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XXXVI.—On the genus Climacograpsus; with notes on the British species of the genus

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It is evident that the two must be distinguished; and if I am wrong in considering *Acmella* a subgenus of *Acicula*, I should be equally in error in proposing to subordinate it to *Tricula*. The latter has, by Stimpson (Researches on the *Hydrobiinæ*, &c.) and Stoliczka (*Palæontologia Indica*, v. p. 271), been referred to the Rissoidæ; but Stoliczka places it in a different subfamily from *Assimineæ*. I have very little doubt that this position is correct; and the conclusion at which I have arrived is that *Cyclostoma tersum*, Bens., belongs to the Rissoidæ, that it is allied to *Tricula* and also, probably, to *Acicula*, but that it must be considered the type of a distinct genus, thus characterized:—

ACMELLA, gen. nov.

(Subgen. nov., Ann. & Mag. Nat. Hist. 1869, ser. 4.
vol. iii. p. 178.)

Testa ovata, cornea; apertura ovata; peristomate obtuso.

Operculum corneum, tenuissimum, paucispirale; nucleo excentrico, sinistrali.

Animal *Assimineæ* simile; proboscide brevi; tentaculis brevibus, obtusis, oculos insuper haud procul ab extremitatibus gerentibus; pede mediocri, ovato.

Species unica typusque:—

Acmella tersa (Bens.).

Cyclostoma tersum, Bens. Ann. & Mag. Nat. Hist. 1853, ser. 2. vol. xi. p. 285.

Hydrocena tersa, Pfr. Mon. Pneum. ii. 158, iii. 172.

Since last year, Major Godwin-Austen has obtained a second species of *Cyathopoma* from the ranges south of Assam, which agrees much better with Mr. Benson's description of *Cyclostoma milium* than that first found; it, however, has spiral sculpture. It thus appears more than ever probable that *C. milium* is a *Cyathopoma*, and possibly a worn specimen of the shell last found, in which the sculpture had been abraded.

XXXVI.—On the Genus *Climacograpsus*; with Notes on the British Species of the Genus. By HENRY ALLEYNE NICHOLSON, M.D., D.Sc., M.A., F.R.S.E., &c., Lecturer on Natural History in the Extra-Academical School of Edinburgh.

THE genus *Climacograpsus* was originally founded by Hall, the eminent American palæontologist (Grapt. Quebec Group, p. 111) to include certain species of Graptolites which had

previously been placed under the genus *Diplograpsus*. He also included under this head certain other forms, which he referred to a subgenus, under the name of *Dicranograpsus*. This subgenus, however, should unquestionably have the rank of a distinct genus, having for its type *D. ramosus*, Hall; and some of the forms placed under it by its originator (viz. *D. sextans* and *D. divaricatus*) should properly be removed to the genus *Didymograpsus* of M'Coy.

The genus *Climacograpsus* was defined by Hall as follows:—

“Simple stipes with subparallel margins, having a range of cellules on each side; axis filiform; cellules short and square; apertures apparently excavated in the margin of the stipe, and transversely oval or subquadrate; cell-denticles or appendages, if present, usually on the upper side of the aperture.”

The essential point of this definition, whereby *Climacograpsus* is fundamentally distinguished from the closely allied genus *Diplograpsus*, is that the cell-apertures are situated in a hollow, which is scooped out of the margins of the polypary. The cell-apertures are placed, therefore, below, or internal to, the general boundary of the frond (fig. 1 a), and they are not placed at the end of tooth-like “denticles,” as in *Diplograpsus*. In lateral views of *Climacograpsus*, where the frond is simply compressed, or is exhibited in section (as in fig. 1 a), this arrangement is particularly conspicuous, the cell-apertures appearing as a number of rounded or subquadrate notches sunk below the general level of the polypary. It was upon specimens such as these that Professor M'Coy founded his *Diplograpsus rectangularis* (Pal. Foss. p. 8, pl. 1 B. fig. 8). Judging, also, merely from examples of this nature, it would certainly be supposed that the cellules of *Climacograpsus* were not separated one from another by distinct cell-partitions. It was pointed out, however, by Salter that it was often possible to trace from the base of each cell-mouth a short impressed line, extending nearly as far as the next cell-mouth below (Quart. Journ. Geol. Soc. vol. viii. p. 389, pl. 21. figs. 3 b, 4 b). That this line is truly the edge of a cell-partition is shown conclusively by an examination of specimens preserved in relief (fig. 1 c), of which the Coniston Mudstones have yielded to me a magnificent series. From these specimens it becomes at once evident that the cellules in *Climacograpsus* are really as distinct from one another as in *Diplograpsus*, each cellule being bent so that its outer portion becomes parallel with the axis of the frond, thus bringing the cell-mouth directly beneath the cellule immediately above. The foreshadowing of this

arrangement of parts is shown in certain of the *Diplograpsi* (e. g. in *D. putillus*, Hall, and *D. tamariscus*, Nich.). Upon the whole, then, *Climacograpsus* differs from *Diplograpsus* merely in the fact that the cell-apertures are not placed at the extremity of projecting denticles. This difference is not, perhaps, one of great structural importance; but it communicates such a peculiar aspect to the whole group of the *Climacograpsi* that for the present the distinctness of the genus may well be maintained.

Taking *Climacograpsus teretiusculus*, His., as the type, the following may be described as the structure of the genus, though it is probable that some of the species differ from this in respects more or less important:—

The frond (fig. 1) is diprionidian, having cellules on each side, and is cylindrical in shape, tapering more or less rapidly towards the base. It is composed of two simple unicellular stipes placed back to back, their internal or dorsal walls coalescing to form a single vertical septum (fig. 1 *g*), along the centre of which runs a delicate solid axis, in the form of a fibrous filiform rod. Along the lateral margins of the frond (or the margins furthest removed from the solid axis) open the cell-mouths, forming a row on each side. The solid axis is always prolonged as a naked rod beyond the distal end of the frond; and there is almost always a similar extension beyond the proximal extremity.

In order to comprehend fully the structure of *Climacograpsus teretiusculus*, it may be advantageously compared to an ordinary lead-pencil. Such a pencil, when taken to pieces, is found to consist of two longitudinal semicircular halves, applied to one another by their flat surfaces, and having the lead running through the centre as a median rod. This is almost exactly the structure of *C. teretiusculus*. Each half of the pencil corresponds to one of the stipes composing the frond, the lead represents the solid axis, and the glue cementing together the two halves of the pencil may be taken to represent the vertical septum formed by the coalescence of the two internal walls of the stipes. To make the analogy complete, we have only to suppose that the pencil tapers gradually towards one of its ends, whilst the lead should be prolonged beyond one or both extremities, and a row of transverse openings should exist on the convex side of each of the lateral halves.

The correctness of this view of the structure of *Climacograpsus teretiusculus* is conclusively proved by an extensive suite of specimens, preserved in relief, which I have obtained from the Mudstones of the Coniston series of the north of

England. These specimens, as I have elsewhere mentioned (*Quart. Journ. Geol. Soc.* vol. xxiv. p. 529), very readily split up, entirely or partially, into their component halves—thus exhibiting the structure of the frond in an exceedingly beau-

Fig. 1.

- a.* Specimen of *Climacograpsus teretiusculus*, His., showing the notch-like cell-apertures and the distal and proximal extensions of the axis; twice the natural size: from the Upper Llandeilo Shales of Dobb's Linn, near Moffat. *b.* Specimen of the same in a scalariform view, showing the mouths of the cellules; twice the natural size: Upper Llandeilo, Garple Linn, near Beattock. *c.* Specimen of the same in relief, showing the cell-partitions and suture; much enlarged: Coniston Mudstones, Skeigill Beck, near Ambleside. *d.* Fragment of a scalariform specimen of the same, much enlarged: Dobb's Linn, near Moffat. *e.* Another fragment, greatly enlarged: Skiddaw Slates. *f.* A specimen in relief, but split in half till close upon the base, showing the median septum and the solid axis running along its centre; twice the natural size: Mudstones of the Coniston series. *g.* Transverse section of a specimen of *C. teretiusculus*, preserved in the round, showing the median septum and the solid axis.

tiful and instructive manner. One of these specimens I have figured (fig. 1 *f*) ; and the only other point about them which is worthy of notice is the very general presence in the median septum of oblique lines running from the axis towards the margins of the stipe. The exact nature of these oblique corrugations I have hitherto been unable to make out.

Whilst the above is unquestionably a correct interpretation of the intimate structure of the frond of *C. teretiusculus*, it would appear that some, at any rate, of the other members of the genus differ very materially from this type. With regard to most of the *Climacograpsi*, we have absolutely no certain knowledge of their structure ; and the appearances which they ordinarily present are so like those exhibited by *C. teretiusculus* that we may almost unhesitatingly assume an identity of structure. This, at any rate, is the case with *C. bicornis*, Hall, *C. tuberculatus*, Nich., and *C. innotatus*, Nich. In the case, however, of *C. typicalis*, Hall, a species not yet recorded as British, there appears to be a different disposition of parts. It would appear, namely, from the researches of Hall (Grapt. Quebec Group, p. 28, pl. A. figs. 1-9) that in this species there is no median septum dividing the frond into two separate and independent moieties, but that there is a central, rod-like, solid axis running up the centre of a tube common to the two series of cellules. The absence of the median septum may safely be doubted, and is certainly not demonstrated by any of Hall's hitherto recorded observations ; but another point of great importance seems to have been fairly proved beyond reasonable doubt—namely, the fact that the cell-partitions absolutely reach the solid axis, to which they are actually attached. Assuming this to be the case (as it certainly is not in most of the *Climacograpsi* and *Diplograpsi*), the communication of the separate cellules with one another can only be accounted for by Hall's hypothesis that the cell-partitions are in the form of triangular plates, having their apices attached to the solid axis, and having "an unequally arched or convex upper surface, and a concave lower surface." On this assumption, and apparently on no other, can we conceive of the separate polypites being connected by a *cœnosarc*. In *C. teretiusculus*, as I have before said, the specimens preserved in relief in the mudstones of the Coniston series demonstrate unequivocally the existence of cell-partitions. I am enabled, however, to add that some of these specimens, which exhibit hollow casts of the interior of the frond, show in the most conclusive manner that in this species the cell-partitions did *not* reach the solid axis, but are, on the contrary, separated from the median septum by a very well-marked "common

canal" for the conveyance of the cœnosarc. This is also the structure in all the *Diplograpsi* which I have had an opportunity of examining in a sufficiently good state of preservation.

From the peculiar nature of the cellules in *C. teretiusculus*, and in all other members of the genus *Climacograpsus*, it will be at once seen that all the views of the frond which can possibly be obtained appear to be more or less "scalariform." The cellules are so welded together that their mouths are sunk below the general surface, and are separated by more or less tumid interspaces; hence the impossibility of ever obtaining views which show lateral serrations or denticles, as in the *Diplograpsi*. As in all other cases, however, the appearances presented by any given specimen vary with the surface of the cylindrical frond which may happen to be exposed to view. If a lateral view is exhibited (fig. 1 *a*), we find the cell apertures as rounded or nearly square notches along each side. Along the centre, between the rows of notches, is a straight or slightly undulating impressed line, which I have termed the "suture," and which is constituted, not by the solid axis, but by the edge of the median septum dividing the two halves of the cylinder. From each notch (fig. 1 *c*) is directed downwards and inwards, in well-preserved examples, a short impressed line, which is really the edge of a cell-partition; and between the bases of these and the "suture" is a narrow plain space indicating the position of the common canal. This view of *C. teretiusculus* was originally described by M'Coy as a distinct species, under the name of *Diplograpsus rectangularis*. If, on the other hand, either of the two surfaces on which the cellules open be exposed, we get the appearances shown in fig. 1 *d*, *e*. We get, namely, an impression bounded by perfectly plain lateral margins and exhibiting a number of transverse, lunate or elliptical slits or apertures. This is a true "scalariform" view, in the sense in which we use the term as applied to a monoprionidian species. In well-preserved specimens exhibiting this view, two faint lines proceed outwards and downwards, one from each angle of the transverse aperture, marking the position of the cell-partitions. The "suture" may be exhibited if the view is slightly oblique (as in fig. 1 *e*); but very often the suture is wholly invisible (fig. 1 *d*). The solid axis is, of course, not visible directly, except beyond the two extremities of the frond proper; but it is not uncommonly traceable in much compressed specimens; and in these, too, it is far from infrequent for the apertures of the row of cellules on the opposite side of the frond to be seen indistinctly through the test. Between these extreme terms

(as shown in fig. 1 *a* & *b*) intermediate forms exist in great variety, varying in every possible way with the exact portion of the surface of the frond which may be exposed to view.

The entire genus *Climacograpsus* appears, in Britain at any rate, to be exclusively confined to the lower division of the Silurian rocks. In the Skiddaw Slates three of the five British species have been detected by myself, namely, *C. antennarius*, Hall, *C. bicornis*, Hall, and *C. teretiusculus*, His. In the Upper Llandeilo rocks we have *C. teretiusculus*, *C. bicornis*, *C. tuberculatus*, Nich., and *C. innotatus*, Nich., the two former being highly characteristic of the formation. In the Caradoc rocks only *C. teretiusculus* has hitherto been detected; but it is extremely abundant in some portions of this series. Above the Caradoc rocks the genus is represented solely by a single example of *C. teretiusculus*, discovered by Professor Harkness in the Lower Llandovery rocks of Haverfordwest.

Climacograpsus teretiusculus, His., sp.

Prionotus teretiusculus, His. Leth. Suecica, Supp. 2, t. 38. fig. 4.

Diplograpsus rectangularis, M'Coy, Ann. Nat. Hist. ser. 2. vol. v. p. 271; Pal. Foss. p. 8, pl. 1 B. fig. 8.

Diplograpsus teretiusculus, Salt. Quart. Journ. Geol. Soc. vol. viii. pl. 21. figs. 3, 4.

Climacograpsus teretiusculus, Nich. Quart. Journ. Geol. Soc. vol. xxiv. p. 139, pl. 5. figs. 11-13; *ibid.* pp. 528, 529.

Climacograpsus scalaris, Carruthers, Geol. Mag. vol. v. p. 131.

Climacograpsus minutus, Carruthers, *ibid.* p. 132.

Having already described the appearances which are ordinarily presented by this species, it will not be necessary for me to do more here than simply to notice the characters of the base, as it is by these that *C. teretiusculus* is distinguished from the closely allied *C. bicornis*.

In normal specimens of *C. teretiusculus* the solid axis is prolonged proximally below the base of the frond for a greater or less distance in the form of a filamentous cylindrical radicle. This is the ordinary condition of the base; and the only variation in this respect which is at all common relates to the length of the proximal extension of the axis. In a great many individuals (fig. 2 *a*) the radicle is extremely short, not exceeding from $\frac{1}{2}$ to 1 line or 2 lines, and this though the frond may be from $\frac{1}{2}$ to 1 inch in length or even more. In other individuals, again (fig. 1 *a*, *b*), the length of the radicle is much greater, varying from $\frac{1}{4}$ inch to as much as $1\frac{1}{2}$ inch, the frond itself reaching sometimes a length of as much as $2\frac{1}{2}$ inches. These variations, however, are probably due merely to the age of any given individual.

Several departures, however, from the above simple state of

the parts are observable. In the first of these (fig. 2 *b*), whilst the radicle or proximal extension of the axis retains its normal characters, there are superadded to this two long lateral spines, which may be as long as the radicle itself. The specimens which exhibit this peculiarity are in no other respect different from typical examples of *C. teretiusculus*, and they are strictly comparable to an analogous variety of *Diplograpsus pristis*, which sometimes occurs in the same beds. The presence of three basal processes brings this form into close relation, also, to one of the varieties of *C. bicornis*, Hall; but the central radicle in the latter is always very short, or is even quite

Fig. 2.

- a.* Base of the common form of *C. teretiusculus*, with a short radicle: Coniston Mudstones. *b.* Base of the same, showing a long median radicle and two long lateral spines: Upper Llandeilo, Dobb's Linn, near Moffat. *c.* Base of the same, showing the commencement of the radicle enveloped in a sheath: Upper Llandeilo, Hart Fell, near Moffat. *d.* Base of the same, showing the radicle swelling out below into a species of vesicular dilatation: Upper Llandeilo, Garple Linn, near Moffat. All much enlarged.

rudimentary. A second peculiarity, first noticed by Mr. Carruthers (Intellectual Observer, June 1867), consists in the fact that whilst the filiform radicle may be prolonged for an inch or more below the body of the frond, its upper extremity is enclosed, for the space of a line or thereabouts, in a tubular sheath derived from the proximal end of the frond (fig. 2 *c*). In the third variety (fig. 2 *d*) the proximal extension of the axis is slender at its commencement close to the base of the frond, but gradually dilates into a long narrow vesicular body, which is elliptical or fusiform in shape, and may attain a length of nearly five lines with a breadth of more than half a line. This singular variation, though not of very common occurrence, cannot be looked upon as accidental.

Before leaving *C. teretiusculus*, I cannot forbear making a few remarks upon the circumstances which have induced some modern observers to substitute the specific name of *scalaris* for that of *teretiusculus*. The name *Graptolithus* was originally applied by Linnæus to certain natural objects most of which were certainly not Graptolites, and which he himself did not believe to be true fossils at all. In the twelfth edition of the 'Systema' (Stockholm, 1768) there is to be found a description of a fossil termed by Linnæus *Graptolithus scalaris*, the exact nature of which has formed a subject of some controversy. This so-called *G. scalaris* was originally described by Linnæus and figured in his 'Scanian Travels' (*Skanska Resa*), which were published in 1751. I have not at present an opportunity of reproducing the original figure of Linnæus; but I subjoin a copy of the facsimile of the same given by Geinitz (*Die Graptolithen*, t. 6. fig. 20), which will be accurate enough for all practical purposes (fig. 3).

Fig. 3.

Figure of *Graptolithus scalaris*, Linn., after Linnæus. From 'Skanska Resa,' p. 147. Copied from Geinitz.

From this figure it will be seen that two wholly dissimilar objects are represented in this primitive sketch. The two spiral bodies are unquestionably Graptolites, and may very possibly be referable to the base of the species now known as *G. Sedgwickii*, Portl. The straight body, however ("lineam striasque transversas referens") is the original *G. scalaris*; and a rather unfruitful controversy has been carried on as to its exact nature. The question, however, is not wholly unimportant, as changes in our nomenclature have been advocated on the basis of the supposed nature of this figure.

By Wahlenberg, Geinitz, and Barrande, *G. scalaris*, Linn., is regarded as a unicellular or monopronidian Graptolite (viz. *G. sagittarius*) compressed in a direction rectangular to the cellules, so that the apertures of the cellules are shown running across the stipe transversely. Upon this view the term "sca-

lariform" was introduced, to indicate specimens of any Graptolite compressed in this peculiar manner. By Hall (Grapt. Quebec Group, p. 111) *G. scalaris* is looked upon as the type of a double-celled or diprionidian genus (*Climacograpsus*), of which the typical form is the well-known *Prionotus* (*Diplograpsus*) *teretiusculus* of Hisinger. This view of Hall's is adopted by Mr. W. Carruthers (Intellectual Observer, May 1867; Geol. Mag. vol. v. p. 131), who further adopts Hall's suggestion that the familiar species *C. teretiusculus*, His., sp., should be named *C. scalaris*.

As regards my own views upon this subject, I should be rather disposed to doubt that the original figure of *G. scalaris* was taken from any Graptolite at all. Admitting, however, that it is a Graptolite, it is quite certain that it is impossible at the present day to decide what species it was originally meant for. I am also perfectly satisfied that it is wholly impossible, as things stand, to determine whether *G. scalaris* was intended for a monoprionidian or a diprionidian form; and no grounds can be found for the substitution of *scalaris* for *teretiusculus*, unless it can be demonstrated that the original *G. scalaris* was a bicellular form. The promoters of this substitution appear to have proceeded upon the entirely erroneous belief that unicellular Graptolites do not exhibit "scalariform" views. On the contrary, numerous instances occur in which monoprionidian Graptolites exhibit "scalariform" impressions which are absolutely undistinguishable from those impressions of any *Climacograpsus* in which no more than the apertures of a single row of cellules is exhibited. This is shown most satisfactorily by the occurrence of specimens of monoprionidian Graptolites which exhibit their ordinary characters over part of their course, but are then twisted so as to exhibit a "scalariform" view. It is also most satisfactorily proved by the occurrence of numerous scalariform impressions in rocks (such as the Coniston Grits of the north of England) in which the most careful search has hitherto failed to reveal a single double-celled Graptolite. I subjoin a cut (fig. 4) showing the phenomena above mentioned, as they occur in *G. colonus*, Barr., and *G. priodon*, Bronn—all the specimens figured having been obtained from deposits which have hitherto yielded no examples of either *Diplograpsus* or *Climacograpsus*.

If, then, the original *G. scalaris*, Linn., be a Graptolite, it is, to say the least of it, quite as likely to be the scalariform impression of a monoprionidian species as of a double-celled form. I am, therefore, decidedly of the opinion that there are no grounds for accepting the change proposed by Hall and followed by Carruthers—a change which would substitute for

a well recognized and long current form an altogether dubious and undeterminable species.

Fig. 4.

a. Scalariform impression of *G. colonus*, Barr., from the Coniston Grits near Sedbergh. *b.* Another specimen of the same, from the same locality, in which the frond is slightly twisted, so as to yield a completely scalariform impression in its lower portion and a semiscalariform view in its upper portion. *c.* Scalariform view of a fragment of *G. priodon*, Bronn, preserved in relief, from the Coniston Flags of Broughton Moor. *d.* Back view of the frond of *G. priodon*, Bronn, showing the solid axis and cell-partitions; from a specimen from the base of the Coniston Flags, west side of Long Sleddale. *e.* Ordinary lateral view of a fragment of *G. colonus*, Barr., showing the cell-denticles; from the Coniston Grits near Sedbergh. All considerably enlarged.

Loc. Skiddaw Slates (upper beds): Thornship Beck, near Shap; Ellergill Beck, near Milburn. *Lower Llandeilo*: Tyobry and other localities in Wales. *Upper Llandeilo*: everywhere in the Anthracitic Shales (Moffat Shales) of the south of Scotland, and in numerous localities in North and South Wales and in Ireland. *Caradoc*: common in the Mudstones of the Coniston series of the north of England. *Lower Llandovery*: Haverfordwest (collected by Prof. Harkness).

Climacograpsus bicornis, Hall.

Graptolithus bicornis, Hall, Pal. New York, vol. i. p. 268, pl. 73. figs. 2 *a-s*. *Diplograpsus tricornis*, Carruthers, Ann. & Mag. Nat. Hist. Jan. 1859.

The frond in this species is diprionidian, from half an inch to two inches in length, averaging about one inch, having a breadth of about $\frac{1}{5}$ of an inch at the base, and widening out gradually till a width of more than a line may be attained. A central solid axis is present; but this does not appear to be ever produced, either proximally or distally, beyond the frond to any thing like the extent observable in *C. teretiunculus*. As regards the characters of the *base*, four distinct forms may be distinguished, though it is not clear whether these should be

regarded as genuine varieties or as being dependent upon age or development.

Fig. 5.

- a.* Base of *C. bicornis*, after Hall, showing a basal disk or bulb; magnified two diameters. *b.* Base of the same, showing an imperfect basal crescentic disk; enlarged, from a specimen from the Llandeilo Shales of Glenkiln Burn, Dumfriesshire. *c.* Base of the ordinary form of *C. bicornis* in Dumfriesshire, without a central radicle; enlarged. *d.* Base of the same, after Hall, showing the lateral spines flanking a central radicle (= *Diplograpsus tricornis*, Carr. ?).

In the first of these (fig. 5 *c*), which may be regarded as the typical form of the species, the base is simply provided with two curved spines or mucronate processes, which diverge from the lateral angles of the base and enclose an angle of from 40° to about 140°. As a rule, these basal processes form strong arcuate cornua; but they are not unfrequently of the nature of slender spines, and are then usually straight or only slightly curved. In any case they seldom attain a length of more than a line.

In the second form (= *Diplograpsus tricornis*, Carr. ?), in addition to the two lateral spines, there is a median process or "radicle" (fig. 5 *d*), which varies in length from a mere tubercle to half a line or more.

In the third form (fig. 5 *b*) there is developed round the lateral processes a corneous disk or bulb, of a crescentic shape, each horn of the crescent sometimes attaining, in large specimens, a length of nearly three lines. This rare and singular variety occurs not very uncommonly in a band of highly anthracitic shale in Glenkiln Burn, Dumfriesshire.

In the fourth variety (fig. 5 *a*), which was described by Hall, the basal disk is very much more extensively developed, losing its crescentic form, and extending both completely between the basal spines and also up to the level of the third or fourth cell-aperture on each side.

The frond itself of *C. bicornis* differs in no important parti-

cular from that of *C. teretiusculus*, fragments of the two species being, in the absence of the base, almost if not quite undistinguishable one from another. As in *C. teretiusculus*, the appearances exhibited vary with the particular aspect of the frond which may be presented to view. The two chief phases in which the cell-apertures present themselves are either as elliptical or lunate openings running transversely across the frond, or as lateral notches directed at right angles to the axis or having a slight downward inclination.

From the ordinary form of *C. teretiusculus* (figs. 1 a, 2 a) the present species is distinguished by its being constructed upon a scale altogether rather smaller, by its not being reduced to an acute point at the base, by its attaining its full width more gradually, and by the characters of the base itself. From that form of *C. teretiusculus* (fig. 2 b) in which three basal spines are present *C. bicornis* is separated by the much greater length and slenderness of the lateral processes in the former, and by the much greater development of the median spine or "radicle." In *C. bicornis*, on the other hand, the lateral spines are much shorter, stronger, and thicker, and the median process, when present at all, is very seldom so long as the lateral processes. From *C. antennarius*, Hall (fig. 6), *C. bicornis* is easily distinguished by its wanting the long setiform lateral processes at the base, and the peculiar squareness of build and uniformity of breadth which characterize the former. From *C. tuberculatus*, Nich., in which the characters of the base are somewhat the same, *C. bicornis* is separated by the absence of the tubercles which occur on the sides of the frond of the former. The spines, too, in *C. tuberculatus* are much thicker and stronger, and are nearly or quite rectangular to the axis of the frond, whilst there is always a blunt central radicle.

The presence of a basal disk or cup in some forms of the species is a remarkable fact, since there can be little hesitation in comparing this to the corneous disk of some of the *Dichograpsi* and *Tetragrapsi*.

Loc. Skiddaw Slates (upper beds): Thornship Beck, near Shap. *Lower Llandeilo*: Penmorfa &c. *Upper Llandeilo*: Anthracitic Shales of Dobb's Linn, Hart Fell, and Glenkiln Burn in Dumfriesshire.

Climacograpsus antennarius, Hall.

Diplograpsus antennarius, Nicholson, Quart. Journ. Geol. Soc. vol. xxiv. p. 139.

This beautiful species has been fully described by Hall (Grapt. Quebec Group, p. 112, pl. 12. figs. 11-13), and was

first described by myself from British specimens which I obtained from the Skiddaw Slates, our British equivalent of the Quebec group of Canada. I subjoin figures of the species; but it will be unnecessary to give any detailed description, more especially as all extant British examples are in a state of preservation which does not admit of the determination of minute points of structure.

Fig. 6.

a. Climacograpsus antennarius, after Hall, showing the cell-apertures; from the Quebec group. *b.* Small specimen of the same, from the Skiddaw Slates; nat. size. *c.* Base of another specimen from the Skiddaw Slates, with unusually long basal spines; enlarged.

The essential characteristic by which *C. antennarius* is distinguished from its relatives *C. teretiusculus* and *C. bicornis* consists in the presence of three basal processes (fig. 6), of which the two lateral ones are extremely long, straight or slightly curved, whilst the central one is in the form of a minute obtusely triangular "radicle." The radicle is always extremely short, in fact, a mere tubercle; but the axis is always prolonged beyond the distal end of the frond for a greater or less distance. The frond, instead of being cylindrical, as in *C. teretiusculus* and *C. bicornis*, gives decided evidence of having been subquadrangular; but as none of our British specimens are preserved in relief, I can only judge of this point in Hall's description by the peculiar squareness of cut which all our examples exhibit. The length of the frond varies from one-fifth of an inch to somewhat over an inch; but this does not appear to be exceeded. The cellules, according to Hall, are from twenty-four to twenty-eight in the space of

an inch, "short, nearly twice as wide as long; the cell-denticles nearly rectangular to the axis."

Loc. Skiddaw Slates (lower beds): Outerside, near Keswick.

Climacograpsus tuberculatus, Nich.

I have so recently described this species (Ann. & Mag. Nat. Hist. ser. 4. vol. iv. p. 239, pl. 11. fig. 18) that any detailed reference to it is unnecessary. It is closely allied to *C. bicornis*, but is distinguished by the following points:—1. The base is furnished with a short central radicle, and two strong, curved, lateral cornua, which always enclose an angle of nearly 180°, or, in other words, are nearly rectangular to the axis of the frond. 2. The frond is furnished on each side with a row of tubercles, which appear to spring from the lateral angles of each cell-aperture.

Loc. Upper Llandeilo: rare in the Anthracitic Shales of Dobb's Linn, near Moffat.

Climacograpsus innotatus, Nich.

This species also has been recently described by myself in the paper just referred to (*op. cit. supra*, p. 238, pl. 11. figs. 16 & 17), and therefore requires little notice. It has recently, however, been confounded with the so-called *Climacograpsus minutus*, Carr., which is really nothing more than the immature form of *C. teretiusculus*, from which it differs in no characteristic of specific importance. *C. innotatus*, on the other hand, is at once distinguished by the possession of a short stout spine which arises from the inferior angle of each of the portions of the frond between the cell-apertures, and is directed horizontally over the mouth of the cellule immediately below. No such structure is recognizable in *C. teretiusculus* at any period of its development.

XXXVII.—On an existing Coral closely allied to the Palaeozoic Genus Favosites; with Remarks on the Affinities of the Tabulata. By W. SAVILLE KENT, F.Z.S., F.R.M.S., of the Geological Department, British Museum*.

[Plates XVII. & XVIII.]

DURING a pleasant fortnight spent last year in studying the fine typical collection of Madreporae contained in the Paris Museum, my attention was arrested by a worn specimen,

* A brief notice of this new form was given at the recent meeting of the British Association at Liverpool.