CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
BULLETIN 40

A CARBONIFEROUS SPORE ASSEMBLAGE, IN COAL FROM THE SOUTH NAHANNI RIVER AREA, NORTHWEST TERRITORIES

By

P. A. Hacquebard and M. S. Barss

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
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PREFACE

Coal seams of Mesozoic and Tertiary age have long been known in Western Canada, where they are important sources of heat and power. Many of the world's largest coalfields are, however, in rocks of much older (Carboniferous) age and although Carboniferous coal is mined in Nova Scotia, none was known in Western Canada.

Geologists of the Canadian Gulf Oil Company examined a narrow coal seam on the South Nahanni River area and a sample from it was sent to the Sydney Office of the Geological Survey of Canada for analysis. This report describes the results of an examination that revealed the presence of spores similar to those from Carboniferous coals in the United States, Western Europe and the U.S.S.R.

GEORGE HANSON,
Director, Geological Survey of Canada

OTTAWA, September 12, 1956

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A CARBONIFEROUS SPORE ASSEMBLAGE, IN COAL FROM THE SOUTH NAHANNI RIVER AREA, NORTHWEST TERRITORIES

INTRODUCTION

Coals of Mesozoic and Tertiary age are widely distributed in Western Canada. Carboniferous coal deposits have not been reported previously, however, and all known Carboniferous strata have been considered as marine or near-shore deposits. The presence of coal in the South Nahanni River country has been known for some time. A. E. Cameron and P. S. Warren (1938)[1] mention reports on coal seams said to occur in the area on the west side of the lower South Nahanni River. C. O. Hage (1945) also mentions that Indians and white trappers have reported coal seams 6 feet thick on Mattson and Flett creeks.

Geological exploration by several oil companies has confirmed the existence of coal and from field relations it became apparent that a Carboniferous coal occurrence is present in the South Nahanni River area.

The coal sample, on which this study was based, was collected by John Patton, then a graduate student of the University of Alberta, who studied the stratigraphy of the locality while employed by the Canadian Gulf Oil Company. Because an age determination of the coal itself was considered imperative, Dr. J. D. Campbell of the Research Council of Alberta suggested that a microscopic study be made. For this purpose he forwarded a sample of the South Nahanni River coal to the Sydney office of the Geological Survey of Canada, and in doing so initiated the investigation presented in this report.

Information concerning the sample locality was obtained from Mr. Patton's unpublished Master's thesis, with the consent of Dr. P. S. Warren of the Department of Geology, University of Alberta, under whose direction it was written.

ACKNOWLEDGMENTS

The authors wish to thank John Patton and Dr. J. D. Campbell for making the coal of this unique occurrence available for study; Dr. R. M. Kosanke of the State Geological Survey of Illinois for initiating the senior author in spore research, and for giving suggestions on certain aspects of the present study; and Dr. L. R. Wilson of the

[1]Dates in parentheses are those of references cited in the Bibliography at the end of this report.

University of Massachusetts for reading the manuscript and giving valuable advice and criticism.

The translation by Dr. D. C. West of Canadian Industries Limited, Montreal, of the Russian publication by Luber and Waltz on spores contained in some Carboniferous coals of the U.S.S.R. has been of invaluable help in this study.

DATA ON SAMPLE LOCALITY AND STRATIGRAPHY

The sample was taken from a 4-foot thick coal seam that is exposed for a short distance along a creek valley situated on the west bank of Jackfish River, which is a westerly tributary of South Nahanni River. The exact locality is given as 123°59′ W. longitude and 61°06′ N. latitude (*see* Figure 1).

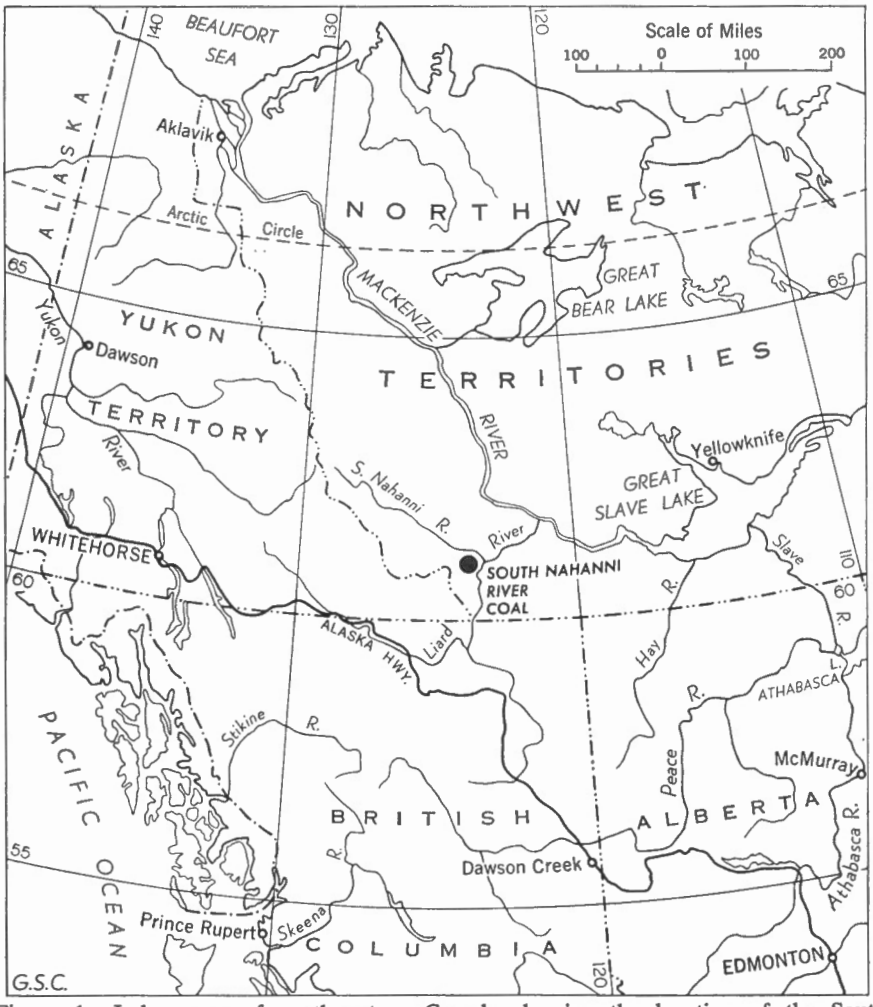

Figure 1. Index map of northwestern Canada showing the location of the South Nahanni River coal.

According to Patton, the coal seam occurs at 648 feet from the base of a sequence of 3,734 feet of fine- to medium-grained sandstones, light buff-coloured, heavily bedded, largely unfossiliferous, and with some of the beds of possibly continental origin. He states that the lower limit of the sandstone formation is marked by fossiliferous marine sediments of Mississippian age which he correlates with the Rundle formation of the Alberta Rocky Mountain region. Carbonaceous plant remains, which occur to about 1,622 feet above the coal and also in the underlying 648 feet of strata, are identified as *Lepidodendron* sp. A, *Lepidodendron* sp. B and *Stigmaria*. Patton reports the occurrence of *Spirifer* cf. *S. pellaensis* Weller in a cherty bed 2,302 feet above the base of the sandstone formation, and makes the tentative suggestion that these beds, well above the coal seam, are of Mississippian age.

Fossil collections from the same area were collected by geologists of Mobil Oil of Canada Ltd. Several collections were obtained from beds corresponding with the upper part of Patton's sandstone formation. These were identified by P. Harker of the Geological Survey of Canada who considered them to be of Pennsylvanian age.

Considering the Mississippian dating of the limestone underlying the sandstone formation and the thick sequence of beds involved, it could reasonably be expected that the sandstone might include beds of Pennsylvanian age. Although it is shown in this report that internal evidence of age indicates the coal to be Mississippian, this is not in conflict with the suggestion that the upper part of the sandstone formation is Pennsylvanian, and the coal may well occur near the Mississippian-Pennsylvanian boundary.

CHEMICAL AND PETROGRAPHIC ANALYSES

Although merely a few blocks of weathered coal, not a representative sample, were collected, both a chemical and a petrographic analyses were carried out because of the rather unique nature of the occurrence. The chemical analysis, reported on an "as received" basis by J. F. Fryer, Chief Coal Analyst, Research Council of Alberta, is as follows:

Moisture	3.3%
Ash	3.6%
Volatile matter	34.9%
Fixed carbon	58.2%
Ultimate carbon	73.3%
Ultimate hydrogen	4.2%
Calorific value (as received)	12,560 BTU/lb.
Calorific value (moist.-ash free basis)	12,670 BTU/lb.

Probable rank (A.S.T.M.): High volatile "C" or possibly "B" bituminous coal.

A microscopic examination of the coal, carried out with the aid of polished surfaces and reflected light, revealed that it has a normal banded micro-structure, and that all coal macerals commonly occurring in Carboniferous coals are present. Very outstanding are the

numerous spores, both small spores and megaspores, which in cross-section range in size from .026 to 1.40 mm.

The great abundance of spore exines, and particularly the presence of large megaspores, indicate that this coal is not of Cretaceous or Tertiary age, but was laid down during Palæozoic time, probably in the Carboniferous period. In Cretaceous coals spores are rarely noted in polished sections. This is not surprising, because the vegetation consisted predominantly of angiospermic plants which produced pollen grains. These pollen grains appear in polished cross-sections as thin elongated bodies and never reveal the trilete mark which is so characteristic of the spores. In Palæozoic coals true pollen grains do not occur, because the angiospermic plants had not developed.

A comparison between photomicrographs taken from a Cretaceous coal from Western Canada (*see* Plate I, figure 1), a Carboniferous coal from the Sydney coalfield (*see* Plate I, figure 2), and the South Nahanni River coal (*see* Plate I, figure 3) shows at once the similarity between the two latter.

A quantitative petrographic analysis, carried out on crushed coal, representing the entire sample, gave the following results.

1. *Maceral analysis*

vitrinite	53%
exinite	19%
micrinite	12%
semifusinite	3%
fusinite	13%

2. *Banded ingredient analysis*

vitrain	2%
clarain	68%
durain	16%
semifusain	2%
fusain	12%

Because no representative sample was taken, the analysis does not give the composition of the seam as a whole. It does show that the coal is high in exinite and fusinite. It is not a principally dull or durainous coal, as was originally supposed from visual examination of the sample, which has a distinctly dull aspect. The dull appearance is caused primarily by the spores, and not by a high amount of micrinite, as would be the case in a true durain or splint coal. The 12 per cent micrinite present in the sample is contributed chiefly by the 16 per cent durain, which was found on the average to contain 54 per cent micrinite. Plate I, figure 6 shows that the micrinite in the durain is present almost entirely in the massive form. The clarain on the other hand contains predominatly granular micrinite, with granules of about 0.5 microns in diameter (*see* Plate I, figure 5). Generally it is believed that coal containing granular micrinite originated under sub-aquatic conditions, without access to air, preventing complete decay (von Karmasin, 1952). The excellent preservation of the spores present in this coal may be related to its assumed sub-aquatic origin in the peat bog.

SPORE ANALYSIS

General Outline

The excellent preservation of the spores, as seen in the polished section, and the relatively low rank of the coal indicated that this material would be most suitable for a spore investigation. With the

aid of Schulze's maceration solution it proved relatively easy to isolate the spores in a satisfactory manner. Only the high fusain content was somewhat of a handicap, because fusain is not dissolved by the acids and subsequent addition of potassium hydroxide, and separates from the coal together with the spores. Consequently, small fragments of fusain are common in the slides, and may partly obscure the spores. This made it difficult to obtain perfect photographs, but did not greatly hinder proper identifications which were made with the Leitz Ortholux microscope at 400 x magnification.

Spore studies have become increasingly important in recent years. Although originally carried out in connection with the coal mining industry only, they are now also being used in oil company laboratories because of their great and widespread stratigraphic value. Although coal is the best source material for spores, they have also been isolated from shales and sandstones, which naturally enhances their usefulness in this field of investigations.

Two types of spores occur and are generally studied separately, because different techniques and different nomenclatures are involved. They are the megaspores and the small spores. The megaspores are larger than 200 microns in diameter and give rise on germination to the female gametophytes. The small spores, usually below 200 microns, comprise the microspores, the isospores and the prepollen. The microspores and the prepollen give rise to the male gametophytes, whereas the isospores produce a prothallium with both female and male organs.

The present study is confined to the small spores only. Megaspores, although noted in polished sections and in the maceration residue, have not been examined.

The binomial nomenclature and generic descriptions of the small spores of Schopf, Wilson, and Bentall (1944) are used in this report. For a few genera not discussed by these authors the descriptions given by Schemel (1950), by Potonié and Kremp (1954), and by Hoffmeister, Staplin, and Malloy (1955b) are followed. For specific identifications the 1938 publication of Luber and Waltz on spores of some Carboniferous coal deposits in the U.S.S.R. was repeatedly consulted.

Stratigraphic Value of the Small Spores

In North America L. R. Wilson (1946) was one of the first to point out that fossil spores can be used as excellent geological time markers, both for individual coal seams and for the major subdivisions of the Carboniferous period. What can be attained by a systematic study of numerous coal seams in one large coal area has been shown in the remarkably complete and decisive publication of R. M. Kosanke (1950). In the Illinois coal basin each of the forty seams that occur in the Pennsylvanian section is characterized by a specific assemblage of species of small spores that differs from the one above and the one below. The range of some species is shown

to be restricted to a few seams only, whereas the range of other species is considerably longer. Although important differences may occur regionally in the relative numbers (actual amounts) in which each species are present, Kosanke (1950), Cross (1952), and others have shown that the fundamental characteristics of the assemblage remains unchanged, thus enabling seams to be correlated on this basis.

Both in Europe and America this work has been primarily restricted to the solution of stratigraphic problems in individual coal areas. To the authors' knowledge only one attempt has been made to arrive at a world-wide picture of the stratigraphic distribution of different spore genera. Potonié and Kremp discuss, in their 1954 publication, the vertical ranges of different genera present in the Devonian, Carboniferous, and Permian periods in the United States, Asia and the U.S.S.R., and Europe. Naturally this review is based on a great number of previous reports, and, as the authors point out, will be revised and added to as the results of more spore investigations become known. The spores of the Pennsylvanian have been most extensively studied, which is not surprising because it was during this time that most of the productive coal measures were laid down. Least known are the spores of the Devonian and the Mississippian. However, from studies made in Great Britain, the United States, and the U.S.S.R. on Lower Carboniferous and Mississippian coals, it is apparent that its spore assemblage is distinctly different from the one that characterizes Pennsylvanian coals, and also that this assemblage has several common characteristics (Schemel, 1950).

These characteristics are:

1. The small spores are generally more numerous and varied in form and sculpturing (Knox, 1942, 1947, 1952).
2. Small spores with a thickened spore coat are abundantly present, and those of the type of *Denso-sporites* usually predominate.
3. Small spores of the *Punctati-sporites, Raistrickia, Reticulati-sporites, Triquitrites,* and *Reinschospora* types vary greatly in abundance, from complete absence to sub-dominance.
4. The genera *Calamospora, Lycospora, Cirratriradites, Endosporites, Schulzospora,* and *Knoxisporites* are usually low in abundance or completely absent.
5. Genera with ranges reported to be restricted to the Mississippian are: *Rotaspora, Convolutispora, Auroraspora* and *Grandispora. Simozonotriletes* and *Tripartites* may be included, but extend into the lowermost Pennsylvanian (Hoffmeister, Staplin and Malloy, 1955a).
6. *Laevigato-sporites* and monolete spores in general are probably either completely absent or very rare. Raistrick (1938) is the only author who noted their occurrence in Mississippian coals.

The above-mentioned characteristics are based on spore examin-

ations of coal seams only. However, as is pointed out by Hoffmeister, Staplin, and Malloy (1955b), coal represents a limited environment of deposition and forms only a small percentage of the total rock column. Assemblages studied by Hoffmeister, Staplin and Malloy (1955b) of Upper Mississippian carbonaceous shales contain essentially the same genera, but in quite different proportions. The genera most abundant in these rocks are *Cirratriradites* (averaging from 40-50 per cent), *Punctati-sporites* (20-35 per cent), *Denso-sporites* (5-12 per cent) and *Granulati-sporites* (3-6 per cent).

Spore Assemblage of the South Nahanni River Coal

A very varied and abundant spore florule is present, as 21 genera and 61 species are recognized. These include 5 new genera, 29 new species, and 12 new types of which only one or two specimens were found. The genera proposed as new are *Cincturasporites* (9), *Labiadensites* (5), *Tendosporites* (3), *Monilospora* (1) and *Perianthospora* (1). Previously described genera recorded are *Calamospora* (2), *Punctati-sporites* (6), *Granulati-sporites* (2), *Raistrickia* (1), *Camptotriletes*? (1), *Convolutispora* (1), *Microreticulati-sporites* (1), *Reticulati-sporites* (2), *Triquitrites* (3), *Tripartites*? (1), *Lycospora* (1), *Denso-sporites* (7), *Simozonotriletes* (2), *Cirratriradites* (5), *Reinschospora* (3) and *Microsporites* (1). In this enumeration the figure in brackets denotes the number of species assigned to each genus. In Table I the names of the different species are listed, together with the range in size observed or the maximum and minimum diameters. The page and plate numbers of the detailed descriptions and illustrations are also given. The 3 genera *Cincturasporites, Labiadensites* and *Denso-sporites* are represented by 21 species, indicating that many forms of the spore florule belong to the suite *Cingulati* (Potonié and Kremp, 1954) characterized by types with a greatly thickened spore coat at the equator. Quantitatively these 3 genera together constitute 47.4 per cent of the assemblage. The zonate forms with equatorial flanges and centrifugal extensions are represented by the genera *Tripartites, Simozonotriletes, Tendosporites, Monilospora, Cirratriradites* and *Reinschospora.* They are represented by 15 species and together constitute 11.3 per cent of the assemblage. Only 2 genera possessing bladders are present, namely *Microsporites* and *Perianthospora,* represented by 2 species and constituting 2.5 per cent of the assemblage. In terms of the classification used by Luber and Waltz (1938) for the small spores in the Carboniferous of the U.S.S.R., 39 species (*Lycospora* included) may be assigned to *Zonotriletes* Waltz, 1935, constituting 62 per cent of the assemblage, and 21 species to *Azonotriletes* Luber, 1935, constituting 38 per cent. *Zonotriletes* includes all forms previously referred to as *Cingulati,* zonate forms and bladder type spores. *Azonotriletes* designates the remaining types and includes *Calamospora, Punctati-sporites, Granulati-sporites, Raistrickia, Camptotriletes, Convolutispora, Microreticulati-sporites, Reticulati-sporites* and *Triquitrites.*

TABLE I

INDEX TO SOUTH NAHANNI RIVER ASSEMBLAGE

with reference to comparable species reported from the Lower Carboniferous of the U.S.S.R. and the Mississippian of the U.S.A.

Species	Description (Page)	Illustration Plate	Illustration Figure	Size Range or Diameter (in microns)	U.S.S.R. Present	U.S.S.R. Similar to	U.S.A. Present
Calamospora cf. *C. microrugosus*	12	II	1	83.0 by 86.0		*C. microrugosus*	x
C. cf. *C. pallidus*	13	II	2	44.3 by 55.4			x
Punctati-sporites nitidus	13	II	3	30.0 to 38.0			x
P. reticulopunctatus	13	II	4	41.0 to 51.0			x
P. cellulosus n. sp.	14	II	5	38.0 to 67.0			
P. nahannensis n. sp.	14	II	6	38.0 to 52.0			
P. pedatus n. sp.	14	II	7	128.0 to 154.0			
P. sp. A	15	II	9	28.8 by 35.2			
Granulati-sporites pipergranus n. sp.	15	II	11	25.0 to 30.0			
G. pustulatus n. sp.	15	II	10	28.0 to 39.0			
Raistrickia sp. A	16	II	12	83.0 by 86.0			
Camptotriletes ? *juglandilis*	16	II	8	80.0 to 102.0			
Convolutispora type A	16	II	13	44.3 by 47.1			x
Microreticulati-sporites fundatus	17	II	14	28.0 by 28.0			x
Reticulati-sporites varioreticulatus n. sp.	17	II	15,16	96.0 to 128.0		*Az. cancellatus*	
R. speciosus n. sp.	18	II	17	96.0 to 128.0			
Triquitrites tendoris n. sp.	18	II	18,19	45.0 to 58.0			
T. ? sp. A	19	II	20	57.6 by 64.0			
T. ? sp. B	19	II	21	97.0 by 116.3			
Tripartites ? *trivalvis* n. comb.	20	II	22	76.8 by 80.0	x		
Lycospora micrograna n. sp.	20	II	23	28.0 to 39.0			
Cincturasporites auritus n. comb.	23	III	1	76.0 to 84.0	x		
C. literatus n. comb.	23	III	2 - 5	76.0 to 100.0	x		
C. sulcatus n. comb.	24	III	6	80.3 by 94.2	x		
C. cf. *Z. stenozonalis* n. comb.	24	III	7	86.0 by 97.0		*Z. stenozonalis*	
C. altilis n. sp.	25	III	8	90.0 to 130.0			
C. appendices n. sp.	25	III	10-12	110.0 to 166.0			

C. irregularis n. sp.	25	III	9	72.0 to 84.0			
C. stenozonalis magnus n. sp.	26	III	13	115.0 to 160.0			
C. sp. A	26	III	14	88.6 by 100.0			
Labiadensites cf. *Z. duplicatus* n. comb.	27	IV	1	58.2 by 66.5		*Z. duplicatus*	
L. fimbriatus n. comb.	28	IV	2	127.0 to 139.0	x		
L. attenuatus n. sp.	28	IV	3 - 6	135.0 to 250.0			
L. serratus n. sp.	29	IV	7	70.0 to 96.0			
L. sp. A	30	IV	8	64.0 by 76.8			
Denso-sporites annulatus	30	IV	9	44.0 to 53.0			
D. cuneiformis n. sp.	31	IV	10	58.0 to 72.0			
D. irregularis n. sp.	31	IV	11-14	58.0 to 75.0		*Z. bialatus*	
D. plicatus n. sp.	32	IV	15	50.0 to 61.0			
D. subserratus n. sp.	32	IV	16	60.0 to 72.0			
D. sp. A	33	IV	17	40.0 by 41.6			
D. sp. B	33	IV	18	38.8 by 41.6			
Simozonotriletes intortus	34	V	1	65.0 to 75.0	x		
S. triquetrus n. sp.	34	V	2	51.0 to 65.0			
Tendosporites subcrenatus n. comb.	36	V	3,4	55.0 to 75.0	x		
T. rotulus n. sp.	36	V	5,6	112.0 to 182.0			
T. subalatus n. sp.	37	V	7	55.0 to 70.0			
Monilospora moniliformis n. sp.	38	V	8,9	58.0 to 68.0			
Cirratriradites cf. *C. granulatipunctatus*	39	V	10	47.0 to 61.0			x
C. uber	39	V	11	30.0 to 38.0			x
C. latitriletes n. sp.	39	V	12	238.0 to 285.0			
C. solaris n. sp.	40	V	14,15	234.0 by 243.0		*Z. auranthiacus*	
C. sp. A	41	V	13	38.4 by 45.0		*Z. subtilis*	
Reinschospora nahannensis n. sp.	41	VI	1,2	70.0 to 80.0			
R. saetosus n. sp.	41	VI	3	45.0 to 58.0		*Z. speciosus*	
R. sp. A	42	VI	4	48.0 by 57.6			
Microsporites macgregori n. sp.	42	VI	5,6	286.0 to 328.0			
Perianthospora crenata n. sp.	44	VI	7,8	133.0 to 166.0			
cf. *Azonotriletes lobophorus*	44	VI	9	47.0 by 47.0		*Az. lobophorus*	
Spore type A	45	VI	11,12	57.0 to 64.0			
Spore type B	45	VI	10	70.4 by 76.8			
Incertae sedis	46	VI	13	163.0 by 230.0			

The percentage in which the different genera and species are present in the assemblage was obtained from a statistical count of 400 spores. The detailed results of this count are as follows:

Genera

	Per cent
Denso-sporites	23.0
Cincturasporites	20.7
Punctati-sporites	19.5
Granulati-sporites	11.7
Reinschospora	7.2
Triquitrites	4.0
Labiadensites	3.7
Perianthospora	2.5
Cirratriradites	2.0
Reticulati-sporites	1.5
Tendosporites	1.4
Other genera	2.8

Species
(per cent of total assemblage)

	Per cent
Denso-sporites irregularis	15.2
Punctati-sporites nahannensis	11.5
Cincturasporites altilis	9.0
Granulati-sporites pipergranus	8.2
Reinschospora nahannensis	6.7
Cincturasporites stenozonalis magnus	6.0
Cincturasporites literatus	4.0
Triquitrites tendoris	3.8
Punctati-sporites reticulopunctatus	3.8
Granulati-sporites pustulatus	3.5
Labiadensites attenuatus	3.5
Denso-sporites cuneiformis	3.5
Punctati-sporites cellulosus	3.0
Perianthospora crenata	2.5
Denso-sporites plicatus	2.3
Reticulati-sporites varioreticulatus	1.2
All other species 1 per cent or less	12.3

The Spore Assemblage of the South Nahanni River Coal compared with Known Assemblages from the Mississippian of the United States and the Lower Carboniferous of the U.S.S.R.

The general characteristics of the spore assemblage from the South Nahanni River coal agree with those of the assemblages reported from Mississippian coals are enumerated on page 6, but has more similarity to the one reported from northern Russia than to the one from the United States. Although the literature on spores of this age

is very limited in both countries, some interesting comparisons with the South Nahanni River material can be made.

1. The genera *Simozonotriletes* and *Reinschospora* are present in both the South Nahanni River coal and in the Lower Carboniferous coals of the U.S.S.R. In the United States only *Simozonotriletes* is reported from the Mississippian (probably Namurian A: Hoffmeister, Staplin and Malloy, 1955a), whereas *Reinschospora* occurs only in the Pennsylvanian (probably Namurian B to Stephanian B).
2. Three of the newly proposed genera of the South Nahanni River assemblage, namely *Cincturasporites, Labiadensites* and *Tendosporites,* are also present in the Russian material but have not been reported from the United States.
3. The genera *Knoxisporites, Auroraspora, Grandispora* and *Rotaspora* known from the Mississippian of the United States are not reported with certainty from the U.S.S.R., and are absent from the South Nahanni River coal.
4. As regards species (*see* Table I), it was found that 8 species from the South Nahanni River coal have previously been reported from the Mississippian (Chester series) of the United States. They include 6 species recently described by Hoffmeister, Staplin, and Malloy (1955b), and belong to 5 genera, of which only *Convolutispora* is typical of Mississippian strata. However, only a single specimen could be assigned to this genus.
5. Sixteen species present in the South Nahanni River assemblage are comparable to species reported from northern Russia. Of these 16, 7 species are conspecific with the Russian ones and 9 are very similar and considered to be very closely related. They show minor differences or are insufficiently described for detailed comparisons. The 16 species belong to 10 genera (one classed under 'genus indeterminate' is included) of which 6 are typical of the Lower Carboniferous of northern Russia. They are: *Simozonotriletes, Cincturasporites, Labiadensites, Tendosporites, Reinschospora* and cf. *Azonotriletes lobophorus.*
6. Some rather unusual species that have been reported only from the U.S.S.R. are considered to be conspecific with types present in the South Nahanni River material. They are: *Tripartites? trivalvis, Cincturasporites auritus, Cincturasporites literatus, Cincturasporites sulcatus, Labiadensites fimbriatus, Tendosporites subcrenatus;* and the cf. types *Labiadensites* cf. *Z. duplicatus,* and cf. *Azonotriletes lobophorus.* Of these species *Cincturasporites literatus* represents 4 per cent of the assemblage, and is considered by Naumova (1937) as a typical and commonly occurring form in the Lower Carboniferous of the U.S.S.R.
7. Luber and Waltz (1938) stated that the spore assemblages of the Lower Carboniferous coals of the U.S.S.R., with the exception

of those of the Karaganda basin, consist predominantly of species assigned to *Zonotriletes,* which averages from 72-75 per cent of the assemblage. Of these, species with thick rims (*Cincturasporites, Labiadensites* and *Denso-sporites*) are most abundant. This compares with the South Nahanni River coal in which 62 per cent are assigned to *Zonotriletes* (*see* p. 7).

8. Another characteristic mentioned by Luber and Waltz (1938) is the presence of broad lips or flat thickenings that surround the trilete rays in many species belonging to *Zonotriletes.* This feature is also present in species from the South Nahanni River coal, where 12 species out of the 39 that may be classed as *Zonotriletes* have this remarkable characteristic. It has not been reported from Mississippian spore florules of the United States.

From the above it is apparent that the spore florule of the South Nahanni River coal most closely resembles that described from the Lower Carboniferous of northern Russia in coals of Viséan age, as the bizarrely ornamented forms of the Tournaisian are not represented. However, the presence of 8 species from the Chester series of the United States, as well as 4 genera (*Simozonotriletes, Reinschospora, Tripartites* and *Camptotriletes*) from the Namurian A of Upper Silesia (Horst, 1955), does not preclude an Upper Mississippian or Namurian A dating of the South Nahanni River assemblage (*see also* p. 3).

SYSTEMATIC DESCRIPTIONS OF GENERA AND SPECIES[1]

Genus Calamospora Schopf, Wilson and Bentall, 1944[2]

Calamospora cf. *C. microrugosus* (Ibrahim) S. W. & B., n. comb.

Plate II, figure 1

Description. Spore is radial, trilete, round in transverse plane, and has numerous plications of the spore coat in the centre and near the margin of the spore. The folds are taper-pointed, have a lenticular outline, and are of major proportions. Only one specimen was observed, which measures 83 x 86 microns. Trilete rays are distinct, very slightly sinuous, and equal $\frac{3}{8}$ of the spore radius. Lips appear to be slightly modified. The spore coat is very weakly punctate-granulose, and is less than 2 microns thick, which accounts for the numerous plications.

Hypotype. Maceration NAH-Slide 8 at 49.5 by 113.9[3] Ortholux.

Discussion. This species is probably conspecific with *C. microrugosus,* but too few specimens were found to make a definite assignment possible.

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[1]As the manuscript was completed in December 1955, the authors were unable to consider in detail the new generic classification and species reassignments proposed by Potonié and Kremp, and published in 1956.

[2]Hereafter abbreviated to S. W. & B.

[3]The figures preceding the word Ortholux for each slide indicate the instrument settings on the Ortholux microscope which are required to locate the specimen referred to.

Calamospora cf. *C. pallidus* (Loose) S. W. & B., n. comb.

Plate II, figure 2

Description. Spores are radial, trilete, round to oval in transverse plane and have taper-pointed folds with lenticular outlines. The folds are of major proportions and occur near the margin and towards the apex of the spore. Only two specimens were observed, measuring 44.3 x 55.4 microns and 44 x 50 microns, respectively. Trilete rays are distinct and measure less than $\frac{1}{2}$ the radius of the spore. Lips are not modified. The spore coat is weakly punctate-granulose, and probably less than 2 microns thick.

Hypotype. Maceration NAH-Slide 1 at 43.8 by 114.1 Ortholux.

Discussion. This species is similar to *C. pallidus,* but not enough specimens were found to make a definite identification possible.

Genus Punctati-sporites (Ibrahim, 1933) emend., S. W. & B., 1944

Punctati-sporites nitidus Hoffmeister, Staplin and Malloy, 1955

Plate II, figure 3

Description. Spores are radial, trilete, round in transverse plane and generally contain arcuate compression folds. Hypotype measures 30.5 x 30.5 microns, and the size range observed is from 30 to 38 microns. The spore coat is levigate to faintly granulose, and approximately 2 microns thick. Trilete rays are distinct and equal from $\frac{2}{3}$ to $\frac{3}{4}$ of the spore radius.

Hypotype. Maceration NAH-Slide 1 at 38.8 by 118.6 Ortholux.

Discussion. This species conforms well to *P. nitidus,* except that the trilete rays appear to be slightly longer.

Punctati-sporites reticulopunctatus

Hoffmeister, Staplin and Malloy, 1955

Plate II, figure 4

Description. Spores are radial, trilete, round to oval in transverse plane and generally obliquely compressed. Folding of the spore coat sometimes occurs. Hypotype measures 41.6 x 46.4 microns and the size range observed is from 41 to 51 microns in the longest diameter. Ornamentation is distinctly punctate. The punctations are shallow and closely spaced and measure approximately 1 micron in diameter. The margin of the spore is very finely notched. Trilete mark is present but not always distinct. The rays equal $\frac{2}{3}$ or more of the spore radius. The spore coat is 2 to 3 microns thick.

Hypotype. Maceration NAH-Slide 4A at 38.8 by 127.6 Ortholux.

Discussion. This species conforms well to the description of *P. reticulopunctatus,* except that the trilete rays are not always distinct.

Punctati-sporites cellulosus n. sp.

Plate II, figure 5

Description. Spores are radial, trilete, round to roundly triangular in transverse plane, and often somewhat obliquely compressed. Holotype measures 51.2 x 57.6 microns, and the known size range is from 38 to 67 microns in the longest diameter. Ornamentation is microreticulate; mesh is 2 to 3 microns, muri are thin. The margin of the spore coat is finely notched. The trilete mark is often obscured by the ornamentation. The rays equal $\frac{1}{2}$ to $\frac{2}{3}$ of the spore radius. The spore coat is approximately 2 microns thick.

Holotype. Maceration NAH-Slide 1 at 42.1 by 124.3 Ortholux.

Discussion. P. reticuloides Kosanke, 1950, is similar, but differs by a more irregular punctate-reticulate pattern showing a mesh that varies between 2 and 5 microns, and having thicker muri.

Punctati-sporites nahannensis n. sp.

Plate II, figure 6

Description. Spores are radial, trilete, circular, oval or roundly triangular in transverse plane, and often have one or two marginal folds. Holotype measures 46.4 x 51.2 microns, and the known size range is from 38 to 52 microns in the longest diameter. Ornamentation is granulose to spinose, with spines up to 1 micron visible at the margin. The trilete mark is often obscured by the folds. The rays of the holotype are of unequal length, with one ray being shorter than the other two. They measure 9.6 and 16 microns, respectively, and equal approximately from $\frac{1}{2}$ to $\frac{2}{3}$ of the spore radius. The spore coat is less than 2 microns thick.

Holotype. Maceration NAH-Slide 8 at 40.5 by 113.3 Ortholux.

Discussion. This species resembles *P. globosus* (Loose) S. W. & B., n. comb., but has a shorter size range and often contains one or two marginal folds.

Punctati-sporites pedatus n. sp.

Plate II, figure 7

Description. Spores are radial, trilete, oval in transverse plane, and in all specimens observed contain a singular fold. The original dimensions of the holotype before folding are 112 x 153.6 microns, and the known size range is from 128 to 154 microns in the longest diameter. Ornamentation is minutely punctate, and the punctations are very closely spaced. Trilete mark is present, but is not distinct. The rays are 32 microns long, or approximately equal $\frac{1}{2}$ of the spore radius. The spore coat is 2 microns thick.

Holotype. Maceration NAH-Slide 7 at 39 by 128.8 Ortholux.

Discussion. This species resembles *Calamospora pedata,* Kosanke, 1950. However, it is considerably larger, and has an ornamentation characteristic of the genus *Punctati-sporites.*

Punctati-sporites sp. A

Plate II, figure 9

Description. Spore is radial, trilete, roundly triangular in transverse plane. The observed specimen measures 28.8 x 35.2 microns. Ornamentation is obvermiculate to rugose, and is visible at margin. The trilete rays are distinct and extend to the spore wall, which is from 2 to 3 microns thick.

Hypotype. Maceration NAH-Slide 7 at 51 by 120.8 Ortholux.

Discussion. The long rays and roundly triangular shape are suggestive of the genus *Lycospora.* However, an equatorial ridge is not present. The species is included with *Punctati-sporites* because of the type of ornamentation and the long rays, which although not common are not unusual for this genus. Only one specimen was observed.

Genus Granulati-sporites (Ibrahim, 1933) emend., S. W. & B., 1944

Granulati-sporites pipergranus n. sp.

Plate II, figure 11

Description. Spores are radial, trilete, subtriangular in transverse plane; margin of the spore wall between radii convex, corners opposite radii bluntly pointed; generally laterally compressed. The holotype measures 28 x 30 microns, and the known size range is from 25 to 30 microns in the longest diameter. Ornamentation is very finely granulose with granules very closely spaced, and barely visible at the margin. Trilete rays are distinct and equal from $\frac{2}{3}$ to $\frac{3}{4}$ of the spore radius. Suture is usually distinct, lips are not modified. The spore coat is about 2 microns thick.

Holotype. Maceration NAH-Slide 2A at 32.3 by 113.6 Ortholux.

Discussion. This species resembles *G. parvus* (Ibrahim, 1933) S. W. & B., n. comb. in size and outline, but differs in ornamentation, which is finely granulose and not finely punctate, as is the case in *G. parvus.*

Granulati-sporites pustulatus n. sp.

Plate II, figure 10

Description. Spores are radial, trilete, subtriangular in transverse plane, margin of the spore wall between radii strongly convex, corners opposite radii broadly rounded, generally laterally compressed and folded. The holotype measures 36 x 38.8 microns, and the known size range is from 28 to 39 microns in the longest diameter. Ornamentation is distinctly granulose, with granules up to 2 microns in diameter that are closely spaced and clearly visible at the margin. Trilete rays are distinct and extend to the margin or nearly so. Suture is usually narrow, lips are not modified. The spore coat is from 2 to 2.5 microns thick.

Holotype. Maceration NAH-Slide 6A at 39.7 by 110.6 Ortholux.

Discussion. No equivalent of this species was found in the literature. It is characterized by a coarsely granulose spore coat, by a roundly triangular shape and by long, simple rays.

Genus Raistrickia S. W. & B., 1944

Raistrickia sp. A

Plate II, figure 12

Description. Spore is radial, thought to be trilete, oval to roundly triangular in transverse plane, and measures 83 x 86 microns. Ornamentation is coarsely verrucose, with warty processes that are closely spaced and measure 6.4 x 9.6 microns. They appear as rounded elevations at the margin of the spore. An indication of the trilete mark is thought to be present, but due to the coarse ornamentation it is not possible to state the length of the rays. The spore coat is about 5 microns thick.

Hypotype. Maceration NAH-Slide 3A at 29.2 by 119.5 Ortholux.

Discussion. This species is assigned to the genus *Raistrickia* because of the coarsely verrucose ornamentation. Only one specimen was observed.

Genus Camptotriletes Naumova, 1937

Camptotriletes ? *juglandilis* Horst, 1943

Plate II, figure 8

Description. Spores are radial, trilete, oval in transverse plane. The hypotype measures 73.6 x 102.4 microns, and the size range observed is from 80 to 102 microns in the longest diameter. Ornamentation consists of solid low ridges or rudimentary cristae, that are very irregular in form and disposition, and vary in width from 4 to 15 microns. Trilete mark is usually not distinct; suture is narrow and lips are not developed. In the hypotype the rays are from 28.8 to 38.4 microns long, or equal about $\frac{2}{3}$ of the spore radius. The spore coat is from 3 to 6 microns thick.

Hypotype. Maceration NAH-Slide 4A at 43.1 by 109.1 Ortholux.

Discussion. This species has somewhat the appearance of a walnut. Except for the spore coat, which is thicker, it conforms well to the description of *C.* ? *juglandilis.*

Genus Convolutispora Hoffmeister, Staplin and Malloy, 1955

Convolutispora type A Hoffmeister, Staplin and Malloy, 1955

Plate II, figure 13

Description. Spore is radial, trilete, round in transverse plane, and measures 44.3 x 47.1 microns. Ornamentation consists of randomly winding ridges, 3 microns wide, 2 to 3 microns high, and appearing as knobby processes at the margin. Trilete rays are distinct, and equal slightly more than $\frac{1}{2}$ the radius of the spore. Suture is narrow, and lips are not developed. Spore coat is relatively thick, but translucent.

Hypotype. Maceration NAH-Slide 4A at 40.2 by 116.4 Ortholux.

Discussion. Only one specimen was found, but it was distinct enough to assign it to *C.* type A.

Genus Microreticulati-sporites

(Knox, 1950) emend., Potonié and Kremp, 1954

Microreticulati-sporites fundatus

Hoffmeister, Staplin and Malloy, 1955

Plate II, figure 14

Description. Spores are radial, trilete, round in transverse plane. Only two specimens were found, which measure 25 x 25 microns, and 28 x 28 microns. Ornamentation is microreticulate, with lacunae varying in size between 1 micron and 3 microns. The muri are thin and approximately 1 micron high. Trilete rays are indistinct and equal $\frac{2}{3}$ of the spore radius.

Hypotype. Maceration NAH-Slide 4A at 38.8 by 121.6 Ortholux.

Discussion. As pointed out by Hoffmeister, Staplin and Malloy (1955b) the small diameter and distinctly reticulate surface of the spore are characteristic.

Genus Reticulati-sporites (Ibrahim, 1933) emend., S. W. & B., 1944

Reticulati-sporites varioreticulatus n. sp.

Plate II, figures 15, 16

Description. Spores are radial, trilete, round to oval in transverse plane. The holotype measures 115.2 x 115.2 microns and the known size range is from 96 to 128 microns in the longest diameter. The spore coat is reticulate with lacunae varying in size between 6 and 16 microns on the holotype, but ranging as high as 26 microns in other specimens. They average about 16 microns. The muri are from 3 to 5 microns thick and 10 microns high, and in places are irregularly thickened at or near their junction. They protrude past the body margin, where some membranous material may be present between them. The trilete mark is frequently not distinct in that it is covered by the muri. In the holotype the rays measure from 32 to 42 microns, or equal about $\frac{2}{3}$ of the spore radius. Lips are 3 microns wide and slightly elevated; suture is narrow but distinct. The spore coat, exclusive of the muri, is from 3 to 6 microns thick.

Holotype. Maceration NAH-Slide 4A at 47.2 by 107.2 Ortholux.

Discussion. Except for its dimensions and size range, which are larger, this species has much in common with *R. muricatus* Kosanke, 1950. It could be conspecific with *Azonotriletes cancellatus* Waltz, 1938, but the brevity of the description precludes a definite assignment.

Reticulati-sporites speciosus n. sp.

Plate II, figure 17

Description. Spores are radial, trilete, round to oval in transverse plane, and have a distinct body that is enclosed on the distal side only by a transparent outer spore coat (perispore?), which is coarsely reticulate. The overall dimensions of the holotype are 121.6 x 121.6 microns, and the known size range is from 96 to 128 microns in the longest diameter. The spore body in the holotype measures 89.6 x 89.6 microns, and is finely, but distinctly punctate on both proximal and distal sides. Trilete rays are distinct and range from 32 to 51 microns in length, and extend to, or nearly to, the margin of the body wall. The rays are accompanied by broad flat lips, which are from 3 to 5 microns wide in the holotype. The spore coat of the spore body is 3 microns thick. The reticulate and transparent "perispore" extends about 20 microns past the spore body in transverse plane. The lacunae of the reticulation are fairly regular and average 22 microns in size. The muri are 2 to 3 microns thick.

Holotype. Maceration NAH-Slide 9A at 28.6 by 120.3 Ortholux.

Discussion. This species could represent a bladder type spore, but because of the distinct coarse reticulation, which is external rather than internal as is the case in bladders, it is included with the genus *Reticulati-sporites.* However, contrary to the presently known species, the reticulate ornamentation is restricted to the distal side of the spore.

Genus Triquitrites Wilson and Coe, 1940

Triquitrites tendoris n. sp.

Plate II, figures 18, 19

Description. Spores are radial, trilete, subtriangular in transverse plane, and have at the equator a flange-like centrifugal extension of the spore coat with arcuate thickenings at the corners. The interradial margins of the spore are concave, and the corners are rounded. The holotype measures 54.4 x 54.4 microns and the known size range is from 45 to 58 microns in the longest diameter. The centrifugal extension averages 6.5 microns in width in the interradial areas. At the corners it not only becomes wider (9.6 to 12.8 microns), but also appreciably thicker, giving rise to arcuate thickenings that are "knee-cap-like" in appearance. Trilete rays are distinct and extend to within 3 microns of the thickened corners. Lips are moderately developed, and there is a definite *area contagionis,* which is indicated by small punctations in the pyramic segments. The spore coat, except for these punctations, is levigate.

N.B. The central area in the holotype appears to be rather thin, probably due to corrosion, as this is not the case in other specimens present (*see* Plate II, figure 19).

Holotype. Maceration NAH-Slide 5A at 48.6 by 109.5 Ortholux.

Discussion. Although this species has a centrifugal extension of the

spore coat, and therefore is structurally similar to *Simozonotriletes* and *Tendosporites,* it is included with *Triquitrites,* because of the arcuate thickenings. Except for the arcuate thickenings, it shows much resemblance to *Simozonotriletes intortus,* (Waltz, 1938) Potonié and Kremp, n. comb., to which it may be closely related.

Triquitrites ? sp. A

Plate II, figure 20

Description. Spore is radial, trilete, subtriangular in transverse plane. The interradial margins are straight to very slightly concave, and the arcuate thickenings are large and "knob-like" in appearance. The specimen measures 57.6 x 64 microns. The arcuate thickenings vary in length from 12.8 to 22.4 microns and are 16 microns wide. Trilete rays are distinct and extend almost to the margin of the spore wall. They are accompanied by broad contact areas, which are indicated by a series of grooves and punctations and which are slightly elevated. The spore coat is levigate, and in the interradial areas is from 2 to 3 microns thick.

Hypotype. Maceration NAH-Slide 7 at 48.6 by 114.1 Ortholux.

Discussion. The distinct thickening of the radial angles of the spore coat indicate that this spore is closely related to the genus *Triquitrites.* However, the very pronounced radial extension of the arcuate thickenings is a feature not now associated with this genus. Since only one specimen was observed, it is provisionally included with the genus *Triquitrites.* More specimens are necessary before a decision on a generic segregation can be made.

Triquitrites ? sp. B

Plate II, figure 21

Description. Spore is radial, trilete, subtriangular in transverse plane. The interradial margins are slightly convex, and the arcuate thickenings are relatively large and "knob-like" in appearance. The specimen measures 97 x 116.3 microns. The spore coat is levigate, thin and strongly folded, and is in this respect similar to *Calamospora.* The trilete mark is present, but the length of the rays is difficult to determine, because of the numerous folds. They appear to equal at least $\frac{4}{5}$ of the "body" radius. The arcuate thickenings are from 20 to 28 microns long, and from 28 to 39 microns wide. They appear in transverse plane as semi-circules attached to the body, and probably overlapping onto same.

Hypotype. Maceration NAH-Slide 9M at 39.2 by 129.1 Ortholux.

Discussion. This species is likely congeneric with *Triquitrites*? sp. A. Both spores have distinct arcuate thickenings, indicating a close relationship with the genus *Triquitrites.* The pronounced radial extensions, however, are not present in any described species of this genus. Furthermore *Triquitrites* ? sp. B would extend by at least 41 microns the present known size range. Since only one specimen was

observed, it is provisionally included with the genus *Triquitrites*. More specimens are necessary before a decision on a generic segregation can be made.

Genus Tripartites Schemel, 1950

Tripartites ? trivalvis (Waltz, 1938) n. comb.

Plate II, figure 22

Description. Spores are radial, trilete, subtriangular in transverse plane, and have at the equator a flange-like centrifugal extension of the spore coat with very large arcuate thickenings at the corners. The interradial margin is distinctly concave, and the corners are broadly rounded. Only two specimens were observed, measuring 76.8 x 80 microns and 64 x 73.6 microns, respectively. In the hypotype the centrifugal extension is 6.4 microns wide in the interradial areas. At the corners it not only becomes much wider, but also considerably thicker, giving rise to the arcuate thickenings, which are 19.2 microns wide and 44.8 microns long. The central area is triangular in shape, with rounded corners and straight or concave sides. It measures 48 x 48 microns. The trilete mark is obscure due to the corrosion of the central area. However, it may be noted that one ray extends to within 6 microns of the arcuate thickening. Lips do not appear to be developed. The spore coat of both central area and equatorial portion is levigate.

Hypotype. Maceration NAH-Slide 17 at 36.8 by 129.6 Ortholux.

Discussion. This species is conspecific with *Zonotriletes trivalvis* Waltz, 1938, except that it is 15 microns larger in size. Luber and Waltz (1938) mention that *Z. trivalvis* is very similar to *Z. incisotrilobus* (Naumova) Waltz, 1938, from which it is distinguished only by the absence of plications in the widest portions of the centrifugal extension. The latter species is according to Schemel (1950) apparently congeneric with *Tripartites vetustus*, the genotype of his genus *Tripartites*. On this basis and Schemel's generic description of *Tripartites*, the new combination *Tripartites trivalvis* has provisionally been adopted.

Genus Lycospora S. W. & B., 1944

Lycospora micrograna n. sp.

Plate II, figure 23

Description. Spores are radial, trilete, roundly triangular to oval in transverse plane, and have an equatorial ridge, which is 3 microns wide. The ridge is perforated and therefore appears thinner than the central area. The holotype measures 35.2 x 38.4 microns and the known size range is from 28 to 39 microns in the longest diameter. Trilete mark is present, but is not distinct. The rays extend to the equatorial ridge. Ornamentation is distinctly, but finely granulose, and granules are closely spaced. The spore coat is 2 microns thick.

Holotype. Maceration NAH-Slide 3A at 47 by 115.6 Ortholux.

Discussion. This species differs from *L. granulata* Kosanke, 1950 in that it has a finer granulation and no distinct lip development.

Genus Cincturasporites n. gen.

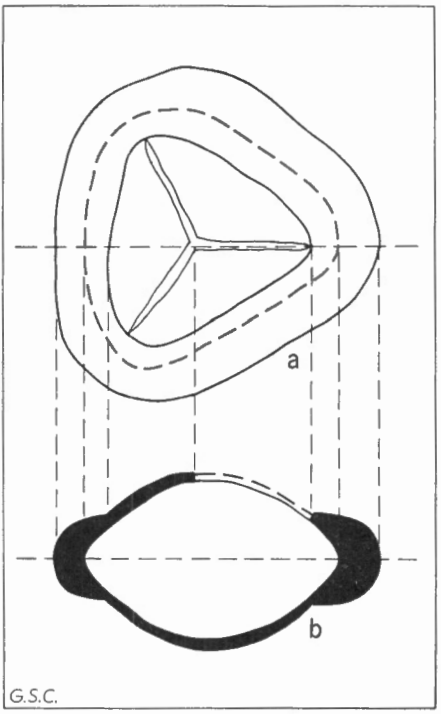

Figure 2. Diagrammatic drawing of *Cincturasporites* n. gen.; a, equatorial (transverse) plan; b, axial (longitudinal) plan.

Description. Spores are radial, trilete, roundly to subtriangular in transverse plane, and have an abrupt equatorial thickening of the spore coat. The abrupt thickening, hereafter referred to as the cingulum, appears as a massive ridge or as a flange-like rim, that extends polewards from 2 to 9 microns past the inner spore wall in the different species that were found. This poleward extension is called the overlap in the descriptions of the different species assigned to this genus. The cingulum is generally of about equal width, and less than the radius of the central area. At the corners it may be wider and occasionally somewhat thicker, and in some species the cingulum contains concentric furrows. On the forms now known the central area is strongly trilete, with rays extending to the cingulum or nearly so, and often with contact markings or a considerable lip development. The spore coat of the central area is never membranous but is 3 microns or more thick in the specimens where it could be measured. Both the cingulum and the central area are essentially levigate to faintly punctate or granulose, but the central area may contain large projections or ridge-like elevations on the distal side, as was

noted in three species assigned to this genus. The size range presently observed is from 72 to 166 microns in the longest diameter.

Genotype. Cincturasporites altilis n. sp.

Discussion. Structurally this genus and *Denso-sporites* (Berry, 1937) S. W. & B., 1944, are closely related, since in both genera the spore coat is greatly thickened at the equator. In *Cincturasporites* the increase in thickness of the spore coat gives rise to a cingulum (abrupt equatorial thickening), which may represent an arcuate ridge in its origin. The width of the cingulum (thickness of spore coat at equator plus a 2 to 9 micron poleward extension) does not exceed the radius of the central area, and is usually considerably less. In *Denso-sporites* the spore coat thickens gradually and not abruptly from the polar region to the equator, where the thickness of the spore coat alone usually exceeds the radius of the central area, without considering the poleward extension. A gradual equatorial thickening (crassitude), and not a cingulum is represented.

In transverse plane the difference in structure of the equatorial portions is revealed by the following characteristics. Both genera contain a distinct concentric line that separates a translucent central portion from a more opaque outer portion. In *Cincturasporites* this line represents the point where the spore coat begins to thicken. Between this line and the outer margin of the spore the inner spore wall is present, either as a vague or a distinct line. In *Denso-sporites* the distinct line represents the inner spore wall, whereas the point where the spore coat begins to thicken is usually difficult to determine, and occurs near the apex of the spore.

Longitudinal sections through compressed specimens of both genera are "dumbbell" shaped, but in *Cincturasporites* are less pronounced because the difference in thickness of the spore coat at the pole and at the equator is less than it is in *Denso-sporites.*

Another important difference between the two genera is the marked development of a trilete in *Cincturasporites* and weak occurrence in *Denso-sporites.*

The species assigned here to *Cincturasporites* could conceivably belong to the genus *Anulatisporites* (Loose, 1934) emend, when compared with illustrations 54 to 56 of Potonié and Kremp (1954). However, the description of *Anulatisporites* does not mention an abrupt equatorial thickening, nor does it state that this thickening is less in width than the radius of the central area. Moreover, *Anulatisporites* is described as having indistinct to perceptible trilete rays, which in *Cincturasporites* are always very distinct. Furthermore, *Zonalesporites annulatus* Loose, 1934, the genotype of *Anulatisporites* Pontonié and Kremp, emend., 1954, has been included with *Densosporites* by Schopf, Wilson and Bentall (1944), whose generic description of *Denso-sporites* differs substantially from the emended version of this genus by Pontonié and Kremp.

The authors are of the opinion that this emended version of *Densosporites* is rather confusing, the more so because the genotype *D.*

covensis Berry, 1937, has more *Anulatisporites* than *Denso-sporites* characteristics, as defined by Potonié and Kremp.

The strong trilete character of *Denso-sporites* as mentioned by Potonié and Kremp, is also a feature that is not now associated with spores that are included with *Denso-sporites* by Schopf, Wilson and Bentall.

The authors, therefore, have decided to follow Schopf, Wilson and Bentall, and do not recognize *Anulatisporites*.

Cincturasporites auritus (Waltz, 1938) n. comb.
Plate III, figure 1

Description. Spores are radial, trilete, triangular in transverse plane, and have a smooth cingulum that is thickened at the corners, and has a 4 to 6 micron overlap. The interradial margin is straight or slightly convex, and the corners are rounded or somewhat truncated. The hypotype measures 69.3 x 84 microns, and the observed size range is from 76 to 84 microns in the longest diameter. The cingulum is 19.2 to 22.4 microns wide at the corners, and measures from 9.6 to 12.8 microns at the sides. At the corners the cingulum contains arcuate thickenings, which in the hypotype are 9.6 microns wide and 32 microns long. These thickenings are not always well defined in the different specimens that were observed. Often only a greater opacity of the cingulum is represented. The central area is roundly triangular to ovoid in shape with pointed corners which at the junction of the rays are slightly indented. It measures 33.2 x 47.1 microns. Trilete rays are distinct and extend to the cingulum. They are accompanied by broad flat lips, which are 3 to 4 microns wide. The spore coat of both cingulum and central area is levigate.

Hypotype. Maceration NAH-Slide 9 at 29.2 by 112.9 Ortholux.

Discussion. This species is conspecific with *Zonotriletes auritus* Waltz, 1938, except that it is 19 microns larger in size range.

Cincturasporites literatus (Waltz, 1938) n. comb.
Plate III, figures 2 to 5

Description. Spores are radial, trilete, roundly triangular to oval in transverse plane, and have a smooth cingulum with a 3 micron overlap. The hypotype measures 86.4 x 86.4 microns, and the size range observed is from 76 to 100 microns in the longest diameter. The cingulum is generally regular in outline and is from 12 to 16 microns wide. The central area is oval to roundly triangular in shape, and measures 44.8 x 64 microns. It is levigate on the proximal side, and contains distinct trilete rays with well developed broad lips that extend to the cingulum. These lips, or ridges, parallel with the rays are 9.6 microns wide in the hypotype, and usually contain a single row of small punctations in the middle. On the distal side of the spore occur lobes or thick convex bands that protrude from both the central area and the cingulum. There are usually from three to four of these

protuberances, which are approximately 10 microns thick. When compressed transversely the protuberances attached to the cingulum appear like thickenings. In laterally compressed specimens, which occur almost as abundantly as the transversely compressed ones, the protuberances appear like appendages attached to the cingulum.

Hypotype. Maceration NAH-Slide 20 at 26.5 by 109.5 Ortholux.

Discussion. This species is conspecific with *Zonotriletes literatus* Waltz, 1938, but has a larger size range.

Cincturasporites sulcatus (Waltz, 1938) n. comb.
Plate III, figure 6

Description. Spores are radial, trilete, roundly triangular in transverse plane, and have a smooth cingulum, with a 5 to 6 micron overlap. Only two specimens were observed. They measure 80.3 x 94.2 microns, and 69.3 x 86 microns. The cingulum is from 16 to 22 microns wide, and is uniform except for minor indentations at the periphery. It contains distinct concentric furrows, and is somewhat thicker at the inner margin where it joins the central area. Although essentially smooth, small punctations, probably associated with the furrows, may be noted on the cingulum. The central area is roundly triangular and measures 44.3 x 55.4 microns, and 41.6 x 50 microns in the two specimens that were found. Trilete rays are distinct and extend to the cingulum. Broad, flat lips, that are slightly elevated are present; suture is thin. The spore coat of the central area is levigate and approximately 3 microns thick.

Hypotypes. Maceration NAH-Slide 1 at 44.8 by 115.7 Ortholux.
Maceration NAH-Slide 2A at 45.1 by 119.3 Ortholux.

Discussion. The two forms described are considered to be conspecific with *Zonotriletes sulcatus* Waltz, 1938.

Cincturasporites cf. *Z. stenozonalis* (Waltz, 1938) n. comb.
Plate III, figure 7

Description. Spores are radial, trilete, round to oval in transverse plane, and have a smooth cingulum with a 3 to 5 micron overlap. Only two specimens were observed, which measure 86 x 97 microns, and 80 x 93 microns. The cingulum varies in width between 7 and 11 microns and is very regular in outline. The central area in the hypotype measures 66.5 x 77.6 microns. Trilete rays are distinct and equal from $\frac{2}{3}$ to $\frac{3}{4}$ the radius of the central area. The rays are accompanied by broad flat lips, that are slightly elevated, 3 microns wide, and are partly obscured by the ornamentation. The spore coat of the central area is granulose-punctate, but this ornamentation may be internal and due to the inner surfaces of proximal and distal parts being brought into contact with one another by compression.

Hypotype. Maceration NAH-Slide 4A at 30.5 by 121.9 Ortholux.

Discussion. This species resembles *Zonotriletes stenozonalis*, but is about 10 microns larger and has broad lips that are not reported by Waltz (1938).

Cincturasporites altilis n. sp.
Plate III, figure 8

Description. Spores are radial, trilete, subtriangular in transverse plane, and have a smooth cingulum with a 5 to 8 micron overlap. The holotype measures 91.4 x 102.5 microns, and the known size range is from 90 to 130 microns in the longest diameter. The cingulum is from 14 to 22 microns wide and is uniform except for minor indentations at the periphery. The central area is subtriangular in shape with convex sides and pointed to slightly rounded corners, and measures 58 x 63 microns in the holotype. Trilete rays are distinct and extend to the cingulum. Lips are elevated and suture is usually wide. The spore coat of the central area is faintly punctate-granulose, and more than 3 microns thick.

Holotype. Maceration NAH-Slide 4A at 41.3 by 113.7 Ortholux.

Discussion. This species is characterized by its subtriangular shape; by the cingulum, which considerably overlaps onto the central area; and by the raised lips and usually wide suture.

Cincturasporites appendices n. sp.
Plate III, figures 10 to 12

Description. Spores are radial, trilete, roundly triangular in transverse plane, and have a smooth to faintly punctate cingulum, with a 3 to 6 micron overlap. The holotype measures 102.5 x 124.7 microns, and the known size range is from 110 to 166 microns in the longest diameter. The cingulum is from 16 to 22 microns wide and is uniform except for some minor indentations at the periphery. In some specimens it contains narrow concentric furrows. The central area is roundly triangular and measures 72 x 83.1 microns in the holotype. Trilete rays are distinct and extend to the cingulum, or nearly so. Suture is thin and lips are not developed. Ornamentation of the proximal side of the central area is faintly punctate-granulose. The distal side contains from three to ten blunt to rounded projections or appendages, that measure from 12 to 25 microns in the different specimens observed. They are situated more or less near the centre of the central area on the distal side.

Holotype. Maceration NAH-Slide 10 at 44.3 by 107 Ortholux.

Discussion. This species has distinct appendages on the distal side. However, in several of the observed specimens the central area is thin, due to corrosion or the maceration process. In this case the appendages are no longer present, but are inferred from other specimens that are only partly corroded.

Cincturasporites irregularis n. sp.
Plate III, figure 9

Description. Spores are radial, trilete, more or less subtriangular in transverse plane, and have an almost smooth cingulum, with a 3 to 4 micron overlap. The holotype measures 67.2 x 73.6 microns, and

the known size range is from 72 to 84 microns in the longest diameter. The cingulum is irregular in width, being wider in the areas opposite the rays, with one of these areas usually broader than the other two. In the holotype the cingulum opposite the rays measures 16, 16 and 22.4 microns. The width in the interradial areas varies between 8 and 9.6 microns. The central area is subtriangular with convex sides and pointed corners, and measures 35.2 x 44.8 in the holotype. Trilete rays are distinct and extend to the cingulum. Lips are moderately developed, suture is wide, and contact areas are present although not always distinct. The spore coat of the central area is faintly punctate-granulose and is more than 3 microns thick. The cingulum, although essentially smooth, contains small punctations in the areas opposite the rays.

Holotype. Maceration NAH-Slide 4 at 31.4 by 107.8 Ortholux.

Discussion. This species is probably related to *C. auritus* (Waltz, 1938) n. comb., but does not contain arcuate thickenings and the central area has a different shape.

Cincturasporites stenozonalis magnus n. sp.

Plate III, figure 13

Description. Spores are radial, trilete, oval to roundly triangular in transverse plane, and have a smooth cingulum, with a 2 to 4 micron overlap. The holotype measures 110.8 x 124.7 microns, and the known size range is from 115 to 160 microns in the longest diameter. The cingulum is from 16 to 22 microns wide and is uniform, except for minor indentations at the periphery. It usually contains one or two concentric furrows. The central area is oval in shape, and measures 74.8 x 83.1 microns in the holotype. The trilete rays are not always distinct and equal $\frac{3}{4}$ or more of the radius of the central area. Suture is thin and lips are not developed. The spore coat of the central area is finely punctate-granulose and about 3 microns thick.

Holotype. Maceration NAH-Slide 4 at 36.2 by 109.8 Ortholux.

Discussion. This species resembles *C. altilis* n. sp. but has no raised lips, is more oval in shape and usually contains concentric furrows. Furthermore the spore coat of the central area is not as thick as in *C. altilis,* and the overlap of the cingulum is not as large. Except for its size range, which is 75 microns larger, this species is similar to *Zonotriletes stenozonalis* Waltz, 1938.

Cincturasporites sp. A

Plate III, figure 14

Description. Spore is radial, trilete, oval to roundly triangular in shape, and has a smooth cingulum with a 3 micron overlap. Only one specimen was observed, which measures 88.6 x 100 microns. The cingulum is regular in outline and averages 16 microns in width. The central area is oval in shape and measures 55.4 x 72 microns. Trilete rays are distinct and extend to the cingulum. They are accompanied

by broad, flat lips that are slightly elevated. The spore coat of the central area is faintly punctate-granulose and contains on the distal side a rather unusual thick ridge. This ridge is in general concentric with the cingulum and completely surrounds the distal pole of the central area. It is smooth and from 11 to 13.5 microns wide.

Hypotype. Maceration NAH-Slide 2A at 45.4 by 109 Ortholux.

Discussion. The distal ring of thickening may indicate that this species is related to the genus *Knoxisporites* Potonié and Kremp, 1954, but the connecting bars to the cingulum are not present. Only one specimen was found.

Genus Labiadensites n. gen.

Description. Spores are radial, trilete, round or roundly triangular in transverse plane, and have a gradual equatorial thickening of the spore coat (a crassitude). The equatorial thickening is not of uniform structure, but may be strongly tapered so as to simulate a flange, or may possess an irregularly thickened, segmented outer margin. The central area is thinner than the equatorial part, and is always strongly trilete, with greatly developed lips, except in corroded specimens. Trilete rays equal ¾ or more of the radius of the central area. The spore coat of both equatorial and central portions is levigate to punctate-granulose. The size range presently observed is from 70 to 250 microns in the longest diameter.

Genotype. Labiadensites attenuatus n. sp.

Discussion. Structurally this genus and *Denso-sporites* are very similar, since in both genera the spore coat gradually increases in thickness from the polar regions to the equator. However, contrary to *Denso-sporites* a strong trilete and greatly developed lips are always present. On this basis, and the much larger size range, it was advised by Dr. L. R. Wilson not to include these spores with *Denso-sporites,* but to erect a new genus, for which the authors propose the name *Labiadensites.*

Labiadensites cf. *Z. duplicatus* (Naumova; Waltz, 1938) n. comb.

Plate IV, figure 1

Description. Spore is radial, trilete, roundly triangular in transverse plane, and measures 58.2 x 66.5 microns. The equatorial portion averages 19 microns in width, and has a strongly serrated outer margin with "mushroom-like caps" at the apex of each serration. The specimen has 23 of these caps, which vary in width between 5 and 11 microns, and occur isolated or in contact with each other. The inner part of the equatorial portion appears to be slightly thicker than the outer part, except for the "mushroom caps", which may represent the thickest part of the spore. Proximal and distal portions of the spore coat are slightly thinner than the equatorial portion. Trilete rays are distinct and are equal to the radius of the central area. Lips are developed and suture is thin. The spore coat of both

central area and equatorial portion is essentially levigate. A direct transverse measurement shows that about 50 per cent of the spore is the equatorial portion of the spore coat.

Hypotype. Maceration NAH-Slide 4A at 43.9 by 110.1 Ortholux.

Discussion. Since only one specimen was observed, no definite assignment can be made. The species does resemble rather closely *Zonotriletes duplicatus,* both in size and in the presence of the "mushroom-like caps" at the margin. It is included with *Labiadensites,* because the central area is thinner than the equatorial portion, and a strong trilete with lip development is present.

Labiadensites fimbriatus (Waltz, 1938) n. comb.

Plate IV, figure 2

Description. Spores are radial, trilete, round in transverse plane. The hypotype measures 135.7 x 139 microns, and the size range on the specimens observed is from 127 to 139 microns in the longest diameter. The equatorial portion is from 30 to 38 microns wide, and consists of a smooth "opaque" inner part and a more translucent outer part. The margin between these two parts is well defined, regular and smooth. The more translucent area is irregularly thickened, due to plications, and has an irregular, more or less distinctly lobed outer margin, that on occasion is very finely toothed. More than one-half of the equatorial portion is occupied by the more translucent area. The proximal and distal portions of the spore coat are thinner than the equatorial portion, but probably are 8 microns or more in thickness. Trilete rays are distinct and measure from 20 to 24 microns in the hypotype, or are slightly shorter than the radius of the central area. They are accompanied by broad lips, which are from 6.5 to 8.3 microns wide, distinctly elevated and reaching the equatorial portion. At their outer margin the lips are wrinkled, whereas the parts immediately adjoining the rays are smooth and flat. The spore coat of the central area is finely punctate-granulose. A direct transverse measurement of the hypotype shows that 48 per cent of the spore is the equatorial portion of the spore coat.

Hypotype. Maceration NAH-Slide 2A at 50.4 by 123.2 Ortholux.

Discussion. This species is very similar to *L. attenuatus* n. sp. but differs in having lips that extend to the equatorial portion, and in possessing a much shorter size range. Also the central area is more distinctly punctate-granulose, and the outer margin is more lobed. It conforms very well with the description of *Zonotriletes fimbriatus* Waltz, 1938, but extends the size range by 9 microns.

Labiadensites attenuatus n. sp.

Plate IV, figures 3 to 6

Description. Spores are radial, trilete, roundly triangular to round in transverse plane. The holotype measures 122 x 139 microns, and the known size range is from 135 to 250 microns in the longest di-

ameter. The equatorial portion is from 22 to 72 microns wide, and consists of a smooth "opaque" inner part that graduates into a more translucent outer part. The margin between these two parts is in some specimens quite distinct, regular and smooth. The more translucent area is irregularly thickened, due to plications, and usually has a lobed outer margin. About one-half or more of the equatorial portion is occupied by the more translucent area. The proximal and distal portions of the spore coat are definitely thinner than the equatorial portion, but may measure as much as 8.3 microns in thickness. The trilete rays are almost always distinct and equal about ¾ of the radius of the central area. One ray is usually longer than the other two, the difference being as much as 16 microns in an extreme case. The rays are accompanied by broad lips, which are from 6 to 9 microns wide, slightly or distinctly elevated, and usually bordered by a single row of small punctations or grooves. The lips do not reach the equatorial portion. The spore coat of both equatorial and central portions is essentially levigate, but may be weakly punctate-granulose. In some specimens the entire central portion is distinctly ornamented, but careful observation reveals that this ornamentation is internal, and thought to be due to the inner surfaces of proximal and distal portions being brought into contact with one another by compression. A direct transverse measurement of the holotype shows that 50 per cent of the spore is the equatorial portion of the spore coat.

Holotype. Maceration NAH-Slide 6A at 47 by 111 Ortholux.

Discussion. This species, which was chosen as the genotype of *Labiadensites,* clearly possesses a crassitude, or gradual equatorial thickening of the spore coat that starts in the polar regions. In an obliquely compressed specimen, illustrated in Plate IV, figure 4, a gradual increase in thickness of the spore coat from 8.3 microns at the proximal and distal poles to 22.2-27.7 microns at the equator (exclusive of the more translucent part) was noted. Also, specimens devoid of the central area, showing only the equatorial portion were found (*see* Plate IV, figure 6).

Labiadensites serratus n. sp.

Plate IV, figure 7

Description. Spores are radial, trilete, roundly triangular to oval in transverse plane. The holotype measures 70 x 70 microns, and the known size range is from 70 to 96 microns in the longest diameter. The equatorial portion is from 16 to 22 microns wide and consists of an essentially opaque inner part that is strongly serrated, and that graduates into a usually more translucent outer part. The margin of the outer part is somewhat ring-like, being 3 to 6 microns wide. Proximal and distal portions of the spore coat are thinner than the equatorial portion. Trilete rays are distinct, extend to the margin of the central area, and are accompanied by broad flat lips. Suture is thin, and the spore coat of both proximal-distal and equatorial portions is levigate. A direct transverse measurement of the holotype

shows that 48 per cent of the spore is the equatorial portion of the spore coat.

Holotype. Maceration NAH-Slide 7 at 37.8 by 111.3 Ortholux.

Discussion. The equatorial portion of this species is similar in construction to that of *Denso-sporites subserratus* n. sp., but the serrations are more pronounced, and the outer margin is more a solid ring, rather than united segments. It is included with the new genus *Labiadensites* because of the strong trilete and the broad flat lips.

Labiadensites sp. A

Plate IV, figure 8

Description. Spore is radial, trilete, round to oval in transverse plane, and measures 64 x 76.8 microns. A central area, measuring 27.7 x 36 microns, and an equatorial portion that is from 16.6 to 24.9 microns wide are present. The central area is levigate and contains trilete rays that reach to the equatorial portion, and that are accompanied by broad, flat lips. The equatorial portion has a marginal thickening with an irregular, ruffled, almost segmented surface that is from 5.5 to 8.2 microns wide. The inner part of the equatorial portion is smooth, but near the marginal thickening it is serrated in several places.

Hypotype. Maceration NAH-Slide 1 at 24.6 by 127.3 Ortholux.

Discussion. Only one specimen was found. It resembles *L. serratus* n. sp., but the equatorial margin is wider and also considerably thicker.

Genus Denso-sporites (Berry, 1937) emend., S. W. & B., 1944

Denso-sporites annulatus (Loose, 1934) S. W. & B., n. comb.

Plate IV, figure 9

Description. Spores are radial, trilete, oval to roundly triangular in transverse plane. The hypotype measures 42 x 44 microns and the size range on the specimens observed is from 44 to 53 microns. The equatorial portion is smooth, from 9 to 10 microns wide and of about equal thickness, being essentially opaque between inner and outer margins. Proximal and distal portions of the spore coat are thin, often membranous, and weakly punctate-granulose. Trilete mark is obscure, but may be observed in some specimens after careful focusing. The rays extend to the equatorial portion. A direct transverse measurement of the hypotype shows that 38 per cent of the spore is the equatorial portion of the spore coat.

Hypotype. Maceration NAH-Slide 10 at 31.5 by 126.7 Ortholux.

Discussion. This species matches very well the description of *D. annulatus,* but is about 10 microns larger in size range.

Denso-sporites cuneiformis n. sp.

Plate IV, figure 10

Description. Spores are radial, thought to be trilete, subtriangular in transverse plane. The holotype measures 58.2 x 60.9 microns and the known size range is from 58 to 72 microns in the longest diameter. The equatorial portion is from 16 to 22 microns wide and consists of an essentially opaque part that is surrounded by a more translucent area. The border between these two areas is somewhat irregular, but never clearly lobed. The opaque part occupies from $\frac{1}{2}$ to $\frac{2}{3}$ of the width of the equatorial portion. The more translucent area likely represents a tapering of the equatorial thickening towards the periphery of the spore. The equatorial portion of the spore coat is levigate, except for the more translucent part which has a slightly rough appearance. The proximal and distal portions are thin, but always present and not membranous. The ornamentation of this part is finely granulose. Trilete mark has not been observed, but is inferred from the triangular shape of the central area. The equatorial portion varies between 60 and 66 per cent of the transverse diameter of the spore.

Holotype. Maceration NAH-Slide 9 at 39.3 by 110 Ortholux.

Discussion. This species differs from *D. irregularis* n. sp. by the structure of the equatorial thickening, which consists of a wider opaque portion with a more regular border, and a translucent, but not a membranous part. The central area in *D. cuneiformis* is, moreover, smaller, finely granulose and not membranous. It differs from *D. tenuis* Hoffmeister, Staplin and Malloy, 1955b, in that the trilete mark was not observed, and the equatorial portion is persistently wider in relation to the size of the spore.

Denso-sporites irregularis n. sp.

Plate IV, figures 11 to 14

Description. Spores are radial, trilete, subtriangular to roundly triangular in transverse plane. The holotype measures 57.6 x 60.8 microns and the known size range is from 58 to 75 microns in the longest diameter. The equatorial portion is from 13 to 19 microns wide and appears to be distinctly tapered towards the periphery, where it becomes translucent and often membranous. The thicker inner part of the equatorial portion is essentially opaque and has either a fairly regular or an irregular outer margin, that may become distinctly lobed. Due to the variable nature of the shape and extension of the opaque part different forms are represented in transverse plane. However, they are not considered as individual species, because transitions from the one form to the other were noted. It is believed that the mode of preservation, as well as the degree of corrosion perhaps caused by the maceration process, is mainly responsible for the differences that occur.

Three main forms are represented that have the following characteristics:

1. The opaque portion has a fairly regular outer margin and is mostly distinctly, but finely punctate (*see* Plate IV, figure 12).
2. The opaque portion has an irregular outer margin that may become distinctly lobed, but does not reach the periphery of the spore. It is usually only weakly punctate (*see* Plate IV, figure 13).
3. The opaque portion is distinctly lobed and extends to the outer margin of the spore, somewhat like the spokes of a wheel. It is distinctly, but finely punctate (*see* Plate IV, figure 14).

In all forms the proximal and distal portions of the spore coat are very thin and often not present. Trilete mark is obscure, but may be observed on some specimens after careful focusing. The rays extend to the equatorial portion, or nearly so. Direct transverse measurements show that from 52 to 58 per cent of the spore is the equatorial portion of the spore coat.

Holotype. Maceration NAH-Slide 2A at 34.8 by 129.2 Ortholux.

Discussion. This species may be conspecific with *Zonotriletes bialatus* Waltz, 1938, in particular the forms described here under 1 and 2. However, the variations in the shape and extent of the "opaque" portion of the equatorial thickening that were noted in this material are not referred to by Luber and Waltz (1938).

Denso-sporites plicatus n. sp.

Plate IV, figure 15

Description. Spores are radial, thought to be trilete, subtriangular in transverse plane. The holotype measures 45 x 60.9 microns and the known size range is from 50 to 61 microns in the longest diameter. The equatorial portion is from 14 to 18 microns wide and of about uniform thickness, being essentially opaque between inner and outer margins. The equatorial portion is levigate to slightly rough and distinctly plicated in a radial fashion. Proximal and distal portions of the spore coat are thinner than the equatorial portion, but not membranous. They are distinctly granulose. Trilete mark has not been observed, but is inferred from the triangular shape of the central area. Direct transverse measurements show that from 50 to 54 per cent of the spore is the equatorial portion of the spore coat.

Holotype. Maceration NAH-Slide 4A at 49.4 by 120 Ortholux.

Discussion. This species is similar to *D. triangularis* Kosanke 1950, but differs in that it has an equatorial portion with plications and no spines visible at the outer margin.

Denso-sporites subserratus n. sp.

Plate IV, figure 16

Description. Spores are radial, trilete, roundly triangular in transverse plane. The holotype measures 52.6 x 60.9 microns, and the

known size range is from 60 to 72 microns in the longest diameter. The equatorial portion is from 13 to 16.5 microns wide and consists of an essentially opaque inner part with a weakly serrated margin, that graduates into a more translucent outer part with a segment-like margin, which is from 2 to 4 microns wide. Proximal and distal portions of the spore coat are thin, sometimes even membranous. Trilete rays are not distinct, but when present equal at least $\frac{2}{3}$ the radius of the central area. Lips are not developed, and suture may on occasion be open. The spore coat of both proximal-distal and equatorial portions is levigate. A direct transverse measurement of the holotype shows that 48 per cent of the spore is the equatorial portion of the spore coat.

Holotype. Maceration NAH-Slide 7A at 45 by 122.6 Ortholux.

Discussion. The equatorial margin of this species resembles that of *Labiadensites* cf. *Z. duplicatus* (Naumova; Waltz, 1938) n. comb. However, distinct "mushroom-like caps" are not present, but a series of fused segments that are much smaller in size is represented.

Denso-sporites sp. A

Plate IV, figure 17

Description. Spore is radial, trilete, round in transverse plane, and measures 40 x 41.6 microns. The equatorial portion is from 6 to 10 microns wide and consists of an essentially opaque part surrounded by a membranous area, which extends to the periphery of the spore. The margin between the two areas is well defined and almost a smooth line. From $\frac{1}{3}$ to $\frac{1}{2}$ of the equatorial portion is occupied by the opaque area. The membranous part is flange-like. The equatorial portion of the spore coat is levigate. The proximal and distal portions are membranous and contain a very small trilete mark, with rays only 3 microns long. The ornamentation of this part of the spore coat is very finely granulose. A direct transverse measurement reveals that 42 per cent of the spore is the equatorial portion of the spore coat.

Hypotype. Maceration NAH-Slide 8 at 38.7 by 108.7 Ortholux.

Discussion. This species is somewhat similar to *D. irregularis* n. sp. but differs in that it is smaller, round in shape, and that the outer margin of the opaque area of the equatorial portion is smooth and regular. Only one specimen has been observed.

Denso-sporites sp. B

Plate IV, figure 18

Description. Spores are radial, alete (?), round in transverse plane. Only two specimens were observed, which measure 35.2 x 36.8 microns, and 38.8 x 41.6 microns. The equatorial portion is from 9 to 10 microns wide and essentially opaque between inner and outer margins. It has a rough appearance, due to irregular, radiating plications and contains a few small spines at the outer margin. The proximal and distal portions of the spore coat are coarsely granulose, with

granules up to 3 microns in diameter that are fairly closely spaced. Trilete mark has not been observed. A direct transverse measurement reveals that 60 per cent of the spore is the equatorial portion of the spore coat.

Hypotype. Maceration NAH-Slide 7 at 32 by 114.9 Ortholux.

Discussion. This species resembles *D. plicatus* n. sp. but differs in that it contains a few spines at the outer margin, is more coarsely granulose and about 8 microns smaller in size. It is also similar in construction to *D. ruhus* Kosanke 1950, but the central area is distinctly granulose and not punctate as is the case in *D. ruhus.*

Genus Simozonotriletes

(Naumova, 1937) emend., Potonié and Kremp, 1954

Simozonotriletes intortus

(Waltz, 1938) Potonié and Kremp, n. comb.

Plate V, figure 1

Description. Spores are radial, trilete, subtriangular with concave sides and rounded corners in transverse plane, and have a centrifugal extension of the spore coat. The hypotype measure 60.9 x 66.5 microns, and the known size range is from 65 to 75 microns in the longest diameter. The centrifugal extension is restricted to the equator and is in outline entirely conformable to the central area. In the hypotype it is 8.3 microns wide at the sides and 11 microns at the corners. The thickness at the sides is about equal to the thickness of the central area (proximal plus distal walls), but at the corners it may be slightly thicker. The centrifugal extension is levigate; the central area is finely punctate-granulose. Trilete rays are distinct and equal $\frac{3}{4}$ or more of the radius of the central area. Contact markings surround the rays and are indicated by a single row of punctations. The central area of the hypotype measures 38.8 x 44.3 microns.

Hypotype. Maceration NAH-Slide 11 at 26.1 by 106.6 Ortholux.

Discussion. This species matches very well the description and photomicrographs of *S. intortus* of the 1955 publication of Horst. However, contrary to Potonié and Kremp, 1954, the authors contend that not a true cingulum, but a centrifugal extension is represented in the genus *Simozonotriletes,* as noted in the new genus *Tendosporites.* The genus *Murospora* Somers, 1952, may be regarded congeneric with *Simozonotriletes,* although it is widely separated in stratigraphic occurrence, and considerably smaller (20 to 31 microns).

Simozonotriletes triquetrus n. sp.

Plate V, figure 2

Description. Spores are radial, trilete, subtriangular with straight to slightly convex sides and rounded corners in transverse plane, and have a centrifugal extension of the spore coat. The holotype

measures 47.1 x 55.4 microns, and the known size range is from 51 to 65 microns in the longest diameter. The centrifugal extension is restricted to the equator and is in outline conformable to the central area. It varies in width from 9 to 12 microns, being generally slightly wider at the corners than at the sides. The central area measures 30.5 x 36 microns in the holotype. In thickness (proximal plus distal walls) it equals the thickness of the centrifugal extension. Trilete rays are distinct, and are almost equal to the radius of the central area. Lips are moderately developed and contact markings are present, as is indicated by small punctations in the interradial segments. The spore coat of both central area and centrifugal extension is essentially levigate to faintly punctate-granulose.

Holotype. Maceration NAH-Slide 7 at 31.3 by 116.2 Ortholux.

Discussion. This species, although not possessing concave sides, is included with *Simozonotriletes* because the centrifugal extension is in outline conformable to the central area.

Genus Tendosporites n. gen.

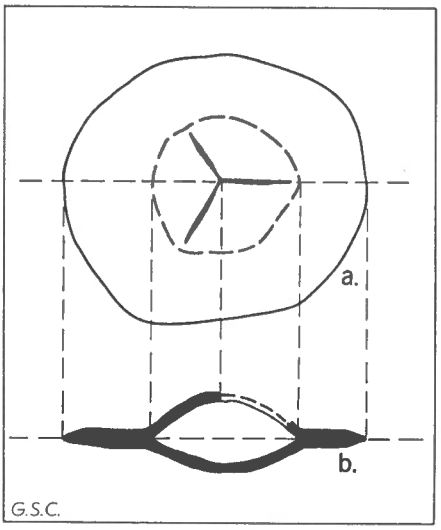

Figure 3. Diagrammatic drawing of *Tendosporites* n. gen.; a, equatorial (transverse) plan; b, axial (longitudinal) plan.

Description. Spores are radial, trilete, round to oval or roundly triangular in transverse plane, and have a centrifugal extension of the spore coat. The extension is flange-like, entirely restricted to the equator of the spore, and is in outline not truly conformable to the central area, as is the case in *Simozonotriletes*. In thickness it is about equal to the combined thicknesses of the proximal and distal walls, but in width it is considerably more. The centrifugal extension is essentially levigate, but may contain plications and concentric furrows. At the periphery it may be tapered or rolled to a considerable degree, as was noted in one species assigned to this genus. The central area is oval, ovoid or subtriangular with convex sides in the species

now known. Trilete rays are distinct and are $\frac{2}{3}$ or almost equal to the radius of the central area. Lips and contact markings may be present. The spore coat of the central area is also essentially levigate in the species that were found. The size range presently observed is from 55 to 182 microns in the longest diameter.

Genotype. *Tendosporites subalatus* n. sp.

Discussion. This genus is structurally intermediate between *Cincturasporites* and *Cirratriradites.* A true cingulum in the meaning of an abrupt equatorial thickening is not represented, but a flange-like centrifugal extension of the spore coat at the equator, which contrary to *Cirratriradites* is not appreciably thinner than the spore coat of the central area. In transverse plane the demarcation line between the central portion and the centrifugal extension represents the inner spore wall, and not the margin of a spore body as in *Cirratriradites.* Longitudinal sections through compressed specimens are not "dumbbell" shaped, but are of about equal thickness, as is illustrated in Plate I, figure 5. The original shape of the spores assigned to this genus may be compared to illustrations of the so-called "flying saucers".

Tendosporites subcrenatus (Waltz, 1938) n. comb.

Plate V, figures 3, 4

Description. Spores are radial, trilete, subtriangular in transverse plane. The hypotype measures 55.4 x 55.4 microns, and the size range observed is from 55 to 75 microns in the longest diameter. The flange-like centrifugal extension is from 9.5 to 13 microns wide and irregularly thickened at the periphery, due to plications of the spore coat. The outer margin of the centrifugal extension is irregularly indented, and in some specimens becomes almost fringed. The central area is subtriangular with convex sides and rounded corners, and measures 29 x 29 microns in the hypotype. In thickness (proximal plus distal wall) it is about equal to the thickness of the centrifugal extension. Trilete rays are usually distinct and measure from 9.6 to 12.8 microns in length, or equal about $\frac{1}{3}$ of the radius of the central area. Lips are not modified, and suture is thin. The spore coat of both central area and centrifugal extension is levigate.

Hypotype. Maceration NAH-Slide 6A at 47.9 by 112.9 Ortholux.

Discussion. In most specimens the thickness (density) of the central area about equals the thickness of the centrifugal extension. However, specimens in which the central area is thinner were also encountered, but these have a rather corroded appearance. This species matches well the description of Luber and Waltz (1938) of *Zonotriletes subcrenatus,* but extends the size range by 12.5 microns.

Tendosporites rotulus n. sp.

Plate V, figures 5, 6

Description. Spores are radial, trilete, round to oval in transverse plane. The holotype measures 124.7 x 152.4 microns, and the known

size range is from 112 to 182 microns in the longest diameter. The flange-like centrifugal extension is from 22 to 52 microns wide and has a rolled outer margin, with rolls occurring on the proximal side, or alternating from the proximal to the distal side of the same specimen. In transverse plane the rolls are very dark in colour and vary in width from 12.8 to 26 microns. No specimens were found with a centrifugal extension that is complete; the majority have lost the parts that occur opposite the rays (*see* Plate V, figure 6). The central area is round, oval or ovoid in shape, measures 72 x 77.6 microns in the holotype, and ranges in size from 54 to 100 microns. In thickness (proximal plus distal walls) it is about equal to the thickness of the centrifugal extension. Trilete rays are distinct and equal $\frac{2}{3}$ of the radius of the central area. They are accompanied by broad lips, which are from 5 to 6 microns wide, slightly elevated, and usually bordered by a single row of small punctations or grooves. The spore coat of both central area and centrifugal extension is levigate.

Holotype. Maceration NAH-Slide 4A at 33.5 by 127.6 Ortholux.

Discussion. Since there is no distinct difference in density between the central area and the equatorial portion, this species is regarded as a *Tendosporites*. The thickened outer margin is considered a secondary feature that resulted from a rolling or curling of the periphery, as may be noted in dry leaves. Further evidence for this is the presence of the rolls alternating between proximal and distal sides of the same specimen; their absence in many specimens in the areas opposite the rays, may result from the spore coat being too brittle to be rolled, and therefore breaking. Moreover the centrifugal extension, being spherical in outline, cannot be rolled at the margin without showing radial cracks and broken parts.

Tendosporites subalatus n. sp.

Plate V, figure 7

Description. Spores are radial, trilete, roundly triangular in transverse plane. The holotype measures 60.9 x 66.5 microns, and the known size range is from 55 to 70 microns in the longest diameter. The flange-like centrifugal extension is from 14 to 16.5 microns wide, and tapers towards the periphery, where it may become almost membranous. It has a somewhat irregular surface, due to wrinkles in the spore coat, and has a slightly sinuous outer margin. The central area is subtriangular with convex sides and rounded corners, and measures 30.5 x 33.2 microns in the holotype. In thickness (proximal plus distal walls) it is about equal to the thickness of the centrifugal extension. Trilete rays are usually distinct and almost equal the radius of the central area. Lips are not developed, and suture is thin. The spore coat of both the central area and centrifugal extension is levigate.

Holotype. Maceration NAH-Slide 11 at 29.2 by 128.4 Ortholux.

Discussion. This species resembles *T. subcrenatus* (Waltz, 1938) n.

comb., but differs in having a more regular outer margin and a centrifugal extension that is distinctly tapered at the periphery.

Genus Monilospora n. gen.

Description. Spores are radial, trilete, roundly triangular to round in transverse plane, and have an equatorial flange with a marginal thickening. Only one species has been assigned to this new genus. The marginal thickening of this species (the genotype) is not uniform, but consists of a great number of segments that are usually linked together and somewhat resemble a necklace. The trilete rays in the genotype equal from ½ to ⅔ the radius of the spore body. Both flange and body are levigate, and the spore coat is generally thin. The size range observed on the genotype is from 64 to 86 microns in the longest diameter.

Genotype. Monilospora moniliformis n. sp.

Discussion. In general construction these spores are similar to those belonging to the genus *Cirratriradites,* which also has a body and a flange. However, the marginal thickening and the short rays are features not now associated with *Cirratriradites.* Moreover, species now classed under this genus "show such general agreement in numerous characteristics that a considerable degree of natural relationship is attributed to it" (Schopf, Wilson and Bentall, 1944, p. 43). For these reasons it was felt that the characteristics of *M. moniliformis* n. sp. are such as to warrant the formation of a new genus.

Monilospora moniliformis n. sp.

Plate V, figures 8, 9

Description. Spores are radial, trilete, oval to roundly triangular in transverse plane, and have a wide equatorial flange with a marginal thickening. The holotype measures 60.8 x 83.2 microns, and the known size range is from 58 to 68 microns in the longest diameter. The flange is thin, at times membranous, and is characterized by a marginal thickening, which is from 3 to 10 microns wide. This thickening is not uniform, but consists of a great number of segments that are usually linked together. The flange is from 10 to 20 microns wide, and usually contains several narrow concentric rings. The spore body is sub- to roundly triangular, and ranges in size from 42 to 48 microns. Trilete rays are not always distinct, but when present equal from ½ to ⅔ of the radius of the spore body. Lips are not developed, and suture may on occasion be open. The spore coat of the body does not exceed 2 microns in thickness. Both flange and body are essentially levigate.

Holotype. Maceration NAH-Slide 1 at 34.8 by 127.9 Ortholux.

Discussion. This species is considered as having an equatorial flange, because specimens were observed in which the flange is clearly detached from the body (*see* Plate V, figure 9).

Genus Cirratriradites Wilson and Coe, 1940

Cirratriradites cf. *C. granulatipunctatus*

Hoffmeister, Staplin and Malloy, 1955

Plate V, figure 10

Description. Spores are radial, trilete, oval in transverse plane, and have a thin, narrow equatorial flange. The hypotype measures 47.1 x 58.2 microns, and the size range observed is from 47 to 61 microns in the longest diameter. The flange averages from 5 to 6 microns in width, and on some specimens is finely but irregular striate. Trilete mark is present, although not always distinct. The rays extend to the spore wall, or nearly so, but not into the flange. Lips are moderately developed. In nearly all specimens the spore coat is thinner in the centre than at the periphery, where it is 1.5 microns thick. Ornamentation of central body is finely granulose-punctate.

Hypotype. Maceration NAH-Slide 7 at 31.7 by 118.8 Ortholux.

Discussion. This species is likely conspecific with *C. granulatipunctatus,* but is 9 microns larger in size range.

Cirratriradites uber Hoffmeister, Staplin and Malloy, 1955

Plate V, figure 11

Description. Spores are radial, trilete, roundly triangular to round in transverse plane, and have an equatorial flange that is 3 to 5 microns wide. The hypotype measures 33 x 38 microns, and the size range on the observed specimens is from 30 to 38 microns. The spore coat appears thickened, due to folding at the juncture of the flange and the body margin. This thickening measures 2 microns. Trilete rays are distinct and extend into the flange. Lips are elevated and suture is thin. Ornamentation of central body is finely but distinctly granulose.

Hypotype. Maceration NAH-Slide 3A at 32 by 127 Ortholux.

Discussion. This species would undoubtedly be classed as *Lycospora* by previous workers, but since the rays penetrate the equatorial flange Hoffmeister, Staplin and Malloy (1955b) are of the opinion that it belongs to the genus *Cirratriradites.* Species like *L. minutus, L. pseudoannulata* and *L. punctata* are for the same reason now included with *Cirratriradites* by these authors.

Cirratriradites latitriletes n. sp.

Plate V, figure 12

Description. Spores are radial, trilete, roundly triangular in transverse plane, and have an equatorial flange. The holotype measures 238 x 285 microns and the known size range (on three whole specimens only) is from 238 to 285 microns in the longest diameter. The spore body is roundly triangular and not distinct. In the holotype it

measures 171 x 171 microns. The flange is somewhat wider in the areas opposite the rays, where it measures from 38 to 55 microns in width. In the interradial areas the flange is between 28 and 30 microns wide. Ornamentation of both body and flange is finely punctate, with the punctations very closely spaced. Trilete mark is strongly developed and the rays extend to the outer margin of the flange. They are accompanied by broad, flange-like lips, which are tapered towards the end of the rays. The greatest width of the lips in the holotype is 16.6 microns. Folding of flange and lips are common. Around the apex of the spore body on the distal side there occurs a concentric ring, which is not always distinct, and which in the holotype measures 72 microns in diameter.

Holotype. Maceration NAH-Slide 7M at 35.4 by 127.9 Ortholux.

Discussion. Although the margin of the spore body is indistinct, the species is assigned to *Cirratriradites* because of the long and distinct trilete rays, and because of the presence of a concentric ring around the apex at the distal side. In general, this species is similar to *C. saturni* (Ibrahim) S. W. & B., n. comb., but is more than twice as large.

Cirratriradites solaris n. sp.

Plate V, figures 14, 15

Description. Spores are radial, trilete, subtriangular in transverse plane, and have a broad, membranous equatorial flange. The holotype measures 234 x 243 microns, flange included. The dimensions of the spore body are 86.4 x 99.2 microns. Because parts of the thin flange are usually broken off, the known size range can only be given of the spore body. This size range is from 76 to 106 microns, in the longest diameter. The flange of the holotype is 64 microns wide in the areas between the rays, and measures from 83 to 90 microns opposite the rays. This, in effect, gives the spore a triangular outline. The flange is supported by a great number of thin ribs or veins, that are forked at the tip and anastomose. In most specimens the flange is not complete. It is attached to the proximal side of the spore body, with overlap of 6 to 10 microns. The spore body is roundly triangular in transverse plane, and has a micro-reticulate (or coarsely punctate) ornamentation. Trilete mark is distinct; the rays extend to the margin of the spore body, and are accompanied by broad lips, 3 microns wide and distinctly elevated. In a few specimens the rays extend beyond the margin of the spore body into the flange.

Holotype. Maceration NAH-Slide 15 at 31.8 by 129.9 Ortholux.

Discussion. This species is in many respects similar to *Zonotriletes auranthiacus* (Naumova) Waltz n. comb., 1938. However, the latter is considerably smaller, ranging in overall size from 85 to 130 microns, and in body size from 42 to 50 microns. Furthermore *Z. auranthiacus* has no distinct trilete mark.

Cirratriradites sp. A

Plate V, figure 13

Description. Spore is radial, trilete, roundly triangular in transverse plane, and has an equatorial flange, which is 6 microns wide. The specimen measures 38.4 x 45 microns. The flange has a frilled appearance, with an irregular outer margin. Trilete rays are distinct and measure 9.6 and 12.8 microns, or equal about $\frac{2}{3}$ or more of the spore body radius. In the observed specimen two of the rays are distinctly curved. Ornamentation is finely rugose to punctate.

Hypotype. Maceration NAH-Slide 8 at 28.9 by 126.8 Ortholux.

Discussion. This species is included with the genus *Cirratriradites* because it possesses a distinct though narrow flange, rather than an equatorial ridge as is characteristic for the genus *Lycospora.* Only one specimen has been observed. *Zonotriletes subtilis* Luber, 1938, is similar and may be conspecific with the species described here.

Genus Reinschospora S. W. & B., 1944

Reinschospora nahannensis n. sp.

Plate VI, figures 1, 2

Description. Spores are radial, trilete, and triangular in transverse plane, exclusive of setae-like flange. The margin of the spore wall between radii is concave, and the corners opposite radii are broadly rounded or even truncated. The holotype, exclusive of the flange, measures 70.4 x 80 microns, and the known size range is from 70 to 80 microns in the longest diameter. The spore coat is levigate; trilete mark is distinct and the rays extend $\frac{4}{5}$ or more the distance to the margin of the spore wall. Suture is narrow and lips are slightly elevated. The spore coat is 3 microns thick. The flange consists of a variable amount of setae, which are separate at their base and united at top. The setae vary in width from 1 micron to 5 microns at base, are slightly tapered, and expand laterally at top, where they are united. In the holotype the setae are embedded as much as 9 microns into the proximal side of the spore body. However, in other specimens the setae originate at the spore body margin. The flange is widest midway between the radii, and varies from 16 to 22 microns in width in the different specimens observed. No setae were noted at the corners. The spore, flange included, has a circular outline in transverse plane.

Holotype. Maceration NAH-Slide 3A at 39.9 by 109.5 Ortholux.

Discussion. Spores of this species are quite common in this material, but they often occur without a flange or with only parts thereof. *R. magnifica* Kosanke, 1950 shows certain similarities but is not considered to be conspecific.

Reinschospora saetosus n. sp.

Plate VI, figure 3

Description. Spores are radial, trilete, triangular in transverse plane. The margin of the spore wall between radii is concave, and the

corners opposite radii are roundly pointed. The holotype measures 41.6 x 44.8 microns. The known size range is from 45 to 58 microns in the longest diameter. The spore coat is levigate; trilete mark is present, but not always distinct. The rays extend almost to the margin of the spore wall. The "flange" consists of 10 to 12 separate setae, which originate on the proximal side or on the body margin. They may be embedded as much as 3 microns into the spore coat. The setae are bluntly pointed, 3 microns wide at their base and from 3 to 11 microns long, with the longest setae present between the radii. No setae occur at the corners opposite the radii.

Holotype. Maceration NAH-Slide 7A at 47.4 by 126.8 Ortholux.

Discussion. This species shows certain similarities with *R. speciosa* (Loose) S. W. & B., n. comb. 1944, but the "flange" consists of distinct setae rather than fine radial ridges. However, in the illustration given by Luber and Waltz (1938) of *Zonotriletes speciosus* the "flange" and general outline are very similar to *R. saetosus,* and it is therefore suspected that the same species is present in the Russian material.

Reinschospora sp. A

Plate VI, figure 4

Description. Spore is radial, trilete, trefoil in transverse plane. The margin of the spore wall between radii is very concave, with the sides running parallel with the rays for a considerable distance. The corners opposite radii are broadly rounded or truncated. The specimen measures 48 x 57.6 microns. The spore coat is levigate; trilete mark is distinct, the rays extend almost to the margin of the spore wall, and the suture is open. From 7 to 8 short, sharply pointed spines are protruding from the spore margin in the interradial areas. The spines are 3 microns wide at base and 4 microns long. They are all of about equal length and do not occur at the corners opposite the radii.

Hypotype. Maceration NAH-Slide 5 at 25.2 by 128 Ortholux.

Discussion. This spore is classed as *Reinschospora* because the spinose processes occur on the margin in the interradial area only, and because of its general outline. Only one specimen has been observed.

Genus Microsporites Dijkstra, 1946

Microsporites macgregori n. sp.

Plate VI, figures 5, 6

Description. Spores are radial, trilete, roundly triangular in transverse plane, and have one bladder which completely encloses the body and which is inflated considerably at the equator. The overall size of the holotype is 285 x 328 microns, and the known size range is from 286 to 328 microns in the longest diameter. The spore body in the holotype measures 119 x 119 microns, and ranges in size from 119 to 162 microns. Its margin is obscured by the bladder, but is indi-

cated by a darker concentric zone, which may be related to the attachment of the bladder to the spore body. In the holotype the bladder extends from 62 to 86 microns beyond the spore body in the interradial areas, and from 95 to 114 microns in the areas opposite the rays. This, in effect, gives the spore a triangular outline in transverse plane. The bladder is reticulate on the proximal and distal sides of the spore body and slightly beyond the body margin, at which point the reticulation becomes less distinct and changes into a finely punctate pattern. The alveoli measure from 6 to 11 microns across. The spore body is oval to round in transverse plane and contains a trilete mark with rays extending to the body margin. Folds, suggestive of a continuation of the rays to the outer margin of the spore usually occur in the bladder. The latter is also generally folded near its outer margin, or may be entirely folded over the body. The rays are accompanied by swelled lips, which are approximately 3 microns wide, and which are not always distinct.

Holotype. Maceration NAH-Slide 10M at 34.2 by 115.9 Ortholux.

Discussion. The presence of one reticulate bladder, which is inflated equatorially only, and the large size, indicate that this spore belongs to the genus *Microsporites* Dijkstra 1946, as described by Potonié and Kremp in 1954 (p. 170). It is very similar to *M. radiatus* (Ibrahim) Potonié and Kremp, 1954 and *M. karczewskii* (Zerndt) Dijkstra, 1946, except for the mesh of the bladder reticulation, which is considerably larger. Also, a transition from a coarsely reticulate bladder surface in the centre to a finely punctuate pattern near the periphery is not mentioned in the two species referred to.

Genus Perianthospora n. gen.

Description. Spores are radial, trilete, round or oval in transverse plane, and have one bladder which completely encloses the spore body and extends about an equal distance from it at the equator. Only one species has been assigned to this new genus. It is characterized by a crenate outer margin of the bladder, which in places becomes distinctly incised resulting in spatulate-shaped areas. The bladder is at least 2 microns thick and has a granulose ornamentation, with the granules appearing as fine teeth at the margin. The spore body is not clearly discernible because of the overlying bladder. In the genotype the trilete rays equal $\frac{2}{3}$ the radius of the body and are accompanied by broad, slightly elevated lips. The presently known size range is from 133 to 166 microns in the longest diameter.

Genotype. Perianthospora crenata n. sp.

Discussion. This genus may be included with Potonié and Kremp's subdivision *Monosaccites* Chitaley 1951. Structurally it is thought to be similar to the genus *Schulzospora,* which also has one bladder completely enclosing the body. However, contrary to *Schulzospora* the bladder extends about an equal distance from the spore body at the equator, and moreover has an irregular outer margin and a granulose ornamentation.

Perianthospora crenata n. sp.

Plate VI, figures 7, 8

Description. Spores are radial, trilete, round or oval in transverse plane, and have one bladder which completely encloses the spore body and extends about an equal distance from it at the equator. The overall size of the holotype is 130.2 x 146.8 microns, and the known size range is from 133 to 166 microns in the longest diameter. The spore body is round or oval, measures 58 x 64 microns in the holotype, and ranges in size from 64 to 78 microns. The bladder is from 30 to 52 microns wide at the equator in the different specimens observed, and has a crenate outer margin that in places may become distinctly incised, resulting in spatulate shaped areas. The bladder is finely granulose, with the granules appearing as fine teeth at the margin. It is more than 2 microns thick on the one specimen on which it could be measured. The spore coat of the body is essentially levigate and measures 2 microns in thickness. The trilete rays are nearly always discernible and equal $\frac{2}{3}$ the radius of the spore body. They are accompanied by broad, slightly elevated lips, that measure from 7 to 8.5 microns in width.

Holotype. Maceration NAH-Slide 7 at 39.4 by 119.3 Ortholux.

Discussion. This spore is interpreted as having a body and a bladder, as is clearly revealed by a broken specimen (*see* Plate VI, figure 8). This specimen shows that the equatorial portion consists of two layers, of which the one on the distal side clearly overlies the spore body. On the proximal side this is less obvious, but since the body margin is always indistinct on this side, it is concluded that the bladder overlies the proximal side of the body also. The bladder may be attached to the spore body at the trilete rays, in the same way as is suggested by Potonié and Kremp (1954) for the genus *Schulzospora.* The bladder is unusual in that it has a crenate outer margin that in places is distinctly incised.

Genus Indeterminate

cf. *Azonotriletes lobophorus* Waltz, 1938

Plate VI, figure 9

Description. Spore is radial, trilete, trefoil in transverse plane, and measures 47 x 47 microns. The areas opposite the rays appear to be blunted and resemble "mushroom-like caps", which are accentuated by the strongly concave, almost U-shaped, interradial margins. The spore coat is levigate and 2 microns thick. Trilete rays are discernible and equal about $\frac{3}{4}$ of the spore radius. Suture is narrow, and lips are not developed.

Hypotype. Maceration NAH-Slide 6A at 27.8 by 124.6 Ortholux.

Discussion. This spore is similar to, but probably not identical with, *A. lobophorus.* It differs because the spore coat is not granulose, and does not contain symmetrically located protuberances at the corners

of the "lobes". It is listed under genus indeterminate, since *Azonotriletes* as used by Luber and Waltz has no generic status comparable to other genera that are now recognized. This term simply refers to the azonate forms that do not have equatorial rims, flanges or bladders. In outline this spore closely resembles the genus *Tripartites* Schemel, 1950, but a division into a central area and equatorial portion is not apparent.

Spore type A

Plate VI, figures 11, 12

Description. Spores are radial, trilete, roundly triangular in transverse plane, and are characterized by a coarse ornamentation that is restricted to the distal surface. The hypotype measures 57.6 x 57.6 microns, and the known size range is from 57 to 64 microns in the longest diameter. The proximal surface of the spore is finely granulose-punctuate, whereas the distal surface is covered with closely spaced, imbricating, blunt to round projections, that are clearly visible at the margin. The projections are from 6.4 to 9.6 microns long and about equally wide at their base. Trilete rays are distinct and extend to the margin of the spore wall. Suture is narrow and lips are not developed. The spore coat is about 3 microns thick, exclusive of the distal ornamentation.

Hypotype. Maceration NAH-Slide 8 at 49.2 by 106.6 Ortholux.

Discussion. There are only two known genera that have a pronounced difference in ornamentation between the proximal and distal sides. They are *Schopfites* Kosanke, 1950 and *Galeatisporites* Potonié and Kremp, 1954. With neither of these genera can the species described here be included with any certainty. Its generic status is therefore undecided, and has to await more material for study.

Spore type B

Plate VI, figure 10

Description. Spore is radial, trilete, subtriangular in transverse plane with broadly rounded corners and two distinctly concave sides, and has a massive equatorial thickening of the spore coat. The specimen measures 70.4 x 76.8 microns. The equatorial portion is of unequal width, being only 6.4 microns at two sides and from 16 to 22.4 microns at the corners and remaining third side of the central area. On the distal side the equatorial thickening extends only $\frac{2}{3}$ the distance to the pole, which can be seen by the presence of a concentric ring. However, on the proximal side it extends to the polar region. The central area is roundly triangular and has pointed corners. It is levigate and has a distinct trilete mark with rays extending to the

equatorial portion. Suture is plain and lips are weakly developed. A direct transverse measurement shows that 45 per cent of the spore is occupied by the equatorial portion of the spore coat.

Hypotype. Maceration NAH-Slide 2A at 43.5 by 119.7 Ortholux.

Discussion. Only one specimen was found, that is characterized by its shape, its strong trilete, a massive equatorial thickening and a concentric ring on the distal side. A gradual increase in thickness of the spore coat towards the equator from the apex down is represented on the proximal side, but on the distal side this increase starts more abruptly at the concentric ring. Since this structure does not occur in any of the known genera that possess an equatorial thickening, it may indicate a new genus. In the original tetraed the individual spores probably resembled the shape of a gourd but were not as elongated. Transverse compression resulted in the pear shaped form as is illustrated.

Incertae sedis

Plate VI, figure 13

Description. Unknown spore or plant structure, bean shaped in outline, and containing numerous circular dots on proximal (?) side of a membranous coat. The dots are arranged in a triradiate pattern and resemble contact markings. Only one specimen was found. It measures 163 x 230 microns.

Hypotype. Maceration NAH-Slide 9A at 27.8 by 116.6 Ortholux.

REMARKS ON THE REGIONAL DISTRIBUTION OF TERRESTRIAL STRATA OF MISSISSIPPIAN[1] AGE

The South Nahanni River coal is the first definite indication of terrestrial deposition during the Carboniferous period in Western Canada. As the known Carboniferous strata are of marine or near shore deposition, the question arises if the South Nahanni River deposit represented an isolated occurrence, or was part of a more extensive terrestrial facies of Mississippian strata.

As was pointed out previously, the spore florule of the South Nahanni River coal is much more closely related to the florule from northern Russia than to that known from the United States. This may indicate that different floral provinces existed during Mississippian time. A "northern" floral province may have extended from northwestern Canada to northern Russia through the Arctic regions. The geographic locations of the Mississippian coal deposits in the two countries suggest this possibility. Figure 4 shows that both lie at about an equal distance from the pole at roughly the same meridian.

[1]Because the Namurian A is included with the Mississippian, it is not certain that all of the North American Mississippian deposits are Lower Carboniferous. However, since all the Lower Carboniferous deposits outside North America can be included in the Mississippian, it was decided to use this term for these deposits, even though they are locally referred to as Lower Carboniferous.

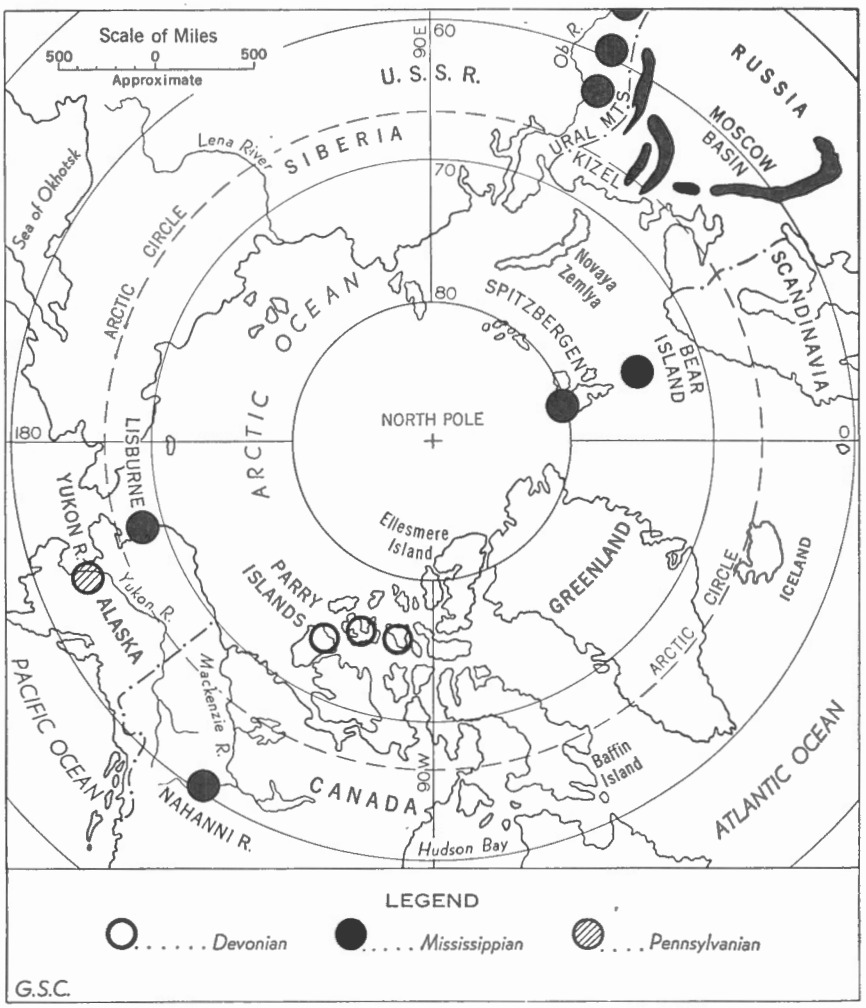

Figure 4. Palæozoic coal deposits in northern and Arctic latitudes.

Other Mississippian coal occurrences that may belong to this floral province are present in Bear Island, Spitzbergen, possibly in the Canadian Archipelago, and in Alaska.

The coals of Bear Island that were mined from 1916 to 1925 are of Upper Devonian age, but the uppermost seam is considered to belong to Mississippian strata (van der Heide, 1949). Spore investigations of these coals have not been made, as far as is known to the authors.

On Spitzbergen Mississippian coals are also present, but apparently not of commercial value, since only Tertiary coals are mined (van der Heide, 1949). Luber and Waltz (1938) mentioned that the spore florule of these Mississippian coals is similar to the one reported by

them from northern Russia, and therefore may be included with the "northern" floral province.

The coal deposits of Banks, Melville and Prince Patrick Islands of the Canadian Archipelago, which formerly were regarded as Mississippian or late Palæozoic (Fortier *et al.*, 1954), are now placed in the Devonian period (E. T. Tozer, Geological Survey of Canada, oral communication, 1955). Devonian coal, has also been reported from Cornwallis Island on the basis of a recent spore study by N. W. Radforth and D. C. McGregor (unpublished reports submitted to R. Thorsteinsson of the Geological Survey of Canada, 1955 and 1957).

In Alaska two Carboniferous coal deposits are present, which are mentioned by E. S. Moore (1940). The coal area situated 20 miles to the south of Cape Lisburne is supposed to be Mississippian, whereas the deposits along the lower Yukon River are thought to be of Pennsylvanian age. More palæontological studies may be necessary to substantiate these datings.

Terrestrial strata of both Mississippian and Pennsylvanian age are also known from the northeast coast of Greenland, between 70° and 81°N. latitude (Witzig, 1951). As the Mississippian strata contain a flora that is very similar to the one reported from Spitzbergen, this flora may also be included with the "northern" province. The Greenland occurrence is not indicated in Figure 4, because no coal deposits are mentioned in the reports.

The extent of the landmasses that carried the flora of the "northern" province is impossible to state. However, it appears reasonable to assume that the terrestrial strata of Mississippian age of the South Nahanni River area may have extended a considerable distance to the north.

Systematic spore studies of all coal occurrences should therefore be made, since they provide a ready means of age determinations of strata, that otherwise may be quite barren of fossil remains. As was mentioned previously, a tremendous number of plant microfossils are contained in coal, and therefore a prolific source of palæontological material is available wherever coal is encountered.

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PLATES I TO VI

PLATE I

Photomicrographs of Polished Sections of Coal

Figure 1. Cretaceous coal from Coleman, Alta., showing numerous pollen grains. Magn. x107.

Figure 2. Carboniferous coal from Sydney, N.S., showing a megaspore (400 microns long) and numerous small spores. Magn. x107.

Figures 3 to 6. Coal from the South Nahanni River area.

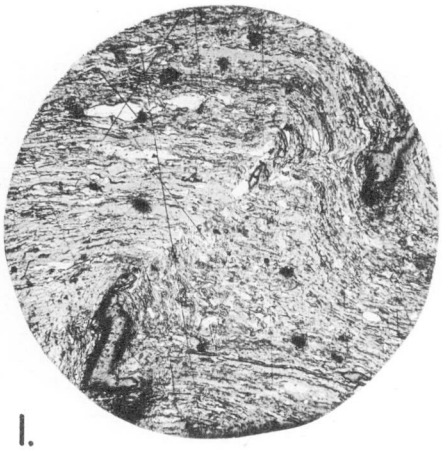
Figure 3. Durain with a megaspore (473 microns long) and numerous small spores. Magn. x107.

Figure 4. Fragments of fusain and clarain. Magn. x107.

Figure 5. Clarain with possibly a *Tendosporites* n. gen. type spore, and granular micrinite. Magn. x430 with oil immersion lens.

Figure 6. Durain with small spores and massive micrinite. Magn. x107.

PLATE I.



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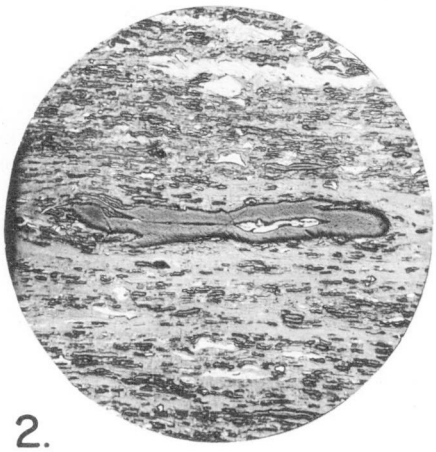

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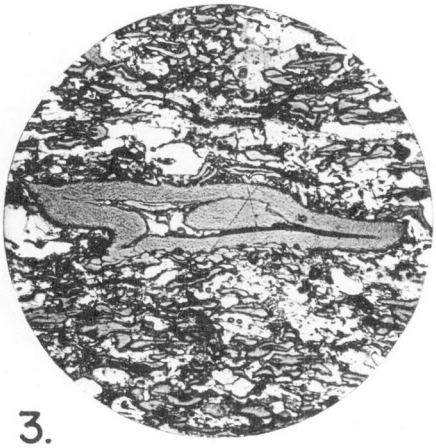

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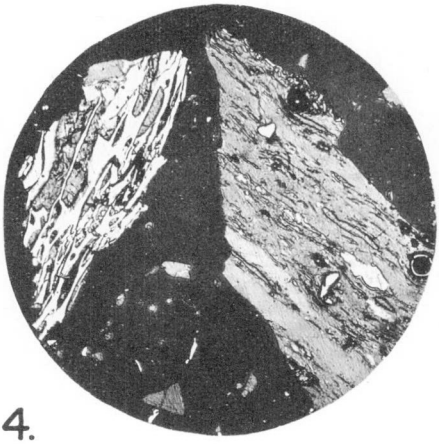

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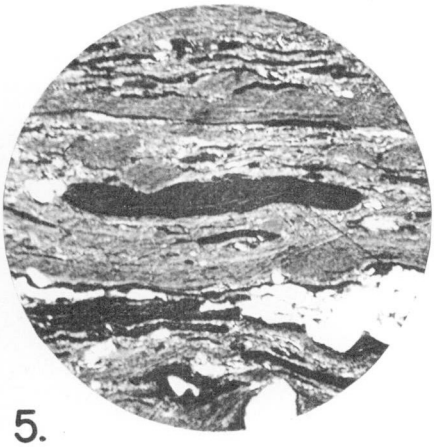

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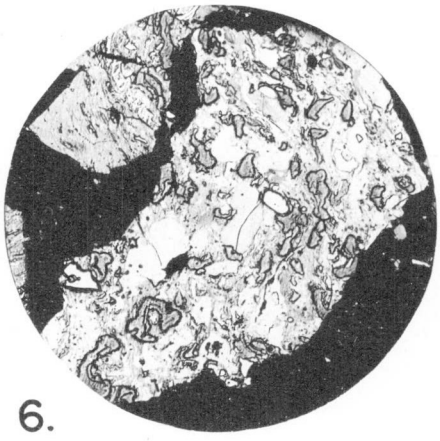

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PLATE II

(All figures x500, except those marked *, which are x250)

Figure 1. *Calamospora* cf. *C. microrugosus* (Ibrahim) S. W. & B., n. comb.; 83 x 86 microns. Slide 8 at 49.5 by 113.9 Ortholux; page 12.

Figure 2. *Calamospora* cf. *C. pallidus* (Loose) S. W. & B., n. comb.; 44.3 x 55.4 microns. Slide 1 at 43.8 by 114.1 Ortholux; page 13.

Figure 3. *Punctati-sporites nitidus* Hoffmeister, Staplin and Malloy, 1955; 30.5 x 30.5 microns. Slide 1 at 38.8 by 118.6 Ortholux; page 13.

Figure 4. *Punctati-sporites reticulopunctatus* Hoffmeister, Staplin and Malloy, 1955; 41.6 x 46.4 microns. Slide 4A at 38.8 by 127.6 Ortholux; page 13.

Figure 5. *Punctati-sporites cellulosus* n. sp., holotype; 51.2 x 57.6 microns. Slide 1 at 42.1 by 124.3 Ortholux; page 14.

Figure 6. *Punctati-sporites nahannensis* n. sp., holotype; 46.4 x 51.2 microns. Slide 8 at 40.5 by 113.3 Ortholux; page 14.

Figure 7*. *Punctati-sporites pedatus* n. sp., holotype; 72 x 153.6 microns. Slide 7 at 39 by 128.8 Ortholux; page 14.

Figure 8. *Camptotriletes*? *juglandilis* Horst, 1943; 73.6 x 102.4 microns. Slide 4A at 43.1 by 109.1 Ortholux; page 16.

Figure 9. *Punctati-sporites* sp. A; 28.8 x 35.2 microns. Slide 7 at 51 by 120.8 Ortholux; page 15.

Figure 10. *Granulati-sporites pustulatus* n. sp., holotype; 36 x 38.8 microns. Slide 6A at 39.7 by 110.6 Ortholux; page 15.

Figure 11. *Granulati-sporites pipergranus* n. sp., holotype; 28 x 30 microns. Slide 2A at 32.3 by 113.6 Ortholux; page 15.

Figure 12. *Raistrickia* sp. A; 83 x 86 microns. Slide 3A at 29.2 by 119.5 Ortholux; page 16.

Figure 13. *Convolutispora* type A Hoffmeister, Staplin and Malloy, 1955; 44.3 x 47.1 microns. Slide 4A at 40.2 by 116.4 Ortholux; page 16.

Figure 14. *Microreticulati-sporites fundatus* Hoffmeister, Staplin and Malloy, 1955; 28 x 28 microns. Slide 4A at 38.8 by 121.6 Ortholux; page 17.

Figure 15*. *Reticulati-sporites varioreticulatus* n. sp., holotype; 115.2 x 115.2 microns. Slide 4A at 47.2 by 107.2 Ortholux; page 17.

Figure 16*. *Reticulati-sporites varioreticulatus* n. sp., paratype; 102.4 x 102.4 microns, showing thickened muri at or near junctions. Slide 6A at 42.7 by 126.8 Ortholux; page 17.

Figure 17*. *Reticulati-sporites speciosus* n. sp., holotype, proximal side; 121.6 x 121.6 microns. Slide 9A at 28.6 by 120.3 Ortholux; page 18.

Figure 18. *Triquitrites tendoris* n. sp., holotype; 54.4 x 54.4 microns. Slide 5A at 48.6 by 109.5 Ortholux; page 18.

Figure 19. *Triquitrites tendoris* n. sp., paratype; 48 x 52.6 microns, central area not corroded. Slide 5A at 46.7 by 109.4 Ortholux; page 18.

Figure 20. *Triquitrites* ? sp. A; 57.6 x 64 microns. Slide 7 at 48.6 by 114.1 Ortholux; page 19.

Figure 21*. *Triquitrites* ? sp. B; 97 x 116.3 microns. Slide 9M at 39.2 by 129.1 Ortholux; page 19.

Figure 22. *Tripartites* ? *trivalvis* (Waltz, 1938) n. comb.; 76.8 x 80 microns. Slide 17 at 36.8 by 129.6 Ortholux; page 20.

Figure 23. *Lycospora micrograna* n. sp., holotype; 35.2 x 38.4 microns. Slide 3A at 47 by 115.6 Ortholux; page 20.

PLATE II.

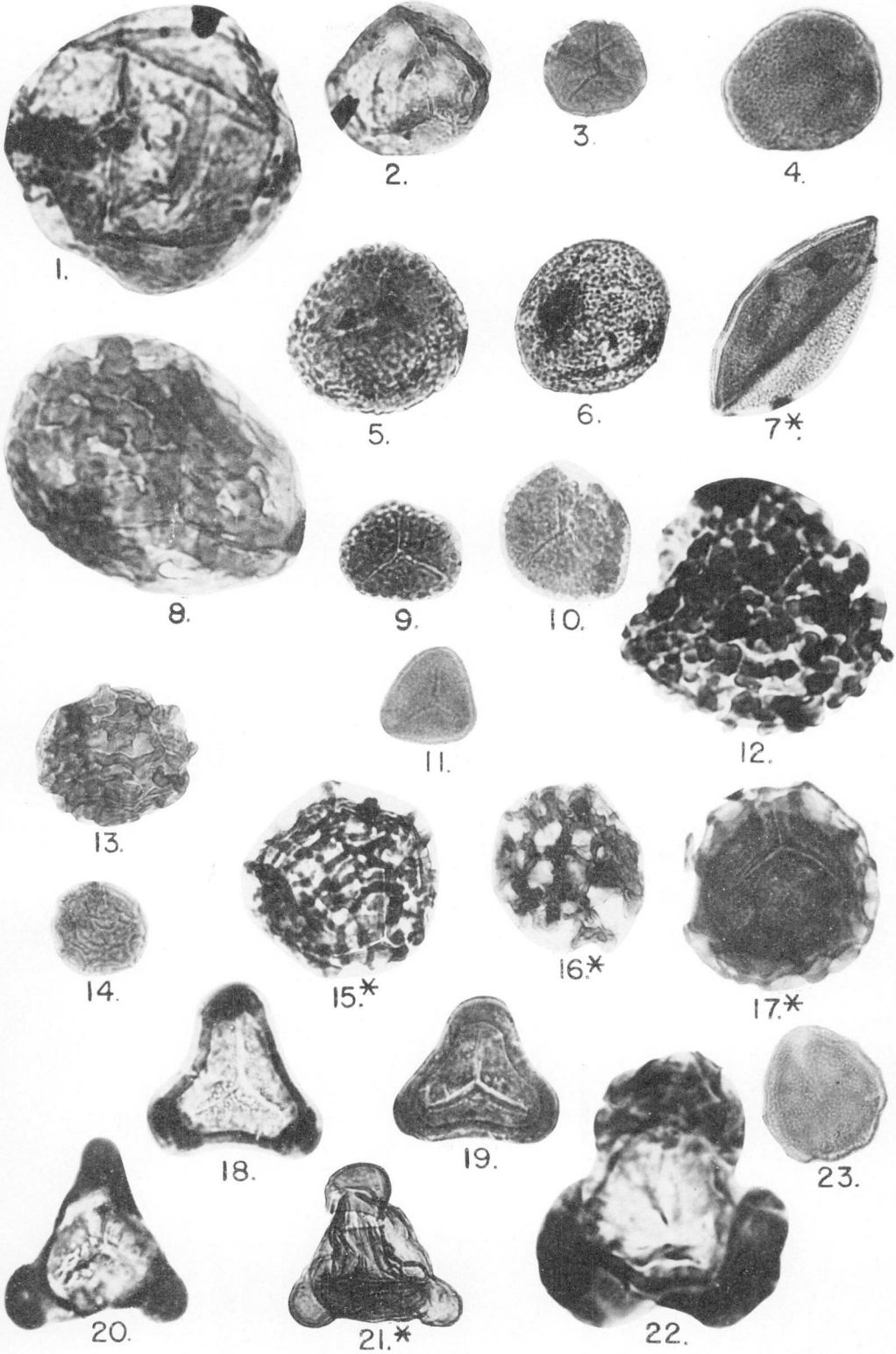

PLATE III

(All figures x500, except those marked *, which are x250)

Figure 1. *Cincturasporites auritus* (Waltz, 1938) n. comb.; 69.3 x 84 microns. Slide 9 at 29.2 by 112.9 Ortholux; page 23.

Figures 2-3. *Cincturasporites literatus* (Waltz, 1938) n. comb.; 86.4 x 86.4 microns; Figure 2 proximal side, Figure 3 distal side. Slide 20 at 26.5 by 109.5 Ortholux; page 23.

Figure 4. *Cincturasporites literatus* (Waltz, 1938) n. comb.; 70.4 x 89.6 microns, showing single row of punctations in the middle of the lips or ridges running parallel with the rays. Slide 7 at 32.2 by 112.8 Ortholux; page 23.

Figure 5. *Cincturasporites literatus* (Waltz, 1938) n. comb.; 96 x 96 microns; laterally compressed specimen showing attachment of cingulum and protuberances. Slide 4 at 26.8 by 109 Ortholux; page 23.

Figure 6. *Cincturasporites sulcatus* (Waltz, 1938) n. comb.; 80.3 x 94.2 microns. Slide 1 at 44.8 by 115.7 Ortholux; page 24.

Figure 7. *Cincturasporites* cf. *Z. stenozonalis* (Waltz, 1938) n. comb.; 86 x 97 microns. Slide 4A at 30.5 by 121.9 Ortholux; page 24.

Figure 8. *Cincturasporites altilis* n. sp., holotype; 91.4 x 102.5 microns. Slide 4A at 41.3 by 113.7 Ortholux; page 25.

Figure 9. *Cincturasporites irregularis* n. sp., holotype; 67.2 x 73.6 microns. Slide 4 at 31.4 by 107.8 Ortholux; page 25.

Figures 10*-11*. *Cincturasporites appendices* n. sp., holotype; 102.5 x 124.7 microns; Figure 10 proximal side, Figure 11 distal side. Slide 10 at 44.3 by 107 Ortholux; page 25.

Figure 12*. *Cincturasporites appendices* n. sp., paratype; 108.8 x 118.4 microns, showing concentric furrows on cingulum. Slide 1 at 24.5 by 115.4 Ortholux; page 25.

Figure 13*. *Cincturasporites stenozonalis magnus* n. sp., holotype; 110.8 x 124.7 microns. Slide 4 at 36.2 by 109.8 Ortholux; page 26.

Figure 14. *Cincturasporites* sp. A; 88.6 x 100 microns. Slide 2A at 45.4 by 109 Ortholux; page 26.

PLATE III.

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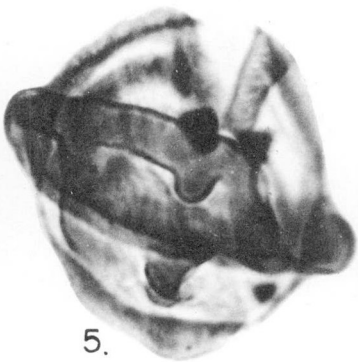

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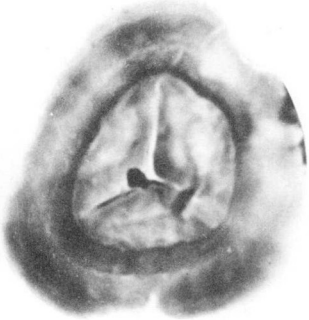

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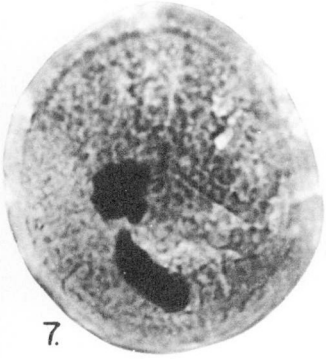

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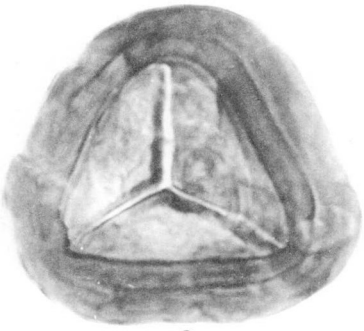

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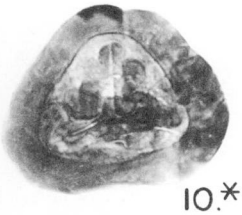

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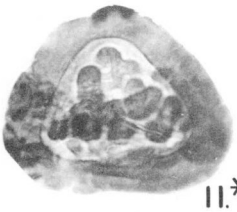

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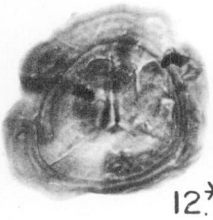

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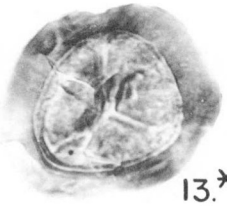

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PLATE IV

(All figures x500, except those marked *, which are x250)

Figure 1. *Labiadensites* cf. *Z. duplicatus* (Naumova; Waltz, 1938) n. comb.; 58.2 x 66.5 microns. Slide 4A at 43.9 by 110.1 Ortholux; page 27.

Figure 2*. *Labiadensites fimbriatus* (Waltz, 1938) n. comb.; 135.7 x 139 microns. Slide 2A at 50.4 by 123.2 Ortholux; page 28.

Figure 3*. *Labiadensites attenuatus* n. sp., holotype; 122 x 139 microns. Slide 6A at 47 by 111 Ortholux; page 28.

Figure 4*. *Labiadensites attenuatus* n. sp., paratype; 111 x 160.7 microns; obliquely compressed specimen showing a gradual thickening of the spore coat from the pole to the equator. Slide 6A at 47.8 by 124.8 Ortholux; page 28.

Figure 5*. *Labiadensites attenuatus* n. sp., paratype; 216.1 x 221.6 microns, showing very large specimen with distinct lip development and internal body ornamentation. Slide 1M at 32.8 by 111.3 Ortholux; page 28.

Figure 6*. *Labiadensites attenuatus* n. sp., paratype; 192 x 220 microns, showing equatorial portion only. Slide 4M at 43 by 108 Ortholux; page 28.

Figure 7. *Labiadensites serratus* n. sp., holotype; 70 x 70 microns. Slide 7 at 37.8 by 111.3 Ortholux; page 29.

Figure 8. *Labiadensites* sp. A; 64 x 76.8 microns. Slide 1 at 24.6 by 127.3 Ortholux; page 30.

Figure 9. *Denso-sporites annulatus* (Loose, 1934) S. W. & B., n. comb.; 42 x 44 microns. Slide 10 at 31.5 by 126.7 Ortholux; page 30.

Figure 10. *Denso-sporites cuneiformis* n. sp., holotype; 58.2 x 60.9 microns. Slide 9 at 39.3 by 110 Ortholux; page 31.

Figure 11. *Denso-sporites irregularis* n. sp., holotype; 57.6 x 60.8 microns. Slide 2A at 34.8 by 129.2 Ortholux; page 31.

Figure 12. *Denso-sporites irregularis* n. sp., paratype No. 1; 66.5 x 72 microns. Slide 1 at 35.7 by 111.5 Ortholux; page 32.

Figure 13. *Denso-sporites irregularis* n. sp., paratype No. 2; 61 x 72 microns. Slide 1 at 35.7 by 107.6 Ortholux; page 32.

Figure 14. *Denso-sporites irregularis* n. sp., paratype No. 3; 54.4 x 64 microns. Slide 11 at 40.5 by 107.6 Ortholux; page 32.

Figure 15. *Denso-sporites plicatus* n. sp., holotype; 45 x 60.9 microns. Slide 4A at 49.4 by 120 Ortholux; page 32.

Figure 16. *Denso-sporites subserratus* n. sp., holotype; 52.6 x 60.9 microns. Slide 7A at 45 by 122.6 Ortholux; page 32.

Figure 17. *Denso-sporites* sp. A; 40 x 41.6 microns. Slide 8 at 38.7 by 108.7 Ortholux; page 33.

Figure 18. *Denso-sporites* sp. B; 35.2 x 36.8 microns. Slide 7 at 32 by 114.9 Ortholux; page 33.

PLATE IV.

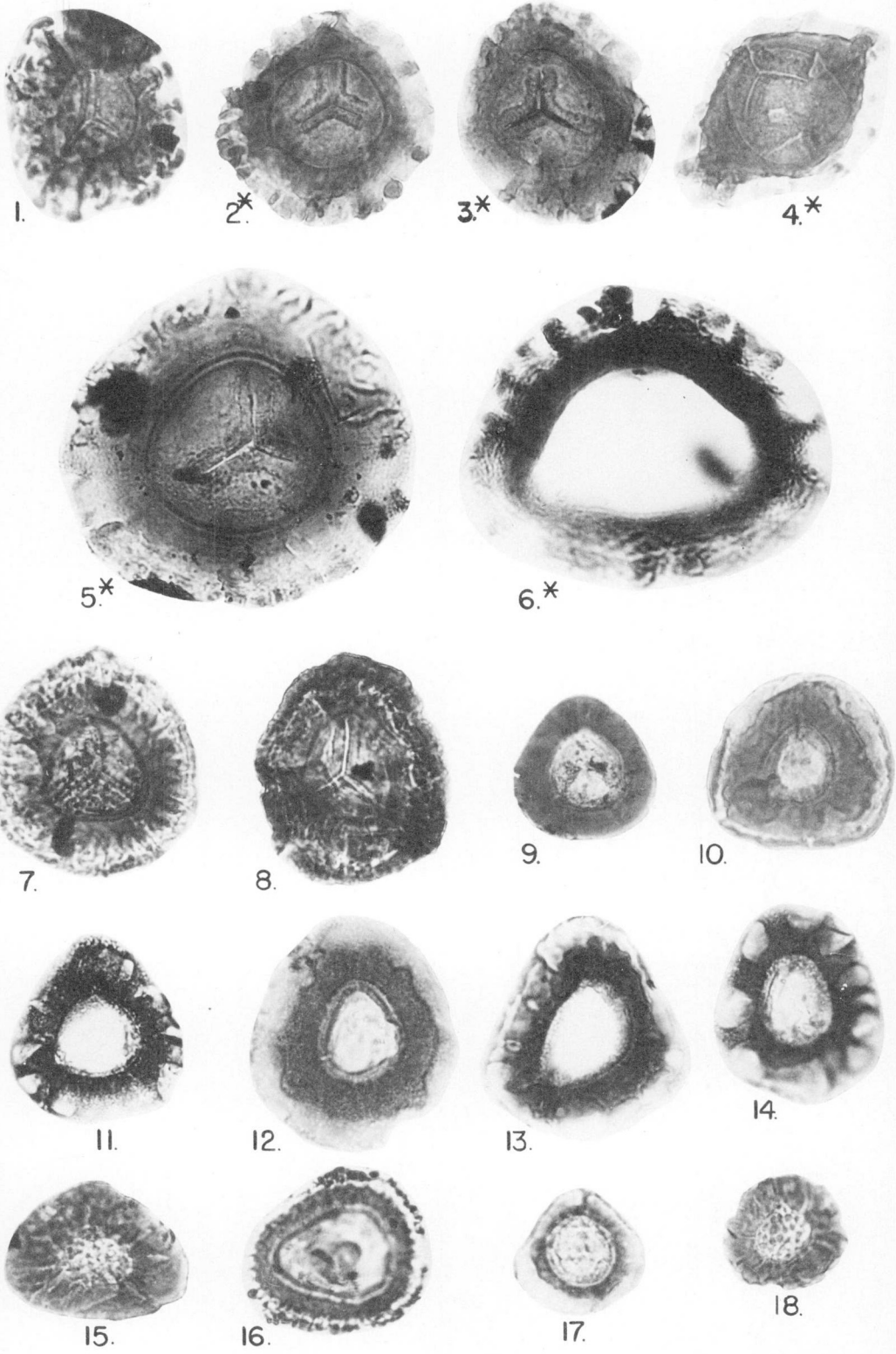


Plate V

(All figures x500, except those marked *, which are x250)

Figure 1. *Simozonotriletes intortus* (Waltz, 1938) Potonié and Kremp, n. comb.; 60.9 x 66.5 microns. Slide 11 at 26.1 by 106.6 Ortholux; page 34.

Figure 2. *Simozonotriletes triquetrus* n. sp., holotype; 47.1 x 55.4 microns. Slide 7 at 31.3 by 116.2 Ortholux; page 34.

Figure 3. *Tendosporites subcrenatus* (Waltz, 1938) n. comb.; 55.4 x 55.4 microns. Slide 6A at 47.9 by 112.9 Ortholux; page 36.

Figure 4. *Tendosporites subcrenatus* (Waltz, 1938) n. comb.; 64 x 64 microns, showing concentric furrows. Slide 10 at 38.6 by 125 Ortholux; page 36.

Figure 5*. *Tendosporites rotulus* n. sp., holotype; 124.7 x 152.4 microns. Slide 4A at 33.5 by 127.6 Ortholux; page 36.

Figure 6*. *Tendosporites rotulus* n. sp., paratype; 160 x 182 microns, showing specimen with parts opposite rays missing. Slide 3 at 27 by 123 Ortholux; page 37.

Figure 7. *Tendosporites subalatus* n. sp., holotype; 60.9 x 66.5 microns. Slide 11 at 29.2 by 128.4 Ortholux; page 37.

Figure 8. *Monilospora moniliformis* n. sp., holotype; 60.8 x 83.2 microns. Slide 1 at 34.8 by 127.9 Ortholux; page 38.

Figure 9. *Monilospora moniliformis* n. sp., paratype; 49.9 x 58.2 microns, showing flange detached from body at lower right-hand corner. Slide 10 at 35.4 by 125.6 Ortholux; page 38.

Figure 10. *Cirratriradites* cf. *C. granulatipunctatus* Hoffmeister, Staplin and Malloy, 1955; 47.1 x 58.2 microns. Slide 7 at 31.7 by 118.8 Ortholux; page 39.

Figure 11. *Cirratriradites uber* Hoffmeister, Staplin and Malloy, 1955; 33 x 38 microns. Slide 3A at 32 by 127 Ortholux; page 39.

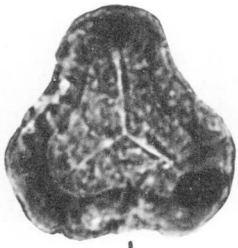
Figure 12*. *Cirratriradites latitriletes* n. sp., holotype; 238 x 285 microns. Slide 7M at 35.4 by 127.9 Ortholux; page 39.

Figure 13. *Cirratriradites* sp. A; 38.4 x 45 microns. Slide 8 at 28.9 by 126.8 Ortholux; page 41.

Figure 14*. *Cirratriradites solaris* n. sp., paratype; 176 x 176 microns, showing broad elevated lips. Slide 3 at 36.3 by 124.9 Ortholux; page 40.

Figure 15*. *Cirratriradites solaris* n. sp., holotype; 234 x 243 microns. Slide 15 at 31.8 by 129.9 Ortholux; page 40.

PLATE V.



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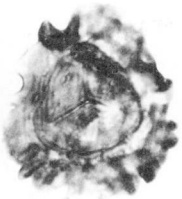

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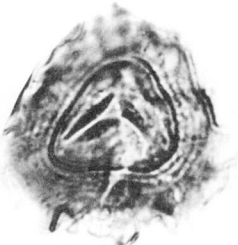

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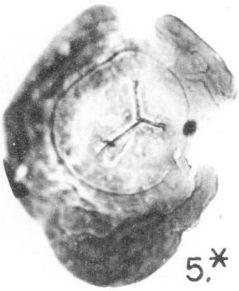

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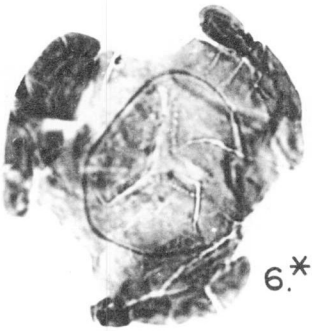

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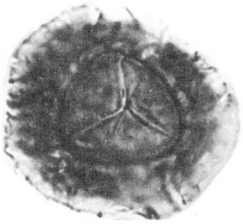

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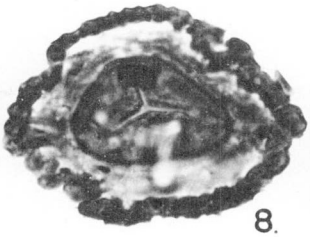

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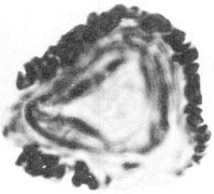

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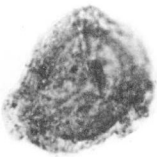

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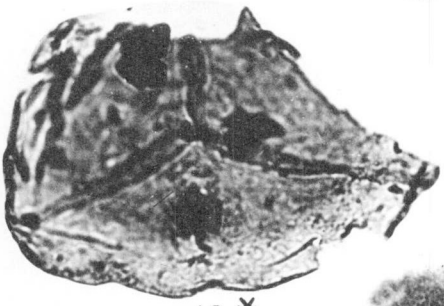

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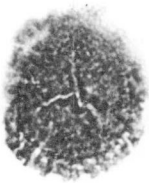

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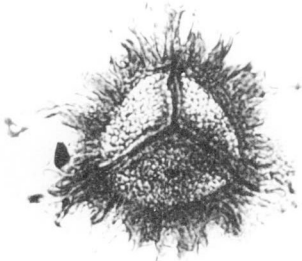

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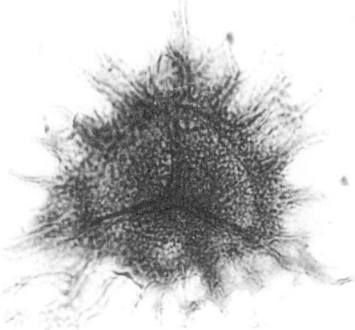

15.*

PLATE VI

(All figures x500, except those marked *, which are x250)

Figure 1. *Reinschospora nahannensis* n. sp., holotype; 70.4 x 80 microns. Slide 3A at 39.9 by 109.5 Ortholux; page 41.

Figure 2. *Reinschospora nahannensis* n. sp., paratype; 67.2 x 73.6 microns, showing a specimen without flange. Slide 16 at 36 by 110 Ortholux; page 41.

Figure 3. *Reinschospora saetosus* n. sp., holotype; 41.6 x 44.8 microns. Slide 7A at 47.4 by 126.8 Ortholux; page 41.

Figure 4. *Reinschospora* sp. A; 48 x 57.6 microns. Slide 5 at 25.2 by 128 Ortholux; page 42.

Figure 5*. *Microsporites macgregori* n. sp., holotype; 285 x 328 microns. Slide 10M at 34.2 by 115.9 Ortholux; page 42.

Figure 6*. *Microsporites macgregori* n. sp., paratype; 276 x 309 microns, showing folding of bladder. Slide 2M at 31.2 by 110.2 Ortholux; page 42.

Figure 7*. *Perianthospora crenata* n. sp., holotype; 130.2 x 146.8 microns. Slide 7 at 39.4 by 119.3 Ortholux; page 44.

Figure 8*. *Perianthospora crenata* n. sp., paratype; 72 x 102.5 microns, showing bladder overlapping the body. Slide 7 at 47.1 by 109.3 Ortholux; page 44.

Figure 9. cf. *Azonotriletes lobophorus* Waltz, 1938; 47 x 47 microns. Slide 6A at 27.8 by 124.6 Ortholux; page 44.

Figure 10. Spore type B; 70.4 x 76.8 microns. Slide 2A at 43.5 by 119.7 Ortholux; page 45.

Figures 11-12. Spore type A; 57.6 x 57.6 microns; Figure 11 proximal side, Figure 12 distal side with projections. Slide 8 at 49.2 by 106.6 Ortholux; page 45.

Figure 13*. *Incertae sedis*, unknown spore ? or plant structure; 163 x 230 microns. Slide 9A at 27.8 by 116.6 Ortholux; page 46.

PLATE VI.