XXXVI.—*On the British Species of* Didymograpsus. By
HENRY ALLEYNE NICHOLSON, M.D., D.Sc., M.A., F.R.S.E., F.G.S., Lecturer on Natural History in the Extra-Academical School of Edinburgh.

[Plate VII.]

THE genus *Didymograpsus* was originally proposed by M'Coy (1851), to include those Graptolites which are "bifid from the base" (Palæozoic Fossils, p. 9). In the year 1852, Geinitz proposed the genus *Cladograpsus*, chiefly for such forms as had been intended by M'Coy to be placed under *Didymograpsus*. With these, however, he placed species which have been subsequently removed by Hall to the genus *Dicranograpsus* (e.g. *D. ramosus*). Still, under the head of *Cladograpsus* Geinitz placed none but such forms as were understood by the *species gemellæ* of Bronn, or, in his own words, "zweiarmige oder gabelförmige Graptolithinen." Recently the genus *Cladograpsus* has been redefined by Mr. Carruthers, and has been made to include two generic forms which not only are in no sense "species gemellæ," but which differ from one another so widely that they cannot be placed under the same genus at all (viz. *Pleurograpsus linearis*, Carr., sp., and *Helicograpsus gracilis*, Hall, sp.). There can be no hesitation, however, in retaining the term *Cladograpsus* simply in the sense in which it was employed by its original inventor—namely, as a synonym for *Didymograpsus*.

The genus *Didymograpsus* was rejected by Hall upon very insufficient evidence, in the belief that all the forms included under this head would be found ultimately to be fragmentary, and to be merely portions of compound Graptolites. Hall, however, has failed to show that this is the case, in America, with any other species than *D. caduceus*, Salt., which he proved satisfactorily to be referable really to *Tetragrapsus bryonoides*, a four-stiped species. No British palæontologist, however, doubts for a moment the integrity of the forms referable to *Didymograpsus*; and, in point of fact, the genus is one of the most natural in the whole family of the Graptolitidæ.

The genus *Didymograpsus* may be defined as comprising those Graptolites in which the frond is bilaterally symmetrical and consists of two monoprionidian branches springing from an "initial point," which is generally marked by a distinct mucro or "radicle." In some cases the radicle may be very rudimentary, as in *D. sextans*, Hall, and in some examples of *D. bifidus*, Hall; and it seems sometimes to be even altogether absent, as in many specimens of *D. anceps*, Nich.

The species of the genus *Didymograpsus* may be conveniently and naturally divided into three sections:—

I. Those *Didymograpsi* in which the radicle is on the inferior aspect of the frond, and the cellules are on the opposite or superior aspect, whilst the "angle of divergence" of the two stipes is not greater than 180°. This group comprises *D. Murchisoni*, *D. geminus*, *D. affinis*, *D. patulus*, and, in fact, the greater number of the *Didymograpsi*.

II. Those *Didymograpsi* in which the radicle is on the inferior side of the frond, and the cellules on the opposite or superior aspect, as before; but the angle of divergence of the stipes is now greater than 180°. In this group, which differs from the last only in the fact that the stipes are reflexed, are *D. flaccidus*, Hall, and *D. anceps*, Nich.

III. Those *Didymograpsi* in which the radicle maintains its position, but the situation of the cellules is reversed, these being now placed on the inferior aspect of the frond, or on the *same* side as the radicle. In this group are *D. sextans*, Hall, and *D. divaricatus*, Hall.

For the full comprehension of the value of the above divisions, it is necessary to define exactly what is to be understood by the "angle of divergence," since this term has been very loosely employed, and has led to a great deal of confusion. As I have before had occasion to remark, it is perfectly obvious that in any *Didymograpsus* the two stipes form *two* angles—one upon one side of the frond, and one upon the opposite side. Each of these angles has, in different species, been treated as the angle of divergence; but it is absolutely necessary to fix accurately one of these angles, which can be constantly employed as a standard of comparison. In the foregoing definitions, therefore, and in the following descriptions, I shall employ the term "angle of divergence" solely for the angle included between the stipes on the side of the frond *opposite to that on which the radicle is situated.* The other angle, or the angle included between the stipes *on the same side as the radicle*, I shall term the "radicular angle." As the radicle in all cases marks the organic base of the frond, we obtain thus a constant standard of comparison between the different species, however much the position of the cellules may vary.

It will, then, be at once seen, that in the first two sections of *Didymograpsus*, the "angle of divergence" is on the *same* side of the frond as the cellules, or, in other words, it is the angle included between the celluliferous margins of the stipes. In *D. sextans* and *D. divaricatus*, however, which constitute the third section of the genus, this state of affairs is reversed—the "angle of divergence" being now on the *opposite* side of the frond to the cellules, whilst it is the "radicular angle" which is included between the celluliferous margins of the stipes.

The genus *Didymograpsus* is characteristically, and, as far as is yet known, exclusively, confined to the Lower Silurian period. Not only is this the case, but the genus is very decidedly more richly represented in the inferior portion of the Lower Silurian series than in its higher portions. The genus attains its maximum in the Skiddaw and Quebec group (Lowest Llandeilo), where it is represented by no less than nine British species and an equal number of American forms, of which, however, some appear to be nothing more than mere varieties. In the Lower Llandeilo or Arenig group we have two very characteristic British species (*D. geminus*, His., and *D. patulus*, Hall), both of which occur also in the Skiddaw Slates. In the Upper Llandeilo rocks we have four British species, with at least one additional American form (*D. serratulus*, Hall), which only occurs in Britain in the Skiddaw Slates. In the Caradoc or Bala series no *Didymograpsi* occur, except in Ireland, where two species are found in rocks of this age (Baily). In the most richly graptolitiferous Caradoc beds which occur throughout Britain, namely the mudstones of the Coniston series of the north of England, no single *Didymograpsus* has hitherto been detected. The same absence of *Didymograpsi* appears to obtain in certain strata in Scotland which overlie the Graptolitic shales of Moffat, and which have been recently described by Mr. Lapworth of Galashiels as the probable equivalent of the Coniston Mudstones, under the name of the Gala beds. In America, however, several species of *Didymograpsus* are known to occur in the Utica Slate and Hudson-River group, two formations which are believed to be of Bala age.

In the last edition of 'Siluria,' Mr. Carruthers mentions ten species of *Didymograpsus* as occurring in Britain; but some of these cannot be retained as valid species. In the following communication I shall describe fourteen species of the genus, with which I am acquainted as occurring in Britain. Several of these, however, have been already described as fully as the extant materials will permit; and of these I shall merely give a short diagnosis accompanied by an illustration, so as to enable them to be readily recognized.

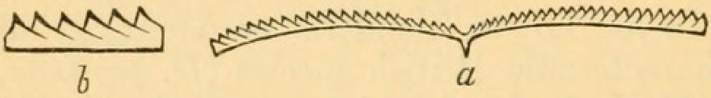
Didymograpsus patulus, Hall, sp. Pl. VII. figs. 1, 1 *a*.

Graptolithus patulus, Hall (Grapt. Quebec Group, p. 71, pl. 1. figs. 10–15).

Didymograpsus hirundo, Salt. (Quart. Journ. Geol. Soc. vol. xix. p. 137, fig. 13 *f*; Mem. Geol. Survey, vol. iii. p. 331 and pl. 11. figs. 6 & 7).
Didymograpsus patulus (Nicholson, Quart. Journ. Geol. Soc. vol. xxiv. p. 135).

Frond composed of two monoprionidian stipes diverging from a small radicle at an angle of 180° (sometimes a little less, and very rarely a little more). The stipes have a very considerable length, reaching two or three inches each without showing any signs of a termination. The stipes are narrow at their commencement, but widen out gradually till a width of one-tenth of an inch may be attained. In smaller specimens, however, as in the subjoined cut, this width is not

Fig. 1.



a, Small specimen of *Didymograpsus patulus*, Hall, from the Skiddaw Slates of Outerside, near Keswick, nat. size; *b*, fragment of *D. extensus*, enlarged, to show the smaller inclination of the cellules.

reached. The cellules are on the opposite side of the frond to the radicle, or, in other words, they occupy the sides of the angle of divergence. The number of cellules to an inch is from thirty to thirty-two or thirty-four in our British specimens, but is stated by Hall as not more than from twenty-four to twenty-six in the American examples. The cellules make with the axis an angle of between 50° and 60°; the cell-mouths make an angle of 100° to 120° with the axis, and they are always produced into well-marked submucronate denticles. In Hall's better-preserved specimens the outline of the cell-apertures is seen to be curved, and the walls of the cellules are marked with fine striæ or lines of growth running parallel to the cell-mouths.

On comparing Hall's beautiful figures of this species with the woodcut in Mr. Salter's above-quoted paper, there cannot be any question that *D. hirundo*, Salt., is the same as *D. patulus*, Hall; and the latter name must be retained, as it has the priority. In the Memoir of the Geological Survey (vol. iii. p. 331), Mr. Salter's description confirms this in every respect. The figures 6 and 7 in pl. 11 of the same work are not named, but they are apparently intended for *D. hirundo*. If this be so, they neither conform with Mr. Salter's own description and previous figure of the species, nor with Hall's account of *D. patulus*. It is probable, therefore, that some error has crept in here, and the figures have not been intended for *D. hirundo*. The *Didymograpsus* figured in Lyell's ' Elements,' at p. 563 (fig. 656), and by some oversight named *D. geminus*, His., is also really *D. patulus*.

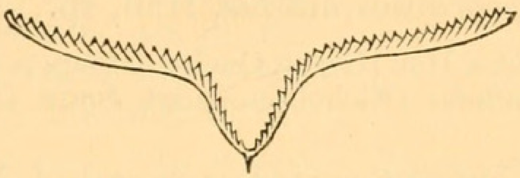
Loc. Skiddaw Slates of Outerside, near Keswick, and Egg-beck, near Pooley; Lower Llandeilo, west of the Stiperstones. (Also in the Lower Graptolite schists of Sweden, and the Quebec group of Canada.)

Didymograpsus V-fractus, Salt.

(Quart. Journ. Geol. Soc. vol. xix. p. 137, fig. 13 *e*.)

This species, of which I subjoin a cut taken from Mr. Salter's figure, was originally named by Mr. Salter from a specimen obtained from the Skiddaw Slates. Mr. Salter, however, never gave any description of the species, so that, unfortunately, it is hardly possible at present to decide positively as to its value. My own collection includes a few fragments, but no perfect specimen. The character upon which the spe-

Fig. 2.



Didymograpsus V-fractus, after Salter. Skiddaw Slates.

cies was founded is the peculiar curvature of the stipes, which are bent abruptly outwards at the distance of about a quarter of an inch from the radicle. The fragments in my possession exhibit this character, but in all other respects they are absolutely undistinguishable from *D. patulus*, Hall. I should therefore be disposed to think that the form cannot be regarded as more than a *variety* of *D. patulus*, unless this character can be shown to be constant in a considerable number of examples.

Loc. Barff, near Keswick (Skiddaw Slates).

Didymograpsus extensus, Hall, sp. Pl. VII. figs. 2, 2 *a*.

Graptolithus extensus, Hall (Grapt. Quebec Group, p. 80, pl. 2. figs. 11–16).

Frond composed of two long slender stipes diverging at an angle of 180° from a small radicle. The stipes attain a length of several inches without showing any signs of a termination. They have a breadth of about one-fiftieth of an inch close to the radicle, and not more than one-fifteenth of an inch at the distance of three inches from the radicle. Cellules twenty-four in the space of an inch, making with the axis an angle of about 45°; the denticles angular and pointed, but not mucronate, the cell-mouths making an angle of about 100° with the axis.

Of this species I have only a single example, which I have recently obtained from the Skiddaw Slates; but its state of preservation is better than that of most of the Graptolites of this formation, and I have no doubt as to its identity with the Quebec form. In most characters *D. extensus* agrees with *D. patulus*, especially in the shape of the frond; the two forms, however, appear to be satisfactorily separated by some minor but constant differences. The stipes are altogether much more slender than in *D. patulus*; the cellules are slightly fewer to the inch, and make a smaller angle with the axis, and they are not prolonged into markedly submucronate points. To show these differences, I have reproduced Hall's enlarged figures of fragments of the two forms (Pl. VII. figs. 1 *a* & 2 *a*).

Loc. Skiddaw Slates, Outerside, near Keswick.

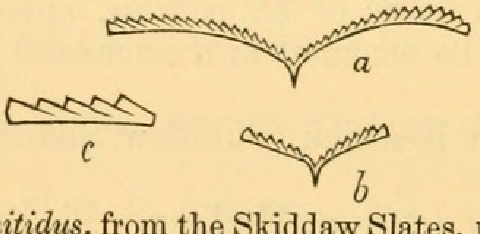
Didymograpsus nitidus, Hall, sp. Fig. 3.

Graptolithus nitidus, Hall (Grapt. Quebec Group, p. 69, pl. 1. figs. 1–9).
Didymograpsus nitidus (Nicholson, Quart. Journ. Geol. Soc. vol. xxiv. p. 135).

Also figured, but not named or described, by Mr. Salter in the Quart. Journ. Geol. Soc. vol. xix. p. 137, fig. 13 *d*.

Frond composed of two simple stipes proceeding from a small pointed radicle at an angle of 150° to 175°. The stipes vary in length from one-half to three-quarters of an inch, and are very narrow at their commencement, but widen out till a width of from one-twentieth to one-fifteenth of an inch may be

Fig. 3.



a, *Didymograpsus nitidus*, from the Skiddaw Slates, nat. size; *b*, a smaller example, slightly enlarged; *c*, fragment, enlarged, to show the cellules.

attained. The cellules are on the opposite side of the frond to the radicle, or occupy the sides of the angle of divergence. They vary from thirty-two to thirty-four in the space of an inch, and are inclined to the axis at an angle of from 40° to 45°. The denticles are simply angular, and are not submucronate, and the cell-mouths are nearly at right angles to the cell-walls.

This exceedingly pretty little species occurs pretty abundantly and in a state of beautiful preservation in one locality in the Skiddaw Slates. The specimens from which the above description is taken agree perfectly with some of Hall's figures (pl. 1. figs. 1, 6, 9); but Hall has referred to this species other examples (pl. 1. figs. 3, 7, 8) which are considerably larger, and which approximate more closely to *D. patulus*.

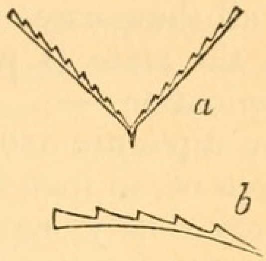
Loc. Skiddaw Slates, Barff, near Keswick.

Didymograpsus affinis, Nich. Fig. 4.

(Ann. & Mag. Nat. Hist. October 1869, pl. 11. fig. 20.)

Frond composed of two simple linear stipes, of extreme tenuity, proceeding from a long pointed radicle at an angle of divergence of from 90° to 150°. The stipes vary in length from one-half to three-quarters of an inch each, and have a uniform width of not more than from one-fortieth to one-fiftieth of an inch, which never appears to be exceeded. The cellules are on the opposite side of the frond to the radicle, or occupy the sides of the angle of divergence. In shape the cellules are altogether undistinguishable from those of *G. Nilssoni*, Barr., and they vary from sixteen to eighteen in the space of an inch. They are inclined to the axis at an extremely low angle (from 15° to 20°); they do not overlap one another at all; and the cell-mouths are from three to four times as short as the outer cell-walls, and form short transverse apertures at right angles to the axis.

Fig. 4.



a, *Didymograpsus affinis*, from the Skiddaw Slates, nat. size; *b*, fragment of the same, enlarged.

This little species occurs in great numbers, all confusedly matted together, in some parts of the Skiddaw Slates, it being rare to find a detached individual showing both sides of the frond. The characters of the cellules are alone quite sufficient to separate the species from all other known forms.

Loc. Lower beds of the Skiddaw Slates, Barff, near Keswick; upper beds of the Skiddaw Slates, Ellergill, near Milburn, and Eggbeck, near Pooley.

Didymograpsus serratulus, Hall, sp. Pl. VII. figs. 3, 3 *a*, 3 *b*, 3 *c*, 3 *d*.

Graptolithus serratulus, Hall (Pal. N. York, vol. i. p. 274, pl. 74. fig. 5).
Didymograpsus serratulus (Nicholson, Quart. Journ. Geol. Soc. vol. xxiv. p. 136).

Frond composed of two long and very slender stipes proceeding from a long and slender radicle and including between them an angle of divergence which may be stated to average 140°. If I am right, however, in referring to this species a number of ill-preserved forms which occur in the Skiddaw Slates, the angle of divergence is exceedingly variable, ranging from no more than 80° up to very nearly 180°. In the figures which I have given of these Skiddaw-Slate specimens, fig. 3 may be taken as the typical form; and there can be no doubt of the identity of this with Hall's species. Fig. 3 *c* shows a form apparently the same in all essential characters, but having an angle of divergence of close upon 180°, whilst fig. 3 *d* exhibits a very much smaller angle, but is in other respects the same. The preservation, however, of these forms is so bad that it is impossible to be positive as to their absolute identity.

In all these cases we have the following common characters, when the state of preservation is such as to allow of their determination:—

The stipes are exceedingly slender, from one-fortieth to one-thirtieth of an inch at their commencement, and they widen out very slowly, never attaining a greater width than from one twenty-fourth to one-twentieth of an inch. The length of the stipes is very great, being over four inches in one specimen. In the most typical forms the stipes are perfectly straight, but in others they are gently curved. The cellules are always on the opposite side of the frond to the radicle, or occupy the sides of the angle of divergence. They vary in number from twenty-five to more than thirty in the space of an inch; they make a small angle with the axis; and the cell-mouths are at right angles to the axis, giving the fragments a close superficial resemblance to *G. sagittarius*. The radicle is always very long and slender.

The only Skiddaw-Slate species with which these could be confounded is *D. extensus*; but the radicle in this species appears to be always short and blunt, and the stipes attain a decidedly greater width, whilst the angle of divergence is constantly 180°. The preservation of the specimens here referred to *D. serratulus* is too poor to allow of any more minute comparison.

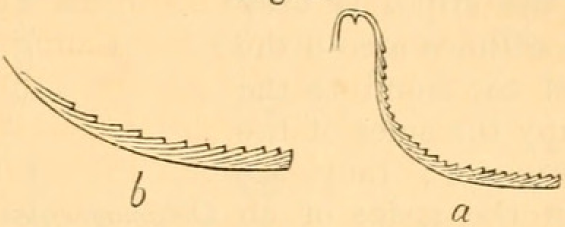
Loc. Skiddaw Slates (lower beds), Outerside and Barff, near Keswick; (upper beds) Thornship Beck, near Shap.

Didymograpsus fasciculatus, Nich. Fig. 5.

(Ann. & Mag. Nat. Hist. October 1869, pl. 11. figs. 21, 22.)

Frond consisting of two simple stipes arising from a short obtuse radicle, at a primary angle of about 330°, but afterwards curved away from the radicle, so as to become nearly horizontal. The angle of divergence of the stipes may therefore be stated upon the whole as 180°. The stipes are extremely narrow at first, but widen out till a width of one-

Fig. 5.



a, Didymograpsus fasciculatus, from the Skiddaw Slates, restored; *b,* a fragment, enlarged. The inclination of the cellules to the axis is too great in these figures.

twenty-fourth of an inch or more may be attained. The cellules are on the opposite side of the frond to the radicle, or occupy the sides of the angle of divergence. They are excessively long and narrow, about twenty-four in the space of an inch, curved in accordance with the curvature of the stipes, overlapping one another for fully two-thirds of their entire length, the cell-mouths being at right angles to the axis. The common canal is extremely narrow.

The materials in my possession for a diagnosis of this species are not satisfactory. Those specimens which exhibit the general form of the frond are too ill-preserved for a proper determination of the cellules; and those which exhibit the cellules are all fragments broken off close to the radicle. I am, however, fully satisfied of the identity of the two sets of specimens, and have therefore ventured to restore the species provisionally, in the hope of shortly obtaining more perfect examples.

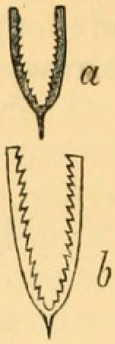
Loc. Upper beds of the Skiddaw Slates: Ellergill, near Milburn; Thornship Beck, near Shap; and Eggbeck, near Pooley.

Didymograpsus geminus, His. Fig. 6.

(See Hisinger, Lethæa Suecica, pl. 38. fig. 3; Salter, Quart. Journ. Geol. Soc. vol. xix. p. 137, fig. 13 *c*, and Mem. Geol. Survey, vol. iii. pl. 11 B. fig. 8; Nicholson, Quart. Journ. Geol. Soc. vol. xxiv. p. 134, pl. 5. figs. 8–10.)

Frond consisting of two small stipes springing from a long and slender radicle, at an angle of divergence which is primitively about 15°. The base is almost always more or less rounded; and the stipes very rapidly become parallel or subparallel, being bent towards the middle line so as to diminish the primary angle of divergence. The average length of the stipes is not more than a quarter of an inch; but in rare cases more than half an inch may be attained. The width of the stipes is very uniform. The cellules are on the opposite side of the frond to the radicle, or occupy the sides of the angle of divergence; they are about thirty in the space of an inch, the denticles angular, and the cell-mouths at right angles to the axis of the stipe. The length of the radicle is from one-twelfth to one-tenth of an inch.

Fig. 6.



Didymograpsus geminus, His., from the Skiddaw Slates: *a*, an unusually large specimen, nat. size; *b*, another specimen, enlarged and with the cellules partially restored.

D. geminus is an unmistakable species, being at once recognized by the general shape of the frond (something like that of a tuning-fork), in which it differs from all other forms. *Didymograpsus* (*Graptolithus*) *indentus*, Hall (Grapt. Quebec Group, pl. 1. fig. 20), is probably a large example of this species; otherwise the form does not appear to be represented in the Silurian rocks of America. *D. geminus* is extremely abundant in some beds of the Skiddaw Slates; but it is very rare to find any specimen in which the form of the cellules is exhibited. The larger examples of the species approximate to the smaller forms of *D. bifidus*, Hall, and *D. Murchisoni*, Beck; but the shape of the cellules is sufficiently distinctive.

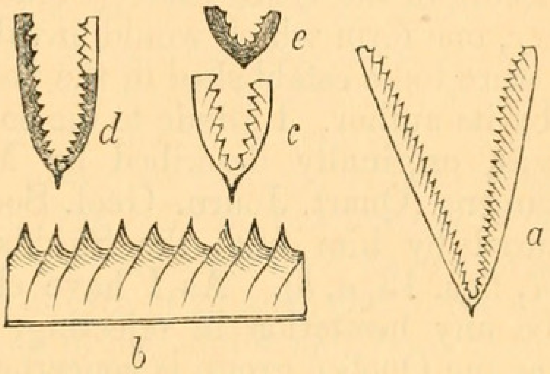
Loc. Skiddaw Slates: Outerside and Barff, near Keswick; Bannerdale Fell, near Mungrisedale; Thornship Beck, near Shap (upper beds). Lower Llandeilo: Cefn Gwynlle; Shelve, Shropshire.

Didymograpsus bifidus, Hall, sp. Fig. 7.

Graptolithus bifidus, Hall (Grapt. Quebec Group, p. 73, pl. 1. figs. 16–18, pl. 3. figs. 9, 10).
Didymograpsus bifidus (Nicholson, Quart. Journ. Geol. Soc. vol. xxiv. p. 136).

Frond composed of two stipes diverging from a short blunt radicle at an angle of from 15° to 30° (as much as 60° in a specimen figured by Hall). The length of the stipes varies from a quarter of an inch to one inch; and the breadth varies in different parts of the stipe. Towards the base each stipe is very narrow; but it gradually expands till a width of a line may be attained (from one-eighth to one-quarter of an inch in American examples), and then a gradual diminution of width takes place towards the extremity. The celluliferous margin of each stipe is therefore curved, whilst the back is more or less completely straight. The cellules are placed on the opposite side of the frond to the radicle, or occupy the sides of the angle of divergence. The cellules are from thirty-two to thirty-six in the space of an inch, long, narrow, and slightly curved, inclined to the axis at an angle of about 45°, the cell-mouths curved and prolonged into long submucronate teeth. The base is

Fig. 7.



Didymograpsus bifidus, from the Skiddaw Slates: *a*, typical example, natural size; *b*, fragment of the same, enlarged, to show the cellules; *c*, base of another individual, with a well-developed radicle; *d*, a small example hardly separable from *D. Murchisoni*, slightly enlarged; *e*, base of another example, in which the radicle is quite rudimentary.

usually rounded, with a short obtuse radicle; but in some cases it is much more pointed, and the radicle is pretty long.

In its most typical form (as in fig. 7 *a*) the distinctness of this species can hardly be a matter of question. The smaller forms, however, of *D. bifidus*, and especially those which have a pointed base and a well-developed radicle, are certainly not distinguishable by any good characters from the younger examples of *D. Murchisoni*. This latter form, however, has hitherto proved so local in its distribution, and the fully grown forms of the two species are so distinct, that I prefer retaining all my Skiddaw-Slate specimens, in the meanwhile, under *D. bifidus*.

Loc. Upper beds of the Skiddaw Slates: Ellergill, near Milburn (abundant and very well preserved); Eggbeck, near Pooley. Rare in the lower beds of the Skiddaw Slates: Outerside, near Keswick.

Of the nine species of *Didymograpsus* which I have now described as occurring in the Skiddaw Slates, it will be seen that all, except *D. fasciculatus*, belong to the first section of the *Didymograpsi*—namely, to those in which the cellules are on the opposite side of the frond to the radicle, and the angle of divergence is not more than 180°. Indeed *D. fasciculatus* may be regarded as no more than an apparent exception to this statement, as the stipes become ultimately horizontal. We may, therefore, conclude, as far as our present materials go, that the second and third sections of *Didymograpsi* are a further and later development of the primitive type of the genus, since they are unrepresented in rocks older than the Upper Llandeilo. The primitive type, however, does not cease to be represented with the Skiddaw and Quebec groups; for *D. Murchisoni* is characteristically Upper-Llandeilo, and *D. serratulus* occurs in the Utica Slate (Caradoc) of America. There is, further, one form which would invalidate this generalization, if it were to be established in the position originally assigned to it by its author. I allude to the so-called *Didymograpsus caduceus*, originally described by Mr. Salter from Canadian specimens (Quart. Journ. Geol. Soc. vol. ix.), and afterwards figured by him from the Skiddaw Slates (*ibid.* vol. xix. p. 137, figs. 13, *a*, *b*). As I have elsewhere stated, there cannot be any hesitation in rejecting, with Hall, this species, as far as the Quebec group is concerned; and an examination of a very extensive suite of specimens from the Skiddaw Slates (including Salter's original specimens) has fully satisfied me that Hall's explanation applies also to the examples from this formation. *D. caduceus*, namely, as described by Salter, was unquestionably founded upon fragmentary examples of the four-stiped *Tetragrapsus bryonoides*, Hall, or of the hardly separable *Tetragrapsus* (*Graptolithus*) *Bigsbyi*, Hall. Recently Mr. Baily has stated that *Didymograpsus caduceus*, Salter, occurs abundantly in strata of Caradoc age in Wexford (Quart. Journ. Geol. Soc. vol. xxv. p. 160). Not having had the opportunity of seeing the specimens in question, I do not presume to express any opinion with regard to them, except that, if the name of *D. caduceus* is to be retained, it must be made to apply to forms different from those originally placed under it by Mr. Salter. It appears, however, very unlikely that the genus *Tetragrapsus*, which has hitherto not been discovered in any Upper Llandeilo deposit, should have survived into the Caradoc period; and Mr. Baily's specimens are therefore likely to be genuine *Didymograpsi*.

Mr. Carruthers (Geol. Mag. vol. v. p. 129) admits that *D. caduceus*, Salter, has certainly four branches, but still places it under *Didymograpsus*—a position obviously unsuited for it, whilst he does not recognize its unquestionable identity with *Tetragrapsus bryonoides*, which he also gives as a *Didymograpsus**.

* It being now certain that the specimens originally described by Salter as *D. caduceus* are really referable to that afterwards named by

Didymograpsus Murchisoni, Beck, sp. Pl. VII. figs. 7, 7 *a*, 7 *b*.

Graptolithus Murchisoni, Beck (Sil. Syst. p. 694, pl. 26. fig. 4).
Graptolites Murchisoni, M'Coy (Pal. Foss. ii. p. 5).

Frond consisting of two stipes springing from a mucronate base, and including between them an angle of divergence of from 10° to 15° or 20°. The stipes vary in length from a quarter of an inch up to two inches or more, proceeding from the radicle outwards and upwards with a slight curve, and being then continued to their terminations nearly in straight lines. The width of the stipes varies greatly in different individuals; but they are always narrowest at the base, expand gradually till their full width is attained, and then gradually contract towards their distal extremities. The back of the stipe, however, is never so straight as in typical examples of *D. bifidus*, Hall, and the celluliferous margin is not so strongly convex. Specimens of average size have a breadth near the base of one twenty-fourth of an inch, and in the fully-developed portion of from one to one and a half line. Gigantic individuals, however, not unfrequently occur (fig. 7 *a*) in which these same measurements are one line and a half and one-quarter of an inch respectively; and even these limits are occasionally exceeded. The base is obtusely pointed, and is furnished with a long triangular mucro or radicle, the length of which is from one to one and a half line. In the large specimens, however, the radicle is much less developed proportionally, and is blunt and obtuse. The cellules are on the opposite side of the frond to the radicle, or occupy the sides of the angle of divergence, and are from twenty-two to thirty-two in the space of an inch, having the proximal lip of the cell-apertures prolonged into long acute denticles. In the smaller specimens the cellules form an angle of about 45° with the axis, are free for about half their entire length, and have the cell-mouths somewhat curved and nearly rectangular to the axis. In the larger specimens, the cellules in the fully-developed portion of the stipe lose many of these characters, becoming more nearly horizontal or rectangular to the axis, whilst they overlap one another throughout the greater part of their length, and have the cell-apertures directed decidedly downwards, owing to the great prolongation of the proximal margin of each.

Hall *Tetragrapsus* (*Graptolithus*) *bryonoides*, Salter's specific name should have the priority, as bearing the date 1853, whereas Hall's name was given in 1857. The species, therefore, should be called *Tetragrapsus caduceus*, Salt., sp. There appears, however, to be no doubt that the form is really identical with the *Fucoides serra* of Brongniart, published in 1828. In strict justice, therefore, the species should be called *Tetragrapsus serra*, Brongn., sp.

This well-marked species has long been known to all students of Silurian geology, but has never been fully described. It is characteristically Upper-Llandeilo, and I am not aware that it occurs in any other formation. One of the most remarkable points about this form is the extraordinary disproportion in size between different individuals. Numerous intermediate examples, however, occur, connecting the smallest and largest individuals; so that there can be no doubt as to their specific identity.

Loc. Upper Llandeilo rocks of various parts of Wales, Abereiddy Bay in Pembrokeshire being one of the most noted localities. Llandeilo rocks of County Meath, in Ireland (Baily).

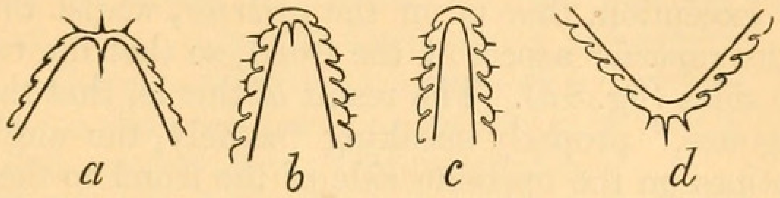
Didymograpsus divaricatus, Hall, sp. Pl. VII. figs. 4 & 4 *a*.

Graptolithus divaricatus, Hall (Pal. New York, vol. iii. Suppl. p. 513).
Dicranograpsus divaricatus, Hall (Grapt. Quebec Group, p. 57).
Didymograpsus elegans, Carruthers (in part), Geol. Mag. vol. v. pl. 5. fig. 8*a*.
Didymograpsus Moffatensis, Carruthers, Ann. & Mag. Nat. Hist. Jan. 1859.

Frond consisting of two long and narrow stipes springing from a mucronate base, attaining each a length of from two to three inches or more, and including between them an "angle of divergence" of from 90° to 130°. The base (fig. 8 *d*) is convex and rounded, and is formed by a long triangular median radicle, flanked by two shorter lateral spines, the whole three occupying a non-celluliferous space of over one line in breadth. The radicle is in its normal position on the inferior aspect of the frond, and *the cellules are on the same side of the frond as the radicle.* In this species, therefore, as in *D. sextans*, the true angle of divergence is bounded by the non-celluliferous margins of the stipes. The "radicular angle," or that on the same side of the frond as the radicle, is in this case contained between the celluliferous margins of the stipes, and varies from 270° to 230°. Each stipe is about one-fortieth of an inch in breadth at its commencement, and gradually widens out till a width of half a line may be attained. The cellules are from twenty to twenty-six in the space of an inch, their outer margins curved, convex, and nearly parallel to the axis, the denticles obtuse and rounded, and the cell-apertures forming oblique indentations or pouches which extend about halfway across the stipe, and are rounded-off internally. According to Hall, "the surface is marked by a row of small nodes placed obliquely to the direction of the axis, and situated just below and a little on one side of the bottom of the serrature."

This beautiful species (originally described by Hall from the Hudson-River group of America) is distinguished from all others by the possession of a median radicle and two lateral spines, placed on the *same* side of the frond as the cellules. *D. flaccidus*, Hall, has three smaller spines placed in a similar manner on the same side of the frond as the cellules (fig. 8);

Fig. 8.



a, base of *D. flaccidus*, Hall; *b*, base of *D. anceps*, Nich., showing the internal radicle; *c*, base of another example of *D. anceps*, in which there is no radicle; *d*, base of *D. divaricatus*, Hall, showing the radicle with its two lateral spines. All enlarged.

but the central spine of these is not the *radicle*, as is shown by the occurrence of the true radicle on the *opposite* side of the frond—this completely altering the whole relations of the parts. These anti-radicular ornamental spines of *D. flaccidus* have, however, been confounded by Mr. Carruthers with the genuine radicle with its flanking spines in *D. divaricatus*. As regards the form of the cellules *D. divaricatus* cannot be distinguished from *D. sextans*, Hall, and *D. anceps*, Nich. The former, however, of these is readily distinguished by its general form, and the latter, as I shall immediately explain, is separated by the fundamental structure of the frond.

Didymograpsus Moffatensis, Carr., and one of the specimens included under *D. elegans*, Carr., are clearly identical with one another; and both (unless figured upside down) appear to be referable to *D. divaricatus*, Hall, which bears the date of 1855, and has therefore the priority*.

Loc. Rare in the anthracitic shales of Glenkiln Burn, in Dumfriesshire (Upper Llandeilo).

Didymograpsus anceps, Nich. Pl. VII. fig. 5, 5 *a*, 5 *b*.
(Geol. Mag. vol. iv. p. 110, pl. 7. figs. 18–20.)

Frond consisting of two stipes, diverging from an initial point which may or may not be marked by the presence of a

* It is quite possible that *Didymograpsus* (*Cladograpsus*) *Forchammeri*, Geinitz, is really identical with *D. divaricatus*, Hall, in which case Geinitz's name would have to be retained, as it was published in 1852. Accepting, however, the accuracy of the figure given by Geinitz (Die Grapt. pl. 5. figs. 28, 29), the base appears to be destitute of the radicle and lateral spines so characteristic of *D. divaricatus*. The other figures of Geinitz (*ibid.* pl. 5. figs. 30, 31) are certainly referable to a different form, probably to *D. flaccidus*, Hall.

radicle. In some cases the initial point is recognized simply by the fact that it is the point of flexion of the frond, and from it the cellules point in opposite directions. In other specimens the initial point is marked by the presence of a slender radicle, the length of which varies from a mere node up to nearly one line. In all specimens which exhibit any traces of a radicle, without exception, this is on the *inferior*, whilst the cellules are on the *superior* aspect of the frond, so that the two are on opposite sides (fig. 8 *b*). The result of this is, that the "angle of divergence," properly speaking (namely, the angle formed by the stipes on the opposite side of the frond to the radicle), is in this case to be measured between the celluliferous margins of the stipes; and it varies from 340° to 355°. The "radicular angle," on the other hand, is included between the non-celluliferous margins of the stipes; and it varies from 5° to 20°. The margin of the frond opposite to the radicle is never ornamented by spines, and is simply formed by the coalescence of the bases of the first two cellules. This structure is of interest, as agreeing with *D. sextans*, Hall (at any rate, in its ordinary form), and apparently foreshadowing what we find in *Dicranograpsus*. The stipes are very little narrower at their origin than elsewhere; and they retain a pretty uniform width throughout, varying in different individuals from one twenty-fourth of an inch up to two thirds of a line. The cellules are not distinguishable in shape from those of *D. divaricatus*, Hall, and *D. sextans*, Hall. They are from twenty-five to thirty in the space of an inch, their outer margins convex and nearly parallel to the axis, their apices rounded off, and the cell-apertures forming oblique pouch-like indentations, which extend halfway across the stipe. In some specimens, the first few cellules on either side of the initial point are provided each with a short blunt spine proceeding from the centre of their outer margins. In some examples there are minute pustules or circular depressions in the centre of each denticle where it joins the body of the stipe; but this phenomenon is not constant in its occurrence. As I have already said, in the shape of the cellules *D. anceps* is not distinguishable from *D. divaricatus*, Hall (=*D. Moffatensis*, Carr. ?). In all other respects, however, they are totally distinct; and they could only be confounded, as they have been (Carruthers, Geol. Mag. vol. v. p. 129), by turning *D. anceps* upside down. In the first place, in *D. anceps* the radicle and cellules are on opposite sides of the frond, whilst in *D. divaricatus* they are on the *same* side. In addition to this very obvious and, indeed, fundamental distinction, the following points of difference may be mentioned:—In *D. anceps* the "angle of divergence," as measured between the stipes on the side opposite to the radicle, is from 340° to 355°, the radicle is not furnished with lateral spines, and the width of the stipes is extremely uniform in any given individual. In *D. divaricatus*, on the other hand, the "angle of divergence," measured in the same way, is from 90° to 130°, the radicle is invariably flanked by two lateral spines, and the stipes are considerably narrower at their commencement than towards their distal extremities. These points of difference should be sufficient to prevent in future any confusion between two species which in reality belong to two different *sections* of the *Didymograpsi*.

Loc. Upper Llandeilo, Dobbs's Linn, near Moffat.

Didymograpsus flaccidus, Hall, sp. Pl. VII. figs. 6, 6 *a*, 6 *b*, 6 *c*.

Graptolithus flaccidus, Hall (Grapt. Quebec Group, Suppl. p. 143, pl. 2. figs. 17–19).
Didymograpsus flaccidus (Nicholson, Geol. Mag. vol. iv. p. 110).
Didymograpsus elegans, Carruthers (in part), Geol. Mag. vol. v. pl. 5. figs. 8 *b*, 8 *c*.

"Frond consisting of two slender, linear, flexuous stipes, which are widely divergent from a small, short, obtuse radicle" (Hall). The stipes are about one fiftieth of an inch in breadth at their commencement, but widen out till a width of one twenty-fifth of an inch may be attained, and they not unfrequently reach a length of several inches without showing any signs of a termination. The proper "angle of divergence" of the stipes, as measured on the opposite side of the frond to the radicle, is from 280° to 320°, whilst the "radicular angle" is from 40° to 80°. The radicle varies in length from one twenty-fourth of an inch up to one tenth, being sometimes long and pointed, at other times short and obtuse, whilst it is invariably situated on the inferior or concave margin of the frond. The margin of the frond immediately opposite to the radicle is adorned by three short and delicate processes or spines—one directly opposed to the radicle, and one springing from the first cellule on each side (fig. 8 *a*). These spines are simply ornamental appendages, so to speak, and have nothing whatever to do with the true *radicle*, from which they must be carefully distinguished. The cellules are on the opposite side of the frond to the radicle, from twenty-five to thirty in the space of an inch, averaging twenty-eight, narrow, their outer margins straight or very slightly curved, inclined to the axis at a very low angle (about 20°), their apices usually gently rounded, and the cell-apertures running partially across the body of the stipe.

As to the complete identity of this beautiful species with the *Graptolithus flaccidus* described by Hall from the Utica Slate, there can be no doubt; and in this opinion I am fully borne out by Prof. Harkness, who has examined some of my specimens. Our British specimens have been placed by Mr. Carruthers under his *D. elegans*, which seems to be founded partly upon *D. divaricatus*, Hall, and partly upon *D. flaccidus*. The specimens figured by Mr. Carruthers as *D. elegans*, and really belonging to *D. flaccidus*, are figured upside down (Geol. Mag. vol. v. pl. 5. figs. 8 *b*, 8 *c*).

Our British examples, however, agree with *D. flaccidus*, as described and figured by Hall, in the general shape of the frond, in the position of the radicle, in the shape of the cellules and in their number to the inch, and, in fact, in every essential respect, except in the fact that the American specimens appear to want the small spines which are found opposite to the radicle in our form. These, however, are not constantly preserved, even in the British specimens; and even if constantly wanting in the American examples, their absence would not be enough of itself to constitute a specific distinction. From *D. divaricatus*, Hall, the present species is distinguished by the fact that the cellules are on the opposite side of the frond to the radicle, the reverse being the case in the former; whilst the characters of the cellules in the two show several decided points of difference. From *D. anceps*, Nich., in which the cellules and the radicle hold the same relative position as in *D. flaccidus*, the latter is distinguished by the much greater length and tenuity of the stipes, as well as by the different characters of the cellules.

I have only to add that, in connexion with the fully grown fronds of this species, there often occur numerous young forms in different stages of development, commencing with those which exhibit only one or two cellules on each side of a central radicle (Pl. VII. fig. 6 *c*). Even in these small forms, however, the three minute spines opposite to the radicle can be recognized.

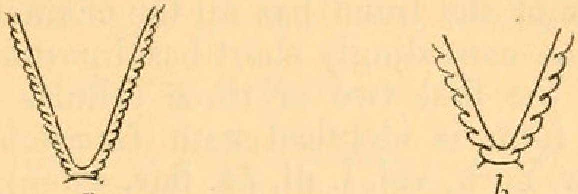
Loc. Upper Llandeilo rocks of Dobbs's Linn, and Hart Fell, near Moffat.

Didymograpsus sextans, Hall, sp. Fig. 9.

Graptolithus sextans, Hall (Pal. New York, vol. i. p. 273, pl. 74. figs. 3 *a–e*).
Diplograpsus (?) *sextans*, M'Coy (Pal. Foss. part 2, p. 9).
Graptolithus sextans, Salter (Quart. Journ. Geol. Soc. vol. v. p. 17, pl. 1. fig. 10).
Dicranograpsus sextans, Hall (Grapt. Quebec Group, p. 57).
Didymograpsus sextans, Baily (Characteristic British Fossils, pl. 9. figs. 6 *a–d*).

Frond consisting of two small stipes, generally from four to five lines each in length, with an average breadth of about half a line, diverging from a mucronate base at an angle of about 60°. The base is rounded, and is seen, in the few specimens which are well preserved, to be provided with two

Fig. 9.



Didymograpsus sextans: *a*, a specimen slightly enlarged and with the cellules partially restored; *b*, base of the same, enlarged.

lateral spines, and sometimes with a central minute spine or radicle, though this latter can only rarely be detected. The radicle is, as usual, on the inferior aspect of the frond, and the cellules are situated on the *same* side—a peculiarity found in no other *Didymograpsus* except *D. divaricatus*, Hall. The "angle of divergence" is therefore included between the non-celluliferous margins of the stipes; and it is almost always about 60°. The "radicular angle" is bounded by the celluliferous margins of the stipes, and is, of course, about 300°. The cellules are from thirty to thirty-five in the space of an inch, and the first two are coalescent by their bases, as in *D. anceps*. In all essential respects the cellules are identical with those of *D. divaricatus* and *D. anceps*. The outer cell-walls, namely, are curved and subparallel with the axis; the denticles are obtusely rounded off; and the cell-apertures form oblique indentations extending about halfway across the stipe. These, at any rate, are the characters of the cellules in our British specimens, in those few examples in which they admit of examination, as they rarely do. In Hall's original description the cellules are said to terminate in "slender mucronate points;" but some error must undoubtedly have been made upon this head. This is rendered certain by the fact that Hall has subsequently placed *D. sextans* in the genus *Dicranograpsus* along with *D. divaricatus*, expressly upon the ground of the similarity in the shape of the cellules, whilst he has figured the latter with cellules such as I have described above.

The propriety of placing *D. sextans* in the genus *Dicranograpsus* as this genus is understood by British palæontologists, may still be looked upon as an open question. In none of the many specimens which have passed through my hands have I observed any thing more than the coalescence of the first two cellules by their bases. This, though perhaps an approximation to *Dicranograpsus*, occurs also in *D. anceps*, and is not sufficient to require the removal of the species from *Didymograpsus*. Recently, however, Mr. John Hopkinson has been kind enough to send me drawings of some specimens which appear to belong, beyond a question, to *D. sextans*, but in which this amalgamation has gone further. In these, namely, whilst the bulk of the frond has all the characters of *D. sextans*, there is an exceedingly short basal portion formed by a coalescence of the first two or three cellules on each side. Whether this form is identical with *Graptolithus furcatus*, Hall (Pal. New York, vol. i. pl. 74. figs. 4 *a–h*), or whether it should be looked upon as a transition between *D. sextans* and *Dicranograpsus* proper, I am unable to say. *D. sextans*, in its typical form, as above described, is easily recognizable by the shortness of the stipes, the constancy of the angle of divergence, the presence of the radicle and the cellules on the *same* side of the frond, and the characters of the cellules.

Loc. Abundant, but badly preserved, in the anthracitic shales of Glenkiln Burn in Dumfriesshire, and Cairn Ryan in Ayrshire; also in several localities in Ireland (Baily).

EXPLANATION OF PLATE VII.

Fig. 1. *Didymograpsus patulus*, Hall, nat. size. From the Skiddaw Slates of Outerside, near Keswick.

1 *a*. Portion of *D. patulus*, enlarged, to show the cellules, after Hall.

Fig. 2. *Didymograpsus extensus*, Hall, nat. size. From the Skiddaw Slates of Outerside, near Keswick.

2 *a*. Fragment of *D. extensus*, enlarged, to show the cellules, after Hall.

Fig. 3. *Didymograpsus serratulus*, Hall, nat. size. From the Skiddaw Slates of Outerside, near Keswick.

3 *a*. Base of *D. serratulus*, enlarged, after Hall.

3 *b*. Base of *D. serratulus*, from another specimen, from the Skiddaw Slates of Outerside. Enlarged.

3 *c*. *D. serratulus* (?), from the Skiddaw Slates of Outerside, natural size. The angle of divergence is much greater in this than in ordinary specimens.

3 *d*. *D. serratulus* (?), from the Skiddaw Slates of Thornship Beck, near Shap. The angle of divergence in this specimen is much less than in ordinary specimens. Natural size.

Fig. 4. *Didymograpsus divaricatus*, Hall, slightly restored from a Dumfriesshire specimen.

4 *a*. Base of a specimen of *D. divaricatus*, from the Upper Llandeilo rocks of Dumfriesshire. Enlarged.

Fig. 5. *Didymograpsus anceps*, Nich., slightly enlarged. Upper Llandeilo rocks of Dobbs's Linn, near Moffat.

5 *a*. Base of another specimen of the same, enlarged. In this specimen there is no radicle.

5 *b*. Base of another specimen of the same, in which a radicle is present; enlarged.

Fig. 6. *Didymograpsus flaccidus*, Hall, natural size: From the Upper Llandeilo rocks of Dobbs's Linn, near Moffat.

6 *a*. Base of another specimen of the same, enlarged, showing the three small spines opposite to the radicle.

6 *b*. Fragment of the same, enlarged, to show the cellules.

6 *c*. Germs of *D. flaccidus*, nat. size.

Fig. 7. Small specimen of *Didymograpsus Murchisoni*, Beck, nat. size. From the Upper Llandeilo rocks of Abereiddy Bay, in Pembrokeshire.

7 *a*. Large specimen of *D. Murchisoni*, from the same locality, nat. size.

7 *b*. Base of another small specimen of *D. Murchisoni*, enlarged. The base is considerably more obtuse and rounded in this specimen than in fig. 7.

XXXVII.—*List of Species in a small Collection of Butterflies from the South Seas*. By Arthur Gardiner Butler, F.L.S. &c.

A collection of Diurnal Lepidoptera has recently been sent to the British Museum by Julius Brenchley, Esq., which, though small, contains several interesting novelties. The species are all referable to two of the five Rhopalocerous families, and the majority of them to the subfamily Danainæ.

Family **Nymphalidæ**, (Westwood) Bates.

Subfamily *Danainæ*, Bates.

Genus Euplœa, Fabricius.

1. *Euplœa anthracina.*

Euplœa anthracina, Butler, P. Z. S. p. 280. n. 39, p. 281. fig. 1 (1866).

One example. South-Sea Islands.

2. *Euplœa Brenchleyi*, sp. nov.

♂. Alæ supra saturate fuscæ, area apicali alba; margine late fusco; stria infra ramum primum medianum sericea: posticæ fuscæ, area externo-anali pallidiore; costa sericea dilutiore.

Alæ subtus pallidiores, area externa alba: anticæ punctis tribus mediis violaceis quorum maximo discoidali et puncto discali albo: posticæ costa pallide fusca; macula discoidali serieque punctorum quinque discalium in serie angulata violascentium; punctis consuetis basalibus albis: corpus nigrum, albo punctatum.

♀ differt supra area anticarum alba duplo latiore et area externa posticarum late alba; subtus stria anticis interna alba.

Exp. alar. unc. 3, lin. 2.

Five specimens (4 ♂, 1 ♀). South-Sea Islands.

Resembles another species in the same collection, which has