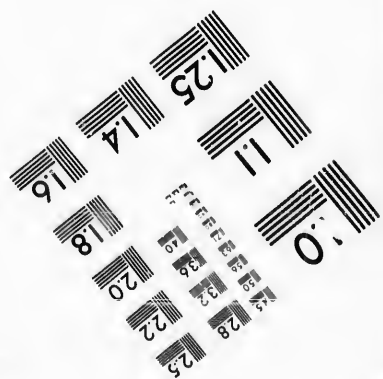
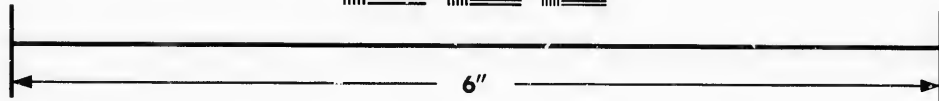
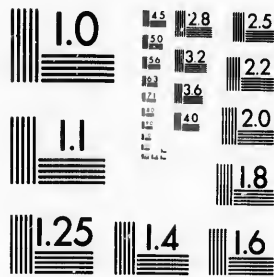


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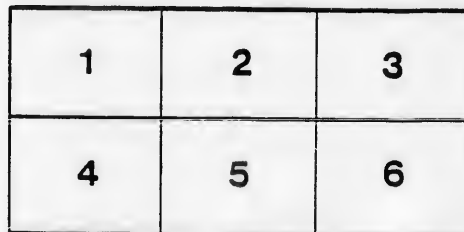
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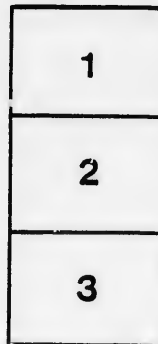
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**GEOLOGICAL SURVEY OF CANADA.**

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**REPORT**

ON

**CANADIAN GRAPTOLITES.**

BY

**JAMES HALL, Esq.,**  
OF ALBANY.

EXTRACTED FROM  
SIR WILLIAM E. LOGAN'S REPORT OF PROGRESS,  
FOR 1857.

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Montreal:

PRINTED BY JOHN LOVELL.

1858

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# REPORT

OF

JAMES HALL, Esq.,

ADDRESSED TO

SIR WILLIAM E. LOGAN, F.R.S.,  
DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.

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ALBANY, 1st *March*, 1858.

SIR,

In reply to your enquiry regarding the Graptolites and other allied genera, confided to me for description on behalf of the Geological Survey of Canada, partly in 1854, and partly at a subsequent time, I have the honor to inform you that six plates of the Graptolites have been engraved, and are now only waiting to be lettered, and that drawings for ten more plates are in the engraver's hands.

The description of twenty-four species accompanies the present communication, and the plates will follow as fast as they are completed.

In April 1855, I communicated to you a note upon these remarkable Graptolites, discovered in the progress of the Geological Survey during the previous year. This discovery gave for the first time a knowledge of the true forms and mode of growth of these fossils, of which fragments and detached branches have for so many years been described as complete forms. Neither up to that time, nor so far as I am aware to the present, has any evidence of the existence of perfect forms such as these been given to the public.

Two of the species were described in the note transmitted to you in 1855, and I have preceded the description of the remainder by a repetition of that note.

I have the honor to be,

Sir,

Your most obedient servant,

JAMES HALL.

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DESCRIPTIONS

OF

CANADIAN GRAPTOLITES.

NOTE upon the Genus GRAPTOLITHUS, and descriptions of some remarkable new forms from the shales of the Hudson River group, discovered in the investigations of the Geological Survey of Canada, under the direction of Sir W. E. Logan, F.R.S. By James Hall.

[Communicated in

The discovery of some remarkable forms of this genus during the progress of the Canada Geological Survey, has given an opportunity of extending our knowledge of these interesting fossil remains. Hitherto our observations on the Graptolites have been directed to simple linear stipes, or to ramose forms, which except in branching, or rarely, in having foliate forms, differ little from the linear stipes. In a few species, as *G. tenuis* (Hall), and one or two other American species, there is an indication of more complicated structure; but up to the present time this has remained of doubtful significance. The question whether these animals in their living state were free or attached, is one which has been discussed without result; and it would seem to be only in very recent times that naturalists have abandoned altogether the opinion that these bodies belonged to the *Cephalopoda*.

In the year 1847 I published a small paper on the Graptolites from the rocks of the Hudson River group in New York. To the number there given, two species have since been added from the shales of the Clinton group. Other species, yet unpublished, have been obtained from the Hudson River group; and since the period of my publication in 1847, large accessions have been made to our knowledge of this family of fossils, and to the number of species then known. The most important publications upon this subject are, *Les Graptolites de Bohême*, par J. Barrande, 1850; *Synopsis of the Classification of British Rocks, and Descriptions of British Palaeozoic Fossils*, by Rev. A. Sedgwick and Frederick McCoy, 1851; *Grauwacken Formation in Sachsen, c.*, by H. B. Geinitz, 1852.

The radix-like appendages, known in some of our American as well as in some European species, have been regarded as evidence that the animal in its living state was fixed; while Mr. J. Barrande, admitting the force of these facts, asserts his belief that other species were free. It does not however appear probable that in a family of fossils so closely allied as are all the proper *Graptolitideæ*, any such great diversity in mode of growth would exist.

It will appear evident from what follows, that heretofore we have been compelled to content ourselves, for the most part, with describing fragments of a fossil body, without knowing the original form or condition of the animal when living. Under such circumstances, it is not surprising that various opinions have been entertained, depending in a great measure upon the state of preservation of the fossils examined. The diminution in the dimensions, or perhaps we should rather say in the development, of the cellules or serrations of the axis towards the base, has given rise to the opinion advanced by Barrande, that the extension of the axis by growth was in that direction, and that these smaller cells were really in a state of increase and development. In opposition to this argument, we could before have advanced the evidence furnished by *G. bicornis*, *G. ramosus*, *G. sextans*, *G. furcatus*, *G. tenuis*, and others, which show that the stipes could not have increased in that directi<sup>on</sup>. It is true that none of the species figured

by Barrande indicate insuperable objections to this view; though in the figures of *G. serræ* (Brong.), as given by Geinitz, the improbability of such a mode of growth is clearly shown.

It is not a little remarkable that with such additions to the number of species as have been made by Barrande, McCoy, and Geinitz, so few ramose forms have been discovered; and none, so far as the writer is aware, approaching in the perfection of this character to the American species.

Maintaining as we do the above view of the subject, which is borne out by well-preserved specimens of several species, we cannot admit the proposed separation of the Graptolites into the genera *Monograpsus*, *Diplograpsus*, and *Cladograpsus*, for the reason that one and the same species, as shown in single individuals, may be *monoprioniæan* or *diprioniæan*, or both; and we shall see still farther objections to this division, as we progress, in the utter impossibility of distinguishing these characteristics under certain circumstances. We do not yet perceive sufficient reason to separate the branching forms from those supposed to be not branched, for it is not always possible to decide which have or have not been ramose, among the fragments found. Moreover, there are such various modes of branching, that such forms as *G. ramosus* present but little analogy with such as *G. gracilis*.

Mr. Geinitz introduces among the *Graptolitiæ* the genus *Nereograpsus*, to include *Nereites*, *Myrianites*, *Nemertites*, and *Nemapodia*. Admitting the first three of these to be organic remains, which the writer has elsewhere expressed his reasons for doubting, they are not related in structure, substance, or mode of occurrence, to the Graptolites, at least so far as regards American species; and the *Nemapodia* is not a fossil body, nor the imprint of one, but simply the *recent track of a slug* over the surface of the slates. The genus *Rastrites* of Barrande has not yet been recognized among American *Graptolitiæ*. These forms are by Geinitz united to his genus *Cladograpsus*, the propriety of which we are unable to decide.

The genus *Gladiolites* (*Retiolites* of Barrande, 1850, *Graptophyllia* of Hall, 1849) occurs among American forms of the *Graptolitiæ* in a single species in the Clinton group of New

York. A form analogous, with the reticulated margins and straight midrib, has been obtained from the shales of the Hudson River group in Canada, suggesting an inquiry as to whether the separation of this genus on account of the reticulated structure alone, can be sustained. In the mean time we may add that the Canada collection sustains the opinion already expressed, that the *Dictyonema* will form a genus of the family *Graptolitiæ*. The same collection has brought to light other specimens of a character so unlike anything heretofore described, that another very distinct genus will thereby be added to this family. The Canadian specimens show that the Graptolites are far from always being simple or merely branching flattened stems.

The following diagnosis will express more accurately the character of the genus *Graptolithus*, as ascertained from an examination of perfect specimens in this collection.

*Genus* GRAPTOLITHUS, (Linn.)

*Description.*—Corallum or bryozoum fixed, (free?) compound or simple, the parts bi-laterally arranged, consisting of simple stipes or of few or many simple or variously bifurcating branches, radiating more or less regularly from a centre, and in the compound forms united towards their base in a continuous thin corneous membrane or disk formed by an expansion of the substance of the branches, and which in the living state may have been in some degree gelatinous. Branches with a single or double series of cellules or serratures, communicating with a common longitudinal canal, affixed by a slender radix or pedicle from the centre of the exterior side.

The fragments, either simple or variously branched, hitherto described as species of *Graptolithus*, are for the most part to be regarded as detached portions from the entire frond.

In the living state we may suppose those with the corneous disks, and numerous branched fronds to have been concavo-convex (the upper being the concave side), or to have had the power to assume this form at will. In many specimens there is no evidence of a radix or point of attach-

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ment, and they have very much the appearance of bodies which may have floated free in the ocean.

GRAPTOLITHUS LOGANI.

PLATE I. Fig. 1-6. PLATE II. Fig. 1-4.

*Description.*—Fronde composed of numerous branches nearly equally disposed on two sides of a central connecting stipe, and each again subdividing nearly equally, after which they bifurcate, always near the base, with greater or less regularity; connecting membrane thin, composed of the same substance, and continuous with the branches, extending from the centre to some distance beyond the bifurcations; the branches after the third bifurcation become marked on the inner side by a row of cellules, and along the centre by an abruptly impressed line which follows the divarication of the branches; cellules minute, not prominent towards the base of the branches, being compressed vertically, and appearing like a double series with a central depressed line, becoming developed as they recede from the base. The branches beyond the disk are turned on one side and laterally flattened, and present a single series of cellules or serrations, which are moderately deep, with the serratures acute at their extremities; from twenty-four to twenty-eight in an inch. The substance of the branches upon the exterior surface near the centre, is marked by a depressed longitudinal line, which follows the ramifications, and gradually dies out as the branches become finally simple, when the surface on the same side is smooth or somewhat obliquely striated. The disk is smooth exteriorly, and from the centre is a small radicle from which the two sets of branches diverge.

This species, though in a general manner bi-lateral and presenting four principal branches, is nevertheless from the irregular division of these, usually unequal upon the two sides; and we find on examination of those figured that they are as ten and ten, nine and eleven, eight and nine, ten and eleven, seven and ten, twelve and twelve, eight and eight, eight and ten, while the half which is figured on Plate II has eleven rays.

PLATE I. Fig. 1. An individual showing the exterior surface; the central portions entire, with the impression of the connecting corneous membrane, some portions of which remain still attached to the arms. The extent and outline of the membrane are very distinctly preserved. Some of the arms are broken off at the termination of this membrane or disk, while others extend to some distance beyond its limits; all however are imperfect.

The appearance of serratures is due to exfoliation, which shows the impression of the inner side upon the stone.

Fig. 2. Exterior view of another individual, in which some portions of the membrane still remain, the branches being all broken off just beyond the last bifurcation.

Fig. 3. The inner side showing the commencement of the cells, which appear in some places to be in a double series. The connecting membrane of the branches is removed in this specimen.

Fig. 4. Enlarged view of the exterior surface of the central portion of an individual.

Fig. 5. Enlarged view of the inner surface, exhibiting the appearance of a double series of cells, separated by a depressed line in the substance of the branch. In some instances these appear to be absolutely separate, while in others they are connected, showing that there is but a single series, and the apparent separation is due to the depression along the centre.

Fig. 6. An enlarged view of a fragment of a branch, showing serratures on one side, with a corresponding row of obscure, elevated ridges, which may perhaps be due to the foldings of the branch.

PLATE II. Fig. 1. An individual preserving the connecting membrane almost entire, showing the sinuous outline.

Fig. 2. A specimen exhibiting the half of an individual, in which the disk is unequally extended between the rays. The margins are apparently entire between all of these, and from whatever cause or injury this inequality may be due, it existed in the animal while living.

Fig. 3. A fragment of slate preserving portions of three individuals. The connecting membrane had been removed by maceration before they were imbedded in the stony matter, but the branches are preserved to the length of more than seven inches. It does not appear that the portions preserved present the entire skeleton; on the other hand, it is almost certain from the condition of the specimens, that the branches were originally much longer. It will be observed that the branches do not all show the serrated margin at equal distances from the centre, but this is due to the accidental position assumed by the branches as they were imbedded; some present the exterior surface for a considerable distance, and gradually turning, become flattened laterally.

Fig. 4. The exterior of the base of a specimen, showing the small node or radicle which proceeds from the centre of the vinculum or connecting stipe.

The preceding illustrations are of a single species in different degrees of preservation. The manner of branching, although subject to slight modifications, is still always reliable for the purposes of distinguishing the species.

*Locality and Formation.*—These specimens were obtained at Point Lévy, opposite to Quebec, in a band of bituminous shale, separating beds of grey limestone. These strata belong to the Lower Silurian series, and are of that part of the Hudson River Group which is sometimes designated as Eaton's sparry limestone, being near the summit of the group; they form also the rocks of Quebec.

*Collectors.*—J. Richardson, Sir W. E. Logan, and James Hall.

#### GRAPTOLITHUS ABNORMIS.

##### PLATE III. Fig. 1.

*Description.*—This species, of which only imperfect specimens have been seen, presents four principal branches diverging from the centre, two from each extremity of the vinculum, and each one of these bifurcating and branching unequally, and at unequal distances from the centre.

The forms above described do not by any means exhaust the variety presented in this collection. With a single exception however, all the specimens which offer any new light in regard to the habit of the Graptolites, indicate that the mode of growth was in the manner described, in branches radiating from a centre, or in tufts joining in a central connecting substance.

The specimens from the Canadian locality afford further evidence in confirmation of what we have elsewhere observed, that with few exceptions, the species have a limited geographical range. This locality has already, after very cursory examination, afforded eight new species of Graptolites, with one or two species which appear to be identical with those previously found in the State of New York. A comparison of specimens from more southern localities with those of New York, shows a large proportion of new species; and it now appears probable that the number of American species of *Graptolithus* previously known (about twenty,) will soon be increased by an equal number of new ones.

*Locality and Formation.*—Point Lévy; Hudson River Group.

*Collectors.*—J. Richardson, Sir W. E. Logan, and James Hall.

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Since the date of the above communication, great numbers of Graptolites have been added to the Canada collection; and with an increased number of species, our knowledge of the structure of these animals has been very much extended. Had we at that time possessed all the materials which we now have, the subject might perhaps have been treated in a more natural order by presenting in the first place the more simple forms; but since the first two plates of the species were then engraved, I follow this note with the descriptions of others of the same character, which have been prepared since that time.

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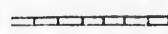

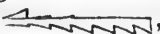


## GRAPTOLITHUS FLEXILIS.

PLATE III. Fig. 2-6.

*Description.*—Multibrachiate, bi-lateral; branches slender, flexile, bifurcating at irregular intervals; bifurcations of contiguous branches often opposite, repeated four times within one and a-half inches of the centre, having from thirty-two to forty or more branchlets at the extremities. Substance of branches thin, extremely compressed; non-celluliferous side smooth or faintly striated; celluliferous side with slight transverse indentations when compressed vertically, and with serratures when compressed laterally; serratures not deep, acute at the extremities, variable in prominence according to the position of the branch; about twenty-four in an inch. Branches often compressed in the direction of the cell to such a degree as to give an apparent double serrature, or serrature on each side of the axis. In this condition the edges of the cells are at right angles to the axis, very shallow, and not pointed.

When the celluliferous side, compressed in the direction of the cell, is uppermost on the surface of the shale, a line may be traced across the branch joining the edge of the serratures, thus showing that the two apparent serratures are but the single one, so compressed that its extremities project beyond the margin.

We have thus all gradations: the smooth surface of the branch with minute striations upon the outer side; the inner side when not compressed, with serratures showing as indented lines across the surface, ; the double serration, produced by more pressure in the same direction, ; and again, as the branch is turned around, these serratures disappearing from one side, and becoming more prominent upon the other , finally showing their full breadth as the ray is compressed in its transverse or lateral direction.

This condition, which has not been understood with regard to many species, is the principal cause of the diminution and sometimes final disappearance of cells towards the base of a branch. When both sides are serrated, a less degree of

compression, which might very naturally result towards the base, would cause the serratures to be less prominent, as is seen in many of the figures in Barrande's *Graptolites de Bohême*; in the New York Palæontology, etc. It is still true that the serratures are always less developed towards the base of the frond.

The serratures of this species differ essentially from those of any other in the Canadian collection, and from any in the New York collections or others that have come under my observation.

Fig. 2. A part of an individual showing the central connecting stipe or vinculum from the radicle, two of the main branches on one side and one on the other, with some of the branches disconnected by the breaking of the slate in which the fossil is imbedded. The celluliferous margins of the branches towards the base are imbedded in the slate, and it is only as they recede from the centre that the serratures become gradually visible, until finally some of them are exhibited of their full width as the branchlets become turned fully upon one side and laterally compressed.

Fig. 3. A fragment of slate preserving parts of three individuals, all presenting the non-celluliferous side upwards, some of the outer branchlets being turned so as to show the serratures.

Fig. 4. Enlarged view of a part of one of the branches and its branchlets, showing in some parts shallow serratures upon both sides of the branch from compression, as before explained. These sometimes appear almost equally upon the two sides, and in other parts are barely visible on one side; while one of the branchlets is so turned as to show near its extremity the full depth of the serratures.

Fig. 5. View of a portion still farther magnified, showing the branchlets where the serratures are vertically compressed.

Fig. 6. Enlarged view of a fragment which is compressed laterally.

*Locality and Formation.*—Point Lévy; Hudson River Group.  
*Collectors.*—J. Richardson and E. Billings.

## GRAPTOLITHUS RIGIDUS.

PLATE IV. Fig. 1-3.

*Description.*—Multibrachiate, bi-lateral; branches slender, cylindroid exteriorly, rigid, maintaining their width to the third bifurcation, and beyond this very gradually diminishing; bifurcations five in the space of one and a-half inches; internodes unequal, shorter near the base, and increasing towards the extremities; serratures undetermined.

In some specimens the branches are broader and flattened near the base, and the connecting bar or vinculum is broad and strong, with a small central node, the base of the radicle. Some portions of the corneous membrane or disk are preserved in a single specimen.

The subdivisions of each branch are from fifteen to twenty, or perhaps more numerous when entire; giving from sixty to eighty or more branchlets at the extremities of the frond.

A distinguishing feature of the species is its rigid and divergent bifurcation, and the almost uniform size of the branchlets.

All the specimens of this species examined are in a coarse arenaceous shale, and present the exterior or non-celluliferous side only. A single specimen has the extremities of the branches partially turned on one side, and gives some obscure indication of serratures. Individuals are extremely numerous in certain layers, and are spread out in profusion upon the surfaces of the slate, the bifurcating and interlocking branchlets presenting a net-work in which it is extremely difficult to trace the ramifications of each individual. This character is partially represented in fig. 1, pl. 4, in which the parts of the individuals, other than the principal one, are represented in a more subdued tone than they really exhibit in the specimen, where all are equally prominent.

Fig. 1. A portion of the surface of a slab of slate, in which a single individual is preserved nearly entire, with parts of several others shown in the figure.

Fig. 2. A portion of a branch of a larger individual showing the branchlets from above the second bifurcation.

Fig. 3. A fragment of slate showing the extremities of some branchlets partially turned on one side, and having obscure serrations.

*Locality and Formation.*—Point Lévy; Hudson River Group.  
*Collectors.*—J. Richardson and E. Billings.

GRAPTOLITHUS OCTOBRACHIATUS.

PLATE V. Fig. 1-6, and PLATE VI. Fig. 1-3.

*Description.*—Fronde composed of eight simple undivided branches, arranged bi-laterally, and proceeding from the two extremities of a short strong vinculum, which is subdivided, and each part again divided near the base, giving origin at each extremity to four equal rays or branchlets. Branchlets strong, linear, not sensibly diminishing in size as they recede from the centre, subangular, flattened upon the outer side, with a depressed line along the centre; obliquely striated; serratures short and strong, twenty in an inch, varying in depth according to the position of the branch; in one or two instances showing a deeper indentation.

This species presents the essential characteristic of eight simple arms or branchlets, which appear to have been sub-quadrangular in its living state, and when compressed laterally are scarcely broader, excepting the serratures, than when vertically compressed.

The branches are formed by the division of the vinculum at each extremity, first into two parts, making four; each of these is again subdivided almost immediately, and often so close as to present an appearance as if the four branchlets on each side originated from the same point. A careful examination however will show a little intervening space, and in one individual in its young state this feature is very characteristic.

The disk is a thick carbonaceous film, much stronger and coarser than in any of the preceding species, and corresponding in this respect to the stronger branches. It is moreover variable in form and extent in different specimens, and does not always appear to be in proportion to the size of the branches.

All the specimens yet examined present the exterior surface, so that the celluliferous face of the arms has not been seen. An impression of a short fragment of that surface of one of the branchlets shows strong, deep indentations. The vigorous aspect of this species contrasts with all others in this collection. In one specimen, where the frond is imperfect, one of the arms extends to a distance of more than eight and a half inches from the centre, while two others are more than six inches each, and these are all broken at their extremities.

In its long linear branches, this species resembles the *G. sagittarius* (Hall, Pal. N. Y., vol. I., pl. 74, fig. 1, perhaps not the European species of that name), but the branches are stronger and the serrations coarser; it is moreover associated with a group of species, all or nearly all of which are quite distinct from those of New York with which the *G. sagittarius* occurs.

Plate V. Fig. 1. A part of an individual of this species showing the exterior side with the disk partially preserved, with parts of the eight branchlets, which are seen to be gradually turned to one side as they recede from the centre, and are compressed laterally, showing the serratures.

Fig. 2. A fragment preserving a part of the disk very perfect and much extended. The exterior only of the branches is shown upon the stone.

Fig. 3. Enlarged view of a portion of the exterior of a branch, showing the obliquely striated surface.

Fig. 4. A similar fragment of a branch which is turned to one side far enough to show an undulating margin caused by the serratures.

Fig. 5. A fragment exposing the serratures partially.

Fig. 6. A fragment showing the serratures as seen when the branch is compressed laterally.

Plate VI. Fig. 1. An individual retaining a part of the disk, and the outline and impression of the remainder, with the eight branches, some of which are broken off near the centre and others variously bent and folded, while two of

them retain a length of more than six inches, and one a length of eight and a-half inches.

Fig. 2. A smaller individual retaining the branches in part, and showing the lateral and exterior surfaces, with an irregular disk.

Fig. 3. A small specimen preserving the base of the branches with the disk removed. This one shows more clearly than any other specimen the bifurcation of the branches beyond the vinculum.

*Locality and Formation.*—Point Lévy; Hudson River Group.  
*Collectors.*—J. Richardson, and E. Billings.

#### GRAPTOLITHUS OCTONARIUS.

*Description.*—Fronde composed of four principal branches, two diverging from each extremity of the short vinculum; each branch equally subdivided near the base, giving eight branchlets which continue simple to their extremities; branchlets gradually expanding from the base; serratures slightly inclined and truncated above almost rectangularly to the direction of the outer margins and oblique to the rachis, giving a slightly obtuse extremity; about twenty-four in the space of an inch; substance of the branchlets thick; divisions between the cells marked by a strongly depressed line which extends from the base of the serrature downwards as far as the second serrature below, ending near the back or lower side of the branch.

The branchlets of this species resemble those of *G. bryonoides*, and the distance of the serratures is almost the same, while in some well preserved specimens the obliquity of these parts is greater. There is also some difference in the form of the branchlets. In separate branches the characters are too nearly alike to offer the means of discrimination, unless they are in a very perfect state of preservation.

From *G. octobrachiatus* it differs conspicuously in the form of its branchlets, and in the comparative number and form of the serratures.

*Locality and Formation.*—Point Lévy; Hudson River Group.  
*Collectors.*—J. Richardson, E. Billings.

## GRAPTOLITHUS QUADRIBRACHIATUS.

PLATE VII. Fig. 1-5.

*Description.*—Fronde composed of four simple undivided branches arranged bi-laterally, or two from each extremity of the vinculum; branches slender, linear, obliquely striated, usually somewhat incurved, serrated upon the inner side; serratures a little recurved, and mucronate at the tip; about twenty-four in an inch, indented to about one-third the width of the branch when completely flattened. Disk thick, strong, often extending along the branches and giving them a somewhat alate appearance; point of attachment of radicle obscure.

Almost all the specimens of this species are obscure, and all are fragmentary; in a few specimens only the serratures are exhibited with some degree of perfection. The branches are preserved in some specimens to an extent of two inches.

Figs. 1 and 2. Fragments of this species from which the disk has been entirely removed, but preserving the vinculum and bases of the branches, which show the serrations partially.

Fig. 3. An individual in which two of the branches are well preserved, showing the serratures.

Fig. 4. An enlarged view of a portion of a branch showing the form of the serratures.

Fig. 5. A fragment preserving the disk, which has the branches broken off just beyond its margin.

*Locality and formation.*—Point Lévy; Hudson River Group.

*Collectors.*—J. Richardson, E. Billings, Sir W. E. Logan, James Hall.

## GRAPTOLITHUS CRUCIFER.

*Description.*—Fronde composed of four simple strong branches united by a small thickened disk; branches broad, connected by a short vinculum; serratures nearly vertical to the direction of the branch and sloping at an almost equal angle on each side, acute at the extremity and apparently mucronate or setiferous; about twenty-four in an inch.

This species exhibits the general character of *G. quadribrachiatus*, but the branches are much stronger, and about twice the width. The serratures are scarcely oblique to the rachis, and are very clearly mucronate at the tips, while some of them present the appearance of long setæ. The imperfect preservation of the specimen examined renders it impossible to determine accurately the nature of these appendages.

In the specimen here described one of the branches is preserved to the extent of two and a-half inches, with a width of three-sixteenths of an inch to the extremity of the points of the serratures, exclusive of the setæ, the branch to the base of the teeth being five-sixths of the whole width.

*Locality and Formation.*—Point Lévy; Hudson River Group.  
*Collectors.*—J. Richardson, E. Billings.

#### GRAPTOLITHUS BRYONOIDES.

*Description.*—Frond composed of four short simple branches, united at the base by a vinculum, and terminating below in a minute radicle; branches short, comparatively broad, obliquely and strongly striated from the base of the serratures to the outer edge of branch; serratures moderately oblique, the outer and inner margins making very nearly a right angle; mucronate at the tip; from twenty-four to twenty-eight in an inch.

Of several specimens in the collection none of the branches exceed an inch in length, while they are almost one-eighth of an inch in width from the tip of the solid part of the serratures to the outer edge. They are all strongly striated from the base of the serratures to the outer margin, the striae sometimes a little curved. The serratures are usually slightly oblique, or with the longer sloping side directed towards the base of the branch, and the shorter side advanced a little beyond a right angle to the rachis. In one specimen, where the branches are less than five-eighths of an inch in length, the serratures seem to be equally or nearly equally sloping on the two sides from the tip to the base.

The vinculum is obscure; and from the mode of imbedding, in many specimens, this part might be inferred to be absent



*Locality and Formation.*—Point Lévy; Hudson River Group.  
*Collectors*—J. Richardson, E. Billings, Sir W. E. Logan,  
 James Hall.

#### GRAPTOLITHUS HEADI.

*Description.*—Frond robust, four-branched; disk large, sub-quadrangular, moderately extended along the branches; branches strong, much elongated, sub-angular exteriorly; serratures small, acute, from twenty-two to twenty-four in an inch; fine distinctly marked striæ extend from the base of the serratures nearly across the branch.

The specimen described presents the disk, which in its diameter across the centre between the branches is nearly one inch and an eighth, or nine-sixteenths of an inch on each side of the centre; while from the centre to its extent along the branches it varies from about three-fourths of an inch in one branch to an inch in another. The substance of the disk is strong and somewhat rugose, either from its original character or from the accidents accompanying its imbedding in the rock. The specimen exhibits the inner or serrated side, and the branches are turned so as to be compressed laterally at a distance of two inches or more from the centre; one of the branches presents a length of nearly seven inches from the centre. This species is named after its discoverer, Mr. John Head.

*Locality and Formation.*—Point Lévy; Hudson River Group.  
*Collectors.*—Mr. John Head, and Sir W. E. Logan.

#### GRAPTOLITHUS ALATUS.

*Description.*—Frond composed of four branches; disk much extended along the sides of the branches, giving them an extremely alate character; branches strong, angular on the lower side; upper or serrated side unknown. Some indentations on the exterior side of the branches, which may indicate the place of serratures on the opposite side are about one twenty-fourth of an inch distant.

The only specimen of this species yet recognized is a part of the disk with three of the branches, two of which present

sent the corneous expansion apparently entire, extending about two inches from the centre along the branches, while its margin in the indentation between the branches is not more than three-eighths of an inch from the centre. This species is much more robust than *G. quadribrachiatus* or *G. bryonoides*, and the form of the disk when preserved will always be a distinguishing feature.

*Locality and Formation.*—Point Lévy; Hudson River Group.  
*Collectors.*—Mr. John Head, and Sir W. E. Logan.

#### GRAPTOLITHUS FRUTICOSUS.

*Description.*—Branches bifurcating from a long slender filiform radicle, and each division again bifurcating at a short distance above the first; branches and branchlets short, narrow linear; serratures apparently commencing in the lower axil, where there are one or two between the first and second bifurcations. Serratures somewhat obtuse at the tip; lower side longer, upper margin nearly at right angles to the rachis; about sixteen serratures in the space of an inch. Substance of the branches thin, fragile.

In one specimen the position of the serratures is such as to present elongate acute apices in one of the branches.

This species has the general habit of *G. nitidus* and *G. bryonoides*, but is very distinct in its long, slender radicle, narrow fragile branches, and distant, obtuse serrations. Two individuals only have been obtained, but the form and habit are so precisely alike, and so distinctive in both of these, as to mark it a very well characterised species.

*Locality and Formation.*—Island of Orleans; Hudson River Group.

*Collectors.*—J. Richardson, E. Billings.

#### GRAPTOLITHUS INDENTUS.

*Description.*—Froud consisting of two simple branches, diverging at the base from a slender radicle, and continuing above in a nearly parallel direction; branches narrow, slender;

serratures very oblique, somewhat obtuse, truncated above almost rectangularly to the line of the rachis; about twenty-four in the space of an inch; a depressed line reaching from the serrature to near the base or outer margin of the branch where it terminates in a small node; surface of branches striate.

This species resembles the *G. nitidus* in form, except that it is less divergent, the divergence from the base being at an angle of about thirty-six degrees for half an inch or more, after which the two branches continue nearly parallel. Though it is probable that this character may vary in some degree, it seems nevertheless to mark the species, and in numerous individuals of *G. nitidus* I have seen none with parallel or converging branches. The serratures in the two species differ in some degree in form, and the proportional distances, thirty-two and twenty-four, form a very characteristic distinction. A single fragment of a branch measures six inches, but the full extent when perfect is not known.

*Locality and Formation.*—Point Lévy; Hudson River Group.

*Collectors.*—Sir W. E. Logan, James Hall.

#### GRAPTOLITHUS NITIDUS.

*Description.*—Fronde composed of two simple branches, diverging from a small radicle; branches narrower towards the base, gradually expanding towards the extremities, which in perfect specimens appear to be rounded, and the last serrations a little shortened; serratures small, shorter at the base and becoming gradually developed as they recede from this point; acute at the extremities, almost vertical to the line of the rachis, and making an angle of about sixty degrees, the two sides being almost equal in length; about thirty-two in the space of an inch. A well-defined groove or depressed line extends from the base of the serrature obliquely towards the base of the branch, and at its termination the surface of the branch is marked by a minute but distinct round tubercle.

This beautiful little species differs very distinctly from any others of this genus, in the thickened substance of its branches, the closely arranged serratures, and the minute tubercles

at the base of the grooves or striae. The specimens usually preserve considerable substance, and are far less flattened than most of the other species, owing either to their original character or to the nature of the surrounding matrix. The impressions of the oblique lines or striae are often well preserved in imprints of the fossil left in the slate.

The impressions of *G. bryonoides* resemble those of this species; but the branches are broader, and the striae are less rigid and less distinctly impressed, while the absence of tubercles, and the coarser serratures, when visible, at once serve to distinguish the species.

In mode of growth and general aspect this species resembles the *G. serratulus* (Pal. N. Y., vol. 1, p. 274, pl. 74, fig. 5, a, b,) of the Hudson River shales; but in the latter the serratures are coarser and more oblique, the lower side being much the longer. The branches of that species are also more distinctly linear, while in this they become gradually wider from the base, and are very distinctly striate and tuberculate in well-preserved specimens.

The preceding description applies to the specimens of this species where the branches diverge abruptly, or nearly at a right angle, from the radicle.

*Locality and Formation.*—Point Lévy; Hudson River Group.

*Collectors.*—J. Richardson, E. Billings.

#### GRAPTOLITHUS BIFIDUS.

*Description.*—Two-branched; branches very gradually and uniformly diverging from the base to the extremities; surfaces obliquely striated; serratures moderately oblique; extremities often nearly vertical to the rachis, and submucronate (?); from thirty-eight to forty in the space of an inch; radicle short.

This species resembles in general features the *G. nitidus*, and might be mistaken for that species with the branches approximated by pressure. In several individuals examined the serratures are much closer, being from six to eight more in the space of an inch, while the general form is constant. The

outer margins of the branches are curved for a short distance from the radicle, and thence proceed in a uniform divergent line. The entire branch is very narrow at the base, but becomes gradually wider, the full width being attained at about half an inch from the bifurcation, while a few of the serratures towards the outer extremity, not having attained their full development, leave the branches narrower in that part. The same feature is observed in *G. nitidus* and others of this general character, and probably may be observed in all species where the extremities of the branches are entire.

*Locality and Formation.*—Point Lévy; Hudson River Group.  
*Collectors.*—J. Richardson, E. Billings.

#### GRAPTOLITHUS PATULUS.

*Description.*—Fronde composed of two simple widely diverging branches from a small radicle; branches long-linear, having a width from the base of the serratures to the back of the branch of from one-sixteenth to one-twelfth of an inch; serratures oblique, with vertical mucronate points, which from base to apex are more than half as wide as the branch. A well defined line or ridge extends downwards from the apex of the denticle two-thirds across the branch.

Fragments of this species are numerous upon some slabs of greenish or blackish-green slate where no other species occurs. The fragments are sometimes five or six inches in length, offering in different individuals little variation in width. Sometimes the branches are compressed vertically, and present the smooth linear base or exterior, which is less in width than when compressed laterally.

The lateral faces of the branches exhibit considerable variety of surface, dependant on the degree of compression, or in some instances, the replacement or filling of the interior by iron pyrites. In such cases, or when the branch is not flattened, the surface is deeply striated or wrinkled obliquely. In some of the extremely compressed individuals the surface has an appearance of vesicular structure; but this is probably due to influences attending the mineralization of the fossil, or

the filling up of the original canal, and not to the structure of the substance itself.

*Locality and Formation.*—Point Lévy ; Hudson River Group.  
*Collectors.*—J. Richardson, E. Billings.

#### GRAPTOLITHUS EXTENSUS.

*Description.*—Fronde probably two-branched ; branches long-linear, varying in width in different individuals from one-twelfth to one-tenth of an inch exclusive of the serratures, and from one-tenth to one-eighth of an inch including the serratures. Serratures oblique, with the extremities slender and nearly erect, mucronate at the tip ; about twenty in the space of an inch ; base of branch scarcely narrowed, showing a few smaller serratures ; surface strongly striated, the striæ being preserved in those specimens which are extremely compressed.

The branches of this species bear a very close resemblance to those of *G. octobrachiatus*, but an individual in which the base is preserved shows in its peculiar curving and smaller serratures a feature which belongs only to the two-branched forms. The serratures also appear to be more slender, and are slightly closer in their arrangement ; branches of the same size in the two, presenting respectively eighteen and twenty serratures.

This species in separate branches of from three to six or eight inches in length, is abundant on some slabs of decomposing grayish-brown shale, associated with *G. bryonoides*, *G. nitidus*, and others.

*Locality and Formation.*—Point Lévy ; Hudson River Group.  
*Collectors.*—J. Richardson, E. Billings, Sir W. E. Logan, James Hall.

#### GRAPTOLITHUS DENTICULATUS.

*Description.*—Fronde apparently consisting of two broad branches, (the base and junction of which are obscure in the specimen ;) margins defined by a rigid line, beyond which on the inner side, are serratures having the form and charac-

ter of small denticulations inserted upon the margin of the branch and vertical to its direction, broad at base, abruptly tapering above, and ending in mucronate points; about sixteen in the space of an inch.

This very peculiar species is readily recognised by the denticulations, which have the character of small sharp teeth fixed upon the margin of the branch. These denticles are more widely separated than those of any other species observed, as well as different in character.

*Locality and Formation.*—Point Lévy; Hudson River Group.

*Collectors.*—Sir W. E. Logan, James Hall.

#### GRAPTOLITHUS PRISTINIFORMIS.

*Description.*—Stipe simple, with serratures on both sides; serratures closely arranged, very oblique, acute, mucronate; thirty-two in the space of an inch.

This species approaches to *G. pristis* (Pal. N.Y., vol I., p. 265, pl. 72, fig. 1), but the serratures are more ascending, and the extremities more distinctly mucronate. The specimens observed however, are imperfect fragments, which are very closely compressed, being barely a film upon the surface of the shale, and the determination is somewhat unsatisfactory.

*Locality and Formation.*—Point Lévy; Hudson River Group.

*Collector.*—J. Richardson.

#### GRAPTOLITHUS ENSIFORMIS.

(*Genus RETIOLITES?* Barrande.)

*Description.*—Stipe simple, sub-ensiform or elongate-spatulate, usually broader in the middle and narrower towards the extremities; a central rib, with strongly marked obliquely ascending striæ which reach the margins; serratures obscure, apparently corresponding to the striæ; margin usually well defined.

Several specimens of this form occur on a single slab of slate, associated with *G. tentaculatus* and *G. quadribrachiatus*.

The oblique striæ apparently indicate the direction of the serratures, and in one specimen there is an appearance of obtuse indentations upon the margin; but it is scarcely possible at the present time to define satisfactorily the character of these serratures. In form and general character this species differs from all the others sufficiently to be readily distinguished.

*Locality and Formation.*—Point Lévy; Hudson River Group.  
*Collectors.*—J. Richardson, Sir W. E. Logan, James Hall.

### GRAPTOLITHUS TENTACULATUS.

(Genus RETIOLITES, Barrande.)

*Description.*—Stipe simple, linear, elongate-lanceolate or sometimes elongate-elliptical when entire; midrib double, extending much beyond the apex of the frond; exterior margins when entire, reticulate and armed with mucronate points, (and with mucronate points alone, or smooth, when imperfect,) with an extended setiform tentacle-like process from each side of the basal extremity; substance of the centre reticulate or cellular?

This species presents much variety of appearance dependant upon the condition of preservation. In specimens most nearly entire, the double midrib often extends beyond the apex nearly as far as the length of the frond; the margins present a series of oval or sub-hexagonal reticulations, every second one (and sometimes each one,) of which is armed by a minute mucronate spinule. When these outer cells or reticulations are broken away, the transverse walls between them often remain, and the specimens then present an undulating margin, with a short mucronate extension, which is the original wall between the marginal reticulations, and which is continuous with the striæ or fibres which traverse the frond from the midrib to the margins. On each side of the basal extremity the long setiform fibres extend obliquely forward to the distance of half an inch, and between these are two short terminal ones, like the processes on the sides of the frond.



In many specimens the whole exterior reticulate portion is removed, leaving the frond with straight or nearly straight parallel sides, the long extended midrib above, and the two setiform processes from the lower extremity; while in some specimens these parts also are removed. The serratures cannot well be determined in any of the numerous individuals examined, but they doubtless correspond to the vein-like markings of the centre, and the reticulate marginal extension.

Some specimens indicate that the central portion may be finely reticulate, which character, with that of the exterior, would be regarded as sufficient to warrant us in referring it to the genus *Retiolites*.

*Locality and Formation.*—Point Lévy; Hudson River Group.  
*Collectors.*—J. Richardson, Sir W. E. Logan, James Hall.

#### PHYLLOGRAPTUS.

Among the various forms in this Canadian collection of *Graptolitidæ* there are several which approach in general form to *G. ovatus* of Barrande, and *G. folium* of Hisinger. They present however some differences of character, varying from broad-oval with the extremities nearly equal, to elongate oval or ovate, the apex usually the narrower, but in a few instances the base is narrower than the apex. These forms are sometimes extremely numerous in the shales, and present on a cursory examination a general similarity to the leaves of large species of *Neuropteris* in the shales of the coal measures.

Instead of the narrow filiform mid-rib represented in the figures and descriptions of the authors mentioned, these specimens present a broad linear mid-rib continued from the apex to the base, and extended beyond the base in a slender filiform radicle, usually of no great extent, but in some instances nearly half an inch in length. The mid-rib is rarely smooth, varying in width, with its margins not often strictly defined. In examining a great number of individuals of one species, I have discovered that this mid-rib is serrated; and though for the most part the serratures are obscure, they nevertheless present all the characteristics which they exhibit in grap-

tolites of other forms, in which the branches have been compressed vertically to the direction of the serratures.

In this view, the lateral leaf-like portions appear to be appendages to the central serrated portion; but these are nevertheless denticulate on their margins, and the intermediate spaces are well-defined, as if admitting of no communication by serratures or cellular openings with the centre.

In another species the central axis or mid-rib is strong and broad, often prominent and distinctly serrate, the edges of the interspaces being all broken off as if the extremities had been left in the slate cleaved from the surface. At the same time the lateral portions are so well preserved as to show distinct cellules upon each side. We have therefore three ranges of cells visible, the central axis projecting at right angles to the two lateral parts. This remarkable feature leads to the inference that this graptolite was composed of four semi-elliptical parts joined at their straight sides, and projecting rectangularly to each other, presenting on each of the four margins a series of serratures, which penetrating towards the centre, were all united in a common canal, and all sustained upon a simple radicle.

In another more elongate form, the specimens examined are extremely compressed, and I have not been able to detect serratures in the axis, which however is sufficiently wide to admit of this feature.

For these remarkable forms, whether consisting of bilateral or quadrilateral foliate expansions, or with two or four series of cellules, I propose the name of *PHYLLOGRAPTUS*, from their leaf-like appearance when compressed in the slaty strata.

It is easy to perceive how bodies formed as these are may present different appearances, dependant upon the line of separation of the parts by the slaty laminæ. When separated longitudinally through the centre, the cells of the parts laterally compressed would be seen with the mid-rib not strictly defined; and the bases of the cells of that part vertically compressed, scarcely or not at all visible. When a small portion of the base of that part which is vertically compressed is preserved, the bases of the cells remain and mark the axis.

When instead of being imbedded so that two parallel sides are compressed laterally and the other vertically, the whole frond lies in an oblique position, the two adjacent rectangular parts are spread open and flattened upon the surface of the slate, the specimen then appears as if the cells were conjoined at their bases, or as if separated by a filiform mid-rib. An individual compressed in this manner and then separated through the middle, will present the bases of the two adjacent divisions with the cells lying obliquely to the plane of the slaty laminæ. These and other varieties of appearance are due to the position in which the fossil was imbedded, and the direction of the cleavage or lamination of the slate.

PHYLLOGRAPTUS. (New Genus.)

*Description.*—Fronde consisting of simple, foliate expansions, celluliferous or serrated upon the two opposite sides; margins with a mucronate extension from each cellule; or of similar foliate forms united rectangularly by their longitudinal axes, and furnished on their outer margins with similar cellules or serratures, the whole supported on a slender radicle.

These bodies which usually appear upon the stone in the form of simple leaf-like expansions, may possibly have been attached in groups to some other support; but the form of some of them, and the character of the projecting radicle at the base, indicates that we have the entire frond. These forms furnish perhaps the best illustration of all the *Graptolitidæ*, of the lesser development of the cells at the base, and their gradual expansion above, until they reach the middle or upper part of the frond. Many of them diminish from the centre upwards, and rarely the cells are more developed above the centre, reversing the usual form, and leaving the narrower part at the base.

PHYLLOGRAPTUS TYPUS.

PLATE VIII. FIG. 1-11.

*Description.*—Fronde elliptical, elongate-ovate or lanceolate,

broad-oval or obovate; margins ornamented by mucronate points; serratures closely arranged, about twenty-four, rarely twenty-two and sometimes twenty-six in an inch, usually obscure at the margins; axis or mid-rib broad, often crenulate or serrate; radicle usually short; frond robust.

This species assumes considerable variety of form; and from the examination of a few specimens of the extremes of the series one might be disposed to regard them as distinct species. After examining several hundred individuals however, I have not been able to find reliable characters in the form, or subordinate parts, to establish specific differences. The individuals figured represent the principal varieties noticed, though a greater number of forms might have been given. I have not thus far observed forms intermediate between the short broad ones and the more elongate oval ones; but it is probable that larger collections will furnish such. The number of serratures in entire fronds varies in different individuals from twenty-five or twenty-eight to fifty on each side, depending on the size and form of the specimen. The smallest examined have about twenty-five on each side.

The specimens of this species examined are all so much compressed that the rectangular arrangement of the parts of the frond, as seen in *P. ilicifolius*, cannot be shown, the only evidence of this character being the serratures along the central axis, which are transverse to those of the two sides.

Figures 1, 2, 3, 4. Examples of the ordinary forms of this species. Fig. 1 shows a smooth axis; while figures 2, 3 and 4 show indistinct serratures along the mid-rib.

Figures 5, 6, 7. Specimens which are more elliptical than the ordinary forms; the mid-rib or axis is well defined, but preserves no evidence of serratures.

Fig. 8. A broad oval form, showing serratures along the axis.

Fig. 9. An obovate form, showing serratures along the axis.

Fig. 10. A very large and elongate frond, shewing more than fifty serratures on each side; the central axis shows no serratures.

Fig. 11. A fragment of slate preserving twelve individuals of small size, upon the surface.

*Locality and Formation.*—Point Lévy; Hudson River Group  
*Collector.*—J. Richardson.

PHYLLOGRAPTUS HLICIFOLIUS.

*Description.*—Fronde apparently broadly oval or ovate, with the margin ornamented by mucronate points; mid-rib or axis broad, serrated; the extension of the serratures broken off in the separated laminae of shale; radicle short. Serratures from thirty to thirty-two in the space of an inch, varying slightly with the proportionate length of the frond.

The form in reality however is that of two broadly oval or ovate leaves or fronds, joined rectangularly at their centres or by the longitudinal axis, and in a transverse section presenting a regular cruciform figure. The expansions of the two sides, which are laterally compressed, show distinct serratures or cells with projecting mucronate extensions. Those which are vertically compressed have their outer portions broken off in the separated laminae of slate, and present the bases of the cells, which, having sometimes been filled and distended with mineral matter before imbedding, are very conspicuous. In a few instances the cells of the lateral portions are filled in the same manner, presenting the character of curving, conical tubes, with the broader extremity outwards.

The condition of preservation in several species examined is such as to render unavoidable any other conclusion as to their mode of growth than the one I have given above, however anomalous it may seem. This species differs from *P. typus* in its thicker substance, proportionally shorter and broader form, and more closely arranged serratures.

*Locality and Formation.*—Point Lévy; Hudson River Group.  
*Collector.*—J. Richardson.

PHYLLOGRAPTUS ANGUSTIFOLIUS.

*Description.*—Fronde elongate-elliptical or elongate-lanceolate,

closely serrated; serratures furnished with mucronate extensions, about twenty-four in the space of an inch; mid-rib broad, smooth; radicle scarcely preserved.

This species is readily distinguished from either of the preceding by its narrow and elongate form. The individuals examined are very numerous, but being for the most part upon slaty laminae, which are extremely compressed, they preserve scarcely any substance; a mere outline with a more brilliant surface being almost the only remaining character by which they are recognized.

The individuals of this species are, in several specimens, equally abundant with those of *Phyllograptus typus* represented in pl. 8, fig. 11. The mucronate extensions upon the margins of this species are not so abrupt as in *P. typus* and *P. ilicifolius*, the substance of the cell-margin being more extended along the mucronation. The number of serratures upon each side of the frond varies according to the size of the individual, being ordinarily from eleven or twelve to twenty-four, while in a single individual of nearly two inches in length there are forty-three or forty-four on each side. The mid-rib in this species though broad, like those of the preceding species, is not conspicuously serrate in any of the specimens examined. This feature however may have been obliterated by pressure.

*Locality and Formation.*—Point Lévy; Hudson River Group  
*Collector.*—J. Richardson.

#### PHYLLOGRAPTUS SIMILIS.

*Description.*—Frond broad-oval; margins ornamented by slender, sub-mucronate serratures, which are closely arranged, being in the proportion of thirty-two to an inch, usually from thirteen to sixteen upon each side; axis disjoined; radicle unknown.

This species exhibits much variety of aspect. The more perfect forms are broadly oval, the diameters being about as six to seven. The central portion is open and free from any organic substance, as if there had originally been a cavity in the place of the longitudinal axis. In other specimens the

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parts are separated at one extremity, and appear like three or four branches closely joined at the other extremity, giving it the aspect of a four-branched frond. On examining numerous specimens they appear to have been originally arranged like the species of this genus already described, with perhaps this difference, that the margins of the axial portion were not closely united, or were quite disjoined along the centre. From the equal extremities of the frond, and the almost rectangular serratures, conjoined with the very obscure condition of the specimens, it has not been possible to determine whether the separation of the parts at the extremities has taken place at the base or the summit.

This species occurs associated with *G. Logani* and *G. quadribrachiatus*.

*Locality and Formation.*—Point Lévy; Hudson River group.  
*Collectors.*—Sir W. E. Logan and James Hall.

Besides the forms described in the preceding pages, there are several others belonging to the genus *Graptolithus*, of which I have not specimens in sufficient perfection to furnish a proper description; and there are others which, possessing some abnormal characters, I hesitate to describe as distinct species, until I shall have an opportunity of seeing more specimens. One of these, having the general character of *G. octobrachiatus*, has but seven branchlets, three from one extremity of the vinculum and four from the other, bifurcating as in the species named above. The branches, however, are more slender than in *G. octobrachiatus*, and it may prove to be a distinct species.

Another form having the general habit of *G. Logani* has but nine branchlets, four from one and five from the other side of the vinculum. The exterior side only is visible, and the branches being broken off a short distance from the vinculum, no opportunity is offered of examining the serratures. It seems quite probable that this may prove a distinct species.

A single fragment of a ramose form, with two branches like *G. ramosus*, of New York, has been observed, but I have not thought it desirable to give its characters at present.

Among other forms of the *Graptolitidae*, there are at least three species of *Dictyonema*, which are of common occurrence, associated with the Graptolites of Point Lévy.

The genus *Dictyonema* was described in the Palaeontology of New York, vol. 2, p. 174, from an examination of the broad flabelliform or sub-circular expansions of corneous reticulated fronds common in the shales of the Niagara group. These forms were described as having "the appearance and texture of Graptolites, to which they were doubtless closely allied." Further examinations have demonstrated the truth of this remark in the discovery of serratures, like those of *Graptolithus*, on the inner side of the branchlets of both *D. retiformis* and *D. gracilis*. The celluliferous side adhering more closely to the stone than the opposite, as in *Retepora* and *Fenestella*, is much more rarely seen than the other. The mode of growth, though probably flabelliform in some species, is clearly funnel shaped in *D. retiformis*, the serratures being upon the inner side as in *Fenestella*.

The generic characters heretofore given may therefore be extended as follows.

#### DICTYONEMA.

*Generic characters.*—Frond consisting of flabelliform or funnel-shaped expansions, (circular from compression) composed of slender radiating branches, which frequently bifurcate as they recede from the base; branches and subdivisions united laterally by fine transverse dissepiments; exterior of branches strongly striated and often deeply indented; inner surface celluliferous or serrate, as in *Graptolithus*.\*

The general aspect of the species of this genus is like that of *Fenestella*, both in the form of the fronds and the bifurcation of the branches. Some of the species have hereto-

\* A paper by J. W. Salter, Esq., Palaeontologist of the Geological Survey of Great Britain, read before the American Association, for the advancement of Science, at the Montreal Meeting, 1857, describes a new genus of the Graptolite family under the name of *Graptopora*. Although having had no opportunity of examining this paper, it appears to me that the forms described are true *Dictyonema*.



fore been referred to that genus, and others to *Gorgonia*. They may be known from either of these genera by the striated and serrated corneous skeleton, and absence of round cellules, which latter character, with a calcareous frond, marks the *Fecnestella*.

Since the essential characters of *Dictyonema*, with figures of two species, have been given long ago, and their similarity to Graptolites pointed out, I am disposed to retain the name, and to describe the Canadian species under that designation.

There are still two other types in this collection which seem to merit generic distinction. One of these consists of imperfect branching fronds, the smaller branchlets of which are often rigidly divergent from the main branch at an angle of about thirty-six degrees. In others the branchlets diverge in a similar manner, but are less rigid. Exterior of branches smooth, interior surface celluliferous. There are two or three forms of this type which I propose to designate as DENDROGRAPTUS.

Another form consists of fronds which are strong stipes near the base, and become numerous and irregularly branched, ending in a great number of filiform branchlets, one side of which is serrated. The general aspect is that of a shrub or tree in miniature. For these forms I would propose the generic name of THAMNOGRAPTUS.

There is also a single species approaching in character to that published in the Report of the Fourth Geological District of New York as *Filicites?* The lateral branchlets are much longer, more lax and slender, being in this respect more nearly like *Filicites gracilis* of Shumard, (Geol. Report of Missouri, part 2, p. 208, pl. a. fig. 11) but the branchlets in the Canadian species are longer and more slender. They have all the same general plumose character, and from the well preserved corneous structure in the Canadian specimens, I regard them as belonging to the Graptolitidae, although the celluliferous or serrated margins have not been seen. For these forms of Canada, New York and Missouri, should they prove generically identical, I propose the name of PLUMALINA, making the *Filicites?* cited above, the type of the genus with the name of *Plumalina plumaria*, while the western species will receive the name of *P. gracilis*.

The disk-like forms which are described in the Palæontology of New York, vol. 1, p. 277, under the name of *Discophyllum*, are probably the disks of a species of *Graptolithus* with numerous branches. One specimen preserves a thick corneous substance, which is the exterior surface, while the other preserves the mould of the opposite side, the radiating impressions of which are erenulated. There are no evidences of branches extending beyond the margin of the disk.

We have now so many well-established forms in the family *Graptolitidæ*, that we have the means of comparison with other allied families among palæozoic fossils.

Although numerous species in this collection are shown to be of compound structure, or to consist of fronds composed of two or more branches, and many of them originating in, or proceeding from a disk of thickened corneous substance, yet it is not improbable that there are among true Graptolites simple stipes or stems, as all the species have been usually heretofore regarded. I am disposed to believe that those Graptolites where the stipe is serrated on the two sides (*Diplograpsus*) may have been simple from the base; and that the branching forms having both sides, or one side only of the branches serrated, may possibly also have been simple, or bearing no more than a single stipe from the radicle. The bifurcate appearance at the base of *G. bicornis* however, offers some objections to this view, and these too may have been compound, like those which have only one side serrated.

The numerous compound forms shown in this collection, and the great variety of combination in the mode of branching, induces the belief that all those with a single series of serratures have been originally composed of two, four, or more branches, either diverging from a radicle or connected by a vinculum from which the radicle has extended.

The *Phyllograptus*, although apparently an anomalous form, is not more so with our present knowledge of the Graptolites than *G. Loganii* or *G. octobrachiatus* would have been considered a few years since.

It is not among the least interesting facts, that we should find the *Graptolitidæ* simulating in their mode of growth so many of the Palæozoic *Bryozoa*. We have *Fenestella*

represented in *Dictyonema*; the ramose forms of *Retepora* in *Dendrograptus*; *Glauconome* and *Ichthyorachis* in *Plumalina*; while the spirally ascending forms figured by Barrande appear to simulate in their mode of growth the spiral forms of *Fenestella* or *Archimedes*.

The forms of Graptolites now known are so numerous as to deserve especial consideration in their relations to other groups or families of fossil or living forms. They have been referred to the *Radiata* and to the *Bryozoa*. They were all originally composed of a thin corneous film which enclosed the bodies of the animals inhabiting the cells, and formed the general canal or source of communication along the axis. The substance of the Graptolites was then unlike that of the *Radiata* of the same geological age; the sub-divisions are in twos, or some multiple of two, except in a few instances which appear to be abnormal developments; and when the sub-divisions are irregular there is far less similarity with *Radiata*.

From all Palaeozoic *Bryozoa* the Graptolites differ essentially in the form and arrangement of the cellules, and the nature of the substance and structure of the skeleton; and simulate only the general forms of Bryozoan genera.

JAMES HALL.

