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ASPECTS OF PERMIAN, TRIASSIC AND EARLY JURASSIC PALYNOLOGY OF WESTERN EUROPE – A RESEARCH PROJECT

JOPIE A. CLEMENT-WESTERHOF, J.G.L.A. VAN DER EEM, A.W. VAN ERVE, J.J. KLASEN, W.M.L. SCHUURMAN and H. VISSCHER[1)]

ABSTRACT

A palynological research project in the Permain, Triassic and Lower Jurassic of western Europe is briefly outlined. The project is aimed at the development and promotion of palynology as a primary tool in regional stratigraphical classification and correlation. A number of examples of specific topics currently under investigation are briefly discussed, viz. (1) a *Cordaitina*-assemblage from the Permian Collio Formation of northern Italy, (2) Late Permian megaspores from the Vicentinian Alps, Italy, (3) palynological assemblages from the Muschelkalk and Lettenkohle of Luxemburg, (4) a palynological reconnaissance study in the Keuper of Spain, (5) palynological assemblages from the uppermost Rhaetian of the Northern Limestone Alps in Germany, and (6) palynological assemblages from the Lower Jurassic of the Vicentinian Alps, Italy. It is emphasized that regional palynological studies should be integrated in international multidisciplinary stratigraphical projects.

INTRODUCTION

In the last decades palynology has become an indispensable method to obtain more and better biostratigraphical information with regard to Palaeozoic and Mesozoic sequences throughout the world. It is discouraging to note therefore, that in The Netherlands – in spite of the necessity of a countinuing academic commitment to the study of any development that has relevance to the refinement of gelological knowledge – "pre-angiosperm" palynology receives only cursory attention in the educational and research programmes of the geological training centres of the universities. We feel therefore, that much credit is due to Prof. Dr. F.P. Jonker, professor of special botany at the State University of Utrecht, who initiated already in the early sixties a palynological research project in the Triassic. Strongly believing in the palaeobotanical and stratigraphical potential of the study of Permian and Triassic spores and pollengrains he motivated some geology students to start a palynological investigation of the Dutch Triassic. This initial work (Freudenthal, 1964; Visscher, 1966; Visscher and Commissaris, 1968) has provided the basis for the development of a regional palynological project in the Permian, Triassic and Lower Jurassic of western Europe. The basic philosophy behind the project remained that of creating a possibility for students to obtain a training in Palaeozoic-Mesozoic palynology through an active participation in regional stratigraphical work.

The project is aimed at the study of all lines of evidence bearing on a regional palynological zonation as well as to focus special attention to the potentialities of palynology as a primary biostratigraphical tool in rationalizing chronostratigraphical classification and correlation concepts.

The present state of Permian and Triassic stratigraphy in Europe and the impact of palynology on current concepts has been recently reviewed by Visscher (1974) and need not to be repeated here. It is sufficient to note that at present Permian and Triassic stratigraphy is in a period of unrest – a very healthy unrest as we feel – and as a result of recent trends in biostratigraphical work, traditional concepts of chronostratigraphical classification and correlation are undergoing almost revolutionary changes. It is obvious – though not yet generally appreciated in "academic" stratigraphy – that the frequent availability of palynomorphs in otherwise unfossiliferous Permian and Triassic deposits provides most useful biostratigraphical information facilitating the establishment of more realistic alternative chronostratigraphical concepts. However, with regard to the vast range of regional stratigraphical problems within the Permian and Triassic of western Europe, palynology cannot yet be regarded as operational on a routine basis. It is still in a phase of development and will need continuous efforts to reach the required degree of accuracy.

As to the Lower Jurassic, with its long biostratigraphical tradition, on the other hand, palynological data might at first sight be considered to be of only supplementary importance in chronostratigraphical considerations. However, at least with regard to the problems of classification and correlation of the Lower Liassic the evaluation of marine faunas has never been very successful. As a consequence the Lower Liassic has always remained somewhat of an enigma, not only within the relatively sophisticated framework of Jurassic stratigraphy itself but also in relation to the problem of demarcating a Triassic-Jurassic boundary. For these

[1)] Section of Palaeobotany and Palynology, State University, Utrecht, The Netherlands.

reasons it became necessary to extend our research-project into the Lower Jurassic.

The following paragraphs are intended to provide a brief outline of the project with some emphasis on the nature of the problems it solves and helps to solve. A selection of specific problems that are currently under investigation are presented without any attempt to give even a preliminary synthesis of the results so far obtained. Detailed accounts on the various subjects here presented will be published in the course of the next years.

ASPECTS OF PERMIAN PALYNOLOGY

Problems of Permian chronostratigraphy in western Europe have been recently reviewed in the light of palynological data (Visscher, 1971, 1973; Visscher et al., 1974) together with an alternative concept of classification and correlation. It was emphasized that at present there are no reasons for maintaining a complete Permian System in the generalized stratigraphical column of western Europe. In fact only the existence of its lowermost part (Autunian) and its uppermost part (Thuringian) can be demonstrated, a regional hiatus embracing the greater part of the Permian System. There seems to be sufficient evidence that in a palynologically supported classification the concept of the classic "Middle" Permian Saxonian Stage has no reality. Further verification of this model will stand or fall with the exactness of correlations with the more fully developed "type"-Permian in the European part of the U.S.S.R. Therefore we are now concentrating on a thorough evaluation of Soviet literature on Permian palynology and stratigraphy.

Current investigations in Permian palynology are mainly related to the following topics:

(1) A search for deposits which may represent part of the interval between the Autunian and the Thuringian (see below).

(2) A correlation between dispersed spores and pollengrains and the Thuringian macrofloral remains (study of in situ material; cf. Clement-Westerhof, 1974).

(3) An evaluation of the lycopodiophytic megaspores recently found in the Thuringian of the Italian Alps (see below).

The Cordaitina *assemblage from the Collio Formation (Italian Alps)*

On the basis of plant macrofossils the Collio Formation in the Lombardic Basin of the Italian Alps is usually referred to as Stephanian and/or Autunian (Cassinis, 1966). Such an assignment was already questioned by Visscher (1973) on a theoretical basis. Limited palynological information may now support the idea of a younger age of these deposits.

Most of the samples taken from the Collio Formation proved to be either barren or yielded only very poorly preserved palynomorphs. Only one sample has so far been found from which a very general impression of the composition of the assemblage could be obtained. The main characteristic of the assemblage seems to be the relative abundance of a wide range of forms which are in Russian literature usually assigned to the broad form-genus *Cordaitina* (Plate I). A detailed morphological and taxonomic study is however needed to compare our forms with the more elaborate classification system of presumed pollen of the Cordaitales developed by Dibner (1971).

An additional feature of the assemblage is constituted by the frequent occurrence of diversified multi-taeniate pollengrains, both bisaccates and forms assignable to *Vittatina*. In spite of the taxonomic uncertainties there seems to be sufficient evidence that the composition of the assemblage cannot be compared with that of any assemblage so far known from either Autunian or Thuringian deposits of western Europe. A detailed age-assignement in terms of the Russian classification is not yet possible. However, if we take Faddeeva's (1974) recent work on the Permian of the Urals into consideration, one is forced to believe that assemblages showing high proportions of both *Cordaitina* and multi-taeniate pollen could well be indicative of a Late Artinskian, Kungurian or Early Ufimian age.

It is hoped that more definitive evidence can be produced in the nearby future, but in the meanwhile we are convinced that the Collio Formation could well represent part of the interval between the Autunian and Thuringian which elsewhere in western Europe is marked by a hiatus.

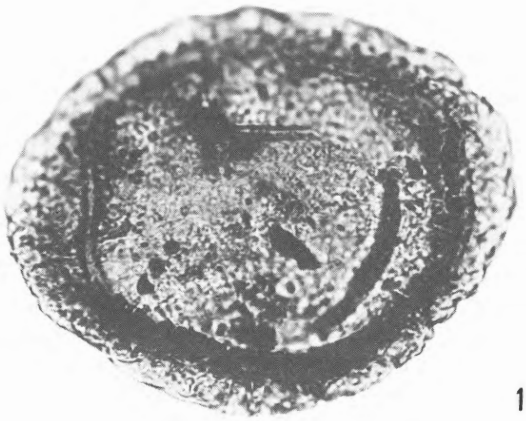
Late Permian megaspores

Although during the last 15 years both the Lower and the Upper Permian of western Europe have been intensively investigated, no megaspores have so far been reported in palynological literature. Our current investigations in the Upper Permian of the Southern Alps, however, have now resulted in the first record of Late Permian megaspores in western Europe. Notably in the Vicentinian Alps an abundance of forms was found, including clusters and tetrads sometimes accompanied by clusters of microspores.

The selection of forms illustrated on Plate II clearly gives an impression of the variety in size (250-600 μm) as well as in ornamentation. Most megaspores are trilete but a rare monolete-dilete form has also been recorded; they are frequently clearly cavate. The forms found have not yet been taxonomically treated but there are reasons to believe that they could well represent a number of new taxa. The forms need to be compared with the Early Triassic assemblages now known from Europe (compare, e.g., Antonescu and

PLATE I

A selection of forms assignable to *Cordaitina* from a palynological assemblage from the Permian Collio Formation, Lombardic Basin, Italian Alps
(magnification x 520)



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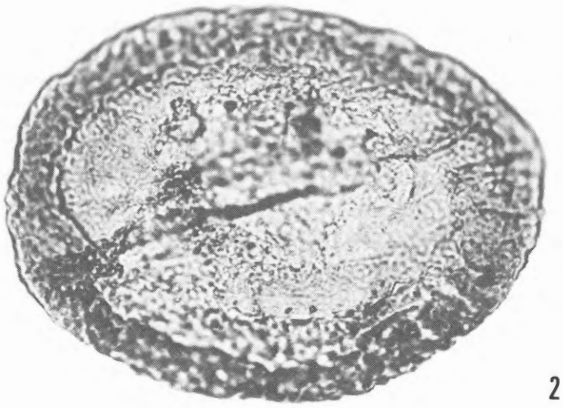

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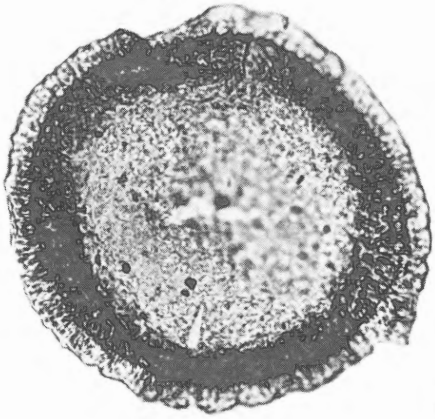

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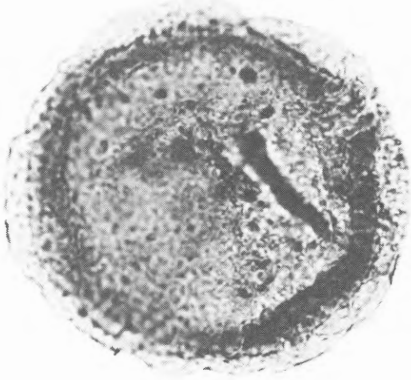

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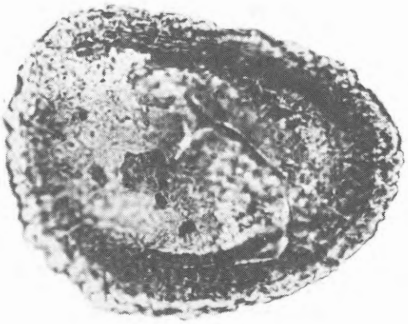

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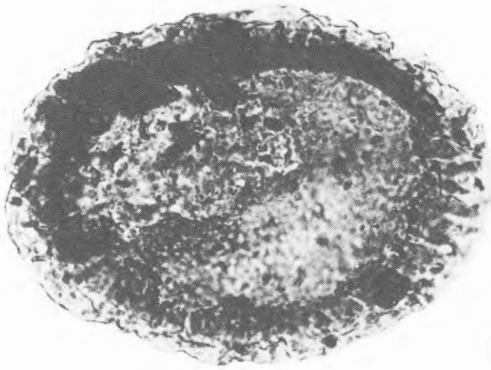

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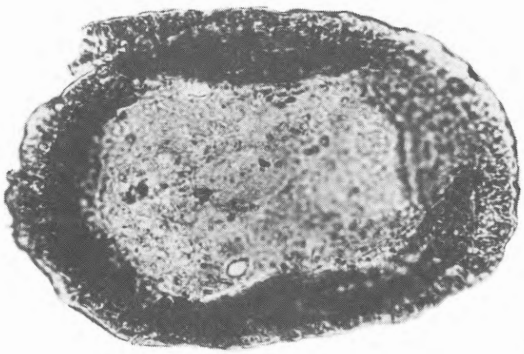

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Taugourdeau-Lantz, 1973), as well as with Permian assemblages from other parts of the world, notably from the Gondwana realm.

The megaspores are considered to originate from heterosporous Lycopodiophyta. These were hitherto unknown in the Late Permian macrofloral assemblages of western Europe. However, besides the megaspores, the Upper Permian of the Vicentinian Alps has also yielded fragments of tiny leafy shoots showing selaginelloid affinities. Presumed lycopodiophytic microspores are often attached to these shoots. Similar spores are very rare in dispersed assemblages but they occur sometimes in conjunction with clusters of megaspores.

We believe that the further evaluation of the Late Permian lycopodiophytic remains may well provide valuable information about the presumably rapid floral development during the Permian-Triassic transition, which includes according to the evidence of dispersed palynological assemblages, a renewed proliferation of lycopodiophytic elements.

ASPECTS OF TRIASSIC PALYNOLOGY

Since the principal difficulty in Triassic stratigraphy of western Europe is to correlate the Germanic and Alpine facies, all present investigations are primarily directed towards the optimum solution to this particular problem. We are thus confronted with the need of composing at least two independent sets of palynostratigraphical data from which to determine the potentialities and limitations of palynology with regard to regional Triassic chronostratigraphical considerations. The Germanic Triassic is now being investigated in Germany, Luxemburg and France, the Alpine Triassic in the German, Austrian and Italian Alps. In addition, the project has recently been extended to the Triassic of various parts of Spain, not only in order to solve more local stratigraphical problems, but also to obtain a more regional picture of the composition and development of Triassic palynofloras.

Current research is mainly concentrating upon the following topics:

(1) The establishment of a detailed zonation of the Muschelkalk, Keuper and Rhaetian of Luxemburg and northeastern France (some results related to the Muschelkalk of Luxemburg will be discussed below).

(2) Investigation of Scythian, Anisian, Ladinian and Karnian deposits in the Dolomites and Vicentinian Alps in Italy.

(3) Investigation of Rhaetian deposits of the Northern Limestone Alps in Austria and Germany (see below).

(4) The establishment of more reliable age determinations of Spanish sequences traditionally classified as "Permo-Triassic" and "Keuper" (see below).

Palynological assemblages from the Muschelkalk and Lettenkohle of Luxemburg

In view of the fact that there exists only a relatively small amount of published palynological information about the Muschelkalk and Lettenkohle of the Germanic Triassic, it appeared to be important to study well-preserved assemblages from these classic facies units. A promising area of investigation was found in southern Luxemburg in 1970. A preliminary study of samples from the predominantly marine facies of what is called in Luxemburg the "normale Entwicklung" of the Triassic (east of the line Ettelbrück-Luxemburg town) is now completed.

Samples taken from Muschelsandstein s.s. (mu 1), grey marls of the Anhydritgruppe (mm 1), Trochitenschichten (mo 1), Ceratitenkalk (mo 2), Grenzschichten (mo 3), Bunte Mergel (ku 1) and Grenzdolomit (ku 2) frequently appeared to be of very good quality.

At least three palynostratigraphical boundaries are very significant:

(1) The first one lies somewhere between the transition of Muschelsandstein and Anhydritgruppe and is among other criteria characterized by the appearance of *Porcellispora longdonensis* (Clarke, 1965) Scheuring, 1970 (Plate III, fig. 10), *Retisulcites perforatus* (Mädler, 1964) Scheuring, 1970 (Plate III, fig. 4), *Eucommiidites microgranulatus* Scheuring, 1970, *Ovalipollis ovalis* Krutzsch, 1955, *Rugubivesiculites convolutus* Pierce, 1961 (Plate III, fig. 12), *Tumoripollenites baculatus* Bharadwaj, 1962 and a strong proportional decrease of *Illinites kosankei* Klaus, 1964 and *Illinites melanocorpus* Klaus, 1964, species which take about 98% of the total assemblage in the Muschelsandstein s.s. to their account.

(2) A second boundary is positioned somewhere between the Anhyditrgruppe and the Trochitenschichten. It is characterized by the disappearance of *Illinites kosankei, Illinites melanocorpus, Stellapollenites thiergartii* (Mädler, 1964) nov. comb.[1], *Rugubivesiculites convolutus, Tumoripollenites baculatus* and the appearance of a number of typical forms such as *Podosporites amicus* Scheuring, 1970, *Schiziosaccus keuperi* Mädler, 1964 and *Concentricisporites plurianulatus* Antonescu, 1969 (Plate III, fig. 2). The occurrence of the last-mentioned species with its striking morphology – originally described from the Anisian of Romania – seems to be the first record in western Europe.

(3) The third boundary lies between the Grenzschichten and the Bunte Mergel of the Lettenkohle. It is not yet clear to what extent this boundary depends on facies changes. The boundary is based on (a) the quantitative relation between

[1] Basionym: *Podocarpeaepollenites thiergartii* Mädler, 1964, Geol. Jahrb., Beih., 65, Taf. 7, fig. 11.

PLATE II

A selection of Late Permian megaspores from the Vicentinian Alps, Italy
(magnification x190)

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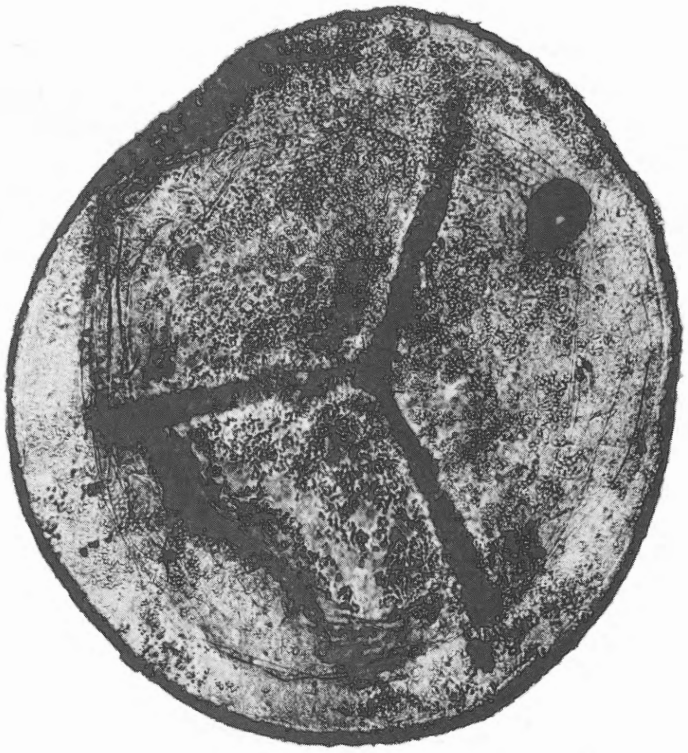

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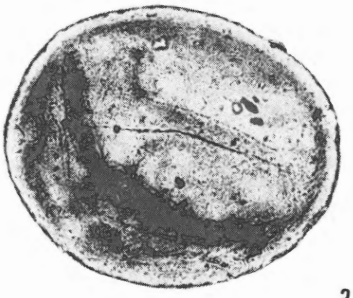

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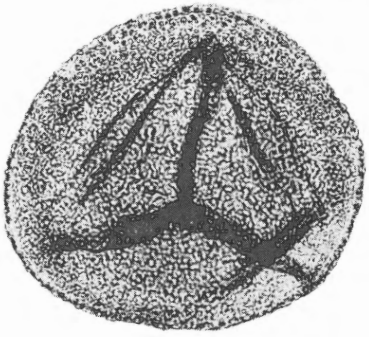

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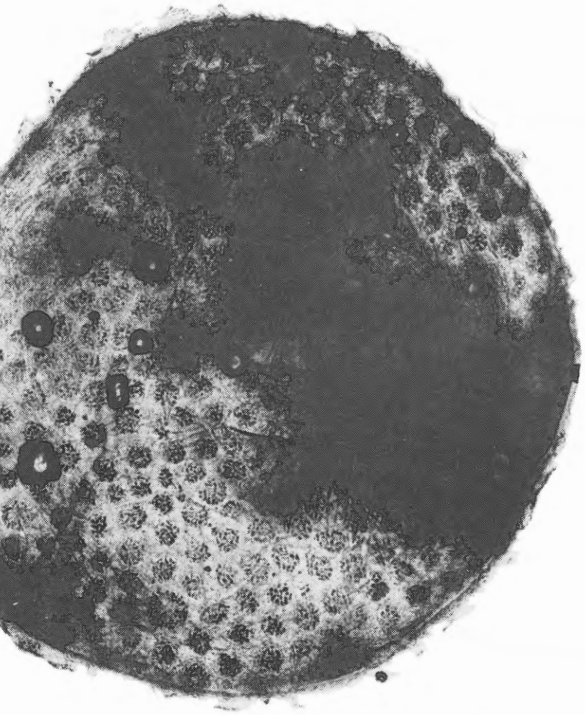

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the bisaccates and the spores, since in the Bunte Mergel the dominance of the bisaccates is taken over by the spores; and (b) the disppearance of *Concentriciporites plurianulatus, Illinites chitinoides* Klaus, 1964 (Plate III, fig. 14) and *Microcachryidites* spp. and other forms.

The following trends can be observed in the sequence from Muschelsandstein to Grenzdolomit:
(1) The general increase of the number of species, both spores and bisaccates.
(2) The progressive change in the dominance of bisaccates to that of spores.
(3) Changes within the relative frequency of bisaccate species, such as (a) the dominance of *Illinites* in the Muschelsandstein s.s.; (b) the dominance of among other forms *Angustisulcites klausii* Freudenthal, 1964 (Plate III, fig. 13) and *Microcachryidites* spp. in the Hauptmuschelkalk (Trochitenschichten and Ceratitenkalk); and (c) a high percentage of taeniate forms, such as *Striatoabietites aytugii* Visscher, 1966 (Plate III, fig. 15), *Infernopollenites sulcatus* (Pautsch, 1958) Scheuring, 1970 and *Lunatisporites acutus* Leschik, 1956 in the Grenzschichten.

Some general conclusions may be drawn from the present state of investigation:
(1) It is possible to develop a palynological zonation for the Triassic of Luxemburg.
(2) The zonation shows a resemblance with the zonation of B i a r d (1963) based on borehole evidence from north-eastern France.
(3) Several palynomophs have a greater vertical range than is stated in other publications; for example *Retisulcites perforatus, Porcellispora longdonensis* and *Eucommiidites microgranulatus* have their first occurrence in the Anhydritgruppe, while *Podosporites amicus, Protodiploxypinus gracilis* (sensu Scheuring, 1970) and *Infernopollenites sulcatus* have their first appearance in the Hauptmuschelkalk.

Further studies are now devoted to the refinement of the zonation, together with an evaluation of its significance in regional correlation both within the Germanic Triassic and with the Middle Triassic of the Alpine realm.

A palynological reconnaissance study in the Keuper of Spain

In order to assess the potential of the Spanish Triassic as a source of palynological data of both local and regional importance, a reconnaissance study was started in southern and central Spain.

Apart from some other promising discoveries (such as the occurrence of Anisian (?) assemblages in the "Permo-Triassic" of the Betic Cordillera, even in epimetamorphic formations of the internal zones), the preliminary study of the samples collected in 1974 has revealed the presence of rich and rather well-preserved assemblages in the generally gypsiferous Keuper sequences of the Subbetic, Prebetic and Iberic mountain chains.

Many of the assemblages so far found show a general resemblance to those of the Keuper of Switzerland, described in detail by S c h e u r i n g (1970). Among the species tentatively identified are the following (illustrated specimens originate from an assemblage found in dark gypsiferous shales of a Keuper sequence in the vicinity of the village of Jocar, province of Guadalajara):
Ovalipollis ovalis Krutzsch, 1955 (Plate IV, fig. 11)
Triadispora aurea Scheuring, 1970
Triadispora obscura Scheuring, 1970
Triadispora suspecta Scheuring, 1970 (Plate IV, fig. 7)
Triadispora vilis Scheuring, 1970
Ellipsovelatisporites rugosus Scheuring, 1970 (Plate IV, fig. 10)
Zonalasporites explanatus Leschik, 1956 (Plate IV, fig. 3)
Enzonalasporites vigens Leschik, 1956 (Plate IV, fig. 6)
Enzonalasporites tenuis Leschik, 1956
Camerosporites pseudoverrucatus Scheuring, 1970 (Plate IV, fig. 2)
Duplicisporites granulatus Leschik, 1956 (Plate IV, fig. 5)
Paracirculina scurrilis Scheuring, 1970 (Plate IV, fig. 9)
Paracirculina quadruplicis Scheuring, 1970 (Plate IV, fig. 1)
Paracirculina tenebrosa Scheuring, 1970
Paracirculina maljawkinae Klaus, 1960
Praecirculina granifer Leschik, 1956 (Plate IV, fig. 4)
Verrucosisporites morulae Klaus, 1960 (Plate IV, fig. 8)
Calamospora nathorsti (Halle, 1908) Klaus, 1960
Aulisporites astigmosus (Leschik, 1956) Klaus, 1960

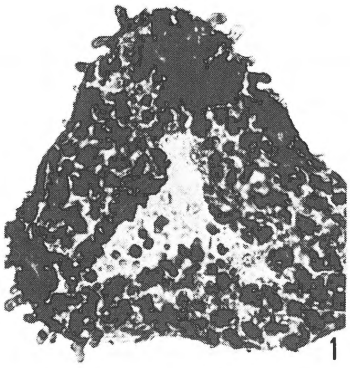
In view of the promising results we have now started more detailed investigations. These will be carried out in collaboration with geologists of the universities of Madrid and Amsterdam who are presently confronted with the crying need for a biostratigraphically founded classification of the Spanish Triassic.

PLATE III

A selection of palynomorphs from the Muschelkalk and Lettenkohle of Luxemburg

fig. 1: *Neoraistrickia americana* Schultz et Hope, 1973
fig. 2: *Concentricisporites plurianulatus*
fig. 3: *Palaeospongiosporis europaeus* Schulz, 1965
fig. 4: *Retisulcites perforatus*
fig. 5: *Aratrisporites granulatus* (Klaus, 1960) Playford et Dettmann, 1965
fig. 6: *Kraeuselisporites apiculatus* Jansonius, 1962
fig. 7: cf. *Cyclotriletes* sp.
fig. 8: *Verrucosisporites congestus* Playford, 1963
fig. 9: *Convolutispora* sp.
fig. 10: *Porcellispora longdonensis*
fig. 11: *Microcachryidites fastidiosus* (Jansonius, 1962) Klaus, 1964
fig. 12: *Rugubivesiculites convolutus*
fig. 13: *Angustisculcites klausii*
fig. 14: *Illinites chitinoides*
fig. 15: *Striatoabietites aytugii*
fig. 16: *Lunatisporites acutus*

(magnification fig. 2, 6-9, 13, 15 x250; fig. 1, 5, 14, 16 x450; fig. 3 x520; fig. 4, 10-12 x650)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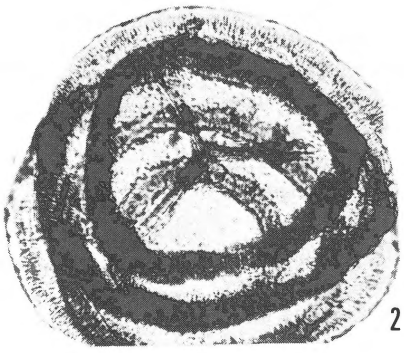
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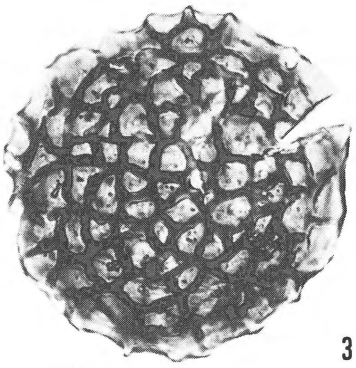
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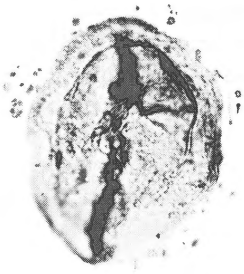

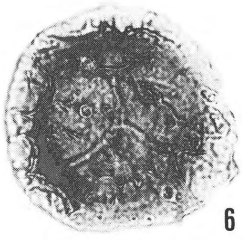
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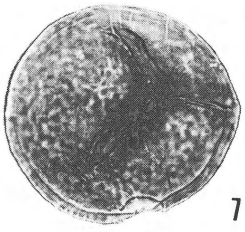
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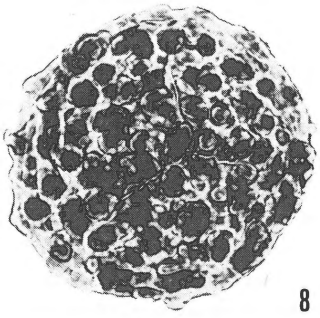
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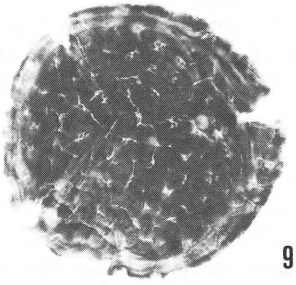
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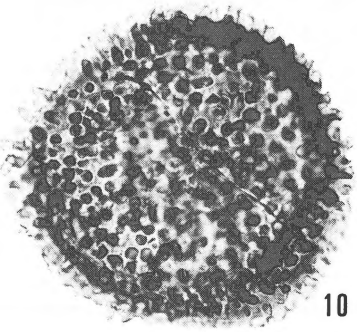
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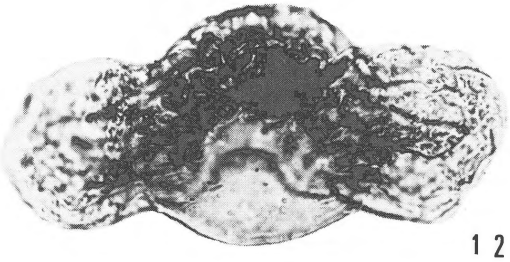
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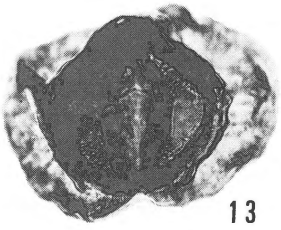
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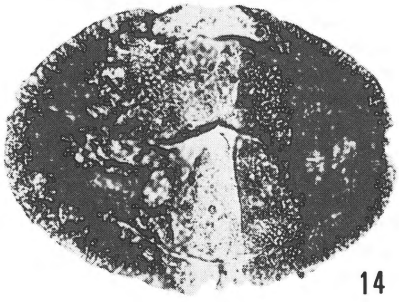
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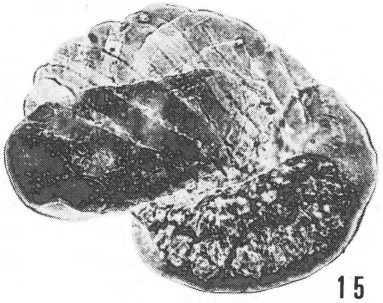
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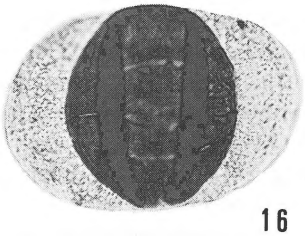
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Palynological assemblages from the uppermost Rhaetian of the Northern Limestone Alps in Germany

Traditionally, correlation of Rhaetian deposits of the Alpine facies with those of the Germanic facies had to be based primarily on the presence of the lamellibranchiate *Rhaetavicula contorta (Avicula contorta).* Nowadays most investigators are aware that this fossil at best supplies additional information but cannot be considered to be diagnostic of a chronostratigraphically useful biostratigraphical zone.

Our current comparative investigations in the Rhaetian of the Northern Limestone Alps and northeastern France may aid in supplying a more accurate tool for correlating these facies realms.

Apart from the similarity between the palynological assemblages from traditional Rhaetian type sections (M o r b e y and N e v e s, 1974; current investigations by B.W. Scheuring, Basel) and those from the "grès et schiste à *Avicula contorta"* in France (studied in our project) – showing in common typical Rhaetian miospores such as *Rhaetipollis germanicus* Schulz, 1967 and *Ricciisporites tuberculatus* Lundblad, 1959 together with *Ovalipollis ovalis Krutzsch, 1955, – Gliscopollis meyeriana* (Klaus, 1960) Venkatachala, 1966 and *Classopollis classoides* Pflug, 1953 – there exists a striking compositional correspondance between the assemblages from the presumed uppermost Rhaetian (uppermost Kössener Schichten) of the Bavarian Alps in Germany and those from the uppermost Rhaetian (Argiles de Levallois) in France.

The assemblages from both the uppermost Kössener Schichten and the Argiles de Levallois are characterized by the first-appearance of *Limbosporites lundbladii* Nilsson, 1958, *Triancoraesporites ancorae* (Rheinhardt, 1962) Schulz, 1967 (Plate V, fig. 6) *Rogalskaisporites cicatricosus* Danzé-Corsin et Laveine, 1963 (Plate V, fig. 10), *Annulispora* sp. (Plate V, fig. 9), *Lycopodiacidites rhaeticus* Schulz, 1967 (Plate V, fig. 1) and *Heliosporites altmarkensis* Schulz, 1967 (Plate V, fig. 2).
Furthermore a great number of miospores which are also present in older Rhaetian deposits can be observed: *Converrucosisporites luebbenensis* Schulz, 1967, *Anapiculatisporites spiniger* (Leschik, 1956) Rheinhardt, 1962 (Plate V, fig. 11), *Convolutispora microrugulata* Schulz, 1967, *Camarosporites rudis* (Leschik, 1956) Klaus, 1960, *Retitriletes austroclavatidites* (Cookson, 1953) Döring et al., 1963 (Plate V, fig. 7), *Densoporites* sp., *Zebrasporites interscriptus* (Thiergart, 1949) Klaus, 1960 (Plate V, fig. 4, 5), *Ovalipollis ovalis* (Plate V, fig. 12), *Ricciisporites tuberculatus, Gliscopollis meyeriana* (Plate V, fig. 8), *Rhaetipollis germanicus.*

The assemblages from the uppermost Rhaetian in the Northern Limestone Alps differ from those from the Argiles de Levallois both by the presence of *Lycopodiacidites kuepperi* Klaus, 1960 (Plate V, fig. 3), and the absence of *Classopollis classoides.*

When considering the differences in depositional environment of the source-strata (the Argiles de Levallois are red or green coloured terrestrial deposits whereas the Kössener Schichten are marine), the similarities between the palynological assemblages are not likely to be the result of facies-control. As a consequence the palynological data from the uppermost Rhaetian appear to be very useful in regional biostratigraphy and even chronostratigraphy.

ASPECTS OF EARLY JURASSIC PALYNOLOGY

As mentioned in the introduction, palynology could well contribute to a solution of regional problems of classification and correlation of Early Jurassic deposits of western Europe, as well as to an evaluation of the Triassic-Jurassic boundary problem (cf. v a n E r v e, 1975). The latter aspect has necessitated the study of assemblages from both the outer-Alpine and Alpine realm. Current research therefore includes the following topics:

(1) Investigation of assemblages from the Hettangian-Sinemurian type-region in northeastern France.

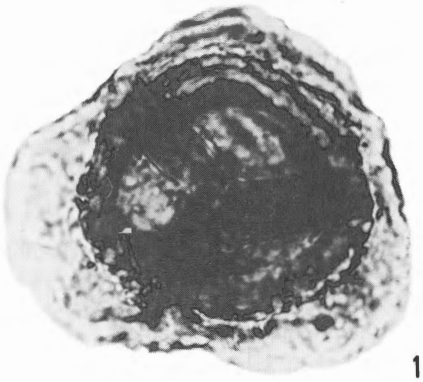
(2) Investigation of Early Jurassic assemblages from the Vicentinian Alps in northern Italy (see below).

Palynological assemblages from the Lower Jurassic of the Vicentinian Alps, Italy

A palynological investigation of the Lower Jurassic of the Southern Alps in Italy was commenced in 1972; a large number of sections in the Bergamasc and Vicentinian Alps were intensively sampled. Only the samples originating from the Lower Jurassic of the Vicentinian Alps yielded well-preserved and rich palynological assemblages. The study of the best-preserved assemblages so far found has resulted in the following provisional list of palynomorphs which may reflect the general composition of the assemblages:
Lycopodiacidites rugulatus (Couper, 1958) Schulz, 1967 (Plate VI, fig. 3,4)
Ischyosoporites variegatus (Couper, 1958) Schulz, 1967 (Plate VI, fig. 12,13)
Convolutispora microrugulata Schulz, 1967 (Plate VI, fig. 14)

PLATE IV

A selection of palynomorphs from the Keuper of central Spain
fig. 1: *Paracirculina quadruplicis*
fig. 2: *Camerosporites pseudoverrucatus*
fig. 3: *Zonalasporites explanatus*
fig. 4: *Praecirculina granifer*
fig. 5: *Duplicisporites granulatus*
fig. 6: *Enzonalasporites vigens*
fig. 7: *Triadispora suspecta*
fig. 8: *Verrucosisporites morulae*
fig. 9: *Paracirculina scurrilis*
fig. 10: *Ellipsovelatisporites rugosus*
fig. 11: *Ovalipollis ovalis*
(magnification x960)



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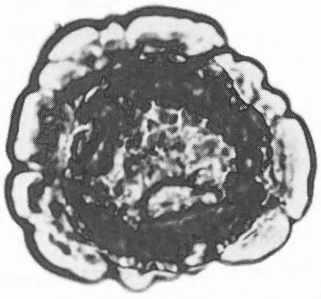

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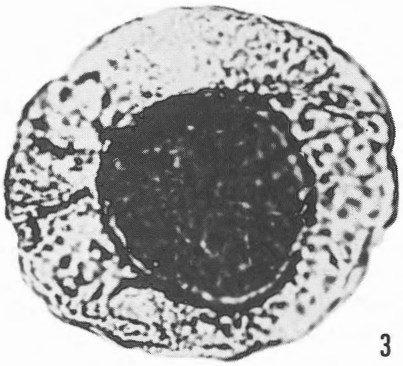

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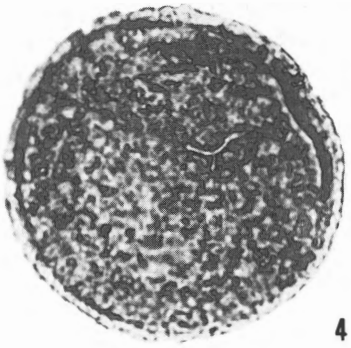

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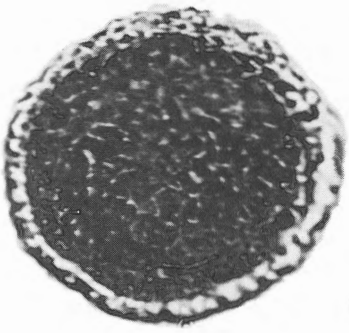

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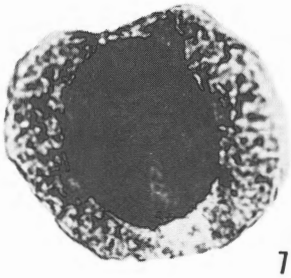

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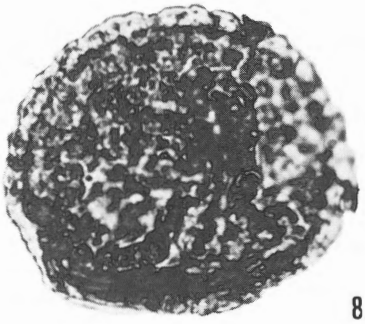

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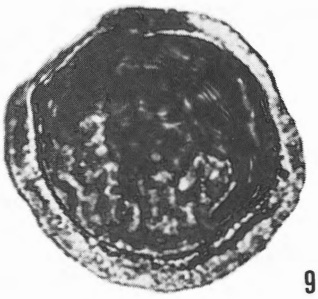

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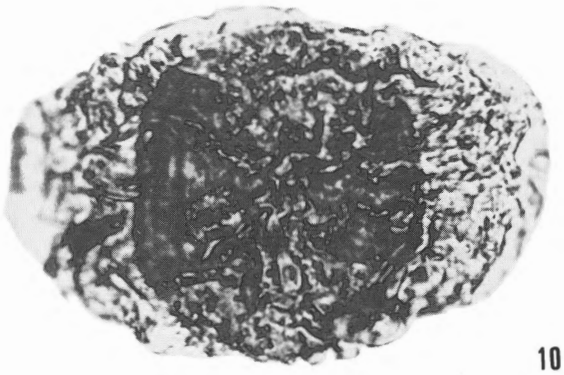

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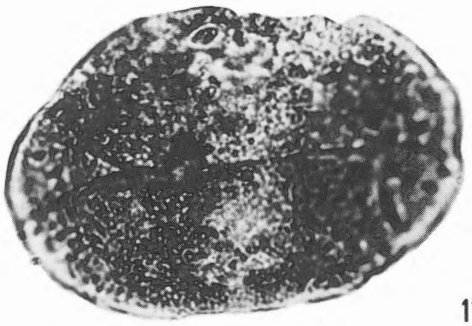

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Tigrisporites halleinis Klaus, 1960 (Plate VI, fig. 5,6)
Tigrisporites sp.
Retitriletes clavatoides (Couper, 1958) Döring et al., 1963
Retitriletes austroclavatidites (Cookson, 1953) Döring et al., 1963
Retritriletes globosus Pierce, 1961 (Plate VI, fig. 9)
Eucommiidites troedssonii Erdtman, 1948
Todisporites minor Couper, 1958
Cerebropollenites macroverrucosus (Thiergart, 1949) Schulz, 1967 (Plate VI, fig. 11)
Cyathidites minor Couper, 1953
Zebrasporites corneolus (Leschik, 1955) Klaus, 1960
Vitreisporites pallidus (Reissinger, 1949) Nilsson, 1958
Heliosporites reissingeri (Harris, 1957) Chaloner, 1969
Porcellispora longdonensis (Clarke, 1965) Scheuring, 1970 (Plate VI, fig. 1,2)
Microreticulatisporites pseudoalveolatus (Couper, 1958) Vinogradova, 1971 (Plate VI, fig. 10)
Toroisporis (T.) neddeni (R. Potonié, 1931) Krutzsch, 1959
Toroisporis spp.
Concavisporites spp.
Gleicheniidites spp.
Monosulcites sp.
Cycadopites spp.
Foveotriletes sp.
Circumpolles-complex (Plate VI, fig. 7)
Bisaccate pollengrains (unidentified)
Michrystridium-complex
Cymatiosphaera pachytheca Eisenack, 1957 (Plate VI, fig. 8)
Tasmanites (Newton) Wall, 1965
Tasmanites suevicus (Eisenack, 1957) Wall, 1965
Crassosphaera hexagonalis Wall, 1965

An evaluation of the composition of the palynological assemblages may lead to the conclusion that there exists a certain resemblance with the assemblages studied from Lias-α deposits of the Paris Basin (the Hettangian-Sinemurian type-region). Many of the above listed species of pollengrains and spores do occur in common, including important elements such as the *Circumpolles*-complex *Heliosporites reissingeri*, and the species of *Retitriletes*. Also the tasmanaceaceous species and *Cymatiosphaera pachytheca* are known from northeastern France. On the other hand a number of the elements found in Italy are unknown form the Lias-α deposits of the type-region in northeastern France. These include *Tigrisporites halleinis, Porcellispora longdonensis* and *Zebrasporites corneolus*.

A comparison with palynological assemblages reported from other areas in western Europe has however shown that the composition of the assemblages from the Lower Jurassic of the Vicentinian Alps can be best compared with that of the "infraliassic" assemblages, described from northwestern France by Levet-Carette (1963) and Danzé-Corsin and Laveine (1963), as well as from Portugal (M.C. Adloff, Strasbourg, Communication to the C.I.M.P. Symposion on Permian and Triassic Palynology, Boussens, 1973).

A detailed account of the assemblages from the Vicentinian Alps and their presumed importance in regional stratigraphical correlation of Early Jurassic deposits will soon be presented elsewhere (van Erve, in preparation).

CONCLUDING REMARKS

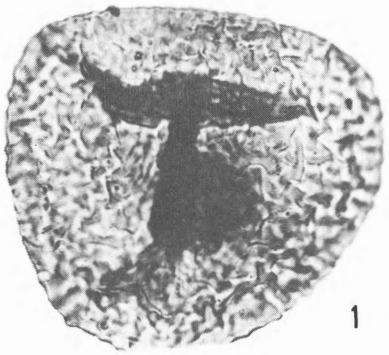
Palynology constitutes a relatively new tool in Permian, Triassic and Early Jurassic chronostratigraphy which certainly cannot replace the more traditional stratigraphical methods. On the other hand, the importance of the development and promotion of palynology ought to be duly recognized not only in the world of exploration geology. We strongly believe in an international multidisciplinary approach to chronostratigraphical problems rather than in unidisciplinary attempts. Many investigations within our project are therefore carried out in collaboration with other institutions or individuals interested in the same problems. In this respect it is encouraging to note the positive attitude to palynology of the newly established I.U.G.S. Subcommissions on Permian and Triassic Stratigraphy, enabling the development of international correlation and classification projects in which our work may become integrated.

ACKNOWLEDGEMENTS

The investigations in the Permian and Lower Jurassic of the Vicentinian Alps and the Rhaetian of the Northern Limestone Alps are sponsored by the "Nederlandse Organisatie voor Zuiver-Wetenschappelijk Onderzoek" (Z.W.O.) and the "Stichting Studiefonds Limburg", respectively; the financial aid is gratefully acknowledged. We are indebted to Mr. H.A. Elsendoorn for the preparation of the photomicrographs.

PLATE V

A selection of palynomorphs of the uppermost Rhaetian of the Northern Limestone Alps in Germany
fig. 1: *Lycopodiacidites rhaeticus*
fig. 2: *Heliosporites altmarkensis*
fig. 3: *Lycopodiacidites kuepperi*
fig. 4,5: *Zebrasporites interscriptus*
fig. 6: *Triancoraesporites ancorae*
fig. 7: *Retitriletes austroclavatidites*
fig. 8: *Gliscopollis meyeriana*
fig. 9: *Annulispora* sp.
fig. 10: *Rogalskaisporites cicatricosus*
fig. 11: *Anapiculatisporites spiniger*
fig. 12: *Ovalipollis ovalis*
(magnification fig. 1-3 x850; fig. 4-12 x1280)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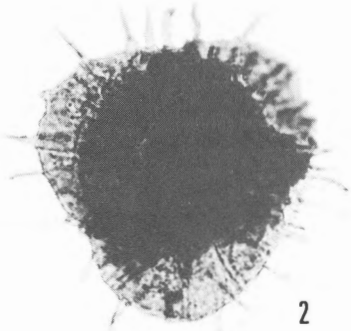
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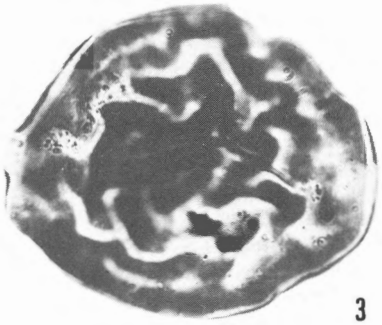
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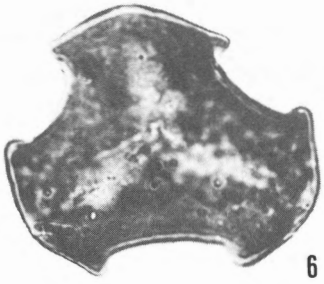
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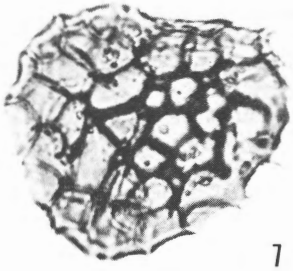
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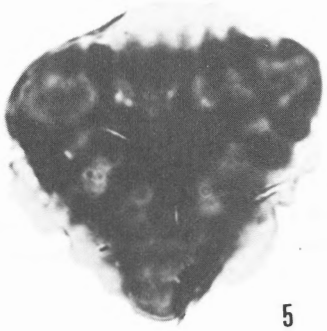
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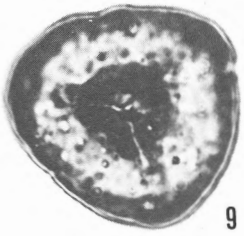
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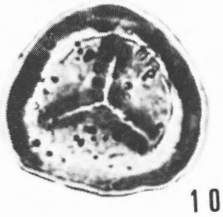
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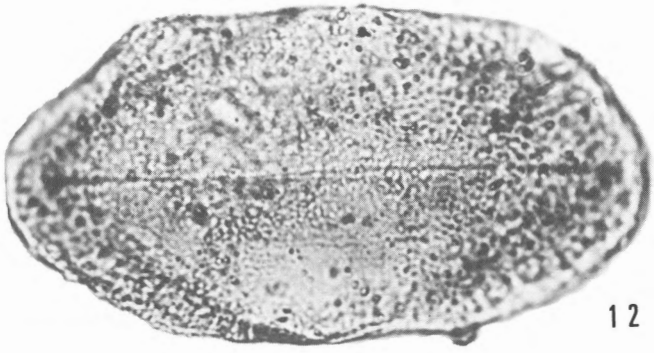
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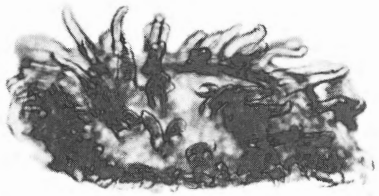
PLATE VI

A selection of palynomorphs from the Lower Jurassic of the Vicentinian Alps, Italy

fig. 1,2: *Porcellispora longdonensis*
fig. 3,4: *Lycopodiacidites rugulatus*
fig. 5,6: *Tigrisporites halleinis*
fig. 7: *Classopollis* sp.
fig. 8: *Cymatiosphaera pachytheca*
fig. 9: *Retitriletes globosus*
fig. 10: *Microreticulatisporites pseudoalveolatus*
fig. 11: *Cerebropollenites macroverrucosus*
fig. 12,13: *Ischyosporites variegatus*
fig. 14: *Convolutispora microrugulata*

(magnification fig. 1 x460; fig. 2-6, 8, 12, 13 x850; fig. 7, 9-11 x280)



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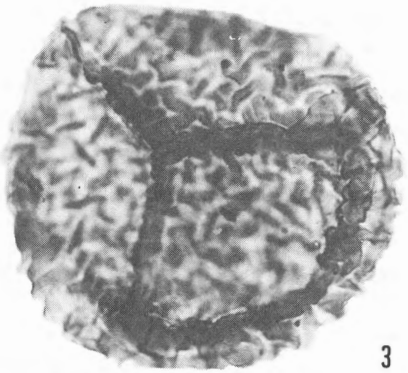

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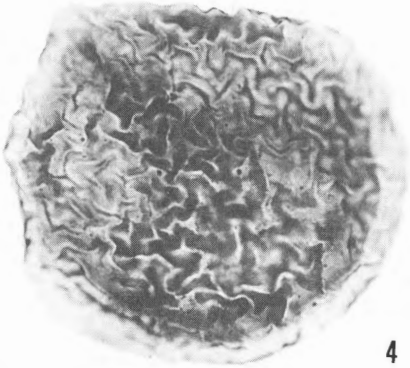

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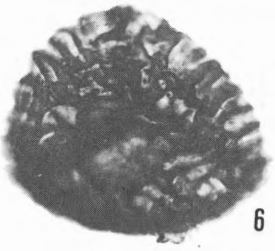

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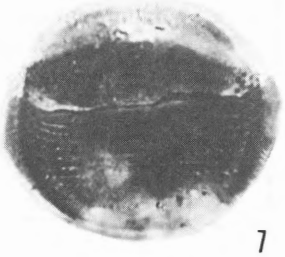

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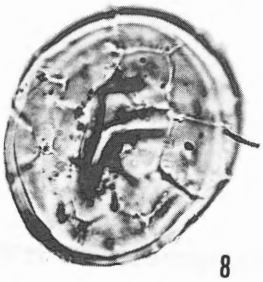

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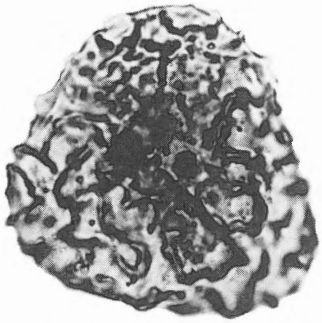

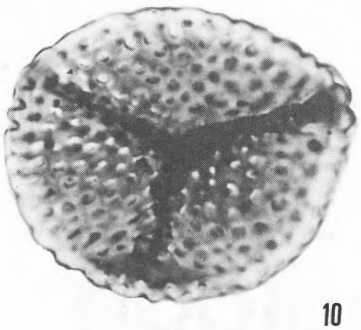

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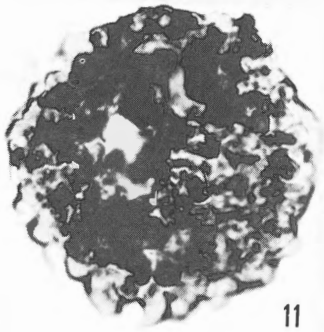

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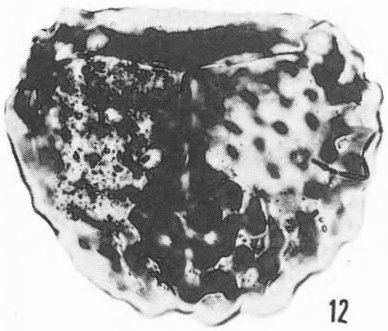

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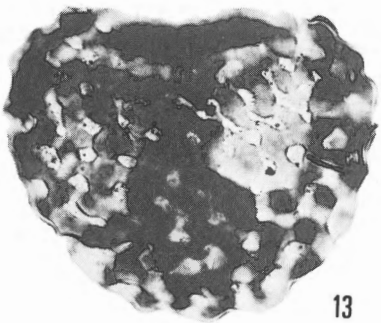

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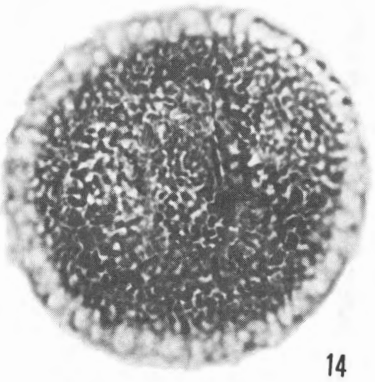

14