polyvary in these puzzling forms, afford evidence that in these genera both series of thecae open into a sub-central common canal, and that the various parts of the polyvary are strengthened by slender chitinous threads connected with the virgula. Nothing further seems needed to show that these collectively form a very distinct group from that already noticed.

Among the species usually classed with *Diplograptus* are two extraordinary types which seem to merit generic distinction. It is, moreover, impossible at present to reconcile their general structure with the previous interpretation of that of the siculate *Diprionida*. In the first of these types, which includes *Diplograptus spinulosus* (H.) and its allies, not only is each theca furnished with two long spines or fibres, extending outwards from the angles of the aperture, but the polyvary itself is ornamented in addition with two opposite, longitudinal rows of gigantic, isolated spurs, developed along the median line of the periderm at right angles with the thecae. The polyvary in these forms is first visible as a small oval disc, bristling with a host of incipient spurs, and is in its later stages, ornamented with a greatly extended single (?) filiform virgula. The generic term *Glossograptus* was proposed for a form of this group by Dr. Emmons in 1855, and although the designation can hardly be considered appropriate now that the true form of the polyvary is known, yet it ought obviously to be retained.

In the adult polyvary of the species of the second type, a slender spine is developed from the outer margin of each theca. At a small but constant distance outside the general boundary of the polyvary, this spine subdivides into (or gives off) numerous minute threads, which inosculate with those originating in a similar manner from the spines immediately above and below. These threads form a connected network or braid almost completely surrounding the polyvary. Perfect examples are excessively rare, but the specimens belonging to the group can be recognized at once, their margins being apparently furnished with minute tufts of tangled hairs. The species of this type I propose to unite in a provisional genus under the title of *Lasiograptus* (Gr. *λάσιος*, hairy, shaggy).

THE ANALYTICAL TABLE OF THE GENERA OF GRAPTOLITES, embodying the foregoing conclusions, together with the Appendix (already referred to), containing descriptions of new genera, will appear in the December Number.

VI.—HISTORY OF THE NAMES CAMBRIAN AND SILURIAN IN GEOLOGY.¹

By Prof. T. STERRY HUNT, LL.D., F.R.S.

(Continued from p. 461.)

WE have already noticed that Barrande, as early as 1852, gave the name of Primordial Silurian to the rocks which, in Bohemia, were marked by the first fauna; although he, at the same time, recognized this as distinct from and older than the second fauna, discovered in the Llandeilo rocks, which Murchison had declared to

¹ Reprinted from the "Canadian Naturalist," new series, vol. vi. no. 3, p. 304.

represent the dawn of organic life. Into the reasons which led Barrande to include the rocks of the first, second and third faunas in one Silurian system (a view which was at once adopted by the British Geological Survey and by Murchison himself), it is not our province to inquire; but we desire to call attention to the fact that the latter, by his own principles, was bound to reject such a classification. In his address before the Geological Society in 1842 (already quoted in the first part of this paper), he declared that the discussion as to the value of the term Cambrian involved the question "whether there was any type of fossils in the mass of the Cambrian rocks different from those of the Lower Silurian series. If the appeal to nature should be answered in the negative, then it was clear that the Lower Silurian type must be considered the true base of what I had named the Protozoic rocks; but if characteristic new forms were discovered, then would the Cambrian rocks, whose place was so well established in the descending series, have also their own fauna, and the Palæozoic base would necessarily be removed to a lower horizon."

In the event of no distinct fauna being found in the Cambrian series, it was declared that "the term Cambrian must cease to be used in zoological classification, it being, in that sense, synonymous with Lower Silurian." (Proc. Geol. Soc., vol. iii. p. 641, et seq.) That such had been the result of palæontological inquiry Murchison then proceeded to show. Inasmuch as the only portion of Sedgwick's Cambrian which was then known to be fossiliferous was really above and not below the Llandeilo rocks, which Murchison had taken for the base of his Lower Silurian, his reasoning with regard to the Cambrian nomenclature, based on a false datum, was itself fallacious; and it might have been expected that when the Government Surveyors had shown his stratigraphical error, Murchison would have rendered justice to the nomenclature of Sedgwick. But when, still later, a farther "appeal to nature" led to the discovery of "characteristic new forms," and established the existence of a "type of fossils in the mass of the Cambrian rocks different from those of the Lower Silurian series," Murchison was bound by his own principles to recognize the name of Cambrian for the great Ffestiniog group, with its primordial fauna, even though Barrande and the Government Surveyors should unite in calling it Primordial Silurian.

He however chose the opposite course, and now attempted to claim for the Silurian system the whole of the Middle Cambrian or Ffestiniog group of Sedgwick, including the Tremadoc slates and the Lingula-flags. The grounds of this assumption, as set forth in the successive editions of *Siluria* from 1854 to 1867, and in various memoirs, may be included under three heads: first, that the Lingula-flags have been found to exist in some parts of his original Silurian region; second, that no clearly-defined base had been assigned by him to his so-called system; and third, that there are no means of drawing a line of demarcation between these Middle Cambrian formations and the overlying Llandeilo.

With regard to the first of these reasons, it is to be said that the only known representatives of the Lingula-flags in the region described by Murchison in his *Silurian System* are the black slates of Malvern; and some scanty outliers which, in Shropshire, lie between the old Longmynd rocks and the base of the Stiper-stones. The former were then (as has already been shown) supposed by him to belong to the Llandeilo, or rather to the passage-beds between the Llandeilo and Cambrian (Bala); while with regard to the latter, Ramsay expressly tells us that they were not originally classed with the Silurian, but have since been included in it. (Mem. Geol. Surv., vol. iii. part 2, page 9; and 242, foot-note.)

The Llandeilo beds were by Murchison distinctly stated to be the base of the Silurian system (*Sil. Syst.* p. 222); and it was farther declared by him that in Shropshire (unlike Caermarthenshire) "there is no passage from the Cambrian to the Silurian strata," but a hiatus, marked by disturbances which excluded the passage-beds, and caused the Lower Silurian to rest unconformably upon the Longmynd rocks. (*Ibid.* p. 256; and plates 31, sections 3 and 6; 32, section 4.) But in *Siluria* (1st ed. p. 47) the two are stated to be conformable; and in the subsequent sections of this region, made by Aveline, and published by the Geological Survey, the evidences of this want of conformity do not appear. Murchison at that time confounded the rocks of the Longmynd with the Cambrian (Bala) beds of Caermarthenshire and Brecon. (*Sil. Syst.* p. 416.) Hence it was that he gave the name of Cambrian to the former; and this mistake, moreover, led him to place the Cambrian of Caermarthenshire beneath the Llandeilo. It is clear that if he claimed no well-defined base to the Llandeilo rocks in this latter (their typical region), it was because he saw them passing into the overlying Bala beds. There was, in the error by which he placed *below* the Llandeilo, strata which were really *above* them, no ground whatever for afterwards including in his Silurian system, as a downward continuation of the Llandeilo rocks (which are the basal portion of the Bala group), the whole of the Ffestiniog group of Sedgwick; whose infra-position to the Bala had been shown by the latter long before it was known to be fossiliferous.

It was, however, claimed by Murchison that no line of separation can be drawn between these two groups. The results of Ramsay and of Salter, as set forth in the address of the former before the Geological Society in 1863, and more fully in the *Memoirs of the Geological Survey* (vol. iii. part 2) published in 1866, with a preface by himself, as the Director of the Survey, are completely ignored by Murchison. The reader familiar with these results, of which we have given a summary, finds with surprise that in the last edition of *Siluria*, that of 1867, they are noticed, in part, but only to be repudiated. In the five pages of text which are there given to this great Middle Cambrian division, we are told that the distinction between the Lower Tremadoc and the Lingula-flags "is difficult to be drawn," and that the Upper Tremadoc slate passes into and forms the lower part of the Llandeilo, "into which it graduates confor-

mably." (Siluria, 4th ed. p. 46.) In each of these cases, on the contrary, according to Ramsay, there is observed "a break very nearly complete both in genera and species, and probable unconformity;" the evidence of the palæontological break being furnished by the careful studies of Salter; while that of the stratigraphical break, as we have seen, leaves no reason for doubt. (Mem. Geol. Surv., vol. iii. part 2, pp. 2, 161, 234.) The student of *Siluria* soon learns that in all cases where Murchison's pretensions were concerned, the book is only calculated to mislead.

The reader of this history will now be able to understand why, notwithstanding the support given by Barrande, by the Geological Survey of Great Britain, and by most American geologists, to the Silurian nomenclature of Murchison, it is rejected, so far as the Lingula-flags and the Tremadoc slates are concerned, by Lyell, Phillips, Davidson, Harkness and Hicks in England, and by Linnarsson in Sweden. These authorities have, however, admitted the name of Lower Silurian for the Bala group or Upper Cambrian of Sedgwick—a concession which can hardly be defended, but which apparently found its way into use at a time when the yet unravelled perplexities of the Welsh rocks led Sedgwick himself to propose, for a time, the name of Cambro-Silurian for the Bala group. This want of agreement among geologists as to the nomenclature of the Lower Palæozoic rocks, causes no little confusion to the learner. We have seen that Henry Darwin Rogers followed Sedgwick in giving the name of Cambrian to the whole Palæozoic series up to the base of the May Hill Sandstone; and the same view is adopted by Woodward in his Manual of the Mollusca. The student of this excellent book will find that in the tables giving the geological range of the mollusca, on pages 124, 125 and 127, the name of Cambrian is used in Sedgwick's sense, as including all the fossiliferous strata beneath the May Hill Sandstone. On page 123 it is however explained that Lower Silurian is a synonym for Cambrian, and it is so used in the body of the work.

The distribution of the Lower and Middle Cambrian rocks in Great Britain may now be noticed. The former, or Bangor group, to which Murchison and the Geological Survey restrict the name of Cambrian, and which they sometimes call the Longmynd, bottom or basement rocks, occupy two adjacent areas in Caernarvon and Merionethshire; the one near Bangor, including Llanberris, to the north-east, and the other, including Harlech and Barmouth, to the south-east of Snowdon; this mountain lying in a synclinal between them, and rising 3571 feet above the sea. The great mass of grits or sandstones appears to be at the summit of the group, but in the lower part the blue roofing-slates of Llanberris are interstratified in a series of green and purple slates, grits and conglomerates. (Some of the Welsh roofing-slates are however supposed to belong to the Llandeilo.) (Mem. Geol. Surv., vol. iii. part 2, pp. 54, 258.) The Harlech rocks in this north-western region are conformably overlaid by the Menevian, followed by the true Lingula-flags, or *Olenus* beds, of the Middle Cambrian. Upon these repose the Tremadoc slates,

which are not known in the other parts of Wales. The third area of Lower Cambrian rocks is that already described at St. Davids in Pembrokeshire, about 100 miles to the south-west; and the fourth, that of the Longmynd hills, about sixty miles to the south-east of Snowdon. The rocks of the Longmynd, like those of the other Lower Cambrian areas mentioned, consist principally of green and purple sandstones with conglomerates, shales and some clay-slates. They occasionally hold flakes of anthracite, and small portions of mineral pitch exude from them in some localities. The only evidence of animal life yet found in the rocks of the Longmynd are furnished by worm-burrows, the obscure remains of a Crustacean (the *Palæopyge Ramsayi*), and a form like *Histioderma*. This latter organic relic, with worm-burrows, and the fossils named *Oldhamia*, is found on the coast of Ireland opposite Caernarvonshire, in the rocks of Bray Head, which resemble lithologically the Harlech beds, and are regarded as their equivalents.

Still another area of the older rocks is that of the Malvern hills, on the western flanks of which, as already mentioned, the Lingula-flags are represented by about 500 feet of black shales with *Olenus*, underlaid by 600 feet of greenish sandstones containing traces of fucoids, with *Serpulites* and an *Obolella*. It is not improbable, as suggested by Barrande and by Murchison, that these 1100 feet of strata represent, in this region, the great mass of the Lingula-flags,—and, we may add, perhaps the whole series of Lower Cambrian strata, which in Caernarvonshire and Pembrokeshire underlie them; since these sandstones of Malvern, like those of St. Davids, rest upon crystalline schists, and are in part made up of their ruins.

These crystalline schists of Malvern, which are described by Phillips as the oldest rocks in England, and by Dr. H. B. Holl are conjectured to be Laurentian, seem from the description of their lithological characters to resemble those of Caernarvon and Anglesea, with which they are, by Murchison, regarded as identical. The crystalline schists of these latter localities are, by Sedgwick, described as hypozoic strata, below the base of the Cambrian. Murchison however, in the first edition of his *Siluria*, adopted the suggestion of De la Beche that they themselves were altered Cambrian strata. In fact they directly underlie the Llandeilo rocks, and were apparently conceived by Murchison to represent the downward continuation of these, upon which he had insisted. This opinion is supported by ingenious arguments on the part of Ramsay. (Mem. Geol. Surv., vol. iii. part 2, passim.) I am however disposed to regard them, with Sedgwick and Phillips, as of pre-Cambrian age, and to compare them with the Huronian series of North America, which occupies a similar geological horizon, and with which, as seen in Northern Michigan, and in the Green Mountains, I have found the rocks of Anglesea to offer remarkable lithological resemblances.

It may here be noticed that the gold-bearing quartz veins in North Wales are found in the Menevian beds, and also, according to Selwyn, throughout the Lingula-flags. These fossiliferous strata at the gold-mine near Dolgelly appear in direct contact with diorites

and chloritic and talcose schists, which are more or less cupriferous, and themselves also contain gold-bearing quartz veins. (Mem. Geol. Surv., part 2, pp. 42, 45; and Siluria, 4th ed., pp. 450, 547.)

The Table on p. 510 gives a view of the Lower Palæozoic rocks of Great Britain and North America, together with the various nomenclatures and classifications referred to in the preceding pages. In the second column, the horizontal black lines indicate the positions of the three important palæontological and stratigraphical breaks signalized by Ramsay in the British succession. (Mem. Geol. Surv., vol. iii. part 2, p. 2.) In a table by Davidson in the GEOLOGICAL MAGAZINE for 1868 (Vol. V. p. 305), showing the distribution of organic remains in these lower rocks, he gives, as the Ffestiniog group of Sedgwick, only the Dolgelly and Maentwrog beds of Belt (the Upper and Middle Lingula-flags); and makes of the two divisions of the Tremadoc rocks a separate group; the whole being described as the Upper Cambrian of Sedgwick. This, however, is not the present grouping and nomenclature of Sedgwick, nor was it his earlier one. So far as regards Middle and Upper Cambrian, this discrepancy is explained by the fact already stated, that, in 1843, Sedgwick proposed, as a compromise, the name of Cambro-Silurian for his Bala group, previously called Upper Cambrian; by which change the Ffestiniog or Middle Cambrian became Upper Cambrian. When the true relation between the Lower Silurian of Murchison and the Bala group was made known, Sedgwick, as we have seen, re-claimed for the latter his former name of Upper Cambrian; but this had meanwhile been adopted for the Ffestiniog group, in which sense it is still used by Lyell, Phillips, Davidson, Harkness, and Hicks. The Ffestiniog group, or Middle Cambrian, as defined by Sedgwick, however, included not only the whole of the Lingula-flags, but the Upper and Lower Tremadoc rocks. (Philos. Mag., rv. vol. viii. p. 362.)

The only change which I have made in the groupings of the British rocks adopted by Sedgwick and Murchison is in separating the Menevian or Lower Lingula-flags from the Ffestiniog, and uniting it with the Bangor group or Lower Cambrian. In this I follow, with Lyell and Davidson, the suggestion of Salter and Hicks.

In the third column, the sub-divisions are those of the New York and Canada Geological Surveys; in connexion with which the reader is referred to a table published in 1863, in the *Geology of Canada*, p. 932. Opposite the Menevian I have placed the names of its principal American localities; which are Braintree, Mass., St. John, New Brunswick, and St. John's, Newfoundland. With regard to the classification of Angelin, it is to be remarked that although he designates II. as *Regio Olenorum*, and III. as *Regio Conocorypharum*, the position of these, according to Linnarsson, is to be reversed; the *Conocoryphe* beds with *Paradoxides* being below and not above those holding *Olenus*. The *Regio Fucoidarum* in Sweden has lately furnished a Brachiopodous shell, *Lingula monilifera*, besides the curious plant-like fossil, *Eophyton Linnæanum*. (Linnarsson, GEOL. MAGAZINE, 1869, Vol. VI. p. 393.)

LOWER PALÆOZOIC ROCKS OF EUROPE AND NORTH AMERICA.

	BRITISH SUB-DIVISIONS.	NORTH AMERICAN SUB-DIVISIONS.	NOMENCLATURES OF SEDGWICK AND MURCHISON.	BARRANDE'S CLASSIFICATION.	ANGELIN'S DIVISIONS.
14	Ludlow.	Lower Helderberg.	Silurian, <i>Sedgwick</i> .	Third Fauna	VIII. VII.
13	Wenlock.	{ Niagara, Clinton,	Upper Silurian,	including	or Regiones
12	Upper Llandovery.	{ Medina, Oneida.	<i>Murchison</i> .	Etages H. G. F. E.	E. and DE
11	Lower Llandovery.	{ Hudson-River, Utica,	Upper Cambrian or	Second Fauna	VI. V. IV.
10	Caradoc.	{ Trenton, Birdseye,	Bala group, <i>Sedgwick</i> .	including	or Regiones
9	Upper Llandeilo.	{ Black-River.	Lower Silurian,	Etage D.	D. C. and BC.
8	Lower Llandeilo.	{ Chazy.	<i>Murchison</i> .		
7	Upper Tremadoc.	{ Lewis.	Middle Cambrian or	First Fauna	III. II. I.
6	Lower Tremadoc.	{ Calcareous.	Ffestiniog group, <i>Sedgwick</i> .	or	or
5	Dolgelly.	{ Potsdam.	Primordial Silurian,	Primordial Fauna,	Regiones
4	Maentwrog.		<i>Murchison</i> .	including	B. and A.
3	Menevian.	Braintree and St. John.	Lower Cambrian or	Etage C,	and
2	Harlech.	— ?	Bangor group, <i>Sedgwick</i> .	and probably also	Regio
1	Llanberris.	— ?	Cambrian, <i>Murchison</i> .	Etage B.	Fucoidarum.