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Palynostratigraphy of Late Visean – Serpukhovian from Borehole Akkas-1, Western Iraq.

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ABSTRACT

The present study depends on (9) samples of the stratigraphic section between the depths (1120.5-1197) m from Akkas-1 borehole, western Iraq. These samples yielded enrichment of well-preserved Miospores except for one sample at (1178) m, which is of poor preservation.
These samples yielded (129) species of Miospores belonging to (57) genera, and (16) species are expected to be new species. The Index species of the studied stratigraphic section indicate Late Visean - Serpukhovian age including:
Aratrisporties saharaensis, Kraeuselisporites ornatus, Colatisporites denticulatus, C.decorus, Rotaspora knoxi, Prolycospora rugulosa, Spelaeotriletes spp., Vallatisporites spp. Savitrisporites nux, Waltzispora polita, W. planianulata, Raistrickia accincta, R. nigra.
The sedimentary basin of these samples was promoted by the swampy and Lagoon ecosystem and the presence of some acritarchs indicating a periodic connection with the sea. The ferns of the plant's group Petridophyta include the presence of genera: *Vallatisporites, Kraeuselisporites, Densosporites, Raistrickia,* and *Spelaeotriletes*, which belong to herbal lycopods within the group of ferns, give us a conviction of the presence of forest conditions adjacent to the swamps

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الطباقية الباليونولوجية من الفيزيان المتأخر – السيربيكوفيان من بئر عكاس –1، غربي العراق

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الملخص

اعتمدت الدراسة الحالية على (9) نماذج من المقطع الطباقي ما بين الأعماق (1120.5–1197) مترا من بئر عكاس –1 غربي العراق. أعطت هذه النماذج مايوسبورات ذات وفرة وحفظ جيد جدا ماعدا النموذج عند (1178) مترا حيث كان ذا حفظ ضعيف .

أعطت هذه النماذج (129) نوعا من المايوسبورات تحت (57) جنسا و(16) نوعا أعتبرت كأنواع جديدة. الأنواع الدالة للمقطع الطباقي المدروس دلت على عمر Late Visean - Serpukhovian

وهذه الأنواع هي:

Aratrisporties saharaensis, Kraeuselisporites ornatus, Colatisporites denticulatus, C.decorus, Rotaspora knoxi, Prolycospora rugulosa, Spelaeotriletes spp., Vallatisporites spp. Savitrisporites nux, Waltzispora polita, W. planianulata, Raistrickia accincta, R. nigra.

البيئة الترسيبية لهذه النماذج هى مستنقعات وبيئات لاكونية، واستدل من خلال وجود بعض أنواع الاكريتارك على حدوث اتصال متقطع مع البحر. كما أظهرت هذه الدراسة وجود متحجرات نباتات من أنواع للايكوبوديات التى تقع ضمن مجموعة السرخسيات مثل اجناس

Vallatisporites, Kraeuselisporites, Densosporites, Raistrickia, Spelaeotriletes

ضمن حشود المتحجرات يدل على وجود الغابات التى كانت تنمو بشكل قريب من البحار.

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Introduction

The studied stratigraphic section is taken from the borehole Akkas-1 (34º 09' 18" L, 40º 57'49" W). This borehole was the first deep exploration well drilled in the northern region of the Western Iraqi desert on the Akkas structure, whose deepest point reached 4238 meters. Akkas' Structure is located south of the Euphrates River and bounded from the east by the Iraqi-Syrian borders (Fig.1).

The age surface rocks of this structure belong to Miocene and Eocene including Ghar Formation, Jaddala Formation, Fat'ha (Injana) Formation, and Euphrates Formation. Whereas under surface, there are missing lower Cretaceous formations and all the Jurassic, Triassic, Permian, and Upper Carboniferous formations according to a study by Iraqi Exploration Oil Company in 1994. The current palynological study deals with core and cutting samples of Akkas-1 borehole stratigraphic section between depths (1120.5-1197) meters. The area is located 30 km south of Qaim City and on the edge of the northeastern slope of the Rutba plateau towards the Anah Basin (Fig.1).

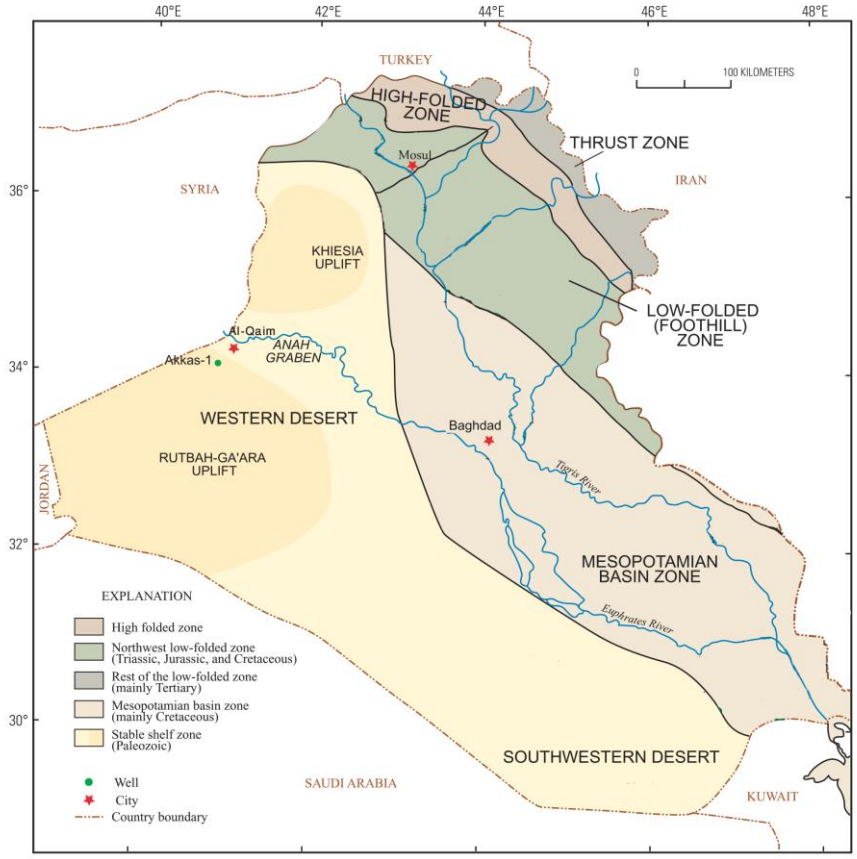

Fig.1. Location Map of Borehole Akkas-1.

The studies on the Paleozoic rocks in Iraq are few due to the lack of their outcrops. Therefore, the reliance was only on the subsurface sections of the well drilling by the Petroleum Exploration Company in the western desert, which penetrated the rocks of these eras.

The important studies are by Nader *et al*. (1993); Nader *et al*. (1997); Baban (1996); Kddo (1997); and Al-Mola (2002).

Materials and Methods

The studied stratified column between the depths (1120.5-1197) meters belongs to Raha Formation (Visean-Serpukhovian) according to Al-Hadidy (2007) (Fig. 2). The samples yielded well-preserved and highly diversified in palynomorph assemblages except for one sample at (1178) meter is of poor preservation (Fig. 3). All samples obtained from the Iraqi oil company laboratories that were prepared using traditional palynological methods namely adding hydrochloric acid (HCl) to dissolve carbonate materials, and hydrofluoric acid (HF) to dissolve the silicates and HNO3 to oxidize the organic materials. All samples of the current study are from the archives of the Department of Geology, College of Science, Mosul University.

Palynological stratification and age determination

The paleontological study of Miospore species aims to determine age, climate and sedimentary environment for the stratigraphic section of borehole Akkas-1 depending on Miospores species. This study depends on (9) samples that yielded (129) species belonging to (57) genera, (16) species are described as new species.

Miospore assemblage indicates Late Tournaisian – Serpukhovian age having the following characteristics:

1. The great diversity of the samples under study gave (129) species including those that persisted from the presence of the lower Carboniferous, which is a distinctive

characteristic of the vegetation Cathaysia flora. This great diversity is an intrinsic characteristic of Late Visean.

There is no difference in miospore assemblages between the Late Visean (Brigantian) and the Serpukhovian. Therefore, the boundary was placed within the

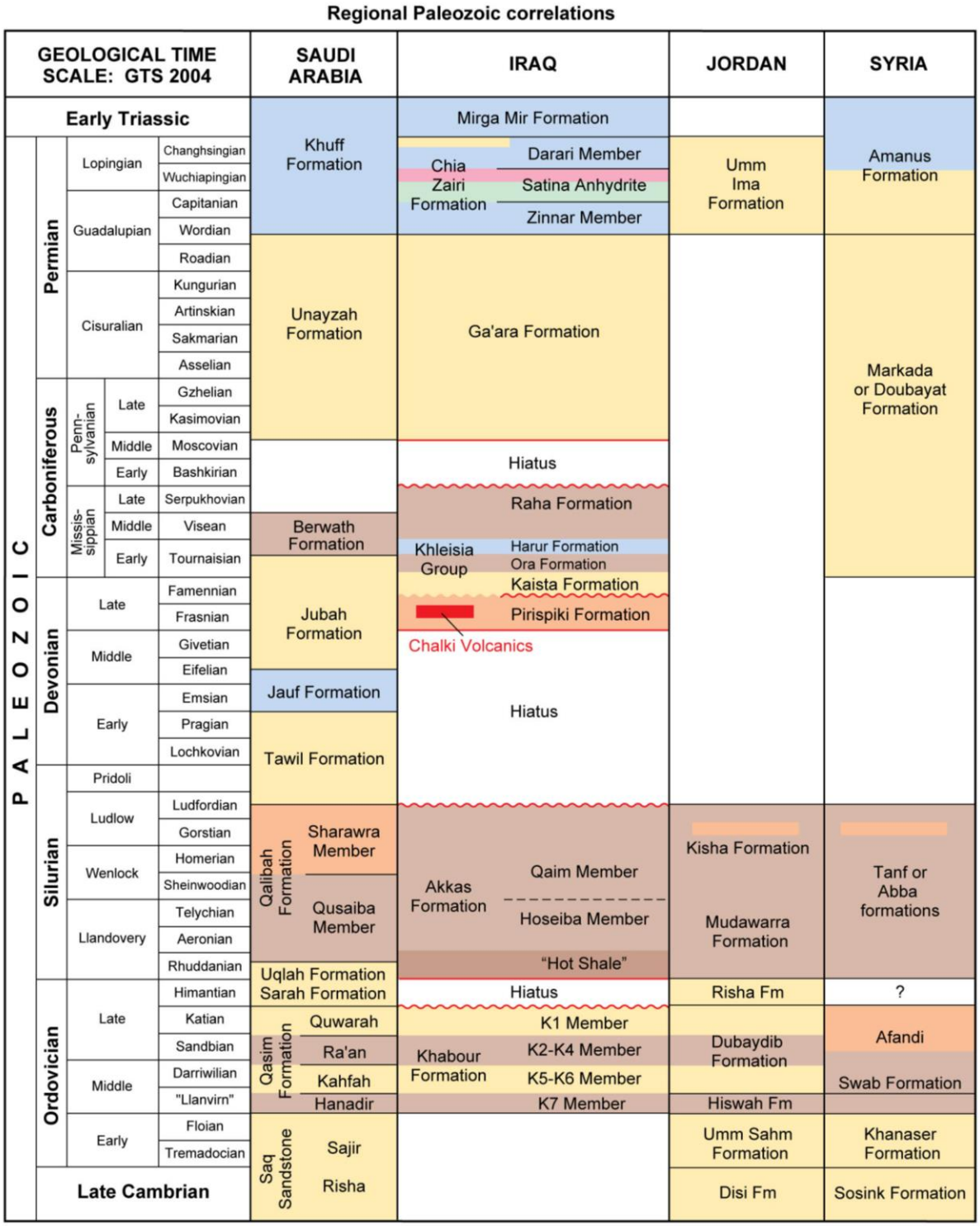

Fig. 2. The Paleozoic and members of Iraq are collected to Iran, Oman, Saudi Arabia, Syria, and southeast Turkey (Al-Hadidy, 2007).

Bellispores nitidus- Reticulatisporites carnosus (NC) biozone Clayton, 1985,
and the beginning of an appearance monosaccate pollen grains (Genus: *Flornites*) indicates on Pendleian according to Neves (1961); Loboziak and Clayton (1988). It is good to mention that genus *Flornites* is not recorded in this study.

2. High diversity and dominance of *Retusotriletes and Puntatisporties* genera that is one of the attributes with age meanings of (Late Visean – Serpukhovian).
3. The appearance of important species in great abundance such as:

Kraeuselisporites ornatus, Colatisporites denticulatus, C.decorus

In addition to the important species such as:

Aratrisporties saharaensis, Kraeuselisporites ornatus, Colatisporites denticulatus, C.decorus, Rotaspora knoxi, Prolycospora rugulosa, Spelaeotriletes spp., Vallatisporites spp. Savitrisporites nux, Waltzispora polita, W. planianulata, Raistrickia accincta, R. nigra.

Punctatisporites spp., Retusotriletes spp. indicating Late Tournaisian – Early Namumian age.

4. The appearance of *Aratrisporites saharaensis*, whose availability is limited to North Africa and Iran ,indicates the zonation during that time when there were plants confined to specific regions and no one else produced these miospores. *Aratrisporites saharaensis* species, whose range (Late Tournaisian – Serpukhovian) is according to Lobozoiak et al. (1986) and the Acme zone in (Early Visean). We recorded it in this study but its availability was limited. There is more abundance of this species in other samples, which are deeper compared with the samples of the previous studies, which are mentioned in the literature review. Thus, the samples under study indicate that they represent the last appearance of *Aratrisporites saharaensis*, which is the beginning of the Serpukhovian.

This confined presence of *Aratrisporites saharaensis* with the continued presence of *Rotaspora knoxi* and *Stenozonotriletes cf. triaangulus* all indicate the end of (Visean) and the beginning of (Serpukhovian) (Clayton, 1985).

5. The appearance of the species *Savitrisporites nux* indicates the end of (Visean) and the beginning of (Serpukhovian) (Smith and Butterworth, 1967).
6. The appearance of *Tricidarisporites* and *Diatomozonotriletes* genera indicates Lower Carboniferous (Visean) (Playford, 1971).

Through the evidence already mentioned and its comparison with similar studies internationally, we conclude that the assemblages under study are of the age of (late Tournaisian – Serpukhovian) and this age is for the first time established in Iraq (Kddo, 1997). The age of plants, which was previously described as being in the Late Visean and Serpukhovian, has been determined to learn more about the plants that predominated throughout the sedimentation of this stratigraphic column. The study of Ravn (1986) and Traverse (1988), in which the two researchers explained the plant yield of the majority of pollen grains and spores of ancient life in the Paleozoic Era, served as the foundation for calculating the yield of these pollen grains and spores to the plants, which they produced. The samples under study are subjected to a quantitative survey, which allowed researchers to identify the dominant types of plants at the time. The following genera of sporomorphs are more abundant than others, as shown in Table (1).

Table .1. The percentage of the genera that appeared in abundance.

Palynomorphs	**Samples**								**Paleobotonical Affinites**
	1120.5	1135	1136	1137	1138	1139	1143.5	1197	
Punctatisporites	16.8	15.6	15.6	18.8	16.4	13.6	13.6	7.2	Petridophyta
Retusotriletes	10.8	16.4	8	18.4	13.6	16.3	9.2	8.8	Sphenopsides
Crassispora	4.8	2	3.2	3.2	3.6	-	2.8	2.8	Sphenopsides
Densosporites	7.2	2	2	6.4	6	3.9	1.6	0.8	Harbaceous lycopods
Kraeuselisporites	-	8.8	5.2	4	8	3.9	7.6	-	Harbaceous lycopods
Vallatisporites	5.6	7.6	9.2	4.4	6	1.9	11.6	12	Harbaceous lycopods
Colatisporites	6.4	8.4	6	13.6	14.4	3.9	14	14	Petridophyta
Spelaeotriletes	12.4	3.6	15.2	3.6	3.6	2.9	11.2	20.8	Ankonwn
Anaplanisporites	1.6	2.8	1.2	-	2.4	-	0.8	7.6	Petridophyta
Apiculiretusispora	3.2	1.6	-	2.4	2.4	2.9	2	0.4	Harbaceous lycopods
Raistrickia	2	5.6	2.8	1.2	3.6	0.9	2	-	Harbaceous lycopods
Acritarchs	2.8	4.8	3.6	1.6	2.8	-	2.8	2.8	

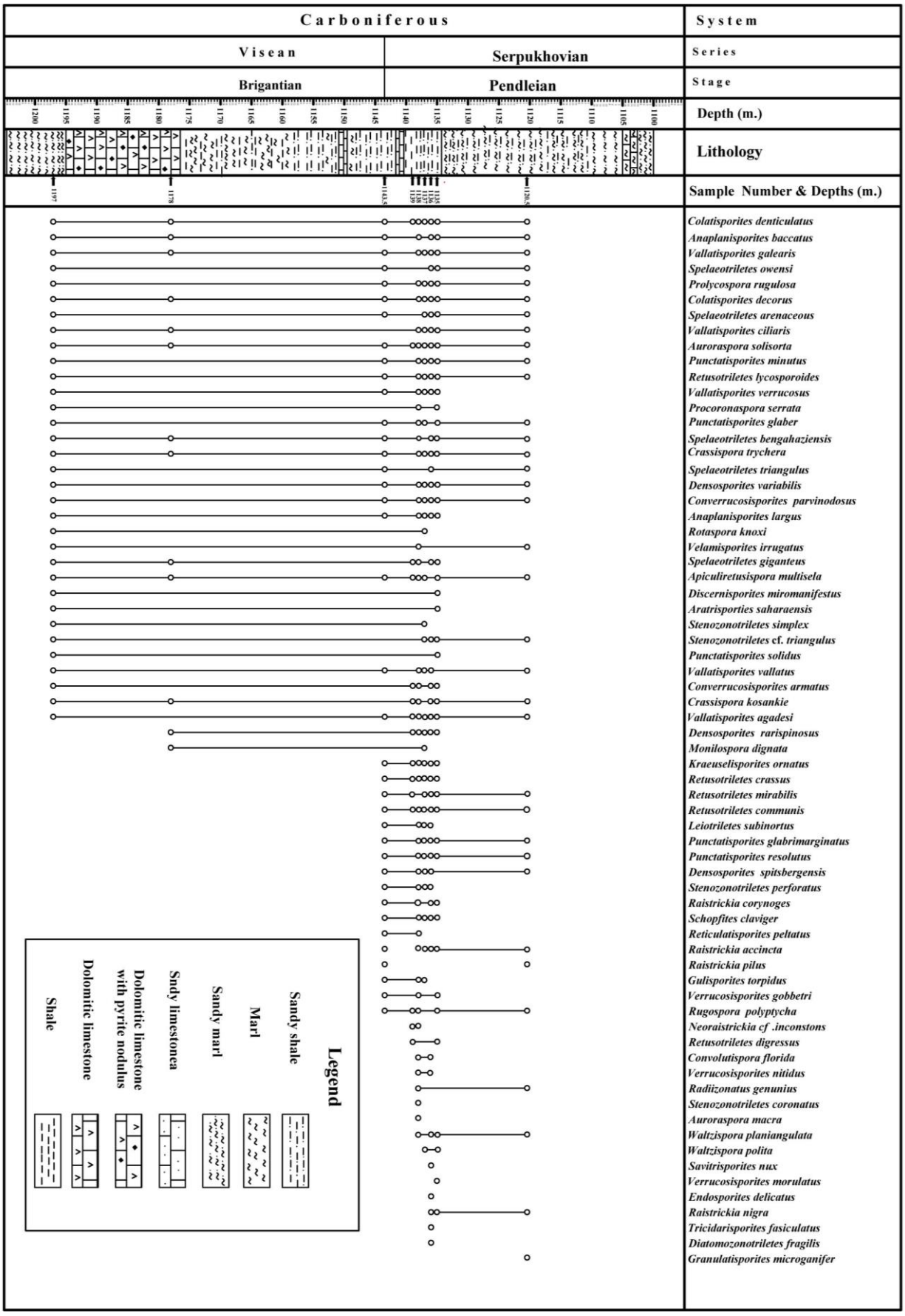

Fig. 3. Stratigraphic succession of borehole Akkas-1 showing the distribution of Sporomorphs.

Based on the information mentioned in Table (1), no dominance of any species appears in this study, which indicates that there was no absolute dominance of one type of plant.

In general, there is the dominion of the ferns of plants group Petridophyta and the presence of genera: *Vallatisporites, Kraeuselisporites, Densosporites, Raistrickia, Spelaeotriletes,* which belong to herbal lycopods within the group of ferns giving us a conviction of the presence of forest conditions adjacent to the swamps, where the herbal lycopods prefer the hot wet swamp conditions. Traverse (1988) explained that lycopods are abundant, predominant, and diverse in areas where slow sedimentation and high humidity for their reproduction.

Good preserving of thin wall Miospore like *Calamospora, Ruosaspora, Velamisporites, and Diaphanosporites;* in addition to the presence of Miospores in tetrad form indicating that the depositional environment of sedimentation conditions was calm. The majority of samples that include acritarchs represent the marine environment in the sedimentary basin and occasionally communicate with the sea. The sedimentary environment can be summarized as a swamp environment intermittently connected to the sea.

Results

1. This study includes descriptions of (129) miospore species from 57 genera and 16 species. In addition to the record seven acritarch species, it can be considered a new species.

Studied miospore assemblages yielded index species for the Late Visean – Serpukhovian:

Kraeuselisporites ornatus, Rotaspora knoxi, Waltzispora polita, W. planianulata,

Savitrisporites nux, Raistrickia accincta, R. nigra, Diaphanosporites fragilis, Tricidarisporites fasciculatus, Procorona serrate, Aratrisporties saharaensis,

Spelaeotriletes spp., Densosporites spp., Punctatisporites spp., Retusotriletes spp., Crassispora kosankei, C.trychera.

2. To replicate the conditions of the Tournaisian (Lower Carboniferous) plants while transitioning to the Upper Carboniferous, the studied samples produced a significant variety of palynomorphs, then the Tournaisian Miospores associated with the (Late Visean - Serpukhovian) miospores, which had a massive effect on other plant areas.
3. The quantitative study of the miospore assemblages indicates that the dominant plants and the sedimentation environment were a marsh and lagoon environment and the presence of some acritarchs indicates periodic connection with the sea.
4.

Conclusions

Numerous and very significant index species are discovered in the studied section of borehole "Akkas-1" in Western Iraq, including *Aratrisporties saharaensis, Kraeuselisporites ornatus, Colatisporites denticulatus, C.decorus, Rotaspora knoxi, Prolycospora rugulosa, Spelaeotriletes spp.,* and *Vallatisporites spp. Raistrickia accincta, Savitrisporites nux, Waltzispora polita, W. planianulata,* and *R. nigra*. In addition to the Paleoecology of this area being marshy and logoonal and the presence of acritarchs indicating periodic interaction with the sea, these features imply Late Visean to Serpukhovian age. *Petridophyta* plants that have been observed, such *Vllatisporites, Kraeuselisporites, Densosporites, Raistrickia*, and *Spelaeotriletes*, convince us that there were formerly forests close to marshes.

Acknowledgements

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Plate -1

Fig.1. ***Calamospora liquida*** Kosanke 1950/ Akk-1138(1), Size90µm.
Fig.2. ***Calamospora microrugosa*** (Ibrahim) Schopt, Wilson and Betall 1944/Akk-1143.5(2), Size 85µm.
Fig.3. ***Calamospora nigrata*** (Naumova) Kosanke 1950/ Akk-1138(1), Size90µm.
Fig.4. ***Gulisporites torpidus*** Playford 1964/ Akk-1138(2), Size50µm.
Fig.5. ***Leiotriletes subintortus*** (Waltz) Ischenko 1952/ Akk-1143.5(1), Size 52µm.
Fig.6. ***L.sp. A.*** / Akk-1135(1), Size 50 µm.
Fig.7. ***Punctatisporites glabrimarginatus*** Owens 1971/ Akk-1135, Size78 µm.
Fig.8**. *P.cf. glabrimarginatus*** Owens 1971 / Akk-1135, size 68 µm.

Plate -2

Fig.1. ***Punctatisporites glaber*** (Naumova) Playford 1962 / Akk-1138 / Size 50 µm.
Fig.2. ***P. greineri*** Varma 1969/ Akk-1135 / 127.9 / Size 57 µm.
Fig.3. ***P. irrasus*** Hacquebard 1957/ Akk-1138/ Size 65 µm.
Fig.4. ***P.cf. irrasus*** Hacquebard 1957/ Akk-1136/ Size 65 µm.
Fig.5. ***P.cf. irrasus*** Hacquebard 1957/ Akk-1138/ Size 75 µm.
Fig.6. ***P. Kankakeensis*** Peppers 1970/ Akk-1138/ Size 57 µm.
Fig.7. ***P. lucidulus*** Playford and Helby 1968/ Akk-1136 / Size 46 µm.

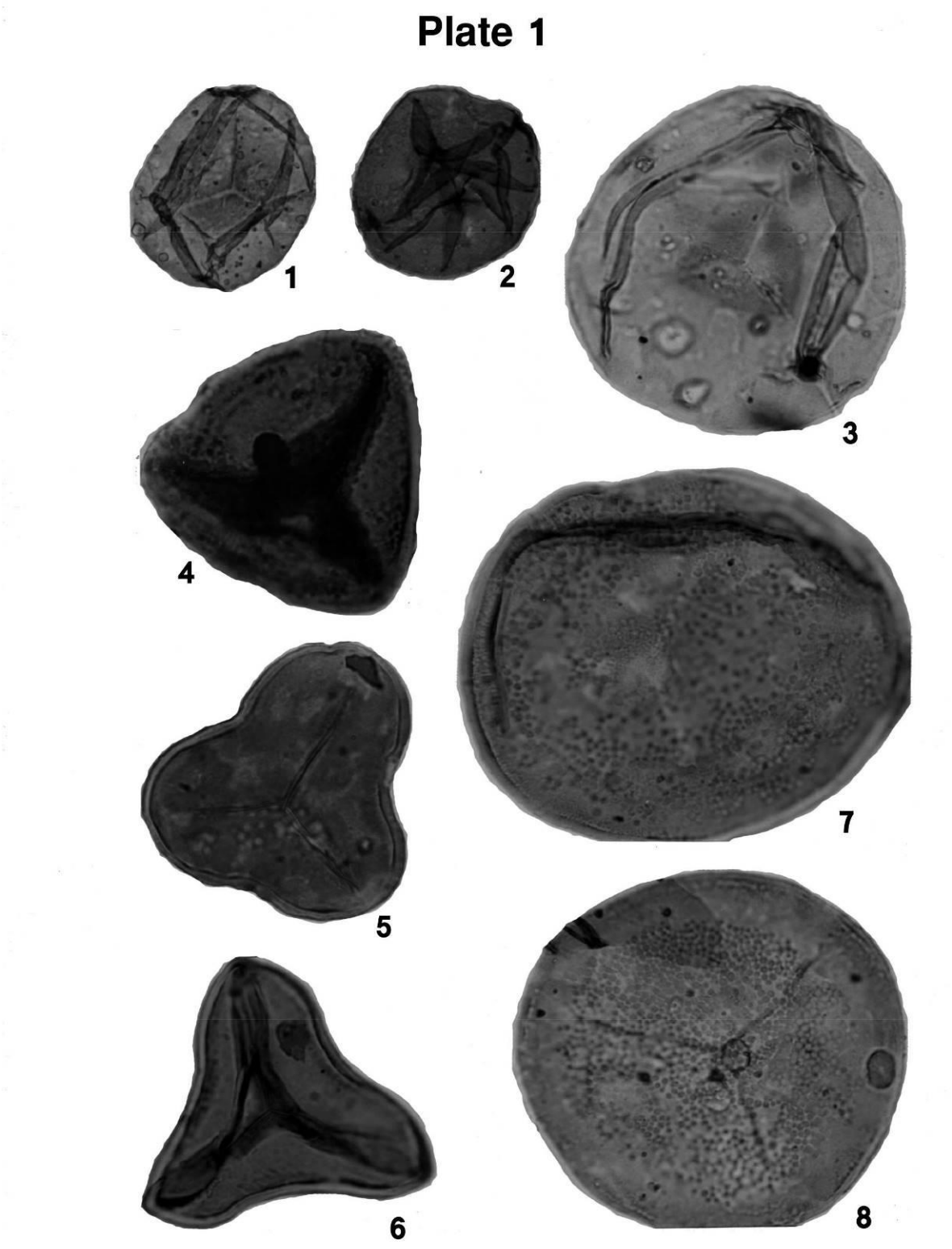


Plate 2

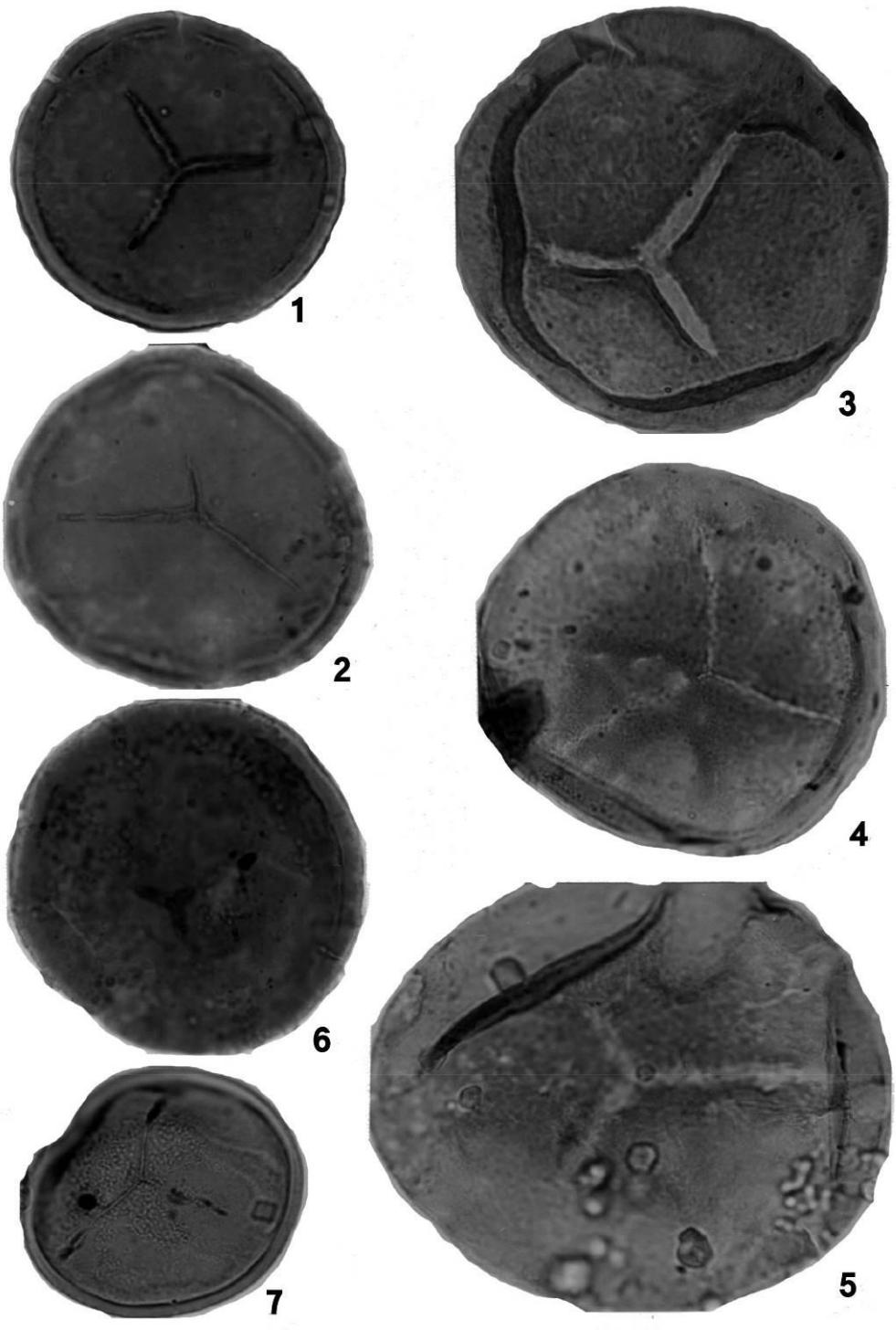


Plate -3

Fig.1. ***Punctatisporites miutus*** Kosanke 1950/ Akk-1135 / Size 90 µm.
Fig.2. ***P. planus*** Hacquebard 1957/ Akk-1137/ Size 58 µm.
Fig.3. ***P. punctatus*** Ibrahim 1933/ Akk-1136/ Size 68 µm.
Fig.4. ***P. putaminis*** McGregor 1960 / Akk-1135/ Size 52 µm.
Fig.5***. P. resolutus*** Playford 1971/ Akk-1136 / Size 47 µm.
Fig.6. *P*. Solidus Hacquebard 1957/ Akk-1143.5/ Size 61 µm.
Fig.7. *P*. sp.1/ Akk-1137/ Size 58 µm.
Fig.8. ***Phyllthecotriletes belloyensis*** Staplin 1960/ Akk-1138 / Size 55 µm.

Plate -4

Fig.1. ***Plicatispora scolecophora*** (Neves and Ionnides) Higgs *et al*., 1988/Akk-1385/Size45µm.
Fig.2. ***Retosotriletes communis*** Naumova, 1953 / Akk-1143.5 /Size 55 µm.
Fig.3. ***Retosotriletes crassus*** Clayton *et al.*, 1980 / Akk-1138 /Size 48 µm.
Fig.4. ***Retosotriletes digressus*** Playford, 1976 / Akk-1139 /Size 73 µm.
Fig.5. ***Retosotriletes golatensis*** Staplin, 1960 / Akk-1138 /Size 43 µm.
Fig.6. ***Retosotriletes incohatus*** Sullivan, 1964 / Akk-1137 /Size 47 µm.
Fig.7. ***Retosotriletes incohatus*** Sullivan, 1964 / Akk-1135 /Size 53 µm.
Fig.8. ***Retosotriletes cf. leptocentrum*** Higgs, 1975 / Akk-1143.5 /Size 50 µm.
Fig.9. ***Retosotriletes lycosporoides*** Butterworth *et al*., 1988 / Akk-1135 /Size 44 µm.
Fig.10. ***Retosotriletes mirabilis*** (Nevile) Playford, 1978 / Akk-1137 /Size 62 µm.

Plate 3

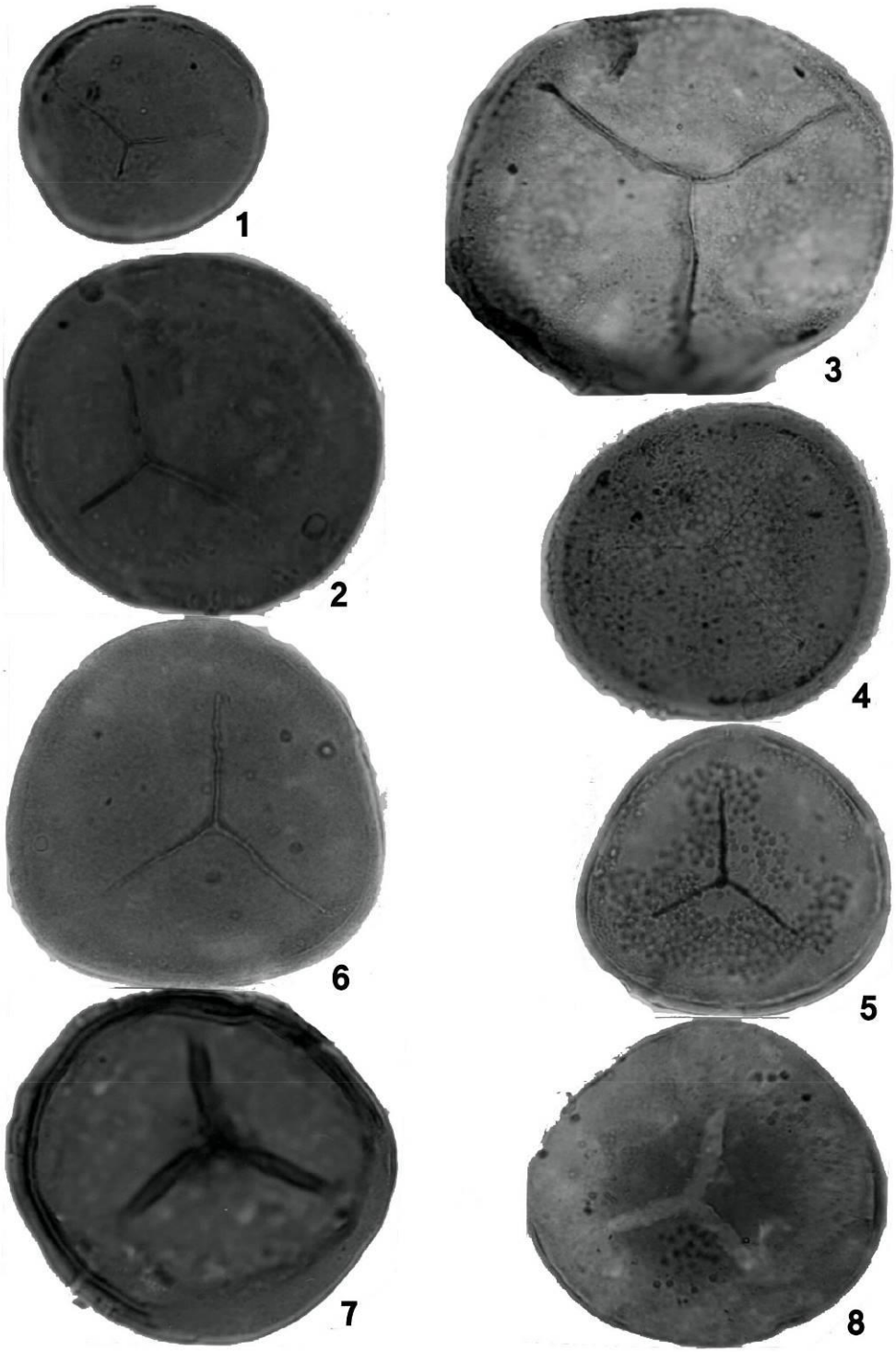


Plate 4

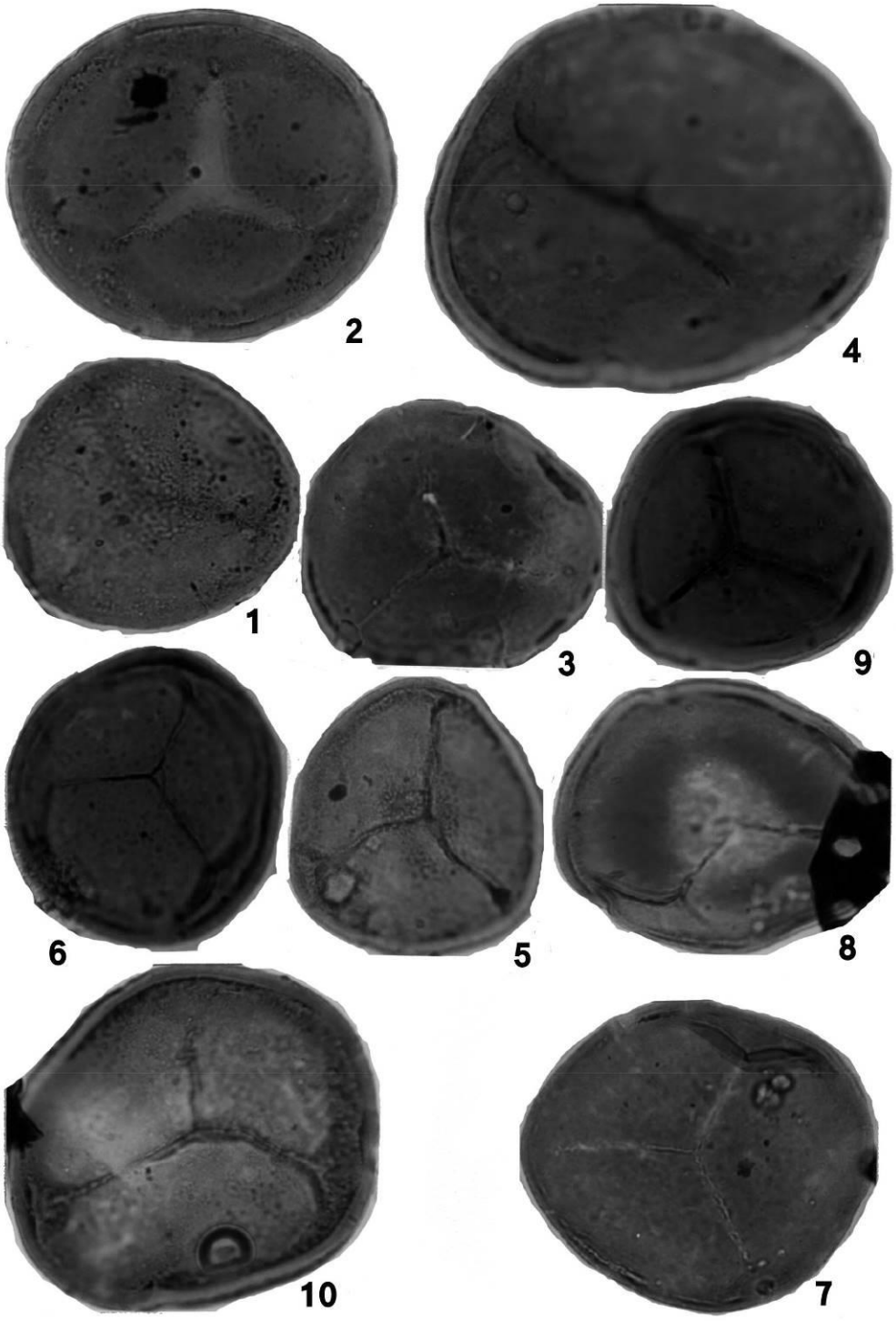


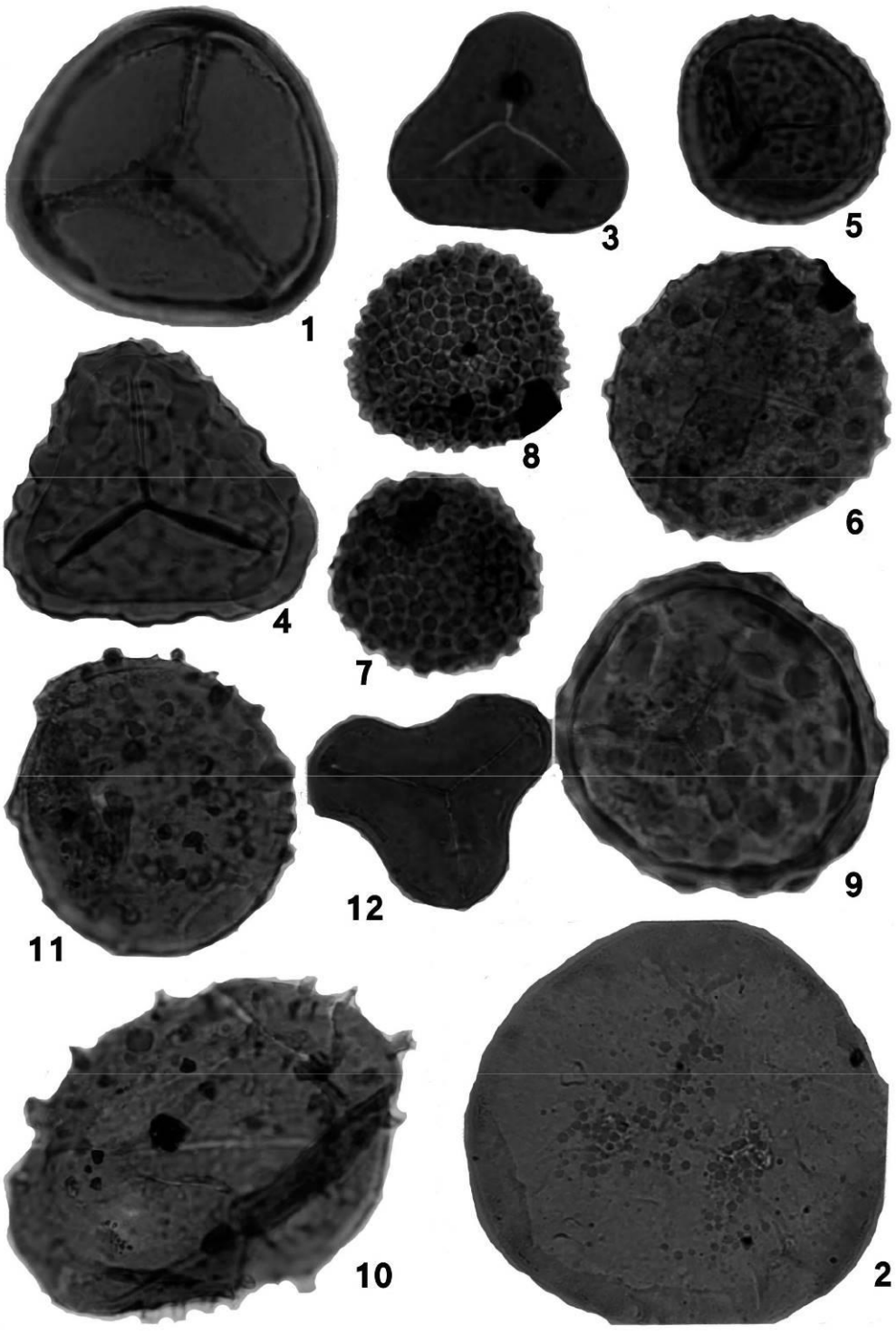
Plate -5

Fig.1. ***Retusotriletes sp.1*** / Akk-1197/ Size50µm.
Fig.2. ***Retusotriletes sp.2***/ Akk-1197/ Size65µm.
Fig.3. ***Granulatisporites microgranifer*** Ibrahim, 1933/ Akk-1120.5/ Size37µm.
Fig.4. ***Coverrucosisporites armatus*** (Dybova and Jachowicz) Smith and Butterworth, 1967/Akk-1135/ Size48µm.
Fig.5. ***C. parvinodosus*** Playford, 1964/ Akk-1143.5/ Size32µm.
Fig.6. ***Verrucosisporites gobbetti*** Playford, 1962/ Akk-1143.5/ Size48µm.
Fig.7. ***V. morulatus*** Knox, 1950/ Akk-1136/ Size32µm.
Fig.8. ***V. morulatus*** Knox, 1950/ Akk-1136/ Size32µm.
Fig.9. ***V. nitidus*** Playford, 1964/ Akk-1136/ Size52µm.
Fig.10. ***Schopfites claviger*** Sullivan, 1968/ Akk-1143.5 / Size 65µm.
Fig.11. ***S. claviger*** Sullivan 1968/ Akk-1137/ Size 47µm.
Fig.12. ***Waltzispora planiangulata*** Sullivan 1968 / Akk-1120.5 / Size 32µm.

Plate -6

Fig.1. ***Waltzispora planiangulata*** Sullivan, 1964/ Akk-1136, Size35µm.
Fig.2. ***W. polita*** (Hoffmeister, Staplin and Malloy) Smith and Butterworth,1967/Akk-1135, Size 29µm.
Fig.3. ***Lophotriletes plicatus*** Butterworth Spinner, 1967/ Akk-1120.5, Size50µm.
Fig.4. ***Anapiculata tisporites concinnus*** Playford, 1962/ Akk-1137, Size35µm.
Fig.5**. *A. confertispinosus*** *Ravn* and Benson, 1988/ Akk-1197, Size 48µm.
Fig.6. ***A. largus*** *Playford*, 1971/ Akk-1197, Size 67µm.
Fig.7. ***A. minor*** (Butterworth and Williams) Smith and Butterworth,1967/Akk-1137, Size31µm.
Fig.8. ***A.redactus*** Playford, 1978/ Akk-1138, Size36µm.
Fig.9. ***A.*sp.1,** *Akk*-1137, Size27µm.
Fig.10. ***Procoronaspora serrata (***Playford) Smith and Butterworth, 1966 /Akk-1136, Size 45 µm.
Fig.11. ***Tricidarisporites fasciculatus (***Love) Sullivan and Marshall, 1966/Akk-1197, Size 45µm.
Fig.12. ***Anaplanisporites baccates*** (Hoffmeister, Staplin and Malloy) Smith and Butterworth, 1967/ Akk-1197, Size 28µm.
Fig.13. ***A. baccatus*** (Hoffmeister, Staplin and Malloy) Smith and Butterworth, 1967/Akk-1197, Size 29µm.

Plate 5



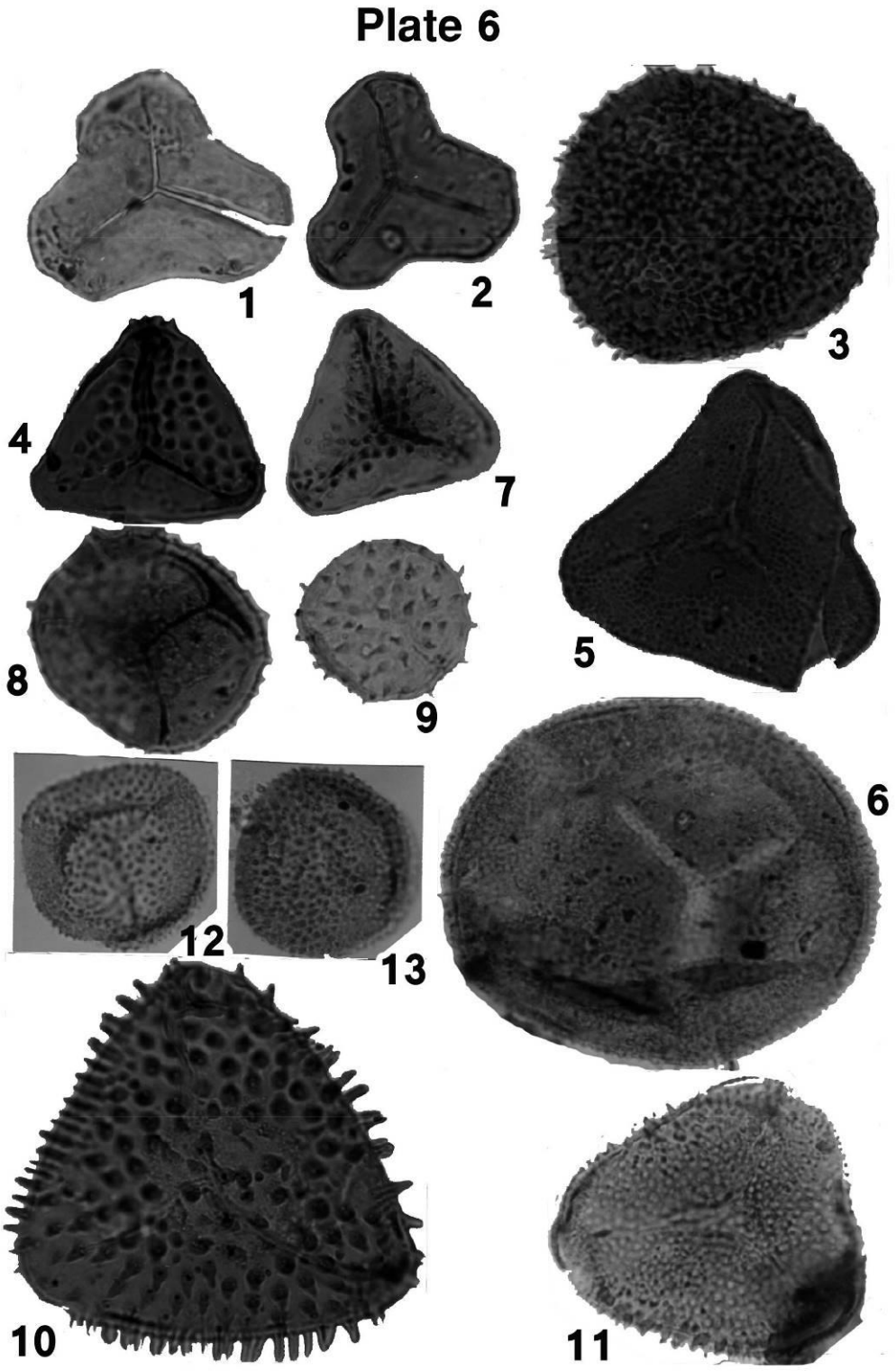


Plate 6
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Plate -7

Fig.1**.** ***Apiculiretusispora multiseta*** (Luber) Butterworth and Spinner, 1967/ Akk-1197(1), Size 54µm.
Fig.2. ***A. denticultata*** Butterworth et al., 1988/ Akk-1137(2), Size37µm.
Fig.3. ***Neoraistrickia cf.inconstans*** Neves,1961 / Akk-1135(2) , Size 51µm.
Fig.4. ***Raistrickia accincta*** Playford and Helby,1968 / Akk-1137(2), Size 25µm.
Fig.5. ***R. accincta*** Playford and Helby,1968 / Akk-1135(2), Size 37 µm.
Fig.6**.** ***Raistrickia accincta*** Playford and Helby,1968 / Akk-1137(2), Size 40 µm.
Fig.7. ***R.corynoges*** Sullivan, 1968/ Akk-1135(1), Size53 µm.
Fig.8. ***R.densa*** Urban, 1971/ Akk-1138(1), Size40 µm.
Fig.9. ***R.cf. kentuckiensis Pebbers***, 1964/ Akk-1143.5(2), Size38 µm.
Fig.10. ***R.cf. kentuckiensis Pebbers***, 1964/ Akk-1143.5(2), Size40 µm.
Fig.11. ***R.nigra*** Love, 1960/ Akk-1135(2), Size65 µm.
Fig.12. ***R.nigra*** Love, 1960/ Akk-1120.5(1), Size34 µm.

Plate -8

Fig.1. ***Raistrickia pisillata*** Hacquebard 1957 / Akk-1143.5(2) /Size60µm.
Fig.2. ***Raistrickia pilus*** (Neves) comb.Nov. / Akk-1136(1) /Size50µm.
Fig.3. ***Raistrickia sp.1*** / Akk-1143.5(2) /Size48µm.
Fig.4. ***Raistrickia sp.2*** / Akk-1143.5(2) /Size 55µm.
Fig.5. ***Raistrickia sp.2*** / Akk-1138(1) /Size45µm.
Fig.6. ***Convolutispora florida*** Hoffmeister, Staplin and Malloy, 1955/ Akk-1135.5 (2) /Size50µm.
Fig.7**.** ***Convolutispora superficialis*** Felix and Burdidge, 1967/ Akk-1143.5(2) /Size 48µm.
Fig.8. ***Convolutispora cf. tuberosa*** Winslow, 1962/ Akk-1120.5(1) /Size 48µm.
Fig.9**.** ***Microreticulatisporites lunatus*** Knox 1950/ Akk-117.5(2) /Size 50µm.

Plate 7

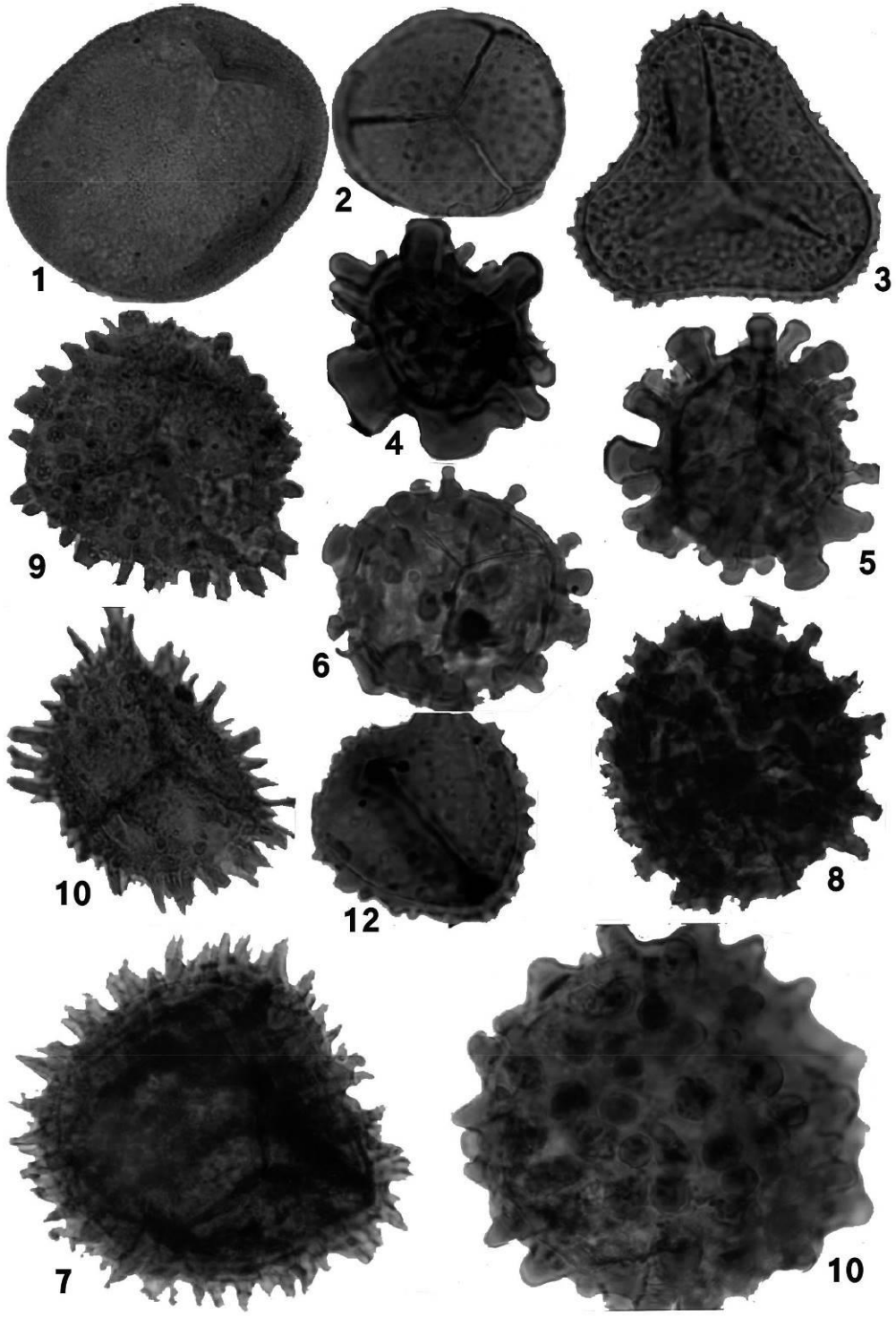

Plate 8

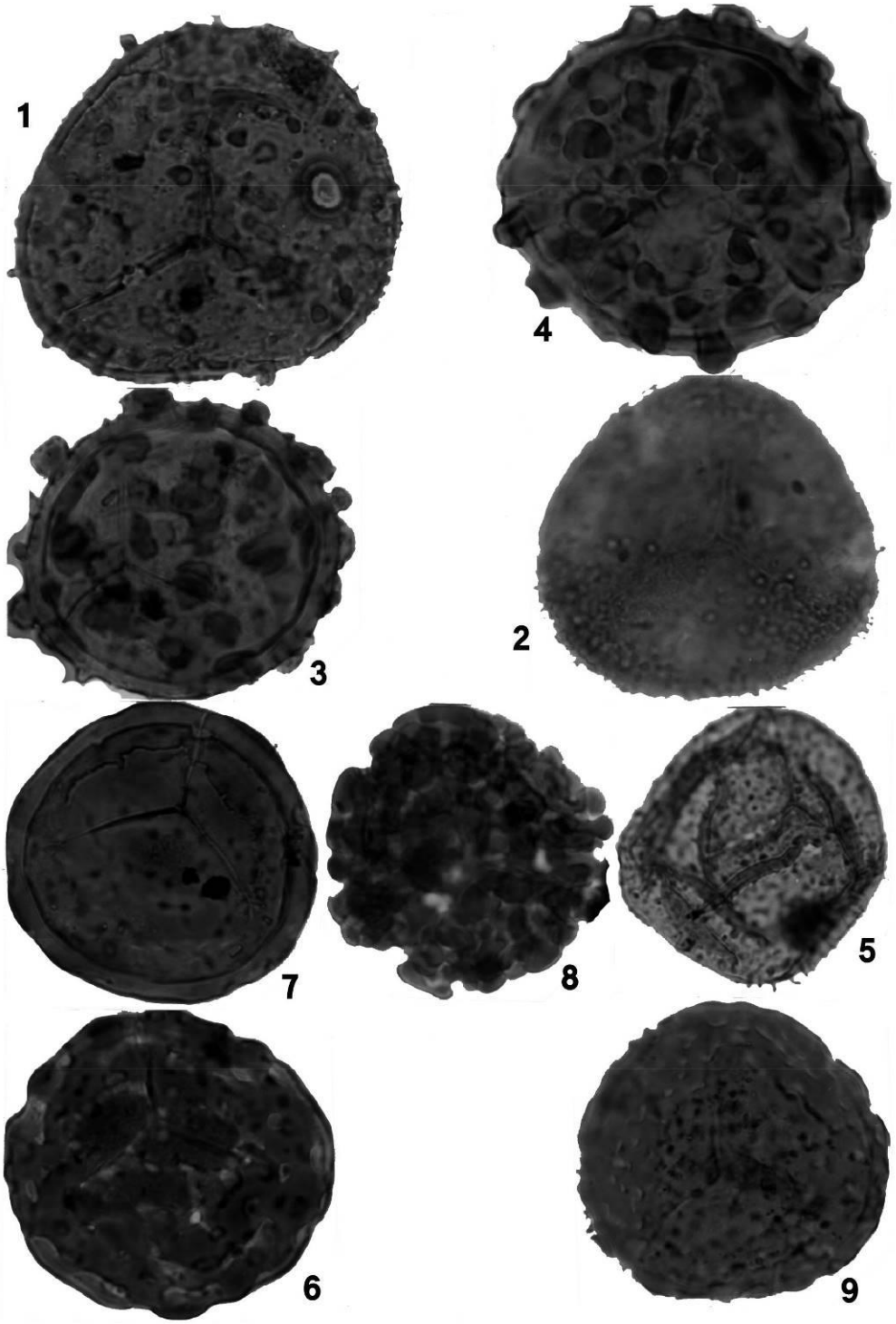

Plate -9

Fig.1. ***Dicyotriletes trivialis*** Naumova 1963 / Akk-1120.5(1) /Size 60µm.
Fig.2. ***Diatomozonotriletes fragilis*** Clayton in Neves et al.,1973/Akk-1135(2)/Size 50µm.
Fig.3. ***Stenozonotriletes coronatus*** Sullivan and Marshall 19636 / Akk-1120.5(1) /Size 37µm.
Fig.4. ***S.perforatus*** Playford 1962 / Akk-1137(1) /Size 60µm.
Fig.5. ***S. simplex*** Naumova 1953 / Akk-1137(1) /Size 37µm.
Fig.6. ***S. cf.simplex*** Naumova, Naumova, 1953 / Akk-1137(1) /Size 32µm.
Fig.7. ***S. cf.triangulus*** Neves, 1961 / Akk-1197(1) /Size 78µm.
Fig.8. ***Knoxisporites ruhlandi*** Doubinger and Rauscher, 1966/Akk-1137(1), Size44 µm.
Fig.9. ***Lophozonotriletes sp.*****1** /Akk-1138(2), Size43 µm.
Fig.10. ***Cymbosporites*** Love, 1960/ Akk-1135(2), Size65 µm.
Fig.11. ***Cunisporites rigidus*** Ravn, 1979/ Akk-1137(1), Size35 µm.

Plate -10

Fig.1. *Savitrisporites nux* (Butterworth and Williams) Smith and Butterworth, 1967/ Akk-1136(1), Size 42µm.
Fig.2***. Leizonotriletes cf. indignities*** **Hacquebard**, 1957/ Akk-1136 (1), Size 62µm.
Fig.3. ***Tetanisporites grnulatus*** Ravn, 1979 / Akk-1143.5(1), Size 42µm.
Fig.4. ***T.sp.*****A** / Akk-1197(2), Size 37µm.
Fig.5. ***T.sp.*****A** / Akk-1135(1), Size 36µm.
Fig.6. ***T.sp.*****A** / Akk-1136(2), Size 50µm.
Fig.7. ***Reticulatisporites cancellatus*** (Waltz)Playford,1962/ Akk-1136(2), Size95 µm.
Fig.8. ***R. Peltatus*** Playford, 1962 / Akk-1143.5(2), size 60 µm.
Fig.9. ***Rotaspora knoxi*** Butterworth and Williams, 1958/ Akk-1197(1), size 40 µm.
Fig.10. ***R. knoxi*** Butterworth and Williams, 1958/ Akk-1137(1), size 41 µm.
Fig.11. ***R. knoxi*** Butterworth and Williams, 1958/ Akk-1137(2), size 35 µm.

Plate 9

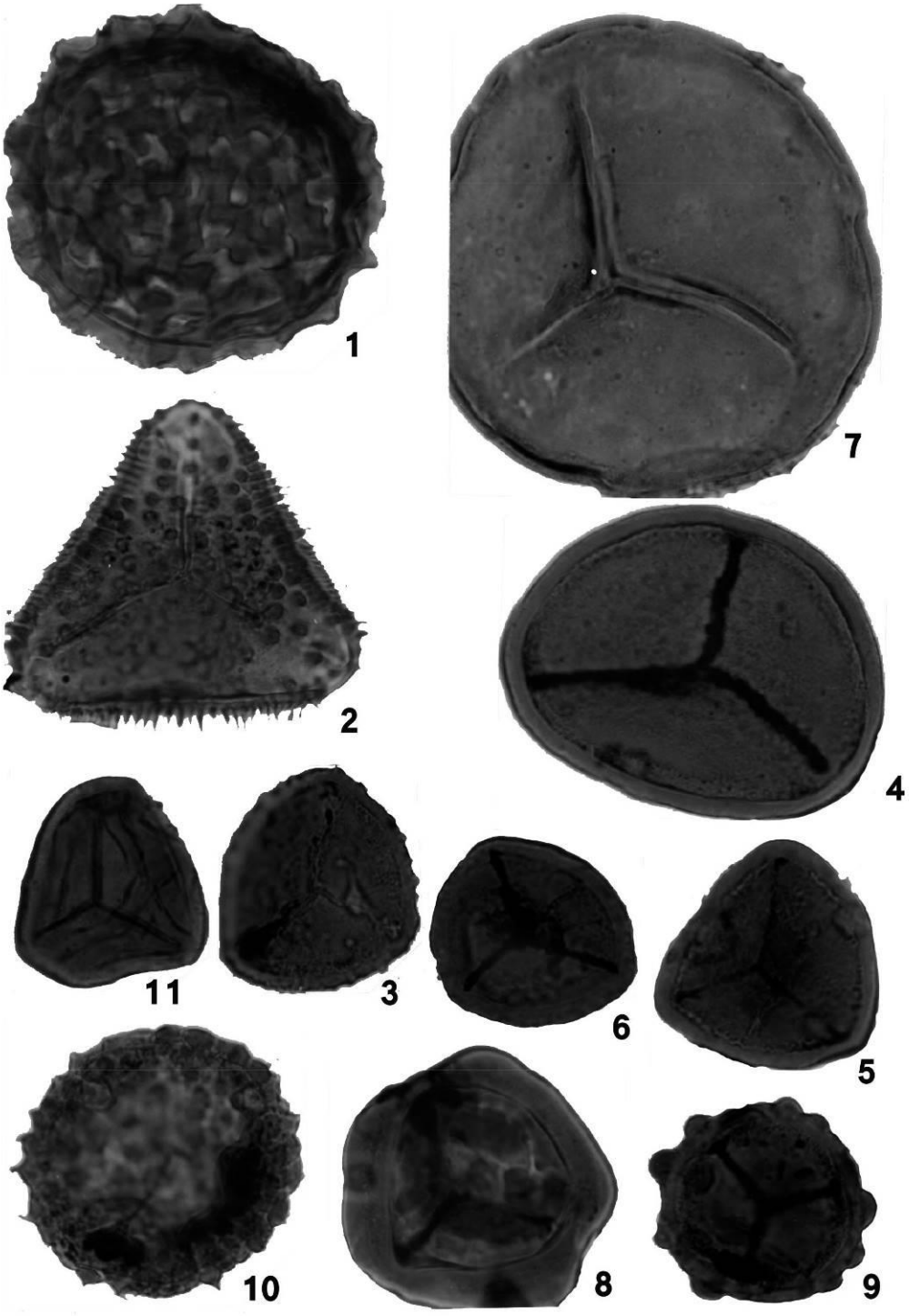

Plate 10

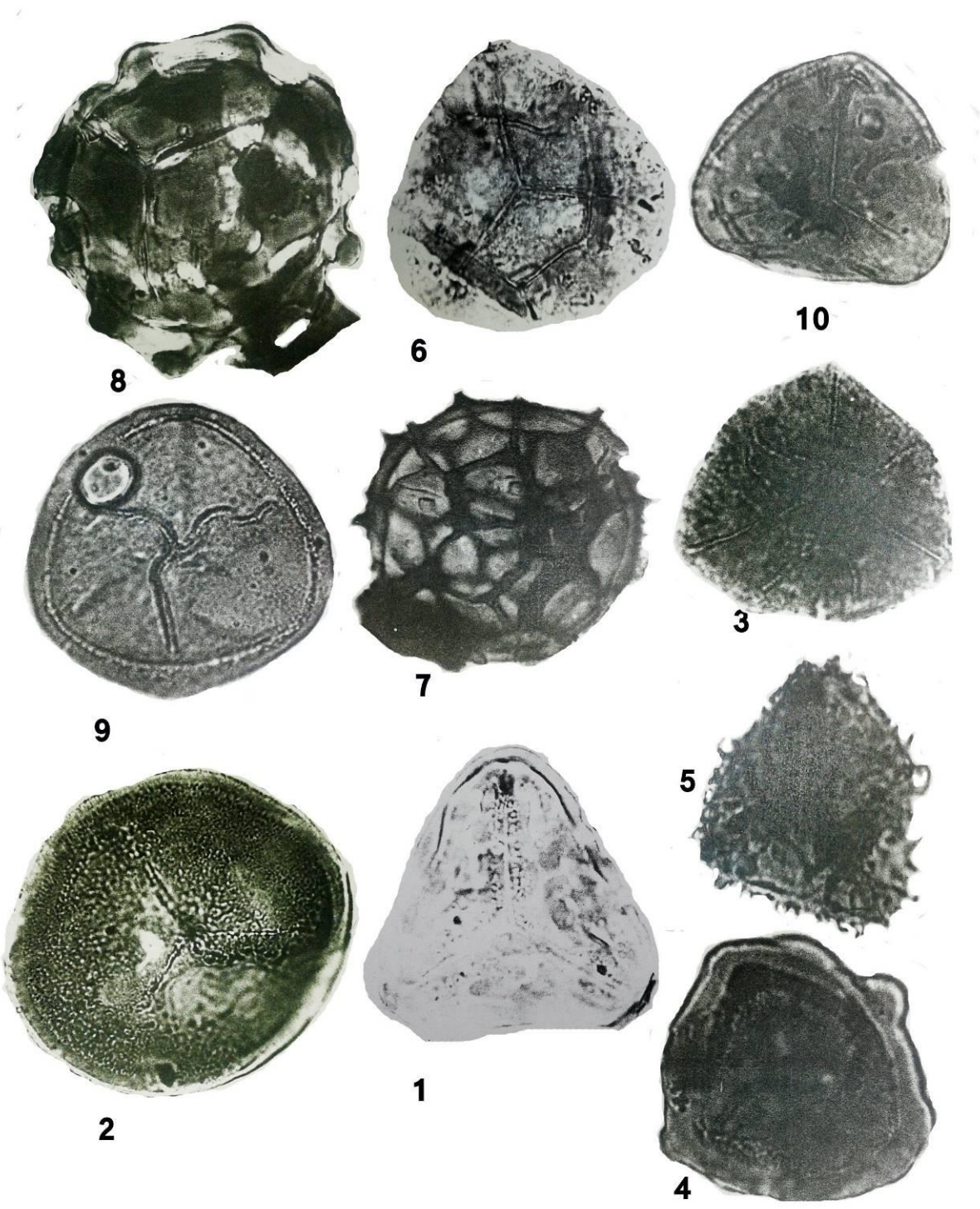

Plate -11

Fig.1. ***Crassispora knosankei*** (Potonie and Kremp) Bharadwaj, 1957/ Akk-1143.5(21), Size69µm.
Fig.2. ***Crassispora trychera*** Neves and Ioannides, 1974/ Akk-1138(1), Size66µm.
Fig.3. ***Densosporites rarispinosus*** Palyford, 1963 / Akk-1135(2), Size55µm.
Fig.4. ***D. spitsbergensis*** Playford, 1963 / Akk-1120.5(1), Size65µm.
Fig.5. ***D. variablilis*** (Waltz) Potonie and Kremp, 1956/ Akk-1136(1), Size 43 µm.
Fig.6. ***D. variomarginatus*** Playford, 1963/ Akk-1143.5(1), Size 48 µm.
Fig.7. ***Cristatisporites echinatus,*** Playford, 1963/ Akk-1138(1), Size56µm.

Plate -12

Fig.1. ***Kraeuselisporties ornatus*** (Neves)Owens, Mishell and Marshall, 1976/ Akk-1138(2), Size 68µm.
Fig.2. ***K. ornatus*** (Neves) Owens, Mishell and Marshall, 1976/ Akk-1136(2), Size 65µm.
Fig.3. ***Vallatisporites agadesi*** Loboziak and Alpen, 1978/ Akk-1138(1), Size 53µm.
Fig.4. ***Vallatisporites ciliaris*** (Luber) Sullivan, 1964b/ Akk-1120.5(1), Size 60µm.
Fig.5. ***Vallatisporites galearis*** Sullivan, 1964b/ Akk-1197(1), Size57µm.
Fig.6. ***V. galearis*** Sullivan, 1964b/ Akk-1137(1), Size48µm.
Fig.7. ***Radiizonatus genuinus*** (Jushko) Loboziak and Alpen, 1978/ Akk-1120.5(1), Size 62µm.
Fig.8. ***Radiizonatus genuinus*** (Jushko) Loboziak and Alpen, 1978/ Akk-1137(1), Size 88µm.
Fig.9. ***Prolycospora rugulosa*** (Butterworth and Spinner) Tumau, 1978/ Akk-1178(1), Size 35µm.

Plate 11

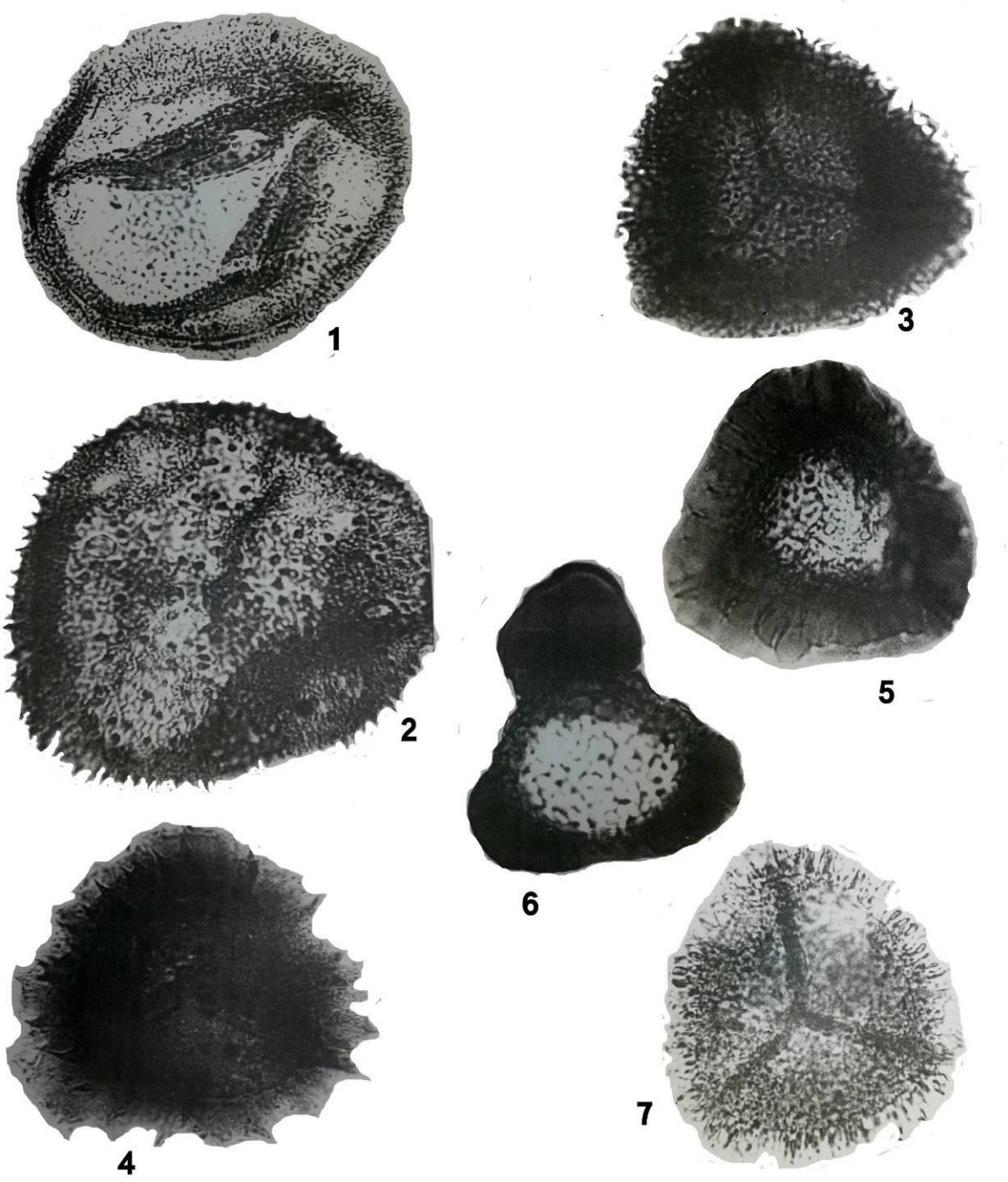

Plate 12

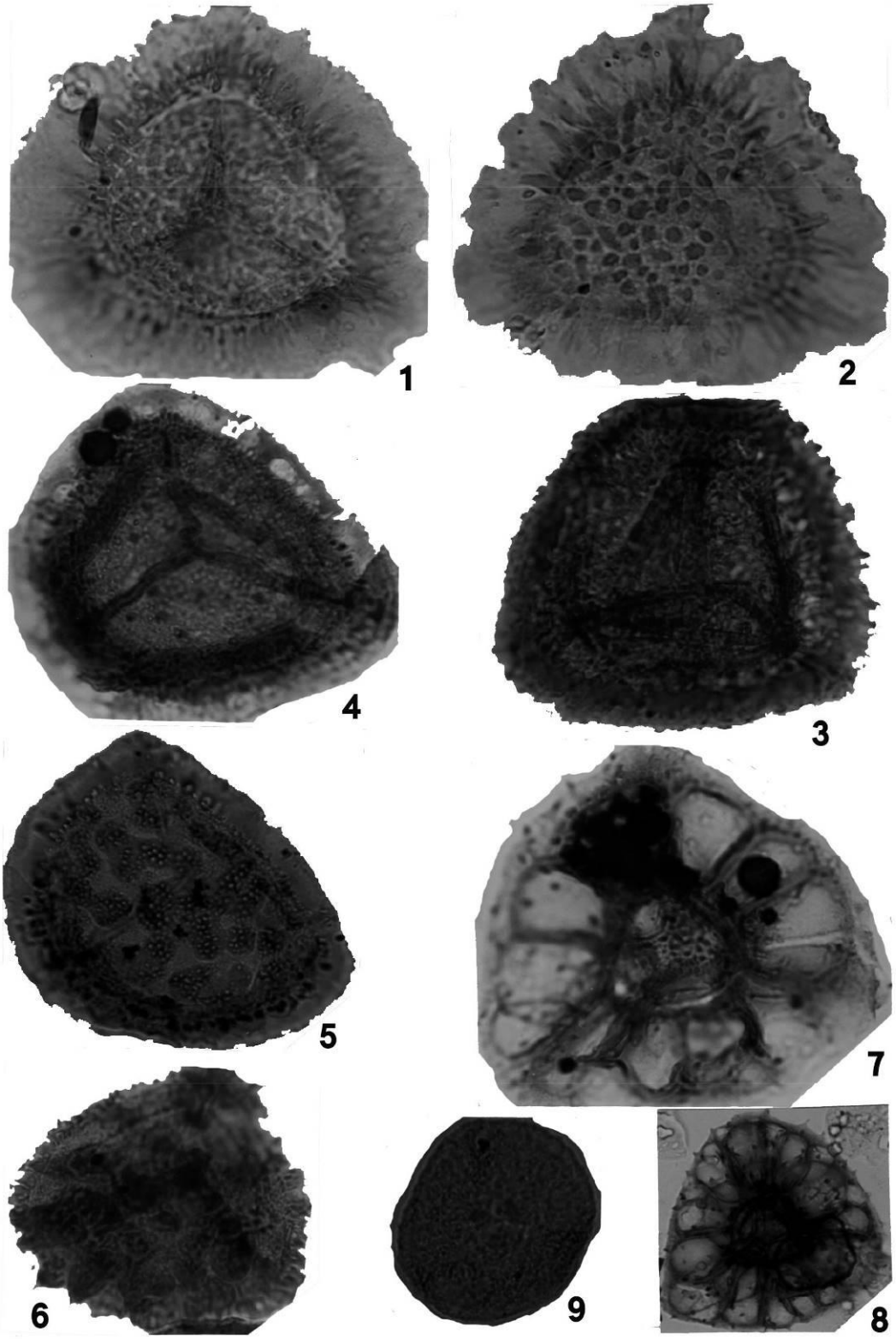

Plate -13

Fig.1. ***Prolycospora rugulosa*** (Butterworth and Spinner) Turnau, 1978/ Akk-1197(1), Size36µm.
Fig.2. ***Vallatisporites vallatus*** Hacquebard, 1957 / Akk-1136(1), Size45µm.
Fig.3. ***Vallatisporites vallatus*** Hacquebard, 1957 / Akk-1136(1), Size42µm.
Fig.4. ***Anulatisporites orbiculatus*** (Waltz) Playford, 1963 / Akk-1120.5(1), Size58µm.
Fig.5. ***Ascetospora carnosa*** Playford, 1963 / Akk-1136(1), Size60µm
Fig.6. ***Ascetospora sp.1*** / Akk-1135(1), Size 63µm.
Fig.7. ***Auroraspora macra*** Sullivan, 1968 / Akk-1138(2), Size 50µm.
Fig.8. ***A. solisorta*** Hoffmeister Staplin and Malloy, 1955/ Akk-1137(2), Size50µm.
Fig.9. ***A. solisorta*** Hoffmeister Staplin and Malloy, 1955/ Akk-1197(1), Size35µm.
Fig.10. ***Colatisporites decorus*** (Bharadwaj and Vekatachala) Williams in Neves et al., 1973/ Akk-1197(1), Size 62µm.

Plate -14

Fig.1.***Colotisporites denticulatus*** Nevile inNeves *etal*.,1973/Akk-1137(2), Size48 µm.
Fig.2. ***C. denticulatus*** Nevile in Neves *et al*., 1973 / Akk-1197(1), Size 45 µm.
Fig.3. ***C.cf. denticulatus*** Nevile in Neves *et al*., 1973 / Akk-1143.5(2), Size 60 µm.
Fig.4. ***Diaphanosporites sp.1*** / Akk-1139(2), Size 55 µm.
Fig.5. ***Discernisporites micromaniferstus*** (Hacquebard)Sabry and Neves,1971/Akk-1197(1), Size 56 µm.
Fig.6. ***Endosporites delicatus*** Staplin, 1960 / Akk-1143.5(1), Size 53 µm.
Fig.7**. *E. zonalis*** (Loose) Knox, 1950 / Akk-1120.5(1), Size 37 µm.
Fig.8. ***Geminospora lemurata*** Balme, 1962 / Akk-1120.5(1), Size 54 µm.
Fig.9. ***Grandispora cf. notensis*** Playford, 1971 / Akk-1137(2), Size 50 µm.
Fig.10. ***Monilospora dignata*** Playford, 1963/ Akk-1137(2), Size48µm.

Plate 13

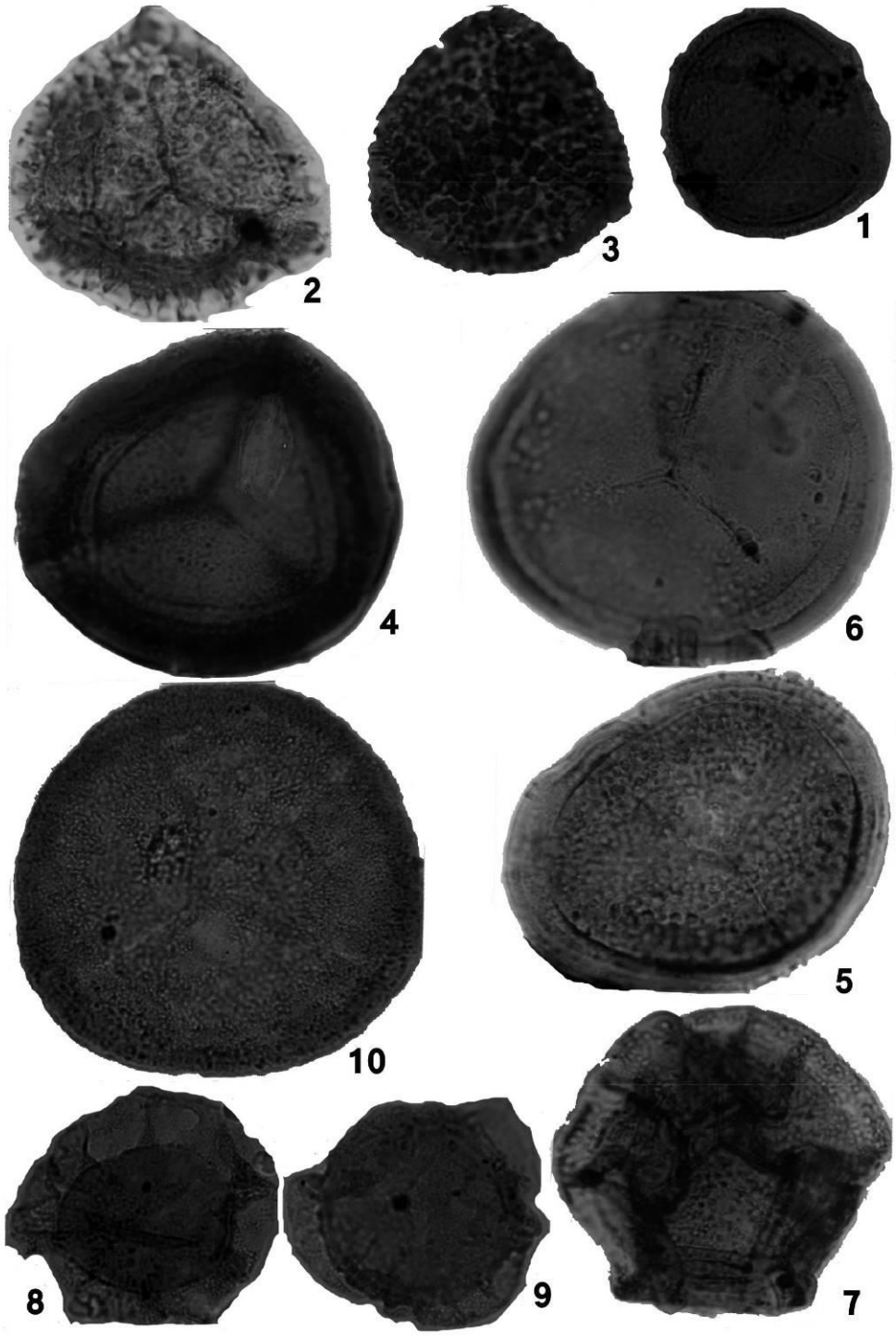

Plate 14

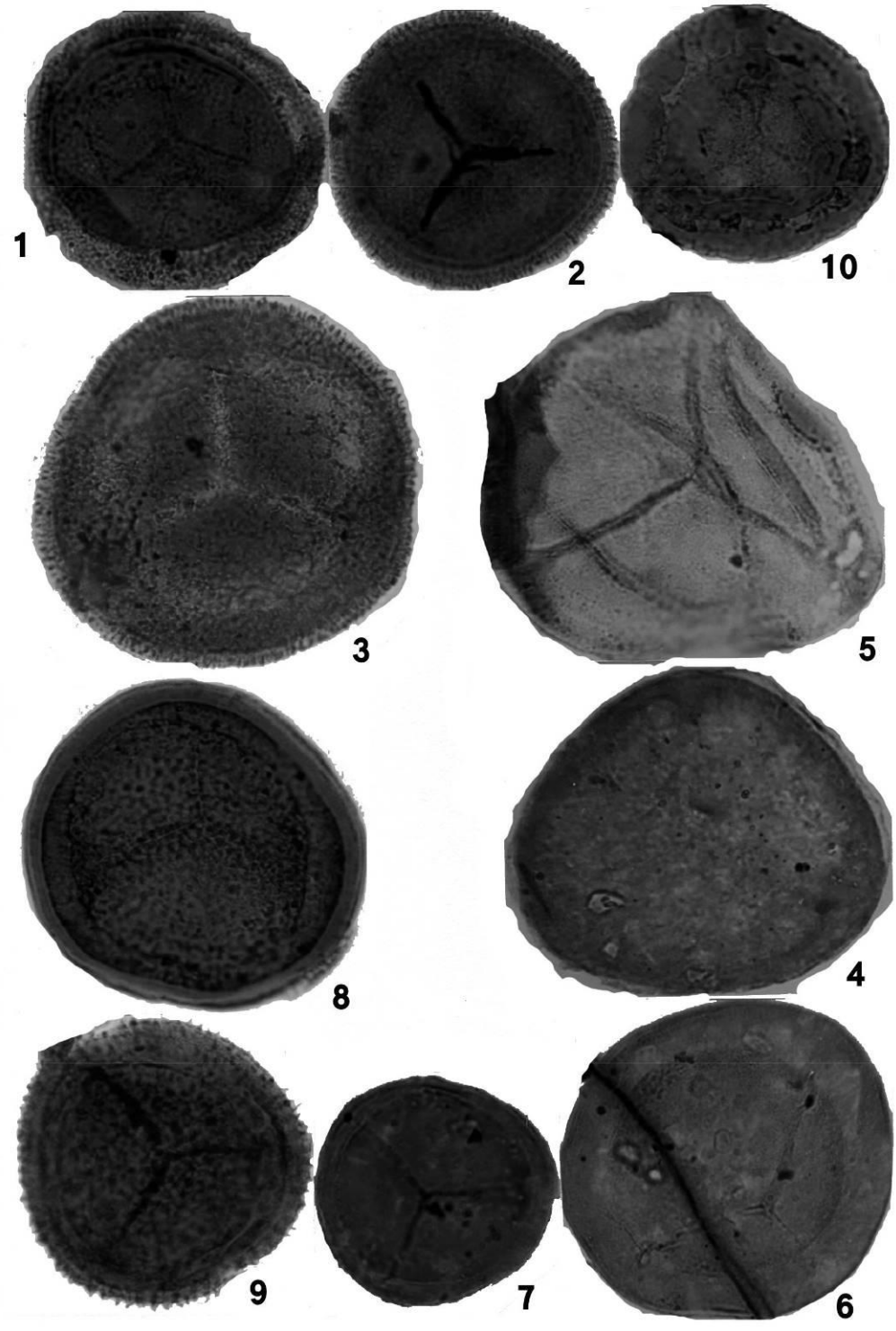

Plate -15

Fig.1. ***Rugospora polyptycha*** Neves and Ioannides,1974/ Akk-1139(2), Size 70µm.
Fig.2. ***Spelaeotriletes arenaceous*** Neves and Owens,1966/ Akk-1136(1), Size 97µm.
Fig.3. ***S.benghaziensis*** Loboziak and Clayton, 1988 / Akk-1136(2), Size 85µm.
Fig.4. ***S.benghaziensis*** Loboziak and Clayton, 1988 / Akk-1143.5(1), Size 90µm.
Fig.5. ***S. crustatus*** Higgs, 1975a / Akk-1197(2), Size 58µm.
Fig.6. ***S. crustatus*** Higgs, 1975a / Akk-1197(1), Size 70µm.
Fig.7. ***S. gigantes*** Loboziak and Clayton, 1988/ Akk-1136(1), Size100µm.
Fig.8. ***Spelaeotriletes Owenis*** Loboziak and Alpern,1978/ Akk-1143.5(1), Size65µm.
Fig.8. ***S. Owenis*** Loboziak and Alpern, 1978 / Akk-1143.5(1), Size 60µm.

Plate -16

Fig.1. ***Spelaeotriletes triangulus*** Neves and Owens, 1966/ Akk-1120(1), Size 125 µm.
Fig.2. ***Velamisporites irrugatus*** Playford, 1978 / Akk-1197(1), Size 72 µm.
Fig.3. ***Aratrisporties saharaensis*** Loboziak, Clayton and Owens, 1986 / Akk-1197(2), Size64µm.
Fig.4. ***Thymospora sp.A*** / Akk-1135(1), Size 62 µm.
Fig.5. ***Latosporites sp.A*** / Akk-1143.5(2), Size 82 µm
Fig.6. ***Tasminites sp.1*** / Akk-1120.5(1), Size 54µm.
Fig.7. ***Acritarch type A*** / Akk-1135(2), Size 50µm.
Fig.8. ***Acritarch type B***/ Akk-1135(2), Size32µm.
Fig.9. ***Acritarch type C***/ Akk-1136(2), Size110µm.
Fig.10. ***Acritarch type D***/ Akk-1197(1), Size21µm
Fig.11. ***Acritarch type E***/ Akk-1120.5(1), Size25µm
Fig.12. ***Acritarch type F***/ Akk-1135(2), Size35µm

Plate 15

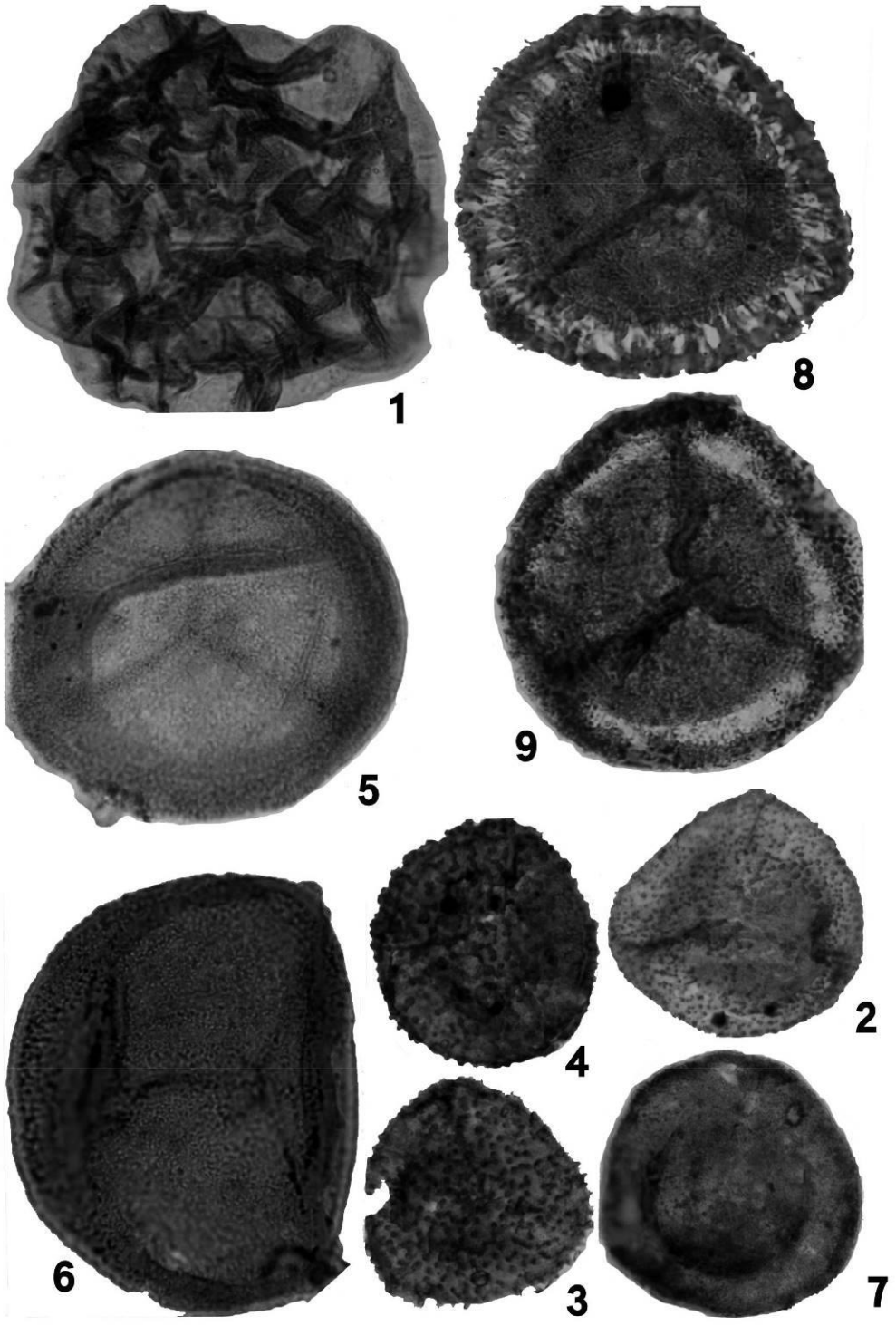

Plate 16