tinuous; the limits of many cannot be traced, but they also occur as isolated patches environed on all sides by the slate. The nuclei of the bleached spheres represent their smallest development, between which and the continuous layers patches of every intermediate size occur.

The ultimate composition of the green beds would be consistent with their containing a large proportion of hornblende. Bischof¹ refers to beds of similar character interstratified with clay slates in the Thuringian Forest, and discusses the question whether they may not be a metamorphic product from the slates; but in the case of the Welsh slates, whatever be the source of the materials composing the green layers, whether simply detrital accumulations from eruptive rocks, or otherwise, their sedimentary interstratification is scarcely open to question.

The bleaching of the blue slate adjacent to the dykes of intrusive Greenstone seems to be of a different character to that adjacent to the interstratified layers. Instead of being defined by a distinct outline as in Plate VII., the pale colour graduates into the normal colour of the slate, and analyses of examples from the Penrhyn and Llanberis quarries indicated that the change of colour was due to the reduction of most of the iron from sesquioxide to protoxide, probably by the agency of a moderate degree of heat on the intrusion of the Greenstone. As I believe there is no published analysis of the composition of these Welsh Greenstones, it may not be out of place to give the result of a determination made for me by Dr. Voelcker for comparison with the composition of the green layers interbedded with the slate.

ANALYSIS OF GREENSTONE DYKE, PENRHYN QUARRIES.

Water of Combination	1.99	* Carbonate of Lime	14.85
Bisulphide of Iron	0.23	* Carbonate of Magnesia	14.59
Protoxide of Iron	10.22	Potash	0.43
Peroxide of Iron	1.97	Soda	0.70
Titanic Acid	2.51	Silica	47.47
Alumina	5.80		
Sulphate of Lime	0.08		100.639

* The carbonate of lime (and magnesia?) occurs for the greater part in the shape of separate crystals, which are visible in a fresh fracture to the naked eye, and effervesce in isolated spots on the application of hydrochloric acid.

IV.—A REVISION OF THE BRITISH GRAPTOLITES, WITH DESCRIPTIONS OF THE NEW SPECIES, AND NOTES ON THEIR AFFINITIES.²

By WM. CARRUTHERS, F.L.S., F.G.S., Botanical Department, British Museum.

(PLATE V. p. 64.)

Class, HYDROZOA. Order, *Graptolitida*.

GEN. I. RASTRITES, Barr. (Grapt. de Boh. p. 64). Polypary simple, consisting of a slender capillary common tube, supporting a single series of isolated hydrothecæ, which are free throughout their whole length.

¹ "Chemical and Physical Geology." English edition, vol. iii., p. 315.

² Concluded from the February Number of the GEOLOGICAL MAGAZINE, p. 74.

Sp. 1. *R. peregrinus*, Barr. (Grapt. de Boh. p. 67, pl. 4, fig. 6), Loc. Moffat.

2. *R. Linnæi*, Barr. (loc. cit. p. 65, pl. 4, fig. 2-4). Common tube, very slender, supporting largish hydrothecæ, broad at the base and narrowing gradually upwards. From 10 to 15 in an inch, uniform in the same specimen. Plate V. Fig. 15. Loc. Moffat.

3. *R. maximus*, sp. nov. (Pl. V. Fig. 14). Common tube slender, supporting very large hydrothecæ at wide intervals. Hydrothecæ nearly half an inch long, somewhat enlarged towards the apex, and furnished at the base with a triangular corneous membrane extending a short distance up the margin of the cells. About 6 cells in an inch. Loc. Moffat.

4. *R. capillaris*, sp. nov. (Pl. V. Fig. 16). Common tube very slender, with short isolated triangular hydrothecæ, their base of attachment to the common canal as long or longer than their depth. About 16 cells to an inch. Loc. Moffat. Richter figures this specimen in Zeitschr. Deutsch. Geol. Gesellsch. V. 1853, Tab. xii. fig. 34 a., referring it to *R. gemmatus*, Barr., which is very different, and of which his fig. 34 b. is a good representation.

R. triangulatus, Harkn. (Geol. Journ. vol. vii. p. 58), was founded on portions of the proximal end of *G. convolutus*, His., as has been stated by several observers. It is remarkable, however, that this species of *Graptolithus* really terminates proximally in a polypary that cannot be distinguished from *Rastrites*. This was pointed out to me by Prof. Wyville Thompson in a specimen figured on Pl. V. Fig. 1, which Prof. McDonald found one day he joined me in the search for the fossils at Bell Craig, near Moffat. The specimen is now in Jermyn Street Museum. I have in my own collection a smaller specimen, which exhibits also both structures on the same organism. How far this may affect the stability of the genus *Rastrites* I cannot at present say. All the species are founded on comparatively small fragments, and it is possible that they may all be the proximal terminations of different species of *Graptolithus*.

R. Barrandi, Harkn. (Geol. Journ. xi., 475), was founded upon specimens of *Cladograpsus gracilis*, Carr., according to Prof. Harkness himself (GEOL. MAG. IV. p. 258).

Besides the forms enumerated, I have obtained several fragments agreeing with the figures of Richter's *Graptolithus urceolus* (Zeitschr. Deutsch. Geol. Gesell. V. 1853, p. 462, Tab. xii., fig. 29, 30), and with the specimens drawn on Tab. v. fig. 3 and 4 of Geinitz's "Graptolithen," which he refers to the lower portion of the stem of *R. triangulatus*, Harkn., but which are certainly the same as the forms figured by Richter. These fragments differ from *R. peregrinus*, Barr., in having a small portion of the free end of the hydrotheca bent at a right angle, the mouth being turned round so as to open in the direction of the proximal end of the polypary. This character is so marked that I would not hesitate to include it in *Rastrites*, as a true species of that genus as it is at present understood, were it not that I have hitherto met with it only in very short fragments; and these will be found, I believe, when more perfect specimens are obtained, to be the proximal terminations of a *Graptolithus*, agreeing in this respect with what I have described in *G. convolutus*, His.

GEN. II. GRAPTOLITHUS. Linn. (Syst. Nat., Ed. I.). Polypary simple, with a single series of hydrothecæ in contact throughout more or less of their length.

Sp. 1. *Nilssoni*, Barr. (Grapt. de Boh. p. 51, pl. 2, figs. 16, 17). Loc. Moffat.

2. *G. intermedius*, sp. nov. (Pl. V. Fig. 18). Polypary slender; proximal end composed of a slender canal with distant, isolated, and very small hydrothecæ; adult hydrothecæ, short, triangular, the upper margin of the cell forming an acute angle with the common canal. About 26 cells to an inch. This species differs from *G. Nilssoni*, *G. tenuis*, and *G. Hisingeri* in the form of the cells, and from the last also in the slender common canal. Perhaps Portlock's figure 6a. pl. 19 of his Report belongs to this species. Loc. Moffat.

3. *G. tenuis*, Portl. (Report of Geol. of Londonderry, p. 319, pl. 19, fig. 7). Loc. Moffat.

4. *G. Salteri*, Gein. (Die Grapt. p. 36), *G. tenuis*, Salter (Quart. Journ. vol. vii. p. 173, pl. 10, fig. 1). Loc. Girvan.

5. *G. Hisingeri*, Carr., *G. sagittarius*, His. et auct., non Linn. I have, in a

previous page, given the reasons for changing this name. Although so well marked a species, it has perhaps been more frequently figured and described as new than any other graptolite. To it I refer the following: *G. scalaris*, Gein. (Leon. and Br. Jahrb., 1842), *G. incisus*, Salter (Quart. Journ.), *G. tenia*, Sow. and Salt. (Geol. Journ. vol. v.), *G. barrandei* Scharen. (Grapt. p. 15), *G. virgulatus*, Scharen. (Grapt. p. 14), *G. latus*, Roem. (L. and Br. Jahrb., 1855), *G. polyodonta* Roem. (*ibid.*), *G. oblique-truncatus*, Roem. (*ibid.*), *G. Jungsti*, Roem. (*ibid.*), *G. serratus*, Gein. (L. and Br. Jahrb., 1842), *G. nuntius*, Richt. (Zeitschr. Deutsch. Geol. Ges., 1853), *G. latus* Nic. (Quart. Journ. vi.). *G. rectus*, Emm. (American Geol. i.) is the same species, but it is erroneously drawn with the cells directed towards the proximal end. *G. Conybeari*, Portl. (Report, p. 320),—I cannot distinguish the authentic specimens in the Geological Museum, Jermyn Street, from *G. Hisingeri*. Loc. Moffat, etc.

6. *G. Flemingii*, Salter (Quart. Journ. viii. p. 390, pl. 21, figs. 5-7). Loc. Wigton.

7. *G. convolutus*, His. (Leth. Suec. p. 114, pl. 35, fig. 7). The following synonyms belong to this species *G. spiralis*, Gein. (L. and Br. Jahrb. 1842). *G. Sedgwickii*, M'Coy, not Portl. (Pal. Foss. p. 6, pl. 18, fig. 2). *G. sagittarius*, Giebel (Die Silur. Fauna, pl. 6, fig. 11). *G. pectinatus*, Richt. (Zeitsch. Deut. Geol. Ges. 1853). *G. elegans*, Emmons (Am. Geol. i. p. 106). *Rastrites triangularis*, Harkn. (Quart. Journ. vol. vii.). I have figured on Pl. V. Fig. 1 the most perfect specimen of this species I have yet seen. The importance of the specimen was pointed out to me by Prof. W. Thompson. The older portion of the polypary has the structure of *Rastrites*. The cells are linear and isolated. Each cell is furnished with two spinous processes from the sides of the mouth. Indications of these are to be seen in the specimen figured, but I have numerous other specimens in which they are more obvious, appearing as in Figs. 1*b*, and 1*c*. The first cells are long and slender, they gradually become shorter and thicker, and then they assume the triangular form characteristic of the full-grown polypary, with the bases extended so far along the common canal as to meet. Loc. Moffat, etc.

8. *G. Sedgwickii*, Portl. (Report, p. 318, pl. 19, figs. 1-3, 6). M'Coy having mistaken this species, has caused it to be confounded with *G. convolutus*. Harkness gives a very good representation of the species from Dumfriesshire specimens (Quart. Journ. vol. vii. p. 58). In the original description Portlock clearly distinguishes it from *G. convolutus*. He says: "The serratures are strong projecting hooks having a wide base."

9. *G. priodon*. Bronn. (Leth. Geogn. p. 56, pl. 1, fig. 13). *G. ludensis*, Murch. (Sil. Syst. p. 694). Loc. Ludlow, etc.

10. *G. Halli*, Barr. (Grapt. p. 48, pl. 2, fig. 12, 13, excl. fig. 14, 15). Loc. Moffat.

11. *G. Becki*, Barr. (Grapt. p. 50, pl. 3, figs. 14-18). *G. lobiferus*, M'Coy (Pal. Foss. p. 4, pl. 1*b*, fig. 3). *G. Nicoli*, Harkn. (Quart. Journ. vol. vii., p. 61). *G. millepeda*, M'Coy (Pal. Foss. p. 5, pl. 1*b*, fig. 6). *Diplograpsus nodosus*, Harkn. (Quart. Journ. vol. vii., p. 63). Loc. Moffat.

12. *G. Clingani*, sp. nov. (Pl. V., Figs. 19*a*., 19*b*). Polypary, small and arcuate, with a broad common canal, and slender somewhat recurved hydrothecae. This beautiful little graptolite I long supposed to be only the proximal portion of some other species, but the large number I have met with, all equally perfect, none larger than fig. 19*a*, and many showing the prolongation of the axis beyond the distal end, together with the great breadth of the common canal (forming two-thirds of the breadth of the whole polypary), unlike the early portion or proximal fragment of any graptolite with which I am acquainted, have induced me to consider it a good species. I have associated with it the name of my earliest friend, the late J. Morison Clingan, M.A., my school-mate and fellow-student, my companion in rambles over the green hills and among the picturesque valleys of our native district, in exploring its geology or enjoying its beauty, and my friend and counsellor until death early cut him off, but not until he had shown promise of great excellence in the literary pursuits to which he had devoted himself, and had endeared himself by his virtues to a large circle of friends.

13. *G. Griestonensis*, Nic. (Quart. Journ. vol. vi. p. 53). Loc. Peebleshire.

GEN. III. CYRTOGRAPSUS, Carr. (Murch. Sil., Ed. IV., p. 540).

Polypary growing in one direction from the proximal end, and giving off simple or compound branches at irregular intervals.

Sp. 1. *C. Murchisonii*, sp. nov. (Table V. Fig. 17a, 17b). Hydrothecæ triangular apiculate, furnished with a spine. The upper margin of the cell at right angles to the axis, about twenty-eight cells to the inch. The polypary is considerably incurved at its proximal end, and as it grows it gradually opens into a larger curve. The branches spring from celluliferous surface of the polypary, but as there is no break in the continuity of the hydrothecæ, they must rise from the periderm covering the common canal. The branches also curve in the same direction as the main portion of the polypary. Loc. Pencerrig, Builth. I have associated the name of the author of "Siluria" with this remarkable species. The only British specimens I have seen are in the Geological Museum, Jermyn Street, but among the specimens obtained by the British Museum from M. Barrande there is a specimen from Listice, labelled *G. priodon.*, which belongs to this species.

2. *C. hamatus* (*G. hamatus*, Bail. I. Quart. Journ. Geol. Soc. Dubl., 1861, pl. 4, fig. 6). This remarkable form, of which I believe only a single specimen has been found, now in the Museum, Jermyn Street, where I have examined it, probably belongs to this genus.

GEN. IV. DIDYMOGRAPSUS, M'Coy (Brit. Pal. Fossils, p. 9). Polypary growing bilaterally from the initial point, consisting of two simple or bifurcate branches and without a central disc. The initial portion of the proximal end forming a non-celluliferous process always proceeding from the common canal or axis; the opposite or celluliferous side of the polypary frequently ornamented with one or more teeth or spines. The branches of the polypary sometimes extend at right angles to the initial process (*D. hirundo*), sometimes they are bent backwards upon it (*D. Moffatensis*), and less frequently they are turned inwards from it (*D. Murchisonii*).

The forms with bifurcating branches for which Salter proposed the genus *Tetragrapsus* do not differ in any essential character from the type of *Didymograpsus*. The precise number of branches is not taken into account in his genus *Dichograpsus*, in which there are species with eight, eighteen, etc., branches; and if of no value there, it can scarcely be employed here. It is not easy indeed to discover any character whereby to separate *Dichograpsus* from this genus, except it be the corneous disc that envelopes the non-celluliferous proximal portions of the polypary, which has never been found associated with specimens of *Didymograpsus*, and only with certain forms of *Tetragrapsus* and *Dichograpsus*. But this disc is not always present even in those graptolites in which it is known to occur; it may have been more perishable than the polypary itself; perhaps, however, the species which originally possessed it may be distinguished by other characters, as by the possession of an obvious branching hydrocaulus. There are, unfortunately, no materials in this country to enable one to determine this; but if this character should prove a good one, it would enable us to class the various forms into two well marked genera; some species of *Tetragrapsus*, such as *G. (T.) Headi* and *G. crucifer*, belonging to *Dichograpsus*, while *G. (T.) bryonoides*, etc., would be placed in *Didymograpsus*.

Sp. 1. *D. hirundo*, Salt. (Quart. Journ. xix. p. 137, fig. 13f). *D. constrictus*, Hall (Grapt. Quebec Gr. p. 76). Polypary of two branches, diverging at right angles from the initial points, and having its full size from the beginning. From 22 to 26 cells in an inch. Loc. Skiddaw Slates.

2. *D. Murchisonii*, M'Coy, *Graptolithus Murchisonii*, Beck (Sil. Syst. p. 694, pl. 26, fig. 4). *Prionotus geminus*, His. (Leth. Suec. Suppl. 2, p. 5, pl. 38, fig. 3). Loc. Llandrindod, etc.

3. *D. V-fractus*, Salt. (Quart. Journ. xix. p. 137, fig. 13e). Polypary of two branches bent inwards, forming an acute angle but speedily opening, and widely diverging from each other. From 20 to 24 cells in an inch. Loc. Skiddaw Slates.

The amount and direction of divergence of the branches are so variable in some well-marked species of this genus, as might be expected in polyparies com-

posed of a flexible substance, that I doubt if specific characters of value can be deduced from them.

4. *D. sextans*, McCoy (Pal. Foss. p. 9). *G. sextans*, Hall (Pal. of N. York, vol. i., p. 273, pl. lxxiv., fig. 3). Loc. Moffat.

5. *D. Forchhammeri*, Baily (Grapt. of Meath, etc., p. 6, fig. 7). *Cladograpsus Forchhammeri*, Gein. (Die Grapt., p. 31, pl. v. figs. 28–31). Branches of polypary slender, divaricating in straight lines, and at a wide angle, bent backwards towards the initial point. Hydrothecæ not very marked, in contact throughout almost their whole length; about 28 in an inch. Initial process permanent: the two first cells developed at a right angle to it, their mouths furnished each with a very fine short spine; a third similar spine proceeds from between the bases of the two primary cells opposite to the initial process. Loc. Moffat, and Kilnacreegh, Co. Clare.

6. *D. elegans*, sp. nov. (Pl. V., Fig. 8, a b c). Branches of the polypary divaricating at various angles, and with a slight curve within a short distance of the proximal origin of the polypary. The hydrothecæ are rounded at the apex, and free throughout a considerable portion of their length, and the intervening spaces are rounded at the base; about 22 cells in an inch. The initial process is obvious in young specimens, but I have not been able to detect it in old individuals; the outer apex of the angle ornamented with 3 short strong spines. Loc. Moffat.

Dr. Nicholson has enabled me to refer his *D. flaccidus* (GEOL. MAG., Vol. IV., p. 110, Pl. VII., Figs. 1–3) to this species. His fig. 1 has a general resemblance to Hall's *G. flaccidus*, but the form and number of the cells and the breadth of the polypary are very different. In Hall's species there are "from 28 to 30 and near the base sometimes 31" cells in the space of an inch. In Dr. Nicholson's drawing, "nat. size," there are 14! The figs. 2 and 3 made me fancy that he might mean the species I have just described, but it would have been impossible, except on his own authority, to have settled the matter. Loc. Moffat.

7. *D. Moffatensis*, Carr. (Trans. R. Phys. Soc. Edin., 1858, p. 469, fig. 3). *G. divaricatus*, Hall (Pal. N. York, vol. iii. pt. 1, p. 514, 1859). *D. anceps*, Nicholson (GEOL. MAG., Vol. IV., p. 110, Pl. VII., Figs. 18–20). The last paragraph in Dr. Nicholson's description of this species shows that he had overlooked *D. Moffatensis* when he wrote it, and his comparison of his fossil with Hall's figure puts it beyond a doubt that I have rightly placed *D. anceps* here as a synonym. Loc. Moffat.

8. *D. caduceus*, Salt. (Quart. Journ. vol. xix., p. 137, fig. 13). *G. Bigsbyi*, Hall (Grapt. Quebec Gr. p. 86). Hall has to my mind clearly shown this to have four branches. Loc. Skiddaw Slates.

9. *D. bryonoides*.—*Tetragrapsus bryonoides*, Salt. (Quart. Journ., vol. xix., p. 137, fig. 8a). *G. bryonoides*, Hall (Grapt. Quebec Gr. p. 84). Loc. Skiddaw Slates.

10. *D. quadribrachiatus*.—*G. quadribrachiatus*, Hall (Geol. Surv. of Canada, Rep. 1857, p. 125). *Tetragrapsus crucialis*, Salt. (Quart. Journ., vol. xix., p. 137, fig. 8b). Loc. Skiddaw Slates.

GEN. V.—*DICHOGRAPSUS*, Salt. (The Geologist, iv., p. 74). Polypary compound, growing bilaterally, and branching more or less frequently in a dichotomous manner, the hydrocaulus, or non-celluliferous bases of the branches invested with a corneous disc.

Sp. 1. *D. octobrachiatus*.—*G. octobrachiatus*, Hall (Canada Rep. 1857, p. 122; Grapt. Queb. Gr. p. 96, pl. 7, 8). *D. aranea*, Salt. (Quart. Journ. xix., p. 137, fig. 9). Loc. Skiddaw Slates.

2. *D. Sedgwickii*, Salt. (Quart. Journ. xix. p. 137, fig. 11). Loc. Skiddaw Slates.

GEN. VI.—*CLADOGRAPSUS*, Carr. (Trans. R. Phys. Soc. Edin., 1858, p. 467). Polypary compound, growing bilaterally from the primary point irregularly, and repeatedly branching and rebranching, and without a central disc. *Pleurograpsus*, Nicholson (GEOL. MAG., Vol. IV., p. 256).

Sp. 1. *C. linearis*, Carr. (Trans. R. Phys. Soc. Edin., 1858, p. 467, fig. 1). *Pleurograpsus linearis*, Nich. (l. c.) This species has a slender polypary, and cells

so slightly elevated as not to be clearly seen without the aid of a lens; there are about 18 to the inch. Dr. Nicholson's figure, "nat. size," represents a strong polypary with well-marked cells, and from 6 to 9 in an inch! I have no doubt that it was drawn as Dr. Nicholson says for this species, but it is greatly to be regretted that such drawings are published; they can serve only to increase the difficulties that under the most favourable circumstances beset every scientific investigation. Loc. Moffat.

2. *C. capillaris*, sp. nov. (Pl. V., Fig. 7 *a*, *b*) Extremely slender polypary, with remote branches, and very minute hydrothecæ; about 24 in an inch. It is not so abundant as *C. linearis*, and is very easily distinguished by its capillary appearance. It is probably the same species as that figured and described by Emmons in his American Geology, vol. i., p. 109, pl. 1, fig. 7, under the name of *Nemagrapsus capillaris*. Loc. Moffat.

3. *C. gracilis*,—*G. gracilis*, Hall (Pal. N. York, i. p. 274, pl. lxxiv, fig. 9); *Rastrites Barandei*, Harkn. Loc. Moffat, and Bellewston Hill, Meath.

GEN. VII.—*DENDROGRAPTUS*, Hall (Grapt. Quebec Gr. p. 126). Polypary compound, with a thick common hydrocaulus giving off branches irregularly, which repeatedly subdivide in a dichotomous manner.

Sp. 1. *D. furcatulus*, Salt. (Mem. Geol. Surv. iii., pl. II. *a*, fig. 5).

2. *D. lentus*, Carr. (Murch. Sil., Ed. iv., p. 541, fig. 5). Branches of the polypary repeatedly dichotomising; hydrothecæ acute-angular, about 18 in the inch. This is a much more robust species than that described by Salter. I have seen no more of it than the well-marked specimen figured (Pl. V., Fig. 5). Loc. Fernanagh.

GEN. VIII. *DIPLOGRAPTUS*, M'Coy (Pal. Foss., p. 7). Polypary with a double series of cells on either side of a slender axis. Hydrothecæ distinct from the periderm of the common canal.

Sp. 1. *D. pristis*, His. (Leth. Succ. p. 114, pl. xxxv. fig. 5), *D. foliaceus*, Murch. (Sil. Syst.) *Fucoides dentatus*, Brongn. (Hist. Veg. Foss. I. p. 70). *D. physophora* Nich. (Ann. Mag. Nat. Hist., January, 1868, p. 56). *D. vesiculosus*, Nich. (ibid p. 57). This is the best known and most abundant species of *Diplograpsus*. Although it has been frequently figured I have had four specimens drawn on Pl. V., with the view of illustrating the different forms of the appendages at the proximal end. The species generally appears as if it terminated in an acute point, formed by the approximation of the two primal cells; occasionally a spine continuing the line of the axis, and two lateral ones, are found (13 *b*, *c*, *d*), and in one specimen (13 *a*) I have observed two long slender processes rising together from the proximal points of the polypary, and produced apparently by the abnormal division of the medial spine. The axis is generally prolonged at the distal end, and is sometimes twisted and enlarged as described by Barrande (Grapt. de Boh. p. 4), and figured in different species of *Diplograpsus* by Barrande, Geinitz, Baily, etc. Dr. Nicholson has founded his *D. vesiculosus* on a specimen with the axis in this condition, and *D. physophora* is evidently another specimen of the same species in accidental contact with a "grapto-gonophore," or some other body. Loc. Moffat, etc.

2. *D. minutus*, sp. nov. (Pl. V., Fig. 12, *a*, *b*). This agrees with *D. pristis* in general appearance, and in the form and arrangement of the cells, except that the whole polypary and all its parts are so very small. Had I met with only a few specimens, I would have considered it as merely an accidental variety, but I have seen so many, all agreeing in size, that I cannot doubt that it is a good species, especially as young specimens of *D. pristis* early attain their full breadth, and the increase of the polypary is by additions to its distal end, and not to the size of the already formed hydrothecæ, just as in the living *Sertulariadae*. About 38 cells to one inch. Loc. Moffat.

3. *D. angustifolius*, Hall (Pal. N. York III., p. 515, figs. 1 and 2). *D. acuminatus*, Nich. (GEOL. MAG., IV., p. 109, Pl. VII., Figs. 16 and 17). Loc. Moffat.

4. *D. persculptus* (Cat. Foss. Mus. Pract. Geol. p. 25). Beautiful specimens of this species, which I recently saw in the Woodwardian Museum, Cambridge, convinced me of its distinctness. It is nearly allied to *D. pristis* and *D. folium*.

A satisfactory description and drawing of it would be of value. Loc. Gogofau, Carmaerthenshire.

5. *D. Whitfieldi*, Hall (Pal. N. York, iii. p. 516, fig. i.). *D. quadri-mucronatus*, Nich. (GEOL. MAG. IV. Pl. VII. Fig. 6). This species I had long considered to be a mucronate form of *D. pristis*, with which species it for the most part agrees, except in the possession of the spines proceeding from the cell mouths. In the drawings, Pl. V. Fig. 3*b* and 3*c*, the spines are represented by somewhat too strong lines; their direction, which seems in life to have been at right angles to the direction of the polypary, depends in the fossil upon the way in which they have been pressed before or during fossilization. The direction is different on the two sides of Fig. 3*c*.

6. *D. mucronatus*, Hall (Pal. N. York i. p. 268, pl. 73, fig. i.), Pl. V. Fig. 2. Loc. Moffat.

It is not easy to determine how far the processes from the mouths of the hydrothecæ are to be depended upon for specific characters. Mr. Baily, from Irish specimens, has figured under the name of *D. mucronatus* (Grapt. of Meath, etc., fig. 4*a*, *b*, *c*), a remarkable form, with the general aspect of *D. pristis* and *D. Whitfieldi*, but with several branching and apparently anastomosing processes from the cell mouth. I have met with the same form at Moffat, and figured them in the Intellectual Observer, May, 1867, pl. 1, fig. 6; and Hall, also, in his Graptolites of the Quebec group, pl. B. fig. 10, gives a drawing of a somewhat similar structure. He considers the processes to be the marginal fibres of the reproductive sacs, the sacs themselves having been removed (by maceration). The discovery of additional specimens may show that it is really a new species; and should it turn out to be so, I would suggest that it be called *D. Bailyi*, after the palæontologist who is doing so much towards the illustration of the palæozoic fauna of Ireland. The polypary has been very flexible, as bent and twisted specimens have occurred both to Mr. Baily and myself.

7. *D. tricornis*, Carr. (Trans. R. Phys. Soc. Edin. 1858, p. 468, fig. 2). *G. marcidus*, Hall (Pal. N. York iii. p. 515, figs. 1-3). When I described this species I had not detected the mouths of the cells in those specimens in which they should have been shown on the upper surface. In more perfectly preserved specimens since obtained these have been beautifully shown (Pl. V. Fig. 11*a*). I have given a drawing (Fig. 11*b*) of the early state of this graptolite. I drew attention to this early form and figured it in the Physical Society's Transactions for 1858, and in the Annals and Magazine of Natural History for January, 1859. In the third volume of the Palæontology of New York, published in 1859, with the dedication dated September, 1859, Prof. Hall figured the early state of the same species, p. 508.

8. *D. cometa*, Gein. (Grapt. p. 26, pl. 1, fig. 28). *D. tubulariformis*, Nich. (GEOL. MAG. Vol. IV., p. 109, Pl. VII. Figs. 12-15). This is a remarkable species, which should, perhaps, be made the type of a new genus. Geinitz's figure is very imperfect and fragmentary; an excellent figure is given by Richter in the German Geol. Society's Zeitschrift (1853, pl. xii. figs. 16, 17). I have given (Pl. V. Figs. 4*a*, *b*, and *c*) drawings of three different forms. These faithful drawings by Mr. Hollick may be compared with Dr. Nicholson's figures quoted, and some idea may be formed of the value of his illustrations; but his own drawings supply materials for their condemnation, for in his enlarged drawing of Fig. 14 he has made the 8 cells of the "nat. size" into 10, and in fig. 15 the 4 cells in the "nat. size" become 6 in the enlargement, so increasing not only their size but their number also.

GEN. IX. CLIMACOGRAPTUS, Hall (Grapt. Quebec Gr. p. 111). Polypary with a double series of cells hollowed out of the common epiderm.

Sp. 1. *G. scalaris*, Hall (Grapt. Quebec Gr. p. 111), *Graptolithus scalaris*, Linn. (Skanska Resa, p. 147), *Prionotus scalaris*, His. (Leth. Suec. p. 113). *G. palmatus*, Barr. in part (Grapt. Boh. pl. 3, figs. 5 and 6). *G. nuntius*, Barr. in part (*ibid.* pl. 2, figs. 7 and 8). *G. Halli*, Barr. in part (*ibid.* pl. 2, figs. 14 and 15). *G. personatus*, Scharen. (Grapt. p. 15, pl. 1, fig. 12). *G. teretiusculus*, Salt. (Quart. Journ. viii. pl. 20, figs. 3 and 4). *Diplograpsus rectangularis*, Mc'Coy (Pal. Foss. p. 8, pl. 1*B*, fig. 8). *D. pristis*, var. *scalariformis*, Baily (Grapt. fig. 2*a*, *b*, *c*).

From the time of Hisinger until Hall restored the name, this species was greatly

misunderstood. It is a misfortune that cannot now be corrected, that this, the only species which Linnaeus describes, finds a resting place in one of the most recently established genera, instead of being the type of the genus *Graptolithus*. Loc. Moffat, etc.

2. *C. minutus*, sp. nov. (Pl. V. Fig. 10a, b). This is a very minute but well-marked species, never attaining a greater size than represented on the Plate. There are at the rate of from 32 to 40 cells in the space of an inch. Loc. Moffat.

3. *C. bicornis*, Hall (Grapt. Quebec, Gr. p. 111). Loc. Moffat.

4. *C. bullatus*,—*Diplograpsus bullatus*, Salt. (Quart. Journ. vii., p. 174, pl. x., fig. 2). Loc. Piedmont Glen.

I have never seen a specimen of *D. pennatus*, Harkn.; it probably belongs to this genus, if it be not founded upon two mono-prionidian forms accidentally placed back to back.

GEN. X. *DICRANOGRAPTUS*, Hall (Grapt. Quebec Gr. p. 57). Polypary in the proximal portion, with a double series of cells, but dividing distally into two branches, with a single series of cells in their outer aspect. Hall describes this genus as having the structure of *Climacograptus*, as regards the cells in which the polypites were lodged, but in the two British species the polypites are certainly lodged in true hydrothecæ. The form of the polypary, however, supplies sufficient characters for the separation of the group as a distinct genus.

Sp. 1. *D. ramosus*, Hall (Grapt. Quebec, Gr., p. 57). Loc. Moffat.

2. *D. Clingani*, sp. nov. (Pl. V., Fig. 7a, b, c). Polypary with a short diprionidian portion, the proximal end furnished with three very delicate spines; hydrothecæ forming a slight serration along the margin; 21 cells in the inch. Loc. Moffat.

GEN. XI.—*RETIOLITES*, Barr. (Grapt. Boh., p. 68). Polypary without a solid axis, cells arising from a central common canal in a double series, and in contact throughout their whole length. Polypary reticulated on the outer surface.

In *Dicranograptus* the double septum and axis become separated in the branches into their elements, forming a closed back and axis to the two mono-prionidian polyparies. The structure of *Diplograpsus* is exactly that of the proximal portion of *Dicranograptus*, being theoretically, if not actually, composed of two mono-prionidian polyparies, united back to back. In *Climacograptus* the filiform axis alone remains, and the divisions between the polypites is carried down to the axis, leaving, however, a continuous free space on either side of the axis for the common cœnosarc. In *Retiolites* this union is still more complete, the cœnosarc of the colony being common to the two series of polypites by the total disappearance of the axis and dorsal portion of the epiderm in *Graptolithus*, or axis and septum in *Diplograpsus*.

Sp. 1. *R. Geinitzianus*, Barr. (Grapt. Boh., p. 69). (Murch. Sil., Ed. IV., p. 541, fig. 2.) Loc. Cumberland.

2. *R. venosus*, Hall (Pal. N. York ii., p. 40, pl. 17 A., fig. 2). Loc. Cumberland.

GEN. XII.—*PHYLLOGRAPTUS*, Hall (Canada Geol. Report, 1857, p. 135). Polypary consisting of four laminæ of cells united rectangularly by their longitudinal axes.

The British specimens of this genus which I have seen exhibit only thin films on the surfaces of highly indurated or somewhat metamorphosed rocks, sufficient to determine their relation to Hall's genus, but utterly insufficient to exhibit any details of the remarkable structure of the genus. If I rightly understand Hall's descriptions and figures, the individual polypites in this genus are entirely separated from each other, the septa between the hydrothecæ being united to the periderm and continued to the axis. This structure is so anomalous among the *Graptolitidae* that I am inclined to think that I misunderstand it, especially as Hall does not

ACTINOCERAS BACCATUM. *Sp. Nov.*

Woolhope Limestone, - Little-Hope Quarry, Woolhope.

distinctly describe it, although it seems to me to be necessarily implied in his figures and descriptions.

Sp. 1. *P. angustifolius*, Hall (Canada Rep., p. 139; Quart. Journ., vol. xix, p. 137, fig. 7). Loc. Skiddaw Slates.

V.—ON *ACTINOCERAS BACCATUM*, A NEW SPECIES OF ORTHOCERATITE
FROM THE WOOLHOPE LIMESTONE.

By HENRY WOODWARD, F.G.S., F.Z.S.

[PLATE VIII.]

THE fossil about to be described was obligingly sent to me by Dr. Bull, of Hereford, having been happily rescued from the remorseless hammer of the road-mender, by Richard Johnson, Esq., the Town Clerk of that city. It exhibits the shell in section, fractured longitudinally, and embedded in a hard compact mass of dark blue Woolhope Limestone, which may be seen well exposed *in situ* in the Little Hope quarries, near Woolhope, from whence the block which contains the fossil was derived. Dr. Bull informs me that the Woolhope Limestone from these quarries is always used for road-metal in the surrounding district.

It is most faithfully delineated (of the natural size) in the accompanying lithograph (Plate VIII.), by the able pencil of Dr. Bull.

The fossil has been fractured so as to remove the upper surface, exposing seven perfect and two fractured beads of the siphuncle, and giving evidence of ten septa; the chambers formed by which remain partially hollow and are partly filled by calcareous spar. None of the exterior wall is visible from which the nature of the ornamentation of the shell, if any, might have been ascertained, but the interior portion is so characteristic of the genus that I have no hesitation in referring it to *Actinoceras*.

That genus is characterized as follows:—"Siphuncle very large, inflated between the chambers, and connected with a slender central tube by radiating plates."¹

Of the species referred to this genus five are British, namely:

<i>Actinoceras Brongniartii</i> , Portl.	Lr. Silurian,	Tyrone.
„ <i>Brightii</i> , Sowerby,	U.	„ Malverns.
„ <i>nummularium</i> , Sowerby,	„	„ Tortworth.
„ <i>giganteum</i> , Sowerby,	Carb. L.	„ Yorkshire, etc.
„ <i>pyramidatum</i> , M'Coy,	„	„ Ireland.

The Woolhope fossil most closely resembles *A. pyramidatum*, of M'Coy, both in the beaded form of the siphuncle and the general proportions of the chambers, but the beads of the siphuncle are much less spherical in *A. pyramidatum*, and the sides of the chambers form a less acute angle at their junction with the outer wall of the shell than in the fossil before us.²

¹ See "Woodward's Manual of the Mollusca," p. 58.

² Compare figure on Plate VIII. with M'Coy's figure in Carbonif. Foss. of Ireland, table 4, fig. 5; see also Barrande's "Syst. Silur. de Bohême (Cephalopoda)" vol. ii., pl. 232, fig. 11.