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ART. XXII.—SEDGWICK and MURCHISON: *Cambrian and Silurian*; by JAMES D. DANA.

ERRONEOUS impressions have long existed among American geologists with regard to the relations to one another, and to Cambrian and Silurian geology, of SEDGWICK and MURCHISON. The Taconic controversy in this country served, most unreasonably, to intensify feelings respecting these British fellow-workers in geology, and draw out harsh judgments. Now that right views on the American question have been reached, it is desirable that the facts connected with the British question should be understood and justly appreciated.

Sedgwick and Murchison were literally fellow-workers in their earlier investigations. Professor John Phillips, in a biographical sketch of Sedgwick,* whose intimate friendship through fifty years “he had the happiness of enjoying,” speaks thus, in 1873, of their joint work:

“Communications on Arran and the north of Scotland, including Caithness (1828) and the Moray Firth; others on Gosau and the eastern Alps (1829–1831); and still later, in 1837, a great memoir on the Palæozoic strata of Devonshire and Cornwall, and another on the coeval rocks of Belgium and North Germany, show the labors of these intimate friends in the happiest way—the broad generalizations in which the Cambridge professor delighted, well supported by the indefatigable industry of his zealous companion.”

* Nature, Feb. 6, 1873, vii. 257.

Professor Phillips then speaks of the Cambrian and Silurian labors "of two of the most truly attached and mutually helpful cultivators of geological science in England."

Of these Cambrian and Silurian labors it is my purpose to give here a brief history derived from the papers they published. They were begun in 1831, without concert—Sedgwick in Wales, Murchison along the Welsh and English borders.

In September of 1831, the summer's excursions ended, Murchison made his first report at the first meeting of the British Association. It was illustrated by a colored geological map representing the distribution of the "Transition rocks," the outlying Old Red Sandstone, and the Carboniferous limestone.*

These "Transition Rocks" (of Werner's system), upturned semi-crystalline schists, slates and other rocks, passing down into uncrystalline, and regarded as mostly non-fossiliferous, the "*agnotozoic*" of the first quarter of the century, were the subject of Sedgwick's and Murchison's investigations—the older of the series, as it turned out, being included in Sedgwick's part.† They were early resolved into their constituent formations by Murchison, and later as completely by Sedgwick in his more difficult field.‡

Already in March and April of 1833, Murchison showed, by his communications to the Geological Society of London, that he had made great progress; for the report says: § He "separated into distinct formations, by the evidence of fossils and the order of superposition, the upper portion of those vast sedimentary accumulations which had hitherto been known only under the common terms of Transition Rocks and Grauwacke." And these "distinct formations" were: (1) the Upper

* Murchison, Report of the British Association, i, 91, 1831.

† Murchison says, in the introductory chapter of his *Silurian System*, p. 4, "No one [in Great Britain, before his investigations began] was aware of the existence below the Old Red Sandstone of a regular series of deposits containing peculiar organic remains." "From the days of De Saussure and Werner, to our own, the belief was impressed on the minds of geologists that the great dislocations to which these ancient rocks had been subjected had entirely dis severed them from the fossiliferous strata with which we were acquainted."

‡ The term "Transition" early appeared in American geological writings. Sixty to seventy-five years ago it was applied by Maclure, Dewey and Eaton to the rocks of the Taconic region and their continuation; for these were upturned, apparently unfossiliferous, semi-crystalline to uncrystalline, and extended eastward to a region of gneisses. The study of the rocks was commenced; but in 1842, before careful work for the resolution of them had been done—like that in which Murchison and Sedgwick were engaged—they were, unfortunately, put, as a whole, into a "Taconic system" of assumed pre-Potsdam age; at the same time "Transition" was shoved west of the Hudson, over rocks that were horizontal, and already resolved. Owing to this forestalling of investigation, and partly also to inherent difficulties, the right determination of the several formations comprised in this Taconic or "Transition" region was very long delayed.

§ Murchison, Proceedings of the Geol. Soc. London, i, 470, 474, 1833, in a paper on the Sedimentary deposits of Shropshire and Herefordshire.

Ludlow rocks; (2) the Wenlock limestone; (3) the Lower Ludlow rocks; (4) Shelly sandstones, "which in Shropshire occupy separate ridges on the southeastern flanks of the Wrekin and the Caer Caradoc"; (5) the Black Trilobite flagstone whose "prevailing Trilobite is the large *Asaphus Buchii*, which with the associated species," he observed, "is never seen in any of the overlying groups;" and, below these, (6), Red Conglomerate sandstone and slaty schist several thousand feet in thickness.

By the following January, 1834, Murchison was ready with a further report,* in which he described the "four fossiliferous formations" in detail, and displayed, on a folded table arranged in columns, their stratigraphical order, thickness, subdivisions, localities, and "characteristic organic remains." The subdivisions of the rock-series in the memoir are as follows, commencing above: I, Ludlow rocks, 2,000 feet; II, Wenlock and Dudley rocks, 1,800 feet; III, Horderley and May Hill rocks (afterward named Caradoc), 2,500 feet; IV, Builth and Llandeilo flags, characterized by *Asaphus Buchii*, 1,200 feet; and, below these, V, the Longmynd and Gwas-taden rocks, many thousand feet thick, set down as unfossiliferous.

Thus far had Murchison advanced in the development of the Silurian system by the end of his third year. Upper and Lower Silurian strata were comprised in it, but these subdivisions were not yet announced.

During the interval from 1831 to 1834, Sedgwick presented to the British Association in 1832 a verbal communication on the geology of Caernarvonshire, and another brief report of progress in 1833. A few lines for each are all that was published. The difficulties of the region were a reason for slow and cautious work.

In 1834, as first stated in the Journal of the Geological Society for the year 1852, the two geologists took an excursion together over their respective fields. Sedgwick says:† "I then studied for the first time the Silurian types under the guidance of my fellow-laborer and friend; and I was so struck by the clearness of the natural sections and the perfection of his workmanship that I received, I might say, with implicit faith everything which he then taught me." And further, "the whole 'Silurian system' was by its author placed *above* the great undulating slate-rocks of South Wales." The geologists next went together over Sedgwick's region, and the sec-

* Murchison, Proc. Geol. Soc., ii, 13, 1834. The subject was also before the British Association: Report for 1834, p. 652.

† Sedgwick, Quarterly Journal of the Geological Society, viii, 152, 1852.

tions from the top of the Berwyns to Bala. Murchison concluded, after his brief examination, and told Sedgwick, that the Bala group could not be brought within the limits of his system. He says: "I believed it to plunge under the true Llandeilo flags with *Asaphus Buchii* which I had recognized on the east flank of that chain." "Not seeing, on that hurried visit, any of the characteristic Llandeilo Trilobites in the Bala limestone, I did not then identify that rock with the Llandeilo flags, as has since been done by the Government surveyors."*

In 1835, the terms "Silurian" and "Cambrian" first appear in geological literature. Murchison named his system the "Silurian" in an article in the *Philosophical Magazine* for July of that year, and at the same time defined the two grand subdivisions of the system: I, the *Upper Silurian*, or the Ludlow and Wenlock beds; and II, the *Lower Silurian*, or the Caradoc and Llandeilo beds.†

During the next month, August, the fourth meeting of the British Association was held at Edinburgh, and in the report of the meeting,‡ the two terms, *Silurian* and *Cambrian*, are united in the title of a communication "by Professor Sedgwick and R. I. Murchison," the title reading, "On the Silurian and Cambrian systems, exhibiting the order in which the older sedimentary strata succeed each other in England and Wales." Murchison, after explaining his several subdivisions, said that "in South Wales" he had "traced many distinct passages from the lowest member of the 'Silurian system' into the underlying slaty rocks now named by Professor Sedgwick, the Upper Cambrian." Sedgwick spoke of his "*Upper Cambrian group*" as including the greater part of the chain of the Berwyns, where he said, "it is connected with the Llandeilo flags of the Silurian and expanded through a considerable part of South Wales;" the "*Middle Cambrian group*" as "comprising the higher mountains of Caernarvonshire and Merionethshire;" the "*Lower Cambrian group*" as occupying the southwest coast of Caernarvonshire, and consisting of chlorite and mica schists, and some serpentine and granular limestone; and finally, he "explained the mode of connecting Mr. Murchison's researches with his own so as to form one general system."

Thus, in four years Murchison had developed the true system in the rocks he was studying; and Sedgwick likewise had reached what appeared to be a natural grouping of the rocks of his complicated area. Further, *in a united paper*, or papers presented together, they had announced the names Silurian and Cambrian, and expressed their mutual satisfaction with the

* Murchison, *Q. J. G. Soc.*, viii, 175.

† *Phil. Mag.*, vii, 46, July, 1835.

‡ *Brit. Assoc.*, v, August, 1835.

defined limits. Neither was yet aware of the unfortunate mischief-involving fact that the two were overlapping series.

It is well here to note that *the term "Cambrian" antedates "Taconic" of Emmons by seven years*; and also that Emmons did not know—any more than Sedgwick with regard to the Cambrian—that his system of rocks was in part Lower Silurian, and of Llandeilo and Caradoc age.

In May, of 1838, nearly three years later, Sedgwick presented his first detailed memoir on North Wales and the Cambrian rocks to the Geological Society.* Without referring to the characteristic fossils, he divides the rocks below the Old Red Sandstone, beginning below, into (I) the PRIMARY STRATIFIED GROUPS, including gneiss, mica schist and the Skiddaw slates, giving the provisional name of *Protozoic* for the series should it prove to be fossiliferous, and (II) the PALÆOZOIC SERIES; the latter including (1) the Lower Cambrian (answering to Middle Cambrian of the paper of 1835), (2) the Upper Cambrian and (3) the *Silurian*, or the series so called by Murchison. Without a report on the fossils, no comparison was possible at that time with Murchison's Silurian series. Yet Sedgwick goes so far as to say that the "Upper Cambrian," which "commences with the fossiliferous beds of Bala, and includes all the higher portions of the Berwyns and all the slate-rocks of South Wales which are below the Silurian System," "appears to pass by insensible gradation into the lower division of the Upper System (the Caradoc Sandstone);" and that "many of the fossils are identical in species with those of the Silurian System."† Respecting the *Silurian System* he refers to the abstracts of Mr. Murchison's papers and "his forthcoming work."

The *Protozoic* division included the "Highlands of Scotland, the crystalline schists of Anglesea and the Southwest Coast of Caernarvonshire." It is added: "The series is generally without organic remains; but should organic remains appear unequivocally in any part of this class they may be described as the Protozoic System."

In the later part of the same year, 1838, Murchison's "Silurian System" was published‡—a quarto volume of 800

* An abstract appeared in the Proc. Geol. Soc., ii, 675, 1838. A continuation of the paper appeared in 1841, *ibid.*, iii, 541. See also Q. J. Geol. Soc., viii, 1852.

† Of these fossils, he had mentioned "*Bellerophon bilobatus*, *Producta sericea* and several species of *Orthis*" as occurring in the Bala limestone, "all of which are common to the Lower Silurian System," in a Syllabus of his Cambridge lectures, published in 1837.

‡ Murchison's "Silurian System" bears on its title page the date 1839. He states in the Q. J. Geol. Soc., viii, 177, 1852, that the work was really issued in 1838. The fossil fishes of the volume were described by Agassiz, the trilobites, by Murchison, and the rest of the species, by Sowerby.

pages, with twenty-seven plates of fossils, and nine folded plates of stratigraphical sections, besides many plates in the text—the outcome of his eight years of work. Five hundred pages are devoted to the Silurian System.

The dedication is as follows :

“To you, my dear Sedgwick, a large portion of whose life has been devoted to the arduous study of the older British rocks, I dedicate this work.

Having explored with you many a tract, both at home and abroad, I beg you to accept this offering as a memorial of friendship, and of the high sense I entertain of the value of your labours.”

Through Murchison's investigations here recorded, as he remarks in his Introduction with reasonable satisfaction, “a complete succession of fossiliferous strata is interpolated between the Old Red Sandstone and the oldest slaty rocks.” He observes as follows of Sedgwick: “In speaking of the labours of my friend, I may truly say, that he not only shed an entirely new light on the crystalline arrangement or slaty cleavage of the North Welsh Mountains, but also overcame what to most men would have proved insurmountable difficulties in determining the order and relations of these very ancient strata amid scenes of vast dislocation. He further made several traverses across the region in which I was employed; and, sanctioning the arrangement I had adopted, he not only gave me confidence in its accuracy, but enhanced the value of my work by enabling me to unite it with his own; and thus have our joint exertions led to a general view of the sequence of the older fossiliferous deposits.” In accordance with these statements many of the descriptions and the very numerous sections represent the Cambrian rocks lying beneath the Silurian, —though necessarily with incorrect details, since neither Murchison nor Sedgwick had then any appreciation of the actual connection between the so-called Cambrian and Silurian.

The Silurian system, as here set forth, is essentially that of Murchison's earlier paper of 1835; and through the work, as each region is taken up, the rocks of the *Upper* and *Lower* divisions, and their several subdivisions, are described in order, with a mention of the characteristic fossils. As to the relations of the two grand divisions, he says that “although two or three species of shells of the Upper Silurian rocks may be detected in the Lower Silurian, *the mass of organic remains in each group is very distinct.*” Later he makes the number of identical species larger; but even the newest results do not increase it so far as to set aside Murchison's general statement of 1838.

Sedgwick, with all the light which the fossils of the "Silurian System" were calculated to throw on his Upper Cambrian series, found in the work no encroachments on his field or on his views. They were still side by side in their labors among the hitherto unfathomed British Paleozoic rocks.

In 1840 and 1841 Murchison was in Russia with M. de Verneuil and Count Keyserling, and also in Scandinavia and Bohemia, seeking to extend his knowledge of the older fossiliferous rocks and verify his conclusions; and in 1845 the great work on the Geology of Russia and the Urals came out, with a further display of Upper and Lower Silurian life. In his Presidential addresses of 1842 and 1843, reviewing the facts in the light of his new observations, he went so far as to say that the Lower Silurian rocks were the oldest of fossiliferous rocks and that the fossiliferous series of North Wales seemed to exhibit no vestiges of animal life different from those of the Lower Silurian group.

Still Sedgwick made no protest. He states definitely on this point in his paper of 1852,* that from 1834, the time of the excursion with Murchison, until 1842, he had accepted Murchison's conclusions, including the reference of the Meifod beds to the Caradoc or Silurian, without questioning; but that from that time, 1842, he began to lose his confidence in the stability of the *base-line* of the "Silurian System." He adds that in 1842, Mr. Salter, the paleontologist, informed him that the Meifod beds were on the same horizon nearly with the Bala beds; and he accepted this conclusion to its full extent, using the words "if the Meifod beds were Caradoc, the Bala beds must also be Caradoc or very nearly on its parallel." Thus the inference of Murchison was adopted and discrepancy between them deferred. And on the following page he acknowledges that all his papers of which there is any notice in the Proceedings or Journal of the Geological Society between 1843 and 1846 admit this view as to the Bala beds and certain consequences of it—"mistakes" as he pronounced them six years later, in 1852.†

In 1843, Sedgwick read before the Geological Society in June, a paper entitled *An Outline of the Geological Structure of North Wales*, which was published in abstract in the Proceedings (iv, 251); and in November of the same year, one *On the Older Palæozoic (Protozoic) Rocks of North Wales* (from observations by himself in company with Mr. Salter), which appeared, with a map, in the Journal of the Geological Society (i, 1). The abstract in the Proceedings was prepared by Mr. Warburton, the President of the Geological Society, and the paper of the following November, makes no allusion to this fact, or any objection to the abstract.

* Q. J. Geol. Soc., viii, 153, 1852.

† Ibid., p. 154.

A remarkable feature of the November paper is that it nowhere contains the term *Upper Cambrian or even Cambrian*, although the rocks are Sedgwick's Upper Cambrian, together with Murchison's Upper Silurian.

A second fact of historical interest is the use of the term "Protozoic," not in the sense in which it was introduced by him in 1838, but in that in which introduced in 1838 by Murchison, on page 11 of his *Silurian System*, where he says :

"But the Silurian, though ancient, are not, as before stated, *the most ancient fossiliferous strata*. They are, in truth, but the upper portion of a succession of early deposits which it may hereafter be found necessary to describe under one comprehensive name. For this purpose I venture to suggest the term *Protozoic Rocks*, thereby to imply the first or lowest formations in which animals or vegetables appear."

These facts are in accordance with Sedgwick's acknowledgment, mentioned on the preceding page.

The map accompanying the paper as originally prepared, had colors corresponding to five sets of areas, those of the "Carboniferous Limestone," "Upper Silurian," "Protozoic" Rocks, "Mica and Chlorite Slate," "Porphyritic Rocks;" and here again Cambrian, Upper or Lower, does not appear, the term Protozoic being substituted. The map, as it stands in the *Journal of the Geological Society*, has in place of simply *Protozoic*, the words "Lower Silurian (Protozoic)." Sedgwick complains, in his paper of 1852, pages 154, 155, of this change from his manuscript, and attributes it to Mr. Warburton, saying that "the map with its explanations of the colors plainly shows that Mr. Warburton did not comprehend the very drift and object of my paper." "I gave one colour to this whole Protozoic series only because I did not know how to draw a clear continuous line on the map between the upper Protozoic (or lower Silurian) rocks and the lower Protozoic (or lower Cambrian) rocks." "Nor did I ever dream of an incorporation of all the lower Cambrian rocks in the system of Siluria." Sedgwick also says on the same point: "I used the word *Protozoic* to prevent any wrangling about the words Cambrian and Silurian." But this is language he had no disposition to use in 1843, as the paper of 1843 shows.

Page 155 has a foot note. In it the aspect of the facts is greatly changed. He takes back his charges, saying, "I suspect that, in the explanation of the blank portion of the rough map exhibited in illustration of my paper I had written *Lower Silurian and Protozoic*, and that Mr. Warburton, erroneously conceiving the two terms identical, changed the words into Lower Silurian (Protozoic)" "I do not by any means accuse

Mr. Warburton of any *intentional* injustice—quite the contrary; for I know that he gave his best efforts to the abstract. But he had undertaken a task for which he was not prepared, inasmuch as he had never well studied any series of rocks like those described in my papers.” Sedgwick here uses Protozoic in the Sedgwick sense, not, as above in the Murchison sense. Sedgwick again in 1854, speaks of “the tampering with the names of my reduced map.” But these explanations of his should take the harshness out of the sentence, as it was in 1843 to 1846 out of all his words.

The paper has further interest in its long lists of fossils in two tables: I, “Fossils of the Older Palæozoic (Protozoic) Rocks in North Wales, by J. W. Salter and J. de C. Sowerby,” showing their distribution; and II, “Fossils of the Denbigh flagstone and sandstone series.”

Thus, until 1846, no serious divergence of views had been noted by Sedgwick. This is manifested in his paper on the Slate rocks of Cumberland, read before the Geological Society on the 7th and 21st of January, 1846,* which says, on the last page but one: “Taking the whole view of the case, therefore, as I know it, I would divide the older Palæozoic rocks of our island into three great groups: 3d, the upper group, *exclusively Upper Silurian*; 2, the middle group, or *Lower Silurian*, including Llandeilo, Caradoc, and perhaps Wenlock; 1, the first group, or *Cambrian*,” differing in this arrangement from Murchison only in the suggestion about the Wenlock. The italics are his own. He adds:

“This arrangement does no violence to the Silurian system of Sir R. Murchison, but takes it up in its true place; and I think it enables us to classify the old rocks in such a way as to satisfy the conditions both of the fossil and physical as well as mineralogical development.”

But before the year 1846 closed not only the overlapping of their work was recognized but also the consequences ahead, and divergence of opinion began.

In December a paper was presented by Sedgwick to the Geological Society on “the Fossiliferous Slates of North Wales, Cumberland, Westmoreland and Lancashire,”† which contains a protest against the downward extension of the Silurian so as to include the Cambrian. It is excellent in spirit and fair in argument. Many new facts are given respecting sections of the rocks in South Wales and North Wales, in some of which occur the *Lingula* flags, and characteristic fossils are mentioned. In describing some South Wales sections, Sedg-

* Q. J. Geol. Soc., ii, 106, 122, 1846.

† Ibid., iii, 133, Dec., 1846.

wick uses the term *Cambro-Silurian* to include, beginning below, (1) "Conglomerates and slates, (2) Lower Llandeilo flags, (3) Slates and grits (Caradoc Sandstone of Noeth Grug, etc., (4) Upper Llandeilo flag passing by insensible gradations into Wenlock shale." The Cambrian series is made to include (1) The Festiniog or Tremadoc group; (2) Roofing slates, etc., the "Snowdonian group," fossiliferous in Snowdon, etc.; (3) the Bala group; and then (4) "the *Cambro-Silurian* group," comprising "the lower fossiliferous rocks east of the Berwyns between the Dee and the Severn—the Caradoc Sandstone of the typical country of Siluria—and the Llandeilo flags of South Wales, along with certain associated slates, flags, and grits." The extension of the term Silurian down to the Lingula flags, or beyond, is opposed because the beds below the Llandeilo are not part of the Silurian system; the term Silurian [derived from the Silures of Southeast Wales and the adjoining part of England] is not geographically applicable to the Cambrian rocks; and because the only beds in North Wales closely comparable "with the Llandeilo flags are at the top of the whole Cambrian series." This last reason later lost its value when it was proved, as Sedgwick recognized years afterward, that Murchison's Llandeilo flags were really older than Sedgwick's Bala rocks.

Sedgwick's paper was followed, on January 6th, with one by Murchison,* objecting to this absorption of the Lower Silurian and reiterating his remark of 1843 that the fossiliferous Cambrian beds were Lower Silurian in their fossils, and arguing, thence, for the absorption of the Cambrian, to this extent, by the Silurian. Having, eight years before, in his great work on the "Silurian System," described the Lower Silurian groups with so much detail, and with limits well defined by sections and by long lists of fossils, over a hundred species in all, many of them figured as well as described, and having thus added a long systematized range of rocks to the lower part of the Paleozoic series, he was naturally unwilling to give up the name of Lower Silurian for that of Upper Cambrian or Cambro-Silurian. Moreover, the term "Silurian," with the two subdivisions of the system, the Upper and Lower, had gone the world over, having been accepted by geologists of all lands as soon as proposed, become affixed to the rocks to which they belonged, and put into use in memoirs, maps and geological treatises.

In 1852, the controversy, begun by encroachments not intended on either part, reached its height. Sedgwick's earnest presentation of the case† and appeal before the Geological

* Q. J. Geol. Soc., iii, 165, Jan., 1847.

† *Ibid.*, viii, 152.

Society in February of that year—making the latter part of a memoir by him on the “Classification and Nomenclature of the Lower Palæozoic Rocks of England and Wales”—argues, like that of 1846, for the extension of the Cambrian from below upward to include the Bala beds, and thereby also the Llandeilo flags, and Caradoc sandstone, although, he says “my friend has published a magnificent series of fossils from the Llandeilo flagstone.” Sedgwick also expresses dissatisfaction with Mr. Warburton’s abstract of his paper of June, 1843, and with the change made in his map of November, 1843, as indicated on page 174, but, as there shown, he has no blame for Murchison and little for Mr. Warburton. He also points out some errors in the stratigraphical sections of the “Silurian System,”—since the publication of which fourteen years had passed. He closes with the words (p. 168):

“I affirm that the name ‘Silurian,’ given to the great Cambrian series below the Caradoc Group, is historically unjust. I claim this great series as my own by the undoubted right of conquest; and I continue to give it the name ‘Cambrian’ on the right of priority, and, moreover, as the only name yet given to the series that does not involve a geographical contradiction. The name ‘Silurian’ not merely involves a principle of nomenclature that is at war with the rational logic through which every other Palæozoic group of England has gained a permanent name, but it also confers the presumed honor of a conquest over the older rocks of Wales on the part of one who barely touched their outskirts and mistook his way as soon as he had passed within them.

“I claim the right of naming the Cambrian rocks because I flinched not from their difficulties, made out their general structure, collected their fossils, and first comprehended their respective relations to the groups above them and below them, in the great and complicated Palæozoic sections of North Wales. Nor is this all,—I claim the name Cambrian in the sense in which I have used it, as a means of establishing a congruous nomenclature between the Welsh and the Cumbrian Mountains, and bringing their respective groups into a rigid geological comparison; for the system on which I have for many years been laboring is not partial and one-sided, but general and for all England.”

Sedgwick does not seem to have recognized the fact that Murchison had the same right to extend the Silurian system to the base of the Llandeilo beds, whatever its horizon, that he had to continue the Cambrian to the top of the Bala beds.*

* One important fact is pointed out in this paper in a letter from M’Coy, on page 143: that the May Hill group, which Murchison had referred to the Caradoc series, really belonged by its fossils to the Upper Silurian. This point was the subject of a paper by Sedgwick in the next volume (vol. ix) of the Journal of the Geological Society.

Murchison's reply was made at the meeting of the Geological Society in June.* He remarked, with regard to Sedgwick's allusion to the excursion of 1834, that "if I lost my way in going downward into the region of my friend, it was under his own guidance; I am answerable only for Silurian and Cambrian rocks described and drawn as such within my own region."

In his closing remarks Murchison says:

"I am now well pleased to find that, with the exception of my old friend, all my geological contemporaries in my own country adhere to the unity of the Silurian System and thus sustain its general adoption."

"No one more regrets than myself that Cambrian should not have proved, what it was formerly supposed to be, more ancient than the Silurian region, and thus have afforded distinct fossils and a separate system; but as things which are synonymous cannot have separate names, there is no doubt that, according to the laws of scientific literature, the term "Silurian" must be sustained as applied to all the *fossiliferous* rocks of North Wales.

"Lastly, let me say to those who do not understand the nature of the social union of the members of the Geological Society, that the controversy which has prevailed between the eloquent Woodwardian Professor and myself has not for a moment interrupted our strong personal friendship. I am indeed confident we shall slide down the hill of life with the same mutual regard which animated us formerly when climbing together many a mountain both at home and abroad."

Murchison was right in saying that all British geologists were then with him, even in the extension of the name Silurian to the lower fossiliferous Cambrian rocks; and this was a chief source of irritation to Sedgwick. It was also, with scarcely an exception, true of geologists elsewhere. This state of opinion was partly a consequence of Murchison's early and wonderfully full description of the Silurian rocks and their fossils, which made his work a key to the Lower Paleozoic of all lands. Sedgwick's Cambrian researches and the paleontology of the region were not published in full before the years 1852-1855, when appeared his "Synopsis of the Classification of the British Palæozoic Rocks," along with M'Coy's "Descriptions of British Palæozoic Fossils."

But this general acceptance was further due to the fact that the discovered fossils of the Cambrian, from the Lingula Flags downward, or the "Primordial," were few, and differed not more from Silurian forms than the Silurian differed among themselves; and also, because the beds were continuous with the Silurian, without a break. Geologists under the weight of

* Q. J. Geol. Soc., viii, 173, 1852.

the evidence, American as well as European, naturally gravitated in the Murchisonian direction, while applauding the work of Sedgwick.

In 1853, Mr. Salter showed, by a study of the fossils,* that the Bala beds from Bala in Merioneth, the original Bala, were included within the period of the Caradoc. Sedgwick subsequently (in the preface to the Catalogue of the Woodwardian Museum by J. W. Salter), divided his Upper Cambrian into (1) The *Lower Bala*, to include the Llandeilo flags (Upper Llandeilo of the Geological Survey, the Arenig being the Lower); (2) the *Middle Bala*, corresponding to the Caradoc sandstone, the Bala rocks, and the Coniston limestone (Geological Survey); and the *Upper Bala* or the Caradoc-shales, Hirnant limestone and the Lower Llandovery.”†

In 1854, the Cambrian system not having secured the place claimed for it, Sedgwick brought the subject again before the Geological Society. Besides urging his former arguments, he condemned Murchison's work so far as to imply that none of his sections “give a true notion of the geological place of the groups of Caer Caradoc and Llandeilo”; and to speak of the Llandeilo beds, in a note, as “a remarkable fossiliferous group (about the age of the Bala limestone) of which the geological place was entirely mistaken in the published sections of the Silurian System.” There were errors in the sections, and that with regard to the May Hill group was a prominent one; but this was sweeping depreciation without new argument; and, in consequence of it, part of the paper was refused publication by the Geological Society.

The paper appeared in the Philosophical Magazine for 1854.‡ It contains no bitter word, or personal remark against Murchison. Sedgwick was profoundly disappointed on finding, when closing up his long labors, that the Cambrian system had no place in the geology of the day. He did not see this to be the logical consequence of the facts so far as then understood. It was to him the disparagement and rejection of his faithful work; and this deeply moved him, even to estrangement from the author of the successful Silurian system.

CONCLUSION.

The ground about which there was reasonably a disputed claim was that of the Bala of Sedgwick's region and the Llandeilo and Caradoc of Murchison's. Respecting this common field, long priority in the describing and defining of the

* Q. J. Geol. Soc. x, 62.

† Cited from Etheridge, in Phillips' Geology, ii, 77, 1885.

‡ Fourth series, volume viii, pages 301. 359. 481.

Llandeilo and Caradoc beds, both geologically and paleontologically, leaves no question as to Murchison's title. Below this level lie the rocks studied chiefly by Sedgwick; and if a dividing horizon of sufficient geological value had been found to exist, it should have been made the limit between a Cambrian and a Silurian System.

The claim of a worker to affix a name to a series of rocks first studied and defined by him cannot be disputed. But Science may accept, or not, according as the name is, or is not, needed. In the progress of geology, the time finally was reached, when the name Cambrian was believed to be a necessity, and "Cambrian" and "Silurian" derived thence a right to follow one another in the geological record.

"To follow one another;" that is, directly, without a suppression of "Silurian" from the name of the lower subdivision by intruding the term "Ordovician," or any other term. For this is virtually appropriating what is claimed, (though not so intended), and does marked injustice to one of the greatest of British geologists. Moreover, such an intruded term commemorates, with harsh emphasis, misjudgments and their consequences, which are better forgotten. Rather let the two names, standing together as in 1835, recall the fifteen years of friendly labors in Cambria and Siluria and the other earlier years of united research.