A Palynological Study of the Subdivision of the Cardita Shales (Upper Triassic) of Bleiberg, Austria

Palynologische Studie zur Gliederung der Cardita-Schiefer (Obertrias) von Bleiberg, Österreich

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Whit 3 Figures

Zusammenfassung

Drei Carditaschiefer-Horizonte aus dem Bergbau Bleiberg (Kärnten, Österreich) wurden sporenstratigraphisch untersucht, um die Möglichkeit einer Feingliederung der karnischen Stufe der alpinen Trias mittels Mikrosporen zu prüfen.

Insgesamt wurden 14 Proben aus den drei Cardita-Schiefern analysiert, wobei 52 Sporengattungen mit 82 Arten gefunden wurden. Bestimmte Sporengesellschaften gestatteten eine Unterscheidung der drei Schieferhorizonte. Wechselnde Prozentsätze einiger Gattungen und das begrenzte Vorkommen einiger weniger häufiger Sporenformen wurden als Grundlage zur Identifizierung der Schiefer herangezogen. Folgende Sporengattungen und Arten scheinen für die Feinstratigraphie von Bedeutung zu sein:

1. Schiefer:

Taeniaesporites kraeuseli LESCHIK (h)
Araucariacites
Aratrisporites (ss)
Decussatisporites
Parvisaccites spp.
Monosulcites of. *minimus* COOKSON
Leschikisporis aduncus (LESCHIK)

2. Schiefer:

Aratrisporites (h)
Araucariacites
Taeniaesporites kraeuseli LESCHIK (ss)
Cycadopites
Rimaesporites
Zebrasporites Kahleri KLAUS
Cycadopites aff. *Marsupipollenites*

3. Schiefer:

Araucariacites
Taeniaesporites kraeuseli LESCHIK
Aratrisporites
Klausipollenites (h)
Cycadopites aff. *Marsupipollenites*

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Abstract

Fossil spores and pollen of the Cardita shales from the Bleiberg area have been analysed for establishing further stratigraphical subdivisions of the Upper Triassic rocks. Counting analysis of 52 genera and 82 related species from 14 available samples proved that each individual shale unit of the section could be recognized by some of their important spore population assemblages. The changes in percentage of a few genera and a restricted occurrence of several other groups of pollen and spores were only used as the key indices in recognizing the different shale units. Important genera and species that were found to be good stratigraphical indicators were: *Aratrisporites, Araucariacites, Taeniaesporites kraeuseli, Klausipollenites, Parvisaccites, Rimaesporites, Decussatisporites, Cycadopites, Monosulcites* cf. *minimus, Leschikisporis aduncus* and *Zebrasporites Kahleri.*

Acknowledgments

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This work in general was carried out at the Palynological Laboratory of the Geological Survey of Austria under personal guidance of Doz. Dr. W. Klaus. The author takes this opportunity to place on record his sincere gratitude for introducing him to the field of Palynology and to select such an intersting topic as Triassic Palynology, for the preparation of a final study. The advices in respect of spore identification, preparation methods, nomenclature, stratigraphy, the valuable discussions on taxonomy and on the preliminary results contributed much to the successful completion of this work. The demonstrations on spore microphotography and counting analysis contributed in no less measure.

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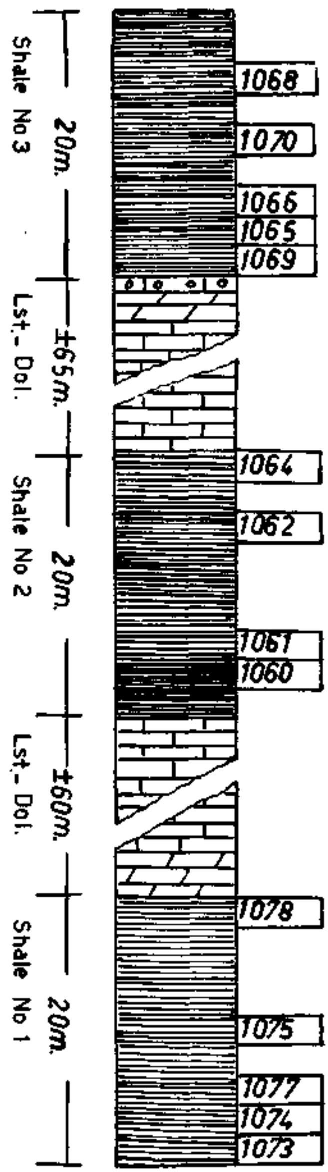
Introduction

This work is a part of Dr. Klaus' research program on the subdivision of the Upper Triassic of the East Alps. Upon the earlier results (Klaus 1959, 1960) it appeared to be successful to follow spore investigations on a regional basis. Klaus concluded on the basis of a statistical analysis of three Cardita shales (Lower part of Upper Triassic) from Mezica (Yugoslavia near the Austrian border) that identification of each shale could be possible in this area.

It was one of the main subjects of this report to examine if the same possibilities could also be found in a similar stratigraphic horizon at a distance of approx. 100 km. in the western direction.

The work involves the palynological investigations of 14 samples from the "Antonio-Middle Shaft" (Cardita shales of the Bleiberg area) (Lat. 46° 37'; Long. 31° 19'). This section is about 16 km. west of the town of Villach, Carinthia, Southern Austria. The samples were received by the courtesy of



GENERALIZED LITHOLOGY INDICATING THE LOCATION OF SAMPLES

Text Fig.1

Text Fig. 1.

Dr. L. KOSTELKA, Chief Geologist of Bleiberger Bergwerks-Union (Mining-Union), Austria, and have been made available to the author by the Palynological Laboratory of the Geol. Survey of Austria, Vienna.

The examined samples are from three different shale units (Cardita shales, Carnian stage *). They are separated from each other by 60—65 m. of limestones, dolomitic at places, especially between the first and the second shale units (Text Fig. 1). The lower most unit consists of black to dark grey hard compacted shaly material with a trace of carbonaceous matrix, in a few samples. The middle unit (Shale No. 2) consists of stratified black calcareous material and is softer and more laminated towards the upper reaches. The upper most unit (Shale No. 3) constists of slightly dark grey shaly material. It is darker and denser at the base, but more carbonaceous and lighter in colour at the top.

All treated samples were productive and yielded a good number of spores and pollen. Concentration and/or preservation of the microflora differed from sample to sample, but in most cases the middle unit shale samples had a greater recovery. They contained more desirable assemblages.

The objectives of this study were to record the stratigraphical markers of each shale unit and to establish a possible palynological basis for reliable correlation of the different shale units within the lead mining district of the Bleiberg area. With these purposes in view, the author undertook the statistical population analysis of the microflora of the three different lithological units of the Cardita shale assemblages.

Previous Investigations of Upper Triassic Sediments in Alpine-Regions

The first note on the microflora of the Carnian stage of Austria was recorded by KLAUS in 1959. In 1960, he also published a comprehensive report on the spores and pollen of the same age. In this critical report he cleared the confusion then existing on some different genera by illustrating the important diagnostic features. He also expressed the opinion that some spores may prove to be valuable in making finer stratigraphic divisions of the Triassic period.

BHARADWAJ & SINGH (1963) listed 40 species from the Upper Triassic coals of Austria (Lunz). These forms are mainly made up of trilete and monosaccate grains. The author's conclusion indicates that the Upper Triassic microflora acts as a transitional stage between predominantly striated-winged grains of the Lower Triassic and nonstriated-winged grains of the Liassic or the Younger Mesozoic ages. Another contribution to the study of fossil spores and pollen of the Upper Triassic Alpine-Region is of PAUTSCH (1958) from the Swierczyna, Poland.

From the adjacent countries of Austria, the works of LESCHIK (1955), Switzerland; MÄDLER (1964), Germany; and VENKATACHALA & GOĆZAŃ (1964), Hungary, have also been referred though, they are not from the Alpine-Region and are not exactly of the same stratigraphic horizon.

Preparation of Samples

The laboratory procedures adopted in preparation of the samples are based on the principal techniques that are commonly employed in the Palynological Laboratory of the Geol. Survey of Austria, Vienna.

*) Carnian stage is the lower part of Upper Triassic in East Alp, and it corresponds to Lower-Middle Keuper of Germany.

The successful step in destruction of the organic residues has been adopted from ERDTMAN's method with a minor modification introduced by KLAUS. As modified, this method is applicable to various kinds of sediments and not only to modern herbarium, peat and/or lignits.

All the calcareous shale samples were made to undergo the stages hereby described. Intensity treatment and the duration of each process was different for different samples. They were applied according to the individual needs of the studied materials.

The samples were powdered, cooked with HCl and washed three times. Later the residues were boiled with 70% HF and were washed thrice. The washed materials were then treated with HCl and centrifuged. At this stage the samples were divided into two parts. With one part the modified ERDTMAN's method was carried out. In this process the chlorination step was done first and later acetolysis. The second part was also processed by the same method but after the heavy liquid separation with Bromoform. The pollen bearing residues from the two different parts were compared to access the preferability of the techniques and in many cases the results were almost the same.

Shaly samples without calcarous matrix were also treated with the above techniques except for omitting the first HCl treatment.

The Palynokoïnum

The three different Cardita shale units were very rich in microflora. Fossil spores and pollen such as *Triletes*, *Monoletes*, *Monosaccites* and *Disaccites* are present in all samples and only the abundance of the above mentioned groups was found to change from one to another sample.

The spore assemblages of the Cardita shales show some similarities to the Upper Triassic coals of Lunz (BHARADWAJ & SINGH) but they were found to be more similar and identical with the assemblages of Cardita- and Halobia layers of Austria (KLAUS) and the Middle Keuper of Switzerland (LESCHIK).

Systematic description of the examined specimens are not given in this report as they have already been treated and dated elsewhere at full length. An attempt is only made here to list all the names of the identified forms of the various samples. All the vertical ranges of these forms are not restricted to the Carnian stage and some have already been reported from higher or lower stratigraphic horizons than Upper Triassic.

SPORITES

Triletes

Azonaletes

Laevigati:

Aulisporites astigmosus (LESCHIK)
Aulisporites canalis LESCHIK
Calamospora nathorsti (HALLE)
Calamospora sinuosus LESCHIK
Carnisporites hercynicus MÄDLER
Dictyophyllidites harrisii COUPER
Dictyophyllidites lunzensis (KLAUS)
Leschikisporis aduncus (LESCHIK)

Todisporites fissus BHARADWAJ & SINGH
Todisporites major COUPER
Todisporites minor COUPER
Todisporites sp.

Apiculati:

Apiculatisporis hirsutus (LESCHIK)
Apiculatisporis lativerrucosus (LESCHIK)
Apiculatisporis parvispinosus (LESCHIK)
Conbaculatisporites mesozoicus KLAUS
Conbaculatisporites sparsus (BHARADWAJ & SINGH)
cf. Concavissimisporites sp. DELCOURT & SPRUMONT
Conosmundasporites othmari KLAUS
Osmundacidites alpinus KLAUS
Osmundacidites congestus (LESCHIK)
cf. Raistrickia sp.
Trilites tuberculatiformis COOKSON
Trilites klausi BHARADWAJ & SINGH
Verrucosisporites morulae KLAUS

Murornati:

Anulispora punctus (KLAUS)
Camarozonosporites rudis (LESCHIK)
Corrugatisporites aff. *klukiformis* NILSSON
Corrugatisporites sp.
Lycopodiacidites kuepperi KLAUS
Microreticulatisporites opacus (LESCHIK)
Tigrisporites halleinis KLAUS
Zebrasporites fimbriatus KLAUS
Zebrasporites kahleri KLAUS

Zonales

Zonotriletes

Zonati:

Styxisporites cooksonae KLAUS

Monoletes

Zonomonoletes:

Aratrisporites coryliseminis KLAUS
Aratrisporites paraspinosus KLAUS
Aratrisporites scabratus KLAUS
Saturnisporites fimbriatus KLAUS
Saturnisporites fischeri KLAUS
Saturnisporites granulatus KLAUS

Aletes

Psilonapiti:

Peroaletes convolutus BHARADWAJ & SINGH

POLLENITES

Saccites

Disaccites

Disaccitriletes:

Illinites sp.
Triadispora crassa Klaus
Triadispora staplini (Jansonius)
cf. *Vitreisporites signatus* Leschik

Disaccimonoletes:

Chordasporites singulichorda Klaus
Ovalipollis grebeae Klaus
Ovalipollis lunzensis Klaus
Ovalipollis mohrensis (Leschik)
Ovalipollis rarus Klaus
Ovalipollis distinct species.
Protosacculina cf. *glabrescens* Maljawkina
Striatites sp.
Taeniaesporites kraeuseli Leschik

Disacciatriletes:

Alisporites sp.
Microcachryidites fastidioides (Jansonius)
Minutosaccus potoniei Mädler
Parvisaccites sp.
Klausipollenites sp.
Pityosporites neomundanus Leschik
Pityosporites cf. *ruttneri* Klaus
Platysaccus sp.
Scopulisporites cf. *toralis* Leschik
Rimaesporites

Monosaccites:

Ellipsovelatisporites plicatus Klaus
Enzonalasporites tenuis Leschik
Patinasporites densus Leschik
Patinasporites cf. *funiculus* Leschik
Patinasporites iustus Klaus
Patinasporites toralis Leschik

Circumpolles

Singulipollenites:

Duplicisporites granulatus Leschik
Duplicisporites punctatus Leschik
Paracirculina maljawkinae Klaus
Partitisporites novimundanus Leschik

Napites

Araucariacites australis Cookson

Monocolpates

Cycadopites accerimus (Leschik)
Cycadopites distinct species.
Cycadopites sp. aff. *Marsupipollenites*
Monosulcites cf. *minimus* Cookson
Decussatisporites martini Leschik
Decussatisporites distinct species.

Method of Statistical Analysis

In counting analysis, 150 grains and, wherever possible 200 grains were counted for each slide of the samples. Counting area for all the slides has been 324 sq. mm. (18 × 18 mm.) The counting was made at random, but always starting from the lower left corner of the slide.

Identification of the forms during the counting was based upon the photographs prepared from the grains of various slides from different samples. In some cases shrinkage and poor preservation of these specimens prevented the exact specific identification. So the generic level of the counted grains were taken under consideration during the calculation of percentages.

Sporestratigraphy of the Shales

Each individual shaly member of the Cardita shales of the Bleiberg area could be recognized by counting analysis of the spore assemblages.

The method of statistical analysis employed in this investigation proved that some spores appear to be much of importance for stratigraphical subdivisions. This justifies Klaus' view that it is possible to make smaller stratigraphic divisions within the Triassic sediments with the aid of some spores.

From 52 genera and 82 recognized species only 14 groups could be separated as good stratigraphical indicators (Text Fig. 2). These groups are considered to be important as they act as the microfloristic indices for finer stratigraphic division in Cardita shales.

Distinguishing groups of Shale No. 1:

This lithological unit is identified by a high percentage of *Taeniaesporites kraeuseli* Leschik followed by *Araucariacites* and *Aratrisporites* in order of predominence (Text Fig. 3). It is also characterized by the apparent restriction of *Decussatisporites, Parvisaccites* spp., *Monosulcites* cf. *minimus* Cookson, and *Leschikisporis aduncus* (Leschik). The very minor percentage of *Klausipollenites* and *Rimaesporites* (Text Fig. 2) may also be of value in this unit.

Distinguishing groups of Shale No. 2:

This unit is identified by the highest percentage of *Aratrisporites,* associated with a low percentage of *Araucariacites* and a small representation of *Taeniaesporites kraeuseli* Leschik in comparison with the other units. The *Cycadopites* and *Rimaesporites* appear to extinct towards the top within this unit. The *Zebrasporites kahleri* Klaus, though extremely rare, is a good marker for this lithological unit as it is presumably found only in this unit. The first occurrence of *Cycadopites* aff. *Marsupipollenites* is also noteworthy.

Distinguishing groups of Shale No. 3:

This shale unit is distinguished by the absence of *Araucariacites* and the higher proportion of *Taeniaesporites kraeuseli* LESCHIK with respect to *Aratrisporites*. Furthermore, an increased representation of *Klausipollenites* and *Cycadopites* aff. *Marsupipollenites* in comparsion with the middle shale unit are of great value.

The *Enzonalasporites* and the different species of *Patinasporites* were found in all samples and they show a tendency to decrease in proportion in the second unit (Text Fig. 2). This tendency of decrease in quantity may or may not be of much stratigraphic importance but it probably reflects some ecological factors at the time of their existence.

Although the above proposed stratigraphic markers could be of some value in the Bleiberg area, the validity of them for broader correlations could not be completely reliable unless they were determined by some additional works in other different areas.

Summary and Conclusions

It has already been mentioned that the purpose and the scope of this study has been to identify the spore horizon indicators. From the investigations of the microflora of the Cardita shales (Carnian) it would seem very likely that the statistical analysis would be helpful in recognizing each lithological unit.

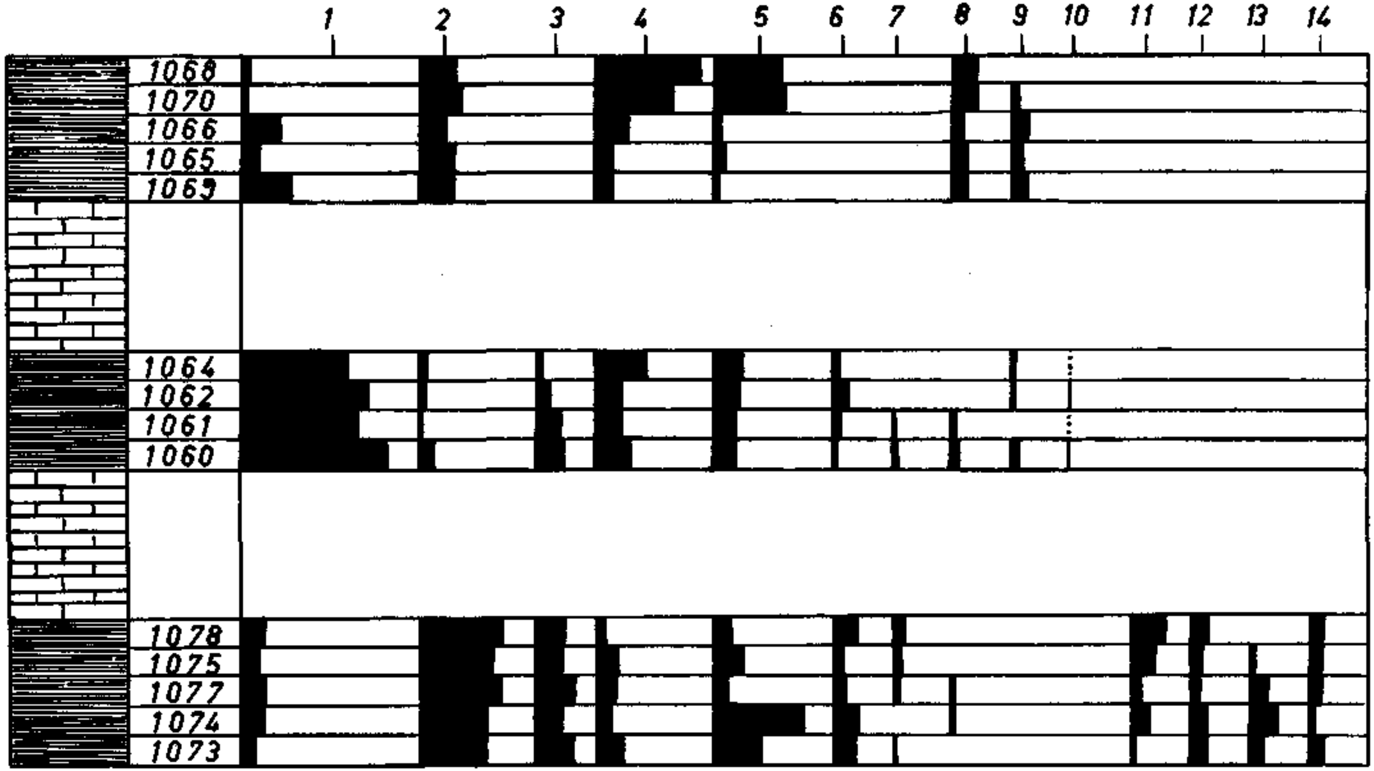
Not all fossil spores and pollen assemblages were useful in this connection, but only some were of great value, as stratigraphic markers. The least valuable forms were *Triletes* whereas *Monoletes* and *Disaccites* were of importance. Appearance or disappearance of some forms coupled with the great abundance of a few genera in all the shale units have been used as a tool in further stratigraphic division of the section.

The first shale is recognized by the greatest abundance of *Taeniaesporites kraeuseli* LESCHIK, lower percentage of *Araucariacites* and least occurrence of *Aratrisporites*. This shale is also represented by a restricted presence of *Decussatisporites*, *Monosulcites* cf. *minimus* COOKSON, *Parvisaccites* and *Leschikisporis aduncus* (LESCHIK).

The predominance of *Aratrisporites* and the least value of *Taeniaesporites kraeuseli* LESCHIK are the best criteria for the recognition of the second shale. Lower percentage of *Araucariacites* and the rare occurrence of *Zebrasporites Kahleri* KLAUS may also be considered as the auxiliary forms that distinguish this unit. Furthermore, *Cycadopites* has apparently disappeared at the top of this shale unit.

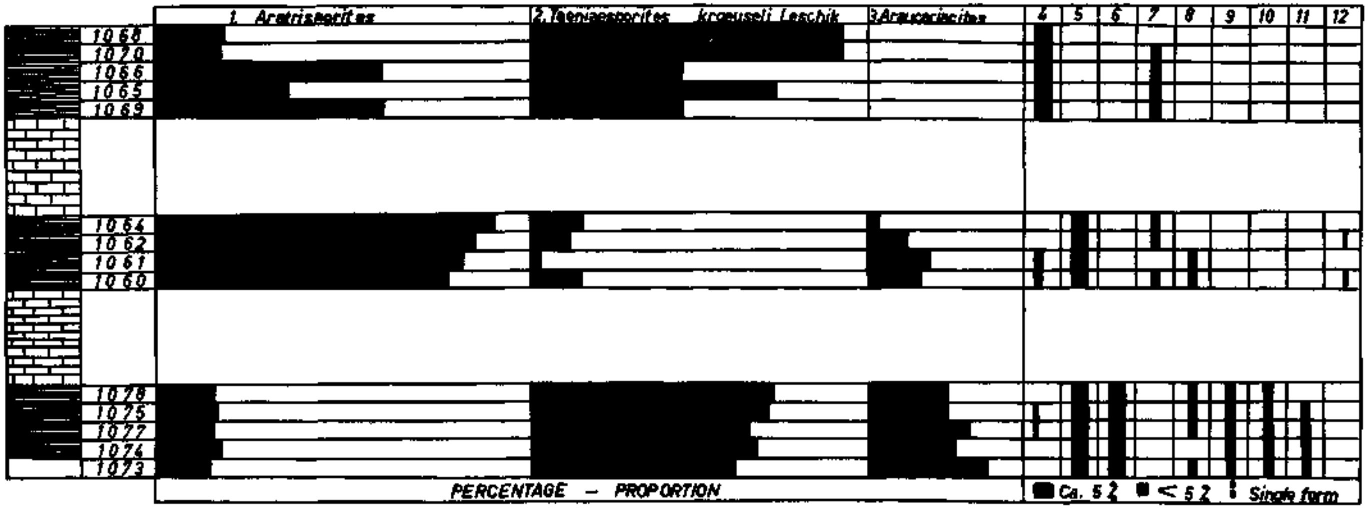
The third shale can be easily identified by the absence of *Araucariacites* and greater percentage of *Taeniaesporites kraeuseli* LESCHIK, in comparison with *Aratrisporites* and the relative abundance of *Klausipollenites* and the occurrence of *Cycadopites* aff. *Marsupipollenites*. The last two forms, however, were more predominant in this unit rather than in the middle unit.

At the moment, the author is unable to provide a complete evidence in support of his suggestions in regard to the above proposed microfloristic indices. However, he hopes that this work is a contribution for further exhaustive and detailed investigation of the spore stratigraphy of the Upper Triassic.



SPOREDIAGRAM OF CARDITA SHALES BLEIBERG

Text Fig. 2. 1. Aratrisporites, 2. Taeniaesporites kraeuseli Leschik, 3. Araucariacites, 4. Enzonalasporites & small Patinasporites, 5. Patinasporites iustus Klaus, 6. Cycadopites, 7. Rimaesporites, 8. Klausipollenites, 9. Cycadopites aff. Marsupipollenites, 10. Zebrasporites, 11. Decussatisporites spp., 12. Monosulcites cf. minimus Cookson, 13. Leschikisporis aduncus (Leschik), 14. Parvisaccites.



Text Fig. 3. 1. Aratrisporites, 2. Taeniaesporites kraeuseli Leschik, 3. Araucariacites, 4. Klausipollenites, 5. Cycadopites, 6. Decussatisporites spp., 7. Cycadopites aff. Marsupipollenites, 8. Rimaesporites, 9. Monosulcites cf. minimus Cookson, 10. Parvisaccites, 11. Leschikisporis aduncus (Leschik), 12. Zebrasporites.

It is noteworthy that the investigation has also resulted in the identification of at least three distinct forms which deserve new specific names. They are 1. specimens of *Decussatissporites* with fewer but broader stripes; 2. specimens of *Cycadopites* aff. *Marsupipollenites* with verrucated sculptures, a distinct horizontal leasure on the proximal side and a large pronouced distal sulcus and 3. specimens of *Ovalipollis* with large air sacs and a very dominant proximal slit. These features clearly demonstrate the transitional stage between this genus and the genus *Illinites*.

References

Bharadwaj, D. C., & H. P. Singh, 1963: An Upper Triassic miospore assemblage from the coals of Lunz, Austria: Paleobotanist vol. 12, no. 1, pp. 28—44, pls. 1—5.

Couper, R. A., 1958: British Mesozoic microspores and pollen grains. A systematic and stratigraphic study: Paleontographica Band 103 B, pp. 75—179, pls. 15—31.

De Jersey, N. J., 1962: Triassic spores and pollen grains from the Ipswich coalfield: Geol. Surv. Qld., Publ. no. 307, pp. 1—18, pls. 1—6.

De Jersey, N. J., 1964: Triassic spores and pollen grains from the Bundamba group: Geol. Surv. Qld., Publ. no. 321, pp. 1—21, pls. 1—2.

Delcourt, A., & G. Sprumont, 1955: Les spores et les grains de pollen du Wealden du Hainut: Mem. Soc. Belge Geol. nouvelle série no. 4, pp. 1—73, pls. 1—4.

Jansonius, J., 1962: Palynology of Permian and Triassic sediments, Peace River area, Western Canada: Paleontographica Band 110 B, pp. 33—98, pls. 11—16.

Klaus, W., 1959: Sporenfunde in der karnischen Stufe der alpinen Trias: Verh. Geol. B. A., Wien, pp. 160—163.

Klaus, W., 1960: Sporen der karnischen Stufe der ostalpinen Trias: Jahrbuch d. GBA, Sonderbd. 5, p. 107—184, 14 fig., 11 pl.

Klaus, W., 1964: Zur sporenstratigraphischen Einstufung von gipsführenden Schichten in Bohrungen. — Erdöl Z., Heft 4, Wien-Hamburg, pp. 1—15, pls. 1—4.

Kostelka, L., 1951: Die Stratigraphie der karnischen und norischen Stufe in den östlichen Gailtaler Alpen: Reprint from Berg- und Hüttenmännische Mh., Heft 4, Jg. 96, pp. 69—75.

Leschik, G., 1955: Die Keuperflora von Neuewelt bei Basel. II: Iso- und Mikrosporen: Schweiz. Paläontol. Abh. 72, Basel. pp. 1—70, pls. 1—10.

Mädler, K., 1964: Die geologische Verbreitung von Sporen und Pollen in der deutschen Trias: Beih. Geol. Jb. 65, Hannover. pp. 1—147, pls. 1—12.

Maljawkina, W. S., 1953: Spore and pollen complex of Upper Triassic and Lower and Middle Jurassic out of the east and west of Vorural: United Petrol. Res. Geol. Inst. (Vngre), 75, pp. 93—147, pls. 1—6 (Russ.)

Maljawkina, W. S., 1964: Spore and pollen grains from the Triassic Sediments of west Siberian platform: United Petrol. Res. Geol. Inst. (Vngre), 231, pp. 1—293, pls. 1—32 (Russ.).

Nilsson, T., 1958: Über das Vorkommen eines mesozoischen Sapropelgesteins in Schonen: Publ. Inst. Mineral. Paläontol. Quat. Geol. Univ. Lund, Sweden. pp. 1—111, pls. 1—8.

Pautsch, M. E., 1958: Keuper sporomorph from Swierczyna, Poland: Micropaleontol., 4, pp. 321—324, pl. 1.

Potonie, R., 1956: Synopsis der Gattungen der Sporae dispersae. I. Beih. Geol. Jb. Hannover, 23, pp. 1—103, pls. 1—11.

Potonie, R., 1958: Synopsis der Gattungen der sporae dispersae. II. Beih. Geol. Jb. Hannover, 31, pp. 1—114, pls. 1—11.

Potonie, R., 1962: Synopsis der sporae in situ: Beih. Geol. Jb. Hannover, 52, pp. 1204, pls. 1—19.

Venkatachala, B. S., & Goczan, 1964: The Spore-Pollenflora of the Hungarian „Kössen Facies"; Acta Gol. Acad. Sci. Hung., 8, pp. 203—228, pls. 1—3.