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Spores of the Pennsylvanian Toronto Limestone in Kansas and Oklahoma

James F. Carter

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SPORES OF
THE PENNSYLVANIAN
TORONTO
LIMESTONE

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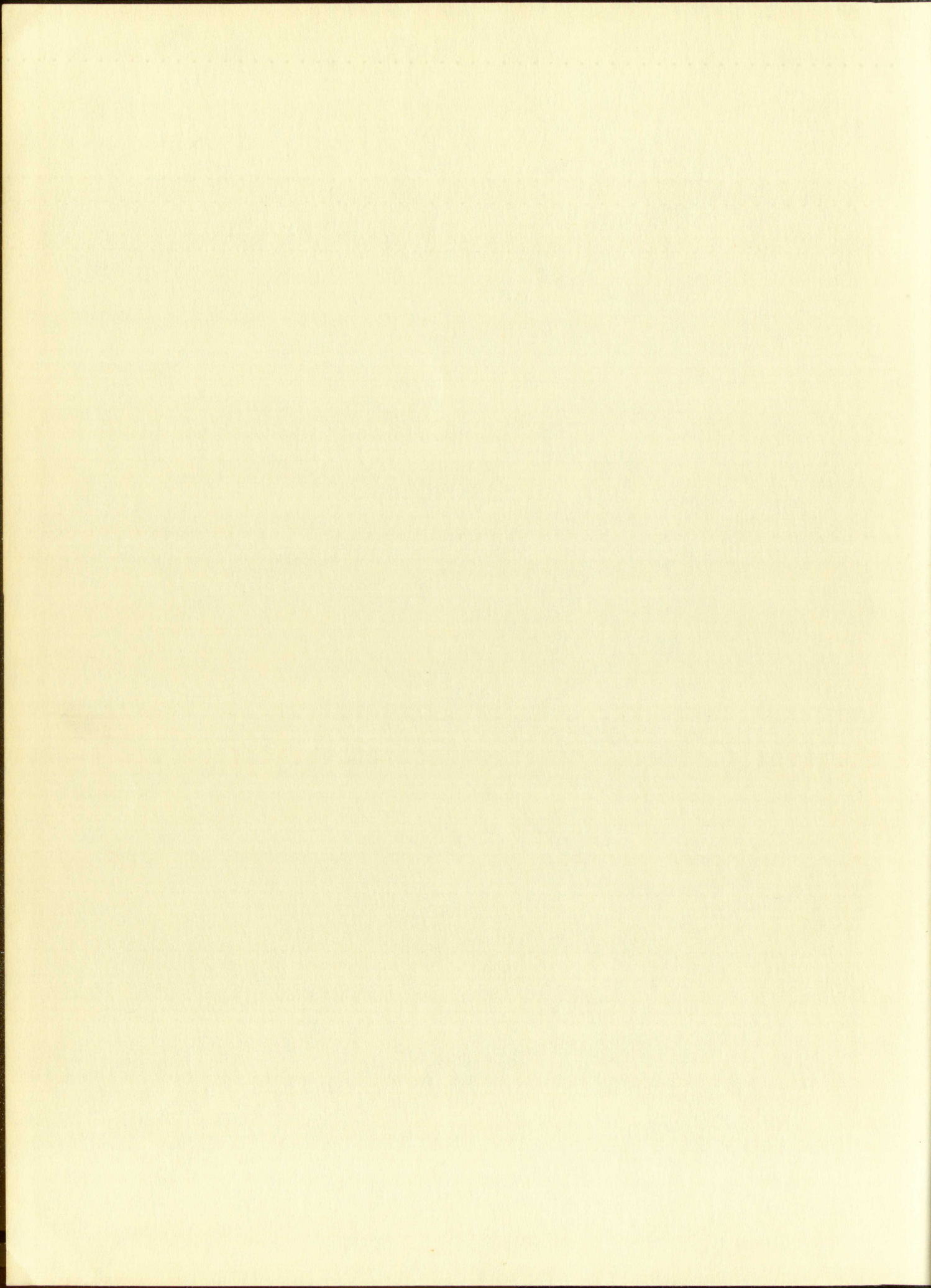
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NAME AND ADDRESS

SPORES OF THE PENNSYLVANIAN TORONTO
LIMESTONE IN KANSAS AND OKLAHOMA

By
James F. Carter



A Thesis
Submitted in Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Geology

The University of New Mexico

1959

REPORTS OF THE PRESIDENTIAL COMMISSION
ON THE ASSASSINATION OF MARTIN LUTHER KING, JR.

James H. Cannon

A Thesis

Submitted in Partial Fulfillment of the
Requirements for the Degree of
Master of Arts in History

The University of New Mexico

1964

as. F. Carter

This thesis, directed and approved by the candidate's committee, has been accepted by the Graduate Committee of the University of New Mexico in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

El Casteller
DEAN

DATE January 20, 1960

Thesis committee

Roger Y. Anderson
CHAIRMAN

Stuart A. Mott

Sherman W. Wengert

This thesis has been examined and approved by the University of New Mexico in partial fulfillment of the requirements for the degree of

MASTERS OF ARTS

UNIVERSITY OF NEW MEXICO

AMERICAN INDIAN

BY

JOHN P. HARRIS

Thesis committee

Robert V. Adams

William H. Starna

James W. Folsom

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ABSTRACT

The Toronto cyclothem is the lower limestone member of the Oread megacyclothem of the Shawnee group, Virgilian series, Pennsylvanian system and crops out in a linear belt extending north-south for a distance of 300 miles across Oklahoma, Kansas, and parts of Missouri and Nebraska.

A total of 367 Toronto limestone, shale, and coal samples were digested, using a standard chemical treatment, and examined for their plant-spore content. Sixty-five of the samples were fossiliferous. The limestone was virtually barren.

Certain dominant spore genera and assemblages seem to be characteristic of the various environmental zones of the Toronto limestone. Lycospora and Cadizospora are dominant in the lower non-marine shale and Florinites in the upper non-marine shale. Cadizospora, Endosporites, and Calamospora are the dominant genera of the underclay. The coal is characterized by Endosporites, Laevigatosporites, and Calamospora which are genera common in many coals of Pennsylvanian age. The transitional shale contains Cyclogranisporites as the dominant genus. Endosporites and Planisporites are most numerous in the marine shale.

The presence of a few grains of the genus Illinites in the southern part of the area suggests a dry highland area some distance to the south as a source area for the parent flora and sediment.

The Toronto cycloids are the lower limestone layers of the Great megacystids of the same group. British fossils, Pennsylvania system and those of the lower part extending north-south for a distance of 100 miles from Ontario, Kansas, and parts of Missouri and Wisconsin.

A total of 57 Toronto limestone, shale, and coal sections were digested, using a standard chemical treatment, and examined for their plant-remains content. Twenty-five of the sections were fossiliferous. The limestone was virtually barren.

Certain distinctive fossil groups are characteristic of the various and somewhat diverse of the Toronto limestone. Limestone and shale are common in the lower non-marine shale and limestone in the upper non-marine shale. Limestone, sandstone, and shale are the dominant genera of the water-layers. The coal is characterized by *Indopistia*, *Leptosticta*, and *Calamagrostis* which are genera common in many parts of Pennsylvania. The transitional shale contains *Leptosticta* and the dominant genera. *Leptosticta* and *Indopistia* are most numerous in the marine shale.

The presence of a few plants of the genus *Indopistia* in the southern part of the shale suggests a dry climate and some distance to the sea as a source of the plants. Limestone and sediment.

The presence of Densosporites in rocks of Virgilian age is definitely established.

The presence of hemorrhoids in some of

is definitely established.

INTRODUCTION

Purpose of Investigation

A spore analysis of the Toronto limestone was undertaken to obtain paleoecologic data, substantiate correlations already established, and indicate the direction of shorelines.

Inasmuch as the Toronto cyclothem is predominantly limestone it was expected that most of the rock samples would be barren of spores. However, any spores present might reflect changing environments as evidenced by the rapidly changing lithologies. Total spore content might give a good indication of the direction of the shoreline and source area of the spores.

Regional correlations were expected to be difficult to establish because of the short time interval involved and lack of palynological data concerning units above and below the Toronto limestone.

Acknowledgment

This study was made possible by Shell Oil Company of Midland, Texas and Shell Development Company of Houston, Texas. Company rock samples of the Toronto limestone were used and all laboratory and reproduction facilities were at the disposal of the writer. Special thanks are given to Dr. James M. Parks, Jr. and Jesse B. Pogue, Jr. for their indispensable information concerning all phases of this study.

GENERAL DISCUSSION OF SPORES

Definition

"The term 'spore' is derived from 'spora', the Greek word for seed" (Guennel, 1952, p. 6). Spores are propagative bodies which represent a stage in the gametophyte generation of the plant reproductive cycle. There are two types of reproductive cycles (Figs. 1 and 2). Ancient free-sporing plants producing spores of different sizes are termed heterosporous. The male spores (microspores) are generally small and the female spores (megaspores) relatively large. Free-sporing plants whose male and female spores are the same size are called isosporous or homosporous (Schopf, 1938, p. 10). The spores of isosporous plants are the same size, generally small and serve both male and female functions. Most fossil spores represent only the resistant outer coat (exine) of the spore which did not lodge in a habitat suitable for development and growth (Schopf, 1957).

The term "microspore" has given rise to much controversy. The term has come to be applied to all spores of relatively small size. Not all small spores are microspores as the term refers only to the male spores of heterosporous plants. Many megaspores may be small enough to be called microspores and there certainly is no definite size boundary to separate the two. Other terminology has been proposed to correct this situation but this only succeeds in adding to an already unfortunately large nomenclature.

Definition

"The term 'spore' is defined as 'any body which represents a stage in the reproductive cycle of the plant reproductive organs. There are two types of reproductive organs (Wigg. 1 and 2). The male reproductive organs producing spores of different sizes and termed microspores. The male spores (microspores) are generally small and the female spores (megaspores) relatively larger. Some sporting plants where male and female spores are the same size are called isogamous or homogamous (Schubert, 1934, p. 10). The spores of isogamous plants are the same size, generally small and serve both male and female functions. Both female spores represent only the vegetative stage and (being) of the spore which did not develop as a vegetative stage for development and growth (Schubert, 1934, p. 10). The term 'microspore' has been given also to such other small spores. The term has come to be applied to all spores of small size. Not all small spores are microspores as the term refers only to the male spores of heterogamous plants. Some megaspores may be small enough to be called microspores, but there certainly is no definite limit as to size for the two. Other terminology has been proposed to remove this situation but this only serves to add to the confusion. Unfortunately large numbers are

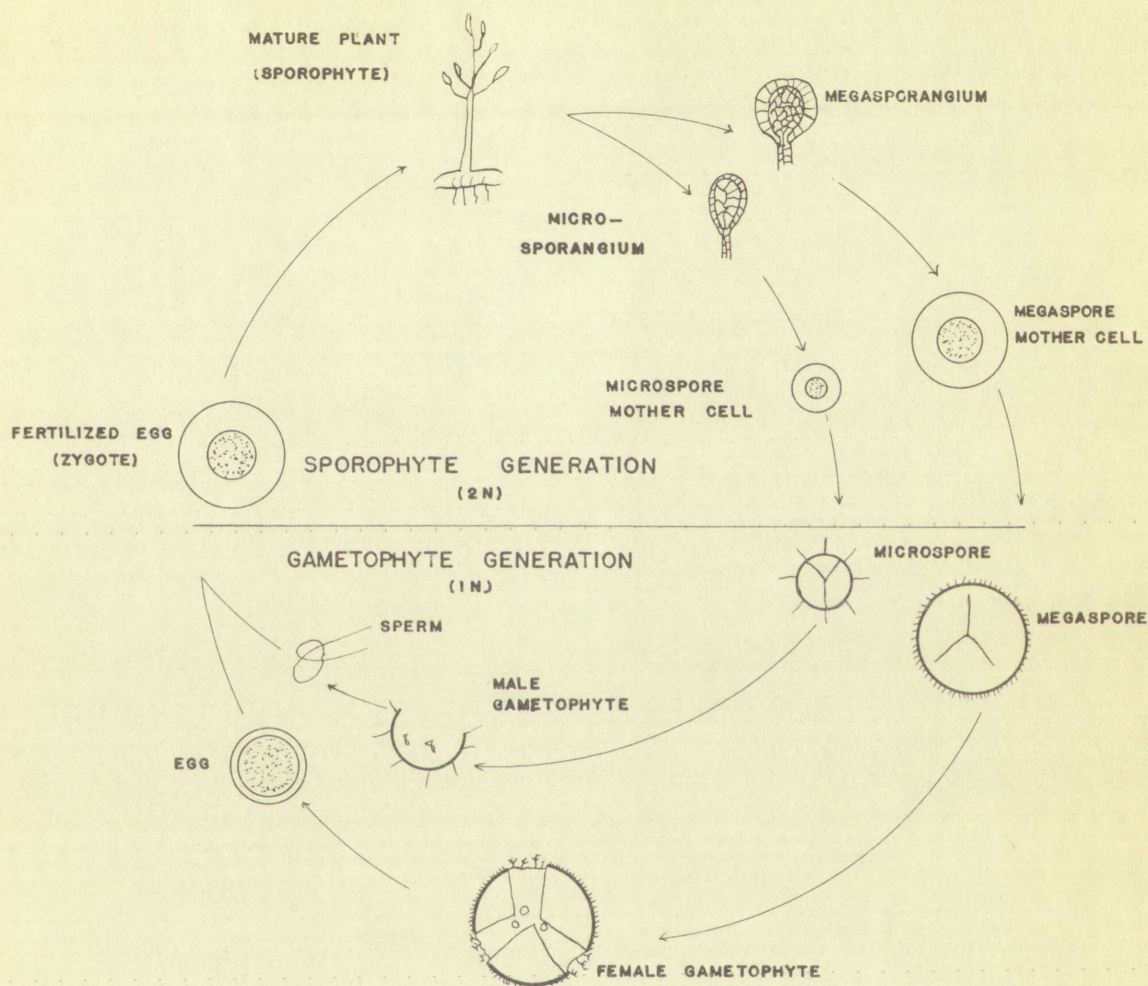


FIGURE 1 — LIFE CYCLE OF TYPICAL HETEROSPOROUS PTERIDOPHYTE

(FROM GUENNEL, 1952)

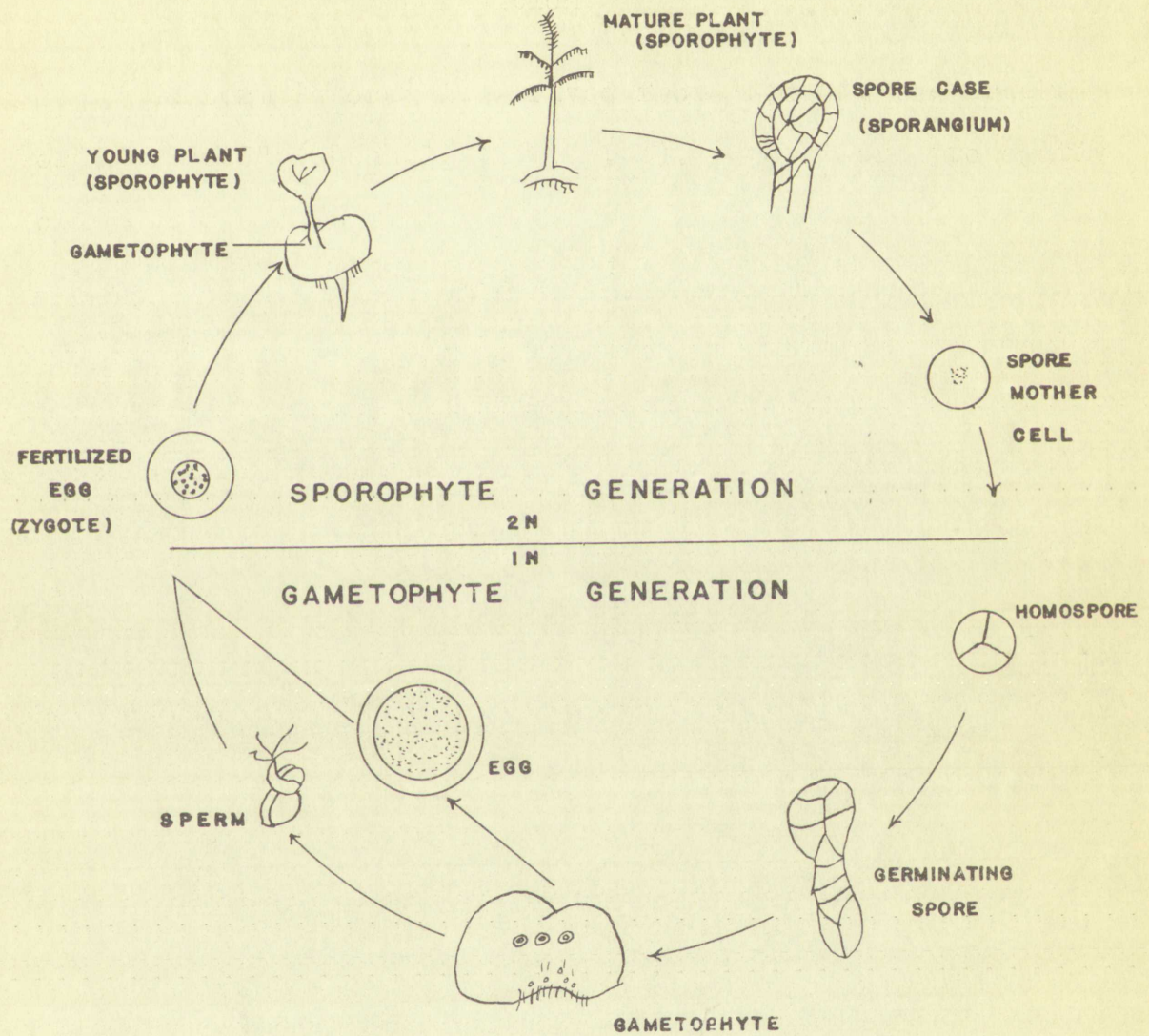


FIGURE 2 — LIFE CYCLE OF TYPICAL HOMOSPOROUS PTERIDOPHYTE

(FROM GUENNEL, 1952)

Stratigraphic Importance

Spores are produced in tremendous numbers. "A single birch catkin may produce in excess of ten million pollen grains. The production of one hectare of wind-fertilized alder trees has been estimated at more than 2×10^{13} grains per annum" (Erdtmann, 1943). Because of their small size (10-100 microns usually) and their low density (ranging from 1.1 to 1.2), spores may be transported by the wind for great distances. Many forms have bladders and other types of appendages which are believed to be an aid to wind transport. Greenland peats contain pollen grains of pine and spruce that must have been carried at least 100 kilometers. Pollen grains from the United States have been found 700 kilometers east of Newfoundland (Erdtmann, 1954). Wind-dispersed spores usually attain a homogeneous mixture so that by analysis of the soil on which they rain a true estimate of the parent flora may be made. Other things being equal the greater number of spores is deposited on sediments nearest the place of origin. The few grains that may be carried a great distance are not important in statistical analyses but may serve as regional correlation markers. Most spores are allochthonous, and because of their unique means of dispersal transgress environments which might limit the distribution of other types of organisms that may be fossilized. Allochthonous spores may be used only to infer the ecologic conditions of the area from which they were derived.

Spores are produced in tremendous numbers. It is difficult to estimate the production of any particular species of spore-producing organism. The production of one species of spore-producing organism is estimated to be more than 100,000 spores per annum" (Bridgman, 1933). "Bridgman (1933) estimated that (10-100 million spores) and their low density (floating from 1.1 to 1.2). Spores may be transported by the wind for great distances. Many forms have bladders and other special appendages which are believed to be an aid to wind transport. Greenland peats contain pollen grains of grass and various trees must have been carried at least 100 kilometers. Pollen grains from the United States have been found 500 kilometers west of Newfoundland (Bridgman, 1933). Wind-dispersed spores usually attain a homogeneous mixture so that by analysis of the soil on which they fall, some estimate of the general flora may be made. Other factors being equal, the greater number of spores is deposited on vegetation nearest the place of origin. The few grains that may be carried a great distance are not important in statistical analysis but may serve as regional correlation markers. Most spores are microscopic and because of their minute size, of biological significance environments which limit the distribution of other types of organisms must be considered. All organisms spores may be used only to indicate the general conditions of the area from which they were derived.

Certain spores such as those growing in low-lying swamps are not dispersed much beyond the area bearing the parent flora. These autochthonous spores are excellent ecologic indicators.

Spores occur in abundance from the Devonian to the Recent and thus may be used for correlation and ecologic studies during most of the geologic history that contains fossils.

Because of their small size, spores can be easily obtained from well cuttings when as little as one gram of rock is available. The maceration processes are fairly simple and, using the most advanced methods, spores may be extracted from their matrix and be ready for study in several hours.

There are some disadvantages of using spores for stratigraphic studies. Spores may not give a true representation of the flora because of differences in spore reproduction rates of the plants. Accessory plants could possibly produce many more spores than the dominant flora. The floating capacity of spores may be different. The smaller or bladdered forms may be carried further and thus give a false representation of the flora. Preferential preservation may be important. Thin-skinned spores may be more easily destroyed by salt water and other chemical reactions. Spores may be transported by water. Just as other fossils, they may be reworked from older sediments and redeposited. During certain geologic periods, correlations over great distances from north to south may be difficult to determine because of north-south climatic zones and matching floral changes.

Certain spores such as those growing in late-lying waters
are not dispersed much beyond the area of origin. These
autonomous spores are excellent evidence of localities.
Spores occur in abundance from the bottom to the surface
and thus may be used for correlation and stratigraphic studies.
During most of the geologic history that contains fossils,
because of their small size, spores can be easily ob-
tained from well cuttings when a little care and luck of luck
is available. The preservation of spores and their identification
using the most advanced methods, spores can be extracted from
their matrix and be ready for study in a few hours.
There are some disadvantages of using spores for stratigraphic
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many more spores than the original flora. The floating
capacity of spores may be different. The spores are dispersed
forms may be carried further and thus give a false representation
of the flora. Presumably, however, they may be important.
Thin-skinned spores may be more easily destroyed by acids
water and other chemical reactions. Spores may be transported
by water. Just as other fossils, they may be preserved from
older sediments and redeposited. During certain geologic
periods, correlations over great distances may not be possible
may be difficult to determine because of local climatic
zones and varying floral changes.

Principal Morphological Features

The following features can be readily noted or inferred from microscopic examination of fossil spores and are used for identification.

Shape: A spore is either radially or bilaterally symmetrical. The original shape is controlled by the nature of the division of the spore in the spore mother cells within the sporangium. "Some or all of the cells of the sporangium which are called spore-mother cells undergo either two successive divisions without wall formation to result in tetrahedral tetrads when the intervening walls do form, or tetragonal tetrads which are arranged in two planes by successive divisions with accompanying wall formation" (Cross, 1950, p. 5).

Form: Spores before compression may be spherical, subspherical, ovoid, subpyramidal, or polyhedral in form. After compression the outline of radially symmetrical spores may be circular, subcircular, triangular, or subtriangular. Bilaterally symmetrical spores when compressed are bean-shaped, oval, or elliptical in outline. Spores may be oriented preferentially after compression because of the original form. The spores will usually be compressed in a plane parallel to their longer axis.

Orientation: Radially symmetrical spores may be divided into proximal and distal hemispheres which may be irregular and of unequal size. The hemisphere bearing the trilete mark was originally the inward-facing hemisphere of the spore which

Principal morphological features

The following features can be used to identify the

from microscopic examination of fossil spores and are used

for identification.

Shape: A spore is either elliptical or bilobed, rarely round.

The original shape is conserved by the nature of the material

of the spore in the fossil record, unlike in the case of

"some or all of the cells of the sporangium which are subject

spore-mother cells undergo an anisogamous division

without wall formation as found in bivalved spores which

the intervening walls are found in a separate layer which

are arranged in two planes by successive divisions with

accompanying wall formation" (Cribb, 1970, p. 11).

Form: Spores before compression may be roughly spherical,

ovoid, subtriangular, or subrectangular in form. After compression

the outline of a fossil spore may be circular,

subtriangular, or subrectangular, bilobed,

symmetrical spores when compressed are heart-shaped, oval,

or elliptical in outline. Spores may be oriented proximally

distally after compression, depending on the original form. The

spores will usually be normal in shape after distal compression

longer exist.

Orientations: Fossil spores may be divided into

proximal and distal depending on the position of the

of unguiculate sides. The unguiculate sides are the

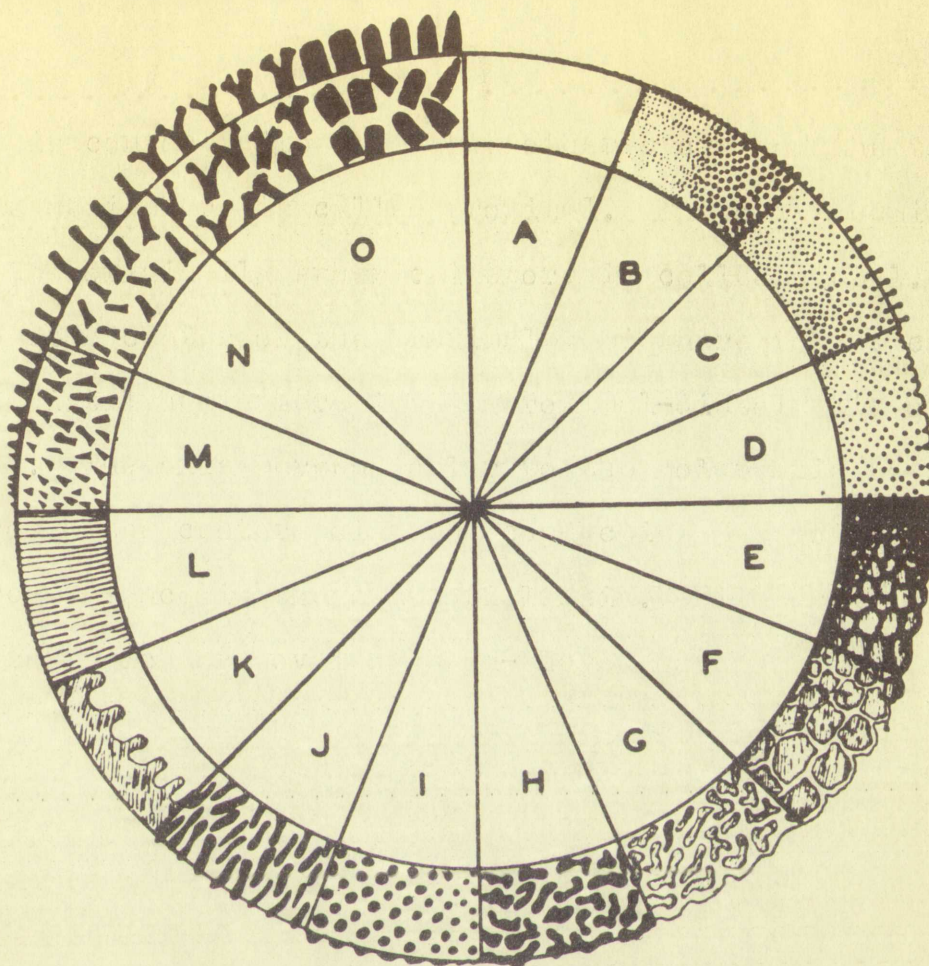
originally the innermost surfaces of the spore which

was in contact with the three other spores of the tetrad. This hemisphere is called proximal. The outer hemisphere of the originally spherical spore is called distal. An axis from the center of the proximal hemisphere to the center of the distal hemisphere is the proximal-distal axis or polar axis. The axis perpendicular to the polar axis passing through the center point and connecting the points of maximum circumference is the equatorial axis. Bilaterally symmetrical spores which are oval or bean-shaped have a polar axis passing from the center of the straight or concave side (proximal and containing monolete mark) to the center of the periphery of the distal side. The longest dimension of the spore perpendicular to the polar axis is the equatorial axis.

Ornamentation: The exine of spores may be levigate (smooth) and featureless. Fortunately, most spore exines are ornamented principally on the external surface (Cross, 1950, p. 11).

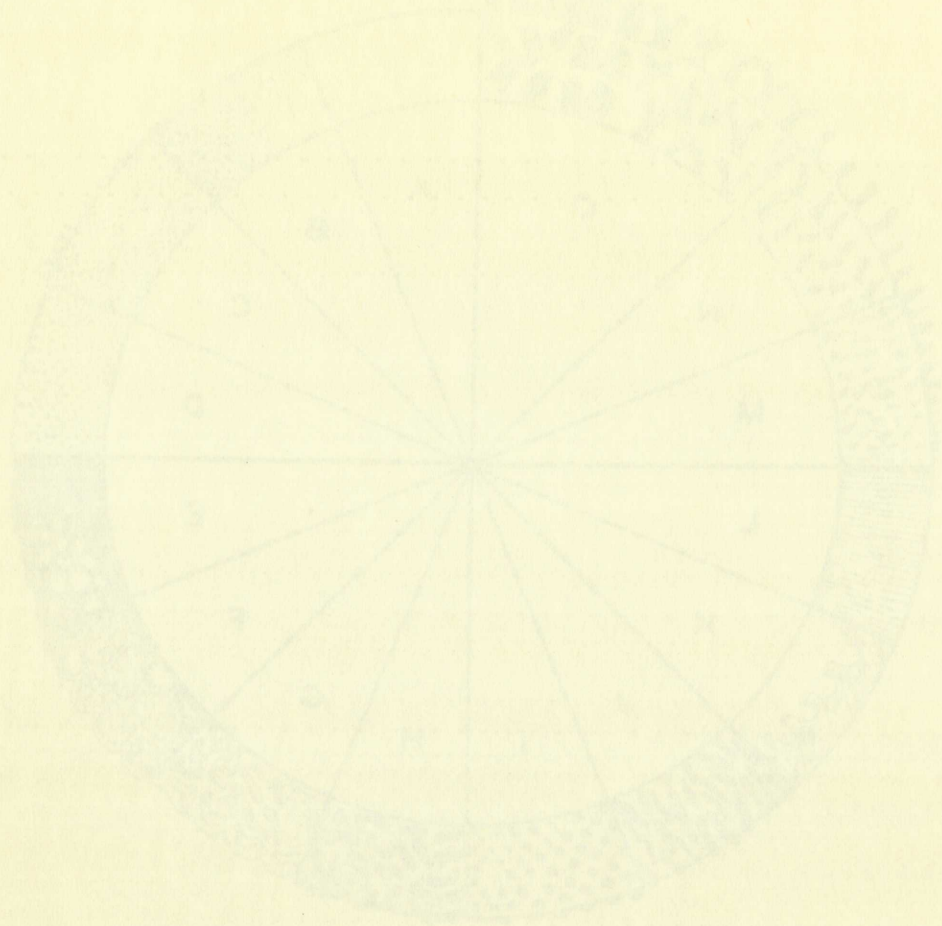
The external ornamentation may be granulose, papillate, punctate, reticulate, vermiculate, verrucose, rugose, lobate, striate, spinose, setaceous, or have processes and projections (Fig. 3). These various ornamentations may be dense, sparse, scattered or arranged in definite patterns, cover the entire exine or be confined to one part of the spore coat. Combinations of the various types of sculpturing may be present. Internally the spores may be sculptured, usually with granules or reticulations. Bladders are commonly ornamented internally. The bladders and flanges may have a different ornamentation from that of the spore body.

was in contact with the other three sides of the ...
This homotaxy is called ...
of the originally ...
from the center of the ...
the distal homotaxy is the ...
axis. The axis perpendicular to the ...
through the center point and ...
reference is the ...
spores which are ...
passing from the ...
(proximal and ...
periphery of the ...
spore perpendicular to the ...
Organization: The axis of ...
and ...
practically on the ...
The external ...
panstate, ...
state, ...
tectons ...
spare, ...
entire ...
Combinations of the ...
Internally ...
or ...
nally. The ...
section from ...



- A. Levigate
- B. Granulose
- C. Papillate
- D. Punctate
- E. Punctate-Reticulate
- F. Reticulate
- G. Vermiculate
- H. Obervermiculate
- I. Verrucose
- J. Rugose
- K. Lobate
- L. Striate
- M. Spinose
- N. Setaceous
- O. Processes-Projections

FIGURE 3 — DIAGRAMMATIC DRAWING OF VARIOUS TYPES
OF SPORE COAT ORNAMENTATION (FROM KOSANKE, 1950)



- A. Lactate
- B. Glucose
- C. Fructose
- D. Sucrose
- E. Fructose-1,6-bisphosphate
- F. Pyruvate
- G. Lactate
- H. Glucose-6-phosphate
- I. Fructose-1,6-bisphosphate
- J. Pyruvate
- K. Lactate
- L. Glucose
- M. Fructose
- N. Sucrose
- O. Fructose-1,6-bisphosphate

FIGURE 1. A circular scale of the relative concentrations of the various metabolites in the cell.

Size: Size is a factor very difficult to evaluate. Spores range from ten microns to about 25 millimeters in size (Cross, 1950). Spores have no fixed size and may vary according to environmental conditions in the sporangium and outside the sporangium. The size of the spores may vary with the type of maceration process used. Except when absolutely necessary size should not be used as a sole criterion for identification. However, it may be necessary to determine and use average size ranges in identifying species that have no other distinguishing characteristics.

Germinal apparatus: The trilete mark or triradiate scar is usually quite distinct and evident. The rays or radii may extend only a short distance or completely across the proximal surface. The rays may be different in grains of the same species if the suture has split apart. Accessory upturned ridges along the sutures are called lips. These may be extremely large and prominent or barely discernible. The areas adjacent to the trilete rays may be pressed together in the original tetrad to give a slightly different color and texture at this location. These are called the contact or pyramic areas.

Presence of flanges and bladders: These zonal appendages immediately indicate the larger classification of the spore. The flange consists of tissue generally derived from an outgrowth from the surface of the proximal side at or near the contact area (Cross, 1950, p. 13). Flanges may have typical

Size is a factor very difficult to determine, range from ten to twenty millimeters in size (Cross, 1950). Spores have a thick wall and are according to environmental conditions, the structure and outside the sporangium. The shape of the spores may vary the type of maceration process used. Spores when necessary also should not be used as a sole criterion for identification. However, it may be necessary to determine and use average size ranges in identifying species that have no other distinguishing characteristics.

General appearance: The spores are usually pale distal and ventral. The spores may extend only a short distance at one end of the spore. The rays may be different in length of the same species if the spore has a thick wall. Spores may be ridges along the surface are called lines. Spores may be extremely large and prominent on both sides. The spores adjacent to the ridges may not be present in the original tetrad to give a slightly different color and shape at this location. These are called the ventral and dorsal areas.

Presence of flange and flange: These words are immediately indicated in the identification of the spore. The flange consists of a small, raised area at the growth from the surface of the spore. It is not the contact area (Cross, 1950). The flange may have a small

ornamentation. Bladders are actual outgrowths of the spore wall and function as air sacs to aid wind dispersal or as protective structures against desiccation. The bladders are usually thinner than the spore body and vary in number, shape, and ornamentation.

METHODS OF STUDY

Laboratory Procedures

The purpose of processing rock samples for palynological study is to extract the spores from their matrix and to obtain a residue that contains the least extraneous material and the most well-preserved spores. The methods used depend upon the preference and experience of the investigator, the type of equipment available, and the purpose and time allowed for the study.

Rock samples should be from a fresh, and not from a badly weathered, surface. Spores are resistant to most chemical action but may be destroyed by oxidation over a long period of time.

Care should be taken to avoid contamination during processing. All equipment should be washed and rinsed with distilled water before use. Distilled water is used to dilute the chemicals, to clean the residues, and as a final rinse after washing equipment. Tap water may contain a variety of organisms and harmful salts. Contamination from the air may be minimized by covering the samples. A knowledge of modern pollen and spore types will eliminate any of these

ornamentation. Flattened and narrow of the top
well and function as a shield to the kind of ornamentation
protective ornamentation. Ornamentation is
usually thinner than the body of the ornament, and
and ornamentation.

METHOD OF STUDY

Laboratory Preparation

The purpose of the present study is to extract the
study is to extract the study is to extract the study
tain a result that contains the same amount of material
and the most well-preserved material. The study is to
upon the preference and experience of the investigator,
type of equipment available, and the type of material
for the study.

Hook samples should be made of steel, and not of wood
weathered, surface. The study is to extract the study
section but may be destroyed by the action of the
of time.

Care should be taken to avoid any distortion during
processing. All samples should be prepared with
distilled water before use. Distilled water is used for
the chemicals, to clean the surface, and to clean the
after washing samples. The study is to extract the study
of organisms and their habits. The study is to extract the study
may be obtained by covering the surface with a material of
modern pollen and spores. The study is to extract the study

from the spore count.

The chemicals used in processing are dangerous to the skin, eyes, and lungs. Hydrofluoric acid is especially dangerous, having a maximum allowable concentration in air of three parts per million (Sax, 1951). This acid may cause medically serious and very painful burns which appear immediately, or several hours later, depending on the concentration of the acid. All chemical work should be done in the fume hood. Long gauntlet type rubber gloves, a transparent plastic face mask, and a rubber apron should be worn. The antidotes to the chemicals used should be handy and if possible a shower should be located just outside the laboratory to permit immediate flooding of acid-burned skin. The centrifuge should be a type that is enclosed in a protective metal case or body.

Different lithologies require slightly different treatment. The following methods were used to process the Toronto rock samples.

Shales, sandstones, clays, carbonaceous limestone:

1. Five grams of the rock are broken into approximately 1/16 inch pieces or smaller with a steel mortar and pestle.
2. The samples are placed in plastic beakers, covered with dilute hydrochloric acid (2 parts water to 1 part 37.5% HCl) and allowed to stand until chemical action ceases. Additional acid may be added if needed. The supernatant liquid is decanted, water added, the samples centrifuged, and the liquid decanted. All centrifuging

from the above.

The chemicals used in the following tests are:

skin, eyes, and lungs. Every minute of the day.

dangerous, having a maximum allowable concentration in the

of three parts per million (3 ppm). This will not cause

medically serious and very harmful effects which appear in

mediately, or several hours later, depending on the dose.

generation of the acid. All chemical tests should be done

in the fume hood. Long handled glass vessels should be

transparent plastic if no metal, and a tight stopper should be

worn. The agitator for the chemicals used should be made

and if possible a shower should be located just outside the

laboratory to permit immediate flushing of acid-burned skin.

The centrifuge should be a type that is enclosed in a protective

metal case or booth.

Different lithologic types require different treat-

ment. The following methods were used to process the various

rock samples.

Shales, sandstones, clays, and limestones.

1. Five grams of the rock are broken into approximately 1/16

inch pieces or smaller with a steel mortar and pestle.

2. The samples are placed in lithium bottles, covered with

dilute hydrochloric acid, and the bottles shaken for 2 hours.

3. 37.5% HCl and allowed to react until chemical action

ceases. Additional acid is added if needed. The

supernatant liquid is decanted, and the acid is added, the sample

centrifuged, and the liquid removed. All centrifuging

is done for three minutes at 1800 revolutions per minute. The calcium ion is decanted in the liquid. This prevents the formation of relatively insoluble calcium fluoride crystals during treatment with hydrofluoric acid.

3. The samples are placed in plastic beakers, covered with 49% hydrofluoric acid and allowed to stand 48 to 72 hours. A pound of acid is sufficient for 6 to 8 samples. Hydrofluoric acid is extremely volatile and more acid may be added during the digestion period. The samples are agitated several times. The acid is decanted, water added, and the residue allowed to settle by gravity. The liquid is decanted. Hydrofluoric acid dissolves the silica and siliceous compounds.
4. The residues are placed in glass centrifuge tubes (which are used in all the following steps), covered with dilute hydrochloric acid, and heated in a boiling water bath for several minutes on an electric hotplate. The liquid will usually turn green. The samples are centrifuged, decanted, acid added, and heated again. The process is repeated until the liquid is clear. The hydrochloric acid clears the residues of complex silico-fluoride gels that form during treatment with the hydrofluoric acid. The gels increase the bulk of the residue and obscure the spores on the slides.
5. The residues are covered with dilute nitric acid (1 part water to 1 part 69.8% HNO_3) and heated in a boiling water bath for ten minutes. Prolonged heating will bleach the

is done for the purpose of determining the amount of the calcium hydroxide in the sample.

The formation of a precipitate is observed during the crystallization process.

3. The samples are placed in a flask containing 100 ml of water and allowed to stand for 24 hours.

A portion of the solid is removed and the remaining solid is extremely white and more solid than the

added during the digestion period. The samples are agitated several times. The solid is removed, water

added, and the residue allowed to settle in gravity. The liquid is decanted. Hydrochloric acid is added and the solid

and siliceous components.

4. The residues are placed in a flask containing 100 ml of water and used in all the following steps. The residues are

hydrochloric acid, and heated in a boiling water bath for several minutes on an electric heater. The liquid is

usually turn green. The samples are removed, washed, acid added, and heated again. The process is repeated

until the liquid is clear. The residues are then placed in the residues of samples after the liquid is clear.

during treatment with the hydrochloric acid. The residues increase the bulk of the residues and change the color

on the slides.

5. The residues are placed in a flask containing 100 ml of water to 100 ml of HCl, and heated in a boiling water bath for 24 hours.

spores. The residues are centrifuged, decanted, water added, and centrifuged again. This continues until the liquid remains clear. The nitric acid oxidizes and partially dissolves the humic material present.

6. Four pellets of potassium hydroxide are added. The residues are heated in a boiling water bath for thirty minutes. The samples are centrifuged, decanted, water added, and centrifuged again. This continues until the liquid remains clear. The centrifuging may have to be repeated 10 to 15 times before the liquid remains clear as lesser concentrations of potassium hydroxide are still effective in dispersing the humic material.
7. The residues are stored in water in small glass bottles. A drop of mercuric chloride is added to prevent growth of fungus spores.

Limestones:

Pure and nearly pure limestones are processed using the first two steps outlined above. Further treatment resulted in the complete disappearance of the residue. Because steps 3 through 6 were not used, microforaminifera were found in several residues. These fossils were not the chitinous linings but were composed of the broken-up mineral matter.

Coals:

No one fixed procedure can be recommended for the various ranks of coal. The maceration process depends on the rank of the coal and the degree of weathering.

1. The coal is powdered in a mortar and pestle.

spores. The solution was centrifuged, the supernatant removed, and the residue washed with distilled water. The residue was then dried in a vacuum oven at 60°C for 24 hours. The dried residue was then ground to a fine powder and stored in a desiccator until used.

6.

Four pellets of potassium hydroxide were added to the residue and heated in a boiling water bath for 15 minutes. The samples were then removed, cooled, and added, and centrifuged again. This procedure was repeated until the liquid remained clear. The centrifuging was then repeated 10 to 15 times before the liquid remained clear as a test of completeness of potassium hydroxide extraction. The liquid was then evaporated in a vacuum oven at 60°C for 24 hours.

7.

The residue was added in water in a small glass bottle. A drop of mercuric chloride is added to prevent growth of fungus spores.

Limestone:

Pure and nearly pure limestone was prepared by the two steps outlined above. A further refinement was achieved in the complete disappearance of the residue. The residue was then washed with distilled water and dried in a vacuum oven at 60°C for 24 hours. The residue was then ground to a fine powder and stored in a desiccator until used.

Coals:

No one fixed procedure can be recommended for the treatment of coal. The treatment procedure depends on the nature of the coal and the degree of weathering. 1. The coal is powdered in a mortar and pestle.

2. Dilute nitric acid is added and the residue is heated (not boiled) for thirty minutes. The residues are centrifuged, decanted, water added, and centrifuged again. This continues until the liquid is clear.
3. 8 to 10 potassium hydroxide pellets are added and the residue warmed at 60° C. for 12 hours. The residues are centrifuged, decanted, water added, and centrifuged again. This continues until the liquid remains clear.
4. Steps 2 and 3 may have to be repeated several times.

Slide Preparation

The equipment listed is used for preparing slides for palynological investigation.

Glass slides: size 25 x 75 mm. Thickness 1 mm. \pm 0.05 mm.

Glass cover slides: size 22 x 30 mm. Thinness No. 0.

Toothpicks, eyedroppers, small brush.

Microscopic mounting medium; glycerine jelly.

Constant temperature slide warmer.

General Electric clear varnish No. 1212.

Slides, cover glasses, and the glycerine jelly are placed on a slide warmer which maintains a constant temperature of 60° C. A drop of glycerine jelly is placed on the slide and spread evenly over a small area with a toothpick. The residue in the storage bottle is concentrated by decanting most of the liquid. The residue is agitated to insure a homogeneous mixture. A drop of the residue is placed on the jelly, spread, and allowed to stand until the excess water has evaporated.

2. Dilute nitric acid, filtered and treated with hydrogen peroxide.

(not boiled) for thirty minutes. The residue is removed.

Washed, decanted, water added, and dried in a desiccator.

continued until the liquid is clear.

3. 5 to 10 percent aqueous solution of lithium acetate and lead

residue washed at 50° C. for fifteen minutes. The residue is

centrifuged, decanted, water added, and centrifuged

again. This continues until the liquid remains clear.

4. Steps 2 and 3 may have to be repeated several times.

Slide Preparation

The equipment listed is used for preparing slides for

gynecological investigation.

Glass slides also 2 1/2 x 7 1/2 in. thickness 1/16 in. 1.00 each.

Glass cover slides also 2 1/2 x 7 1/2 in. thickness No. 1.

Toothpick, spreader, well-ribbed.

Microscopic mounting medium; glycerine jelly.

Constant temperature slide warmer.

General Electric slide warmer No. 111.

Slides, cover glasses, and the glycerine jelly are placed

on a slide warmer which is set at a constant temperature of

50° C. A drop of glycerine jelly is placed on the slide and

spread evenly over a well-ribbed slide warmer. The residue

in the storage bottle is added until the slide is covered.

The residue is allowed to remain in the slide warmer

mixture. A drop of the mixture is placed on the slide, spread

and allowed to remain until the glycerine jelly has evaporated.

The cover glass is placed over the mixture. The slide is labelled and allowed to remain on the warmer 24 to 48 hours so that the mixture loses all moisture and air bubbles and becomes evenly spread. General Electric varnish is painted around the edges of the cover glass to prevent the glycerine jelly from dehydrating. The slides are now permanent and may be stacked and stored.

Microscopic Examination

The microscopic investigation was done with a Leitz Labolux microscope having binocular eyepieces, a four-objective nosepiece, and a graduated mechanical stage. Scanning was done with 10X oculars and a 10X objective. Measuring and identification was done with the 10X graduated ocular and 40X apochromatic objective. In some cases the 70X objective or the oil immersion lens was necessary for critical study.

A minimum of two slides were examined for each sample and all identifiable spores were counted. Where enough spores were present for a statistical percentage count, a minimum of 70 spores were counted.

Photomicrography

Spore pictures were taken using the Leitz Labolux microscope equipped with a monocular tube, a two-diaphragm condenser, a substage lamp, a 6X ocular, and a 40X apochromatic objective. This equipment was used with a Leica

The cover glass is placed over the mixture. The slide is
labeled and allowed to remain in the water for 24 hours
so that the mixture loses all water. The slide is then
becomes evenly spread. General results are as follows:
around the edges of the cover glass to prevent the glass from
telly from deteriorating. The slides are now permanent and can
be etched and stored.

Microscopic Examination

The microscopic investigation was done with a Leitz
Labor microscope having binocular eyepieces, a form-
objective nosepiece, and a graduated mechanical stage.
Scanning was done with 10X eyepieces and a 10X objective.
Measuring and identification was done with the 10X eyepieces
ocular and 40X apochromatic objective. In some cases the 63X
objective or the oil immersion lens was necessary for critical
study.

A minimum of two slides were examined for each sample and
all identifiable spots were counted. These counts were then
present for a statistical correlation to a minimum of 50
spots were counted.

Statistical Analysis

Spots pictured were examined with a Leitz Labor
microscope equipped with a binocular eyepiece, a two-lens
condenser, a substage lamp, a 10X eyepiece, and a 10X
chromatic objective. The minimum size was 100 microns.

35 mm. camera mounted on an adjustable stand and bellows. Kodak Panatomic X film was used.

LOCATION OF AREA AND DESCRIPTION OF LITHOLOGIC UNITS

The Toronto limestone interval crops out in a linear belt trending north-northeast across eastern Kansas, extending southward a short distance into Oklahoma and northward into Missouri, Iowa, and Nebraska. The location of the outcrop localities and shallow-hole cores used in this study are shown in Figure 4.

The Toronto limestone is the lower limestone member of the Oread megacyclothem of the Shawnee group, Virgilian (Cisco) series, Pennsylvanian system (Moore, 1949). The Toronto limestone when considered with the immediately underlying coal, underclay, and shale units may be considered a cyclothem making up a part of the larger Oread megacyclothem.

The Shawnee group includes beds from the base of the Oread limestone to the top of the Topeka limestone. This group is a well-defined assemblage of strata in which thick limestones and cyclic sedimentation are prominent features. Four formations of the Shawnee group are made up largely of limestone. The three intervening formations are made up chiefly of shale and sandstone. This alternation of clastics and calcareous deposits reflects major cyclic oscillations of sedimentation which furnish evidence of shifting of strand lines in Virgilian seas (Moore, 1949). The Shawnee group consists of the following formations starting with the oldest:

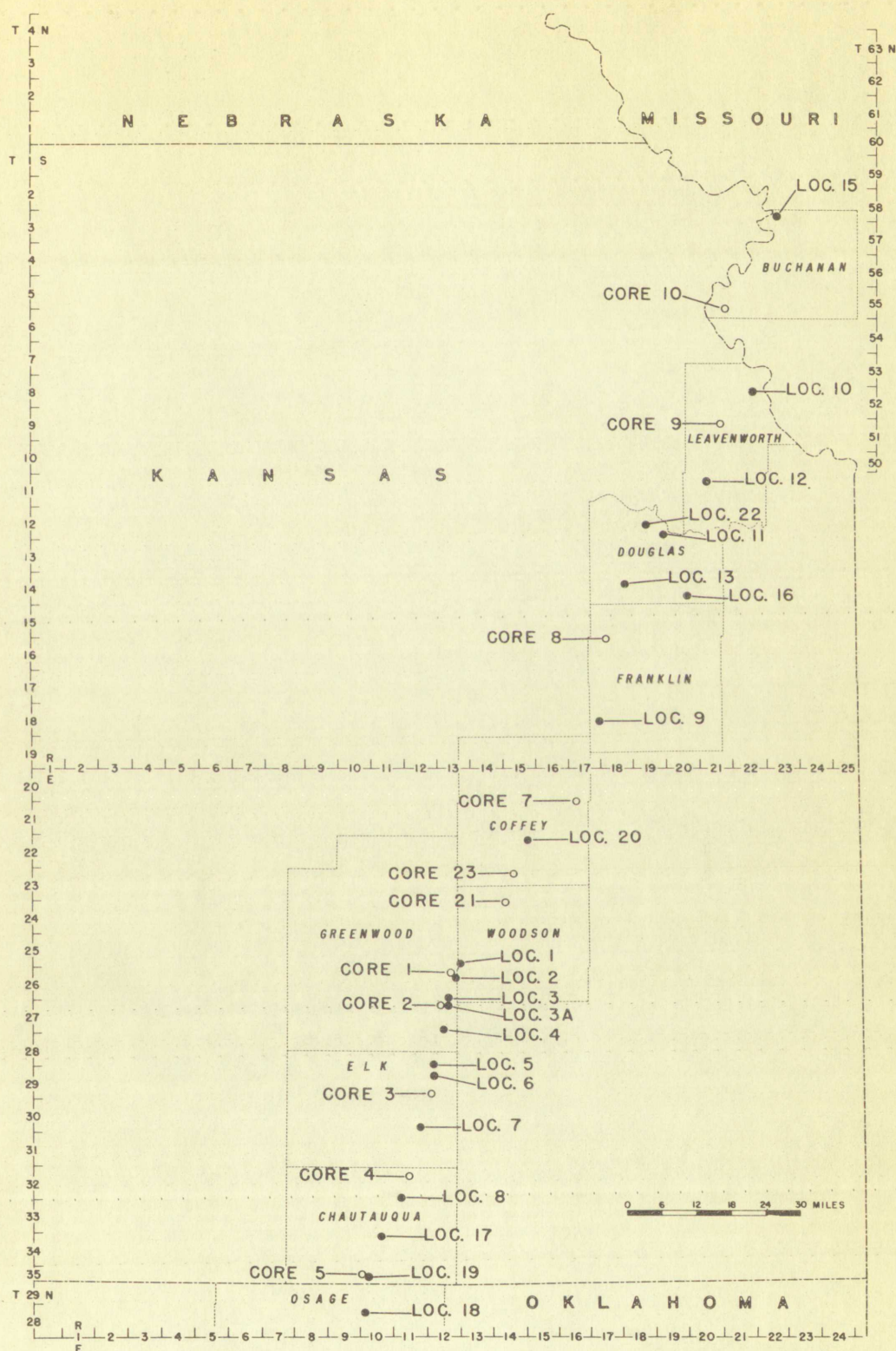
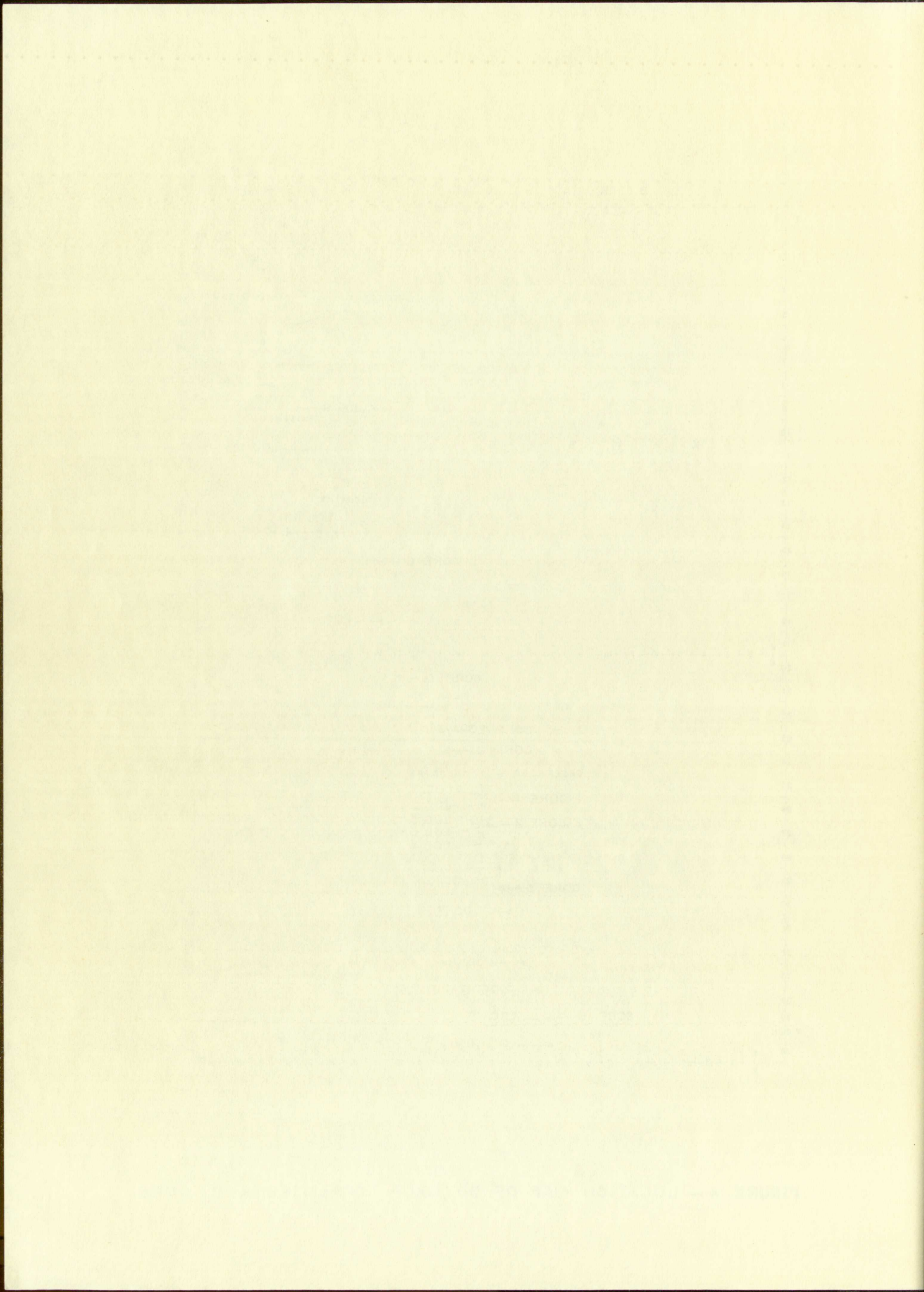


FIGURE 4 — LOCATION MAP OF OUTCROP LOCALITIES AND CORES



Oread limestone, Kanwaka shale, Lecompton limestone, Tecumseh shale, Deer Creek limestone, Calhoun shale, Topeka limestone (Fig. 5).

The Oread limestone or formation has a total thickness of 45 feet at the type area at Lawrence, Kansas. The Lawrence shale lies conformably below the Oread and the Kanwaka shale lies conformably above (Moore, 1949).

The Oread limestone contains the following members starting with the oldest: Toronto limestone, Snyderville shale, Leavenworth limestone, Heebner shale, Plattsmouth limestone, Heumader shale, Kereford limestone (Fig. 5).

The Toronto limestone has a maximum thickness of 16 feet and is a richly fossiliferous limestone divided near the middle by a thin shale unit. It is distinguished by its brown color on the weathered outcrop and its massive character. Locally it is sandy. Fossils are numerous locally and include fusulinids, brachiopods, bryozoans, crinoid stems, and mollusks (Moore, 1949).

The lower shale member of the Oread limestone, called the Snyderville, is a bluish to grayish, and in part red, shale which occurs directly above the Toronto limestone (Moore, 1949).

The middle member of the Oread limestone is the Leavenworth limestone. It is rarely more than 1 to 2 feet thick but has distinctive physical characteristics and crops out for several hundred miles. The Leavenworth is a single massive

Great limestone, known as the "Great limestone", is a
shale, best of the limestone. The limestone is
(Wig. 5).

The Great limestone or limestone is a level of
of 45 feet at the base of the limestone, known as the limestone
shale lies conformably below the Great and the limestone
lies conformably above (Wig. 5).

The Great limestone contains the following members
starting with the oldest: Toronto limestone, Devonian
shale, Leavenworth limestone, Madison shale, Westmoreland
limestone, Hamilton shale, Hamilton limestone (Wig. 5).

The Toronto limestone has a similar thickness of 10
feet and is a finely crystalline limestone which is
middle by a thin shale unit. It is characterized by the
brown color on the weathered surface and the resulting
ter. Locally it is sandy. Fossils are common locally and
include fusulinids, brachiopods, bryozoans, corals, etc.
and mollusks (Moore, 1949).

The lower shale member of the Great limestone, called
the Snyderville, is a shale to argillite and is
shale which occurs directly above the Toronto limestone
(Moore, 1949).

The middle member of the Great limestone is the
worth limestone. It is a fossiliferous limestone 1 to 4 feet
but has distinctive fossiliferous argillite and argillite
for several hundred feet. The limestone is a massive

Wabaunsee group

Shawnee group

Topeka limestone

Calhoun shale

Deer Creek limestone

Tecumseh shale

Lecompton limestone

Kanwaka shale

Stull shale

Clay Creek limestone

Jackson Park shale

Oread limestone

Kereford limestone

Heumader shale

Plattsmouth limestone

Heebner shale

Leavenworth limestone

Snyderville shale

Toronto limestone

Douglas group

Lawrence shale (part only)

Oread megacyclothem

Figure 5 - The Pennsylvanian system, Virgilian series,
Shawnee group of Kansas (after Moore et al., 1951).

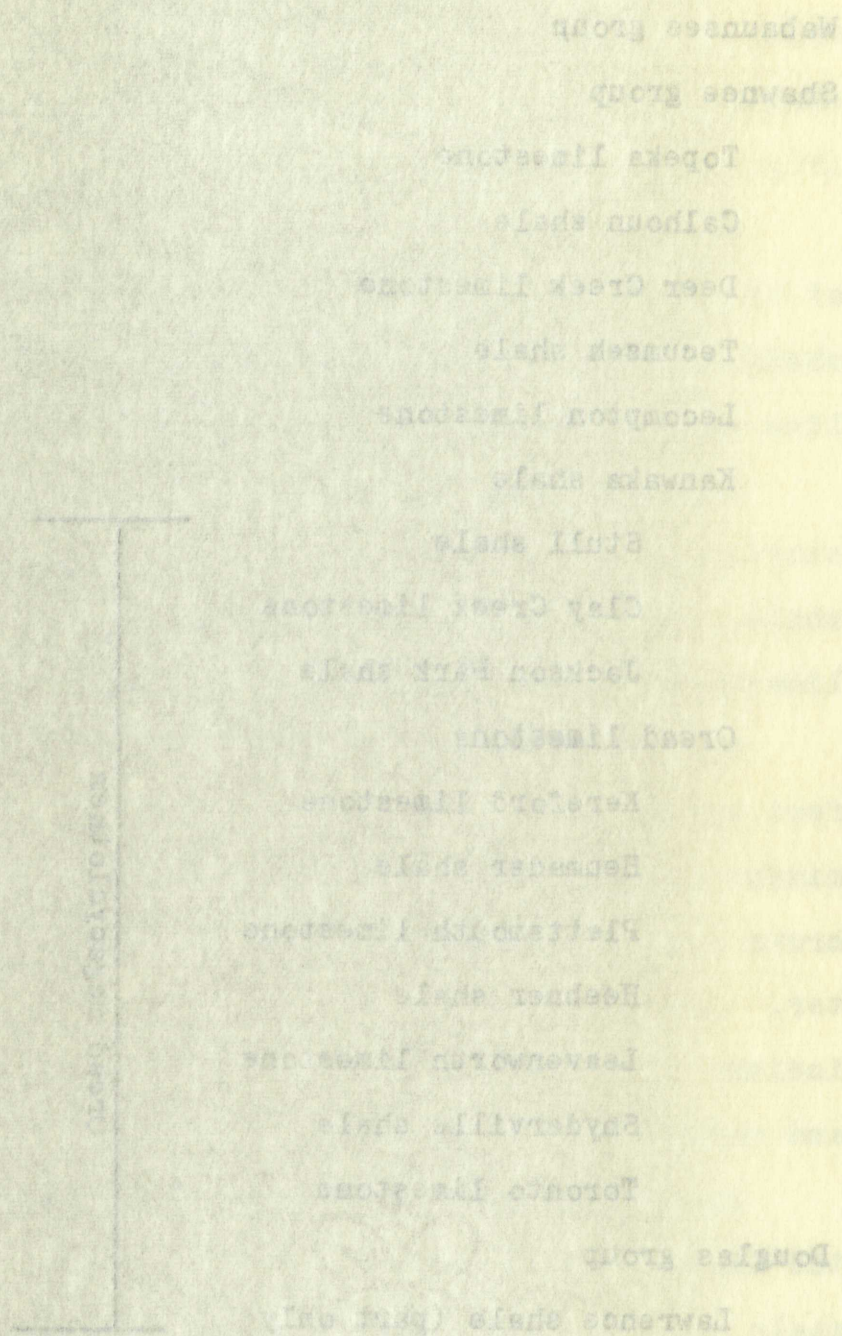


Figure 2 - The Paleozoic system, Virginia section, Shawnee group of rocks (after Smith, 1951).

layer which is uniformly fine-grained, dense, dark bluish in color and is characterized by the prevalence of vertical jointing.

Rock samples from the Toronto limestone and a few from the Snyderville and Leavenworth units were examined for spores.

PALEOGEOGRAPHY

The interior of North America during the Pennsylvanian Period was bounded on the east by Appalachia and on the south by Llanoria which were important sources of detritus. Thick sediments were deposited in the Appalachian and Ouachita geosynclines. The Cincinnati arch and the Ozark dome were positive areas of the interior of the continent. These positive areas never stood high above the neighboring basins, were never rapidly eroded, never contributed large amounts of sediments, and were frequently submerged (Weller, 1957).

The interior lowlands were probably not directly connected with the Atlantic or the Gulf areas during the Pennsylvanian Period. The Midcontinent negative area or shelf was bounded by the Ancestral Rocky Mountains on the west, the Amarillo-Wichita-Arbuckle Mountains on the south, the Ouachita geosyncline on the southeast, the Ozark dome on the east, and to the north lay the ancient stable positive areas of Siouxia and the Canadian Shield. Figure 6 gives the possible paleogeography of the Midcontinent region during a maximum marine stage such as during the deposition of the Toronto limestone.

layer which is uniformly thin-bedded, gray, and is
color and is characterized by the presence of
jointing.

Rock samples from the Toronto Division and the
the Snyderville and Leavenworth areas were examined.

PALEONTOLOGY

The interior of North America during the Pennsylvanian
Period was bounded on the east by the Atlantic and on the south
by the Gulf of Mexico. The interior was occupied by
sediments which were deposited in the Appalachian and Canadian
synclines. The Cincinnati arch and the Ozark dome were
areas of the interior of the continent. The positive areas
never stood high above the neighboring basins, were never
rapidly eroded, never developed large amounts of sediment,
and were frequently submerged (Miller, 1931).

The interior basins were typically wet, and
needed with the Atlantic on the east and the Gulf of Mexico
Pennsylvanian Period. The Mississippi River basin was a
was bounded by the ancestral Rocky Mountains on the west, the
Appalachian Mountains on the east, the Ozark dome on the south,
geosyncline on the west. The interior of the continent
to the north lay the great stable positive areas of the
and the Canadian Shield. Figure 1 shows the possible paleo-
geography of the continent during the Pennsylvanian
stage such as during the deposition of the Toronto limestone.

FIGURE 2. CALIBRATION OF SUBCOMMITMENT REGION

DATE: 10/10/1980

ANALYSIS OF DATA AND CONCLUSIONS

A total of 367 Toronto limestone, shale, and coal samples were digested and examined for spore content. Spore occurrences are scattered and sparse with only 65 samples of coal, shale, and several sandstones being fossiliferous and only a few of these being fossiliferous enough to give a statistical analysis. The limestone was virtually barren. If large amounts of limestone were digested a few spores might have been found but this was not feasible.

Twenty-four genera of spores containing a total of 64 species were found to be present in the Toronto sequence. The genera present include: Leiotriletes, Punctatisporites, Calamospora, Granulatisporites, Cyclogranisporites, Planisporites, Lophotriletes, Acanthotriletes, Pustulatisporites, Raistrickia, Reticulatisporites, Microreticulatisporites, Convolutispora, Triquitrites, Lycospora, Cadiospora, Simozonotriletes, Densosporites, Cirratiradites, Laevigatosporites, Monoletes, Endosporites, Florinites, Illinites.

Microforaminifera were present at several intervals. These were planispirally coiled forms approximately 250 microns in diameter. They resemble the genus Ammodiscus.

Coal

Most of the spores found in the coal are autochthonous. The three dominant genera in the coal, Endosporites, Laevigatosporites, and Calamospora are common in other Pennsylvanian coals of the United States. The genus Laevigatosporites, is

known to occur in almost every coal of Pennsylvanian age that has been studied in Europe and the United States. The genus Calamospora is present in almost every coal bed in Illinois (Kosanke, 1950, p. 27).

The coal intervals are similar in spore genera percentages with the exception of locality 6 (chart showing the percentages of spore genera). At locality 6, Endosporites is not a dominant genus and Cadiospora occurs as a large percentage. Core 3 has a larger percentage of Cyclogranisporites and Planisporites present because the sample consisted of shale and coal. The slight variation in the dominant genera percentages at localities 1, 2, 3A, 9, 13, and core 3 is to be expected. In adjacent rock samples from localities 1A and 1B the percentages vary slightly. Localities 1A and 1B were combined and appear as locality 1 on the percentage chart of spore genera (Chart in pocket). Disregarding slight differences in sampling, the lateral variation may be due to several reasons. Slight differences in ecology and different rates in the regular succession of plants may cause normal variations in a climax vegetation. Plants invade an area in a rather definite order. Because of the short time involved a uniform climax vegetation may not have been attained over the entire area. There were probably small areas of slightly different plants in a forest about to attain uniformity. The normal variations in climax flora and too short a time to attain a climax vegetation could cause the slight variance in spore percentages in the coal intervals.

known to occur in almost every coal field in the world. It has been studied in Europe and the United States. *Calamagrostis* is present in almost every coal field in the world. (Ross, 1930, p. 87).

The coal intervals are similar in spore content and composition with the exception of locality 4 (where spores are not present of spore genera). As locality 4 is a large horizon, dominant genera and *Labiopsis* occur as a large percentage. Core 3 has a larger percentage of *Labiopsis* and *Platanus* present because the horizon consisted of sand and coal. The slight variation in the dominant genera and percentages at localities 1, 2, 3, 4, 5, and 6 is to be expected. In adjacent rock samples from localities 1 and 2 the percentages vary slightly. *Calamagrostis* is and is common and appear as locality 1 of the percentage of spore genera (Chart in pocket). Slight differences in spore content, the lateral variation of the spore content. Slight differences in spore content and different rates in the regular succession of plants and spore content variation is a climax vegetation. There is some variation in the order. Because of the spore content and the order of vegetation may not have been identical over the entire area. There were probably small differences in the plants in a forest about to develop into a climax. The natural variations in climax plants and the order of succession in the vegetation could cause the slight variations in spore percentages in the coal intervals.

Some of the coal intervals such as localities 9 and 13 are much lower stratigraphically and are probably not in the Toronto sequence. Similar floras occur in these beds because of recurrent ecologic conditions.

A fairly good picture of the flora and environment that produced the great Pennsylvanian coal measures can be drawn on the basis of many previous spore studies and studies of larger plant remains. In general, very uniform climatic conditions prevailed during the time in which the coal floras thrived. The climate was probably not tropical but uniform over the swamp areas and similar to the warm temperate rain forest of today. Rainfall could have been moderate or heavy but the humidity was high. Storms and violent winds were probably rare judging from the shallow root systems of the flora. The terrain on which the coal formed in the Toronto sequence would have to have been low-lying.

Clastic Sediments

Many of the spores in the shales and sandstones were allochthonous, being blown in from the adjacent land areas. Since more spores will settle nearer the source and most of the spore-bearing shales occur in the southern part of the traverse, a land source for the parent flora was probably located to the south.

The prepollen genus Illinites occurs in sufficient numbers to give a percentage count in core 5 (as much as 7%) and several grains are present in residues from cores 3, 4,

Some of the coal seams are... are much lower... Toronto region... of recent... conditions.

A fairly good picture of the... produced the... on the basis of... larger plant remains... conditions prevailed... shrived. The climate was... over the swamp area... forest of today. Rainfall would have been... but the humidity was high. Growth was... probably rare... floors. The fauna... sequence would have to have been...

Classification... Many of the... alveolates, being... Since more spores... the spore-bearing... traverse, a large... located to the... The preceding... numbers to give... and several grains...

and 5 which are in the southern part of the traverse.

"Pityosporites has been considered indicative of xerophytic upland flora. The similarity of Pityosporites and Illinites suggests that the latter may be associated with xerophytic climatic conditions" (Kosanke, 1950, p. 51). Illinites is a bladdered type and may be wind transported for quite some distance. From the scattered occurrence at the noted intervals a land area with more xeric conditions may be postulated at some distance to the south.

In the Toronto sequence the genus Florinites is abundant and characteristic of the non-marine shale (Snyderville) above the limestone and is also present in the non-marine shales above the coal and below the limestone. Schopf, Wilson, and Bentall (1944, p. 57) suggest that the genus Florinites is related to the gymnospermie groups that were partially restricted to upland habitats.

Spore Assemblages

There appear to be definite spore genera and assemblages characteristic of the several environmental units of the Toronto sequence. Lycospora and Cadiorpora are dominant in the lower non-marine shale and Florinites in the upper non-marine shale. Cadiorpora, Endosporites, and Calamospora are the dominant genera of the underclay. The coal is characterized by Endosporites, Laevigatosporites, and Calamospora. The transitional shale contains Cyclogranisporites as the dominant

and 5 which are in the northern part of the island.
"Pithecanthropus" has been described in the island of
Sulawesi. The similarity of the island of Sulawesi
suggests that the island may be a possible place for
climatic conditions (Lansdale, 1939, p. 11).
a bladed type and may be found in the island of
distance. From the scattered remains of the island
a land area with more or less continuous, as indicated at
some distance to the south.

In the Toronto sequence the first thing to be noted
and characteristic of the non-marine part is (Pithecanthropus)
the limestone and is also present as the limestone of the
above the coal and below the limestone. (Pithecanthropus, etc.)
Bentall (1944, p. 27) suggests that the lower limestone is
related to the synclinal structure and was possibly re-
stricted to certain basins.

Lower Limestone

There appear to be definite marine and non-marine
characteristic of the lower limestone units of the
Toronto sequence. (Pithecanthropus and other fossils)
the lower non-marine shale and limestone is the lower
marine shale. (Pithecanthropus and other fossils)
the dominant genus of the limestone. The coal is associated
by (Pithecanthropus, etc.)
situated shale contains (Pithecanthropus and other fossils)

genus. Endosporites and Planisporites are most numerous in the marine shale. These generalizations are shown on Figure 7 and the Chart (in pocket) and except for the lower non-marine shale, where Lycospora makes its only dominant appearance, are based on similar spore assemblages in two or more occurrences of the same environment. The spores listed as dominant usually account for 25 percent or more of the total at some place in the core or locality.

Correlations

The scarcity of data and the short time interval involved hamper regional correlations but several limited correlations may be noted on the percentage chart of spore genera (Chart in pocket).

The genus Triquitrites occurs sparingly in some of the intervals and is considered to be a good index fossil of the Pennsylvanian Period.

The genus Densosporites was previously thought to occur not higher than the Des Moines although Hoffmeister, Staplin, and Malloy (1955) report it from rocks of questionable Virgilian age. A few specimens of Densosporites occur in the Toronto sequence which is of Virgilian age.

Genus. *Indonotus* and *Indonotus* are now known in the marine shelf. These correlations are shown in Figure 7 and the Chart (in pocket) and extend for the lower marine shelf, where *Indonotus* makes its last known appearance, are based on similar rock relationships in the occurrences of the same environment. The species listed as dominant nearly extend for 25 percent or more of the total at some place in the core or locality.

Correlations

The accuracy of data and the short time interval involved hamper regional correlations but several limited correlations may be noted for the various parts of the genus (Chart in pocket).

The genus *Indonotus* occurs sparsely in some of the intervals and is considered to be a good index fossil of the Pennsylvanian Period.

The genus *Indonotus* was previously thought to occur not higher than the Gas mines although *Indonotus* *Indonotus* and Meloy (1955) report it from levels at least as high as the base of the *Indonotus* zone.

The Toronto region is a *Indonotus* zone.

Environment	Dominant spores	Associated spores	Occurrences								
			*L-1	L-2	1-3A	L-6	L-7	L-9	L-13	**C-3	C-5
Non-marine shale	<u>Florinites</u>	<u>Calamospora</u> <u>Illinites</u>								X	X
Toronto limestone	Barren	Barren									
Marine Shale	<u>Endosporites</u> <u>Planisporites</u>	<u>Calamospora</u>	X							X	
Transitional (brackish water ?) shale	<u>Cyclogranul-</u> <u>sporites</u>	<u>Calamospora</u> <u>Florinites</u>				X	X			X	
Coal	<u>Endosporites</u> <u>Laevigatosporites</u> <u>Calamospora</u>	<u>Cyclogranul-</u> <u>sporites</u>	X	X	X			X	X	X	
Underclay	<u>Cadlospora</u> <u>Endosporites</u> <u>Calamospora</u>	<u>Triquitrites</u>				X				X	
Non-marine shale	<u>Cadlospora</u> <u>Lycospora</u>	<u>Calamospora</u> <u>Laevigatosporites</u>	X	X							

*L- locality

**C- core

Figure 7 - Environmental occurrence of dominant and associated spores in the several samples studied.

SYSTEMATIC DESCRIPTIONS

For the purpose of this investigation, valid genera arranged in the outline of Potonié and Kremp (1954) were used. Genera not included in this outline were used when spores found were not considered to fit the outline. The species are numbered on the basis of the order in which they are found. The first spore species encountered is called species 1, the second, species 2, etc. Once numbered, the species always retains the same number.

Sporites H. Potonié 1893

Division Triletes Reinsch 1881

Subdivision Laevigati (Bennie and Kidston 1881)

Genus Leiotriletes (Naumova 1937) Potonie and Kremp 1954

Spores trilete, radial, subtriangular. Margin between radii usually concave but may be straight. Surface levigate, outline smooth. Trilete rays distinct and of varying lengths.

Leiotriletes sp. 1

Pl. 1, fig. 1

Trilete, radial, subtriangular. Trilete rays distinct, relatively long ($1/2$ radius). Apices rounded, sides between radii straight or slightly convex. Levigate. Size 48 microns.

Leiotriletes sp. 2

Pl. 1, fig. 2

Trilete, radial, subtriangular. Trilete rays distinct with fairly prominent lips. Sides gently concave. Apices smooth. Size 25-36 microns.

SYSTEMATIC DESCRIPTION

For the purpose of this investigation, the genera
arranged in the outline of genera and species (1957) were
Genera not included in this outline were not included
were not considered as the same. The species
numbered on the basis of the order in which they are listed.
The first spore species encountered is called species 1, the
second, species 2, etc. and numbered, the species listed
retains the same number.

Species 1 (1957)

Division Trilete (1957)

Subdivision Trilete (1957)

Genus *Trilete* (Kuhn 1957) (1957) (1957)
Spores trilete, radial, sub-elliptical, smooth, rounded, with
usually concave but may be slightly convex. Trilete line
fine smooth. Trilete line distinct and at varying lengths.

Trilete sp. 1

Trilete, radial, sub-elliptical

Trilete, radial, sub-elliptical. Trilete line distinct.

relatively long (1/3 radial). (1957) (1957) (1957)

between radial streaks of slight convex. (1957) (1957)

48 microns.

Trilete sp. 2

Trilete, radial, sub-elliptical

Trilete, radial, sub-elliptical. Trilete line distinct and

fairly prominent. (1957) (1957) (1957)

Size 25-30 microns.

Leiotriletes sp. 7

Pl. 1, fig. 3

Trilete, radial, subtriangular. Sides convex, one straight. Very heavy lips. Levigate. Trilete mark prominent. Size 48 microns.

Leiotriletes sp. 8

Pl. 1, fig. 4

Trilete, radial, subtriangular. Sides very sharply concave. Levigate. Size 36 microns.

Genus Punctatisporites (Ibrahim 1933) Potonié and Kremp 1954
Spores trilete, radial, circular. Spore coat finely to coarsely punctate. Trilete rays of variable length. Contact areas absent. Original spherical or subspherical shape indicated by lack of proximal-distal orientation when compressed.

Punctatisporites sp. 10

Pl. 1, fig. 5

Trilete, radial, circular. Trilete rays distinct. Exine evenly and finely punctate. Size 60 microns.

Punctatisporites sp. 12

Pl. 1, fig. 6

Trilete, radial, subcircular. Trilete rays indistinct. Punctations large, evenly distributed, farther apart than width of the pits. Outline shows punctations. Size 40-50 microns.

Genus Calamospora Schopf, Wilson, and Bentall 1944

Trilete, radial, subreticulate. Pores convex, not raised.
Very heavy lips. Levigate. Trilete mark prominent. Size
48 microns.

Trilete, radial, subreticulate. Size very slightly smaller.
Levigate. Size 36 microns.
Genus *Punctatoporia* (Pocock 1933) *Pocockia* sensu 1933
Spores trilete, radial, circular. Pores deep lobate.
Coarsely punctate. Trilete mark of variable length. Con-
text areas absent. Original attachment of attachment I areas
indicated by lines of growth 4-5-6-7-8-9-10-11-12-13-14-15-16-17-18-19-20-21-22-23-24-25-26-27-28-29-30-31-32-33-34-35-36-37-38-39-40-41-42-43-44-45-46-47-48-49-50-51-52-53-54-55-56-57-58-59-60-61-62-63-64-65-66-67-68-69-70-71-72-73-74-75-76-77-78-79-80-81-82-83-84-85-86-87-88-89-90-91-92-93-94-95-96-97-98-99-100-101-102-103-104-105-106-107-108-109-110-111-112-113-114-115-116-117-118-119-120-121-122-123-124-125-126-127-128-129-130-131-132-133-134-135-136-137-138-139-140-141-142-143-144-145-146-147-148-149-150-151-152-153-154-155-156-157-158-159-160-161-162-163-164-165-166-167-168-169-170-171-172-173-174-175-176-177-178-179-180-181-182-183-184-185-186-187-188-189-190-191-192-193-194-195-196-197-198-199-200-201-202-203-204-205-206-207-208-209-210-211-212-213-214-215-216-217-218-219-220-221-222-223-224-225-226-227-228-229-230-231-232-233-234-235-236-237-238-239-240-241-242-243-244-245-246-247-248-249-250-251-252-253-254-255-256-257-258-259-260-261-262-263-264-265-266-267-268-269-270-271-272-273-274-275-276-277-278-279-280-281-282-283-284-285-286-287-288-289-290-291-292-293-294-295-296-297-298-299-300-301-302-303-304-305-306-307-308-309-310-311-312-313-314-315-316-317-318-319-320-321-322-323-324-325-326-327-328-329-330-331-332-333-334-335-336-337-338-339-340-341-342-343-344-345-346-347-348-349-350-351-352-353-354-355-356-357-358-359-360-361-362-363-364-365-366-367-368-369-370-371-372-373-374-375-376-377-378-379-380-381-382-383-384-385-386-387-388-389-390-391-392-393-394-395-396-397-398-399-400-401-402-403-404-405-406-407-408-409-410-411-412-413-414-415-416-417-418-419-420-421-422-423-424-425-426-427-428-429-430-431-432-433-434-435-436-437-438-439-440-441-442-443-444-445-446-447-448-449-450-451-452-453-454-455-456-457-458-459-460-461-462-463-464-465-466-467-468-469-470-471-472-473-474-475-476-477-478-479-480-481-482-483-484-485-486-487-488-489-490-491-492-493-494-495-496-497-498-499-500-501-502-503-504-505-506-507-508-509-510-511-512-513-514-515-516-517-518-519-520-521-522-523-524-525-526-527-528-529-530-531-532-533-534-535-536-537-538-539-540-541-542-543-544-545-546-547-548-549-550-551-552-553-554-555-556-557-558-559-560-561-562-563-564-565-566-567-568-569-570-571-572-573-574-575-576-577-578-579-580-581-582-583-584-585-586-587-588-589-590-591-592-593-594-595-596-597-598-599-600-601-602-603-604-605-606-607-608-609-610-611-612-613-614-615-616-617-618-619-620-621-622-623-624-625-626-627-628-629-630-631-632-633-634-635-636-637-638-639-640-641-642-643-644-645-646-647-648-649-650-651-652-653-654-655-656-657-658-659-660-661-662-663-664-665-666-667-668-669-670-671-672-673-674-675-676-677-678-679-680-681-682-683-684-685-686-687-688-689-690-691-692-693-694-695-696-697-698-699-700-701-702-703-704-705-706-707-708-709-710-711-712-713-714-715-716-717-718-719-720-721-722-723-724-725-726-727-728-729-730-731-732-733-734-735-736-737-738-739-740-741-742-743-744-745-746-747-748-749-750-751-752-753-754-755-756-757-758-759-760-761-762-763-764-765-766-767-768-769-770-771-772-773-774-775-776-777-778-779-780-781-782-783-784-785-786-787-788-789-790-791-792-793-794-795-796-797-798-799-800-801-802-803-804-805-806-807-808-809-810-811-812-813-814-815-816-817-818-819-820-821-822-823-824-825-826-827-828-829-830-831-832-833-834-835-836-837-838-839-840-841-842-843-844-845-846-847-848-849-850-851-852-853-854-855-856-857-858-859-860-861-862-863-864-865-866-867-868-869-870-871-872-873-874-875-876-877-878-879-880-881-882-883-884-885-886-887-888-889-890-891-892-893-894-895-896-897-898-899-900-901-902-903-904-905-906-907-908-909-910-911-912-913-914-915-916-917-918-919-920-921-922-923-924-925-926-927-928-929-930-931-932-933-934-935-936-937-938-939-940-941-942-943-944-945-946-947-948-949-950-951-952-953-954-955-956-957-958-959-960-961-962-963-964-965-966-967-968-969-970-971-972-973-974-975-976-977-978-979-980-981-982-983-984-985-986-987-988-989-990-991-992-993-994-995-996-997-998-999-1000-1001-1002-1003-1004-1005-1006-1007-1008-1009-1010-1011-1012-1013-1014-1015-1016-1017-1018-1019-1020-1021-1022-1023-1024-1025-1026-1027-1028-1029-1030-1031-1032-1033-1034-1035-1036-1037-1038-1039-1040-1041-1042-1043-1044-1045-1046-1047-1048-1049-1050-1051-1052-1053-1054-1055-1056-1057-1058-1059-1060-1061-1062-1063-1064-1065-1066-1067-1068-1069-1070-1071-1072-1073-1074-1075-1076-1077-1078-1079-1080-1081-1082-1083-1084-1085-1086-1087-1088-1089-1090-1091-1092-1093-1094-1095-1096-1097-1098-1099-1100-1101-1102-1103-1104-1105-1106-1107-1108-1109-1110-1111-1112-1113-1114-1115-1116-1117-1118-1119-1120-1121-1122-1123-1124-1125-1126-1127-1128-1129-1130-1131-1132-1133-1134-1135-1136-1137-1138-1139-1140-1141-1142-1143-1144-1145-1146-1147-1148-1149-1150-1151-1152-1153-1154-1155-1156-1157-1158-1159-1160-1161-1162-1163-1164-1165-1166-1167-1168-1169-1170-1171-1172-1173-1174-1175-1176-1177-1178-1179-1180-1181-1182-1183-1184-1185-1186-1187-1188-1189-1190-1191-1192-1193-1194-1195-1196-1197-1198-1199-1200-1201-1202-1203-1204-1205-1206-1207-1208-1209-1210-1211-1212-1213-1214-1215-1216-1217-1218-1219-1220-1221-1222-1223-1224-1225-1226-1227-1228-1229-1230-1231-1232-1233-1234-1235-1236-1237-1238-1239-1240-1241-1242-1243-1244-1245-1246-1247-1248-1249-1250-1251-1252-1253-1254-1255-1256-1257-1258-1259-1260-1261-1262-1263-1264-1265-1266-1267-1268-1269-1270-1271-1272-1273-1274-1275-1276-1277-1278-1279-1280-1281-1282-1283-1284-1285-1286-1287-1288-1289-1290-1291-1292-1293-1294-1295-1296-1297-1298-1299-1300-1301-1302-1303-1304-1305-1306-1307-1308-1309-1310-1311-1312-1313-1314-1315-1316-1317-1318-1319-1320-1321-1322-1323-1324-1325-1326-1327-1328-1329-1330-1331-1332-1333-1334-1335-1336-1337-1338-1339-1340-1341-1342-1343-1344-1345-1346-1347-1348-1349-1350-1351-1352-1353-1354-1355-1356-1357-1358-1359-1360-1361-1362-1363-1364-1365-1366-1367-1368-1369-1370-1371-1372-1373-1374-1375-1376-1377-1378-1379-1380-1381-1382-1383-1384-1385-1386-1387-1388-1389-1390-1391-1392-1393-1394-1395-1396-1397-1398-1399-1400-1401-1402-1403-1404-1405-1406-1407-1408-1409-1410-1411-1412-1413-1414-1415-1416-1417-1418-1419-1420-1421-1422-1423-1424-1425-1426-1427-1428-1429-1430-1431-1432-1433-1434-1435-1436-1437-1438-1439-1440-1441-1442-1443-1444-1445-1446-1447-1448-1449-1450-1451-1452-1453-1454-1455-1456-1457-1458-1459-1460-1461-1462-1463-1464-1465-1466-1467-1468-1469-1470-1471-1472-1473-1474-1475-1476-1477-1478-1479-1480-1481-1482-1483-1484-1485-1486-1487-1488-1489-1490-1491-1492-1493-1494-1495-1496-1497-1498-1499-1500-1501-1502-1503-1504-1505-1506-1507-1508-1509-1510-1511-1512-1513-1514-1515-1516-1517-1518-1519-1520-1521-1522-1523-1524-1525-1526-1527-1528-1529-1530-1531-1532-1533-1534-1535-1536-1537-1538-1539-1540-1541-1542-1543-1544-1545-1546-1547-1548-1549-1550-1551-1552-1553-1554-1555-1556-1557-1558-1559-1560-1561-1562-1563-1564-1565-1566-1567-1568-1569-1570-1571-1572-1573-1574-1575-1576-1577-1578-1579-1580-1581-1582-1583-1584-1585-1586-1587-1588-1589-1590-1591-1592-1593-1594-1595-1596-1597-1598-1599-1600-1601-1602-1603-1604-1605-1606-1607-1608-1609-1610-1611-1612-1613-1614-1615-1616-1617-1618-1619-1620-1621-1622-1623-1624-1625-1626-1627-1628-1629-1630-1631-1632-1633-1634-1635-1636-1637-1638-1639-1640-1641-1642-1643-1644-1645-1646-1647-1648-1649-1650-1651-1652-1653-1654-1655-1656-1657-1658-1659-1660-1661-1662-1663-1664-1665-1666-1667-1668-1669-1670-1671-1672-1673-1674-1675-1676-1677-1678-1679-1680-1681-1682-1683-1684-1685-1686-1687-1688-1689-1690-1691-1692-1693-1694-1695-1696-1697-1698-1699-1700-1701-1702-1703-1704-1705-1706-1707-1708-1709-1710-1711-1712-1713-1714-1715-1716-1717-1718-1719-1720-1721-1722-1723-1724-1725-1726-1727-1728-1729-1730-1731-1732-1733-1734-1735-1736-1737-1738-1739-1740-1741-1742-1743-1744-1745-1746-1747-1748-1749-1750-1751-1752-1753-1754-1755-1756-1757-1758-1759-1760-1761-1762-1763-1764-1765-1766-1767-1768-1769-1770-1771-1772-1773-1774-1775-1776-1777-1778-1779-1780-1781-1782-1783-1784-1785-1786-1787-1788-1789-1790-1791-1792-1793-1794-1795-1796-1797-1798-1799-1800-1801-1802-1803-1804-1805-1806-1807-1808-1809-1810-1811-1812-1813-1814-1815-1816-1817-1818-1819-1820-1821-1822-1823-1824-1825-1826-1827-1828-1829-1830-1831-1832-1833-1834-1835-1836-1837-1838-1839-1840-1841-1842-1843-1844-1845-1846-1847-1848-1849-1850-1851-1852-1853-1854-1855-1856-1857-1858-1859-1860-1861-1862-1863-1864-1865-1866-1867-1868-1869-1870-1871-1872-1873-1874-1875-1876-1877-1878-1879-1880-1881-1882-1883-1884-1885-1886-1887-1888-1889-1890-1891-1892-1893-1894-1895-1896-1897-1898-1899-1900-1901-1902-1903-1904-1905-1906-1907-1908-1909-1910-1911-1912-1913-1914-1915-1916-1917-1918-1919-1920-1921-1922-1923-1924-1925-1926-1927-1928-1929-1930-1931-1932-1933-1934-1935-1936-1937-1938-1939-1940-1941-1942-1943-1944-1945-1946-1947-1948-1949-1950-1951-1952-1953-1954-1955-1956-1957-1958-1959-1960-1961-1962-1963-1964-1965-1966-1967-1968-1969-1970-1971-1972-1973-1974-1975-1976-1977-1978-1979-1980-1981-1982-1983-1984-1985-1986-1987-1988-1989-1990-1991-1992-1993-1994-1995-1996-1997-1998-1999-2000-2001-2002-2003-2004-2005-2006-2007-2008-2009-2010-2011-2012-2013-2014-2015-2016-2017-2018-2019-2020-2021-2022-2023-2024-2025-2026-2027-2028-2029-2030-2031-2032-2033-2034-2035-2036-2037-2038-2039-2040-2041-2042-2043-2044-2045-2046-2047-2048-2049-2050-2051-2052-2053-2054-2055-2056-2057-2058-2059-2060-2061-2062-2063-2064-2065-2066-2067-2068-2069-2070-2071-2072-2073-2074-2075-2076-2077-2078-2079-2080-2081-2082-2083-2084-2085-2086-2087-2088-2089-2090-2091-2092-2093-2094-2095-2096-2097-2098-2099-2100-2101-2102-2103-2104-2105-2106-2107-2108-2109-2110-2111-2112-2113-2114-2115-2116-2117-2118-2119-2120-2121-2122-2123-2124-2125-2126-2127-2128-2129-2130-2131-2132-2133-2134-2135-2136-2137-2138-2139-2140-2141-2142-2143-2144-2145-2146-2147-2148-2149-2150-2151-2152-2153-2154-2155-2156-2157-2158-2159-2160-2161-2162-2163-2164-2165-2166-2167-2168-2169-2170-2171-2172-2173-2174-2175-2176-2177-2178-2179-2180-2181-2182-2183-2184-2185-2186-2187-2188-2189-2190-2191-2192-2193-2194-2195-2196-2197-2198-2199-2200-2201-2202-2203-2204-2205-2206-2207-2208-2209-2210-2211-2212-2213-2214-2215-2216-2217-2218-2219-2220-2221-2222-2223-2224-2225-2226-2227-2228-2229-2230-2231-2232-2233-2234-2235-2236-2237-2238-2239-2240-2241-2242-2243-2244-2245-2246-2247-2248-2249-2250-2251-2252-2253-2254-2255-2256-2257-2258-2259-2260-2261-2262-2263-2264-2265-2266-2267-2268-2269-2270-2271-2272-2273-2274-2275-2276-2277-2278-2279-2280-2281-2282-2283-2284-2285-2286-2287-2288-2289-2290-2291-2292-2293-2294-2295-2296-2297-2298-2299-2300-2301-2302-2303-2304-2305-2306-2307-2308-2309-2310-2311-2312-2313-2314-2315-2316-2317-2318-2319-2320-2321-2322-2323-2324-2325-2326-2327-2328-2329-2330-2331-2332-2333-2334-2335-2336-2337-2338-2339-2340-2341-2342-2343-2344-2345-2346-2347-2348-2349-2350-2351-2352-2353-2354-2355-2356-2357-2358-2359-2360-2361-2362-2363-2364-2365-2366-2367-2368-2369-2370-2371-2372-2373-2374-2375-2376-2377-2378-2379-2380-2381-2382-2383-2384-2385-2386-2387-2388-2389-2390-2391-2392-2393-2394-2395-2396-2397-2398-2399-2400-2401-2402-2403-2404-2405-2406-2407-2408-2409-2410-2411-2412-2413-2414-2415-2416-2417-2418-2419-2420-2421-2422-2423-2424-2425-2426-2427-2428-2429-2430-2431-2432-2433-2434-2435-2436-2437-2438-2439-2440-2441-2442-2443-2444-2445-2446-2447-2448-2449-2450-2451-2452-2453-2454-2455-2456-2457-2458-2459-2460-2461-2462-2463-2464-2465-2466-2467-2468-2469-2470-2471-2472-2473-2474-2475-2476-2477-2478-2479-2480-2481-2482-2483-2484-2485-2486-2487-2488-2489-2490-2491-2492-2493-2494-2495-2496-2497-2498-2499-2500-2501-2502-2503-2504-2505-2506-2507-2508-2509-2510-2511-2512-2513-2514-2515-2516-2517-2518-2519-2520-2521-2522-2523-2524-2525-2526-2527-2528-2529-2530-2531-2532-2533-2534-2535-2536-2537-2538-2539-2540-2541-2542-2543-2544-2545-2546-2547-2548-2549-2550-2551-2552-2553-2554-2555-2556-2557-2558-2559-2560-2561-2562-2563-2564-2565-2566-2567-2568-2569-2570-2571-2572-2573-2574-2575-2576-2577-2578-2579-2580-2581-2582-2583-2584-2585-2586-2587-2588-2589-2590-2591-2592-2593-2594-2595-2596-2597-2598-2599-2600-2601-2602-2603-2604-2605-2606-2607-2608-2609-2610-2611-2612-2613-2614-2615-2616-2617-2618-2619-2620-2621-2622-2623-2624-2625-2626-2627-2628-2629-2630-2631-2632-2633-2634-2635-2636-2637-2638-2639-2640-2641-2642-2643-2644-2645-2646-2647-2648-2649-2650-2651-2652-2653-2654

Spores trilete, radial, circular to subcircular. Exine levigate and usually very thin. Pyramic area often present and may have a different texture than the rest of the exine. Originally spherical. Trilete rays may extend $1/4$ to $2/3$ the distance to the margin. Intense folding is characteristic of the genus.

Calamospora sp. 19

Pl. 1, fig. 7

Trilete, radial, circular to subcircular. Trilete rays distinct, relatively small. Small dark pyramic area present. Commonly folded. Exine thin. Size 72-80 microns.

Calamospora sp. 20

Pl. 1, fig. 8

Trilete, radial, subcircular. Trilete mark distinct. Levigate. Size 17-36 microns.

Calamospora sp. 21

Pl. 1, fig. 9

Trilete, radial, circular to subcircular. Trilete rays prominent extending almost to margin. Levigate. Spore coat heavy, almost opaque, reddish-brown. Usually not folded. Size 78-90 microns.

Calamospora sp. 23

Pl. 1, fig. 10

Trilete, radial, circular to subcircular. Thin, distinct, relatively long trilete mark. Levigate. Commonly folded. Exine thin. Size 56-63 microns.

Spores trilobate, radial, circular, 10-12 microns.
Invasive and usually very thin. The surface is often granular
and may have a different texture than the rest of the spore.
Originally spherical. Trilobate is usually not
the distance to the margin. The distance to the margin
of the genus.

Trilobate sp. 12
Pl. 1. 12. 12
Trilobate, radial, circular, 10-12 microns.
Thin, relatively smooth. The surface is often granular.
Commonly trilobate. Size 10-12 microns.

Trilobate sp. 13
Pl. 1. 13. 13
Trilobate, radial, circular, 10-12 microns.
Size 10-12 microns.

Trilobate sp. 14
Pl. 1. 14. 14
Trilobate, radial, circular, 10-12 microns.
Prominent extending almost to margin. The surface is
heavy, almost opaque, reddish-brown. The surface is
Size 10-12 microns.

Trilobate sp. 15
Pl. 1. 15. 15
Trilobate, radial, circular, 10-12 microns.
Relatively long. The surface is granular. The surface is
Thin. Size 10-12 microns.

Calamospora sp. 24

Trilete, radial, subcircular. Trilete rays long and distinct. Fairly thick coat, reddish brown. Levigate. Size 93-105 microns.

Genus Granulatisporites (Ibrahim 1933) Potonié and Kremp 1954
Spores trilete, radial, subtriangular to triangular in transverse plane. Spore coat densely granulose with granules fine or coarse, circular and evenly distributed. Trilete rays relatively long. Sides either convex or slightly concave and the apices rounded.

Granulatisporites sp. 25

Pl. 1, fig. 11

Trilete, radial, subtriangular. Trilete rays indistinct. Sides gently convex. Very finely granulose. Size 29 microns.

Granulatisporites sp. 26

Pl. 1, fig. 12

Trilete, radial, subtriangular. Trilete rays not prominent and 1/2 length of radii. Sides gently convex. Moderately coarse granules. Granules evenly distributed and fairly dense. Size 21-26 microns.

Genus Cyclogranisporites Potonié and Kremp 1954

Spores trilete, radial, circular to subcircular. Spore coat densely covered with granules. Granules small and spherical to large and slightly irregular in shape (verrucose).

Cyclogranisporites sp. 31

Pl. 2, fig. 1

Trilete, radial, circular to subcircular. Trilete rays distinct to indistinct. Rays extend more than $1/2$ the radius. Finely granulose. Size 40-50 microns.

Cyclogranisporites sp. 32

Pl. 2, fig. 2

Trilete, radial, circular to subcircular. Trilete rays prominent, indistinct (suture line not easily discernible). Coarsely granulose. Size 29-38 microns.

Cyclogranisporites sp. 35

Pl. 2, fig. 3

Trilete, radial, circular to subcircular. Trilete rays usually obscured by ornamentation. Densely verrucose. Outline irregular. Size 62-80 microns.

Cyclogranisporites sp. 37

Trilete (?), circular to subcircular. Very coarsely and densely verrucose. Size 76-82 microns.

Suite Apiculati (Bennie and Kidston) Potonié and Kremp 1954

Genus Planisporites (Knox 1950) Potonié and Kremp 1954

Spores trilete, radial, circular to subcircular. Exine evenly and densely covered with small cones or spines. Trilete rays relatively long.

Planisporites sp. 39

Pl. 2, fig. 4

Trilete, radial, subcircular. Trilete rays indistinct. Spore coat has very small spines. Size 25-27 microns.

Planisporites sp. 41

Pl. 2, fig. 5

Trilete, radial, circular to subcircular. Trilete rays distinct and relatively long. Finely spinose, spines evenly and densely spread. Size 36-43 microns.

Planisporites sp. 42

Pl. 2, fig. 6

Trilete, radial, circular to subcircular. Trilete rays usually indistinct, relatively long. Evenly covered with small spines. Spines prominent on periphery. Not as densely spinose as Planisporites sp. 41. Size 54-72 microns.

Genus Lophotriletes (Naumova 1937) Potonié and Kremp 1954
Spores trilete, radial, subtriangular. Spore coat covered with small cones whose basal diameter can equal their height. Base of cones may touch. Edges concave to convex.

Lophotriletes sp. 44

Pl. 2, fig. 7

Trilete, radial, subtriangular. Trilete distinct and extend almost to apices. Exine evenly covered with small cones which are easily discernible on periphery. Sides gently concave. Size 26-42 microns.

Genus Acanthotriletes (Naumova 1937) Potonié and Kremp 1954
Spores trilete, radial, subtriangular. Spore coat crowded with attenuated spines which are longer than twice their diameter. Attenuation of spines and sharper tips distinguish this genus from Lophotriletes and Apiculatisporites.

Plant Kingdom No. 11

Pl. 2, 112, 1

Trilete, radial, otherwise as subtriangular. Trilete area
distinct and relatively large. Triangular, rarely circular, and densely covered.

Plant Kingdom No. 12

Pl. 2, 112, 2

Trilete, radial, otherwise as subtriangular. Trilete area
usually indistinct, relatively large. Triangular, rarely circular, and densely covered.
small spines. Spines prominent on periphery. Not as distinct
spines as *Planolites* No. 11. Size 25-35 microns.

Genus *Leptothorax* (Linné 1757) Linné and Linné 1757
Spores trilete, radial, subtriangular. Spores often covered
with small cones. Small cones distinct and sharp. Triangular.
Base of cones may be seen. Spores conical to narrow.

Plant Kingdom No. 13

Pl. 2, 112, 3

Trilete, radial, subtriangular. Trilete distinct and sharp
almost to apex. Trilete evenly covered with small cones which
are easily distinguishable on periphery. Spores rarely circular.
Size 25-45 microns.

Genus *Leptothorax* (Linné 1757) Linné and Linné 1757
Spores trilete, radial, subtriangular. Spores often covered
with attenuated spines which are sharp and distinct.
diameter. Attenuation of spines and sharp edges distinguish
this genus from *Planolites* and *Leptothorax*.

Acanthotriletes sp. 46

Pl. 2, fig. 8

Trilete, radial, subtriangular. Trilete rays indistinct. Sides range from concave to convex. Exine densely covered with attenuated spines. Size 26-30 microns.

Acanthotriletes sp. 47

Pl. 2, fig. 9

Trilete, radial, subcircular to subtriangular. Trilete rays obscure. Spore coat densely covered with attenuated spines 3.6 microns long. Size 53 microns.

Acanthotriletes sp. 290

Pl. 2, fig. 10

Trilete, radial, subtriangular. Trilete rays strong, extending $3/4$ or more of the distance to the periphery. Sides gently convex. Long attenuated (10 microns) sparsely scattered spines. Size 66 microns.

Genus Pustulatisporites Potonié and Kremp 1954

Spores trilete, radial, subtriangular to subcircular. Spore coat bears scattered granules, warts, or short cones. Warts may be small to very large. Trilete rays relatively long.

Pustulatisporites sp. 67

Pl. 2, fig. 11

Trilete, radial, subcircular. Trilete mark obscure. Very sparsely scattered cones. Size 19-24 microns.

CONTENTS

Genus *Trilete* 1

1. *Trilete* 1

Trilete, radial, subtriangular, trilete rays distinct.

Sides range from convex to concave, base broadly convex.

With attenuated apices. Size 10-20 microns.

Genus *Trilete* 2

2. *Trilete* 2

Trilete, radial, subtriangular, trilete rays distinct.

Spore coat densely covered with reticulate ridges.

3.6 microns long. Size 10 microns.

Genus *Trilete* 3

3. *Trilete* 3

Trilete, radial, subtriangular, trilete rays distinct.

tending 3/4 or more of the distance to the pole. Sides

gently convex. Long attenuated 1/2 apices, scarcely not-

tered apices. Size 10 microns.

Genus *Trilete* 4

Spores trilete, radial, subtriangular, trilete rays distinct.

coat bears scattered granules, not on short cones. Sides

may be small to very large. Trilete rays relatively long.

Genus *Trilete* 5

4. *Trilete* 4

Trilete, radial, subtriangular, trilete rays distinct.

sparsely scattered granules, not on short cones.

Genus *Trilete* 6

5. *Trilete* 5

Trilete, radial, subtriangular, trilete rays distinct.

Genus *Trilete* 7

6. *Trilete* 6

Pustulatisporites sp. 70

Trilete, radial, subtriangular. Trilete mark indistinct, 1/2 length of radius. Spore coat covered with scattered small cones. Size 31-37 microns.

Pustulatisporites sp. 72

Pl. 3, fig. 1

Trilete, radial, subtriangular. Trilete rays usually obscure, relatively long. Exine thick and covered with large warts that form prominent projections on periphery. Warts unevenly distributed. Sides concave to convex. Size 46-60 microns.

Pustulatisporites sp. 74

Pl. 3, fig. 2

Trilete, radial, subtriangular. Trilete rays extend almost to edge of spore. Exine covered with scattered cones that are thick and irregular in outline. Sides concave to convex. Size 26-31 microns.

Pustulatisporites sp. 84

Pl. 3, fig. 3

Trilete, radial, subcircular. Trilete rays relatively short and indistinct. Exine thick, dark colored, covered with large warts which show as small projections on periphery. Size 46-51 microns.

Genus Raistrickia (Schopf, Wilson, and Bentall 1944) Potonié and Kremp 1954

Spores trilete, radial, circular to subcircular. Original shape probably subspherical. Spore coat densely covered with large blunt processes that are often partate or broadened at their ends. Trilete rays variable in length.

Raistrickia sp. 53

Pl. 3, fig. 4

Trilete, radial, subcircular. Trilete rays usually very indistinct. Exine densely covered with short blunt projections which are prominent at periphery. Projection diameters approximately equal the height. Size 39-65 microns.

Raistrickia sp. 58

Pl. 3, fig. 5

Trilete, radial, subcircular. Trilete rays very indistinct. Exine covered with projections 10 to 12 microns long. Projections have blunt tips and same width over-all. Size 50 microns.

Suite Muronati Potonié and Kremp 1954

Genus Reticulatisporites (Ibrahim 1933) Potonié and Kremp 1954

Spores weakly trilete or show no indication of being trilete. Radial, circular to subcircular in proximal view. Originally spherical or oblate. Exine covered with reticulate network (reticulum). Lumina bordered by high muri. Muri regular or irregular in design. Lumina greater than 6 microns in diameter. Spore coat may appear thinner at periphery and thicker at inner part.

Spores trilete, radial, circular to subcircular, circular
shape probably subcircular. Spore coverings covered with
large blunt spines, most of which are oriented
at their ends. Trilete have variable in length.

Trilete, radial, circular to subcircular

Trilete, radial, circular to subcircular. Trilete have variable in length
distinct. Spine densely covered with blunt sharp spines
which are prominent at angles and rounded at ends
approximately equal in height. Spine 5-10 microns

Trilete, radial, circular to subcircular

Trilete, radial, circular to subcircular. Trilete have variable in length
Spine covered with projections 10 to 15 microns long.
Projections have blunt tips and some with overhanging
50 microns.

Spore covered with blunt spines and small spines

Genus *Retiolobosporium* (Hesselt 1933) Hesselt and Hesse 1933
Spores weakly trilete at show a trilete mark of being trilete.
Radial, circular to subcircular in proximal view. Weakly
spherical or oblate. Spine covered with reticulate network
(reticulum). Spine bordered by high rim. Spine tapering
irregular in design. Spine covered with a network of
diameter. Spore coverings covered with primary and
thicker at inner part.

Reticulatisporites sp. 96

Pl. 3, fig. 6

Trilete, radial, subcircular to circular. Periphery thinner, middle thicker and darker. Lumina 10 to 12 microns in diameter. Muri fairly high and thick. Trilete rays may not be found in most instances. Size 72-87 microns.

Genus Microreticulatisporites (Knox 1950) Potonié and Kremp 1954

Spores trilete, radial, circular to subcircular. Exine extra-reticulate with small lumina that do not exceed 6 microns in diameter. Muri are imperfect and vary in height. Trilete rays usually difficult to distinguish. Diameter of lumina distinguishes this genus from Reticulatisporites.

Microreticulatisporites sp. 102

Trilete, radial, circular to subcircular. Trilete mark very difficult to discern. Lumina average 4.9 microns across. Muri rounded to six sided. Periphery of spores appears to be thinner than polar region. Size 20-46 microns.

Genus Convolutispora Hoffmeister, Staplin, and Malloy 1955

Spores trilete, radial, circular to subcircular to subtriangular. Probable original spherical shape indicated by lack of orientation preference. Ornamentation closely packed overlapping anastomosing vermiculate or obervermiculate ridge-like processes often causing a convoluted or coarsely reticulate-punctate appearance. Trilete rays short and may have distinct lips, often obscured by the overlapping ridges.

Spore coat thick, lacking conspicuous folding. Closely packed anastomosing ridges distinguish this genus.

Convolutispora sp. 105

Pl. 3, fig. 7

Trilete, radial, circular to subcircular. Trilete mark indistinct because of ornamentation. Spore coat vermiculate so that vermicules give appearance of being concentrically arranged. Vermicules project slightly at periphery of spore. Vermicules fairly coarse and dense. Size 24-48 microns.

Convolutispora sp. 107

Pl. 3, figs. 8, 9

Trilete, radial, subtriangular. Trilete rays indistinct because of ornamentation. Sides slightly convex. Vermicules form ridges at their bases that give convoluted, reticulate-punctate appearance. Folding absent. Size 37-48 microns.

Convolutispora sp. 109

Pl. 4, figs. 1, 2

Trilete, radial, subtriangular. Trilete mark distinct, relatively long extending $3/4$ distance to periphery or more. Sides slightly convex. Outline irregular. Anastomosing ridges appear convoluted. Size 53 microns.

Convolutispora sp. 114

Pl. 4, fig. 3

Trilete, radial, subtriangular. Trilete ray indistinct but relatively long. Sides nearly straight. Ridges heavy, prominent and fluted in places. Size 36-60 microns.

Spore coat thin, lateral compressions distinct. Trilete ridges anastomosing ridges extending to the poles.

Trilete, radial, subtrilete

Pl. 1, fig. 7

Trilete, radial, subtrilete. Trilete ridges form distinct beaks of ornamentation. Spore coat very thin so that ornamentation gives appearance of being continuous. Trilete ridges extend to the poles. Trilete ridges extend to the poles. Trilete ridges extend to the poles.

Trilete, radial, subtrilete

Pl. 1, fig. 8

Trilete, radial, subtrilete. Trilete ridges form distinct beaks of ornamentation. Spore coat very thin so that ornamentation gives appearance of being continuous. Trilete ridges extend to the poles. Trilete ridges extend to the poles. Trilete ridges extend to the poles.

Trilete, radial, subtrilete

Pl. 1, fig. 9

Trilete, radial, subtrilete. Trilete ridges form distinct beaks of ornamentation. Spore coat very thin so that ornamentation gives appearance of being continuous. Trilete ridges extend to the poles. Trilete ridges extend to the poles. Trilete ridges extend to the poles.

Trilete, radial, subtrilete

Pl. 1, fig. 10

Trilete, radial, subtrilete. Trilete ridges form distinct beaks of ornamentation. Spore coat very thin so that ornamentation gives appearance of being continuous. Trilete ridges extend to the poles. Trilete ridges extend to the poles. Trilete ridges extend to the poles.

Convolutispora sp. 312

Pl. 4, fig. 4

Trilete, radial, subtriangular. Trilete rays distinct extending $3/4$ distance to apices. Sides gently concave. Ornamentation is a combination of convolute-punctate. Punctations medium size, evenly and densely distributed. Outline shows punctations. Size 36 microns.

Sporites H. Potonié 1893

Division Zonales (Bennie and Kidston 1886)

Subdivision Auritotrilletes Potonié and Kremp 1954

Suite Auriculati (Schopf 1938) Potonié and Kremp 1954

Genus Triquitrites (Wilson and Coe 1940) Potonié and Kremp 1954

Spores trilete, subtriangular to triangular, auriculate.

Trilete rays distinct and usually extend nearly to margin of the spore. Spores usually compressed in good proximal-distal orientation. Folding rare. Interradial margins vary from concave to convex. Exine variously ornamented. Auriculae thickened and darker than the rest of the exine. Auriculae may be levigate, spinose or warty.

Triquitrites sp. 117

Trilete, radial, subtriangular. Trilete rays distinct and greater than $1/2$ radii. Sides gently concave. Spore coat granulose(?). Auriculae thin and not strongly developed. Size 35-37 microns.

1000

Trilete, radial, subtriangular, ...
tending 3/4 distance to apex, ...
Ornamentation is a ...
cations median size, ...
shows punctations, size ...

Subdivided ...
Genus Trilete ...
Spores trilete, ...
Trilete rays distinct ...
the spore, ...
orientation, ...
concave to convex, ...
thickened and ...
may be levigate, ...

Trilete, radial, ...
greater than ...
Granulose, ...
size 35-38 ...

Triquitrites sp. 119

Trilete, radial, subtriangular. Trilete rays indistinct to distinct and relatively long. Sides concave. Auriculae project prominently but are thin. Levigate. Size 27-29 microns.

Triquitrites sp. 124

Pl. 4, fig. 5

Trilete, radial, subtriangular. Trilete rays may have darker pyramic area. Sides slightly convex. Auriculae very prominent and dark. Levigate. Size 34-38 microns.

Triquitrites sp. 125

Pl. 4, fig. 6

Trilete, radial, subtriangular. Trilete rays distinct, relatively long. Sides straight to slightly convex. Auriculae prominent and contain attenuated spines. Size 52-54 microns.

Triquitrites sp. 127

Pl. 4, fig. 7

Trilete, radial, subtriangular. Trilete rays strong, distinct, 1/2 length of radii. Auriculae well developed, dark. Exine levigate. Trilete rays have well-developed lips. Sides gently concave. Size 30-34 microns.

Triquitrites sp. 128

Pl. 4, fig. 8

Trilete, radial, subtriangular. Trilete mark indistinct.

Trilobite, radial, subtriangular. Trilobite very distinct
distinct and well-developed. Trilobite very distinct
project prominently and are well-developed. Trilobite very
microns.

Trilobite sp. 12

Pl. 1, fig. 1

Trilobite, radial, subtriangular. Trilobite very distinct
pyramic area. Trilobite slightly convex. Trilobite very distinct
and dark. Trilobite, subtriangular. Trilobite very distinct

Trilobite sp. 13

Pl. 1, fig. 2

Trilobite, radial, subtriangular. Trilobite very distinct
relatively long. Trilobite slightly convex.
Anterior prominent and contains attenuated apical. Trilobite
52-54 microns.

Trilobite sp. 14

Pl. 1, fig. 3

Trilobite, radial, subtriangular. Trilobite very distinct, slender.
1/2 length of radial. Anterior well-developed, with
fevigate. Trilobite very well-developed. Trilobite
gently convex. Trilobite 50-52 microns.

Trilobite sp. 15

Pl. 1, fig. 4

Trilobite, radial, subtriangular. Trilobite very distinct

Sides gently convex. Auriculae distinct, knobby. Exine has very scattered small warts. Size 26 microns.

Subdivision Zonotriletes (Waltz 1935)

Suite Cingulati Potonié and Klaus 1954 (?)

Genus Lycospora (Schopf, Wilson, and Bentall 1944) Potonié
and Kremp 1954

Spores trilete, radial, round to subtriangular in transverse plane. Trilete rays distinct and generally extend almost to margin of spore coat. Spore has a distinct cingulum which appears as a cuneiform ring in cross section. Spore coat is levigate, granulose or minutely spinose.

Lycospora sp. 138

Pl. 4, fig. 9

Trilete, radial, subtriangular to subcircular. Trilete mark prominent and extends to cingulum. Trilete rays may have lips. Small spines fairly dense in center and on cingulum. Cingulum well developed and moderately wide. Sides convex. Size 47-55 microns.

Lycospora sp. 140

Pl. 4, fig. 10

Trilete, radial, circular to subcircular. Trilete mark strong, distinct, extending to cingulum. Cingulum well developed and relatively thin. Finely granulose. Size 29-40 microns.

Sides gently convex. Anteriorly slightly raised. Very accentuated small area. (Fig. 11)

Subdivision (Larva) (Fig. 12)

White granular, opaque and thin (Fig. 12)

Genus *Lyospora* (Gibbs, 1950) and *Lyospora* (Gibbs, 1950)

and *Lyospora* (Gibbs, 1950)

Spores triflate, radial, round to subtriangular in transverse

plane. Triflate rays distinct and relatively strong, almost to

margin of spore wall. Some have a distinct circular area

appears as a circular ring in cross section. Spore wall is

levigate, granular or minutely reticulate.

Lyospora sp. 12a

Fig. 12, 12a, 12b

Triflate, radial, subtriangular to subcircular. Triflate

mark prominent and extends to circular. Triflate rays are

have tips. Small areas fairly close to center and on circular

Circular well developed and moderately strong. Sides convex.

Size 4.5-5.5 microns.

Lyospora sp. 12b

Fig. 12, 12c, 12d

Triflate, radial, circular to subcircular. Triflate rays

strong, distinct, extending to circular. Circular well

developed and relatively strong. Triflate granular. Size

2.5-4.0 microns.

Genus Cadiospora Kosanke 1950

Spores trilete, radial, circular to subcircular. Trilete rays divide at termini to form arcuate ridges. Cingulum well developed, wide, and dark. Lips thick and prominent. Spore coat thick. Spore coat may be levigate, granulose or finely spinose.

Cadiospora sp. 141

Pl. 4, fig. 11

Trilete, radial, circular to subcircular. Trilete rays strongly developed with wide lips. Rays diverge at termini into arcuate ridge. Spore coat levigate. Cingulum strong, dark, wide. Size 85-99 microns.

Cadiospora sp. 144

Pl. 4, fig. 12;

Pl. 5, fig. 1

Trilete, radial, subcircular. Trilete rays strong with extremely prominent lips. Cingulum dark and broad. Very large granules on exine. Size 100-112 microns.

Genus Simozonotriletes (Naumova 1937) Potonié and Kremp 1954

Spores trilete, radial, subtriangular. Trilete rays extremely sharp reaching more or less to the cingulum. Cingulum broad and smooth, broader at corners. Exine levigate or very finely granulose.

Simozonotriletes sp. 149

Pl. 5, fig. 2

Spores trilete, radial, circular to subcircular. Trilete rays divide at vertex into four angles. Spores developed, wide, and dark. Spores smooth and granular. Spores coat thick. Spores from the leaf surface, granular or finely spinose.

Leptotheca sp. 193
 Pl. 1, fig. 193

Trilete, radial, circular to subcircular. Trilete rays strongly developed with slight rays divide at vertex into acute ridge. Spores coat developed. Spores smooth, dark, wide. Size 85-95 microns.

Leptotheca sp. 194
 Pl. 1, fig. 194
 Pl. 2, fig. 194

Trilete, radial, subcircular. Trilete rays very ex- tremely prominent. Spores circular, dark, and broad. Spores granules on exine. Size 100-115 microns.

Genus *Stenocarpium* (Mastig. 1937) *Stenocarpium* sp. 195
 Spores trilete, radial, subcircular. Trilete rays ex- tremely sharp reaching more or less to the margin. Trilete broad and smooth, smooth to coarse. Exine levigate or very finely granular.

Stenocarpium sp. 195
 Pl. 2, fig. 195

Trilete, radial, subtriangular. Trilete rays very sharp extending almost to cingulum. Cingulum is broad, smooth, and slightly thicker at apices. Sides slightly concave to slightly convex. Levigate. Size 35-37 microns.

Simozonotriletes sp. 152

Pl. 5, fig. 3

Trilete, radial, subtriangular. Trilete mark very sharp extending almost to cingulum. Cingulum 6 microns wide. Sides slightly convex. Levigate. Size 56-58 microns.

Genus Densosporites (Berry 1937) Potonié and Kremp 1954

Spores trilete, radial, subtriangular. Trilete mark indistinct to prominent often extending into cingulum. Exine thin in polar regions becoming much thicker toward the equator forming a massive, dark, sometimes opaque cingulum. Spore coat and cingulum may be levigate, granulose, or spinose. Spore coat always characterized by thin proximal-distal portion and much thicker equatorial portion.

Densosporites sp. 157

Pl. 5, fig. 4

Trilete, radial, subtriangular. Trilete mark distinct to indistinct, extending into cingulum. Cingulum 22-26 microns wide. Exine levigate over-all. Sides gently convex. Size 44-46 microns.

Trilete, radial, subtriangular. Trilete mark very distinct
tending almost to straight. Subtriangular mark, subtriangular
slightly thicker at base. Trilete mark very distinct.
slightly convex. Diameter 15-20 microns.

Hammatosporium sp. 122

Fig. 2, 122, 1-2

Trilete, radial, subtriangular. Trilete mark very weak
extending almost to straight. Subtriangular mark, subtriangular
slightly convex. Diameter 15-20 microns.
Genus *Hammatosporium* (Hammer) P. Karst. and Karst 1927

Spores trilete, radial, subtriangular. Trilete mark indistinct
to prominent often extending into straight. Exine thin
polar region becoming more distinct toward the apical region
a massive, dark, sometimes opaque ornament. Spore wall and
exine may be levigate, granular or spinose. Spores are
always characterized by this granular-thickened portion and more
thicker equatorial portion.

Hammatosporium sp. 123

Fig. 2, 123, 1-2

Trilete, radial, subtriangular. Trilete mark distinct
distinct, extending into straight. Subtriangular mark, subtriangular
wide. Exine levigate smooth. Spores greatly convex. Size
14-16 microns.

Suite Zonati Potonie and Kremp 1954

Genus Cirratriradites Wilson and Coe 1940

Spores trilete, radial, circular to subtriangular, flanged. Trilete rays strong often extending into flange. Flange usually relatively broad, frequently radially striate and is definitely thinner and more translucent than the spore body. Spore body may be spinose or granulose.

Cirratriradites sp. 161

Pl. 5, fig. 5

Trilete, radial, circular to subcircular. Trilete rays distinct extending into flange. Finely granulose over-all. Flange translucent, light colored and sometimes radially striated. Size of central body 55-60 microns, over-all size 84-88 microns.

Division Monoletes Ibrahim 1933

Subdivision Azonomonoletes Lubert 1935

Genus Laevigatosporites Ibrahim 1933

Spores monolete, bilateral, bean-shaped to oval. Suture always monolete and linear, $1/2$ to $3/4$ the length of the spore, may be inconspicuous if it coincides with edge of compressed spore. Ornamentation always levigate. Folding may occur.

Laevigatosporites sp. 163

Pl. 5, fig. 6

Monolete, bilateral, bean-shaped. Exine thin. Size 17×24 microns (average).

Spores monile, rounded, smooth, hyaline, 1-2 microns.

Spores monile, rounded, smooth, hyaline, 1-2 microns.

Spores trilete, rounded, smooth, hyaline, 1-2 microns.

Trilete rays narrow, often extending into flange.

Usually relatively smooth, frequently with small warts and

definitely thinner and more abundant than the spore body.

Spore body may be rounded or flattened.

Trilete, rounded, smooth, hyaline, 1-2 microns.

Trilete, rounded, smooth, hyaline, 1-2 microns.

Trilete, rounded, smooth, hyaline, 1-2 microns.

Since extending into flange, this is generally smooth.

Flange translucent, 1-2 microns, and sometimes reddish.

Striated. Size of central body 2-3 microns, overall 3-4

84-88 microns.

Division monile, rounded, hyaline, 1-2 microns.

Subdivision monile, rounded, hyaline, 1-2 microns.

Spores monile, rounded, hyaline, 1-2 microns.

Spores monile, rounded, hyaline, 1-2 microns.

Always monile and linear, 2-3 microns, and 1-2 microns.

Spore, may be monile, 2-3 microns, and 1-2 microns.

pressed spore, 2-3 microns, and 1-2 microns.

occur.

Monile, rounded, smooth, hyaline, 1-2 microns.

Monile, rounded, smooth, hyaline, 1-2 microns.

Monile, rounded, smooth, hyaline, 1-2 microns.

microns (average).

Laevigatosporites sp. 166

Pl. 5, fig. 7

Monolete, bilateral, oval to bean-shaped. Levigate. May be folded. Size 38 x 70 microns (average).

Genus Monoletes (Ibrahim 1933) Schopf, Wilson, and Bentall 1944

Spores monolete, bilateral, elliptical to rounded lenticular in outline as viewed from proximal side. Relatively large--100 microns to 1/2 millimeter in length. Usually minutely granulose but may appear smooth at low magnification. When closed the suture is very narrow linear groove, lip area may be slightly raised. Most noteworthy diagnostic feature is slight angular deflection of suture line near the middle. This may be hard to detect but is thought to be universally present.

Monoletes sp. 231

Pl. 5, figs. 8, 9

Monolete, bilateral, elliptical. Levigate. Size 158 x 275 microns (average)

Pollenites R. Potonié 1931

Division Saccites Erdtmann 1947

Subdivision Monosaccites Chitaley 1951

Genus Endosporites Wilson and Coe 1940

Spores trilete, radial, elliptical in transverse plane, round to oval or elliptical or slightly triangular in axial plane. Trilete rays distinct and commonly extend to periphery of body and thickened continuations from them may extend into the bladder. Lips may be upraised and definite. Bladder is

Monolete, bifurcate, elliptical, 10-12 x 5-6 microns (average)

be folded. Size 5-6 x 10-12 microns (average)

Genus Monolete (Lewy 1937) Monolete, bifurcate, elliptical, 10-12 x 5-6 microns (average)

Spores monolete, bifurcate, elliptical, 10-12 x 5-6 microns (average)

in outline as viewed from proximal end. Apically slightly

100 microns to 1-2 millimeter in length. Width 10-12 microns

granulose but may appear smooth after sectioning. Spores

closed the surface is very narrow. In some species, the surface

be slightly raised. Most monolete spores are 10-12 microns in

slight angular distortion of surface. Some are 10-12 microns in

may be hard to detect. But in some cases, the surface is

Monolete, bifurcate, elliptical, 10-12 x 5-6 microns (average)

Monolete, bifurcate, elliptical, 10-12 x 5-6 microns (average)

Monolete, bifurcate, elliptical, 10-12 x 5-6 microns (average)

microns (average)

Monolete, bifurcate, elliptical, 10-12 x 5-6 microns (average)

Division of the genus Monolete

Monolete, bifurcate, elliptical, 10-12 x 5-6 microns (average)

Monolete, bifurcate, elliptical, 10-12 x 5-6 microns (average)

Spores trilete, radial, elliptical, 10-12 x 5-6 microns (average)

to oval or elliptical. The surface is slightly granular. In some

Trilete rays distinct and somewhat extended to periphery of

body and thicken at the poles. In some cases, the surface is

the bladder. This may be a result of the method of fixation.

thin and translucent. The body is thicker and not translucent. Spore body usually less than $1/2$ the total diameter. Bladders are levigate, granulose, punctate or reticulate internally. Bladder ornamentation may appear to be superimposed on the body. Body levigate, punctate, or finely granulose.

Endosporites sp. 183

Trilete, radial, circular to subcircular. Trilete mark small and indistinct. Bladder finely infrareticulate. Body commonly folded. Over-all size 126 microns.

Endosporites sp. 185

Pl. 5, fig. 10

Trilete (?), broadly elliptical. Central body opaque, irregularly shaped, folded small (34 microns). Body levigate. Bladder folded, infrareticulate. Over-all size 70 x 106 microns.

Endosporites sp. 186

Pl. 6, fig. 1

Trilete, radial, circular to subcircular. Trilete rays prominent, distinct, and may extend into bladder. Bladder thin, translucent, and infrareticulate, body dark and levigate. Bladder tends to be folded. Size of body 30-48 microns, over-all size 63-116 microns.

Endosporites sp. 190

Pl. 6, fig. 2

Trilete, radial, circular to subcircular. Trilete rays indistinct and extend to periphery of body. Body and bladder

thin and translucent. The body is elongated and spindle-shaped. Spore body usually is 2-3 times as long as wide. Spores are fusiform, sometimes, more or less, slightly curved. Bladder sometimes very prominent, but often not so. Body body, body fusiform, sometimes, or little, or none.

Trilete, radial, circular or subcircular. Trilete, circular and indistinct. Bladder often very prominent, but often not so. Folded. Over-all size 10-15 microns.

Trilete (1), broad, elliptical. Central body elongated, regularly curved, folded, usually 10-15 microns. Body fusiform. Bladder folded, indistinct. Over-all size 10-15 microns.

Trilete, radial, circular or subcircular. Trilete very prominent, distinct, and may extend into bladder. Bladder thin, translucent, and indistinct. Body oval and spindle-shaped. Bladder rarely so distinct. Size of body varies, sometimes all size 10-15 microns.

Trilete, radial, circular or subcircular. Trilete very distinct and extends to periphery of body. Body and bladder

finely granulose. Over-all size 60-70 microns, body 32-34 microns.

Endosporites sp. 278

Pl. 6, fig. 3

Trilete, radial, subcircular. Trilete rays indistinct. Levigate. Bladder and body of approximately equal thickness. Over-all size 31-36 microns, body 17 microns.

Genus Florinites Schopf, Wilson, and Bentall 1944

Pollen trilete, apparently bilateral, broadly elliptical in outline. Trilete mark may be absent, faint, or indistinct. Body spherical and enclosed by a bladder except for a portion of the distal side. Body generally marked by sharp folds especially around periphery. Body levigate, granulose, punctate. Bladder externally levigate or granulose, internally reticulate.

Florinites sp. 195

Trilete mark absent, broadly elliptical. Bladder infra-reticulate. Long axis of flattened body coincides with short axis of flattened bladder. Over-all size 45 x 55 microns, size of body 30 x 38 microns.

Florinites sp. 196

Pl. 6, figs. 4, 5

Trilete mark absent, broadly elliptical. Body subcircular. Long axis of flattened body corresponds to short axis of flattened bladder. Exine levigate. Over-all size 80 x 106 microns, size of body 60 x 68 microns.

finely granular. Over-all size 30-40 microns, body 25-30 microns.

Leptocryptus sp. n.

Pl. 31, fig. 1

Triflate, radial, conical. Triflate and body of a triflate. Levigate. Bladder and body of a triflate. Over-all size 21-25 microns, body 15 microns.

Genus *Leptocryptus* sp. n.

Pollen triflate, apparently spherical, broadly elliptical in outline. Triflate mark may be absent. Levate, or indented. Body spherical and enclosed by a thin membrane for a portion of the distal side. Body generally covered by sharp spines, especially around periphery. Body levigate, granular. Levate. Bladder extremely levigate or granular. Laterally reticulate.

Leptocryptus sp. n.

Triflate mark absent, broadly elliptical. Bladder laterally reticulate. Long axis of flattened body coincides with short axis of flattened bladder. Over-all size 25 x 15 microns, size of body 20 x 10 microns.

Leptocryptus sp. n.

Pl. 31, fig. 2

Triflate mark absent, broadly elliptical. Body conical. Long axis of flattened body coincides with short axis of flattened bladder. Over-all size 25 x 15 microns, size of body 20 x 10 microns.

Florinites (?) sp. 199

Pl. 6, fig. 6

Trilete, broadly elliptical. Trilete mark absent. Body levigate, bladders coarsely infrareticulate. Short axis of body corresponds with short axis of bladder. Over-all size 70 x 110 microns, size of body 47 x 78 microns.

Subdivision Disaccites Cookson 1947

Genus Illinites Kosanke 1950

Prepollen, trilete, radial, over-all shape viewed proximally or distally is oval to elliptical. Disaccate. Trilete rays usually small and indistinct. Body ornamentation is levigate or granulose. Bladders are levigate externally and coarsely punctate to reticulate internally.

Illinites sp. 205

Pl. 6, fig. 7

Trilete, radial, elliptical. Trilete mark distinct or indistinct and extends to periphery of body. Body levigate, bladders infrareticulate. Bladders overlap body to form two darkened areas. Over-all size 48 x 60 microns, size of body 31 x 45 microns.

Trilobes

Fig. 1

Trilobes, broadly elliptical. Trilobes with slender body. Levigate, blades are especially in ventral part. Body corresponds with shape of trilobes. Over-all size of body 70 x 110 microns, size of body 25 x 35 microns.

Radial trilocular trilobes

Fig. 2

Prepolifer, trilobes, radial, over-all size varied greatly. or distally is oval to elliptical. Distal part usually small and indistinct. Body ornamentation is levigate or granulose. Blades are levigate externally and granulate internally. Distal part is granulate internally.

Trilobes

Fig. 3

Trilobes, radial, elliptical. Trilobes with slender body. Distinct and extends to periphery of body. Body levigate. Blades intraventricular. Blades extending distally and darkened areas. Over-all size 60 x 80 microns, size of body 31 x 45 microns.

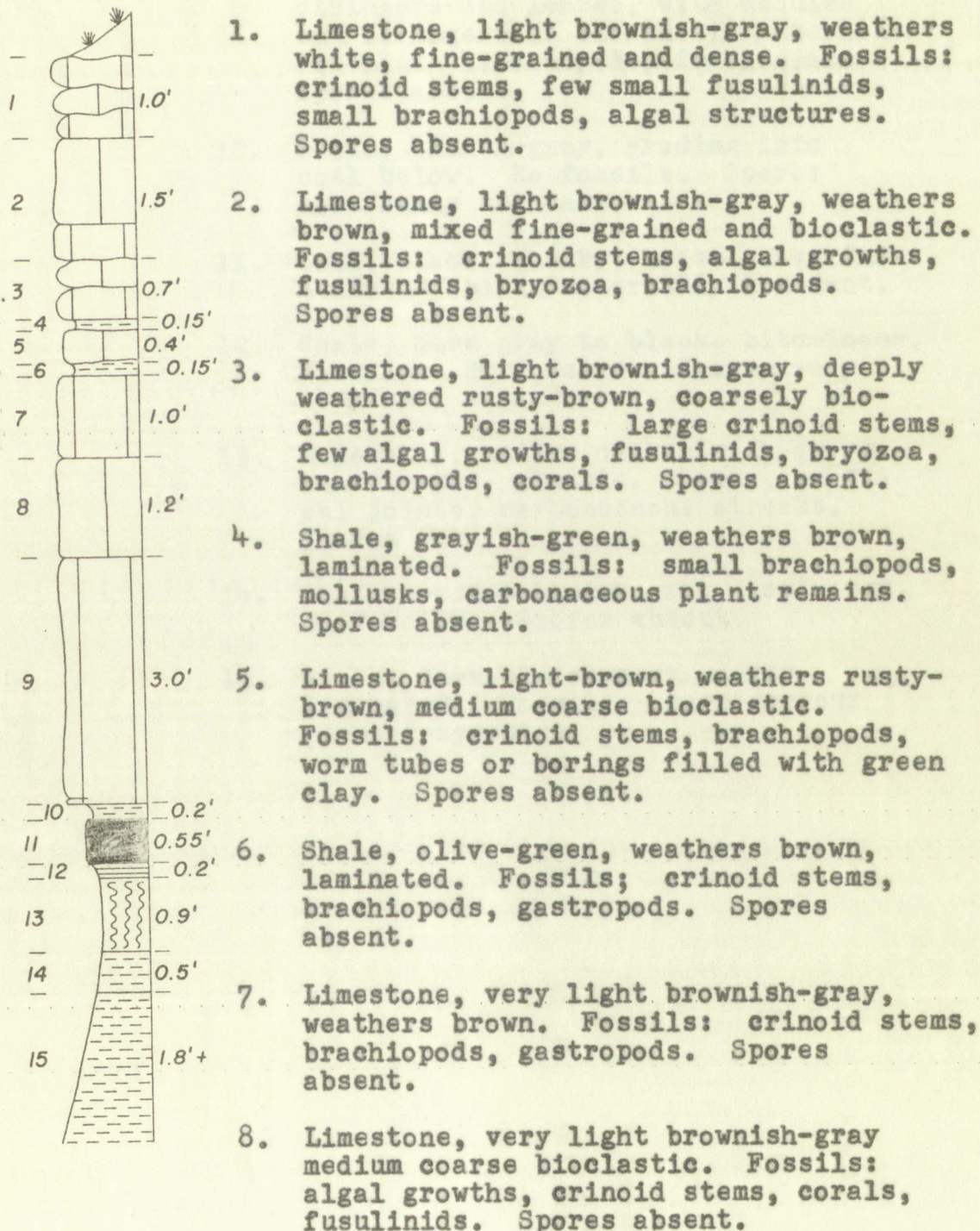
SPORE COUNTS AND LITHOLOGIC DESCRIPTIONS

The following pages contain detailed lithologic descriptions and the exact location of each locality and core sampled. The lithologic descriptions were done in the field by Dr. J. M. Parks, Jr. and Mr. Jesse B. Pogue, Jr. Following each lithologic description is a detailed species count of the spores found in the rock samples from that particular locality or core.

LOCALITY 1A

CNL NW1/4sec. 35, T. 25 S., R. 13 E., Woodson County, Kansas

(Roadcut on east-west U. S. Highway 54, near Woodson-Greenwood County line)



LOCALITY 13

CHL NW 1/4 sec. 35, T. 35 N., R. 13 E., Johnson County, Kansas
(Roadcut on east-west U.S. Highway 50, near Woodson-Graham
County line)

1.	limestone, light brownish-gray, weathered white, thin-bedded and fossiliferous, fossiliferous, low angle (vertical), small brachiopods, slight irregularities.	10
2.	limestone, light brownish-gray, weathered brown, thin-bedded and chalciditic, fossiliferous, small brachiopods, small brachiopods.	11
3.	limestone, light brownish-gray, heavily weathered rusty-brown, coarsely chalciditic, fossiliferous, large oolitic areas, low angle (vertical), brachiopods, brachiopods, corals, corals present.	12
4.	shale, grayish-green, weathered brown, laminated, fossiliferous, small brachiopods, mollusks, corals, corals present.	13
5.	limestone, light-brown, weathered rusty-brown, medium coarse chalciditic, fossiliferous, small brachiopods, small brachiopods or corals filled with green clay, corals present.	14
6.	shale, olive-green, weathered brown, laminated, fossiliferous, small brachiopods, brachiopods, gastropods, corals present.	15
7.	limestone, very light brownish-gray, weathered brown, fossiliferous, small brachiopods, brachiopods, gastropods, corals present.	16
8.	limestone, very light brownish-gray, medium coarse chalciditic, fossiliferous, small brachiopods, small brachiopods, corals, corals present.	17

LOCALITY 1A

9. Limestone, light-gray to brownish-gray, darker-colored "argillaceous" stringers and lenses, with nodules and stringers of bioclastic material. Fossils: brachiopods, fusulinids. Spores absent.
10. Shale, bluish-gray, grading into coal below. No fossils. Spores moderately abundant.
11. Coal, black, chunky, brittle, sulfur stains. Spores moderately abundant.
12. Shale, dark gray to black, bituminous, fissile. No fossils. Spores very abundant.
13. Underclay, medium dark bluish-gray, unlaminated, plastic, blocky, vertical joints, carbonaceous streaks. Spores rare.
14. Shale, medium bluish-gray, laminated. No fossils. Spores absent.
15. Shale, dark bluish-gray poorly laminated. Fossils: carbonaceous plant fragments.

UNITED STATES

9. Shale, light-gray to brownish-gray, somewhat silty, fossiliferous, especially in the lower part. Fossils: small, rounded, smooth-surfaced, light-colored, abundant.
10. Shale, light-gray, somewhat silty, fossiliferous, especially in the lower part. Fossils: small, rounded, smooth-surfaced, light-colored, abundant.
11. Coal, black, somewhat silty, fossiliferous, especially in the lower part. Fossils: small, rounded, smooth-surfaced, light-colored, abundant.
12. Shale, dark gray to black, silty, fossiliferous, especially in the lower part. Fossils: small, rounded, smooth-surfaced, light-colored, abundant.
13. Unconformity, medium-dark gray to black, silty, fossiliferous, especially in the lower part. Fossils: small, rounded, smooth-surfaced, light-colored, abundant.
14. Shale, medium gray to black, silty, fossiliferous, especially in the lower part. Fossils: small, rounded, smooth-surfaced, light-colored, abundant.
15. Shale, dark gray to black, silty, fossiliferous, especially in the lower part. Fossils: small, rounded, smooth-surfaced, light-colored, abundant.

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TABLE IV - Number of species present in each stratum

Stratum	Number of species present				
	1	2	3	4	5
1	1	1	1	1	1
2	1	1	1	1	1
3	1	1	1	1	1
4	1	1	1	1	1
5	1	1	1	1	1
6	1	1	1	1	1
7	1	1	1	1	1
8	1	1	1	1	1
9	1	1	1	1	1
10	1	1	1	1	1
11	1	1	1	1	1
12	1	1	1	1	1
13	1	1	1	1	1
14	1	1	1	1	1
15	1	1	1	1	1
16	1	1	1	1	1
17	1	1	1	1	1
18	1	1	1	1	1
19	1	1	1	1	1
20	1	1	1	1	1
21	1	1	1	1	1
22	1	1	1	1	1
23	1	1	1	1	1
24	1	1	1	1	1
25	1	1	1	1	1
26	1	1	1	1	1
27	1	1	1	1	1
28	1	1	1	1	1
29	1	1	1	1	1
30	1	1	1	1	1
31	1	1	1	1	1
32	1	1	1	1	1
33	1	1	1	1	1
34	1	1	1	1	1
35	1	1	1	1	1
36	1	1	1	1	1
37	1	1	1	1	1
38	1	1	1	1	1
39	1	1	1	1	1
40	1	1	1	1	1
41	1	1	1	1	1
42	1	1	1	1	1
43	1	1	1	1	1
44	1	1	1	1	1
45	1	1	1	1	1
46	1	1	1	1	1
47	1	1	1	1	1
48	1	1	1	1	1
49	1	1	1	1	1
50	1	1	1	1	1
51	1	1	1	1	1
52	1	1	1	1	1
53	1	1	1	1	1
54	1	1	1	1	1
55	1	1	1	1	1
56	1	1	1	1	1
57	1	1	1	1	1
58	1	1	1	1	1
59	1	1	1	1	1
60	1	1	1	1	1
61	1	1	1	1	1
62	1	1	1	1	1
63	1	1	1	1	1
64	1	1	1	1	1
65	1	1	1	1	1
66	1	1	1	1	1
67	1	1	1	1	1
68	1	1	1	1	1
69	1	1	1	1	1
70	1	1	1	1	1
71	1	1	1	1	1
72	1	1	1	1	1
73	1	1	1	1	1
74	1	1	1	1	1
75	1	1	1	1	1
76	1	1	1	1	1
77	1	1	1	1	1
78	1	1	1	1	1
79	1	1	1	1	1
80	1	1	1	1	1
81	1	1	1	1	1
82	1	1	1	1	1
83	1	1	1	1	1
84	1	1	1	1	1
85	1	1	1	1	1
86	1	1	1	1	1
87	1	1	1	1	1
88	1	1	1	1	1
89	1	1	1	1	1
90	1	1	1	1	1
91	1	1	1	1	1
92	1	1	1	1	1
93	1	1	1	1	1
94	1	1	1	1	1
95	1	1	1	1	1
96	1	1	1	1	1
97	1	1	1	1	1
98	1	1	1	1	1
99	1	1	1	1	1
100	1	1	1	1	1

LOCALITY 1B

Resampled and collected later adjacent to Locality 1A.

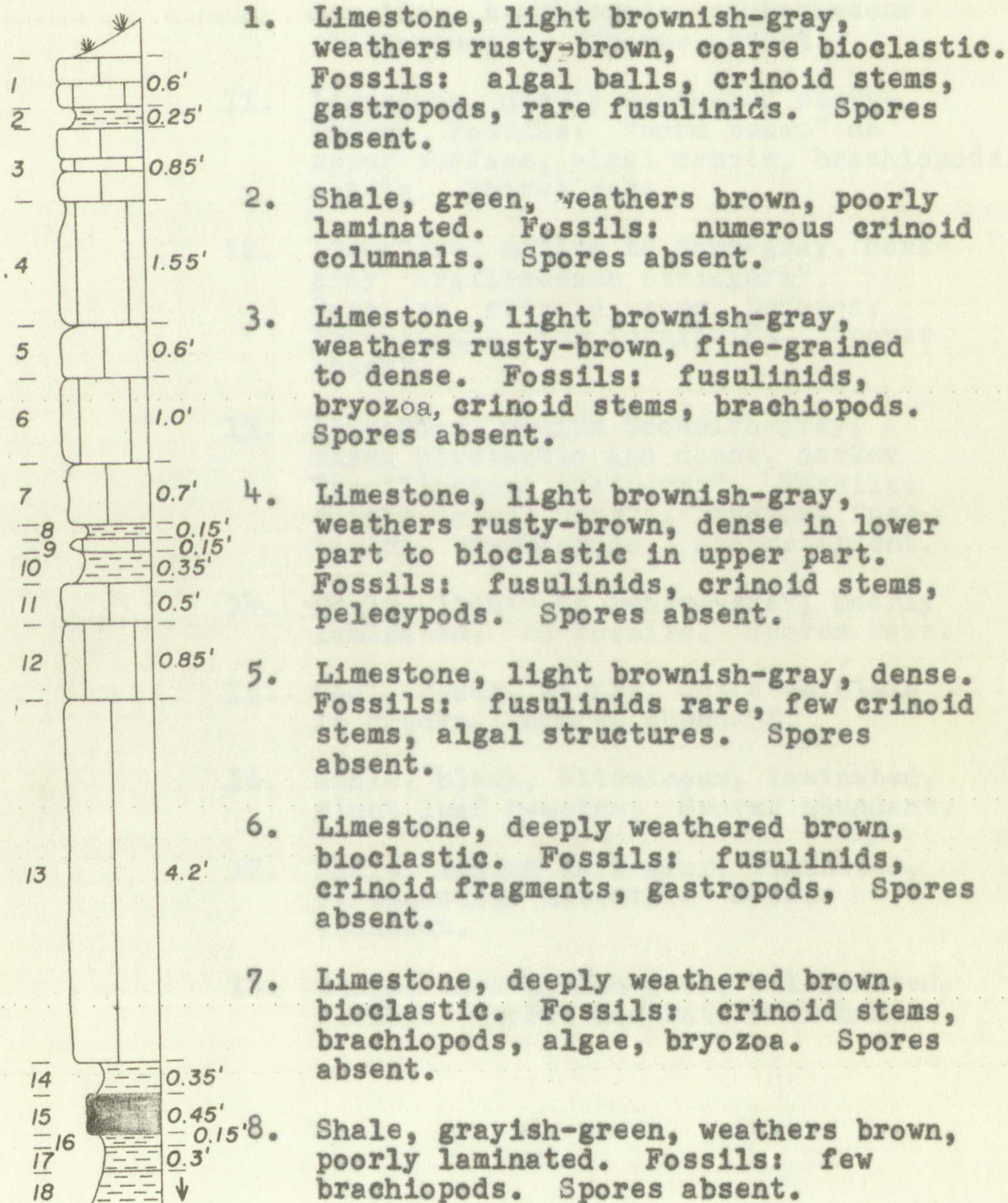
Lithologic descriptions same as 1A.

- 10. Spores moderately abundant.
- 11. Spores moderately abundant.
- 12. Spores very abundant.
- 13. Spores rare.

LOCALITY 2

NE1/4SW1/4sec. 10, T. 26 S., R. 13 E., Greenwood County, Kansas

(Roadcut and small quarry east of road and south of railroad, approximately 2.5 miles south of U. S. Highway 54)



LOCALITY 2

NE 1/4 Sec. 10, T. 20 N., R. 13 E., Greenwood County, Kansas

(Roadcut and small quarry east of road at south of railroad, approximately 1/2 mile south of U.S. Highway 79)

1.	Limestone, light brownish-gray, weathered rusty-brown, coarse bicolored. Fossils: small bryozoan, crinoid stems, gastropods, rare bryozoa. Poros absent.	1
2.	Shale, green, weathered brown, poorly laminated. Fossils: numerous crinoid columns, bryozoa. Poros absent.	2
3.	Limestone, light brownish-gray, weathered rusty-brown, fine-grained. Fossils: bryozoa, crinoid stems, brachiopods. Poros absent.	3
4.	Limestone, light brownish-gray, weathered rusty-brown, dense in lower part to bicolored in upper part. Fossils: bryozoa, crinoid stems, brachiopods. Poros absent.	4
5.	Limestone, light brownish-gray, dense. Fossils: bryozoa, crinoid stems, brachiopods. Poros absent.	5
6.	Limestone, darkly weathered brown, bicolored. Fossils: bryozoa, crinoid stems, gastropods. Poros absent.	6
7.	Limestone, darkly weathered brown, bicolored. Fossils: crinoid stems, brachiopods, bryozoa. Poros absent.	7
8.	Shale, grayish-green, weathered brown, poorly laminated. Fossils: few brachiopods. Poros absent.	8

LOCALITY 2

9. Limestone, deeply weathered dark-brown, bioclastic. Fossils: crinoid stems, brachiopods. Spores absent.
10. Shale, olive-green, poorly laminated. Fossils: brachiopods, carbonaceous plant remains. Spores absent.
11. Limestone, deeply weathered rusty-brown. Fossils: "worm tubes" on upper surface, algal crusts, brachiopods, corals. Spores rare.
12. Limestone, medium to dark-gray, dark-gray "argillaceous stringers". Fossils: crinoid stems, bryozoa, brachiopods, few fusulinids. Spores absent.
13. Limestone, medium brownish-gray, mixed bioclastic and dense, darker "argillaceous stringers". Fossils: corals, algal crusts, bryozoa, fusulinids, brachiopods. Spores absent.
14. Shale, light- to medium-gray, poorly laminated. No fossils. Spores rare.
15. Coal, black, chunky, white veinlets in cracks. Spores abundant.
16. Shale, black, bituminous, laminated, plant leaf remains. Spores abundant.
17. Shale, medium dark-gray, laminated, carbonaceous material. Spores abundant.
18. Shale, dark bluish-gray, unlaminated, blocky. Spores moderately abundant.

LOCALITY 2

9. Limestone, heavily weathered, thin-bedded, micaceous, fossiliferous, corals abundant.
10. Shale, olive-grey, coarsely laminated, fossiliferous, corals abundant, plant remains, corals abundant.
11. Limestone, heavily weathered, thin-bedded, micaceous, fossiliferous, corals abundant, upper surface, slightly irregular, corals abundant.
12. Limestone, nodular, thin-bedded, micaceous, fossiliferous, corals abundant, upper surface, slightly irregular, corals abundant.
13. Limestone, thin-bedded, micaceous, fossiliferous, corals abundant, upper surface, slightly irregular, corals abundant.
14. Shale, thin-bedded, micaceous, fossiliferous, corals abundant, upper surface, slightly irregular, corals abundant.
15. Sand, fine-grained, micaceous, fossiliferous, corals abundant, upper surface, slightly irregular, corals abundant.
16. Shale, thin-bedded, micaceous, fossiliferous, corals abundant, upper surface, slightly irregular, corals abundant.
17. Shale, thin-bedded, micaceous, fossiliferous, corals abundant, upper surface, slightly irregular, corals abundant.
18. Shale, thin-bedded, micaceous, fossiliferous, corals abundant, upper surface, slightly irregular, corals abundant.

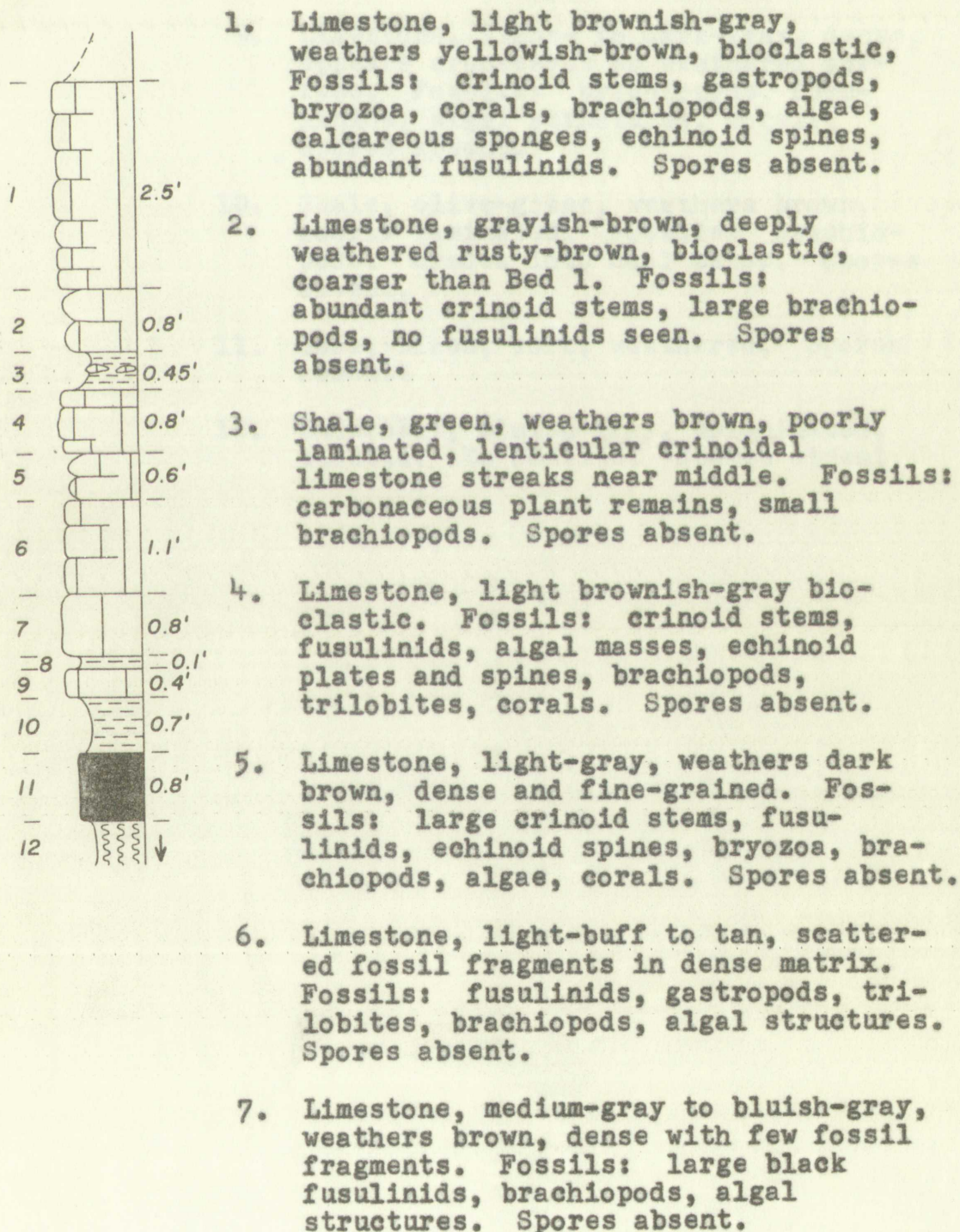
Locality 2 - Number of spores present in each stratigraphic unit

Stratigraphic Unit	Lithology	Triguitrites sp. 128	Lycospora sp. 138	Cadlospora sp.	Cadlospora sp. 141	Cadlospora sp. 144	Stimozonotriletes sp. 152	Cirratriletes sp. 161	Laevigatosporites sp. 163	Laevigatosporites sp. 166	Endosporites sp. 186	Florinites sp. 199	Acanthotriletes sp. 290							
11	Limestone					1					1									
14	Shale		3	1				1			1	1								
15	Coal									53	92		1							
16	Shale				114	2				55	4									
17	Shale	1				227	2		16	18	7									
18	Shale	1	48		2	8				4	1									

LOCALITY 3

CSL SW1/4sec. 33, T. 26 S., R. 13 E., Greenwood County, Kansas

(Roadcut in north-south mid-section road, approximately 8.5 miles south of U. S. Highway 54)

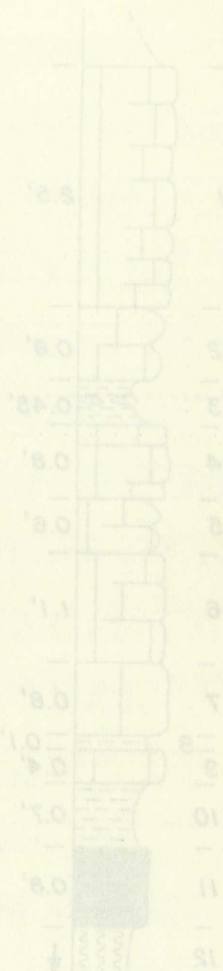


LOCALITY 3

Sec. 33, T. 26 S., R. 13 E., Greenwood County, Kansas

(Roadcut in north-south mid-section road, approximately 8.5 miles south of U. S. Highway 54)

1. Limestone, light brownish-gray, weathers yellowish-brown, biohermal. Fossils: crinoid stems, gastropods, bryozoa, corals, brachiopods, algae, calcareous sponges, echinoid spines, abundant fusulinids. Spores absent.
2. Limestone, grayish-brown, deeply weathered rusty-brown, biohermal. Coarser than Bed 1. Fossils: abundant crinoid stems, large brachiopods, no fusulinids seen. Spores absent.
3. Shale, green, weathers brown, poorly laminated, lenticular crinoidal. Limestone streaks near middle. Fossils: carbonaceous plant remains, small brachiopods. Spores absent.
4. Limestone, light brownish-gray, biohermal. Fossils: crinoid stems, fusulinids, algal masses, echinoid plates and spines, brachiopods, trilobites, corals. Spores absent.
5. Limestone, light-gray, weathers dark brown, dense and fine-grained. Fossils: large crinoid stems, fusulinids, echinoid spines, bryozoa, brachiopods, algae, corals. Spores absent.
6. Limestone, light-buff to tan, weathered fossil fragments in dense matrix. Fossils: fusulinids, gastropods, trilobites, brachiopods, algal structures. Spores absent.
7. Limestone, medium-gray to bluish-gray, weathers brown, dense with few fossil fragments. Fossils: large black fusulinids, brachiopods, algal structures. Spores absent.

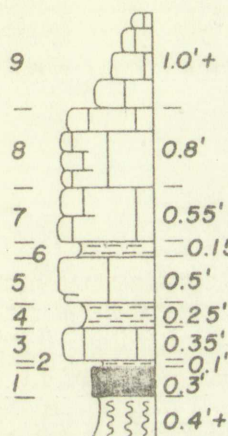


LOCALITY 3

8. Shale, olive-green, weathers brown, nodular calcareous streaks. No fossils seen. Spores absent.
9. Limestone, light- to dark-gray, dense, appears arenaceous on weathered surface. Fossils: brachiopods, fusulinids, algal structures, corals. Spores absent.
10. Shale, olive-green, weathers brown, poorly laminated. Fossils: brachiopods. Grades into coal below. Spores absent.
11. Coal, black, soft, weathered. Spores absent.
12. Underclay, bluish-gray, unlaminated, plastic. No fossils. Spores absent.

LOCALITY 3A

SW1/4sec. 4, T. 27 S., R. 13 E., Greenwood County, Kansas

(Dry falls in intermittent stream approximately
1/4 mile east of road)

Units in reverse order as overlying control beds were missing and collectors worked from the bottom up.

9. Limestone, light, brownish-gray, weathers brown, dense matrix, little bioclastic material. Fossils: few fusulinids, crinoid stems, no corals. Spores absent.
8. Limestone, light-tan, weathers tan, dense matrix. Fossils: profuse local development of colonial reef-building type syringoporoid corals, apparently in growth position. Spores absent.
7. Limestone, light brownish-gray, weathers tan, fine-grained, dense. Fossils: few corals, fusulinids. Spores absent.
6. Shale, olive-green, weathers brown, calcareous, poorly laminated. Fossils: abundant fusulinids, crinoid stems, brachiopods. Spores absent.
5. Limestone, light brownish-gray, weathers brown, fine-grained matrix, fine-textured bioclastic material. Fossils: fusulinids, crinoid stems, brachiopods, few corals. Spores absent.
4. Shale, olive-green, weathers brown, calcareous, poorly laminated. Fossils: abundant fusulinids, crinoid stems, brachiopods. Spores absent.
3. Limestone, light brownish-gray, weathers brown, dense. Fossils: fusulinids, brachiopods, crinoid stems. Spores absent.

LOCALITY

SW 1/4 sec. 4, T. 25 N., R. 13 E., Greenwood County, Kansas

(Dry falls in intermittent stream approximately 1/2 mile west of road)

Units in reverse order as overlying contact
beds were missing and collapsed toward
from the bottom up.

9. Limestone, light brownish-gray,
weather brown, dense matrix, little
dissected surface, fossiliferous.
Trachilasma, corals, etc.

8. Limestone, light tan, weather brown,
dense matrix, fossiliferous, probably local
development of original rock-building
type, corals, etc.

7. Limestone, light brownish-gray,
weather tan, fine-grained, dense,
fossiliferous, corals, etc.

6. Shale, olive-green, weather brown,
calcareous, poorly laminated, etc.
Trachilasma, corals, etc.

5. Limestone, light brownish-gray,
weather brown, fine-grained, matrix,
fine-textured disjunctive material,
fossiliferous, corals, etc.

4. Shale, olive-green, weather brown,
calcareous, poorly laminated, etc.
Trachilasma, corals, etc.

3. Limestone, light brownish-gray,
weather brown, dense, fossiliferous,
Trachilasma, corals, etc.

LOCALITY 3A

2. Shale, dark-gray, laminated. Fossils: coalified plant remains, few pelecypods. Spores present.
1. Coal, black, brittle, chunky. Under-clay, bluish-gray, unlaminated, plastic. This sample and sample 2 were mixed together.

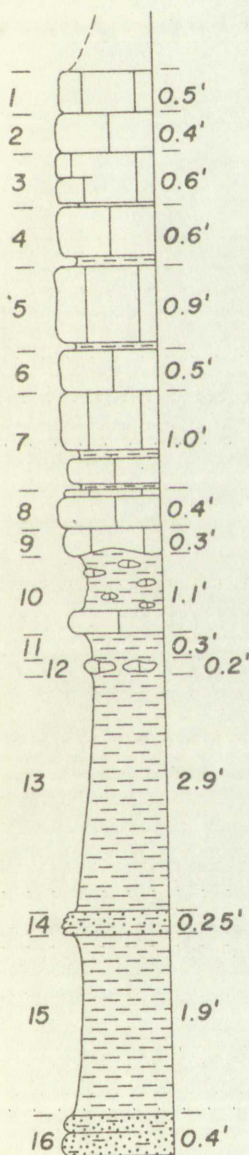
LOCATIONS

1. Coal, black, brittle, on river bank, clay, bluish-gray, siliceous, glassy. This sample is more like No. 2.
2. Coal, dark-gray, laminated, brittle, coalified plant remains, few glassy, black, present.

1902
JANUARY
GEORGETOWN
D. C.
1902

LOCALITY 4

CSL sec.29, T. 27 S., R. 13 E., Greenwood County, Kansas

(Roadcut on east-west section line road
approximately 5 miles north of Fall River)

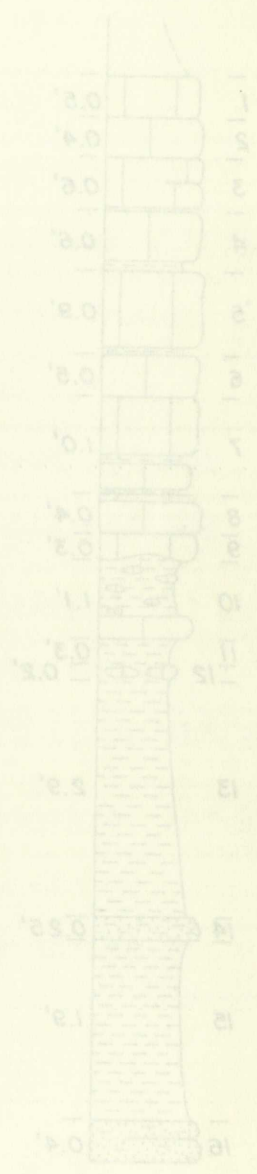
1. Limestone, light-tan, deeply weathered brown, medium fine-grained matrix, bioclastic. Fossils: shell fragments with algal coatings, fusulinids, brachiopods, crinoid stems, pelecypods. Spores absent.
2. Limestone, tan, deeply weathered brown, fine-grained. Fossils: abundant fusulinids, algal coatings on fossil fragments, crinoid stems, bryozoa. Spores absent.
3. Limestone, tan weathers brown, abundant shell detritus. Fossils: algal-coated shell fragments, algal balls, crinoid stems, abundant fusulinids, bryozoa, brachiopods. Spores absent.
4. Limestone, light grayish-tan, coarse textured bioclastic. Fossils: crinoid columnals, no fusulinids, encrusting bryozoa, brachiopods, gastropods. Spores absent.
5. Limestone, light brownish-gray, bioclastic. Fossils: small brachiopods, few fusulinids, bryozoa, crinoid stems, not much algal material. Spores absent.
6. Limestone, light brownish-gray, dense and fine-grained. Fossils: fusulinids, algal structures, calcareous sponge. Spores absent.
7. Limestone, light brownish-gray, dense and fine-grained. Fossils: fusulinids, few algal structures, brachiopods, fragment of trilobite. Spores absent.
8. Limestone, light-brown, coarse texture. Fossils: sparse fusulinids, algal balls, corals, crinoid stems, brachiopods. Spores absent.

LOCALITY

C&P sec. 29, T. 27 S., R. 13 E., Greenwood County, Kansas

(Roadcut on east-west section line road
approximately 5 miles north of Fall River)

1. Limestone, light-tan, deeply weathered brown, medium fine-grained matrix, bio-elastic. Fossils: shell fragments with algal coatings, fusulinids, brachiopods, crinoid stems, pelycypods. Spores absent.
2. Limestone, tan, deeply weathered brown, fine-grained. Fossils: abundant fusulinids, algal coatings on fossil fragments, crinoid stems, pyrozoa. Spores absent.
3. Limestone, tan weathers brown, abundant shell detritus. Fossils: algal-coated shell fragments, algal balls, crinoid stems, abundant fusulinids, pyrozoa, brachiopods. Spores absent.
4. Limestone, light grayish-tan, coarse textured bioelastic. Fossils: crinoid columns, no fusulinids, encrusting pyrozoa, brachiopods, gastropods. Spores absent.
5. Limestone, light brownish-gray, bio-elastic. Fossils: small brachiopods, few fusulinids, pyrozoa, crinoid stems, not much algal material. Spores absent.
6. Limestone, light brownish-gray, dense and fine-grained. Fossils: fusulinids, algal structures, calcareous sponges. Spores absent.
7. Limestone, light brownish-gray, dense and fine-grained. Fossils: fusulinids, few algal structures, brachiopods, fragment of trilobite. Spores absent.
8. Limestone, light-brown, coarse texture. Fossils: sparse fusulinids, algal balls, corals, crinoid stems, brachiopods. Spores absent.

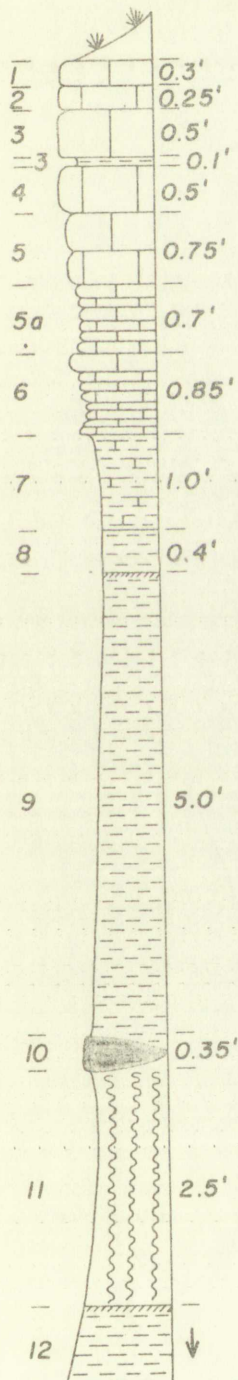


LOCALITY 4

9. Limestone, light brownish-gray, dense. Fossils: large fusulinids, large algal structures, gastropods, echinoid spines, crinoid stems, brachiopods. Spores absent.
10. Limestone, light brownish- to greenish-gray, soft, argillaceous, grades into shale. Fossils: abundant fusulinids, algal material, brachiopods. Spores absent.
11. Shale, green, poorly laminated. No fossils seen. Spores absent.
12. Limestone nodules, light greenish-gray, argillaceous. Fossils: fusulinids, algae, gastropods, corals. Spores absent.
13. Shale, olive-green, poorly laminated. No fossils seen. Spores absent.
14. Sandstone, olive-green, silty. No fossils seen. Spores absent.
15. Shale, olive-green, poorly laminated. No fossils seen. Spores absent.
16. Sandstone, greenish-brown, fine-grained. No fossils seen. Spores absent.

LOCALITY 5

SL NE1/4sec. 36, T.28 S., R. 12 E., Elk County, Kansas

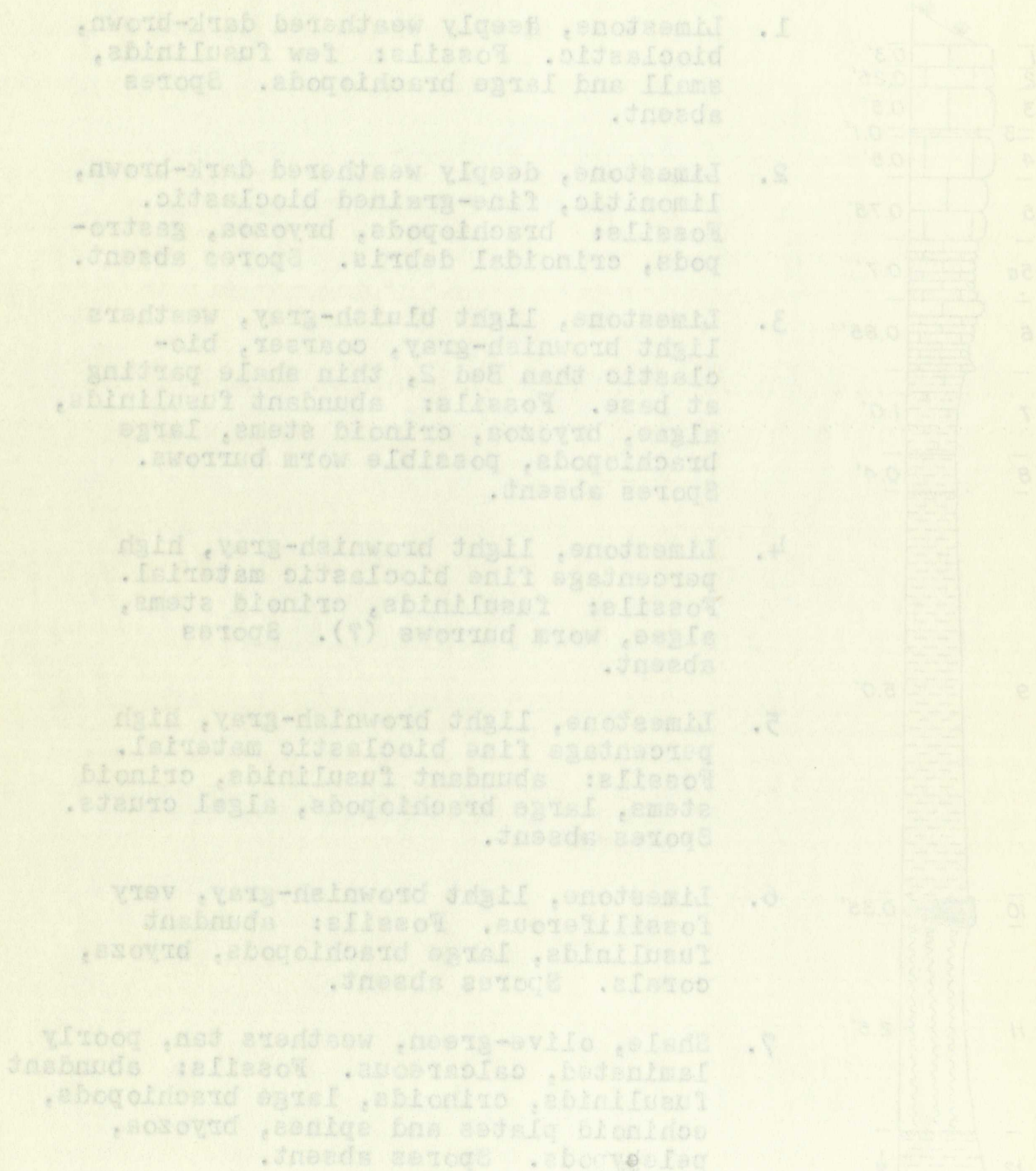
(Roadcut on east-west road, approximately
2.7 miles south of Fall River, Kansas)

1. Limestone, deeply weathered dark-brown, bioclastic. Fossils: few fusulinids, small and large brachiopods. Spores absent.
2. Limestone, deeply weathered dark-brown, limonitic, fine-grained bioclastic. Fossils: brachiopods, bryozoa, gastropods, crinoidal debris. Spores absent.
3. Limestone, light bluish-gray, weathers light brownish-gray, coarser, bioclastic than Bed 2, thin shale parting at base. Fossils: abundant fusulinids, algae, bryozoa, crinoid stems, large brachiopods, possible worm burrows. Spores absent.
4. Limestone, light brownish-gray, high percentage fine bioclastic material. Fossils: fusulinids, crinoid stems, algae, worm burrows (?). Spores absent.
5. Limestone, light brownish-gray, high percentage fine bioclastic material. Fossils: abundant fusulinids, crinoid stems, large brachiopods, algal crusts. Spores absent.
6. Limestone, light brownish-gray, very fossiliferous. Fossils: abundant fusulinids, large brachiopods, bryozoa, corals. Spores absent.
7. Shale, olive-green, weathers tan, poorly laminated, calcareous. Fossils: abundant fusulinids, crinoids, large brachiopods, echinoid plates and spines, bryozoa, pelecypods. Spores absent.

LOCALITY 2

St. Nease, 36, T. 28 S., R. 12 E., Elk County, Kansas

(Road on east-west road, approximately
2.5 miles north of Fall River, Kansas)



LOCALITY 5

8. Shale, olive-green, weathers brown, well-laminated. Fossils: sparse fusulinids near top grading down to none near base, abundant flattened brachiopods, pelecypods. Spores absent.
9. Shale, bluish-gray, to olive-green, top marked by persistent iron-oxide stained zone, poorly laminated. Fossils rare: coalified plant fragments, pelecypods (?). Spores absent.
10. Coal, varies from black smudge to actual coal bed. Spores absent.
11. Underclay, bluish-gray, unlaminated, plastic. No fossils seen. Spores absent.
12. Shale, bluish-gray, block to slightly laminated, indurated, top marked by persistent limonitic streak. Spores absent.

BOND

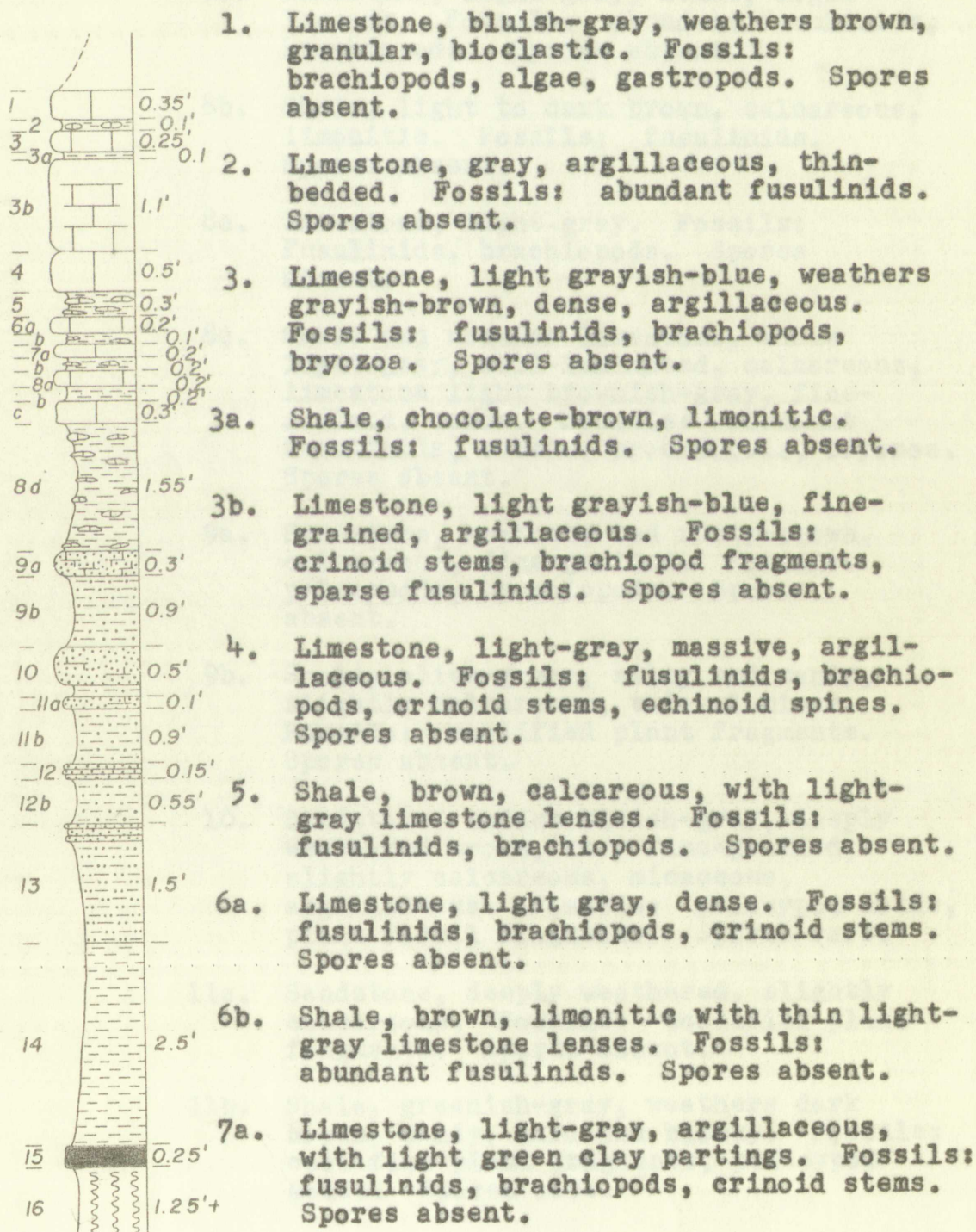
LOCALITY

8. Shale, olive-gray, massive, thin, well-laminated. Fossils: small brachiopods near top, small bryozoans near base, abundant bryozoans, brachiopods, bryozoans. Absent.
9. Shale, olive-gray, thin, massive, top marked by horizontal iron-oxide stained zone, poorly laminated. Fossils: rare small bryozoans, brachiopods (1), bryozoans absent.
10. Coal, variegated from black sand, to actual coal bed. Sparse, absent.
11. Underlay, black-gray, unlaminated, plastic. No fossils seen. Sparse, absent.
12. Shale, black-gray, thin, slightly laminated, bedded, top marked by persistent laminated zone. Sparse, absent.

LOCALITY 6

NE1/4NE1/4sec. 12, T. 29 S., R. 12 E., Elk County, Kansas

(Roadcut and pond excavation on north-south section line road, approximately 6 miles south of Fall River)



LOCALITY 6

NE 1/4 Sec. 12, T. 29 S., R. 12 E., Elk County, Kansas

(Roadcut and pond excavation on north-south section line road, approximately 6 miles south of Well River)

1. Limestone, bluish-gray, weathers brown, granular, biohermal. Fossils: brachiopods, algae, gastropods. Spores absent.
2. Limestone, gray, argillaceous, thin-bedded. Fossils: abundant fusulinids. Spores absent.
3. Limestone, light grayish-blue, weathers grayish-brown, dense, argillaceous. Fossils: fusulinids, brachiopods, bryozoa. Spores absent.
- 3a. Shale, chocolate-brown, limonitic. Fossils: fusulinids. Spores absent.
- 3b. Limestone, light grayish-blue, fine-grained, argillaceous. Fossils: crinoid stems, brachiopod fragments, sparse fusulinids. Spores absent.
4. Limestone, light-gray, massive, argillaceous. Fossils: fusulinids, brachiopods, crinoid stems, echinoid spines. Spores absent.
5. Shale, brown, calcareous, with light-gray limestone lenses. Fossils: fusulinids, brachiopods. Spores absent.
- 6a. Limestone, light gray, dense. Fossils: fusulinids, brachiopods, crinoid stems. Spores absent.
- 6b. Shale, brown, limonitic with thin light-gray limestone lenses. Fossils: abundant fusulinids. Spores absent.
- 7a. Limestone, light-gray, argillaceous, with light green clay partings. Fossils: fusulinids, brachiopods, crinoid stems. Spores absent.



LOCALITY 6

- 7b. Shale, light brown, calcareous with light-gray limestone lenses. Fossils: fusulinids, solitary corals. Spores absent.
- 8a. Limestone, light gray, dense, argillaceous. Fossils: abundant fusulinids, brachiopods. Spores absent.
- 8b. Shale, light to dark brown, calcareous, limonitic. Fossils: fusulinids. Spores absent.
- 8c. Limestone, light-gray. Fossils: fusulinids, brachiopods. Spores absent.
- 8d. Shale and nodular limestone, shale light-gray, well-laminated, calcareous, limestone light brownish-gray, fine-grained, dense. Fossils: abundant fusulinids, corals, brachiopods, bryozoa. Spores absent.
- 9a. Sandstone, weathers red rusty-brown, calcareous, fine-grained. Fossils: pelecypods, brachiopods. Spores absent.
- 9b. Shale, olive-green, silty and sandy, slightly calcareous, thick laminae. Fossils: coalified plant fragments. Spores absent.
- 10. Sandstone, medium bluish-gray, deeply weathered brown, very fine-grained, slightly calcareous, micaceous, argillaceous. Fossils: pelecypod molds, plant fossil fragments. Spores rare.
- 11a. Sandstone, deeply weathered, slightly calcareous. Fossils: coalified plant fragments. Spores absent.
- 11b. Shale, greenish-gray, weathers dark brown, sandy, hard and blocky. Fossils: coalified plant fragments, pelecypod molds. Spores rare.

LOCALITY 6

- 7b. Shale, light brown, calcareous with light-gray limestone lenses. Fossils: Trilobites, brachiopods, corals, bryozoans. Spores absent.
- 8a. Limestone, light gray, dense, finely-laminated. Fossils: abundant Trilobites, brachiopods. Spores absent.
- 8b. Shale, light to dark brown, calcareous, limonitic. Fossils: Trilobites. Spores absent.
- 8c. Limestone, light-gray. Fossils: Trilobites, brachiopods. Spores absent.
- 8d. Shale and nodular limestone, shale light-gray, well-laminated, calcareous, limestone light brownish-gray, fine-grained, dense. Fossils: abundant Trilobites, corals, brachiopods, bryozoans. Spores absent.
- 9a. Sandstone, weathers red rusty-brown, calcareous, fine-grained. Fossils: brachiopods, bryozoans. Spores absent.
- 9b. Shale, olive-green, silty and sandy, slightly calcareous, thick laminar. Fossils: coalified plant fragments. Spores absent.
- 10. Sandstone, medium bluish-gray, deeply weathered brown, very fine-grained, slightly calcareous, micaceous, argillaceous. Fossils: brachiopod molds, plant fossil fragments. Spores rare.
- 11a. Sandstone, deeply weathered, slightly calcareous. Fossils: coalified plant fragments. Spores absent.
- 11b. Shale, greenish-gray, weathers dark brown, sandy, hard and blocky. Fossils: coalified plant fragments, brachiopod molds. Spores rare.

LOCALITY 6

- 12a. Sandstone, fine-grained, argillaceous, laterally variable. Fossils: pelecypods, plant fragments. Spores rare.
- 12b. Shale, bluish-gray, sandy, silty, fissile. Fossils: pelecypods, coalified plant fragments. Spores abundant.
- 13. Shale, olive-green, weathers dark brown, silty, coarsely laminated. Fossils: pelecypods, plant fragments. Spores abundant.
- 14. Shale, bluish-gray, well-laminated, fissile, limonitic stains. Fossils: pelecypod molds, plant fragments. Spores abundant.
- 15. Coal, black, blocky, conchoidal fracture. Thin layer of black bituminous shale above. Spores abundant.
- 16. Underclay, bluish-gray, unlaminated, blocky, hard. No fossils seen. Spores rare.

LOCALITY 6

- 12a. Sandstone, fine-grained, argillaceous, laterally variable. Fossils: pelocypods, plant fragments. Spores rare.
- 12b. Shale, bluish-gray, sandy, silty, fissile. Fossils: pelocypods, coalified plant fragments. Spores abundant.
13. Shale, olive-green, weathered dark brown, silty, coarsely laminated. Fossils: pelocypods, plant fragments. Spores abundant.
14. Shale, bluish-gray, well-laminated, fissile, limonitic staining. Fossils: pelocypod molds, plant fragments. Spores abundant.
15. Coal, black, blocky, conchoidal fracture. Thin layer of black bituminous shale above. Spores abundant.
16. Underlay, bluish-gray, unlaminated, blocky, hard. No fossils seen. Spores rare.

Stratigraphic Unit	Lithology	Punctatisporites sp. 12	Calamospora sp. 19	Calamospora sp. 20	Calamospora sp. 21	Calamospora sp. 23	Cylogranisporites sp. 32	Pustulatisporites sp. 72	Platisporites sp. 42	Convolutispora sp. 105	Convolutispora sp. 107	Convolutispora sp. 114	Triquirites sp.	Triquirites sp. 119	Triquirites sp. 120	Triquirites sp. 124	Triquirites sp. 128	Lycospora sp. 138	Callospora sp. 141	Callospora sp. 144	Simozonotrilletes sp. 152
10	Sandstone		1							1										1	
11b	Shale			1			3														
12a	Sandstone					1	5				1					1					
12b	Shale		3		1	2	51					1		1			1				
13	Shale	1		11		10	80	5			1		1			1	1			1	1
14	Shale		2	15	2	1	70	4			1										
15	Coal		7	27		16	13	12	7								2	2	25	61	
16	Underclay			31				1		1	3			2	4					20	7

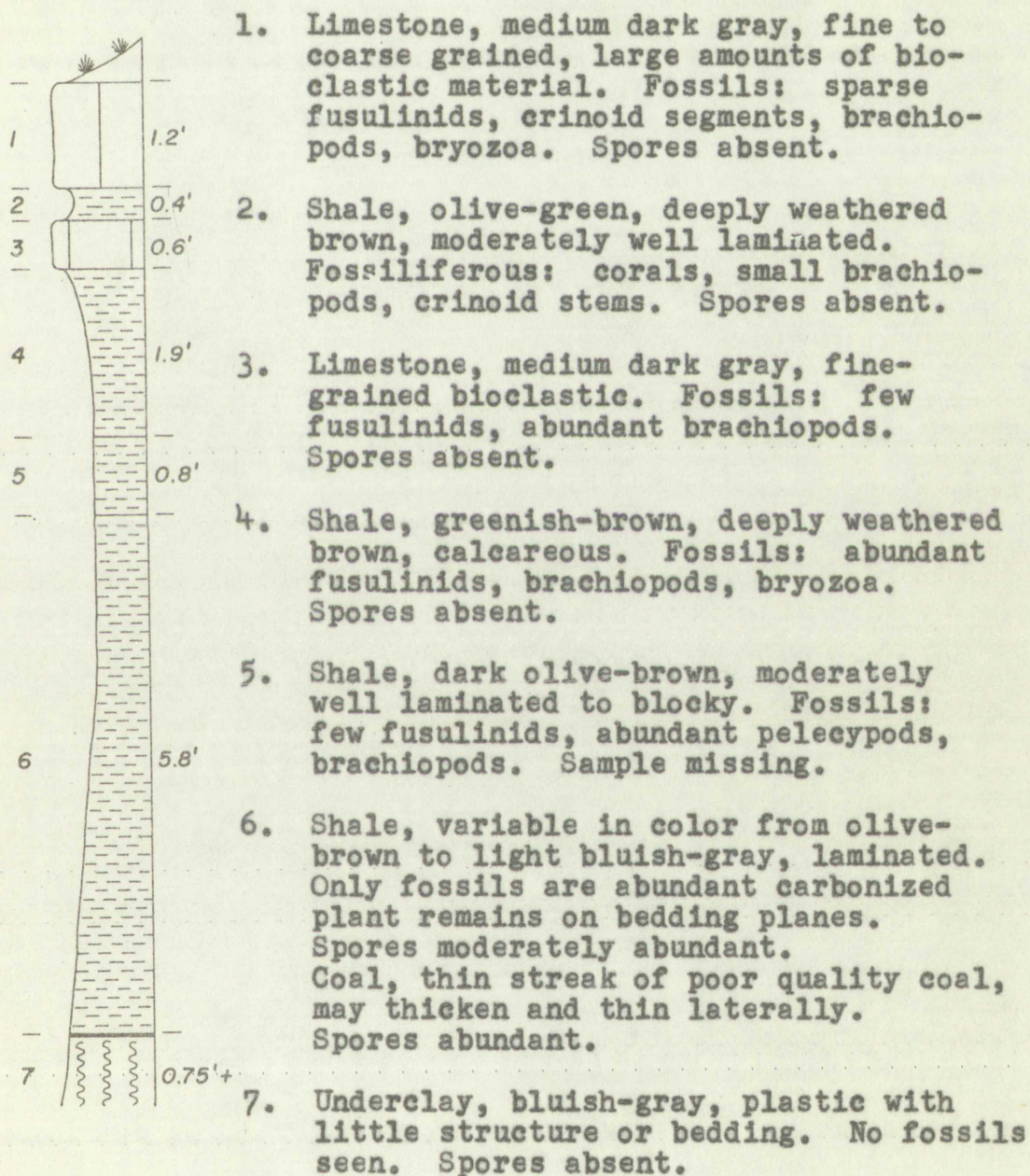
Locality 6 - Number of spores present in each stratigraphic unit

Stratigraphic Unit	Lithology	Number of spores present in each stratigraphic unit														
		Densosporites sp. 157	Cirratiradites sp. 161	Laevigatosporites sp. 163	Laevigatosporites sp. 166	Endosporites sp.	Endosporites sp. 186	Florinates sp.	Florinates sp. 196	Florinates sp. 199	Monoletes sp.	Monoletes sp. 231				
10	Sandstone					1		3								
11b	Shale							2								
12a	Sandstone				1	1										
12b	Shale		2				3	12			2	5				
13	Shale				5	5	6	4	1	1		7				
14	Shale	1				6	6	3								
15	Coal		2	8	24		7		1		1					
16	Underclay						2									

Locality 6 - Number of spores present in each stratigraphic unit

LOCALITY 7

NE1/4SW1/4sec. 27, T. 30 S., R. 12 E., Elk County, Kansas

(Roadcut on north-south road at junction
approximately 2 miles north of Longton)

LOCALITY 7

NE 1/4 Sec. 27, T. 30 N., R. 12 E., Elk County, Kansas

(Road on north-south road at junction
approximately 2 miles north of Langston)

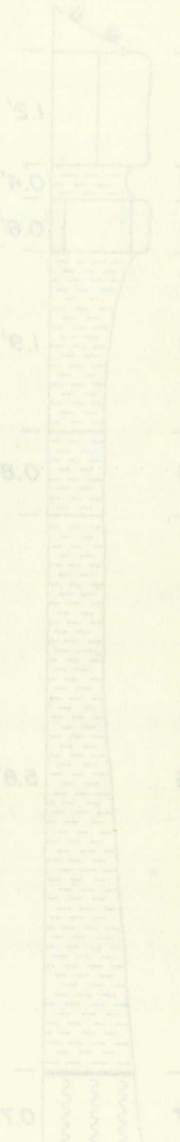
- 
1. Limestone, medium dark gray, fine to coarse grained, large amounts of di-
clastic material. Fossils: sparse
trilobites, crinoid segments, brachio-
pods, pyrozoa. Spores absent.
 2. Shale, olive-green, deeply weathered
brown, moderately well laminated.
Fossils: corals, small brachio-
pods, crinoid stems. Spores absent.
 3. Limestone, medium dark gray, fine-
grained micaceous. Fossils: few
trilobites, abundant brachio-
pods. Spores absent.
 4. Shale, greenish-brown, deeply weathered
brown, calcareous. Fossils: abundant
trilobites, brachio-
pods. Spores absent.
 5. Shale, dark olive-brown, moderately
well laminated to blocky. Fossils:
few trilobites, abundant pely-
poda. Brachio-
pods. Sample missing.
 6. Shale, variable in color from olive-
brown to light bluish-gray, laminated.
Only fossils are abundant carbonized
plant remains on bedding planes.
Spores moderately abundant.
Coal, thin streak of poor quality coal,
may thicken and thin laterally.
Spores abundant.
 7. Underlay, bluish-gray, plastic with
little structure or bedding. No fossils
seen. Spores absent.

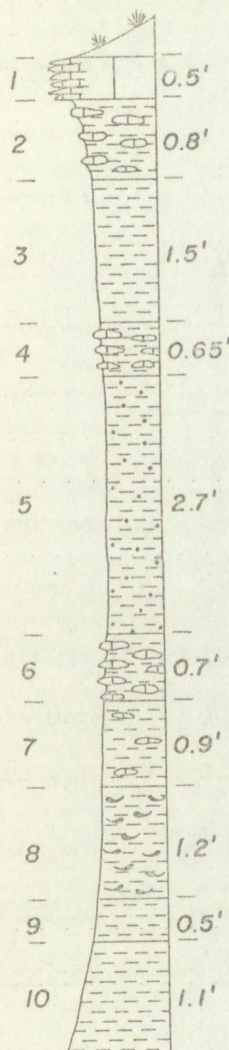
TABLE 1 - Number of species present in each stratum

Stratum	Coast		Shore		Total
	Number	Percentage	Number	Percentage	
1	1	100	1	100	2
2	1	100	1	100	2
3	1	100	1	100	2
4	1	100	1	100	2
5	1	100	1	100	2
6	1	100	1	100	2
7	1	100	1	100	2
8	1	100	1	100	2
9	1	100	1	100	2
10	1	100	1	100	2
11	1	100	1	100	2
12	1	100	1	100	2
13	1	100	1	100	2
14	1	100	1	100	2
15	1	100	1	100	2
16	1	100	1	100	2
17	1	100	1	100	2
18	1	100	1	100	2
19	1	100	1	100	2
20	1	100	1	100	2
21	1	100	1	100	2
22	1	100	1	100	2
23	1	100	1	100	2
24	1	100	1	100	2
25	1	100	1	100	2
26	1	100	1	100	2
27	1	100	1	100	2
28	1	100	1	100	2
29	1	100	1	100	2
30	1	100	1	100	2
31	1	100	1	100	2
32	1	100	1	100	2
33	1	100	1	100	2
34	1	100	1	100	2
35	1	100	1	100	2
36	1	100	1	100	2
37	1	100	1	100	2
38	1	100	1	100	2
39	1	100	1	100	2
40	1	100	1	100	2
41	1	100	1	100	2
42	1	100	1	100	2
43	1	100	1	100	2
44	1	100	1	100	2
45	1	100	1	100	2
46	1	100	1	100	2
47	1	100	1	100	2
48	1	100	1	100	2
49	1	100	1	100	2
50	1	100	1	100	2
51	1	100	1	100	2
52	1	100	1	100	2
53	1	100	1	100	2
54	1	100	1	100	2
55	1	100	1	100	2
56	1	100	1	100	2
57	1	100	1	100	2
58	1	100	1	100	2
59	1	100	1	100	2
60	1	100	1	100	2
61	1	100	1	100	2
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63	1	100	1	100	2
64	1	100	1	100	2
65	1	100	1	100	2
66	1	100	1	100	2
67	1	100	1	100	2
68	1	100	1	100	2
69	1	100	1	100	2
70	1	100	1	100	2
71	1	100	1	100	2
72	1	100	1	100	2
73	1	100	1	100	2
74	1	100	1	100	2
75	1	100	1	100	2
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91	1	100	1	100	2
92	1	100	1	100	2
93	1	100	1	100	2
94	1	100	1	100	2
95	1	100	1	100	2
96	1	100	1	100	2
97	1	100	1	100	2
98	1	100	1	100	2
99	1	100	1	100	2
100	1	100	1	100	2

LOCALITY 8

CEL sec. 36, T. 32 S., R. 11 E., Chautauqua County, Kansas

(Roadcut on north-south section line road,
approximately 8 miles north of Sedan)



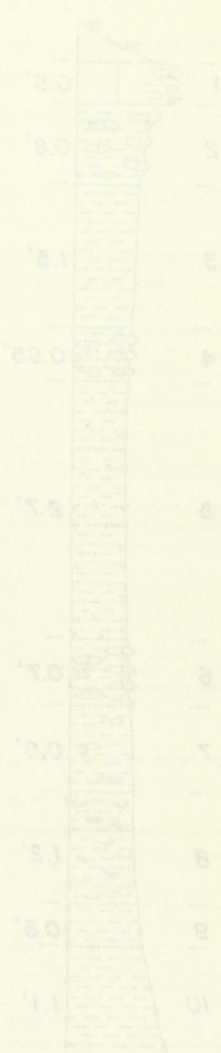
1. Limestone, medium gray to brownish-gray, weathers dark brown and platy, very argillaceous and silty, bioclastic. Fossils: brachiopods, crinoid stems, very few fusulinids. Spores absent.
2. Shale, brown, deeply weathered with limestone nodules. Fossils: brachiopods. Spores absent.
3. Shale, grayish-brown to olive-brown, not well-laminated. Few fossils: small brachiopods. Spores absent.
4. Shale and limestone nodules, olive-brown to rusty-brown. Limestone nodules argillaceous and fossiliferous. Spores absent.
5. Shale, olive-green to olive-brown, blocky to laminated. Abundant fossils: brachiopods, pelecypods, crinoid stems. Spores absent.
6. Shale and limestone nodules, rusty-brown, deeply weathered. Nodules fossiliferous. Spores absent.
7. Shale, gray to olive-brown, weathers brown, scattered small calcareous nodules. Few fossils. Spores absent.
8. Shale, deeply weathered brown. Abundant large pelecypods. Spores absent.
9. Shale, bluish-gray, poorly bedded, calcareous nodules. No fossils seen. Spores absent.
10. Shale, brownish-gray, plastic, little evidence of bedding. Possibly plant fragments. Spores absent.

LOCALITY 8

CNL sec. 36, T. 35 S., R. 11 E., Chautauque County, Kansas

(Roadcut on north-south section line road,
approximately 8 miles north of Sedan)

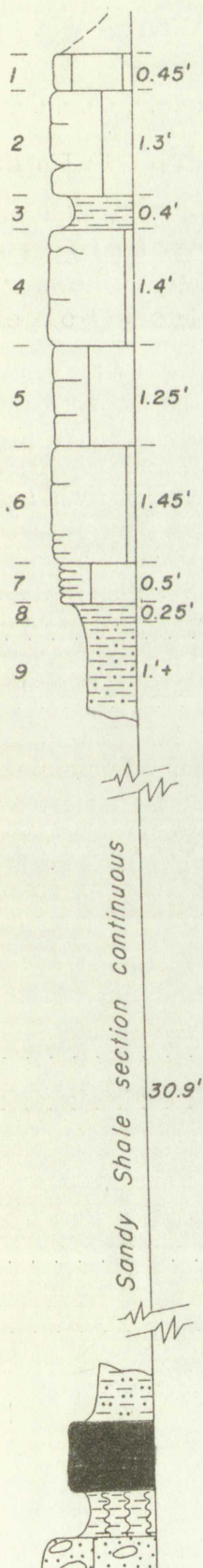
1. Limestone, medium gray to brownish-gray, weathers dark brown and platy, very argillaceous and silty, blocky. Fossils: brachiopods, crinoid stems, very few fusulinids. Spores absent.
2. Shale, brown, deeply weathered with limestone nodules. Fossils: brachiopods. Spores absent.
3. Shale, grayish-brown to olive-brown, not well-laminated. Few fossils: small brachiopods. Spores absent.
4. Shale and limestone nodules, olive-brown to rusty-brown. Limestone nodules argillaceous and fossiliferous. Spores absent.
5. Shale, olive-green to olive-brown, blocky to laminated. Abundant fossils: brachiopods, pelicyopods, crinoid stems. Spores absent.
6. Shale and limestone nodules, rusty-brown, deeply weathered. Nodules fossiliferous. Spores absent.
7. Shale, gray to olive-brown, weathers brown, scattered small calcareous nodules. Few fossils. Spores absent.
8. Shale, deeply weathered brown. Abundant large pelicyopods. Spores absent.
9. Shale, bluish-gray, poorly bedded, calcareous nodules. No fossils seen. Spores absent.
10. Shale, brownish-gray, plastic, little evidence of bedding. Possibly plant fragments. Spores absent.



LOCALITY 9

NW1/4NE1/4sec. 24, T. 18 S., R. 17 E.,
Franklin County, Kansas

(Roadcut on U. S. Highway 50-S, approximately
1 mile southwest of Williamsburg)



1. Limestone, brownish-gray, deeply weathered dark-brown, medium-grained bioclastic, limonitic filling in holes or tubes. Fossils: Algal balls, fusulinids, gastropods, crinoid stems, brachiopods. Spores absent.
2. Limestone, deeply weathered brown, bioclastic. Fossils: fusulinids, algal wafers and pellets, crinoid stems, bryozoa. Spores absent.
3. Shale, greenish-gray, weathers brown, poorly laminated. Fossils: crinoid stems, brachiopods. Spores absent.
4. Limestone, brownish-gray, weathers brown, bioclastic with green shale partings. Fossils: brachiopods, fusulinids, gastropods. Spores absent.
5. Limestone, deeply weathered, less bioclastic than above, finer grained. Fossils: fusulinids, brachiopods, crinoid stems. Spores absent.
6. Limestone, deeply weathered dark-brown, less bioclastic material, finer grained than above. Fossils: fusulinids, brachiopods, crinoid stems. Spores absent.
7. Limestone, deeply weathered dark-brown, argillaceous, fine-grained. Fossils: fusulinids, algal crusts, bryozoa, brachiopods. Spores absent.
8. Shale, brown, deeply weathered. Few fossils seen. Spores absent.
9. Shale, greenish-gray, silty, sandy, blocky, poorly laminated. No fossils seen. Spores absent.

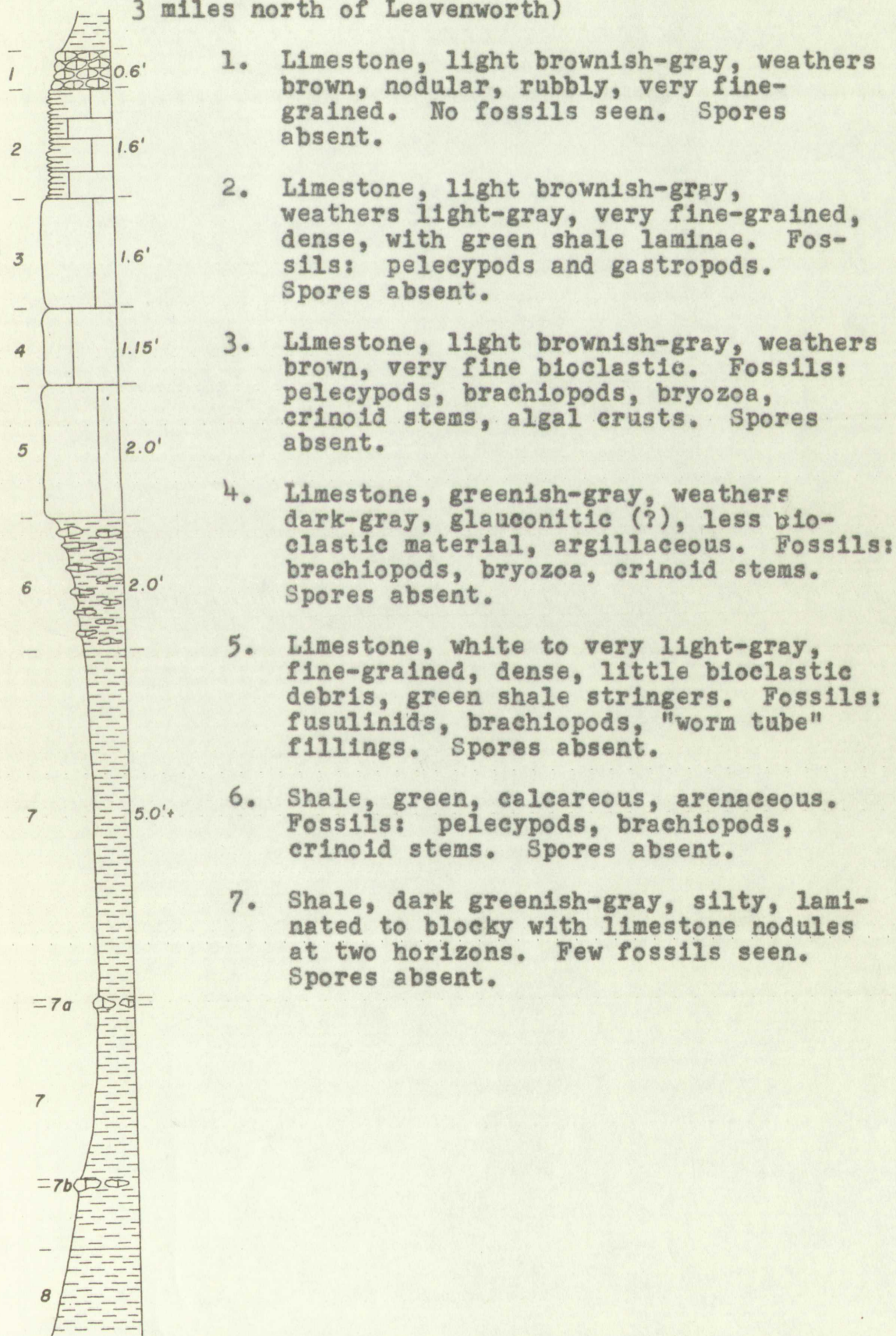
This coal is pre-Toronto and was given no number. Spores rare.

LOCALITY 10

84

NW1/4NW1/4sec. 22, T. 8 S., R. 22 E., Leavenworth County, Kansas

(Roadcut on north-south U. S. Highway 73, approximately 3 miles north of Leavenworth)

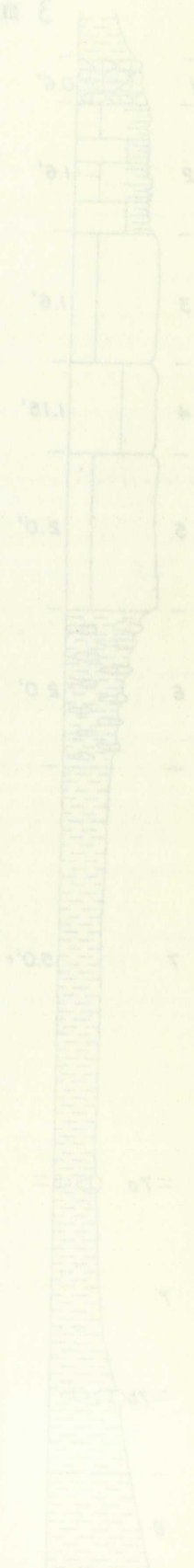


LOCALITY 13

NW 1/4 Sec. 22, T. 8 S., R. 22 E., Leavenworth County, Kansas

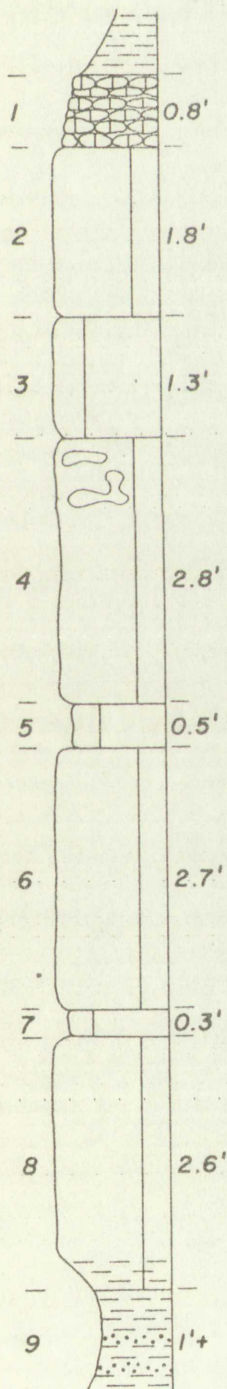
(Roadcut on north-south U. S. Highway 73, approximately 3 miles north of Leavenworth)

1. Limestone, light brownish-gray, weathers brown, nodular, ruddy, very fine-grained. No fossils seen. Spores absent.
2. Limestone, light brownish-gray, weathers light-gray, very fine-grained, dense, with green shale laminae. Fossils: pelaeopods and gastropods. Spores absent.
3. Limestone, light brownish-gray, weathers brown, very fine crystalline. Fossils: pelaeopods, brachiopods, pyrozoa, crinoid stems, algal crusts. Spores absent.
4. Limestone, greenish-gray, weathers dark-gray, glauconitic (?), less plastic material, argillaceous. Fossils: brachiopods, pyrozoa, crinoid stems. Spores absent.
5. Limestone, white to very light-gray, fine-grained, dense, little plastic debris, green shale stringers. Fossils: fusulinids, brachiopods, "worm tubes", trilobites. Spores absent.
6. Shale, green, calcareous, arenaceous. Fossils: pelaeopods, brachiopods, crinoid stems. Spores absent.
7. Shale, dark greenish-gray, silty, laminated to blocky with limestone nodules at two horizons. Few fossils seen. Spores absent.



NW1/4sec. 36, T. 12 S., R. 19 E., Douglas County, Kansas

(Roadcut on east-west U. S. Highway 40, west side of Lawrence)



1. Limestone, deeply weathered brown, nodular, rubbly, fine-grained, and argillaceous. No fossils seen. Spores absent.
2. Limestone, deeply weathered brown, slightly argillaceous, fine-grained. No fossils seen. Spores absent.
3. Limestone, brownish-gray, weathers brown, dense, small amount of bioclastic material. No fossils seen. Spores absent.
4. Limestone, brownish-gray, weathers brown, slightly argillaceous, fine-grained, dense, chert stringers and nodules in upper part. Fossils: fusulinids, brachiopods, crinoid stems. Spores absent.
5. Limestone, brownish-gray, deeply weathered brown, thin-bedded, dense, fine-grained. Fossils: brachiopods, crinoid stems, corals. Gray shale partings above and below. Spores absent.
6. Limestone, light brownish-gray, weathers rusty-brown, very fine-grained bioclastic, massive bedded. Fossils: fusulinids, crinoid stems, brachiopods, corals, algal crusts. Spores absent.
7. Limestone, light brownish-gray, weathers brown, bioclastic. Fossils: algal laminations, fusulinids, brachiopods, crinoid stems. Spores absent.
8. Limestone, light brownish-gray, weathers brown, bioclastic, slightly argillaceous toward base. Fossils: fusulinids, algal encrustations, brachiopods, crinoid stems, pelecypods near base. Spores absent.
9. Shale, greenish-gray, silty to sandy. No fossils seen. Spores absent.

LOCALITY II

WV 1000, 30, T. 12 S., R. 12 E., Douglas County, Kansas

(Roadcut on east-west U. S. Highway 40, west side of Lawrence)

1. Limestone, heavily weathered brown, nodular, tubular, fine-grained, and crystalline. No fossils seen.

2. Limestone, heavily weathered brown, slightly crystalline, fine-grained. No fossils seen. Spores absent.

3. Limestone, brownish-gray, weathered brown, granular, small amount of fine-grained material. No fossils seen. Spores absent.

4. Limestone, brownish-gray, weathered brown, slightly crystalline, fine-grained, dense, open tubular and nodular in upper part. Fossils: brachiopods, crinoids, stems. Spores absent.

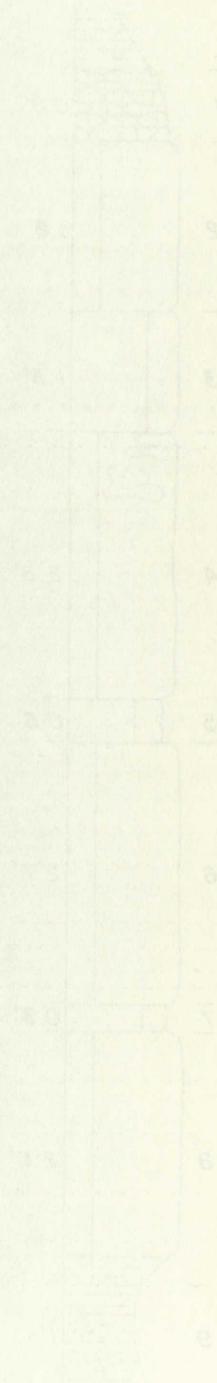
5. Limestone, brownish-gray, heavily weathered brown, fine-grained, dense, tubular, nodular, crystalline. Fossils: brachiopods, crinoid stems, corals. Spores: brachiopods above and below. Spores absent.

6. Limestone, light brownish-gray, weathered rusty-brown, very fine-grained blocky, massive bedded. Fossils: brachiopods, crinoid stems, brachiopods, corals, algal crinoids. Spores absent.

7. Limestone, light brownish-gray, weathered brown, blocky, crystalline, algal laminations, brachiopods, crinoid stems. Spores absent.

8. Limestone, light brownish-gray, weathered brown, blocky, slightly crystalline, algal laminations, brachiopods, crinoid stems, brachiopods. Spores absent.

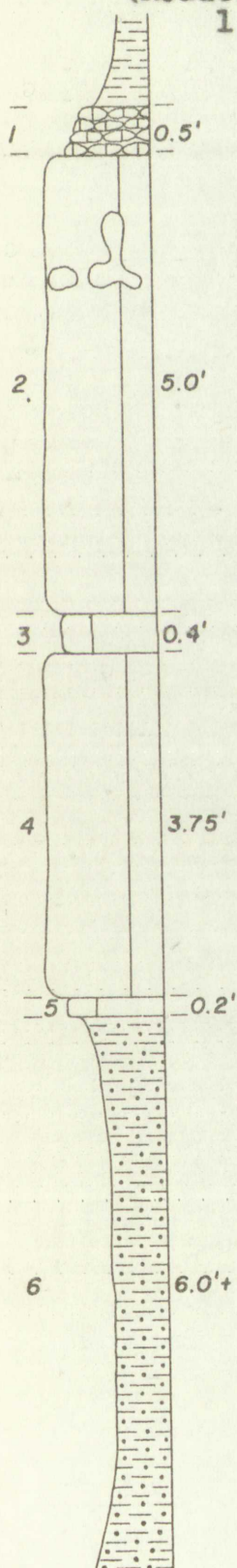
9. Limestone, brownish-gray, alky to rusty, no fossils seen. Spores absent.



LOCALITY 12

CSL NW1/4sec. 8, T. 11 S., R. 21 E., Leavenworth County, Kansas

(Roadcut on east-west State Highway 16,
1 mile west of Tonganoxie)



1. Limestone, deeply weathered rusty-brown, rubbly, nodular, very fine-grained, chalky, limonitic. Fossils: worm tubes (?) filled with green shale. Spores absent.
2. Limestone, brownish-gray, weathers brown, fine-grained toward top, bioclastic toward bottom, zone of tan chert nodules and lenses above middle, massive-bedded. Fossils: mulluscan fauna above chert; no fossils seen in chert zone; lower half contains fusulinids, crinoid stems, brachiopods and algal pellets. Spores absent.
3. Limestone, light brownish-gray, weathers dark-brown, thin shale parting above and below argillaceous, fine-grained. Fossils: crinoid stems, brachiopods. Spores absent.
4. Limestone, light brownish-gray, weathers brown, bioclastic at top, becoming fine-grained toward base. Fossils: fusulinids, crinoid stems, algal structures, brachiopods, bryozoa, coral. Spores absent.
5. Limestone, bluish-gray, weathers brown, fine-grained argillaceous. Few fossils seen. Spores absent.
6. Shale, bluish-gray, sandy and silty, un laminated to blocky. Fossils: phosphatic brachiopods, pelecypods. Spores absent.

LOCALITY 12

CSL NW 1/4 sec. 8, T. 11 S., R. 21 E., Leavenworth County, Kansas

(Roadcut on east-west State Highway 16,
1 mile west of Tonganoxie)

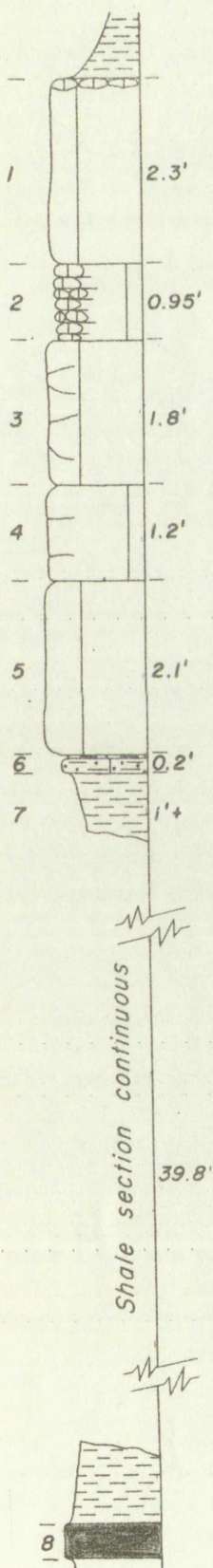
1. Limestone, deeply weathered rusty-brown, ruddy, nodular, very fine-grained, cherty, limonitic. Fossils: worn tubes (?) filled with green shale. Spores absent.
2. Limestone, brownish-gray, weathers brown, fine-grained toward top, bio-elastic toward bottom, zone of tan chert nodules and lenses above middle, massive-bedded. Fossils: molluscan fauna above chert; no fossils seen in chert zone; lower half contains fusulids, crinoid stems, brachiopods and algal pellets. Spores absent.
3. Limestone, light brownish-gray, weathers dark brown, thin shale parting above and below argillaceous, fine-grained. Fossils: crinoid stems, brachiopods. Spores absent.
4. Limestone, light brownish-gray, weathers brown, bioelastic at top, becoming fine-grained toward base. Fossils: fusulids, crinoid stems, algal structures, brachiopods, pyrozoa, coral. Spores absent.
5. Limestone, bluish-gray, weathers brown, fine-grained argillaceous. Few fossils seen. Spores absent.
6. Shale, bluish-gray, sandy and silty, unmineralized to blocky. Fossils: phatic brachiopods, paleopyrozoa. Spores absent.



LOCALITY 13

NE1/4NW1/4sec. 14, T. 13 S., R. 18 E.,
Douglas County, Kansas

(Exposure above west end of dam, Lone
Star Lake, southwest of Lawrence)



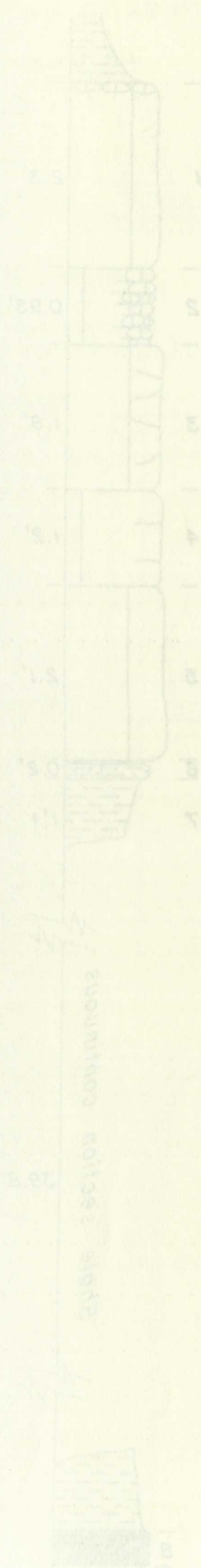
1. Limestone, light yellowish-brown, weathers rusty-brown, upper part rubbly and fine-grained, most of bed bioclastic. Fossils: brachiopods, crinoid stems, fusulinids, algal balls. Spores absent.
2. Limestone, light-gray, deeply weathered brown, fine-grained, dense, rubbly. Fossils: fusulinids, brachiopods, corals. Spores absent.
3. Limestone, light brownish-gray, weathers dark-brown, medium-grained, almost sucrosic. Fossils: fusulinids, brachiopods. Spores absent.
4. Limestone, light brownish-gray, weathers dark-brown, fine-grained, sucrosic. Fossils: fusulinids, brachiopods, crinoid stems. Spores absent.
5. Limestone, white, weathers light-brown, fine-grained, chalky, massive. Fossils: fusulinids, brachiopods, algal structures. Spores absent.
6. Limestone, bluish-gray, weathers brown, argillaceous, arenaceous. Fossils: rare. Spores absent.
7. Shale, bluish-gray, silty, sandy, poorly bedded. Spores absent.
8. Coal. Spores abundant.

LOCALITY 12

NEVADA, sec. 1, T. 13 N., R. 10 E., S. 12 E.
Douglas County, Nevada

(Exposure above west end of Lake, Lane
for Lake, southward at exposure)

1. Limestone, light yellowish-brown,
weathers rusty-brown, upper part
rubble and fine-grained, rest of bed
bicolored. Fossils: brachiopods,
crinoid stems, lamellinaria, algal
balls. Spores absent.
2. Limestone, light gray, evenly weath-
ered brown, fine-grained, dense,
rubble. Fossils: lamellinaria, brachio-
pods, corals. Spores absent.
3. Limestone, light brownish-gray,
weathers dark brown, medium-grained,
almost massive. Fossils: lamellinaria,
brachiopods. Spores absent.
4. Limestone, light brownish-gray,
weathers dark brown, fine-grained,
massive. Fossils: lamellinaria,
brachiopods, crinoid stems. Spores
absent.
5. Limestone, white, weathers light-
brown, fine-grained, cherty, massive.
Fossils: lamellinaria, brachiopods,
algal structures. Spores absent.
6. Limestone, bluish-gray, weathers
brown, effervescent, argillaceous,
fossiliferous. Spores absent.
7. Sand, bluish-gray, silty, sandy, poorly
bedded. Spores absent.
8. Coal. Spores abundant.



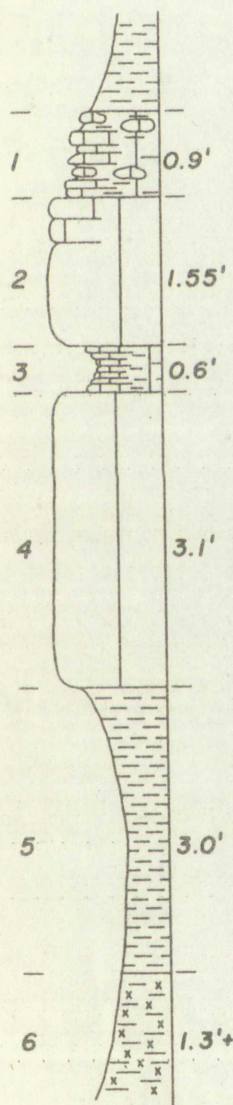
ГОСУДАРСТВЕННЫЙ ЗАКАЗ - номер от абортов вносимых в список

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LOCALITY 15

NE1/4NW1/4sec. 31, T. 58 N., R. 35 W., Buchanan County, Missouri

(Quarry in east river bluff approximately 3.5 miles north and west of St. Joseph, Missouri)



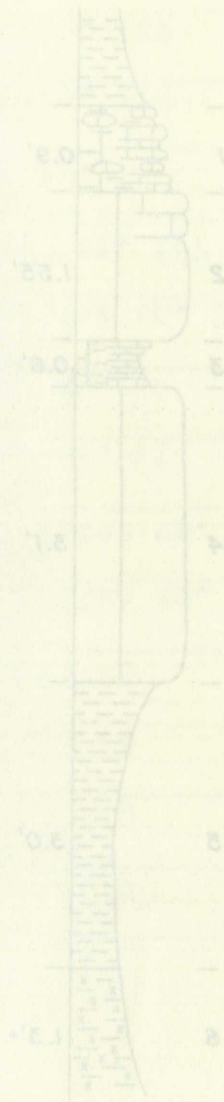
1. Limestone, brownish-gray, weathers brown, fine-grained, argillaceous, rubbly. Fossils: poorly preserved gastropods. Spores absent.
2. Limestone, light brownish-gray, weathers dark-brown, fine-grained, dense, with green shale flakes and stringers. Fossils: poorly preserved pelecypods. Spores absent.
3. Limestone, brownish-gray, weathers brown, softer and shalier than beds above, medium fine-grained. Fossils: gastropods and pelecypods. Spores absent.
4. Limestone, light yellowish-tan, weathers rusty-brown, bioclastic. Fossils: fusulinids, brachiopods, pelecypods, bryozoa, crinoid stems. Spores absent.
5. Shale, light bluish-gray, calcareous, laminated. Fossils: brachiopods, crinoid fragments, pelecypods. Becomes darker gray toward base, less fossiliferous. Spores absent.
6. Shale, red. No fossils seen. Spores absent.

WOLFEY IS

NE 1/4 NW 1/4 sec. 31, T. 58 N., R. 35 W., Buchanan County, Missouri

(Quarry in east river bluff approximately 2.5 miles north and west of St. Joseph, Missouri)

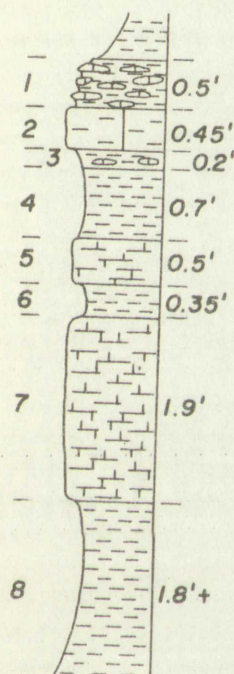
1. Limestone, brownish-gray, weathered brown, fine-grained, argillaceous, tubular, fossiliferous, mostly preserved. Gastropods, bryozoan abundant.
2. Limestone, light brownish-gray, weathered dark brown, fine-grained, dense, with green shale flakes and stringers, fossiliferous, mostly preserved. Helicospira, Spores present.
3. Limestone, brownish-gray, weathered brown, rather soft and shaly, thin bedded, above, medium fine-grained, fossiliferous. Gastropods and Helicospira, bryozoan, abundant.
4. Limestone, light yellowish-tan, weathered whitish, shaly, thin bedded, fossiliferous, bryozoan, brachiopods, pelocypoda, bryozoan, crinoid stems, Spores present.
5. Shale, light bluish-gray, calcareous, laminated, fossiliferous, brachiopods, crinoid fragments, pelocypoda, bryozoan, common, darker gray toward base, fossiliferous, Spores present.
6. Shale, red, no fossils seen. Spores abundant.



LOCALITY 17

NE1/4NW1/4sec. 4, T. 33⁴ S., R. 11 E., Chautauqua County, Kansas

(Roadcut on east-west road, approximately
1.8 miles west of Sedan, Kansas)



Leavenworth limestone: Two spores present

1. Limestone, greenish-gray, weathers dark rusty brown, rubbly, nodular, shaly. No fossils seen. Spores absent. Microforams present.
2. Limestone, dark gray, weathers light to dark brown, very argillaceous, bioclastic. Fossils: crinoid stems, brachiopods, fusulinids. Spores absent.
3. Shale, light-brown, hard, calcareous with limestone nodules. Very fossiliferous: brachiopods, pelecypods, crinoid stems, bryozoa.
4. Shale, greenish-gray, poorly to well laminated, small calcareous nodules. Very few fossils. Spores absent.
5. Shale, weathered drab rusty brown, calcareous. Very fossiliferous: pelecypods, crinoid stems. Spores absent.
6. Shale, greenish-gray, fairly well laminated. Unfossiliferous near top, numerous small brachiopods near base. Spores absent.
7. Calcareous, shale and argillaceous limestone, light brownish-gray. Very fossiliferous: small brachiopods, crinoid stems, pelecypods. Spores absent.
8. Shale, olive-green to olive-brown, unlaminated, blocky. Very few fossils. Spores absent.

LOCALITY 17
 Highway 17, 11.5 miles west of Canton, Kansas

(Roadcut on east-west road, approximately
 1.5 miles west of Canton, Kansas)

Leavenworth limestone. Two species present

1. Limestone, greenish-gray, weathering
 dark rusty brown, nodular, abundant.
 Shale, to fossiliferous, pores
 abundant, microporous present.

2. Limestone, dark gray, weathering light
 to dark brown, very crystalline,
 microporous, fossiliferous, pores
 abundant, microporous present.

3. Shale, light brown, hard, color dark
 with limestone nodules, very
 fossiliferous, microporous, pores
 abundant, microporous present.

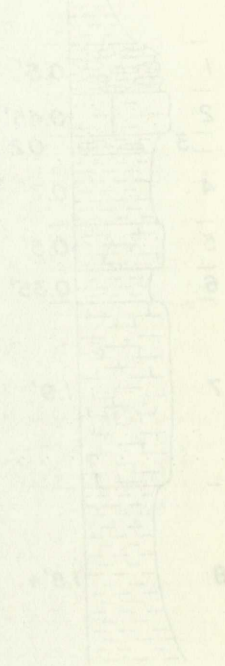
4. Shale, greenish-gray, poorly to well
 laminated, small calcareous nodules,
 very few fossils, pores abundant.

5. Shale, weathered dark rusty brown,
 calcareous, very fossiliferous,
 microporous, pores abundant.

6. Shale, greenish-gray, fairly well
 laminated, microporous near top,
 numerous small microporous near base,
 pores abundant.

7. Calcareous, shale and argillaceous
 limestone, light greenish-gray,
 very fossiliferous, small microporous,
 pores, microporous, microporous,
 pores abundant.

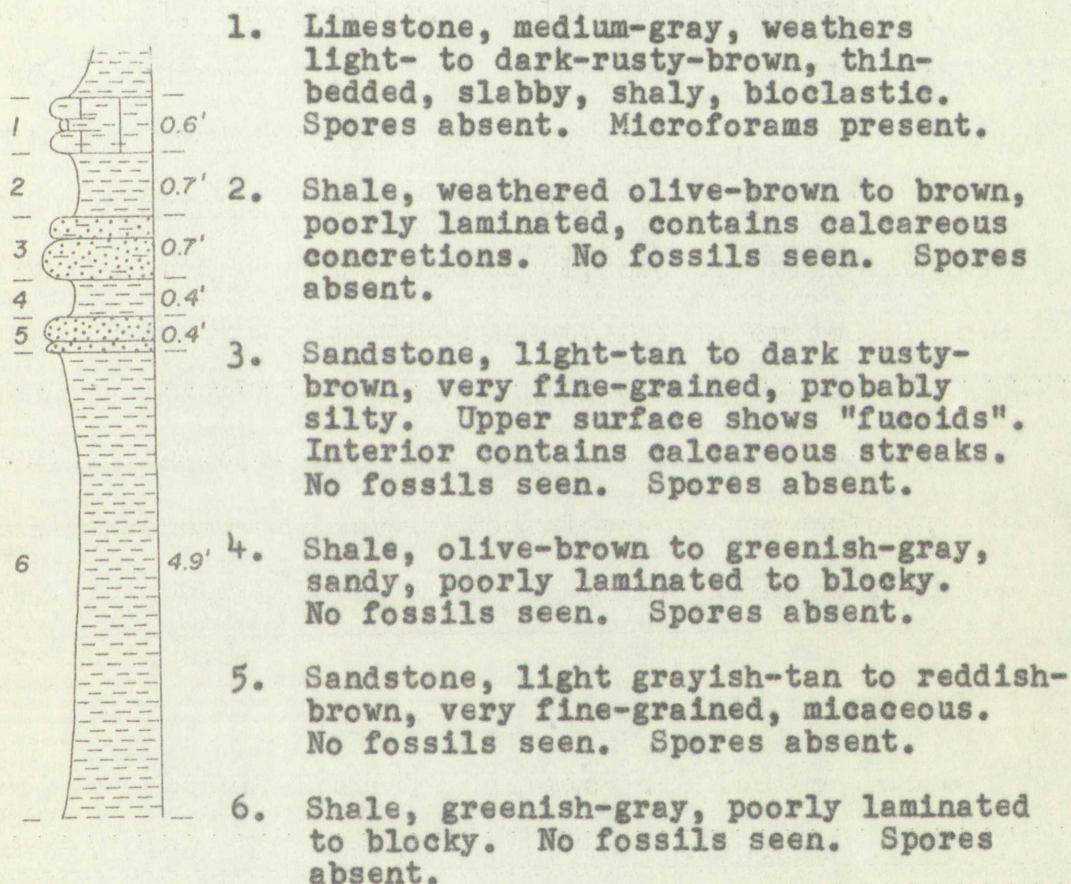
8. Shale, olive-green to olive-brown,
 microporous, dark, very few fossils,
 pores abundant.



LOCALITY 18

NE1/4sec. 7, T. 28 N., R. 10 E., Osage County, Oklahoma

(Roadcut on County Highway 3 approximately
6.5 miles south of Elgin, Kansas)



LOCALITY 18

NE 1/4 sec. 7, T. 26 N., R. 10 E., Garza County, Oklahoma

(Roadcut on County Highway 3 approximately
0.5 miles south of Higin, Kansas)

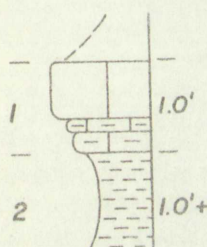
1. Limestone, medium-gray, weathers
light to dark rusty-brown, thin-
bedded, shaly, blocky.
Spores absent. Microfossils present.
2. Shale, weathered olive-brown to brown,
poorly laminated, contains calcareous
concretions. No fossils seen. Spores
absent.
3. Sandstone, light-tan to dark rusty-
brown, very fine-grained, probably
silty. Upper surface shows "lenticles".
Interior contains calcareous streaks.
No fossils seen. Spores absent.
4. Shale, olive-brown to greenish-gray,
sandy, poorly laminated to blocky.
No fossils seen. Spores absent.
5. Sandstone, light grayish-tan to reddish-
brown, very fine-grained, micaceous.
No fossils seen. Spores absent.
6. Shale, greenish-gray, poorly laminated
to blocky. No fossils seen. Spores
absent.



LOCALITY 19

SW1/4NE1/4sec. 12, T. 35 S., R. 10 E., Chautauqua County, Kansas

(Roadcut on north-south road, approximately
2.5 miles north-east of Elgin, Kansas)



1. Upper part:
Limestone, medium dark gray, weathers dark-brown, fine-grained bioclastic, few recognizable fossils: pelecypods and brachiopods. Spores absent.

Lower part:
Limestone, similar to upper part, but coarser-grained bioclastic material. Crinoidal debris prominent. Spores absent.

2. Shale, olive-gray to olive-brown, poorly laminated to blocky, probably silty to finely sandy. No fossils seen. Spores absent.

LOCALITY 19

SW1/NE1/4sec. 12, T. 32 N., R. 10 E., Cherokee County, Kansas

(Roadcut on north-south road, approximately 1/2
2.5 miles north-east of Albia, Kansas)

Upper part:
Limestone, medium dark gray, weathers
dark-brown, fine-grained blocky,
few recognizable fossils; bryozooids
and brachiopods, pores absent.

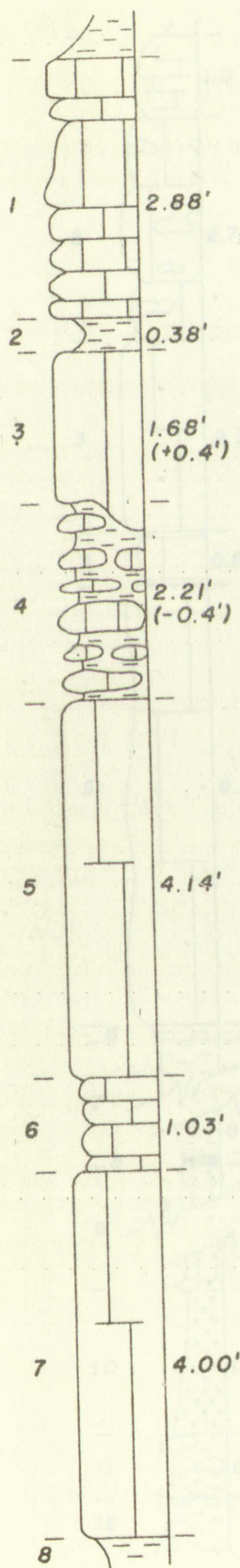
Lower part:
Limestone, similar to upper part,
but coarser-grained blocky
material. Crinoidal debris
prominent. Pores absent.

Shale, olive-gray to olive-brown,
poorly laminated to blocky, probably
slaty to finely sandy. No fossils
seen. Pores absent.

LOCALITY 20

C SE1/4sec. 2, T. 22., R. 15.E.,
Coffey County, Kansas

(Small quarry north of east-west section line
road, approximately 3.5 miles south and
east of Burlington)



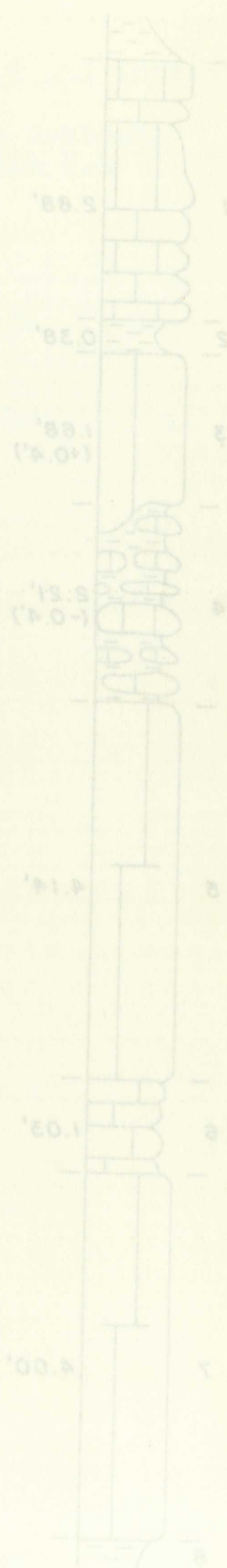
1. Limestone, very light-gray, weathers tan, dense to very fine bioclastic, green shale flakes. Fossils: large algal balls, gastropods, no fusulinids. Spores absent.
2. Shale, green, weathers brown, calcareous. No fossils seen. Spores absent.
3. Limestone, light-gray to creamy white, bioclastic, pelletal, semioolitic, algal coated worn fossil fragments. Recognizable fossils rare, no fusulinids seen. Spores absent.
4. Limestone and shale; green shale stringers, weathers brown, light-gray to creamy white limestone stringers and nodules; fine-grained to fine bioclastic. Fossils: crinoid stems. Spores absent.
5. Limestone, light-gray to creamy white, massive, very fine-grained bioclastic, almost chalky. Fossils: brachiopods, bryozoa, crinoid fragments, algal coatings, no fusulinids seen. Spores absent.
6. Limestone, medium light-gray, darker argillaceous stringers common toward top, with 1/3-inch thick shale stringer at top. Fossils: crinoid stems, fusulinids. Spores absent.
7. Limestone, very light gray to creamy white, fine bioclastic, slightly argillaceous toward base. Fossils: fusulinids abundant in lower third, crinoid stems, brachiopods. Spores absent.
8. Shale, bluish-gray, plastic, blocky. No fossils seen. Spores absent.

LOCALITY 20

C 281/4 sec. 2, T. 22, R. 12, E. 1,
Coffey County, Kansas

(Small quarry north of east-west section line
road, approximately 3.5 miles south and
east of Burlington)

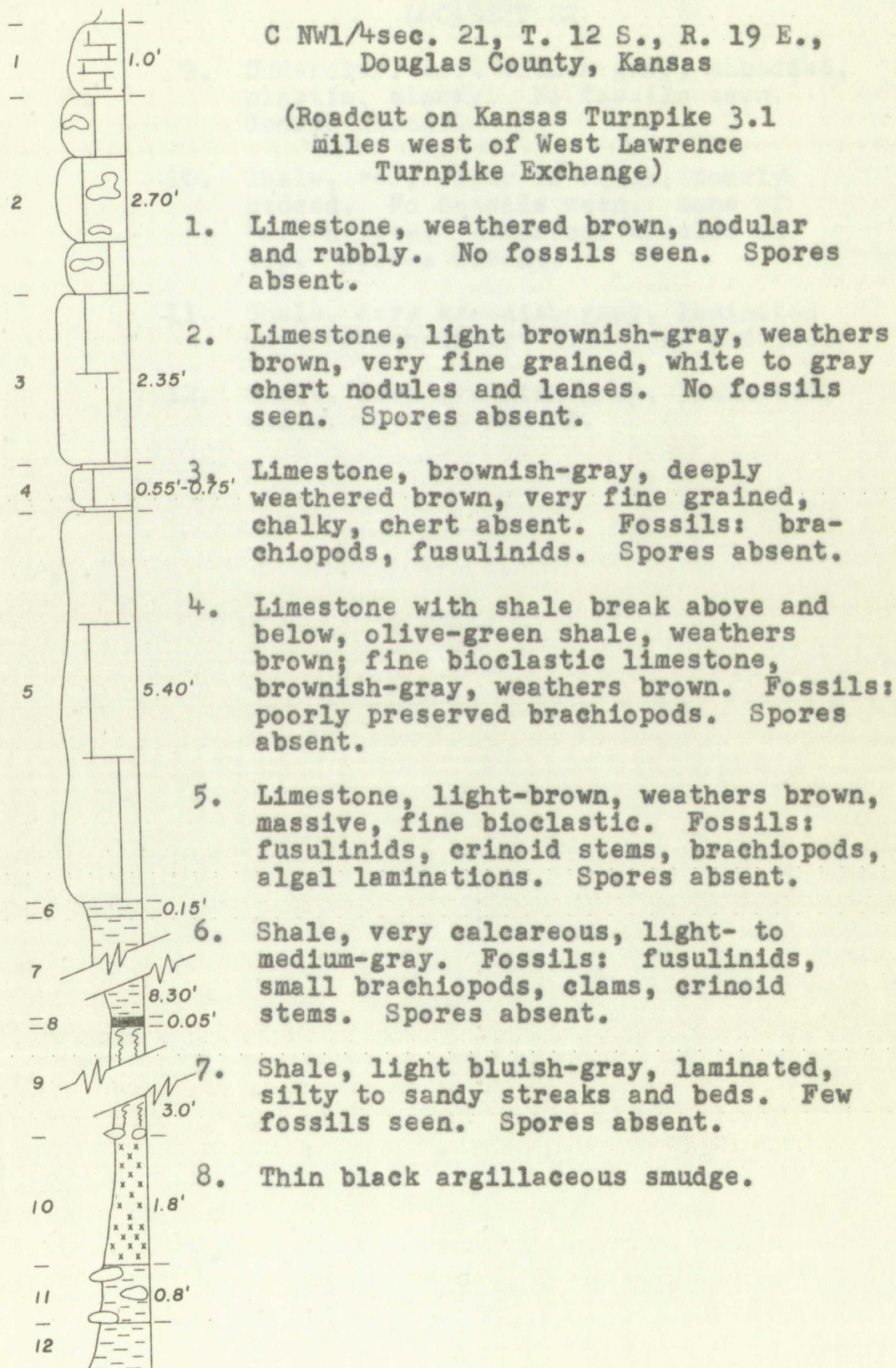
1. Limestone, very light-gray, weathers
tan, dense to very fine bioclastic,
green shale flakes. Fossils: large
algal balls, gastropods, no fusulinids.
Spores absent.
2. Shale, green, weathers brown, cal-
careous. No fossils seen. Spores
absent.
3. Limestone, light-gray to creamy white,
bioclastic, pelletal, semiclastic,
algal coated with fossil fragments.
Recognizable fossils rare, no fusulinids
seen. Spores absent.
4. Limestone and shale; green shale
stringers, weathers brown, light-gray
to creamy white limestone stringers
and nodules; fine-grained to fine bio-
clastic. Fossils: crinoid stems.
Spores absent.
5. Limestone, light-gray to creamy white,
massive, very fine-grained bioclastic,
almost chalky. Fossils: brachiopods,
pyrozoa, crinoid fragments, algal coat-
ings, no fusulinids seen. Spores absent.
6. Limestone, medium light-gray, darker
argillaceous stringers common toward
top, with 1/3-inch thick shale stringer
at top. Fossils: crinoid stems,
fusulinids. Spores absent.
7. Limestone, very light gray to creamy
white, fine bioclastic, slightly
argillaceous toward base. Fossils:
fusulinids abundant in lower third,
crinoid stems, brachiopods. Spores
absent.
8. Shale, bluish-gray, plastic, blocky.
No fossils seen. Spores absent.



LOCALITY 22

C NW1/4sec. 21, T. 12 S., R. 19 E.,
Douglas County, Kansas

(Roadcut on Kansas Turnpike 3.1
miles west of West Lawrence
Turnpike Exchange)



100-111-1
Douglas County, Kansas

(Exposed on Kansas Highway 111
near west of west base of
Trinidad Escarpment)

1. Limestone, weathered brown, fossiliferous and tubular. No fossiliferous, coarse-grained.
2. Limestone, light brown-gray, weathered brown, very fine grained, white to gray, coarse nodules and laminae. No fossils seen. Spores abundant.

3. Limestone, brownish-gray, weathered brown, very fine grained, white, coarse nodules, fossiliferous, abundant. Lamellae abundant.

4. Limestone with shell, brown above and below, olive-green below. Fossiliferous, fine blastic limestone, brownish-gray, weathered brown, fossiliferous, poorly preserved brachiopods. Spores abundant.

5. Limestone, light-brown, weathered brown, massive, fine blastic, fossiliferous, tubular, original form, brachiopods, light fossiliferous. Spores abundant.

6. Limestone, very light brown, light to medium gray, fossiliferous, tubular, small brachiopods, original form, abundant. Spores abundant.

7. Limestone, light medium gray, fossiliferous, light to medium gray, abundant. Spores abundant.

8. This block is lithologically similar.

LOCALITY 22

9. Underclay, dark bluish-gray, unbedded, plastic, blocky. No fossils seen. Spores absent.
10. Shale, red, silty to sandy, poorly bedded. No fossils seen. Zone of "fresh-water" limestone nodules at top. Spores absent.
11. Shale, dark greenish-gray, laminated with "fresh-water" limestone nodules.
12. Shale, dark greenish-gray, laminated, silty. Spores absent.

UNIT 12

9. "Limestone", dark bluish-grey, massive.
Massive, bluish-grey, to fossiliferous.
Spores absent.

10. Sandstone, red, silty to sandy, poorly
bedded. No fossils seen. Known as
"limestone" because of
top. Spores absent.

11. Sandstone, dark greenish-grey, laminated.
With "fresh-water" limestone nodules.

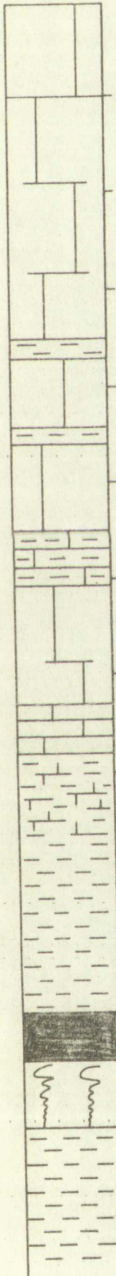
12. Sandstone, dark greenish-grey, laminated.
Silty. Spores absent.

UNIT 12
Limestone
BOLD

CORE 2

NW1/4SW1/4sec. 5, T. 27 S., R. 13 E., Greenwood County, Kansas

Feet

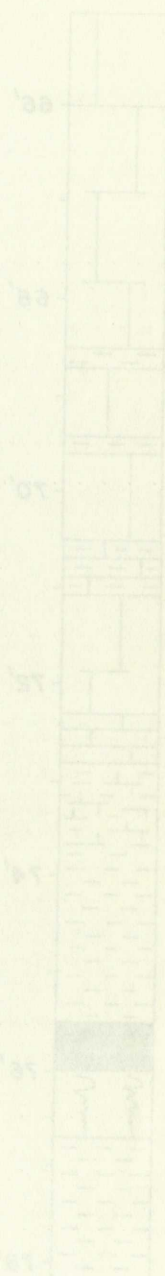
	66'	65.0-68.5 Limestone, white to light-gray, with dark gray argillaceous streaks, very fine-grained bioclastic. Fossils: fusulinids in lower part. Spores absent.
	68'	68.5-68.7 Shale, dark gray, calcareous. Spores absent.
	68'	68.7-69.5 Limestone, light-gray, fine-grained bioclastic. Fossils: fusulinids. Spores absent.
	70'	69.5-69.6 Shale parting, dark gray. Spores absent.
	70'	69.6-70.5 Limestone, light-gray, fine-grained bioclastic. Fossils: fusulinids. Spores absent.
	72'	70.5-71.0 Limestone, light-gray, argillaceous, thin-bedded. Spores absent.
	74'	71.0-72.3 Limestone, light-gray, medium-grained bioclastic, argillaceous stringers. Spores absent.
	76'	72.3-72.9 Limestone, medium-gray, argillaceous. Spores absent.
	76'	72.8-73.6 Shale, dark-gray, calcareous, massive. Spores absent.
	76'	73.6-75.5 Shale, gray, well laminated.
	78'	75.5-76.0 Coal, black, chunky.
	78'	76.0-76.7 Underclay, bluish-gray, unlaminated, blocky.
		76.7-78.0 Shale, dark-gray, laminated.
		75-77 Shale and coal sample. A very few spores present.

COAL 2

WV 42WV 4 sec. 5, T. 27 S., R. 13 E., Greenwood County, Kansas

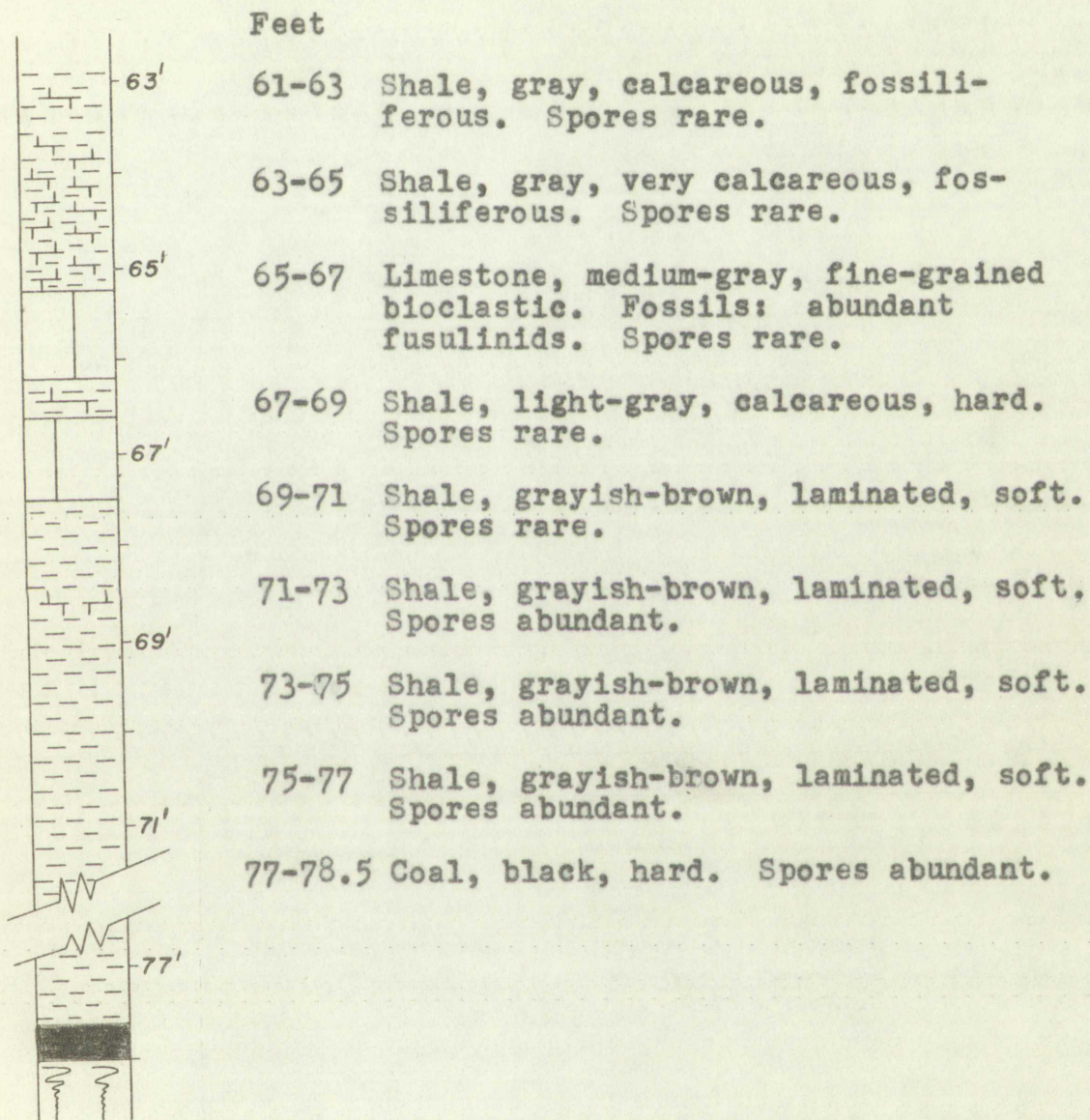
Feet

67.0-68.5	Limestone, white to light-gray, with dark gray argillaceous streaks, very fine-grained blastic. Fossils: Fusulinids in lower part. Spores absent.
68.5-69.7	Shale, dark gray, calcareous. Spores absent.
69.7-69.7	Limestone, light-gray, fine-grained blastic. Fossils: Fusulinids. Spores absent.
69.7-69.8	Shale parting, dark gray. Spores absent.
69.8-70.5	Limestone, light-gray, fine-grained blastic. Fossils: Fusulinids. Spores absent.
70.5-71.0	Limestone, light-gray, argillaceous, thin-bedded. Spores absent.
71.0-72.3	Limestone, light-gray, medium-grained blastic, argillaceous stringers. Spores absent.
72.3-72.9	Limestone, medium-gray, argillaceous. Spores absent.
72.9-73.6	Shale, dark-gray, calcareous, massive. Spores absent.
73.6-75.5	Shale, gray, well laminated.
75.5-76.0	Coal, black, canny.
76.0-76.7	Sandstone, bluish-gray, unconsolidated, blocky.
76.7-78.0	Shale, dark-gray, laminated.
78-79	Shale and coal. A very few spores present.



CORE 3

NE1/4SW1/4sec. 25, T. 29 S., R. 12 E., Elk County, Kansas



Stratigraphic Unit	Lithology	Letotrilletes sp. 1	Letotrilletes sp. 2	Letotrilletes sp. 7	Letotrilletes sp. 8	Calamospora sp. 19	Calamospora sp. 20	Calamospora sp. 21	Calamospora sp. 23	Calamospora sp. 24	Granulatisportes sp. 25	Granulatisportes sp. 26	Cylogranisportes sp. 32	Cylogranisportes sp. 35	Cylogranisportes sp. 37	Plantisportes sp. 39	Plantisportes sp. 42	Lophotrilletes sp. 44	Acanthotrilletes sp. 47	Rastriekia sp. 58	Pustulatisportes sp. 70
61'-63'	Shale						3		1								1				
63'-65'	Shale						3														
65'-67'	Limestone						1														
67'-69'	Shale		1				5				1										
69'-71'	Shale					2	37						1			1	3				
71'-73'	Shale		2	1		1	9		7	1		1	56	1			1	1		1	
73'-75'	Shale				1	3	8						61				7		1		
75'-77'	Shale					2	3	1	1				71				8				2
77'-78-1/2'	Coal and shale	1				2	21		30				10	1	1		27				

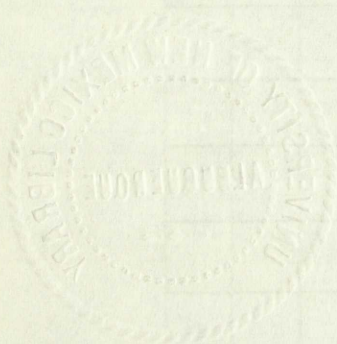
Core 3 - Number of spores present in each stratigraphic unit

Stratigraphic Unit	Lithology	Pustulatissporites sp. 72	Reticulatissporites sp. 96	Convolutisspora sp. 105	Convolutisspora sp. 107	Triquitrites sp.	Triquitrites sp. 120	Triquitrites sp. 127	Triquitrites sp. 128	Lycospora sp. 138	Lycospora sp. 140	Stimozonotrilletes sp. 152	Densosporites sp. 157	Cirratiradites sp. 161	Laevigatosporites sp. 163	Laevigatosporites sp. 166	Cadlospora sp. 141	Cadlospora sp. 144	Endosporites sp.	Endosporites sp. 186	Endosporites sp. 278
61'-63	Shale																3			2	
63'-65'	Shale													1						1	
65'-67'	Limestone																				
67'-69'	Shale																				
69'-71'	Shale		1						1	1							2				
71'-73'	Shale				1	1		1	2	1	1	1						1	2	7	
73'-75'	Shale	6		1	1	1	1		2	2	1		3			1		5		14	
75'-77'	Shale	1			2		2							1	1	1	2	2		14	
77'-78-1/2'	Coal and shale	3			1										7	71	3	4	2	86	

Core 3 - Number of spores present in each stratigraphic unit

Stratigraphic Unit	Lithology	Florinates sp.	Florinates sp. 195	Florinates sp. 196	Florinates sp. 199	Illinites sp.	Illinites sp. 205	Monoletes sp. 31	Simozonotrilletes sp. 149	Cylogranisporites sp. 31										
61'-63'	Shale	28	1	11	19															
63'-65'	Shale				5															
65'-67'	Limestone	2		1																
67'-69'	Shale				1		1													
69'-71'	Shale	2		3	10		2													
71'-73'	Shale	31		1	7	1		4												
73'-75'	Shale	1		3	9			3												
75'-77'	Shale	13		7	1	1		10												
77'-78-1/2'	Coal and shale	1			1				1	9										

Core 3 - Number of spores present in each stratigraphic unit



THE UNIVERSITY OF WISCONSIN

LIBRARY

1911

1912

1913

1914

1915

1916

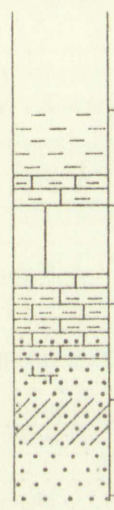
1917

1918

1919

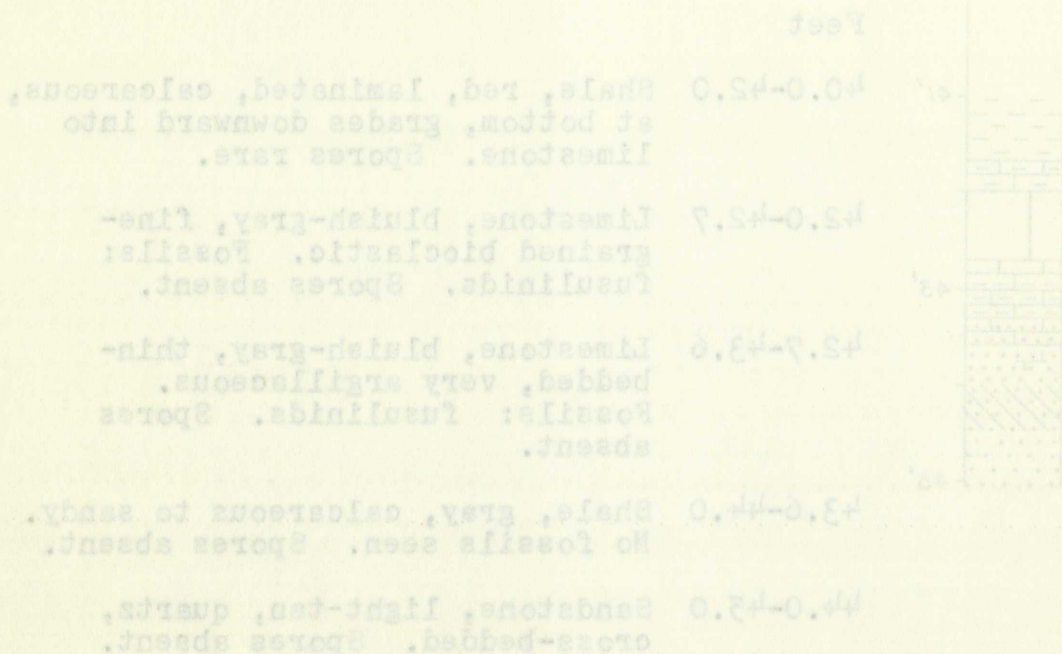
CORE 4

SE1/4NW1/4sec. 8, T. 32 S., R. 12 E., Chautauqua County, Kansas

	Feet	
	40.0-42.0	Shale, red, laminated, calcareous, at bottom, grades downward into limestone. Spores rare.
	42.0-42.7	Limestone, bluish-gray, fine-grained bioclastic. Fossils: fusulinids. Spores absent.
43'	42.7-43.6	Limestone, bluish-gray, thin-bedded, very argillaceous. Fossils: fusulinids. Spores absent.
45'	43.6-44.0	Shale, gray, calcareous to sandy. No fossils seen. Spores absent.
	44.0-45.0	Sandstone, light-tan, quartz, cross-bedded. Spores absent.

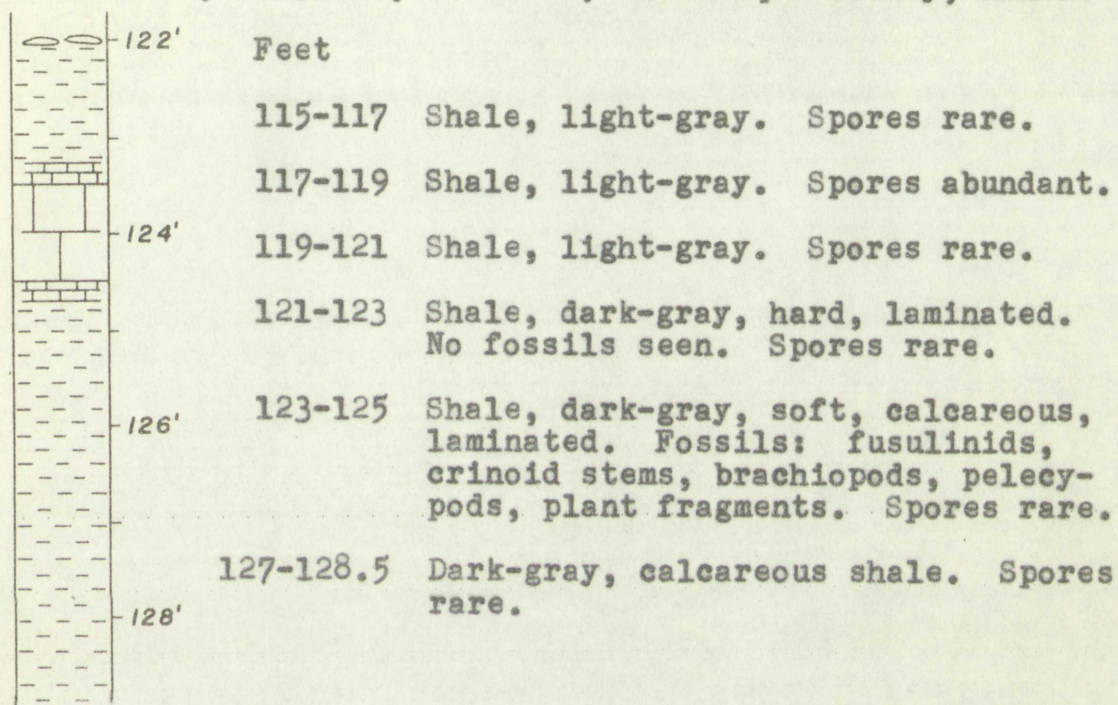
Core #

SR1-HW1/sec. 8, T. 32 S., R. 12 E., Chautauque County, Kansas



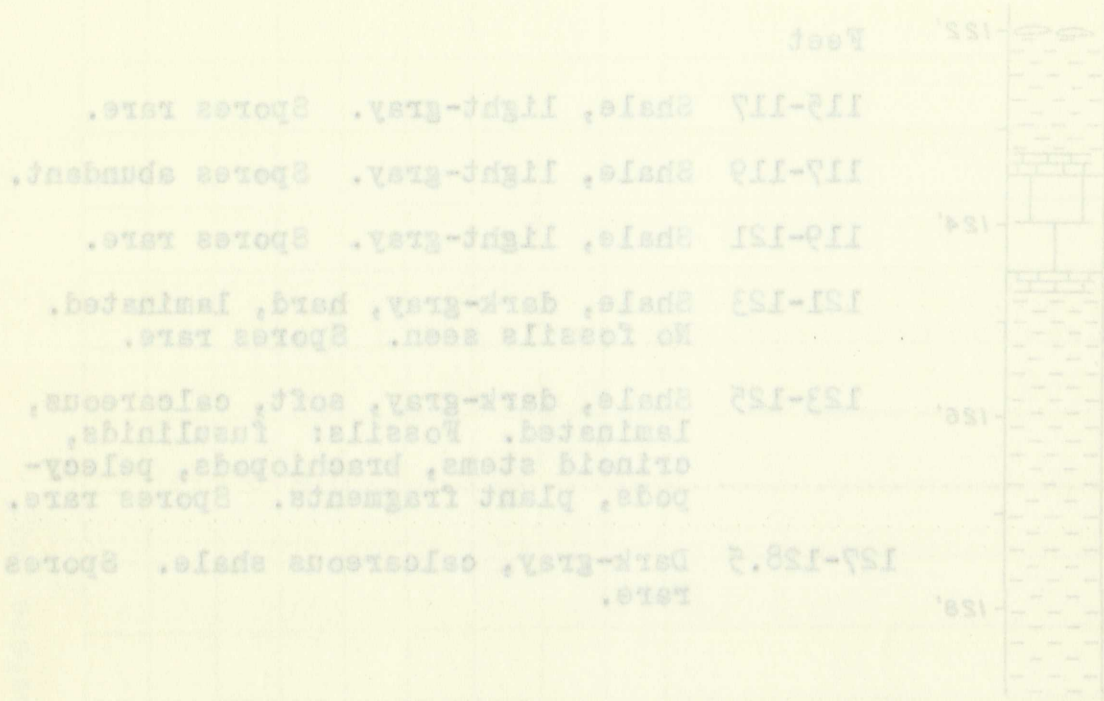
CORE 5

NE1/4sec. 12, T. 35 S., R. 10 E., Chautauqua County, Kansas



CORE 5

NEL/Sec. 12, T. 35 S., R. 10 E., Chautauque County, Kansas

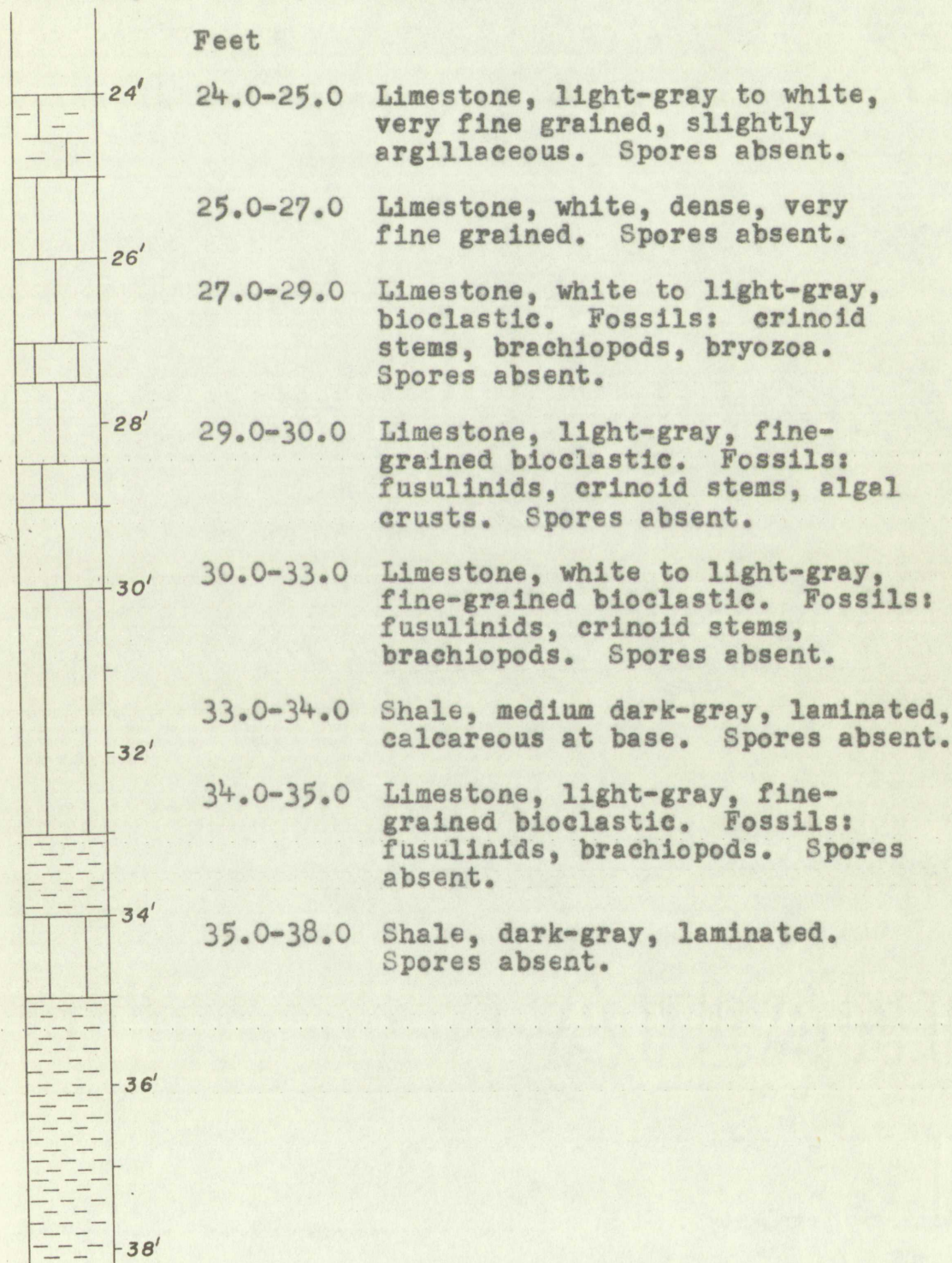


Stratigraphic Unit	Lithology	Letotrilletes sp. 2	Letotrilletes sp. 7	Punctatilisporites sp. 10	Calamospora sp. 19	Calamospora sp. 20	Calamospora sp. 23	Granulatilisporites sp. 26	Cyclogranisporites sp. 32	Cyclogranisporites sp. 35	Planisporites sp. 39	Planisporites sp. 42	Acanthotrilletes sp. 46	Acanthotrilletes sp. 50	Raistrickia sp. 53	Pustulatilisporites sp. 67	Pustulatilisporites sp. 70	Micro- reticulatilisporites sp. 102	Lycospora sp. 140	Densosporites sp. 157	Laevigatosporites sp. 163
115'-117'	Shale		3			21	1		1	1	1									1	
117'-119'	Shale	4		1	1	46			2		4			1		2		1	1	3	1
119'-121'	Shale		4		3	29			1	1		1	3		1	1	2		2		
121'-123'	Shale	1			1	29		4	6	1			1							1	
123'-125'	Shale																				
127'-128'	Shale								1		3	1					1				

Core 5 - Number of spores present in each stratigraphic unit

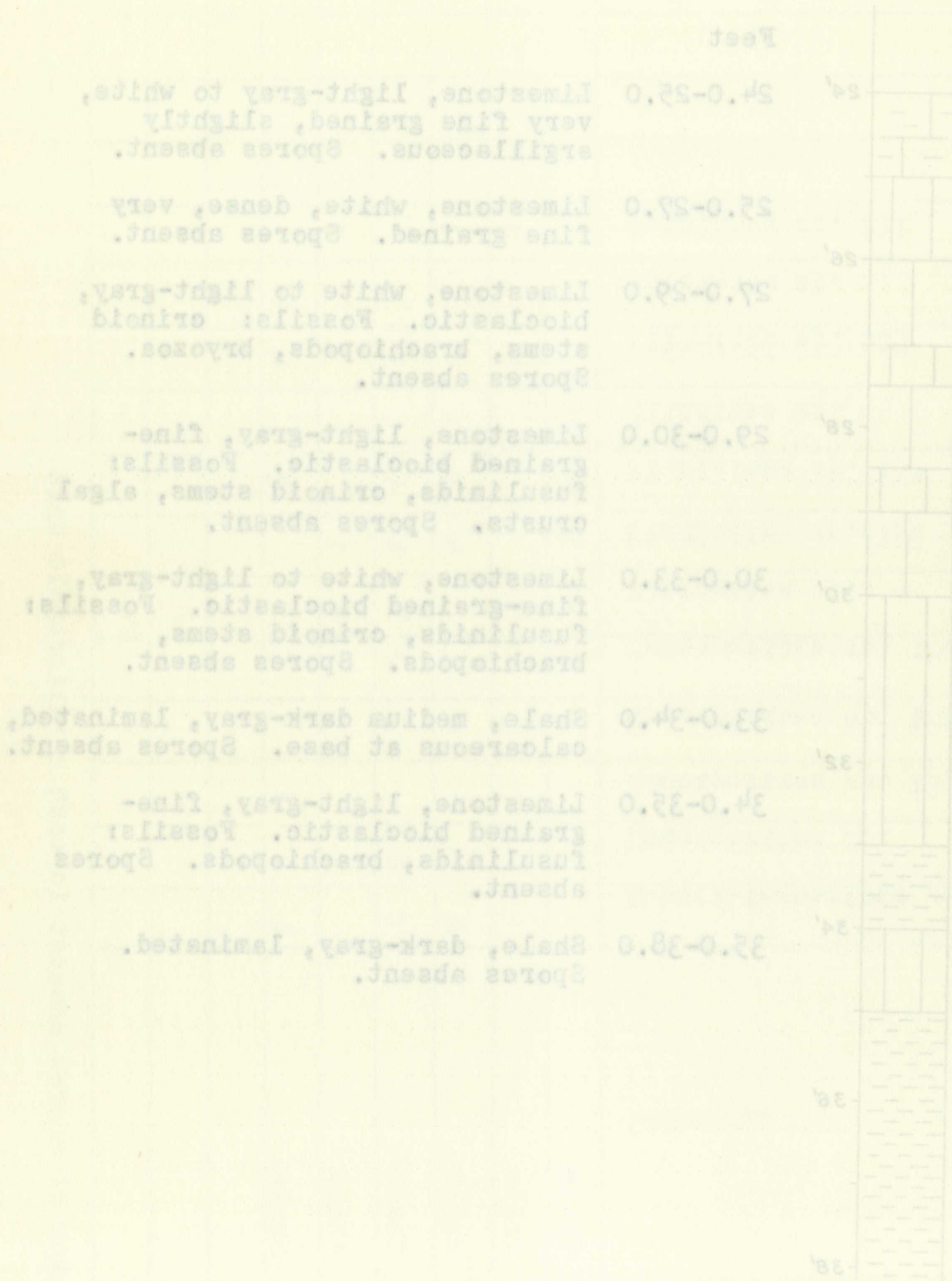
CORE 6

CSL sec. 32, T. 20 S., R. 17 E., Coffey County, Kansas



CORE 5

GSL sec. 32, T. 20 S., R. 17 E., Coffey County, Kansas

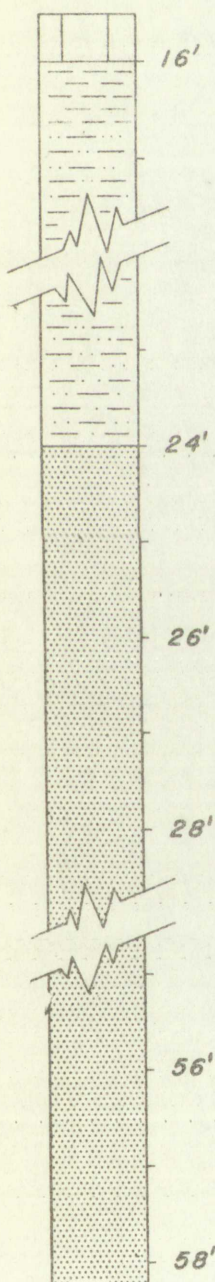


CORE 8

NW1/4NW1/4sec. 5, T. 16 S., R. 18 E., Franklin County, Kansas

Not examined for spores.

Feet



16.0 Base of Leavenworth limestone.

16.0-24.0 Shale, medium-gray to medium dark-gray, silty to finely arenaceous. No fossils seen.

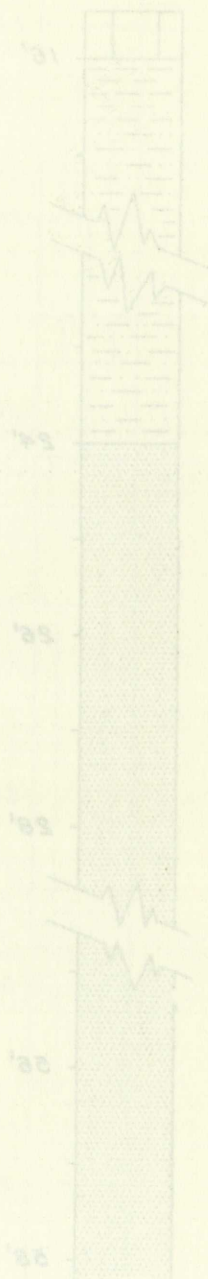
24.0-58.0 Sandstone, light-gray to medium-gray, argillaceous, slightly calcareous, fine-grained. No fossils seen.

CORE 8

NW 1/4 NW 1/4 sec. 5, T. 16 S., R. 18 E., Franklin County, Kansas

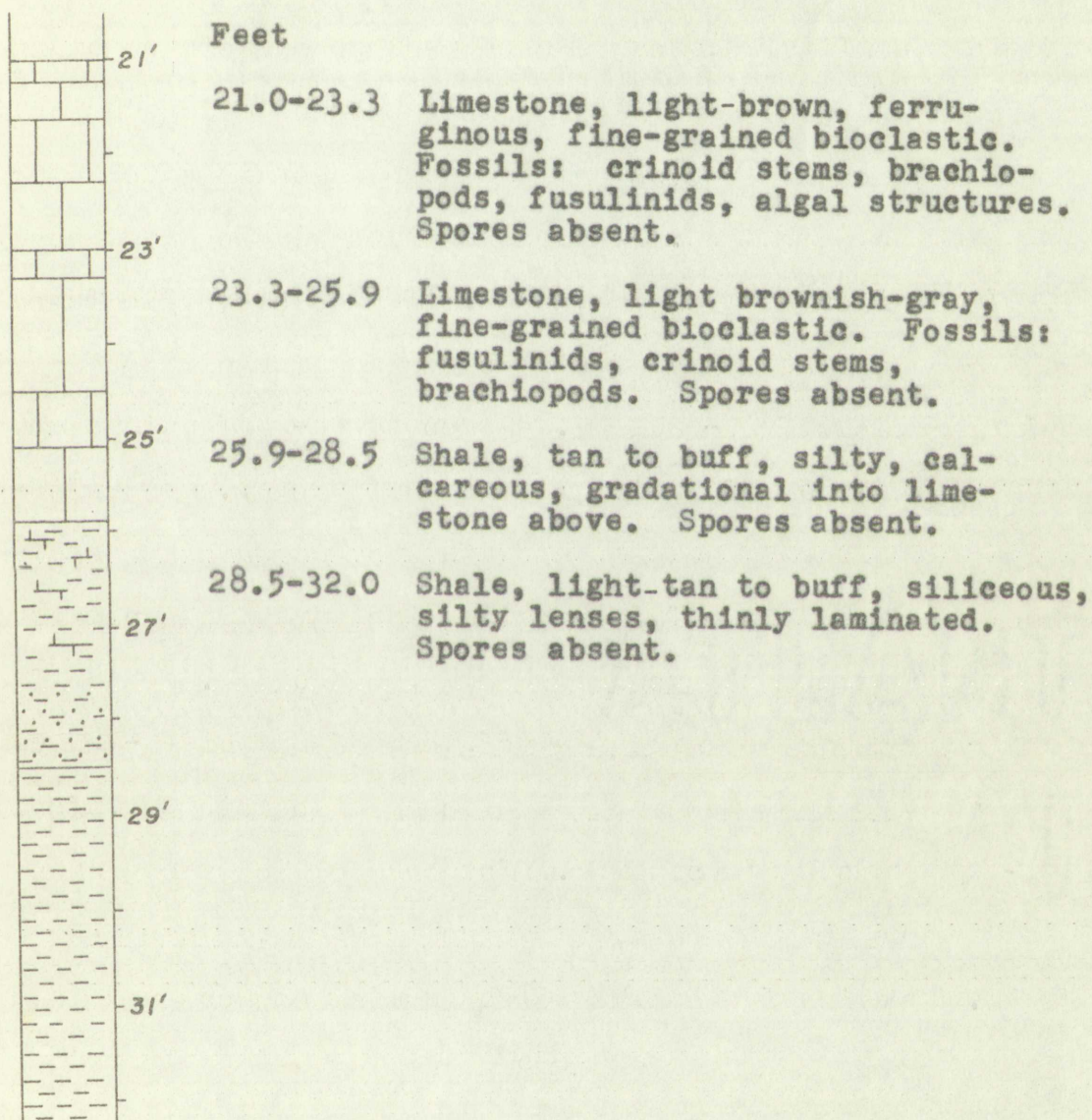
Not examined for spores.

Feet	
16.0	Base of Leavenworth limestone.
16.0-24.0	Shale, medium-gray to medium dark-gray, silty to finely arenaceous. No fossils seen.
24.0-58.0	Sandstone, light-gray to medium gray, argillaceous, slightly calcareous, fine-grained. No fossils seen.



CORE 9

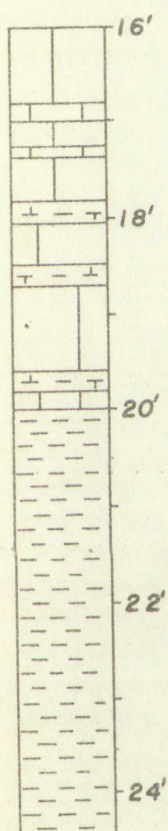
CNL sec. 26, T. 9 S., R. 21 E., Leavenworth County, Kansas



CORE 10

CSL sec. 22, T. 55 N., R. 37 W., Buchanan County, Missouri

Feet



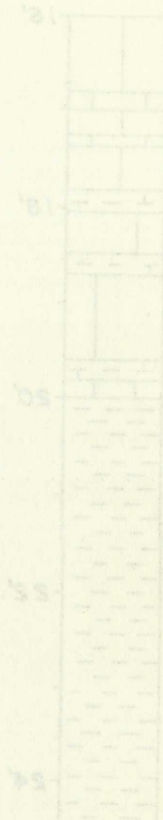
- 16.0-17.2 Limestone, light brownish-gray, bioclastic with fine-grained matrix, massive. Fossils: fusulinids, crinoid stems, algal coatings on shall fragments. Spores absent.
- 17.2-18.5 Limestone, light brownish-gray, bioclastic, possibly solution-channeled top. Fossils: abundant crinoid stems in zones. Spores absent.
- 18.5-20.0 Limestone, light brownish-gray, more bioclastic than above. Fossils: fusulinids, brachiopods, crinoid stems. Spores absent.
- 20.0-24.0 Shale, light-gray, silty, finely laminated. Spores absent.
- 24.0-25.0 Shale, medium-gray, silty, cross-bedded. Spores absent.

CORE 10

GSL sec. 22, T. 22 N., R. 27 W., Buchanan County, Missouri

West

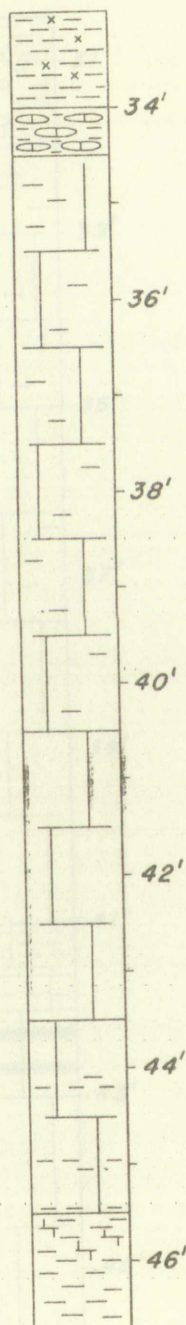
- 16.0-17.2 Limestone, light brownish-gray, blocky with fine-grained matrix, massive. Fossils: fusulinids, crinoid stems, signal corals on shell fragments. Spores absent.
- 17.2-18.2 Limestone, light brownish-gray, blocky, possibly solution-channelled top. Fossils: abundant crinoid stems in zones. Spores absent.
- 18.2-20.0 Limestone, light brownish-gray, more blocky than above. Fossils: fusulinids, brachiopods, crinoid stems. Spores absent.
- 20.0-24.0 Shale, light-gray, silty, finely laminated. Spores absent.
- 24.0-25.0 Shale, medium-gray, silty, cross-bedded. Spores absent.



GROUP 21

SW1/4SE1/4sec. 31, T. 23., R. 15 E.,
Woodson County, Kansas

Feet



8.0-11.0 Shale, olive-drab, poorly laminated.
No fossils seen. Spores absent.

11.0-24.0 Shale, reddish-gray, poorly laminated, silty. No fossils seen.
Spores absent.

24.0-34.0 Shale, slightly reddish at top, grading down into greenish-gray, poorly laminated. No fossils seen. Spores absent.

34.0-40.5 Limestone, very light gray to creamy white, dense to finely bioclastic, vuggy porosity and green shale flakes. Algal-encrusted shell fragments. Spores absent.

40.5-43.5 Limestone, creamy white, dense to finely bioclastic, no vuggy pores or green shale flakes. Fossils: a few fusulinids. Spores absent.

43.5-45.5 Limestone, very light gray, with darker argillaceous (?) streaks, dense to finely bioclastic. Fossils: few fusulinids. Spores absent.

45.5-46.7 Shale (no recovery). Spores absent.

41.0-42.0 Limestone, light-gray, bioclastic with abundant greenish-gray shale stringers and partings. No fossils seen. Spores absent.

42.0-43.0 Limestone, light-gray, coarser bioclastic, numerous fine stylolites. Spores absent.

GROUP 21

SW 1/4 Sec. 31, T. 23, R. 12 E.
Woodson County, Kansas

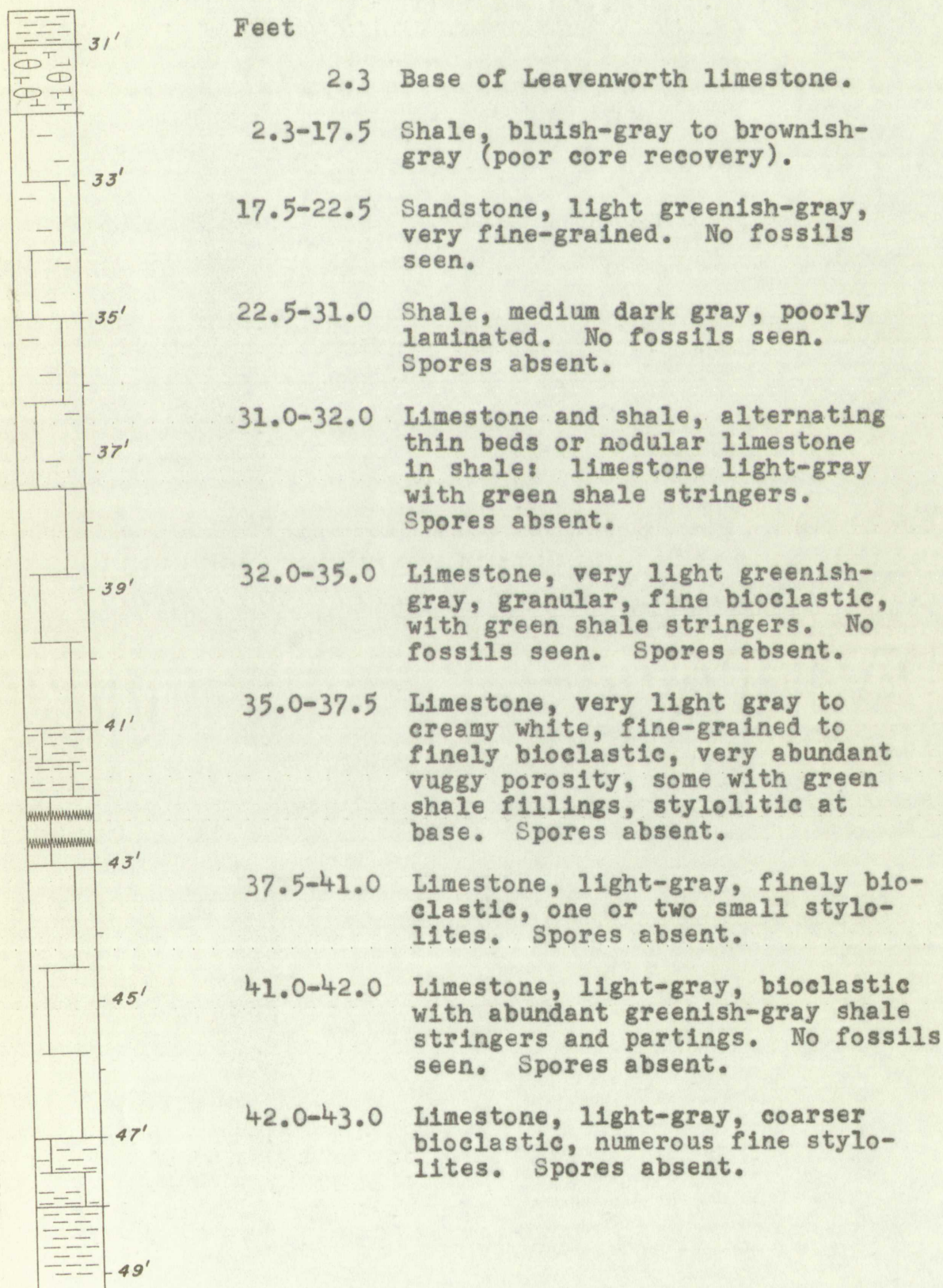
Feet

8.0-11.0	Shale, olive-drab, poorly laminated. No fossils seen. Spores absent.
11.0-24.0	Shale, reddish-gray, poorly laminated, silty. No fossils seen. Spores absent.
24.0-34.0	Shale, slightly reddish at top, grading down into greenish-gray, poorly laminated. No fossils seen. Spores absent.
34.0-40.5	Limestone, very light gray to creamy white, dense to finely biclastic, vuggy porosity and green shale flakes. Algal-encrusted shell fragments. Spores absent.
40.5-43.5	Limestone, creamy white, dense to finely biclastic, no vuggy pores or green shale flakes. Fossils: a few fusulinids. Spores absent.
43.5-45.5	Limestone, very light gray, with darker argillaceous (?) streaks, dense to finely biclastic. Fossils: few fusulinids. Spores absent.
45.5-46.7	Shale (no recovery). Spores absent.



CORE 23

C N 1/2SW1/4sec. 4, T. 23 S., R. 15 E., Coffey County, Kansas



CORE 23

- 43.0-47.0 Limestone, very light gray, medium grained bioclastic, few shale partings. Fossils: sparse fusulinids. Spores absent.
- 47.0-48.0 Limestone, light- to medium-gray, fine-grained, argillaceous. No fossils seen. Spores absent.
- 48.0-53.3 Shale, medium dark gray, non-calcareous, moderately well laminated. Fossils: numerous well-preserved carbonaceous plant leaves and other plant remains. Spores absent.

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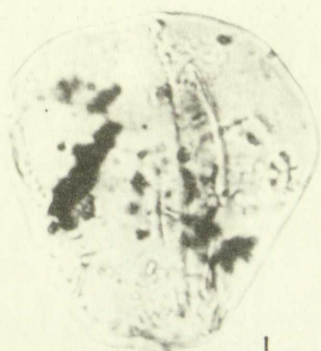
EXPLANATION OF PLATE 1

- Figure 1. Leiotriletes sp. 1, 51 x 51 x 56 microns, p. 31
2. Leiotriletes sp. 2, 35 microns, p. 31
 3. Leiotriletes sp. 7, 44 x 44 x 49 microns, p. 32
 4. Leiotriletes sp. 8, 22 microns, p. 32
 5. Punctatisporites sp. 10, 61 x 61 microns, p. 32
 6. Punctatisporites sp. 12, 56 x 48 microns, p. 32
 7. Calamospora sp. 19, 72 x 82 microns, p. 33
 8. Calamospora sp. 20, 36 x 36 microns, p. 33
 9. Calamospora sp. 21, 83 x 85 microns, p. 33
 10. Calamospora sp. 23, 56 x 63 microns, p. 33
 11. Granulatisporites sp. 25, 29 microns, p. 34
 12. Granulatisporites sp. 26, 24 x 24 x 26 microns, p. 34

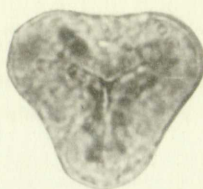
EXPLANATION OF PLATE I

- Figure I. Leptotriton sp. 1, 51 x 51 x 56 microns, p. 31
2. Leptotriton sp. 2, 35 microns, p. 31
3. Leptotriton sp. 7, 44 x 44 x 49 microns, p. 32
4. Leptotriton sp. 8, 22 microns, p. 32
5. Pseudotriton sp. 10, 61 x 61 microns, p. 32
6. Pseudotriton sp. 12, 56 x 48 microns, p. 32
7. Calamagrostis sp. 19, 72 x 82 microns, p. 33
8. Calamagrostis sp. 20, 36 x 36 microns, p. 33
9. Calamagrostis sp. 21, 83 x 85 microns, p. 33
10. Calamagrostis sp. 23, 56 x 63 microns, p. 33
11. Granulatisporites sp. 25, 29 microns, p. 34
12. Granulatisporites sp. 26, 24 x 24 x 26 microns, p. 34

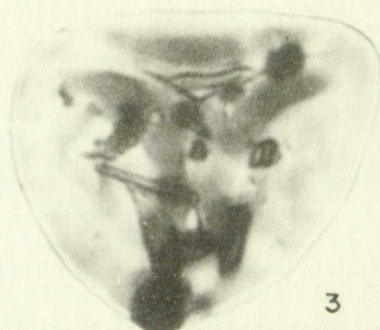
PLATE I



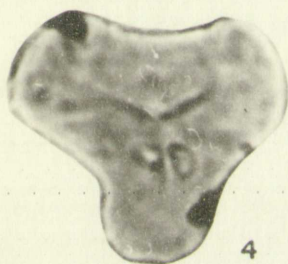
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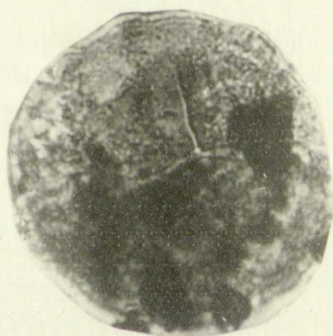
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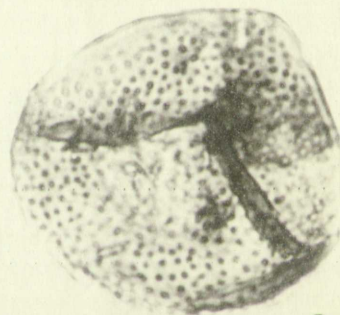
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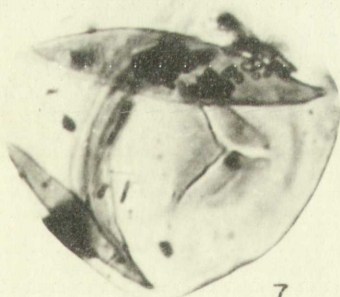
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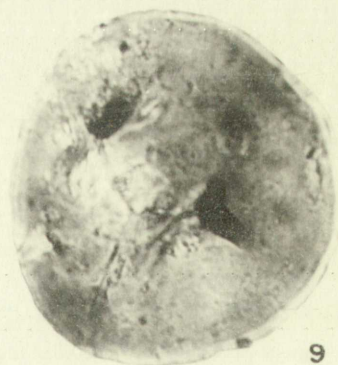
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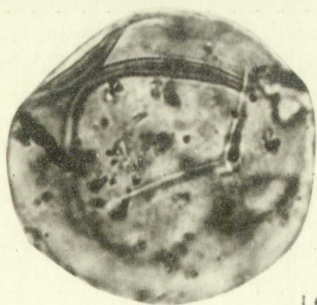
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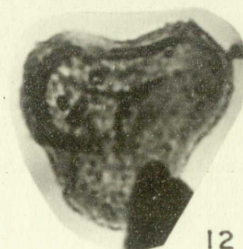
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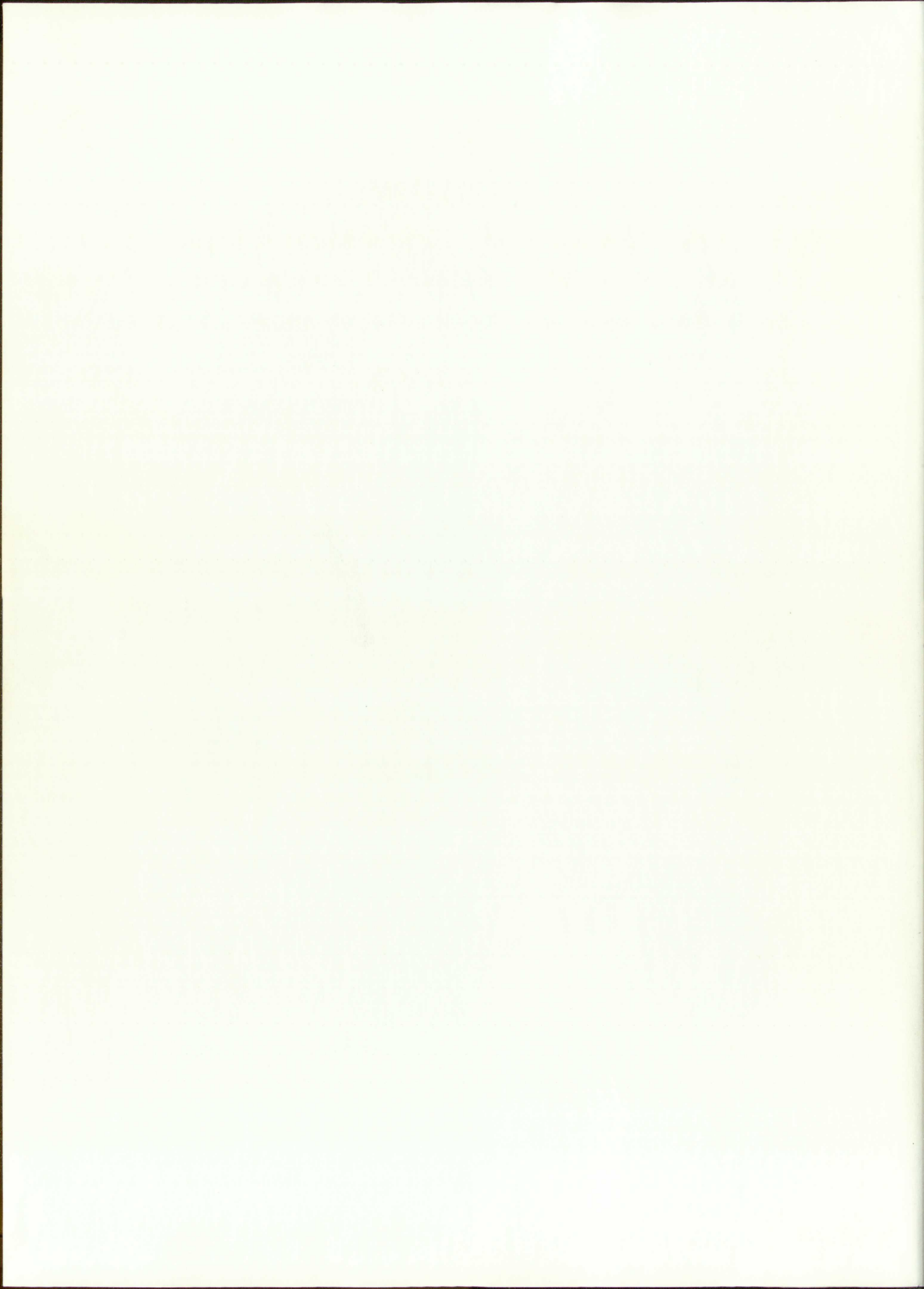
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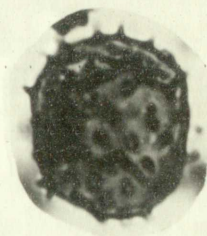
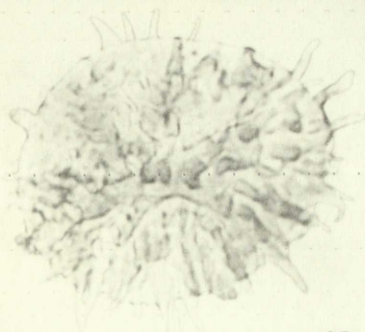
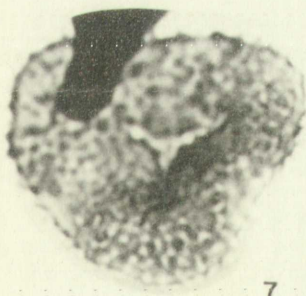
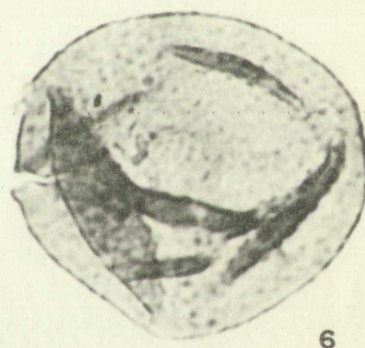
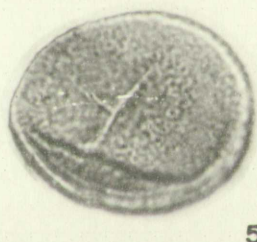
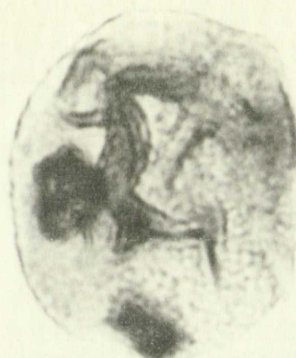
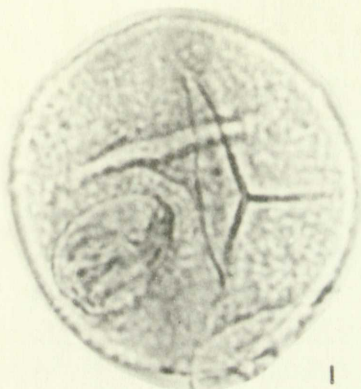
EXPLANATION PLATE 2

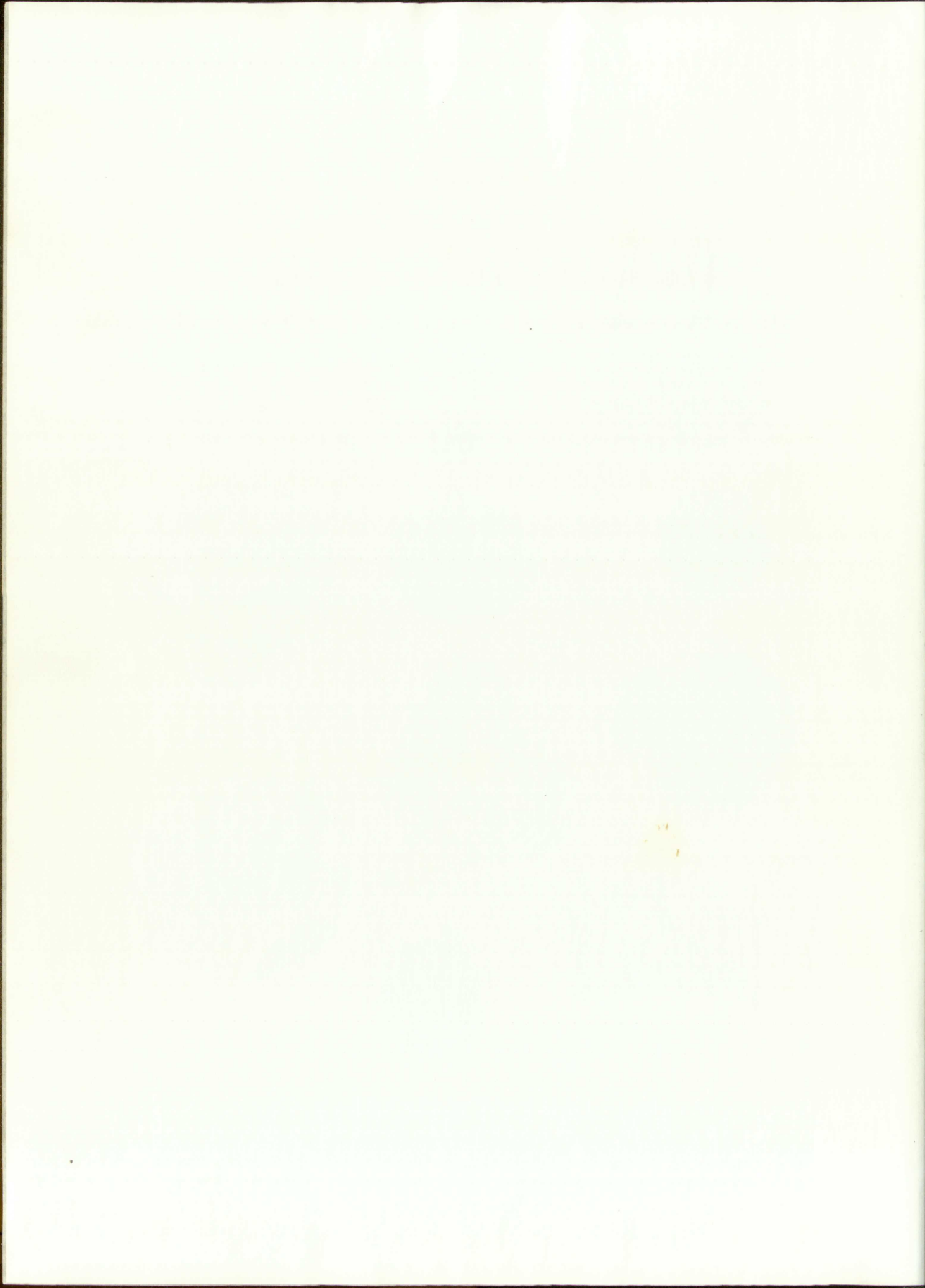
- Figure 1. Cyclogranisporites sp. 31, 49 x 49 microns, p. 34.
2. Cyclogranisporites sp. 32, 36 x 39 microns, p. 35
3. Cyclogranisporites sp. 35, 68 x 69 microns, p. 35
4. Planisporites sp. 39, 22 x 22 microns, p. 35
5. Planisporites sp. 41, 36 x 43 microns, p. 36
6. Planisporites sp. 42, 53 x 58 microns, p. 36
7. Lophotriletes sp. 44, 29 x 32 x 34 microns, p. 36
8. Acanthotriletes sp. 46, 29 x 32 x 32 microns, p. 37
9. Acanthotriletes sp. 47, 41 x 44 x 46 microns, p. 37
10. Acanthotriletes sp. 290, 51 x 63 microns, p. 137
11. Pustulatisporites sp. 67, 24 microns, p. 37

EXPLANATION OF PLATE I

- Figure 1. *Cycloanthracites* sp. 11, 10 x 15 microns, 11.5
 2. *Cycloanthracites* sp. 12, 10 x 15 microns, 12.5
 3. *Cycloanthracites* sp. 13, 10 x 15 microns, 13.5
 4. *Planorbites* sp. 14, 10 x 15 microns, 14.5
 5. *Planorbites* sp. 15, 10 x 15 microns, 15.5
 6. *Planorbites* sp. 16, 10 x 15 microns, 16.5
 7. *Loxostoma* sp. 17, 10 x 15 microns, 17.5
 8. *Acanthopora* sp. 18, 10 x 15 microns, 18.5
 9. *Acanthopora* sp. 19, 10 x 15 microns, 19.5
 10. *Acanthopora* sp. 20, 10 x 15 microns, 20.5
 11. *Pseudoschizothoe* sp. 21, 10 x 15 microns, 21.5

PLATE 2

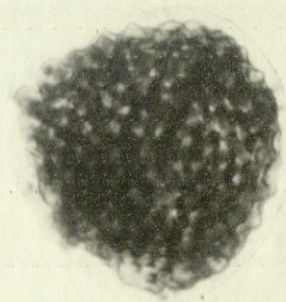
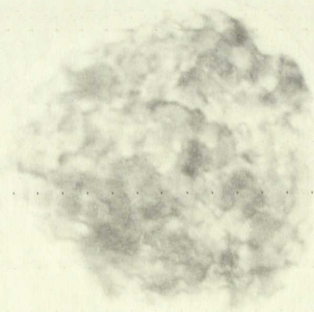
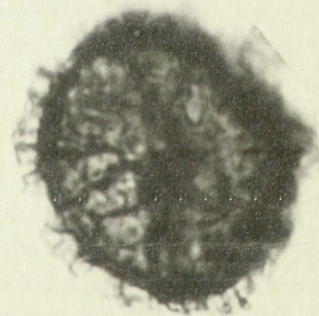
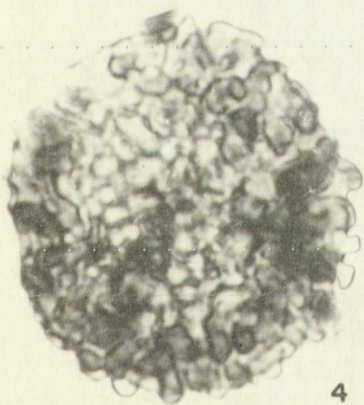
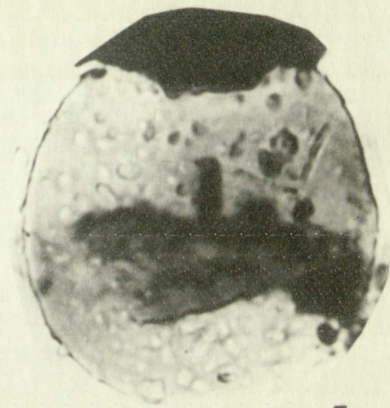
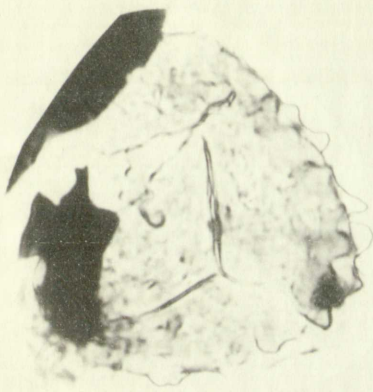


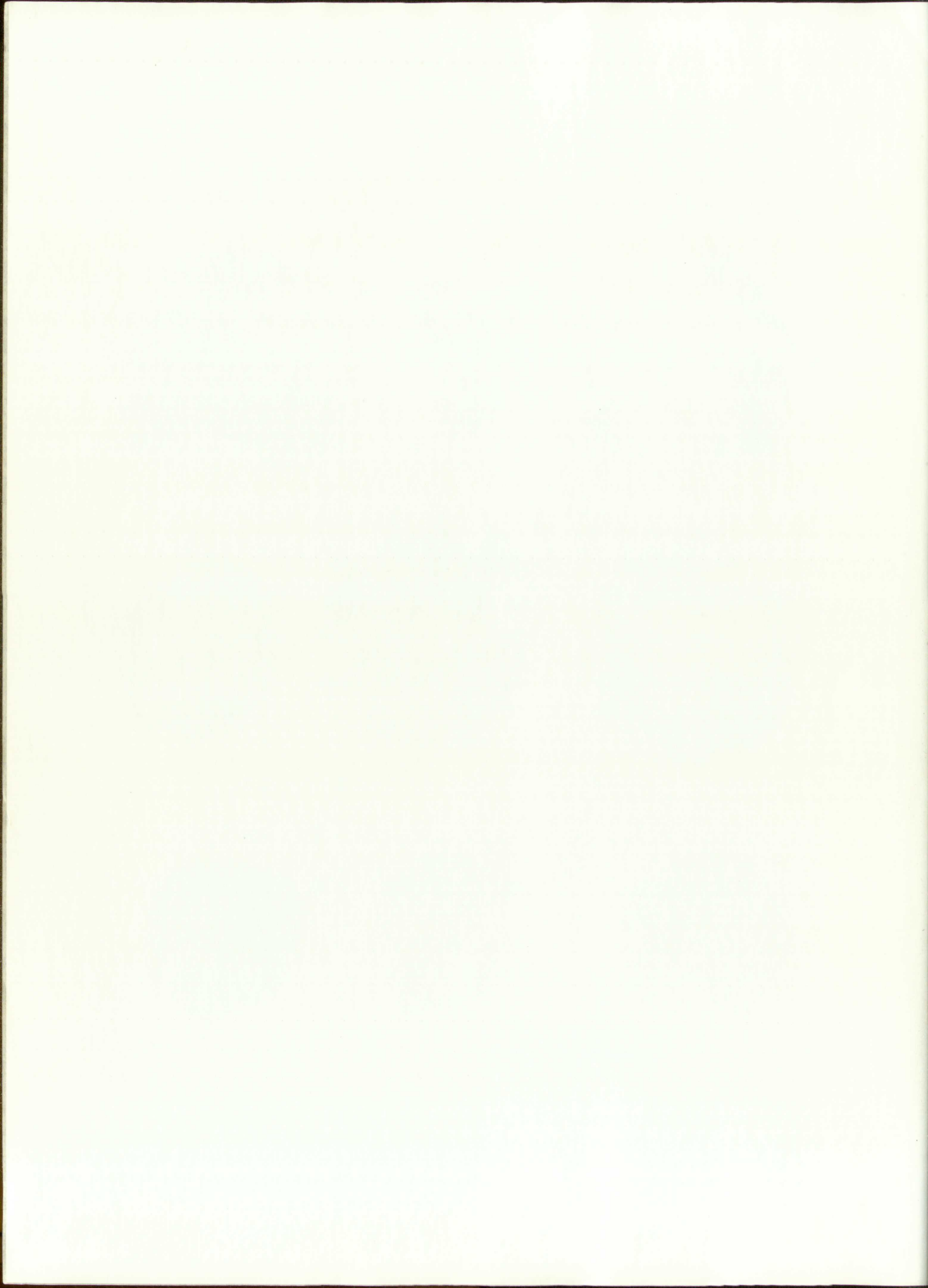


EXPLANATION OF PLATE 3

- Figure 1. Pustulatisporites sp. 72, 50 microns, p. 38
2. Pustulatisporites sp. 74, 26 x 28 microns, p. 38
3. Pustulatisporites sp. 84, 46 x 51 microns, p. 38
4. Raistrickia sp. 53, 48 microns, p. 39
5. Raistrickia sp. 58, 46 x 51 microns, p. 39
6. Reticulatisporites sp. 96, 36 x 39 microns, p. 40
7. Convolutispora sp. 105, 41 x 43 microns, p. 41
8. Convolutispora sp. 107, 46 x 48 microns, p. 41
9. Convolutispora sp. 107, 46 x 48 microns, p. 41

PLATE 3

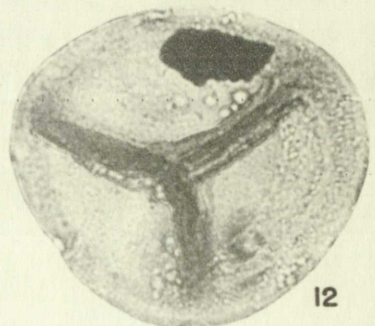
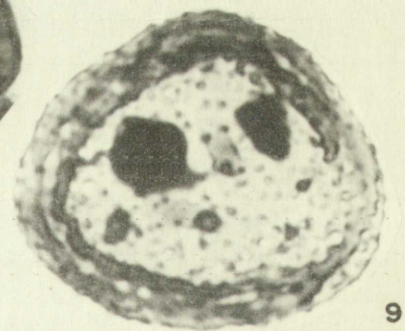
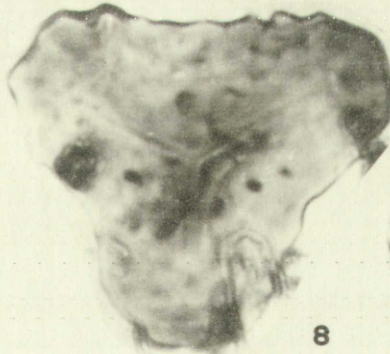
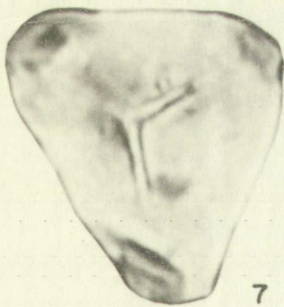
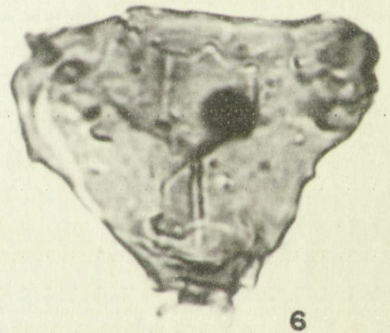
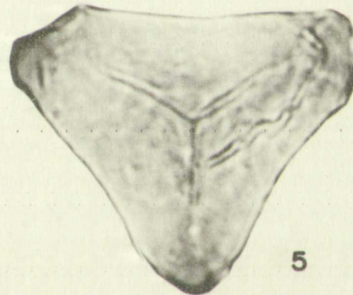
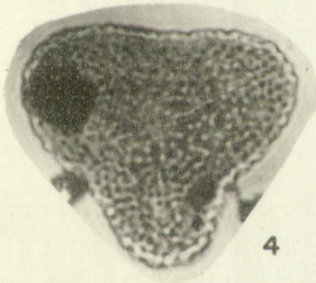
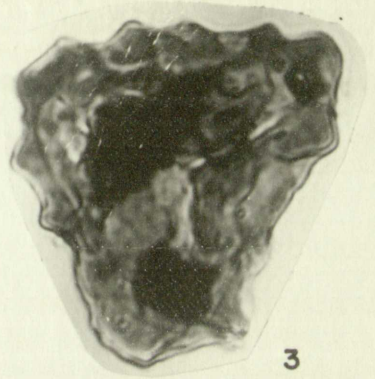
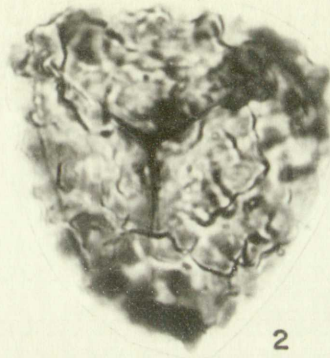
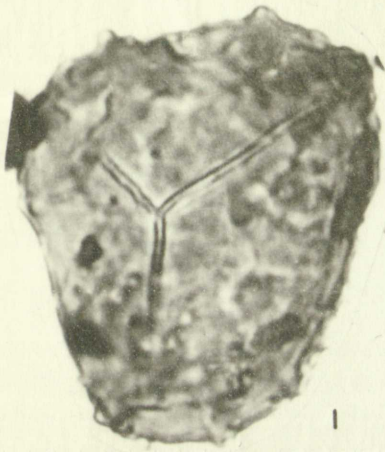


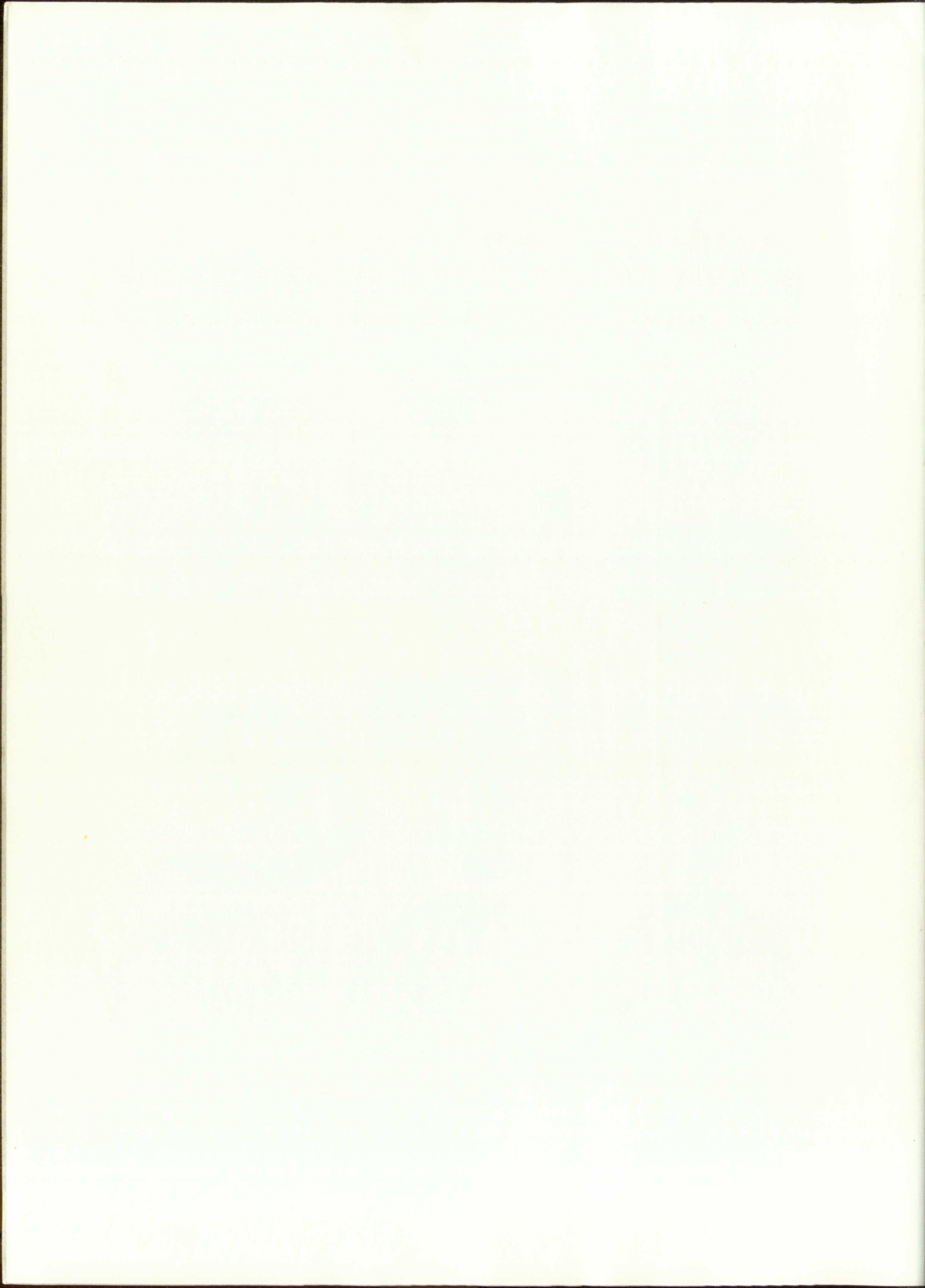


EXPLANATION OF PLATE 4

- Figure 1. Convolutispora sp. 109, 41 x 46 microns, p. 41
2. Convolutispora sp. 109, 53 x 53 microns, p. 41
3. Convolutispora sp. 114, 43 x 43 microns, p. 41
4. Convolutispora sp. 312, 36 x 36 x 36 microns, p. 42
5. Triquitrites sp. 124, 36 x 36 x 39 microns, p. 43
6. Triquitrites sp. 125, 36 x 39 x 41 microns, p. 43
7. Triquitrites sp. 127, 27 x 29 x 29 microns, p. 43
8. Triquitrites sp. 128, 36 x 36 x 36 microns, p. 43
9. Lycospora sp. 138, 56 x 63 microns, p. 44
10. Lycospora sp. 140, 28 x 32 microns, p. 44
11. Cadiospora sp. 141, 102 x 119 microns, p. 45
12. Cadiospora sp. 144, 97 x 102 microns, p. 45

PLATE 4





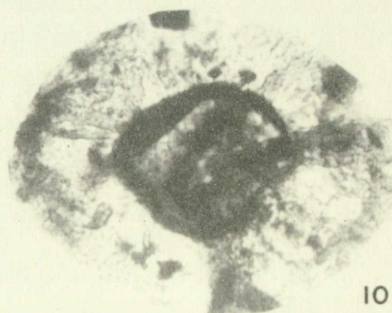
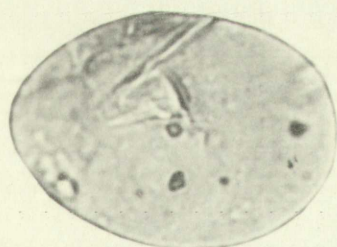
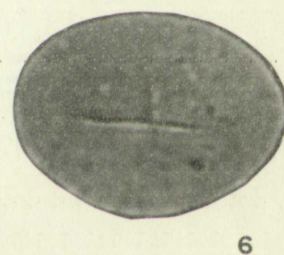
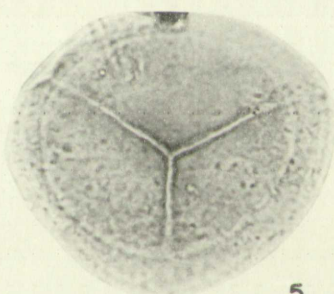
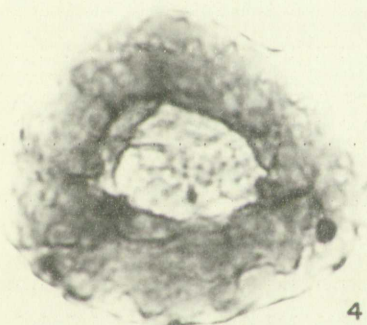
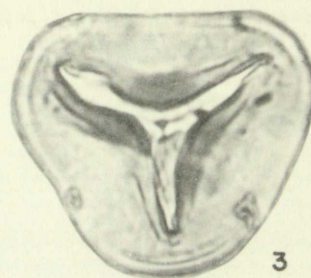
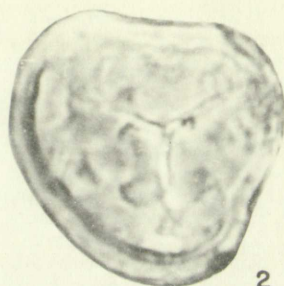
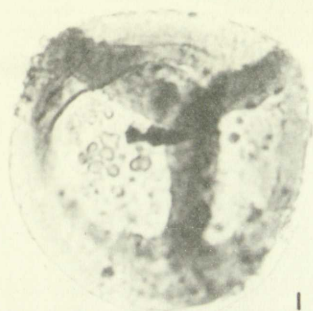
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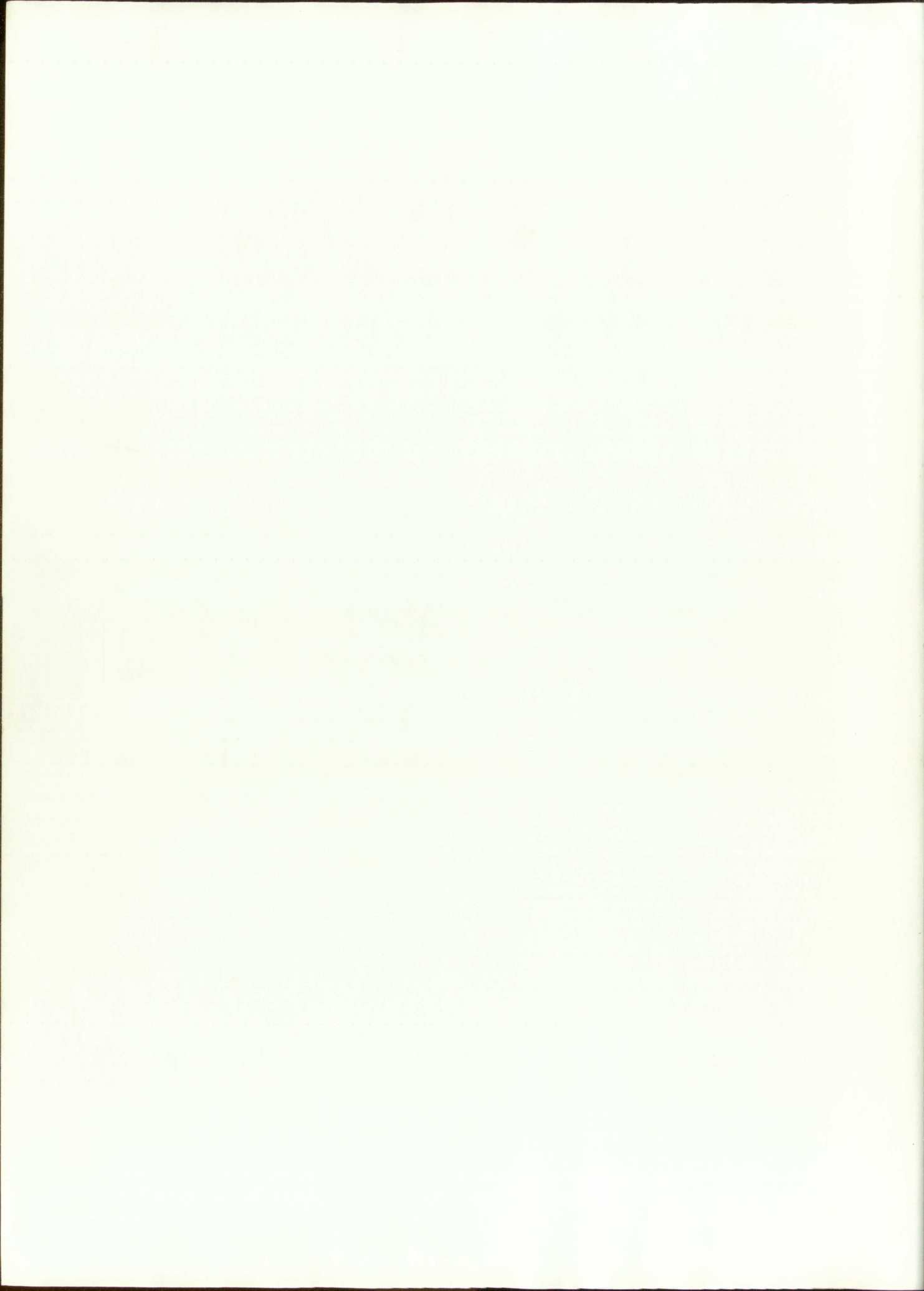
- Figure 1. Cadiospora sp. 144, 75 x 75 microns, p. 45
2. Simozonotriletes sp. 152, 56 microns, p. 46
3. Simozonotriletes sp. 152, 56 microns, p. 46
4. Densosporites sp. 157, 39 x 48 microns, p. 46
5. Cirratriradites sp. 161, 66 x 72 microns, p. 47
6. Laevigatosporites sp. 163, 32 x 41 microns,
p. 47
7. Laevigatosporites sp. 166, 45 x 65 microns,
p. 48
8. Monoletes sp. 231, 97 x 148 microns, p. 48
9. Monoletes sp. 231, 97 x 158 microns, p. 48
10. Endosporites sp. 185, over-all 122 x 122 microns,
body 53 x 56 microns, p. 49

EXPERIMENTAL

- Figure 1. *Chlorobacterium* sp. 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.

PLATE 5





EXPLANATION OF PLATE 6

- Figure 1. Endosporites sp. 186, over-all 102 microns, body
46 x 53 microns, p. 49
2. Endosporites sp. 190, over-all 60 x 70 microns,
body 32 x 34 microns, p. 49
3. Endosporites sp. 278, over-all 51 x 53 microns,
body 29 x 32 microns, p. 50
4. Florinites sp. 196, over-all 58 x 104 microns,
body 49 microns, p. 50
5. Florinites sp. 196, over-all 97 x 126 microns,
body 58 x 61 microns, p. 50
6. Florinites sp. 199, over-all 106 x 138 microns,
body 73 x 92 microns, p. 51
7. Illinites sp. 205, over-all 34 x 51 microns,
body 22 x 34 microns, p. 51

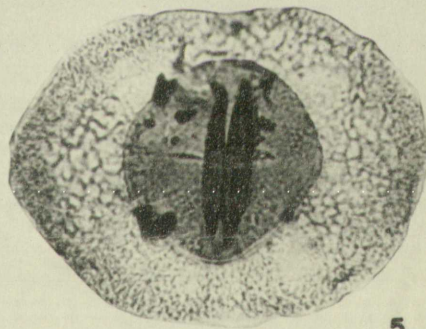
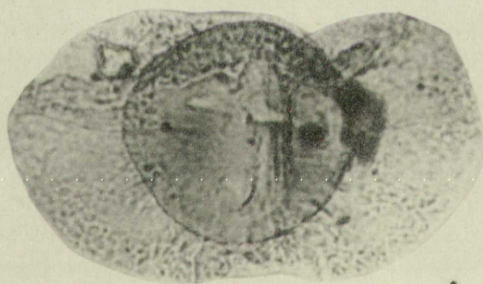
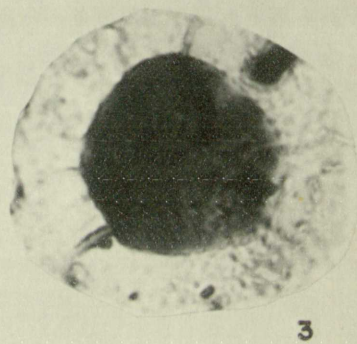
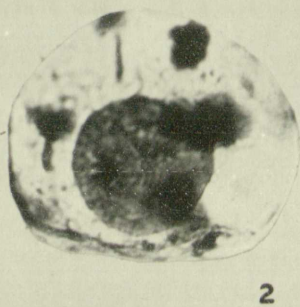
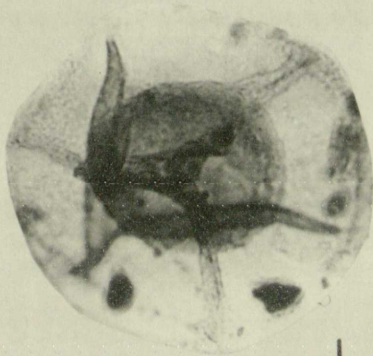
STATION HOUSE

RECORDS OF

- Figure 1. *Phragmites* sp. 195, over-all 1.0 m. wide, body 0.5 m. wide, 0.5 m. high.
2. *Phragmites* sp. 197, over-all 1.0 m. wide, body 0.5 m. wide, 0.5 m. high.
3. *Phragmites* sp. 198, over-all 1.0 m. wide, body 0.5 m. wide, 0.5 m. high.
4. *Phragmites* sp. 199, over-all 1.0 m. wide, body 0.5 m. wide, 0.5 m. high.
5. *Phragmites* sp. 200, over-all 1.0 m. wide, body 0.5 m. wide, 0.5 m. high.
6. *Phragmites* sp. 201, over-all 1.0 m. wide, body 0.5 m. wide, 0.5 m. high.
7. *Phragmites* sp. 202, over-all 1.0 m. wide, body 0.5 m. wide, 0.5 m. high.

STATION HOUSE
RECORDS OF

PLATE 6



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