

## II.—ON THE ASHGILLIAN SERIES.

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IN my Address to the Geological Society in 1905 I proposed the use of the term Ashgillian for the uppermost series of the Ordovician System, but did not discuss therein at length the exact relationship of the beds to which the term was applied, with the underlying and overlying strata. An examination of the literature treating of these rocks showed that there was a considerable amount of confusion with regard to these strata, and it is the object of this paper to clear this up and to indicate what deposits are actually referable to the Ashgillian division.

## I. HISTORICAL.

In the Introduction to the "Synopsis of the Classification of the British Palæozoic Rocks" (which is undated, though a postscript is dated July 19th, 1855), Sedgwick gives the Bala Group as constituting the whole of his Upper Cambrian, while the Arenig slates and porphyries are placed in the upper division of his Middle Cambrian. He divides the Bala Group as follows:—"a. Lower Bala rocks. (1) A great series of dark and sometimes earthy slate. (2) A great series of slates, flags, and grits, ascending to the Bala Limestone.— b. Upper Bala rocks. Under this term are included: (1) The Bala and Hirnant Limestone and the Llandeilo calcareous flag. (2) Flagstones, slates, calcareous beds, and shelly sandstones of Caer Caradoc. The whole series ending, in North Wales, with slate and flagstone; and, in South Wales, with slates, grits, and coarse conglomerates. The group of very great thickness."

In this scheme the term Upper Bala was used in a wider sense than that in which it was subsequently used by Salter with Sedgwick's consent.

In "The Catalogue of the Collection of Cambrian and Silurian Fossils in the Geological Collection of the University of Cambridge," published by the University Press in 1873, the term "Upper Bala" was restricted, and a new term "Middle Bala" introduced and adopted "for the Bala Limestone and its associated sandstones and slates, several thousand feet thick in N. Wales . . . ."

On p. 39 of the Catalogue the following is given as the extent of the Middle Bala Group: "Professor Sedgwick only includes in this group the 9,000 feet of beds, chiefly arenaceous, slaty, and with some calcareous bands, which lie over the dark earthy slates of the Arenig section (Lower Bala). The group extends a short distance, probably a couple of hundred feet, above the Bala Limestone. But it does not include the Hirnant Limestone, which is the base of the Upper Bala group next described. It appears to represent in mass the whole of the Caradoc Sandstone proper, in Shropshire."

We here find a definite statement that the Hirnant Limestone is the base of the Upper Bala Group.

On pp. 72-83 the Upper Bala fossils are catalogued, and at the head of p. 72 the following grouping is given:—

“Upper Bala Group, Sedgw. (restricted in 1866). The Upper Bala of the synopsis includes the Bala Limestone, now *Middle Cambrian*.<sup>1</sup>

“1. *Hirnant Limestone* and Llanfyllin Beds, viz., pale-coloured slates above the Bala Limestone. Ash Gill slates, etc., above the *Coniston Limestone*.

“2. *Llandovery Rocks* (Phillips, Salter, Lyell—*Lower Llandovery of the Survey*).”

The same classification is given in somewhat different words on p. 26 (text).

With regard to the restriction of the term in 1866 I have searched in vain for any printed record of such restriction, and believe that it was the result of conversation between Sedgwick and Salter, for in a note on p. 26 of the Catalogue Salter writes: “Prof. Sedgwick trusts me to arrange them [the Bala fossils] according to the present state of our knowledge, 1867. The Bala Group or Upper Cambrian of Sedgwick therefore consists of:—

UPPER CAMBRIAN (Sedg.).	{	Lower Bala = Llandeilo Flag ( <i>Upper Llandeilo</i> , Geol. Survey, the Arenig being the lower).
		Middle Bala = Caradoc Sandstone and Bala rocks (Geol. Survey and Sir R. I. Murchison).
		Upper Bala = Caradoc shales, Hirnant Limestone, and Lower Llandovery rock (Geol. Survey).”

It is clear to me that the Upper Bala as defined by Salter in the paragraph I have quoted is very different from the Ashgillian as I propose to use it, so far as the Bala region is concerned, for he definitely takes the base of the Hirnant Limestone for its base, whereas I propose to include beds some way below this limestone, which beds, I hope to show, are equivalent to the Ashgill Beds, which Salter includes in the Upper Bala.

The position of the summit of the Upper Bala Group as defined by Salter is even more unsatisfactory. We have seen that he divides the Upper Bala Group into two sub-groups, viz., the Hirnant Limestone, etc., below, and the Llandovery above.

Salter himself says of them (Cat. Camb. and Sil. Foss., p. 72): “The fossils of these two divisions are arranged together, as it is clearly impossible always to draw a line between them; they form, indeed, one series. But the list is kept in *two separate columns here*, as each group contains a few peculiar species.”

The Llandovery Beds here mentioned (now called Lower Llandovery) are at the present day, by general consent, bracketed with the May Hill Beds (Upper Llandovery) to form the basal series of the Silurian system. We are therefore concerned with the rocks containing the fossils placed by Salter in the columns of the Catalogue headed “Upper Bala proper.” Twenty-two forms are recorded in these columns. The first entry, *Nidulites farrus*, is clearly placed in the wrong column owing to a clerical error. Two trilobites are given, viz. *Phacops obtusicaudatus* and *Proetus* sp., from Coldwell and the equivalent strata of Helm(s) Knot, Dent. Salter elsewhere (Cat., p. 26) brackets these Coldwell Beds with the Ashgill Beds—an extraordinary error, the Coldwell Beds actually belonging to the Lower Ludlow

<sup>1</sup> The word Cambrian is clearly a misprint for Bala.

Group. We are left with 19 forms, viz. : 2 Corals, 2 Bryozoa, and 15 Brachiopods, of which 11 are *Orthides*, most of which have a long-range. This attempted definition of the "Upper Bala proper" by its included fauna is almost as unsatisfactory as the attempt to draw definite lines at its base and summit. The one satisfactory determination in the Catalogue is that of the position of the Ashgill Beds.<sup>1</sup>

Having now considered the "Upper Bala" Group as originally defined in the Cat. Camb. and Sil. Foss., we may pass to the consideration of other contributions to the study of the highest Ordovician strata at home and abroad.

The British area where the Ashgillian rocks were first accurately separated from those of Middle Bala (Caradocian) age was, as has been already stated, that of Lakeland, and we may now consider the work which has been done in that region.

The Upper Bala Beds of the Lake District proper, unlike those of Wales, have from the time of the restriction of the term in 1866 been correctly grouped, save that Salter included the Coldwell Beds (of Lower Ludlow age) with the Ashgill Beds proper, but his reference of the Ashgill Beds to the Upper Bala showed that these beds were recognised by him as separable from the Middle Bala Group.

Professor T. McK. Hughes in 1876 showed me that the shales of the Sedbergh area, which he spoke of as the "Fairygill Shales," were, like the Ashgill Shales, distinguishable from the "Coniston Limestone" below (which contains a Middle Bala fauna) by their organic contents, and he discovered *Strophomena(?) siluriana* in the Ashgill Shales of Ashgill, he and the Rev. H. G. Day having previously found it in Fairygill, etc., and sent specimens to Davidson, who described them in the monograph on the Brachiopods published by the Palæontographical Society in 1870. Professor Hughes never published his views, but to him belongs the credit of showing that Salter's Ashgill Beds were more than a local development of beds at Ashgill.<sup>2</sup>

In a paper which appeared in the Quarterly Journal in 1878 I gave a short list of fossils from the Ashgill Shales, but at that time had not recognised a calcareous deposit below the base as belonging to the Ashgill Group. I first referred that limestone to the Ashgill Series in my Sedgwick Essay (1883) in the following words:—

"*Upper Bala Series.* The Ashgill Shales of Sedgwick and Salter succeed the Coniston Limestone, and have a very different fauna. They are never more than 200 feet thick, and consist of a lower stage of grey crystalline limestone, succeeded by poorly cleaved bluish or blackish shales." Then follows a list of fossils, of which those occurring in the lower (calcareous) stage are marked by

<sup>1</sup> I have found it necessary to criticise adversely some of Salter's conclusions. It is only fair to state that at the time when the Cat. Camb. and Sil. Foss. was compiled he was in deplorable health; also that he was unacquainted with the rocks in the field whose fossils he was arranging and cataloguing. I need hardly mention the respect I have for the work he did among the Lower Palæozoic fossils.

<sup>2</sup> There is reason to believe that the name Ashgill Beds was originally suggested to Salter by Aveline, who separated them from the "Coniston Limestone" proper: at any rate, Salter proved the distinctness of the two groups on palæontological grounds.

an asterisk. Among these are *Caryocystites Davisii* and *Staurocephalus clavifrons*. As both limestone and shales are developed in the quarry of the typical locality, Ashgill, it seems peculiarly appropriate, in the absence of any accurate definition of the limits of the so-called Upper Bala Beds, to use the name of this locality in connection with the division, as I suggested in my Address to the Geological Society in 1905.

In 1892 (*GEOL. MAG.*, Dec. III, Vol. IX, p. 97) I published a paper on "The Coniston Limestone Series." In this paper separate lists of the *Staurocephalus* Limestone and Ashgill Shale divisions of the Ashgillian are given, but the Keisley Limestone fossils are wrongly placed with the Caradocian fossils of the Sladdale group.

The true age of this Keisley Limestone was proved by Mr. F. R. Cowper Reed.<sup>1</sup> In his two papers on this limestone he shows that its fauna appertains to the Upper Bala (Ashgillian), and not to the Middle Bala (Caradocian).

Last year I was able to show that the *Staurocephalus* Limestone of the Cross Fell Inlier, previously described by Professor Nicholson and myself, was *in* the Keisley Limestone and not *above* it as we had wrongly concluded. The Ashgillian Beds of the North of England are therefore separable into two divisions—

Ashgill Shales.

*Staurocephalus* Limestone (with Keisley Limestone).

Turning now to South Wales, we find the most satisfactory development of Ashgillian Beds, so far as Britain is concerned, in that area. These beds were classified and described by the late Mr. T. Roberts and myself in 1885 in a paper in the *Quarterly Journal of the Geological Society* (vol. xli, p. 476). We divided the beds as follows:—

Slade Calcareous Shales.

Redhill Shales.

Sholeshook Limestone.

We also showed that the Sholeshook Limestone was comparable with the *Staurocephalus* Limestone of Lakeland, the Rhiwlas Limestone of the Bala area, and other deposits elsewhere, and that the Redhill Beds were comparable with the Ashgill Shales. The Slade Beds presented lithological characters differing from those of other known areas possessing Ashgillian rocks, and there is still some uncertainty concerning their equivalents elsewhere, and accordingly we are yet uncertain as to the precise position of the line marking the top of the Ashgillian Beds of some districts. To this point I shall recur later.

In this paper sufficient fossil lists were given to show the marked difference between the fauna of the Caradoc Beds and that of the overlying Ordovician strata, and the latter were shown to be widely spread in the British Isles and to be represented by beds containing similar faunas on the Continent, although the equivalence of some of the Scandinavian beds with the beds of Ashgill had previously been asserted by one of the authors and likewise by Dr. S. L. Törnquist.

<sup>1</sup> *Q.J.G.S.*, vol. lii, p. 407, and vol. liii, p. 67.

The distinctness of the Caradocian and Ashgillian Series, over wide areas, as based upon lithological characters and faunas, was thus for the first time clearly brought out, and a fairly definite base and summit for the series which I here speak of as Ashgillian was determined. The Ashgillian Series was, in fact, here clearly described as a group worthy of separation from the Caradocian series beneath.

Our classification of these South Welsh deposits has subsequently been confirmed by the officers of the Geological Survey, and later by Mr. D. C. Evans in an admirable paper on the Ordovician of Western Caermarthenshire.<sup>1</sup>

Let us return for a moment to North Wales. The fossils of the Rhiwlas Limestone undoubtedly show its relationship to the Shoeshook and *Staurocephalus* Limestones, and prove its distinction from the Bala Limestone of Caradocian age. This distinction, as I stated in my Presidential Address in 1905, was clearly suspected by a member of the Geological Survey in 1847.

In that address I divided the Ashgillian Beds of North Wales as follows:—

Hirnant Limestone.  
Shales.  
Rhiwlas Limestone.

There is still much work to be done among these North Welsh rocks. In 1880<sup>2</sup> I referred a calcareous grit with *Echinospherites*, "by the roadside about a quarter of a mile south-west of Maeshir," to the "Upper Bala Beds." This is probably correct, but a further reference of the *Orthis alternata* beds of Cerrig-y-druidron to this series is almost certainly an error.

When the Ashgillian Beds of this region are eventually defined the definition will undoubtedly be facilitated in consequence of Mr. T. Ruddy's paper on the area.<sup>3</sup> It is quite clear that some of the rocks described by Mr. Ruddy belong to the Ashgillian division. Miss Wood (Mrs. Shakespear) and Miss Elles have obtained undoubted Ashgill Shales with *Phacops mucronatus* near Conway (Q.J.G.S., vol. lii, p. 273).

As in the case of South Wales, so here, we are in difficulty as to the precise position of the upper limit of the Ashgillian strata.

In 1882<sup>4</sup> Professor Lapworth described the Girvan succession in Ayrshire. At the top of the Ordovician system he places the Drummuck Mudstones, with the following subdivisions:—

Upper Mudstones, Ladyburn.  
Starfish Band, Quarrel Hill.  
Lower Mudstones, Drummuck.  
Basal Sandstones, Auld Thorns.

In our paper on Haverfordwest Mr. Roberts and I remarked that "the Starfish Bed of Professor Lapworth . . . may possibly be the representative of this [Shoeshook Limestone] in the Girvan area. It also contains *Staurocephalus globiceps*." There is very little

<sup>1</sup> Q.J.G.S., vol. lxii (1906), p. 597.

<sup>2</sup> Q.J.G.S., vol. xxxvi (1880), p. 277.

<sup>3</sup> Q.J.G.S., vol. xxxv (1879), p. 200.

<sup>4</sup> Q.J.G.S., vol. xxxviii (1882), p. 537.

doubt as to the correctness of this correlation, in which case the overlying Ladyburn Mudstones are the probable equivalents of the Ashgill Shales.

It must be borne in mind that as there is stratigraphical conformity between the Ordovician Hartfell Shales and Silurian Birkhill Shales of the Moffat area, the uppermost portion of the graptolite-bearing Hartfell Shales must also be referable to the Ashgillian Series.

In Ireland beds of Ashgillian age have been detected in various parts.

In 1896 Messrs. Gardiner & Reynolds<sup>1</sup> described the limestone of the Chair of Kildare, which with previous writers they refer to the Coniston Limestone, and in 1897 the same authors<sup>2</sup> describe, among other rocks, the Portraine Limestone, and state that it is comparable to the Chair of Kildare Limestone on the one hand and on the other to the Keisley and Shoeshook Limestones of Great Britain. Each of these deposits, therefore, belongs to the Ashgillian Series.

But the most interesting Irish development of Ashgillian age is found near Pomeroy. The fauna of these rocks has long been known, having been described in 1863 in Portlock's "Report on the Geology of . . . Londonderry . . . Tyrone, and Fermanagh."

In our paper on Haverfordwest Mr. Roberts and, I state that the group of fossils characteristic of the Shoeshook Limestone "appears to occur at Desertcreat[e], Tyrone," and we enumerate species common to the South Welsh and Irish areas, and state that fossils from the Irish locality seem to show that the representatives of the Redhill stage occur there also.

Recently this tract has been studied by a party of Cambridge geologists, and an outline of their results has been published in the GEOLOGICAL MAGAZINE by Mr. W. G. Fearnside.<sup>3</sup> The beds referred to the Ashgillian Series are there spoken of as the Desertcreate Group. It shows the Drummuck facies, and the point of particular interest is the discovery of graptolites of Upper Hartfell age associated with fossils characteristic of the non-graptolitic facies of Ashgillian deposits. The subdivisions of the Desertcreate Group will be found on p. 422 of Mr. Fearnside's notice, and need not be repeated here.

Abroad the representations of the Ashgillian Series are known only in Scandinavia and Russia. In 1879 S. L. Törnquist,<sup>4</sup> who had examined my specimens of Ashgill fossils and afterwards was taken over the Lake District section by my brother, correlated the Ashgill Shales with the 'Brachiopod-schists' of Sweden, and in 1882<sup>5</sup> I pointed out that they were comparable with the lower part only of these Brachiopod-schists. Later in our Haverfordwest paper Mr. Roberts and I showed that both *Staurocephalus* Limestone and Ashgill Shales were represented in Sweden.

The *Leptaena* Limestone of Dalarna has been referred to various horizons, but Schmidt's work in the Baltic provinces has shown that it is clearly equivalent to stage F of Russia, and it must therefore be

<sup>1</sup> Q.J.G.S., vol. lii, p. 587.

<sup>2</sup> Q.J.G.S., vol. liii, p. 520.

<sup>3</sup> GEOL. MAG., Dec. V, Vol. III, p. 421.

<sup>4</sup> Öfv. af k. Vetensk. Akad. Förhandl., p. 63.

<sup>5</sup> Q.J.G.S., vol. xxxviii, p. 313.

intermediate in age between the *Trinucleus* Shales and the *Lobiferus* Beds of Dalarne, the former being of Caradocian and the latter of Birkhillian age. The general correspondence of its fauna with that of the Ashgillian Beds of Britain indicates its general Ashgillian age, but there are certain differences which suggest that beds of other ages are also represented in the *Leptæna* Limestone.

## II. LITHOLOGICAL CHARACTERS.

There is a striking similarity in the lithological characters of some of the deposits of Ashgillian age over wide areas. Leaving out of account the Slade Beds of South Wales and certain deposits which in other areas are doubtfully Ashgillian, we find a widespread distribution of lower calcareous and upper argillaceous strata. The calcareous division in Cumberland, Wales, parts of Scandinavia, and probably elsewhere is marked by a greyish, somewhat argillaceous limestone with calcareous shales, each weathering olive-green. With these are purer white limestones, which often assume a markedly crystalline character, as at Kesley and the Chair of Kildare. The overlying argillaceous beds are often bluish-grey and not very markedly laminated sandstones. There is a very decided resemblance between these mudstones as found in the Lake District, North Wales (Conway), South Wales, and in parts of Sweden.

## III. FOSSILS.

The fauna of the Ashgillian Beds is very rich, but comparatively little is yet known of it. When the fossils have been collected as assiduously as those of the Chalk (for instance) we shall probably find a marked contrast between the fauna of the Ashgillian Series and those of the Caradocian below and Valentian (Llandovery-Tarannon) above.

In the present state of our knowledge a few notes on the dominant characters of the fossils may be of use to future students of these beds.

In Lakeland and South Wales the abundance and variety of Cystidea is very noteworthy. These fossils are specially found in the *Stauropcephalus* Limestone of the northern area and in the Shoeshook Limestone of the Principality. Cystidea of course have a long range, but some of those found in the Ashgillian Limestones are probably characteristic forms. They appear, however, to be local; for example, I am not aware of any record of these organisms in the Desertcreat Beds.

It has been noted above that *Strophomena* (?) *siluriana* is characteristic of the Ashgillian Beds of the North of England. It is still doubtful if this form and *Orthis hirnantensis* of the Hirnant Limestone are specifically distinct. At present we are only able to use the so-called *Strophomena* locally.

The Slade Beds of Haverfordwest are often crowded with *Phyllopora Hisingeri*. The occurrence of this form in the upper part of the Ashgill Beds of Backside Beck, near Sedbergh, is of significance. The latter beds are worthy of more careful examination.<sup>1</sup>

<sup>1</sup> See Marr & Nicholson on "The Stockdale Shales": Q.J.G.S., vol. xlv, p. 700.

The trilobites have up to the present received most attention. By means of these Crustaceans we can most readily separate the Ashgillian Beds from those of Caradocian and Valentian ages.

The occurrence of *Staurocephalus* in the lower part of the Ashgillian Series and of *Dalmanites mucronatus* in the upper part (and also in the lower) has frequently been noted. A few remarks upon each of these forms will be useful.

The term *Staurocephalus* Beds was first applied to rocks belonging to the Ashgillian age in Sweden and subsequently in Britain. The Swedish form is *Staurocephalus clavifrons*, Ang. *Staurocephalus globiceps*, Portl., is probably identical with the Swedish form. Lastly, Salter (Mon. Pal. Tril., pl. vii) figures a form from Rhiwlas as *Staurocephalus Murchisoni*, Barr. It may be noted that Barrande's type form is from beds of Ludlow age. It is doubtful whether even the British Wenlock forms which are referred to this species are correctly assigned, and there are grave doubts as to the identity of the Bohemian and Rhiwlas forms. The Ashgillian *Staurocephali* require careful study, and the three forms above noted will probably prove to be identical or closely allied, and separable from the Wenlock and Ludlow fossils.

The genus, if found in Caradoc rocks, is extremely rare therein. It is also far from common in rocks of Valentian age, and its wide distribution in the Ashgillian Beds is distinctly noteworthy.

*Dalmanites mucronatus*, Ang., is particularly abundant in beds of Ashgillian age, and is very useful when separating them from the Caradocian deposits, in which, so far as I am aware, it has not been found. On the other hand, it passes up into the Valentian rocks, both in Britain and in Scandinavia, and forms one of the few connecting links of the Ordovician and Silurian faunas.

This form requires study. Angelin describes two species, namely, *Dalmanites mucronatus*, which in Sweden is a Valentian form, and *D. eucentra*, which occurs in the equivalents of the Ashgill Shales. Salter also separated the North of England form from the type *mucronatus* as var. *appendiculatus*. Later writers have referred all to *mucronatus*, and if the Ashgillian and Valentian forms be distinct they are certainly closely allied.

While speaking of the *Phacops*, we may note that the group *Chasmops*, so abundant in rocks of Caradocian age, appears to be absent from the Ashgillian Beds, and that the group *Phacops* proper, which is found abundantly in the overlying Valentian rocks, has also never been recorded from beds of Ashgillian age.

Turning now to the genus *Trinuclaus*, we find that this form, so abundant in all Ordovician rocks, is well represented in the highest Ashgillian Series. The sudden disappearance of this form at the top of the Ashgillian Beds is one of the most important means of separating these from the Lower Valentian (Llandovery) Beds. It is true that *Trinuclaus* has been more than once recorded in beds of Llandovery age, but even if these records be correct the genus is extremely rare in them. Let us for a moment notice these records.

In Cat. Camb. and Sil. Foss., p. 78, Salter records *T. concentricus* from the Lower Llandovery of Pen-y-craig. I find the actual



specimen now placed among the Caradocian fossils in the Sedgwick Museum, on whose authority I cannot say, but Professor Hughes, who knows the district well, assures me that at the time of this determination considerable confusion existed as to the age of the various beds there.

There are various references to the occurrence of *Trinucleus* in both Lower and Upper Llandovery rocks in the Mem. Geol. Survey, vol. iii (3rd edition, 1881), but the information given is of the vaguest, and I cannot help suspecting mistakes.

In 1877 Professor Harkness & Nicholson gave in the Quarterly Journal of the Geological Society a list of trilobites from the Stockdale Shales. In this was included *Trinucleus fimbriatus*, a determination which Professor Nicholson subsequently admitted to be founded on error, and accordingly the species was not recorded in the later paper on those shales by Professor Nicholson and myself.

On the Continent one example of *Trinucleus Wahlenbergi* is recorded in Kjerulf's "Veiviser" from stage 5 (of Llandovery age). It occurred in a nodule, and may possibly be derivative.

In any case the extreme rarity of the genus in the Valentian rocks is in marked contrast to its abundance in even the highest (Slade) stage of the Ashgillian Beds, though it must not be supposed that *Trinucleus* is common or even represented in all Ashgillian strata; it is, for example, distinctly rare in those of most localities in the North of England.

Of trilobite species which, so far as I know, are confined to Ashgillian rocks, I may mention *Encrinurus sex-costatus*, *Cheirurus octolobatus*, *Cyphoniscus socialis*, *Remopleurides longicostatus*, and *Ampyx tumidus*. There are many others which have hitherto been found in one or two localities only.

Several forms which occur rarely in Caradoc rocks are more abundant in the Ashgillian strata, as *Acaste Brongniarti*, *Agnostus tumidus*, and *Phillipsinella parabola*.

The graptolites found at Desertcreat will enable us to compare those rocks with their graptolite equivalents in the Moffat area. As, however, the work is being done by Mr. Fearnside and his colleagues, we must await the publication of their full results.

The following lists of fossils will be useful to students of the Ashgillian rocks at home and abroad:—

Mem. Geol. Survey, Catalogue of Lower Palæozoic Fossils in the Museum of Practical Geology (1878). In this list the specimens recorded as from "Rhiwlas" are, I believe, in all cases from the *Staurocephalus* Limestone. The various papers alluded to above mostly have fossil lists. In the paper by myself on "The Coniston Limestone," the Keisley species, as above stated, belong to the Ashgillian, and not, as there recorded, to the Caradocian. A full list of the Keisley fauna is given in Mr. Reed's papers on the Keisley Limestone. The South Welsh forms are recorded in the paper by Mr. Roberts and myself, and in that by Mr. Evans. Irish forms of Ashgillian age are noticed in Messrs. Gardiner & Reynolds' papers, and in the brief notice of the Pomeroy Beds by Mr. Fearnside. A few Scotch forms are mentioned in Prof. Lapworth's Girvan paper.

In Scandinavia we find records of fossils from the Brachiopod-schists in Linnarsson's account of the Cambrian and Silurian Beds of Westrogothia (K. Svensk. Vetensk.-Akad. Förhandl., Bd. viii, No. 2; in this paper some of the forms are apparently from the Upper Brachiopod schists, of Llandovery age); and also in Tullberg's papers on the Scanian graptolites (Svensk. Geol. Undersökn, series C, No. 50, p. 17), in the zones of *Stuurocephalus clavifrons* and *Phacops mucronata*. Records of fossils of the *Leptæna* Limestone will be found in various papers by Törnquist, especially in a paper on the Palæozoic rocks of the Siljan district (Öfvers. af k. Vetensk.-Akad. Förhandl., 1874); and another on the trilobite fauna of the Siljan district (Sver. Geol. Undersökn, 1884); also in Angelin's "Palæontologia Scandinavica" and in Lindström's "Fragmenta Silurica."

A list of Russian fossils from Stage F will be found in the first part of Schmidt's "Revision der Ostbaltischen Silurischen Trilobiten" (Mem. l'Acad. Imp. des Sciences de St. Pétersbourg, 1881).

The above list is no doubt far from complete, but the student may obtain from a perusal of these papers a good idea of the varied character of the Ashgillian fauna.

#### IV. THE BASE AND SUMMIT OF THE ASHGILLIAN SERIES.

(1) *Base.* In South Wales, where the Ashgillian succession is so well shown, the line of demarcation between the Robeston Wathen Limestone of Caradocian age and the Ashgillian Sholeshook Limestone is usually easily determinable. Although each is a limestone, they are fairly readily separable by lithological characters, and the change in fauna is very marked. Similarly, in the Lake District the change from the Caradocian Sleddale Limestone and the Ashgillian *Stuurocephalus* Limestone is usually well marked, though it is possible that in the fossil lists some forms referred to the Caradocian division really belong to that of the Ashgillian. In the Cross Fell Inlier the difference between the equivalent of the Sleddale Group (Dufton Shales) and the Ashgillian Limestones is most obvious. The exact base of the Ashgillian group at Girvan yet remains to be fixed, and, as before stated, much remains to be done in North Wales.

(2) *Summit.* The line of demarcation between the Ashgillian and Valentian is usually less readily determinable than that at the base of the former series. The difficulty was admitted by Salter when he bracketed the Lower Llandovery and Upper Bala Groups (Cat. Camb. and Sil. Foss.).

There are two causes of difficulty; one the frequent similarity between the Ashgillian and Llandovery rocks, and the other the difference of opinion as to what line should be taken as marking the top of the Ashgillian. With regard to the former, the Ashgillian and Llandovery Beds of the Haverfordwest region have a striking similarity, though separated by a conglomerate, and in Scandinavia the line of demarcation must be drawn in the middle of the Brachiopod-schists.

I believe that the fossils will usually furnish a ready means of distinction. The practical disappearance of *Trinuclæus* at the top of the Ashgillian has already been noted, and, so far as I know, the genera *Nidulites*, *Phacops* (proper), and *Stricklandinia* are not found below the Lower Llandovery.

The difference of opinion as to what line should be taken as separating the Ordovician from the Silurian requires fuller consideration. Professor Lapworth in the Moffat district places the lowest zone of the Birkhill Shales, that of *Diplograptus* (*Cephalograptus*) *acuminatus*, in the Silurian, while Tullberg assigns the corresponding zone in Scania to the Ordovician, because it, like the Scotch zone, has no *Monograpti*. Lithologically and palæontologically, however, it seems to be more closely related to the overlying beds than to those beneath it, and I would follow Lapworth in assigning it to the Silurian.

In North Wales the question is not so easy. The Hirnant Limestone is not a richly fossiliferous deposit, its most frequent fossil being *Orthis hirnantensis*. Salter, as we have seen, referred it to the Upper Bala, while Professor Hughes has maintained that two deposits have been referred to this division, the lower of which is Ashgillian and the upper Llandoverly. The question remains to be settled.

It may be remarked that the Llandoverly Beds of Wales and the Welsh borders still require much work. Professor Hughes has separated the fossils of the Upper and Lower Llandoverly Beds of the typical area, and his collections are preserved in the Sedgwick Museum, but his observations require extension in surrounding areas.

My objects in this paper have been to show that the Ashgillian Beds form a group sufficiently important to be separated as a series from the beds of the Caradocian Series below; to prove that the term Upper Bala applied by Salter was too vaguely defined to stand (even were the term not objectionable on other grounds), and that therefore another term is required, that of Ashgillian being adopted because the term "Ashgill Beds" used by Salter for his Upper Bala Beds in the Lake District was applied to a definite group well defined by him; lastly, to indicate to future workers the lines on which to proceed in giving us what we greatly require, a monograph upon the stratigraphy and palæontology of this important series.

TABLE OF THE ASHGILLIAN STRATA OF THE BRITISH ISLES.

SOUTH WALES.	NORTH WALES.	N. OF ENGLAND.	GIRVAN.	IRELAND.
Slade Beds.	Hirnant Limestone ?	<i>Phyllopora</i> -Beds of Backside Beck, Sedbergh ?	?	?
Redhill Beds.	<i>Mucronatus</i> -Beds of Conway. = Shales near Maeshir ?	Ashgill Shales.	Ladyburn Shales.	Tirnaskea Beds.
Sholeshook Limestone.	Rhiwlas Limestone.	<i>Sturocephalus</i> -Limestone (with Keisley Limestone).	Starfish Bed.	Killey Bridge and Bardahessiag Beds. = Chair of Kildare Limestone. = Portrairie Limestone.