Recapitulation

My attention was first directed to the specimens referred to in this paper by the late Sir W. E. Logan in 1869. He had obtained from Kettle Point Lake Huron specimens of ~~Stratta~~ Shale filled with minute circular discs & asked he referred as Microscopic obscure bodies in his report of 1863. Recognizing them to be macrospores or spore cases I introduced them into the Report on the Erian Flora which I was then preparing under the name Spirangites Hallianus.

× the Upper Erian Shale of

and which was published in 1871,

In 1871 having occasion to make a communication to the American Journal of Science on the question then rising as to the Plant of Spore and Spore cases on the accumulation of coal there common little bodies were again noticed and were described in substance as follows.

"The oldest kind of Spore cases known to me is that at Kettle Point Lake

Hamm. This a bed of hard bituminous shale burning with much flame and under a lens is seen to be studded with flattened disc-like bodies bearing more than a hundredth of an inch in diameter which under the microscope are seen to be spore cases (or microspores) highly papillate externally (or more properly marked with dark pores), and sometimes showing a point of attachment on one side and a slit where it has elongated and sloping on the other. When slices of the rock are made its substance is seen to be filled with these bodies which viewed as transparent objects appear yellow like amber and show little structure except that the walls can be distinguished from the internal cavity which may sometimes be seen to enclose patches of granular matter. In the shale containing them are also vast numbers of rounded translucent grannules which may be escaped spores (microspores)"

The bed, containing these spores, at Kettle Point is overlaid in the upper of the Sedgwick Series by the 12 to 14 feet in

thickness, and besides these Spinecaves it contained fossil plants referable to the Genera Calamites annularia and Lepidodendron primaevum, and I not unnaturally supposed that ~~these~~ the Spirangites might be the fruit of the latter plant. ~~I do~~ I also intend these remarks to the Spinecaves of the Coniferous Conifers the Lepidodendra allied to Lepidodendron and to those fossil fruits described & figured by Carruthers under the name Flemingites as well as to those ~~in the~~ described & figured by Hawkins from certain English Coals and to those ~~fossil~~ from myself from Coniferous of the Carboniferous in which case of Australia. The bed at Kettle Point is known to be marine & to contain Spirophyton and Fucoids of Lingula

The Subject did not again come under my notice till 1882 when Rev. Dr. Dawson of Columbus Ohio sent me some specimens from the Swan Shales of that State which on comparison seemed undistinguishable from Spirangites Burmeensis.

Prof Orton read an interesting paper on these beds at the Meeting of the American Association at Montreal*, in which were some new and striking facts. One of these was the occurrence of these beds throughout the black shale of Ohio, extending from the Huron River on the shore of Lake Erie to the mouth of the Scioto in the Ohio valley, with an outcrop varying from ten to twenty miles in breadth; and estimated to be 350 feet in thickness. Another was the absence of any traces of Lepidodendrons and Cones and the occurrence of plant remains regarded & mostly Ferns the Sphenopteris Leconei to be in some cases attached in pairs. Prof Orton also noticed the absence of the Trigonal form which belongs to the Spines of many Lepidodendra but this is not a constant character. In the discussion on Prof Orton's paper

* On the Source of the Bituminous matter of the Black Shales of Ohio. Proc Am Assn 1882

I submitted that the facts elicited by him shook my previous belief of the lycopodiaceous character of these bodies and induced me to suspect with Prof. Nicholson that they might have belonged to some group of aquatic plants known than the Lycopods.

In same

At the meeting of the American Association, in the discussion of Prof. Orton's paper, Prof. Williams, of Cornell University, mentioned that he had found similar bodies in the Hamilton shales of New York, and that they were associated with the curious pinnately leaved plant *Ptilophyton Vanuxemii*, an observation to which I subsequently referred in discussing the affinities of this plant, in a report on the Erian plants of Canada, published in 1882.* Prof. Williams was kind enough to send me specimens, in which, however, the rouud spore-case-like bodies were much less distinct than in the specimens from Ohio and

* Report on Erian Plants of Canada. Part II.

Lake Huron. In the report above referred to I have also noticed the occurrence of rounded spore-like bodies in association with the stems of *Trochophyllum* of Lesquereux from the lower carboniferous of Pennsylvania, and of which specimens were submitted to me by Mr. Lacoe of Pittston, and Prof. Lesquereux. *Trochopyllum* I regard as closely allied to or perhaps congeneric with *Ptilophyton*, and in the report already referred to have argued that these plants were probably aquatic.

Still more recently Prof. J. M. Clarke, of Northampton, Massachussets, was so kind as send me two fragments of rock containing *Sporangites* similar to those above mentioned—one from the Genessee shale of Canandaigua, N. Y., and another from the Corniferous Limestone. In the latter these bodies retain their globular form, though some are partially crushed in such a way as to show their membranous character. In slices prepared by Prof. Clarke the wall is seen to be thin and carbonaceous with indications of a dense cellular structure, and some of the specimens show a projecting aperture or point of attachment at one side, giving them a somewhat pear-shaped appearance. The size of all these macrospores from the Erian of New York is nearly the same with that of Lake Huron specimens. Those found with *Trochophyllum* in the Lower Carboniferous are much larger.*

No certain clue seemed to be afforded by all these observations as to the precise affinities of these widely distributed bodies; but in March last, Mr. Orville Derby, of the Geological Survey of Brazil sent me specimens found along with fronds of *Spirophyton* in the Erian of that country, which seemed to throw a new light on the whole subject. Mr. Derby's specimens recalled to remembrance certain fossils which had been sent to me several years ago by the late Prof. Hartt, and which, like Mr. Derby's specimens, occurred iu beds holding *Spirophyton*, though these were at that time regarded as Carboniferous. In a note prepared for Prof. Hartt, but not, so far as I am aware, published, I had noticed these fossils as follows:—

"*Sporangites*—Specimens from a shale at Rio Tapagos, above Haituba.

"These are spore-cases, probably of a Lepidodendroid plant, and appear to be similar to those described by Carruthers (London Geological Magazine), as found in cones from Brazil, referred by him to his genus *Flemingites*.* Carruthers' specimens were

* Geological Magazine. Vol. VI, p. 151.

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but there was somewhat [illegible] after prin ch over- pealed plaster.

with Sporangites & pointed out their connection with Spirophyton

There I described at the Meeting of the American Association at Minneapolis at 1883, and subsequently published my notes respecting them in Proceedings & Trans. of the Canadian Royal Society

Assembly Gr. Westminster of the Dominion Parliament,

In March 1883

* Prof Clarke has described his specimens in the American Journal of Science Apl 1885, and has entered some interesting points & he referred to in the Report.

from Rio Grande du Sul, and were found in shales associated with beds of coal, and believed to be of Carboniferous age, though the fossil leaves found with them and attributed to *Noeggerathia* and *Odontopteris* would, if interpreted by North American analogies, be supposed to be older than the true coal formation. The present specimens are labelled as Carboniferous, but the occurrence in them of abundant fronds of *Spirophyton* rather points to a Devonian date."

Mr. Derby's specimens contain *Spirophyton* and also minute rounded *Sporangites* like those obtained by Prof. Hartt. But they differ in showing the remarkable fact that these rounded bodies are enclosed in considerable numbers in spherical and oval sacs, the walls of which are composed of a tissue of hexagonal cells, and which resemble in every respect the involucres or spore-sacs of the little group of modern acrogens, known as Rhizocarps, and living in shallow water. More especially they resemble the sporocarps of the genus *Salvinia*. This fact opens up an entirely new field of investigation, and I would now proceed to describe these interesting specimens, to inquire as to their probable affinities with modern plants and their probable relations to other palaeozoic forms of vegetation found with them.

Mr. Derby's specimens are labelled as from Rio Trombetos and Rio Curuá. They occur in two kinds of matrix. One is a thinly laminated sandy shale, tinged red with peroxide of iron, and with occasional ferruginous laminae. In this the spore-sacs are flattened and black, and show the structure of the walls under the microscope. The contained macrospores, when visible, appear as minute tubercles or sometimes as depressions on the wall of the envelope or more frequently as round light coloured spots, according to their state of preservation (fig. 1 *a*). The other kind of matrix is a gray dense shale in which the spore-sacs appear less flattened and destitute of carbonaceous matter.

The very numerous spore-sacs contained in these shales are extremely variable in size and form, and may have belonged to several species of plants. They resolve themselves, however, into two leading types, which may be provisionally named *Sporangites Braziliensis* and *S. biloba*; though I would suggest for them, in prospect of the discovery of their vegetative parts, the name *Protosalvinia*. They may be described as follows:—

Sporangites (*Protosalvinia*) *Braziliensis*, S. N. (fig. 1 *a*). Sporocarps thin, carbonaceous, having a structure of dense hexagonal cells and enclosing macro-spores which vary in number

Since the publication of my paper on Rhizocarps in the Palaeozoic Period above referred to, I have received two papers from Mr Edward Wethered F.G.S. in one of which he describes spores of plants found in the Lower Limestone Shale of the Forest of Dean, and in the other discusses more generally the structure and origin of Carboniferous Coal Seams. In the latter paper he refers to the occurrence of organisms apparently similar to the Erian ~~Sporangites~~ spores in these Coals and Shales. Prof Clarke has also described in the American Journal of Science for April 1885 the forms already alluded to, and which he finds to ~~[illegible]~~ consist of Macrospores enclosed in Sporocarps. He compares these with my Sporangites Huronensis and Protosalvinia biloba,* but I think it likely that one of them at least is a distinct species. Lastly in the Bulletin of the Chicago Academy of Sciences Dr Johnson and Mr Thomas ~~[illegible]~~ in their paper on the

* Cotteswold Naturalists' Field Club, 1884, Journal of Royal Microscopical Society, 1885.

microscopic organisms of the boulder clay of Chicago. Notice Sporangites Huronensis as among these organisms and have discovered them also in the Chicago water supply. They refer them to the decomposition of the Erian Shales, of which boulders ~~occur~~ chiefly these organisms occur in the clays.

To the kindness of Mr Thomas I am indebted for a large series of microscopic preparations of these ~~organisms~~ fossils and of others obtained by Prof Orton in ~~the~~ Bedford Shale of Ohio, the ~~examination of which and to~~ ~~to~~ results of the microscopical examination of which I propose to notice, and to inquire as to the inferences which are now warranted respecting the affinities of these organisms.

I may add that in the Geological Magazine for 1875 Mr Newton 788 of the Geol Survey of England published a description of the Tasmanite and Australian White Coal in which he shows that the organisms in these deposits are similar to my Sporangites Huronensis and to the Macrospores previously described by Prof Huxley from the Better-bed coal. Mr Newton does not seem to have been aware of my previous description of Sporangites and proposes the name Tasmanites punctatus for the Australian form.

The Typical Glaucospires of the Lias Shales, are perfectly circular in outline, and in the flattened state appear as discs with rounded edges, their average diameter being about 1/60 th of an inch, though they vary considerably in size. This however I do not regard as an important character. The eyes, as seen in profile are smooth, but when examined the flat surface often presents minute dark spots, which at first I mistook for papillæ, but now recognise them to be minute pores from the wall of the disc, and similar to those which Mr Rowe has described in the Tunicate of Ambleside*, and which Mr Wetherell has also recognised on the Glaucospires of the Forest of Dean Shales.

As seen by transmitted light, and either in point or in profile, the discs are of a rich amber colour, translucent and structureless, except the pores above referred to. The walls are somewhat thick from 1/10 to 1/20 the diameter

* Zoological Miscellanies

of the disc in the ~~centre~~ centre. They were enclosed the truncate sacks seen in Spec of Lycopods, in any dispute point of attachment, and ~~I have found~~ ~~Cannot that the Slate should~~ ~~sometimes appear in those~~ ~~latter and must accidental~~ ~~features~~. The interior is usually quite vacant & structureless, but in some cases there are curved internal markings which may indicate a shrunken lining membrane or the remains of a few bottles or cushions. Occasionally a fine granular substance appears in the interior.

though they sometimes show a minute dot. which may be of this nature and they are occasionally seen to have opened & split on the edge or front.

The discs are usually detached and detatched of any envelope, but not unfrequently fragments of flocculent cellular matter are associated with them, and in one Specimen in Prof Dawson's collection from the Carboniferous Limestone of Nova Scotia, and in Mr Thomas's collection I have found a plant of a similar discs parts ending in a cellular base - like members of similar character & that are

Clays the Brachiopod Specimens already referred to.

The characters of all the Specimens are essentially similar and there is a remarkable absence of the symmetry in the Shale. In one instance only I observed a somewhat circular form body with a dark central nucleus, and a wide translucent margin, marked by a slight granulation. Even this specimen may indicate little more than a different state of preservation.

Nothing is more remarkable in connection with these bodies than their confinement to Structures and form in special areas and strata to special thicknesses of rock and the absence of any other kind of Fossil-life. This is more especially noteworthy in contrast with the coarse coals and bituminous Shales of the Carboniferous, which usually contain a great variety of Spores and Spirangia indicating luxuriant vegetation. Many Species

It is proper to observe here that the wall & ceiling sac of these Macrospores must have been of very dense consistency, or they agree with that of the Spores of Lycopods, and the theca of a highly Carbonaceous and hydrogenous plant by their insoluble and readily admitting of change into bituminous matter. In the paper already referred to, on Spore Cases in Coals, I have noticed that the mature composition of Lycopodium and Coal is as follows:—

Cellulose C. 24. H 20. O 20
Lycopodium C 24. H 19 1/2 N. O 5 6/10

Thus such Spores are admirably suited for the production of highly carbonaceous & bituminous Coals &c.

of acrogenous plants, while the Lias & Shales in the Country indicate the almost exclusive predominance of the Pine. This contrast is well seen in the Bedford Shales owing their beds, and the Lithia Limestone Carboniferous, and of which Remains have been kindly Communicated done by Prof. Dawson, and have been prepared by Mr Thomas, In these are seen the familiar Carboniferous Spores with Triradiate markings called Zilates by Reinsch, and which are similar to those of Lycopodiaceous plants. Still more abundant are the Zygospores Spines & hooked Spores or Sporangia called the names Sporocarpon Spinocarpon* and Zygnaria have been given, and some of which Williamson has shown to be Spines of Lycopodiaceous plants.*

The true "Spinangites" or the Carboniferous are round and* smooth with thick Internodes which are

* Zygnaria is to be distinguished from the Calcareous bodies found in the Coniferous Limestone of Kelly's Island which I have described as Spirocaulina Dawsoni, and believe to be Foraminiferal tests.

* on the Canadian Naturalist

commence

~~presented~~ with minute ~~&~~ Fossils.
In these respects ~~&~~ as already stated they closely resemble
the rocks found in the subdivision
White Coal and ~~&~~ Fairmount ~~on the western flank of the~~
~~Cincinnati Arch in the region already~~
~~known~~ mentioned. The precise
Devonian ~~&~~ age of this material is not known
with certainty, but it is believed
to be Palaeozoic.

II. Mode of Occurrence of
Fossils & Geographical Origin.

Under this head we may
note first the great abundance and
wide distribution of these bodies.
The known range of the bed at Kettle
point is not certainly known but it
is traced a northern outlier of the
great belt of Devonian Shales exposed
in ~~&~~ by Lake ~~Huron~~ Ontario and others
extends with a breadth of ten to twenty
miles and a thickness of 250 to 350
feet across the State of Ohio for many
hundred miles. This Ohio Black Shale
which lies at the top of the
Devonian & the base of the
Carboniferous through ~~most~~ portions ~~&~~ mainly of
Devonian age, appears to abound

thumstone in these agreements, and in some beds to be replete with them. In like manner, as Prof. Darby, these agreements are constituted when a great accumulation and thickness of Shale holding Spirifera and apparently belonging to the Upper Devonian. The occurrence of similar forms in the Tasmanite or white coal of Tasmania and Australia is another important part of the distribution. To this we may add the appearance of these Spirifera in coal and Shales of the Carboniferous period, though there an association with other forms.

It is also to be observed that the Devonian Shales and the Drift of Devonian beds described by Withered are marine as shown by their contained fossils; and though there is no certain information as to the Tasmanite and Australian white coal, they would seem from the description of Milligan to occur in distinctly separate, fresh water deposits. Withered has shown that the ditches drained by Burnley and

Neuters in the Better-bed and
Deem in the earth's fragmentary
Layers as distinguished from the
Jura Lias. These occurrences in Coomul
Coal are in the same case,
& that the general mode
of occurrence implies water-drift.
Same in the case of Trees
& large and dense kind-drift
& great distances would be
impossible.

These facts, taken in
connection with the differences be-
tween these macrospores and
those of any known Carboni-
ferous plant of the Palaeozoic, would
lead to the inference that
they were belonged to aquatic
plants, and ~~that~~ there exist abu-
ndant in the waters of the
Silurian & Carboniferous periods. ~~It~~
It is still further to be ob-
served that they are not ac-
companied with any remains of
woody & Scalariform tissues such as
might be expected in connection
with the debris of terrestrial vegeta-
tion and that on the other hand
are found them enclosed in

Cellular Sporocarps, though in the majority of cases these have been removed by dehiscence at once.

These considerations I think all point to the probability which I have suggested in my previous paper on this subject, that we have in these objects the organs of fructification of plants belonging to the order of Rhizocarpeæ or a kin to it. The comparisons which I have instituted with the Sporocarps & Macrospores of these plants confirm this suggestion. Of the modern species which I had an opportunity to examine Salvinia natans & Isoetes setacea presents the closest resemblance. In this plant pairs of round Cellular Sporocarps appear on the surface of the floating fronds They are about a line in diameter when mature, and are of two kinds, one containing Macrospores the other Microspores or antheridia. The first when mature bursts a number of closely packed Globular Sporangia of loose cellular tissue attached to a central placenta

Synangia

Each of these contains a single macrospore perfect & globular and smooth with a dense outer membrane and filled with an irregular granulated & cellular & nucleate probably a pro thallus. I cannot detect in it the peculiar rods which appear in the fossil specimens. Each macrospore is about 1.75 hundredth of an inch in diameter when mature. The sporecarps of the microspores contain a very great number of minute sporangia, about one fiftieth of 1.50 of an inch or the two hundredth of an inch in diameter. My criterion discribe authority a microspores of my minute size.

The ones from Kettle Point and from the Ohio Black Shale are similar to the macrospores of Sphenia except that they have a thicker coat and are a little less in diameter, they about 1.30 a 1.20 hundredth of an inch. The Brazilian sporocarps are considerably larger than those of Western Sphenia and the macrospores appear in size & those of the Western species by being 1.50 hundredth of an inch in diameter. They

also seem like the modern species to have thinner walls than those from Canada and Ohio. No distinct indication has been observed in the fossil species of the inner sporangium of Salvinia, but it was altogether absent, but more probably it is not preserved as a distinct structure.

With reference to the microspores of Salvinia, it is to be observed that the sporocarps and the contained spores & antheridia are very delicate and destitute of the dense outer coat of the macrospores. Hence such parts are little liable to have been preserved in a fossil state, and in the Enon shales, if present, they probably appear merely as the flocculent carbonaceous matter not distinctly marked, as minute grannules not well defined, of which there are great quantities in some of the shales.

The ligulate appendage of the sporangium has not been distinctly recognized. There however found in one of the American specimens two sporocarps attached to what seems a fragment of a cellular frond and numerous specimens of the supposed stem named Sporangites are

found in the shales, but there is no evidence of any connection of the plant with the Protaleuria

4

Modern Rhizocarps present considerable differences as to their vegetative parts. Some, like the

types. Some, like *Pilularia*, have simple linear leaves; others, like *Marsilea*, have leaves in verticils and cuneate in form; while others, like *Azolla* and *Salvinia*, have frondose leaves, more or less pinnate in their arrangement. The first type presents little that is characteristic, but there are in the Erian sandstones and shales great quantities of filamentous and linear objects which it has been impossible to refer to any genus, and which might have belonged to plants of the type of *Pilularia*. It is quite possible also that such plants as *Psilophyton glabrum* and *Cordaites angustifolia*, of which the fructification is quite unknown, may have been allied to Rhizocarps. With regard to the verticillate type, we are at once reminded of *Sphenophyllum*, which many palaeo-botanists have referred to the *Marsiliaceæ*, though like other Palæozoic Acrogens it presents complexities not seen in its modern representatives. *S. primaevum* of Lesquereux is found in the Hudson River group, and my *S. antiquum* in the middle Erian. Besides these there are in the Silurian and Erian beds, plants with verticillate leaves which have been placed with the *Annularieæ*, but which may have differed from them in fructification. *Annularia laxa* of the Erian and *Protannularia Harknessii* of the Silurian may be given as examples. ~~As to pinnate leaves, I have already referred to the remarkable plants of the genus *Psilophyton*, found both in the Erian and Carboniferous, and which seem to have been aquatic in their habit, like Rhizocarps.~~ It is deserving of notice also that the two best known species of *Psilophyton* (*P. princeps* and *P. robustius*), while allied to Lycopods by the structure of the stem and such rudimentary foliage as they possess, are also allied, by the form of their fructification, to the Rhizocarps, and not to ferns as some palaeo-botanists have incorrectly supposed.*

and must have been aquatic plants probably allied to Rhizocarps

The common plants known as Asterophyllites seem also to have been allied to Psilophyton in their fruit though bearing it in spikes instead of on separate sporocarps. ~~Lastly~~ In one of the Canadian specimens I have observed what seems a fragment of cellular fruit bearing two sporocarps.

I would also here direct attention to the Carboniferous pinnate leaves from the Erian & Carboniferous, which I have named

Filopsyton and to these from the
Carboniferous about Sequoiaceae has
named Eochlophyllum. I have
fully discussed the structure of
these in my Report of 1882 on
the Fossil Plants of Canada
and my Two Memoirs State
that I have shown that
these were aquatic plants
probably living in swamps allied
to these Plants found in
the Coal Measures of Nova Scotia.

The whole of this evidence
I think goes to show that in
the Fossil period there were
vast quantities of aquatic plants
allied to the Modern Sphagnums
and that the Wealden
Sphagnales referred to in these
papers were probably these dusky
Marsh Moss of some of these
plants or of plants allied to them
in Structure and Habit of which the
Vegetative organs have perished. I have shown
that in the Fossil period there were vast
swampy flats covered with Eochlophyllum and in
similar submerged tracts near to the Sea
the Carboniferous may have lived the Waters
and have given off the vast multitudes
of Microspores about described. Comments have
Settled in the mud of the Marsh Flats.

Classification of Diatoms

It is of course very unsatisfactory to give names to mere fragments of plants Yet it seems very desirable to have some means of arranging them. With respect to the specimens of the present paper which were originally called Synedra the supposition that they were Synedrae rather than Nitzschiae I think it best now to adopt the generic name Nitzschia for the whole and to speak of the delicately striated or marginate ones and the crenulate membranes when present as Thin Synedras. We shall then have

Nitzschia Hungarica, Grunow, Striated lengthwise, Striae
A Stolz, Brutt and Thick walled
Mr calls penetrated Grunate
pits, Several in one cellular
Process Drawn apart Exp Then 1/10th
Am wet, a little more.

1 Protoxalmia Barnesiana, Dr

Syn- Stemonitis Barnesiana.

Macrospores in the form of discs or globes smooth and thick-walled. Peridium 1/2 millimeter diameter about 1/60th of an inch and a little more. When in the general Macrospores are convoluted in a thin cellular Sporocarp probably globular in form. From the Upper Swan River perhaps Lower Carbon River Banks of Kettle Point Lake Huron and of various places in the State of Ohio. First collected at Kettle Point by Dr W.S. Sturgis and in Ohio by Prof Otten and Mr Thomas, also in New York by Clarke

2 Botryosalmia Brunhemus, Dawson

Macrospores round smooth, a little larger than those of the last species & about 1/75 of an inch in diameter, enclosed in round oval & slightly compressed sporocarps each containing from four to twenty four macrospores. Largest diameter of sporocarps three & two millimetres diameter of wall of sporocarps hexagonal cellular. Some sporocarps show no macrospores and many minute contain microspores

Shale of Brain. Discovered by Mr Orville Derby. The prevalent assemblage of the Dark Coaly shales below about 300 feet Utah and containing the fossils known as Spirophyton and probably com. minuted vegetable matter. Some thin is chocolate and reddish shale in about the best preserved specimens of Botryosalmia occur These beds are very richly distributed and abound in Rhabdocarpa and Dictyophyton

Protosalvinia bilobata Dn

~~S. (P.) bilobg~~ s.n. ~~(fig. 15)~~ Sporocarps oval or reniform, three millimetres to six millimetres in diameter, each showing two rounded prominences at the ends, with a depression in the middle, and sometimes a raised neck or isthmus at one side connecting the prominences. Some of the specimens indicate that each prominence or tubercle contained several macrospores. At first sight it would be easy to mistake these bodies for valves of *Beyrichia*.

Structure of Sporocarp cellular

Found on the same formation with the last Species though as far as the Specimens indicate not present in the same beds Collected by Mr Derby.

Protosalvinia Clarkii Dn

P. bilobata Clarke Ann Hof Science

~~Sporangiospores~~ ~~Macrospores~~ 2/3 of 1 Millimetre in diameter. One two or three contained in each Sporocarp which is cellular The Macrospores have very thick walls with radiating tortuous tubes? Unless this structure is a result of Mineral Cystallization these Macrospores must have had very thick walls and must have resembled in structure the thickened cells of Plant parts and of the Cuticle of the Rean

It is to be observed that bodies Similar to these occur

in the Boyhead earthy bituminous and have been described by Credner.

Hearn found similar bodies in the so called Stellar Coal of the Coal district of Pictou. Some cases of which are filled with them. They occur in lumps or patches which seem to be enclosed in a ~~thin~~ smooth and thin membrane or pericarp. It is quite likely that these bodies are generally distributed thro Pictou & Cumberland

Mr Newton has named* the discs found in the white Coal and Lacunamite Formation the Spencer Bay Lacunamites punctatus but as my name Spirangites had priority I do not think it necessary to adopt this term though there can be little doubt that these organisms are of similar character. The same remark may be made with reference to the bodies described by Hawkes and Newton as occurring in the Better-bed coal.

*Geol Mag., N.S. Dec 2, Vol 2.

from three or four to as many as twenty-five. Form circular, oval or reniform. Longest diameter from three millimetres to six millimetres. Some of the sacs which do not show included round bodies may have held microspores.

S. (*P.*) *biloba*, S.N. (fig. 1 *b*) Sporocarps oval or reniform, three millimetres to six millimetres in diameter, each showing two rounded prominences at the ends, with a depression in the middle, and sometimes a raised neck or isthmus at one side connecting the prominences. Some of the specimens indicate that each prominence or tubercle contained several macrospores. At first sight it would be easy to mistake these bodies for valves of *Beyrichia*.

The geological relations of the beds containing these interesting remains are thus stated by Mr. Derby.*

"The third or Curuá group consists almost exclusively of black and red shales, passing at times into shaly sandstone. These beds form low cliffs along the rivers Maecurú and Curuá for a considerable distance, lying almost horizontal, except where disturbed by eruptions of diorite. On the Trombetas the black shale forms two short cliffs on the river bank and the red shale is badly exposed on a lake near by. At Ereré these rocks are exposed in the eastern part of the plain, and in the base of the serras, particularly that of Tajuri, the front of which is composed entirely of these shales. The black shale forms the lowest bed, the thickness of which, on the Curuá, is estimated by Mr. Smith at 300 feet. It is well laminated, almost slaty in structure, and in the lower part contains numerous large, calcareous and arenaceous concretions. The first are bluish black in colour, have well developed cone-in-cone structure and emit, when struck with a hammer, a strong odour of petroleum."

"The reddish shale lies above the black, having more or less the same thickness. It is generally chocolate-coloured, mottled with spots of a darker hue and banded, parallel with the stratification, with white, yellow or black. The rock consists of clay, mixed with a considerable proportion of finely-divided mica and sand, the last often forming independent layers a few inches thick. The only fossils found in these shales were Fucoids, of the genus *Spirophyton*, and small fruit-like bodies, resembling very much a flattened currant, consisting apparantly of a thin

* Proceedings of the American Philosophical Society, Feb. 21, 1879.

found

have been

I spent the whole Day there you see in the Curua group a Devonian series and a carboniferous in Brazil. There is also of Black shale 300 feet or there, & the Spirophyton & big Spirophyton Shows clearly Devonian shales with Spirophyton and Pentamerus — The Blue rock there and Devonian Corals and with them its all to upper Devonian Pentamerus

pellicle enclosing two to six small grains. The *Spirophyton* is apparently identical with one of those described by Prof. Hall, from the Hamilton group of New York. It occurs abundantly in all the localities, in both the black and red shale, near the junction of the two."

"On the Curuá and Maecurú the red shale, which is undoubtedly Devonian, is followed by beds of coarse sandstone which, according to Mr. Smith, are at least fifty feet thick on the Curuâ. This is followed by fossiliferous Carboniferous beds. The red shale is also overlaid by coarse sandstone, in the mountains of Ererê, but it is not certain that this sandstone is of the same formation as that of the Curuâ."

"As regards the extension of the Devonian series, it has been recognized as far west as the river Uatumâ, a small river between the Tombetas and the Rio Negro. On the southern side of the valley, there are, on the Tapajos, shales containing *Spirophyton* and calcareous concretions, which were referred provisionally to the Carboniferous by Prof. Hartt, but which seem to me to be Devonian, and I refer to the same age the black shale found by Sñr Penna on the Xingû."

I have not seen specimens of the black shales referred to in this description, but should think it likely that on careful examination they might be found to owe their carbonaceous or bituminous matter to the partial decay of *Sporangites*. They also deserve careful examination with the view to the discovery of the vegetation appertaining to the sporocarps. The similarity of these Brazilian beds to those holding similar fossils in Ohio and Ontario is very striking.

There can be no question of the close resemblance of the Brazilian species of *Sporangites* with the spore-envelopes of modern Rhizocarps. Some individuals of the *S. Braziliensis* are scarcely distinguishable in form or contained macrospores from the sporocarps of *Salvinia natans* of the rivers of Europe (fig. 1 *d*). It is true that the analagy of *Salvinia* would lead us to expect other sacs containing microspores; but in ordinary circumstances the latter could not be preserved in a visible state, and on the Brazilian shales there are many specimens not showing macrospores, and which might have been filled with macrospores which have been flattened into an undistinguishable mass.

If we compare the separate macrospores of the Brazilian sporocarps, and especially those which are found detached from their envelopes, with *Sporangites Huronensis*, we see a remarkable

similarity in size, form and texture, sufficient to justify us in supposing that the latter may be of the same nature with the former, but deprived of their outer cases either by dehiscence or by decay, and this is the view which I am now disposed to take of their nature, and which better accords with their wide distribution in aqueous deposits and with their accompaniments than any other supposition. I may add that Prof. Orton and Prof. Clarke, in letters to the author, refer to grouping of the little rounded bodies and traces of enveloping membrane. In this connection I would also mention the sacs containing rounded bodies known as *Parka*, and which have been met with in the Erian beds both in Scotland and in Gaspé, and have been supposed to be ova of crustaceans. It is true that these are much larger than the sporocarps above referred to, but on examination of Gaspé specimens in my collection, I am disposed to suspect that they also may prove to be the fructification of Rhizocarps.

It remains to enquire, Are there any Erian plants known to us in their stems and foliage, to which such organs of fructification as those above described might have belonged?

A preliminary question would naturally be as to the vegetative organs of modern Rhizocarps. On reference to the descriptions, and to a somewhat extensive collection of specimens placed at my disposal by Mr. Poe Watt, of Montreal, I find that these may be referred to three leading types. Some, like *Pilularia*, have simple linear leaves; others, like *Marsilea*, have leaves in verticils and cuneate in form; while others, like *Azolla* and *Salvinia*, have frondose leaves, more or less pinnate in their arrangement. The first type presents little that is characteristic, but there are in the Erian sandstones and shales great quantities of filamentous and linear objects which it has been impossible to refer to any genus, and which might have belonged to plants of the type of *Pilularia*. It is quite possible also that such plants as *Psilophyton glabrum* and *Cordaites angustifolia*, of which the fructification is quite unknown, may have been allied to Rhizocarps. With regard to the verticillate type, we are at once reminded of *Sphenophyllum*, which many palaeo-botanists have referred to the *Marsiliaceæ*, though like other Palæozoic Acrogens it presents complexities not seen in its modern representatives. *S. primaevum* of Lesquereux is found in the Hudson River group, and my *S. antiquum* in the middle Erian. Besides these there are in the Silurian and Erian beds, plants with verticillate leaves which have been placed with the *Annularieæ*, but which may have differed from them in fructification. *Annularia laxa* of the Erian and *Protannularia Harknessii* of the Silurian may be given as examples. As to pinnate leaves, I have already referred to the remarkable plants of the genus *Psilophyton*, found both in the Erian and Carboniferous, and which seem to have been aquatic in their habit like Rhioczarps. It is deserving of notice also that the two best known species of *Psilophyton* (*P. princeps* and *P. robustius*), while allied to Lycopods by the structure of the stem and such rudimentary foliage as they possess, are also allied, by the form of their fructification, to the Rhizocarps, and not to ferns as some palaeo-botanists have incorrectly supposed.*

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