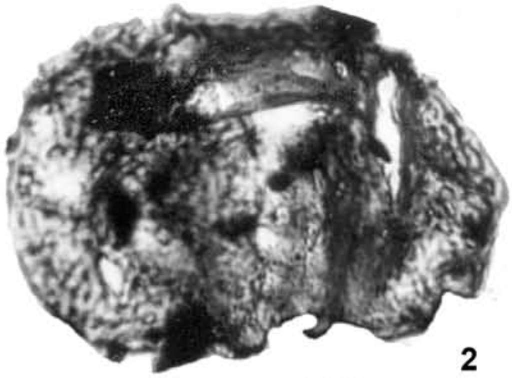
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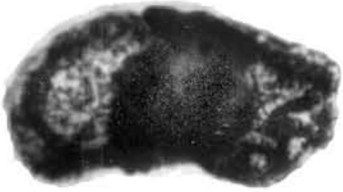
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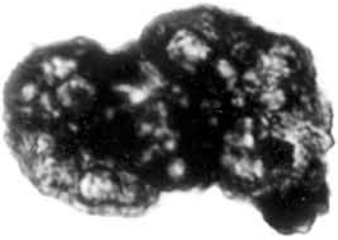
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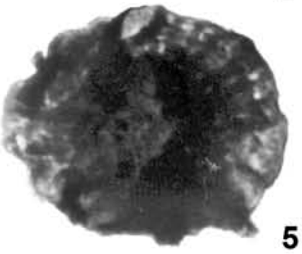
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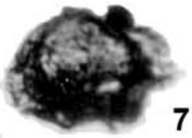
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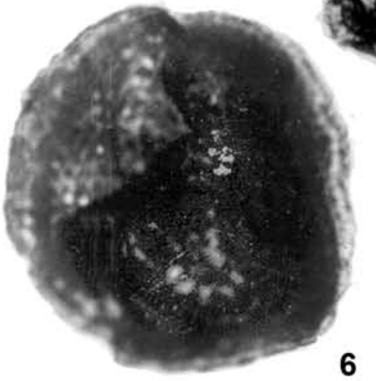
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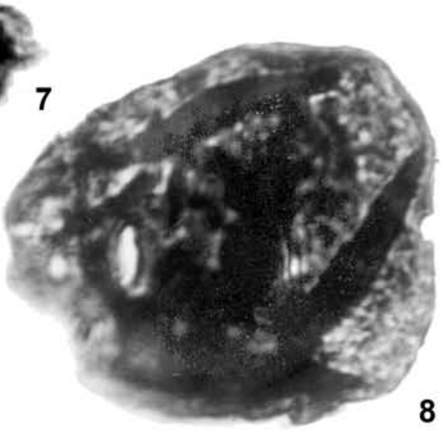
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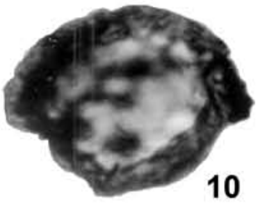
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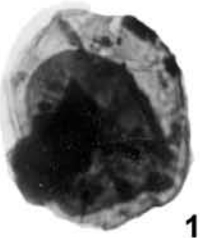
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PLATE 3

Fig. 1. *?Steevesipollenites* sp. (?Bennettitales) (sample 2348/6; 37-10/08).
Fig. 2. *Pareodinia ceratophora var. pachyceras* SARJEANT (sample 2349/1; 1-8/08).
Fig. 3. *Apteodinium* sp. (sample 2348/4; 47-7/08).
Fig. 4. *Pareodinia* cf. *arctica* WIGGINS (sample 3248/4; 45-7/08).
Fig. 5. *Wallodinium* cf. *cilindricum* (HABIB) DUXBURY (sample 2348/1; 29-6/08).
Fig. 6. Acritarcha gen et sp. indet. (sample 2348/6; 48-10/08).
Fig. 7. ?*Epiplosphaera* sp. (sample 2348/4; 57-7/08).
Fig. 8. *Leptodinium* cf. *eumorphum* COOKSON & EISENACK (sample 2348/1; 49-6/08).
Fig. 9. ?*Nanoceratopsis* cf. *pellucida* (DEFLANDRE) EVIT (sample 2348/1; 63-6/08).
Fig. 10. *?Indodinium* sp. (sample 2347/1; 21-6/08).
Fig. 11. *Lagenamina* sp. (Palynoforaminiferae) (sample 234875; 45-6/08).
Fig. 12. ?*Membranolimbus* sp. (sample 2348/3; 45-7/08).
Fig. 13. *Penetetrapites* cf. *mollis* HEDLUND & NORRIS (sample 2348/6; 50-10/08).
Fig. 14. *?Pareodinia* cf. *imbatodinensis* (VOZHENNIKOVA) LENTIN & WILLIAMS (sample 2348/2; 29-7/08).
Fig. 15. *Tasmanites* cf. *tardus* EISENACK (sample 2346/6; 48-10/08).


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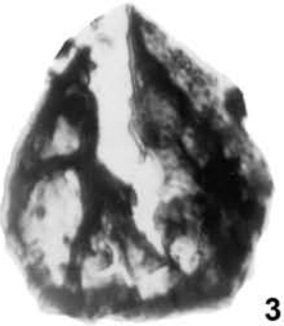
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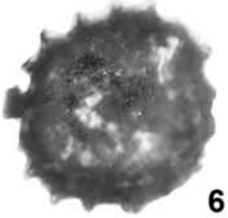
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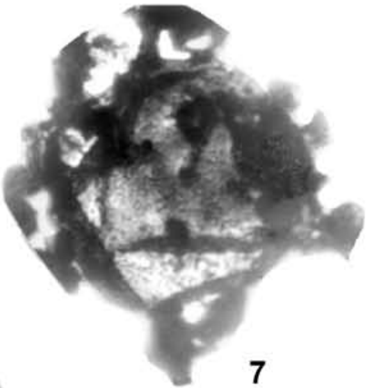
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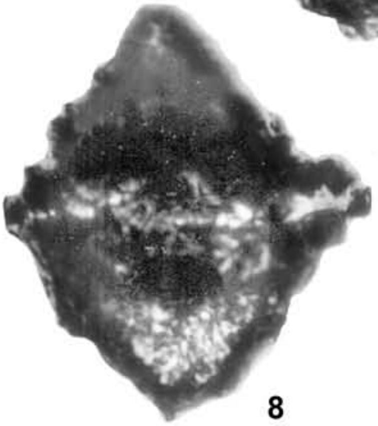
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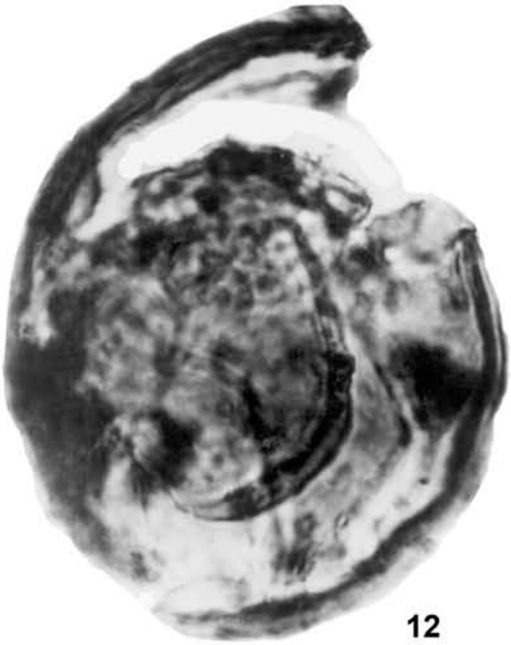
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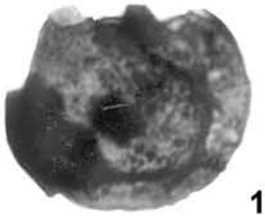
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