

13. *On the SUCCESSION of the ANCIENT ROCKS in the vicinity of St. DAVID'S, PEMBROKESHIRE, with special reference to those of the ARENIG and LLANDEILO GROUPS, and their FOSSIL CONTENTS.* By HENRY HICKS, Esq., F.G.S. (Read December 2, 1874.)

[PLATES VIII.-XI.]

INTRODUCTION.

IN my last paper, communicated to the Geological Society in December 1872, the order of the succession of the strata in the vicinity of St. David's was carefully tabulated to the top of the Tremadoc group; and it was there shown that the succession was a perfectly continuous one from the base of the Cambrian series to the top of the Tremadoc group, and that the only break or unconformity recognized was at the base of the Cambrian, where it rested on the pre-Cambrian ridge. In the accompanying map and sections (Pl. VIII.) the following order of the rocks is shown. Directly under the city of St. David's, or, rather, under its eastern portion, are some massive beds of quartzy conglomerates, very compact in structure, but alternating with dark-green shales, with a strike from N.W. to S.E. These have a thickness as we follow them directly eastward from this spot of about 4000 feet; and they run, with a varying thickness not exceeding this, for about five miles in a N.E. direction from St. David's, but are then cut off by a fault. They also extend in a line to the S.W., reaching the coast of St. Bride's Bay, on the east side of Porth-lisky Harbour, but are considerably reduced in thickness at this part by a fault running in a N.E. direction. The ridge formed by these rocks underlies the whole of the remaining strata of the district, being the axis on which the Cambrian and other rocks are supported. This ridge is marked in the Geological-Survey maps as a mass of intrusive syenite; and in some places, especially near the centre, it may be said, from its very compact nature, to assume almost that character; but when the mass is more carefully examined, it is evident that the whole is composed of bedded rock, partly metamorphosed.

The difference in the thickness of the ridge in our map in places from that shown on the Survey maps is accounted for by our having excluded some strata along the edge which belong to the overlying Cambrian series, and which rest unconformably on the ridge. The bedding of the strata composing the ridge may be distinctly seen in the hill to the N.E. of the Cathedral, also on the west side of the valley beyond the mill between St. David's and Porth-clais, and on the east side of Porth-lisky Harbour. The beds forming the Harlech or Longmynd group, consisting of green shales, conglomerates, and purple, red, and green sandstones and slates, are seen on both sides of the ridge; they rest unconformably on the edges of the beds of the axis; and there are indications that they once

extended over it, but that they have been subsequently denuded off. On the west side, as may be seen in Section I. (Pl. VIII. fig. 2), they form two distinct folds, which terminate on the west coast in a section comprising more than 4000 feet of strata in natural order of succession. Over 3000 feet of the beds in this section have yielded fossils; and good specimens of *Lingulella primæva* are found in the red beds near the conglomerates, at Castell in Ramsey Sound. Many, indeed most, of the beds between Ramsey Sound and St. David's are considerably altered; but there are no intrusive masses amongst them of any importance; the great mass on the east of Ramsey Sound, coloured as greenstone in the Survey maps, is nothing more than bedded Cambrian rock altered. On the east side of the axis the same order of succession occurs as on the west, but the beds are less altered. In the line of the section (fig. 2) it will be seen that they do not repeat themselves as on the west side; but further eastward they again fold over several times. About 700 feet of the beds in this part of the section have been removed by a fault along the line of the bedding; otherwise it is similar to the one in Ramsey Sound. The chief places for fossils on the east side are the red beds faulted against the ridge at Porth-clais, and the same beds on the coast near Nun's Chapel and at Caerfai, also the grey flags in the second point west of Porth-clais, where *Plutonia Sedgwickii*, *Conocoryphe Lyellii*, *Paradoxides Harknessi*, and other fossils occur.

The beds of the Menevian group, the next in order of succession, are best seen on the coast east and west of Porth-y-rhaw. A little to the west side of that creek they may be seen resting conformably on the red beds of the Longmynd group, also at Pen-pleidiau, and in Solva Harbour. In Whitesand Bay, on the west coast, they are also found resting conformably on beds of the underlying group.

The thickness of the Menevian group is about 600 feet; and nearly all the beds are richly fossiliferous wherever found. Lithologically the Menevian group differs considerably from the Longmynd group; but palæontologically the connexion between them is so strong that it is impossible to separate them by any stronger line of division than as subgroups in a great subdivision. It was on this account that as far back as the year 1867* I proposed that the Menevian and Longmynd groups should be combined together as Lower Cambrian, and that the divisional line should be above instead of below the Menevian, as it had up to that time been placed.

The next group in order of succession, the Lingulæ-flag group, is seen resting conformably on the upper beds of the Menevian group, a little to the east of Porth-y-rhaw, and again at Solva Harbour, and near Caerfegga; also on the west coast in Whitesand Bay. The group consists of alternating beds of sandstones and shales, with occasional thick bands of black slates, and it is about 2000 feet thick. It is considerably thinner than in North Wales; and very few fossils have yet been found in it near St. David's. At White-

* Table of strata, exhibited in the Arts and Science Department of the National Eisteddfodd at Carmarthen, 1867, and Brit. Assoc. Report, 1868.

sand Bay, however, and at Ramsey Island, the characteristic *Lingulella Davisii* is to be found in great abundance. At St. David's the series is made up of very even deposits from the beginning to the close, and no sudden change takes place anywhere in the character of the sediment. In North Wales, before the close of the epoch, there is evidence that a depression of the sea-bottom rather suddenly took place; and with this depression a fine silt was thrown down, in which a fauna unknown to South Wales occurs. These are the deposits now known as the *Olenus*-shales, which are found in North Wales and in the neighbourhood of Malvern. For the same reasons we find that the Tremadoc group, which immediately succeeds the *Lingula*-flags, is also rather different lithologically in North and South Wales. The depression in the St.-David's area continued to go on very gradually even in the Tremadoc epoch; hence the character of the deposit is on the whole that of shallower water than that in North Wales, and the fauna varies accordingly, as may be noticed in the unusual prevalence and size of the *Lamelli-branchiata* and the *Brachiopoda* found in these beds at St. David's. Some parts of the series, however, are very similar in character, and indicate the presence of like conditions in both districts, especially in the earlier stages of the formation.

The beds of the Tremadoc group can be seen on the east side of the anticlinal, resting conformably on the *Lingula*-flags about Tremahire, and beyond Caerfegga; but as there are only a few exposures of the strata in that neighbourhood, in consequence of the ground being covered over by drift, the further succession will have to be illustrated chiefly by reference to the sections on the north side of the axis. In the north end of Ramsey Island, or rather at the north-east point (fig. 3), the Tremadoc group is seen in an excellent coast-section with the lower beds resting quite conformably on the *Lingula*-flags, and the change from the one group to the other is very gradual. The group consists for the most part of dark earthy flags and flaggy sandstones, with some iron-stained slates at the top, and it is rather less than 1000 feet in thickness. The beds here are exceedingly rich in fossils, and they have yielded many important new forms. At Trwyn-hwrddyn, in Whitesand Bay, the lower beds of the group are also seen resting conformably on the *Lingula*-flags (fig. 4), but the upper portion is cut off by an east and west fault. A little further inland from this spot, however, the fault has crossed the series, and the group is again seen in its proper thickness*. Near Lanveran the beds are well exposed, and the characteristic fossils are found in them. From here they take a more easterly strike; and they may be followed for several miles in that direction.

The next succeeding groups are the Arenig and Llandeilo; and these I shall have to refer to more in detail, as they have not

* The fault of which this is a branch, as will be seen by reference to the Map and Section IV. (Pl. VIII. figs. 1 & 5), has somewhat interfered with the succession along the north edge of the anticlinal by cutting off the whole of the Menevian group and part of the *Lingula*-flags.

hitherto been described in my papers to the Society, and some of the facts have been but recently made out*.

ARENIG AND LLANDEILO GROUPS.

History of the Names.—In a paper read by Professor Sedgwick before the Geological Society on the 25th Feb., 1852, he describes the "Arenig slates and porphyries" as forming a distinct and well-marked subgroup in his previously named "Ffestiniog group," and as resting conformably on the underlying group, to which he had given the name of "Tremadoc slates." This is the first description of the series under the above heading that I have been able to find; but in papers read by him before the Society on Nov. 29th, 1843, and on Dec. 16th, 1846, the series is frequently referred to, and described as "a great group of roofing-slate, and contemporaneous porphyry," the former passing into grits, flags, &c., and comprised in his Snowdonian group. The series is also stated to occur in the chains of Arenig, Aran Mowddwy, and Cader Idris, and in the Ffestiniog mountains; and sections are given in which its position is clearly marked. In his 'Synopsis of the Classification of the British Palæozoic Rocks,' published in 1852-55, he adopts the same arrangement as in his paper in 1852. Since that time but little has been done to elucidate the position of the group in North Wales, and the name has almost been allowed to lapse. Mr. Salter's researches in portions of the series, however, have been of very great importance, and will be fully referred to when these parts are described.

The Llandeilo group was named by Sir R. Murchison about the year 1834, and was intended by him to indicate a series of calcareous flagstones, schists, and sandstones exposed in the neighbourhood of Llandeilo in Carmarthenshire, and about Builth in Breconshire. The exact position of the group in the succession, however, was a doubtful point for many years afterwards, and it was not made at all clear until the districts were examined by the Geological Survey in 1842, and then chiefly through the labours of Prof. Ramsay. The description given of it at this time (1842), as developed at Llandeilo and Builth, was a series of schists, flags, and limestones, with interstratified trap at the base, the whole underlying conformably the Caradoc or Bala group. As here defined, it does not include properly any beds of the age of the great series previously discovered by Prof. Sedgwick in North Wales, and afterwards described by him in the above-mentioned papers as "Arenig slates and

* Memoirs published on the rocks of St. David's in addition to those mentioned in the Quart. Journ. Geol. Soc. Nov. 1871:—

Hicks, Trans. Liverpool Geol. Soc. 1869.

Harkness and Hicks, Quart. Journ. Geol. Soc. Nov. 1871.

Hicks, Geol. Mag. Dec. 1869; Quart. Journ. Geol. Soc. May 1872; Trans. Brit. Assoc. 1872.

Hopkinson, Trans. Brit. Assoc. 1872.

Hicks, Proc. Geologists' Assoc. vol. iii. 1873; Quart. Journ. Geol. Soc. Feb. 1873; Trans. Brit. Assoc. 1873.

porphyries;" nor could it have been intended at the time that it should comprise more than was really to be found in the typical district. Unfortunately, however, from a mistaken idea of the relative age of the two series, the name Llandeilo was gradually made to include the whole of Prof. Sedgwick's group; and therefore a meaning was given to the name far greater than could have been at first intended, or than it had the slightest claim to—as may be seen by referring to 'Siluria,' 2nd edition, 1859, and to Prof. Ramsay's 'Memoir on North Wales,' 1866, where it is mentioned that "since 1848 the Geological Survey have been in the habit of considering the slates close below and above the Arans and Arenigs &c. of North Wales as equivalent to the Llandeilo flags of Builth and Shelve." The group, as it occurs in the typical Llandeilo district, is sufficiently important to occupy a good position in the classification; and more should not be asked for it. The relative position of the two groups is that of two distinct but conformable series, intervening between the Tremadoc group on the one hand and the Bala group on the other; and the proportion of the series at St. David's now given to each group is that which, on comparison with the sections in the typical districts, each seems to have a real claim to. If, therefore, the arrangement should appear to differ in some of its details from that previously adopted in describing these rocks, I must ask for it the recognition due to more recent observations, to a careful comparison with sections in most other Welsh areas, and to a desire to adopt the lines only for the subdivisions which nature seems to indicate by combined palæontological and lithological evidence.

ARENIG GROUP.

The rocks in the neighbourhood of St. David's, which I propose to group together under Prof. Sedgwick's name, "Arenig," consist for the most part of black slates. They lie conformably on the Tremadoc group along the north side of the anticlinal, and they may be traced in an unbroken course for from six to seven miles, the strike of the beds varying only as they curve with the general axis. They also occur at Ramsey Island, faulted against beds of the Harlech group, having been brought down along with some beds of the Tremadoc group and Lingula-flags. The chief fault which caused this change in their position is the one indicated by the line of Ramsey Sound; but it was doubtless assisted by the others now visible in the island. The rocks indicate the prevalence of a deep sea when they were deposited, and show that the depression of the sea-bottom, which had been gradually taking place during the deposition of previous groups, had now become much more decided. The depression also seems to have culminated early in the Arenig period, and then to have continued much in that state during the remainder of the epoch. The group contains altogether near 4000 feet of these deep-sea deposits; and, considering the very slow rate at which such deposits must have

been accumulated, it is evident that it must span over an enormous period, and, in consequence, that it must contain within it evidences of the presence of many separate and distinct faunas. I propose therefore, for convenience of reference, and for the purpose of comparison with the series in other districts in which the succession may not be so clear, to divide the group, by means chiefly of the fossil zones, into three subgroups, under the names Lower, Middle, and Upper Arenig.

The *Lower Arenig* series is made up of very fine black slates and shales, with a thickness of about 1000 feet, and with the beds generally at a very high angle. In the north end of Ramsey Island, as shown in Section II. (fig. 3), they are seen resting conformably on the Tremadoc group, with a nearly vertical dip, and with a strike from N.N.E. to S.S.W. ; but the upper portion of the series is cut off by a fault which brings them against Lingula-flags dipping in the opposite direction. In the middle portion of the island they occur in greater thickness ; but the succession there is considerably interfered with by faults, and the order of the beds can only be made out by the fossil evidence.

In Section III. (fig. 4), which is taken along the north coast of Whitesand Bay, the chief portion of the series may be seen faulted against the lower beds of the Tremadoc group, the intervening beds having been cut off by an east and west fault. A little inland, however, from this spot the fault has crossed the series, and also the underlying groups ; and the succession is then seen in perfectly natural order.

In this section the strike of the beds is E.N.E. and W.S.W., with a vertical dip ; and this strike is maintained for about three miles, or until we reach the position of Section IV. (fig. 5), when the strike varies to a more nearly east and west course. A line taken along the south side of the greenstone masses called Carn-lwyd, Pen-berry, and Waun-y-beddau will indicate the line of junction of the Arenig group with the Tremadoc group along that strike ; and the upper edge of the felspathic trap to the south of Cwm-wdig, the junction further east. The fossils of this subgroup have been chiefly collected in the cliffs at Whitesand Bay, and near to the fault at Roaduchaf in Ramsey Island. The species discovered before the year 1866 were mentioned in the Report by Mr. Salter and myself to the British Association in that year, in which the beds were first described under the name of the Arenig group, and their relation to the other groups at Whitesand Bay and Ramsey Island first pointed out.

In the summer of 1872, however, a most valuable addition was made to the fauna by the discovery at Ramsey Island, through the joint labours of Mr. Homfray of Portmadoc, Mr. Lightbody of Ludlow, Mr. J. Hopkinson, Mr. Kirshaw of Warwick, and myself, of about twenty-two species of Graptolites, which Mr. Hopkinson pronounced to be for the most part new to this country, several of them being entirely new species. Since then many of these species have been found by Mr. Hopkinson and myself in the cliffs of the

first creek to the north of Trwyn-hwrddyn in Whitesand Bay; and several new forms have again been added by us to the list, which now includes in all about forty-eight species of Graptolites.

The other fossils found in this series comprise *Asaphus Homfrayi*, *Ogygia scutatrix*, *Trinucleus Sedgwickii*, *Conularia Homfrayi*, *Theca* sp., *Lingula petalon*, and *Orthis remota*. This subgroup is strongly characterized by its rich fauna of dendroid Graptolites, the deep-sea conditions prevalent at the time being doubtless favourable to their growth and development, as there is no evidence of their existence in any previous faunas in the succession here.

The *Middle Arenig* is made up of a series of slates and flags, with narrow bands of sandstones intercalated; and it has a thickness of about 1500 feet. The beds rest conformably on the Lower Arenig; and they can only be distinguished from the latter by having on the whole a more flaggy appearance. They are best exposed at Whitesand Bay, and may be said to begin at the point which separates the creek north of Trwyn-hwrddyn from that in which the slate-quarry occurs. They also extend into the creek called Porth Melgan, directly south of St. David's Head; and they reach across that promontory to the north coast. In the bay on the north coast, the extremity of which is marked Porth-y-dwfr, they are lost for some distance; and we do not meet them again in their proper thickness until we reach the coast west of Section III., beyond a place called Porth-y-rhaw, and where the Upper Arenig beds appear on the coast. Along their course several masses of a rough-grained greenstone may be traced running nearly in the line of bedding. A few fossils were discovered in this series as far back as the year 1860, by Mr. Gibbs of the Geological Survey; and the well-known *Trinucleus Gibbsii* was first discovered by him in these beds at Whitesand Bay. Since then, however, I have been able to make a very considerable addition to the fauna; and though most of these fossils have already been described by the late Mr. Salter, there are yet several new species to be added. The most characteristic fossils in this series, and the most plentiful, are the Trilobites *Ogygia bullina*, *Ogygia peltata*, *Trinucleus Gibbsii*, *Æglina grandis*, and *Ampyx Salteri*. There are also a few Graptolites; but most of these occur in the lower beds only, the middle and upper beds indicating apparently conditions more favourable to Trilobites &c.

The rocks composing the *Upper Arenig* resemble more those of the Lower Arenig than the Middle, being like them very fine-grained dark slates or shales. They have a thickness of nearly 1500 feet, and are well exposed along the north coast, resting on the Middle Arenig, and underlying the Lower Llandeilo.

In beds of this series, at Llanrian, Prof. Hughes of Cambridge, several years ago, found a species of *Illænus*, which I propose now to call *Illænus Hughesii*; the same species, along with a few other fossils, were discovered by me also in a quarry under Llanvirn, near Aber-eiddy, in 1865.

The beds of this series, however, were not thoroughly examined

until last summer; nor were the fossils previously discovered sufficiently important to mark it as a distinct subgroup. Last August I was fortunate enough to find, again in the Llanvirn quarry, which is near the centre of the series, a most interesting and important group of fossils, distinct from any previously discovered in any part of the Arenig group at St. David's. Most of the species are new; and amongst the Trilobites is one genus (*Placoparia*) previously unknown in Britain, and found only in France, Spain, and Bohemia. The fauna is, on the whole, very rich in Trilobites; and several genera appear here for the first time in the succession, as *Illænus*, *Illænoopsis*, *Barrandea*, *Phacops*, and *Placoparia*; but along with them also we find the genera *Calymene*, *Trinucleus*, and *Æglina*, which had already appeared in the earlier series. The fauna also contains many species of Graptolites, chiefly of the genera *Diplograptus* and *Didymograptus*; and there are also unusually large Cephalopods, Gasteropods, Brachiopods, and Lamellibranchs. The list, which is a very complete one for so early a series, will be found in the Table accompanying this paper; and I have added descriptions of all the new forms, except the Graptolites, which will be described by Messrs. Hopkinson and Lapworth in their paper. The fauna is very like that found in the Angers slate in France, and in M. Barrande's Etage D. 1, in Bohemia, the almost total absence of which in England hitherto has been frequently noticed; and it now enables us readily to recognize the position of those beds in relation to the general succession in this country.

At the south end of Ramsey Island some beds of the Upper Arenig are seen in the form of black shales, between masses of felspathic quartz-porphry, and faulted against beds of the Harlech group. In these shales at Porth-hayog, in the summer of 1873, Prof. Ramsay, Mr. Etheridge, Mr. Homfray, and myself found several species of Graptolites, also *Calymene parvifrons*, a new *Trinucleus*, and some Brachiopods. These fossils indicate a position for the beds intermediate between the Llanvirn quarry and the Lower Llandeilo.

In the foregoing description of the series which collectively form the Arenig group, I have shown that the sequence of the rocks at St. David's is very perfect, and that there is no evidence of any great physical change from the beginning to the close of the epoch. The lower and upper portions of the series are very homogeneous sediments; but the middle is rather more varied in character, and yet not sufficiently so to indicate any great or sudden change at the time it was deposited. There are three distinct faunas in the group; and only a few species pass from the one to the other. They are closely allied, however, by their general facies; and the group is undoubtedly, both palæontologically and lithologically, one of the most characteristic and important in the early deposits. The succession observed at St. David's is more perfect, and the thickness of the series greater than is found in any other British area; but the group occurs, with nearly the same general succession, also in Carnarvonshire and Shropshire.

In my paper on the Tremadoc rocks of St. David's, read Dec. 1872, I expressed the opinion, on palæontological grounds, that the Lower Arenig beds at St. David's were represented in North Wales by the Upper Tremadoc rocks. The examination of several sections in Carnarvonshire during last summer, under the guidance of Prof. Ramsay and Mr. Homfray, further confirmed my opinion; and I now feel convinced that the Upper Tremadoc beds should be classed with the Arenig group.

The Lower and Upper Tremadoc rocks are quite distinct, and very unlike palæontologically—the fauna of the former, like that of the Tremadoc group at St. David's, being closely allied to that in the Lingula-flags, and that in the latter to the Arenig group. In the Arenig district proper the lower black beds of Prof. Sedgwick's Arenig group are undoubtedly, in regard to their position and their fossils, identical with the Upper Tremadoc as exhibited further west; but there is a slight lithological difference observable, and this probably has prevented their being correlated hitherto.

The sections at Portmadoc, in the Ffestiniog mountains, and to the west of the Arenig mountains, show in each case the following order of the strata:—1. Black shales (Lingula-flags), with *Olenus* &c. 2. Iron-stained slates and flags (Lower Tremadoc), with *Niobe*, *Psiloccephalus*, *Neseuretus*, *Conocoryphe*, &c. 3. Dark slates (Garth beds), with *Asaphus Homfrayi*, *Ogygia scutatrix*, *Angelina*, *Conularia*, &c., and, in the Arenig district, some dendroid Graptolites. 4. A thick grit-bed with no fossils. 5. Dark fine-grained slates (Ty-Obry beds), with *Æglina*, *Asaphus*, *Calymene*, *Trinucleus*, *Dionide*, *Dendrograptus*, &c. 6. Ash and tuff beds, interstratified with blue-black fine slate. It is easy at once to recognize, in the order given here, a likeness to the series at St. David's; indeed, the only difference observed is the occurrence of a thick bed of grit in North Wales, at the part where the Middle Arenig comes in at St. David's. This grit-bed is preceded and succeeded by fine deep-sea deposits; and the change in the character of the sediment is particularly rapid, showing that the sandstone was probably deposited in a deep sea by tidal action, and not a shore-accumulation. There is, as already mentioned, a slight difference also in the character of the sediment in the Middle Arenig at St. David's from that in the Lower and Upper series, and narrow bands of sandstone are intercalated with the slates; but the St.-David's area seems on the whole to have been almost out of the influence of the physical cause, whether tidal or otherwise, which produced this sudden change in the North-Wales series; and hence we have deposits at this period at St. David's with a fauna unknown there. The other St.-David's faunas resemble, in many particulars, those found in the series in North Wales. In Shropshire the order of the beds is almost similar to that observed in North Wales, and the Stiper Stones are doubtless, as first suggested by Mr. Salter, the equivalents of the grit beds in Carnarvonshire. Hitherto the black beds under the Stiper Stones have proved almost barren of organic remains, and they cannot be correlated with other series except by position; but in the beds immediately upon the

Stiper Stones the fauna is exceedingly like that in the Upper Arenig group at St. David's, and contains, like it, the genera *Illenus* and *Illenopsis*, in addition to most of the genera found in the beds at Ty-Obry, in Carnarvonshire.

List of Fossils from the Arenig Group, St. David's.

LOWER ARENIG.

<i>Name.</i>	<i>Localities.</i>
Asaphus Homfrayi, <i>Salt.</i>	Creek north of Trwyn-hwrddyn, Whitesand Bay.
Ogygia scutatrix, <i>Salt.</i>	Ditto.
Trinucleus, sp.	Ditto and Road-uchaf, Ramsey Island.
Lingulella Davisii, <i>M' Coy</i>	Ditto, ditto.
Lingula petalon, <i>Hicks</i>	Ditto, ditto.
Orthis lenticularis, <i>Dalm.</i>	Ditto.
Obolella plicata, <i>Hicks</i>	Ditto and Ramsey Island.
Conularia Homfrayi, <i>Salt.</i>	Ditto, ditto.
Didymograptus extensus, <i>Hall</i>	Road-uchaf, Ramsey Island.
— pennatulus, <i>Hall</i>	Ditto.
— sparsus, <i>Hopk.</i>	Ditto.
Phyllograptus stella, <i>Hopk.</i>	Ditto.
Trigonograptus ensiformis, <i>Hall</i>	Ditto.
— truncatus, <i>Lapw.</i>	Ditto.
Ptilograptus cristula, <i>Hopk.</i>	Ditto.
— Hicksii, <i>Hopk.</i>	Ditto.
Didymograptus arbuscula, <i>Salt. MS.</i>	Creek north of Trwyn-hwrddyn, Whitesand Bay.
— divergens, <i>Hall</i>	Road-uchaf, Ramsey Island.
— flexuosus, <i>Hall.</i>	Ditto and Whitesand Bay.
— persculptus, <i>Hopk.</i>	Creek north of Trwyn-hwrddyn, Whitesand Bay.
— diffusus, <i>Hall</i>	Road-uchaf, Ramsey Island.
Callograptus radiatus, <i>Hopk.</i>	Creek north of Trwyn-hwrddyn and Road-uchaf.
— radicans, <i>Hopk.</i>	Ditto, ditto.
Dictyonema cancellata, <i>Hopk.</i>	Ditto.
— Homfrayi, <i>Hopk.</i>	Ditto.

MIDDLE ARENIG.

Agnostus hirundo, <i>Salt.</i>	Slate-quarry, north side of Whitesand Bay, and south side of Porth Melgan.
Ampyx Salteri, <i>Hicks</i>	Ditto.
Æglina grandis, <i>Salt.</i>	Ditto.
— Boia, <i>Hicks</i>	Ditto.
Calymene, sp.	Ditto.
Cheirurus, sp.	Ditto.
Ogygia peltata, <i>Salt.</i>	Ditto.
— bullina, <i>Salt.</i>	Ditto.
Trinucleus Gibbsii, <i>Salt.</i>	Ditto.
— Sedgwickii, <i>Salt.</i>	Ditto.
Lingula petalon, <i>Hicks</i>	Ditto.
Orthis, sp.	Ditto.
Siphonotreta, sp.	Ditto.
Theca Harknessi, <i>Hicks</i>	Ditto.
Orthoceras sericeum, <i>Salt.</i>	Ditto.
Bellerophon multistriatus, <i>Salt.</i>	Ditto.
Didymograptus patulus, <i>Hull.</i>	Ditto.

MIDDLE ARENIG (*continued*).

<i>Name.</i>	<i>Localities.</i>
Tetragraptus crucialis, <i>Salt.</i>	Chiefly in the beds under the slate-quarry, Whitesand Bay.
— Halli, <i>Hopk.</i>	Ditto.
— Hicksii, <i>Hopk.</i>	Ditto.
— serra, <i>Brong.</i>	Ditto.
Clemagraptus implicatus, <i>Hopk.</i>	Ditto.
Dendrograptus arbuscula, <i>Salt. MS.</i> ...	Ditto.
— flexuosus?, <i>Hall</i>	Ditto.
Callograptus elegans, <i>Hall</i>	Ditto.
— Salteri, <i>Hall.</i>	Ditto.
Dictyonema irregularis?, <i>Hall</i>	Ditto.

UPPER ARENIG.

<i>Æglina obtusicaudata</i> , <i>Hicks</i>	Llanvirn slate-quarry, near Aber-eiddy.
<i>Barrandea Homfrayi</i> , <i>Hicks</i>	Ditto.
<i>Calymene Hopkinsoni</i> , <i>Hicks</i>	Ditto.
— parvifrons, <i>Salt.</i> , var. <i>Murchisoni</i> , <i>Salt.</i>	Porth-hayog, Ramsey Island.
<i>Illænus Hughesii</i> , <i>Hicks</i>	Llanvirn quarry.
<i>Illænopsis?</i> <i>acuticaudata</i> , <i>Hicks</i>	Ditto.
<i>Placoparia cambriensis</i> , <i>Hicks</i>	Ditto.
<i>Phacops llanvirnensis</i> , <i>Hicks</i>	Ditto.
<i>Trinucleus Etheridgei</i> , <i>Hicks</i>	Porth-hayog, Ramsey Island.
— <i>Ramsayi</i> , <i>Hicks</i>	Llanvirn slate-quarry.
<i>Beyrichia</i> , sp.	Ditto.
<i>Dinobolus?</i> <i>Hicksii</i> , <i>Davidson</i>	Ditto.
<i>Lingula attenuata</i> , <i>Sow.</i>	Porth-hayog, Ramsey Island.
<i>Discina</i> , sp.	Llanvirn slate-quarry.
<i>Orthis</i> , sp.	Ditto.
<i>Ophileta</i> , sp.	Ditto.
<i>Pleurotomaria llanvirnensis</i> , <i>Hicks</i> ..	Ditto.
<i>Bellerophon llanvirnensis</i> , <i>Hicks</i>	Ditto.
<i>Theca caereesiensis</i> , <i>Hicks</i>	Ditto.
<i>Conularia llanrianensis</i> , <i>Hicks</i>	Ditto.
<i>Orthoceras caereesiense</i> , <i>Hicks</i>	Ditto.
<i>Buthotrepis</i> , sp.	Ditto.
<i>Didymograptus nanus</i> , <i>Lapw.</i>	Porth-hayog, Ramsey Island.
— <i>affinis</i> , <i>Nicholson</i>	Llanvirn quarry and Porth-hayog, Ramsey Island.
— <i>bifidus</i> , <i>Hall.</i>	Ditto, ditto.
— <i>indentus</i> , <i>Hall</i>	Ditto, ditto.
— <i>patulus</i> , <i>Hall</i>	Ditto, ditto.
<i>Nemagraptus capillaris</i> , <i>Emmons</i>	Llanvirn quarry.
<i>Dicellograptus moffatensis?</i> <i>Carr.</i>	Ditto.
<i>Climacograptus confertus</i> , <i>Lapw.</i>	Porth-hayog.
<i>Diplograptus dentatus</i> , <i>Brongniart</i> ...	Ditto and Llanvirn quarry.
<i>Glossograptus ciliatus</i> , <i>Emmons.</i>	Llanvirn quarry.

LLANDEILO GROUP.

The Llandeilo group, as it occurs in the neighbourhood of St. David's and throughout Pembrokeshire, may be divided into three subgroups on lithological and palæontological grounds. The *Lower Llandeilo* consists of black slates interstratified with volcanic tuff, and rests conformably on the Upper Arenig on the south coast of Aber-eiddy Bay; and the thick tuff-bed extending along that coast shows the line of junction of the two groups. In Section V. (fig. 6) the

beds are nearly vertical, and the thickness of the series is about 500 feet. Two of the tuff-beds attain to a considerable thickness, while others are merely narrow lines. The thickest one, which occurs directly at the base of the series, is in part a conglomerate; but its upper portion has been pulverized and rearranged by the action of water, and made to assume a flaggy appearance. The fossil *Didymograptus Murchisoni* was discovered in the beds of this series at Aber-eady as far back as the year 1841, by Prof. Ramsay; and the locality has ever since been known as a favourite spot for this graptolite and for *Diplograptus foliaceus*, which occur here most plentifully and in a well-preserved state. It is only during our researches of late years, however, that any thing like a fauna has been discovered in the series; and amongst the forms recently added to it are species of *Dendrograptus* and *Ptilograptus*, also the Trilobites *Ogygia*, *Calymene*, *Trinucleus*, and *Æglina*, and the Brachiopods *Lingula* and *Siphonotreta*. The fauna is now a tolerably complete one, and it is distinct from that in the underlying and overlying series.

Middle Llandeilo.—The beds of this series, as shown in Section V. (fig. 6), rest conformably on the last, and consist of black calcareous shales and flags, and at the upper part of tolerably compact limestone. The beds occur at a high angle, with a N.W. dip. The thickness of the series, as shown on the coast, is about 800 feet; but there is every indication of a fault in the line of the Aber-eady valley, along the sides of which the beds occur, and that a portion of the thickness has been therefore cut off. The calcareous nature of the beds enables one easily to recognize them from the series below and above, and it also gives them a good lithological distinctness in the section. Besides this section at Aber-eady, they occur also in several other well-known places in Pembrokeshire, as in Musclewick Bay, on the south of St. Bride's Bay; and in the neighbourhood of Lampeter Velfrey and Llandewi Velfrey, in east Pembrokeshire, where they underlie Caradoc or Bala beds; and they are everywhere characterized by the well-known Trilobites *Asaphus tyrannus*, *Trinucleus Lloydii*, *Trinucleus favus*, *Calymene cambrensis*, &c. The series is therefore palæontologically and lithologically well marked and easily recognized wherever exposed.

The *Upper Llandeilo* rocks occur as black argillaceous slates, flags, and flaggy sandstones; and they rest conformably on the Upper Limestone beds of the Middle Llandeilo on the north coast of Aber-eady Bay, as seen in Section V. (fig. 6). The beds also lie at a high angle; and the dip is about N.N.W. The slate-quarries in Aber-eady Bay are near the base of the series; and the sudden change from the calcareous rock to the true argillaceous slate is very marked at this spot. When the beds of this series were deposited the conditions must have been more like those which prevailed during the Lower-Llandeilo period than in that immediately preceding; and there is evidence also in the presence of interbedded traps of a return of volcanic activity. It is difficult to know the exact thickness of the series in this section; for after attaining a thickness of over 1000 feet in natural succes-

sion, the beds are repeated, and afterwards lost on the north coast. Lithologically this subgroup differs considerably from that immediately underlying it, and also palæontologically sufficiently to warrant its being considered a distinct series. In 1841 the species *Lingula Ramsayi*, *Bellerophon perturbatus*, and *Calymene duplicata* were found in these slate-quarries by Prof. Ramsay and Mr. M'Lauchlan; but many additional species have since been discovered in the series. The fossils are very much distorted by cleavage; and it is difficult in consequence to obtain good specimens; the most characteristic species in this subgroup are *Ogygia Buchii*, *Calymene duplicata*, *Cheirurus Sedgwickii*, *Trinucleus fimbriatus*, *Ampyx nudus*, *Barandea Cordai*, &c.

The Llandeilo group, wherever exposed in South Wales, shows almost exactly the same order of the strata as in this section at Aber-iddy. In the so-called typical districts of Llandeilo and Builth there are no rocks of older date than the tuff beds of the Lower Llandeilo; nor have the characteristic fossils even of this series been found there; but the lithological evidence indicates the presence of the series in each place, and the fossils may doubtless be found there if carefully searched for. The calcareous or Middle Llandeilo beds are well seen in many parts of Carmarthenshire and Breconshire; and it was to this series that the name Llandeilo was first applied. The Upper Llandeilo occurs also in Carmarthenshire and near Builth, in Breconshire; and most of the fossils characteristic of the beds in Pembrokeshire have been found there. In Shropshire the whole Llandeilo group occurs in succession to the Upper Arenig, and the usual fossils are found in each of the series. In North Wales the Lower Llandeilo is found in the Arenig Mountains, in the Ffestiniog Mountains, and in the Arans, resting conformably on the Arenig group; but the evidence of the occurrence of the Middle and Upper Llandeilo series in these districts is still incomplete. The fossils, however, which have been found in beds on the east side of the Arenigs, and on the east of the Berwyn Hills, show that they are not entirely absent; and further examination will most likely prove the presence of a succession there very like that which has now been made out in South Wales.

List of Fossils from the Llandeilo Group, Pembrokeshire.

LOWER LLANDEILO.

<i>Name.</i>	<i>Localities.</i>
<i>Trinucleus Ramsayi</i> , <i>Hicks</i>	Cliffs south side of Aber-iddy Bay.
<i>Calymene Murchisoni</i> ?, <i>Salt</i>	Ditto.
<i>Ogygia</i> , sp.	Ditto.
<i>Æglina</i> , sp.	Ditto.
<i>Lingula attenuata</i> , <i>Sow</i>	Ditto.
<i>Siphonotreta</i> , sp.	Ditto.
<i>Bellerophon perturbatus</i> , <i>Sow</i>	Ditto.
<i>Theca caereesiensis</i> , <i>Hicks</i>	Ditto.
<i>Didymograptus Murchisoni</i> , <i>Beck</i>	Ditto.
—, var. <i>geminus</i>	Ditto.
—, var. <i>furcillatus</i>	Ditto.

LOWER LLANDEILO (*continued*).

<i>Name.</i>	<i>Localities.</i>
Diplograptus foliaceus, <i>Murch.</i>	Cliffs south side of Aber-iddy Bay.
— tricornis, <i>Carr.</i>	Ditto.
Ptilograptus acutus, <i>Hopk.</i>	Ditto.
Dendrograptus serpens, <i>Hopk.</i>	Ditto.
— Ramsayi, <i>Hopk.</i>	Ditto.
Dictyonema, sp.	Ditto.
Nemagraptus, sp.	Ditto.
Climacograptus cælatus, <i>Lapw.</i>	Ditto.

MIDDLE LLANDEILO.

Asaphus tyrannus, <i>Murch.</i>	Aber-iddy Bay (east side), Musclewick Bay, Llandewi Velfrey, and Lampeter Velfrey.
— peltastes, <i>Salt.</i>	Ditto.
Calymene cambrensis, <i>Salt.</i>	Ditto.
Lichas patriarchus, <i>Edgell</i>	Ditto.
Ogygia convexa, <i>Salt.</i>	Ditto.
Trinucleus Lloydii, <i>Murch.</i>	Ditto.
— favus, <i>Salt.</i>	Ditto.
— fimbriatus?, <i>Murch.</i>	Ditto.
Lingula attenuata, <i>Sow.</i>	Llandewi Velfrey.
— granulata, <i>Phil.</i>	Ditto.
Orthis striatula, <i>Conrad</i>	Ditto.
Leptæna sericea, <i>Sow.</i>	Ditto.
Halysites catenulatus, <i>Linn.</i>	Ditto.
Stenopora fibrosa, <i>Goldf.</i>	Aber-iddy Bay.
Bellerophon perturbatus, <i>Sow.</i>	Ditto.
Didymograptus, sp.	Ditto.
Diplograptus, sp.	Ditto.
Nemagraptus, sp.	Ditto.
Dicellograptus moffatensis, <i>Carr.</i>	Ditto.

UPPER LLANDEILO.

Agnostus M'Coyi, <i>Salt.</i>	Aber-iddy Bay (north side), slate-quarry.
Ampyx nudus, <i>Murch.</i>	Ditto.
Acidaspis, sp.	Ditto.
Æglina, sp.	Ditto.
Barrandea Cordai, <i>M'Coy</i>	Ditto.
— longifrons, <i>Edgell</i>	Ditto.
Calymene duplicata, <i>Murch.</i>	Ditto.
Cheirurus Sedgwickii, <i>M'Coy</i>	Ditto.
Ogygia Buchii, <i>Brongniart</i>	Ditto.
—, sp.	Ditto.
Trinucleus fimbriatus, <i>Murch.</i>	Ditto.
—, sp.	Ditto.
Lingula Ramsayi, <i>Salt.</i>	Ditto.
Bellerophon perturbatus, <i>Sow.</i>	Ditto.
Theca, sp.	Ditto.
Orthoceras, sp.	Ditto.
Didymograptus Murchisoni?, <i>Beck</i> ...	Ditto.
Diplograptus pristis?, <i>His.</i>	Ditto.

GENERAL CONCLUSIONS.

In the preceding remarks I have endeavoured, in addition to giving a minute description of the Arenig and Llandeilo groups, and their relation to the groups immediately above and below, to show that the sequence of the rocks of which these form a part, in the promontory of St. David's is a perfectly continuous one from the base of the Longmynd or Harlech group to the Llandeilo group, and that in this section there are no lines of division stronger than what would naturally occur in a great series deposited over a sea-bottom becoming gradually depressed, and subject to the ordinary physical influences which must have prevailed during such a change.

The palæontological record made out in these ancient rocks is shown to be more complete than has hitherto been found to be the case in any other single section; and consequently it has enabled us to recognize the proper position of groups hitherto but imperfectly defined, and to correct the limits which had been incorrectly given.

In instituting comparisons between the succession as here made out with that found in other districts, the evidence has in each case been most carefully considered, and no facts have been accepted which have not been critically examined. Some may object, however, to a comparison of sections in districts even so far apart as North and South Wales, on the ground that the deposits might possibly have been formed under somewhat different conditions; but these objections, if raised, must give way when it is considered that the Welsh area comprised only a very small proportion of the oceanic area which prevailed when these series were deposited, as indicated by the occurrence in Sweden, Belgium, France, Bohemia, and Spain on the one hand, and in North America on the other, of rocks with the same order of succession in the organic remains, and the same general sequence of beds, subject only to what might be called local differences, as of thickness &c.

There are evidences also present within small areas, such as the presence of contemporaneous lavas and ashes and of calcareous beds at certain stages in the strata, which enable us frequently, even without the palæontological evidence, to recognize readily the position of certain beds. The series may, however, on the other hand vary considerably in thickness even within a small area; and sometimes the character of the deposits may change abruptly, as in the case of the great Grit-bed in North Wales, and the Stiper Stones of Shropshire, which were evidently portions of a sandbank extending over those areas in a deep sea in which elsewhere, even within narrow limits, fine muddy deposits were being thrown down. But, taking the series collectively, these local differences are not of much importance; and they do not usually interfere with the order of the general succession so as to prevent its being easily followed out.

In the section at St. David's the strongest palæontological breaks occur at the close of the Menevian group and at the close of the Tremadoc group; and it is there I consider the chief lines for the division of the series should be placed. The Menevian group and

the underlying Cambrian rocks therefore form the lowest subdivision or Lower Cambrian. For the next subdivision or Upper Cambrian I have hitherto followed Sir Charles Lyell and Mr. Salter by making it comprise the overlying series to the top of the Tremadoc group; but with the qualification now that a considerable portion of what has been called by them Tremadoc should be placed in the Arenig group. The palaeontological break at this spot is tolerably strong; but, with the evidence before us of unbroken succession, it must be confessed that it is scarcely important enough to mark the dividing line between the two great systems known by the terms Cambrian and Silurian; and yet if it is not placed here, there certainly is no other break below the top of the Bala or Caradoc group which can possibly be looked upon as sufficiently important for that purpose.

*Descriptions of New Species of Fossils from the Arenig Group
of St. David's.*

AMPYX SALTERI, Hicks. Pl. X. figs. 7, 8.

A. Salteri, Hicks, Cambridge Catalogue.

This species I found several years ago in the flaggy beds to the north of the slate-quarry in Whitesand Bay; and I named it after my late lamented friend, Mr. Salter, in the Cambridge Catalogue. It occurs rather plentifully, and it is a very distinct and well-marked species. It is also one of the earliest species of the genus known, being found almost at the base of the Middle Arenig.

Description.—Nearly 2 inches long without the rostrum, and about $1\frac{2}{10}$ inch wide at the broadest part. Head equal to about one third of the whole length, triangular in shape, and moderately raised; the glabella occupies about one third of the width, is very wide anteriorly, and tapers backwards from about the junction of the anterior fourth, its sides are indented by oblique and longitudinal furrows, which mark off a pair of distinct lateral lobes; rostrum rather more than equal to the whole length of the head.

The body has a rather narrow axis of six rings. The tail is triangular in shape and strongly margined; the axis is slightly raised, has three or four rings, and reaches to the hinder border; the lateral lobes are flattened, and marked with three or four ribs.

The wide margin to the tail, and the very broad glabella distinguish this at once from any other British species.

Locality and Formation. Slate quarry at Whitesand Bay, St. David's: Middle Arenig. In collections of D. Homfray, Esq., and H. Hicks.

TRINUCLEUS ETHERIDGEI, n. sp. Pl. IX. fig. 6.

This well-marked species I obtained last summer from the slate-quarry near Llanvirn, and I have much pleasure in naming it after my friend Mr. Etheridge. The cleavage and bedding very nearly coincide in these slates; and therefore the specimens occur in a tolerably well-preserved state.

Description.—Length nearly an inch and a quarter, width rather less than the length. In shape ovoid, with the head-spines reaching directly backwards to a little beyond the tail. The head occupies about half the length, and, excluding the spines, is semicircular in shape. The fringe-border is nearly equally wide throughout, and has three or four rows of puncta. The glabella, which reaches the inner edge of the fringe, but scarcely indents it, is strongly convex and wide anteriorly, and tapers towards the neck-furrow; the sides are indented by two pairs of furrows, converging in the centre. The cheeks are moderately raised and like the glabella, and have the whole surface finely reticulate. The body has six rings, with a strongly raised tapering axis occupying about a fourth of the width. The tail is sharply triangular, and has a very broad margin, which is equally deep with the lobes at its widest part. Axis of five or six rings, and lateral lobes deeply ribbed.

This can scarcely be confounded with any other British species; the fimbriated border, like that of *T. Murchisoni*, has interposed a few short rays, which may tend to mislead one if the other characters are not looked into. It is, however, a much larger and wider form than *T. Murchisoni*, the tail has a stronger and wider margin, and the lobes are more distinctly ribbed.

Locality and Formation. Llanvirn quarry: Upper Arenig.

TRINUCLEUS RAMSAYI, n. sp. Pl. X. figs. 1, 2.

This species was found in the black shale at Porth-hayog, in Ramsey Island, in the summer of 1872; and specimens of it have since then been found in the black slates between the Ash beds in Aber-eiddy Bay. I have much pleasure in naming it after Prof. Ramsay, in whose company it was found, and to whom we owe so much for his very valuable researches amongst these ancient rocks in North Wales.

Description.—Head semicircular, $\frac{3}{8}$ of an inch long by $\frac{5}{8}$ of an inch broad; fringe-border equally wide throughout, except where indented by a convex ridge in front of the glabella; it has five or six rows of closely set puncta, and the extreme outer margin has on it a row of moderately strong spines. Glabella occupying about one fourth of the width of the head, strongly convex and pyriform in shape, and indented by two pairs of strong furrows behind. Cheeks moderately convex, and the whole surface covered over with minute puncta. The axis of the thorax is narrow and convex. The tail has not been found.

This is a very well-marked species, and differs from *T. Lloydii*, to which it is most nearly allied, in having a more evenly rounded glabella with lateral furrows, the surface of the cheeks covered over with minute puncta, the outer margin of the head covered with minute spines, and the angles scarcely at all expanded.

Locality and Formation. Porth-hayog in Ramsey Island, and Aber-eiddy Bay: Upper Arenig and Lower Llandeilo groups.

ILLÆNUS HUGHESII, n. sp. Pl. IX. fig. 7.

The first specimen of this species was discovered some years ago by Prof. T. M^cK. Hughes, at Llanrian, near Aber-eiddy; and this specimen, along with another in my possession from the Llanvirn quarry, was figured by the late Mr. Salter in his memoir (Palæontographical Soc. vol. xx.) as *Illænus perovalis*. Now, however, that further and more perfect specimens have been found, there can be no doubt that the species has been incorrectly determined. They indicate a species allied to, but yet quite distinct from, the *Illænus perovalis* of Murchison; I have therefore named the species after its discoverer. Mr. Salter's description unfortunately pertains rather to this species than to *Illænus perovalis*, from his having been misled by the specimens from near Aber-eiddy: and he has also placed its position in the series too high; for as yet it has only been found in the *Upper Arenig group*; and it has not been found associated, as there stated, with *Didymograptus Murchisoni*.

Description.—A very broad oval species, from $2\frac{1}{2}$ to 3 inches long and about 2 inches broad. Head semicircular, moderately convex, and occupying rather more than a third of the whole length; the glabella is divided from the cheeks at the lower part by tolerably deep axial furrows as far as the base of the little oval glands. The eyes are separated from the glabella by a space equal to about two thirds of the width of the latter; they are of moderate size, and are situated rather near to the neck-margin. Axis of the thorax strongly raised, and separated from the lateral lobes by deep axial furrows; pleuræ longer than the axis, sharply pointed, and with the fulcrum about midway. Tail semicircular, with the front edge slightly arched; axis narrow and conical, and reaching about half the length; side-lobes moderately convex, and bounded on the outside by a wide margin.

This species is a much broader form than *I. perovalis*, has a more distinct glabella, and the eye is larger and placed nearer the neck-furrow. The position given to the eye in Mr. Salter's figures is not correct for this species, though apparently so for *I. perovalis*.

Locality and Formation. Llanvirn Quarry: Upper Arenig.

ILLÆNOPSIS? ACUTICAUDATA, n. sp. Pl. IX. fig. 5.

The genus *Illænopis* was instituted by Mr. Salter for a form supposed to be intermediate between *Illænus* and *Asaphus*, and which had then been found only in the Arenig rocks of Shelve. The generic characters given by him are:—"Eyes remote, forward; glabella-furrows reaching the front; head not gibbous, only convex; pleuræ grooved." Our species approaches nearer to this genus than to any other; and I place it under it at present, though with some doubt. Ours also occurs in the Arenig rocks and at very nearly the same horizon as Mr. Salter's species.

Description.—Ovate in shape, about $1\frac{1}{8}$ inch long and $\frac{7}{10}$ of an inch wide. Head semicircular, very convex, and nearly equal to

one half the whole length; posterior margin arched backwards. Glabella very wide anteriorly, but narrowing rather abruptly towards the neck, axial furrows moderately strong and extending obliquely to the outer margin. Eyes large and placed at a distance equal to their length from the outer margin. Free cheek triangular in shape, and not produced posteriorly; neck-furrow deep. Thorax composed of ten rings; axis well raised, tapering gradually towards the tail, and about equally wide with the lateral lobes; pleuræ faceted and deeply grooved to the tips, which are rather abruptly pointed. The tail acutely triangular; axis strong and composed of several rings; lateral lobes raised, with a strong outer margin, which is widest opposite the axis.

The only other species known is *Ilænopsis Thomsoni*; and from this our species differs in the following points: the glabella is wider, the eye much larger, and the occipital furrow reaches the outer margin much lower down; the pleuræ are more blunt, and the tail shorter and more triangular in shape.

Locality and Formation. Llanvirn Quarry: Upper Arenig.

ÆGLINA BOIA, Hicks, Cambridge Catalogue, 1872. Pl. X. figs. 9, 9a.

This little species was discovered by me in the year 1865, in the Middle Arenig rocks at Whitesand Bay. The only specimen found is in the Cambridge Museum. It is a small smooth species, with no grooves or markings visible on the head and tail, and it seems distinct from any species hitherto published.

Locality and Formation. Whitesand Bay: Middle Arenig.

ÆGLINA OBTUSICAUDA, n. sp. Pl. X. fig. 3.

The specimens of this species hitherto found are imperfect, but they are sufficient to show that it is a new species.

Description.—About 2 inches long. The head is imperfect, but it appears to occupy about half of the whole length. Thorax of six rings; axis very wide anteriorly, and tapering backwards rather suddenly, moderately raised. Anterior pleuræ very short, hinder ones increasing gradually, so that the last is about twice the length of the anterior one; they are grooved deeply and are obliquely truncate at their extremities. Tail about a fourth of the whole length, wider than long; posterior border bent slightly forward and incurved; axis conical and extending to the posterior incurved margin.

The wide short tail, with bent margin, distinguishes this from any other British species.

Locality and Formation. Llanvirn Quarry: Upper Arenig.

BARRANDEA HOMFRAYI, n. sp. Pl. IX. fig. 8.

Hitherto the genus *Barrandea* in this country has only been found in Upper Llandeilo rocks; but in Bohemia M. Barrande has found a species in his Etage D. 1, which is probably equal in age to

our Upper Arenig. The present species was found in the Llanvirn quarry, and is therefore also of Upper Arenig age. I have named it after my friend Mr. Homfray, to whose researches in these older rocks we are greatly indebted.

Description.—Nearly 2 inches long, and $1\frac{1}{4}$ inch wide. The head is incomplete; but the glabella is seen to be wide, not furrowed, and separated from the cheeks by very faint axial furrows. The axis of the thorax is very wide anteriorly, and tapers sharply towards the tail. The anterior pleuræ are only equal in length to about two thirds of the opposite rings of the axis; but the hindermost ones are half as long again as the width of the axis at that part. The pleuræ are flat and grooved for about one third of their length, the fulcrum being very near the axis; they are also sharply pointed, and their whole surface is ornamented with fine lines. The tail is twice as wide as it is long, and the front arched; the axis is short and conical, prominent at the tip, and with one furrow; the lateral lobes moderately raised, with the whole surface ornamented by tolerably strong lines.

This is a very well-marked species, and it differs in several particulars from the other species hitherto known. The axis is wider at the upper part, and it tapers more regularly than in *B. Cordai*, the species which approaches nearest to it; the glabella also is much wider than it is in that species.

Locality and Formation. Llanvirn Quarry: Upper Arenig.

PLACOPARIA CAMBRIENSIS, n. sp. Pl. IX. figs. 1, 2.

This interesting species is the first of the genus found in this country, and was obtained by me from the Llanvirn quarry in August last. It resembles in some respects the *Placoparia Zippei*, Corda, found in France, Spain, and Bohemia, but is yet distinct, and it is also a smaller form. It is an important link in connecting the British with the Continental Silurian faunas; and it occurs also at about the same horizon in each country.

Description.—Ovate in shape, $1\frac{1}{8}$ inch long and about $\frac{5}{8}$ of an inch wide. Head semicircular and rather more than a fourth of the whole length; glabella very broad in front, occupying more than one third of the width of the head, and reaching the inner edge of the anterior margin, convex, minutely punctate and marked with three strong lateral furrows, besides the neck-furrow, the lowest being directed obliquely backwards until it nearly reaches the neck-furrow. The axial furrows are deep; the cheeks triangular, convex and rather deeply punctate. Eyes small, situated close to the glabella, and near the anterior margin; the posterior facial suture cuts across the margin at the outer angle, which is rounded. Thorax composed of twelve rings, and strongly trilobed; axis rather less than a third of the width, and tapering gradually towards the tail from about the sixth segment; pleuræ convex, with the fulcral point situated near the middle, extremities pointed and directed outwards. The axis of the tail consists of four or five strongly convex rings, and tapers

suddenly to a rather sharp point, the lobes marked with four raised ribs, with their points extending beyond the margin.

The small size, the position of the fulcral point of the pleuræ, and the deeply pitted cheeks distinguish this species from *P. Zippei*, to which otherwise it is most nearly allied.

Locality and Formation. Llanvirn Quarry (near Aber-ciddy): Upper Arenig.

PHACOPS LLANVIRNENSIS, n. sp. Pl. IX. figs. 3, 4.

This species and *Phacops Nicholsoni*, Salter, from the Upper Skiddaw slates of Cumberland, are the earliest species of the genus known in this country. This species was found in the Llanvirn quarry, and therefore in beds of equivalent age to the Upper Skiddaw slates.

Description.—Oval in shape, rather more than 2 inches long by $1\frac{1}{8}$ inch wide. Head one third of the whole length, semicircular, with the angles rounded. Glabella expanded in front and equal to one half the whole width of the head, but narrowing rapidly towards the neck until it is reduced to less than half the width. The neck-furrow is deep; and the basal furrows indent the sides to about a third of the distance across; the remaining furrows, of which apparently there are three on each side, are rather indistinctly marked. The cheeks are triangular, with a strong posterior marginal furrow; surface gently raised and smooth. The eyes small, situated near the anterior margin and close to the glabella. Thorax of eleven moderately convex rings; axis narrower than the pleuræ, widest at about the fourth or fifth segment; pleuræ deeply grooved to three fourths of their length. Tail semicircular, arched in front, moderately convex and with a tolerably distinct margin; axis conical, reaching nearly to the posterior margin and marked with eight or nine rings; the lateral lobes show four or five distinct ribs. This species differs in many points from any other British species, and can easily be distinguished by its wide and only slightly inflated glabella, and its small eyes situated far forward.

Locality and Formation. Llanvirn Quarry: Upper Arenig.

CALYMENE HOPKINSONI, n. sp. Pl. X. figs. 4, 5.

A small species, and one of the earliest of the genus known. Found by me in the Llanvirn quarry some years ago. I have named it after my friend Mr. Hopkinson.

Description.— $1\frac{1}{4}$ inch long and about $\frac{3}{4}$ of an inch wide.

Glabella in length and width about equal, sides nearly straight, with three well-marked lateral furrows directed obliquely forward; apex flattened.

The axis of the thorax convex, less than a third of the whole width, and tapering regularly towards the tail.

Pleuræ flat and deeply grooved to about two thirds of their length.

The tail strongly margined, axis of eight or nine rings, and lobes marked with five or six ribs.

The glabella of nearly equal width throughout, and with the furrows directed forward, are distinguishing characters in this species, and enable it to be easily recognized from *Calymene parvifrons* and *Calymene Murchisoni*, the other species common to rocks of this age.

Locality and Formation. Llanvirn Quarry: Upper Arenig.

DINOBOLOUS ? HICKSII, Davidson. Pl. X. fig. 6.

Mr. Davidson, F.R.S., to whom I submitted specimens of this species for examination, believes it to be more nearly allied to *Dinobolus* than to any other known genus; and he has therefore named it as above.

Description.— $1\frac{3}{4}$ inch wide by about $1\frac{1}{8}$ inch long. Central portion moderately convex, thin and flattened out at the sides and towards the anterior margin; flattened also towards the umbo, which is but very slightly produced. Surface marked with tolerably well-defined lines of growth.

This species, according to Mr. Davidson, approaches nearest in shape to *Dinobolus transversus*, Salter; but as it is from much earlier rocks than that species, it is probably distinct. It also gives the genus a much lower range than has hitherto been ascribed to it, and is interesting therefore as being the earliest known species. It is unfortunate that the material is not perfect enough for giving a proper diagnosis; but it is to be hoped, now that the beds in which it was found are under examination, that better specimens will soon be found.

Locality and Formation. Llanvirn Quarry: Upper Arenig.

OPHILETA, sp. Pl. XI. fig. 3.

This is much like the specimen figured by Mr. Salter in Mem. Geolog. Survey, 1866, pl. 11 v. fig. 21; but it is too imperfect to describe or to give it a specific name. Mr. Salter's species was found in the White-Grit Mine, Shelve, and hence in beds probably of the same age as the Llanvirn beds, in which I found this specimen.

Locality and Formation. Llanvirn Quarry: Upper Arenig.

PLEUROTOMARIA LLANVIRNENSIS, n. sp. Pl. XI. fig. 4.

Description.—Shell moderately convex, of five or six whorls, diameter about $\frac{6}{10}$ of an inch. Surface of the whorls smooth, nearly flat, and forming a gentle slope from the tolerably acute apex to the margin. On the outer edges of the whorls there is a narrow slightly raised band. This is the earliest species of the genus known in this country.

Locality and Formation. Llanvirn Quarry: Upper Arenig.

BELLEROPHON LLANVIRNENSIS, n. sp. Pl. XI. figs. 1, 2.

Description.—Spire of three very rapidly increasing whorls. Outer whorl greatly expanded, but compressed. Lines of growth strongly marked, arched backwards, and approximating to each other more closely in the expanded outer portion. Diameter $1\frac{1}{3}$ inch.

This well-marked species can scarcely be confounded with any other British species. Its very wide outer whorl, strong arched striæ, and compressed state are strongly characteristic and enable it to be recognized at once.

Locality and Formation. Llanvirn Quarry: Upper Arenig.

THECA CAEREESIENSIS, n. sp. Pl. XI. fig. 7.

Description.—About $1\frac{3}{4}$ inch long by $\frac{3}{10}$ of an inch wide, apex rounded. Surface covered with fine longitudinal lines. Lines of growth very indistinct. A tolerably deep furrow down the centre.

The presence of numerous fine longitudinal lines on the surface is perhaps the most characteristic feature in this species.

Locality and Formation. Llanvirn Quarry: Upper Arenig.

THECA HARKNESSI, Hicks, Cambridge Catalogue. Pl. X. fig. 11.

This is a rather small species; and the most marked character is the presence of very strong cross striæ towards the apex in addition to longitudinal ones.

Locality and Formation. Whitesand Bay: Middle Arenig.

CONULARIA LLANVIRNENSIS, n. sp. Pl. XI. figs. 5, 6.

Description.—From 6 to 7 inches long, and about $1\frac{1}{4}$ wide at the larger end, conical, with tolerably straight sides and apex pointed. One strong ridge down the centre of each surface. Lines of growth rather indistinct.

The single ridge down the centre distinguishes this species from *Conularia corium* and *C. Homfrayi*, the only species likely to be confounded with it. The former occurs in rocks of the same age in North Wales, and the latter in the earlier groups in North and South Wales.

Locality and Formation. Llanvirn Quarry: Upper Arenig.

ORTHO CERAS CAEREESIENSE, n. sp. Pl. XI. figs. 8-10.

Description.—Probably at least 6 inches long and about 1 inch wide at the broadest part. Striæ arched gently backwards, fine and closely placed. Shell very thin. This species approaches nearest to *O. Avelinii*, which occurs in rocks of the same age at Shelve, Shropshire; it differs from that species chiefly in being a wider form, and in having the lines of growth much closer.

Locality and Formation. Llanvirn Quarry: Upper Arenig.

Table showing the Range of Genera from the "Longmynd Group" to the "Bala Group" in Wales.

Genera.	Longmynd Group.	Menevian Group.	Lower Lingula-flags.	Middle Lingula-flags.	Upper Lingula-flags.	Tremadoc Group.	Lower Arenig.	Middle Arenig.	Upper Arenig.	Lower Llandello.	Middle Llandello.	Upper Llandello.	Bala Group.
<i>Rhizopoda.</i>													
Protospongia	*	*	*	*
Ischadites	*
<i>Hydrozoa.</i>													
Dictyonema	?	*	*	*	..	*	*
Callograptus	*	*	..	*
Dendrograptus	*	*	..	*
Ptilograptus	*	*	..	*
Trigonograptus	*	*	..	*
Phyllograptus	*	*	..	*
Didymograptus	*	*	*	*	*
Tetragraptus	*	*	*	*
Clemagraptus	*	*	*	*
Nemagraptus	*	*	*	*	..
Dicellograptus	*	*	*	*	..
Climacograptus	*	*	*	*	..
Diplograptus	*	*	*	*	..
Glossograptus	*	*	*	*	..
<i>Actinozoa.</i>													
Favosites	*
Monticulipora	*
Stenopora	*
<i>Echinodermata.</i>													
Protocystites	*
Dendrocrinus	*	*
Palasterina	*	*
<i>Annelida.</i>													
Arenicolites	*	*	*	*	*	*	*	*
Scolites	*	*	..	*	*
Histioderma (Ireland) ..	*
Helmintholites	*
Haughtonia (Ireland) ..	*
Chondrites	*	..
Cruziana	*
Nereites
Palæochorda	*
Soolecoderma	*
Serpulites	*
Myrianites	*	..	*

Table (continued).

Genera.	Longmynd Group.	Menevian Group.	Lower Lingula-flags.	Middle Lingula-flags.	Upper Lingula-flags.	Tremadoc Group.	Lower Arenig.	Middle Arenig.	Upper Arenig.	Lower Llandeilo.	Middle Llandeilo.	Upper Llandeilo.	Bala Group.
<i>Crustacea.</i>													
Agnostus	*	*	*	...	*	*	*	*	*	*	...	*	*
Microdiscus	*	*	*	...	*	*	*	*	*	*	...	*	*
Palæopyge	*	*	*	...	*	*	*	*	*	*	...	*	*
Paradoxides	*	*	*	...	*	*	*	*	*	*	...	*	*
Plutonia	*	*	*	...	*	*	*	*	*	*	...	*	*
Conocoryphe	*	*	...	*	*	*	*	*	*	*	...	*	*
Anopolenus	*	...	*	*	*	*	*	*	*	...	*	*
Arionellus	*	...	*	*	*	*	*	*	*	...	*	*
Erinnys	*	...	*	*	*	*	*	*	*	...	*	*
Carausia	*	...	*	*	*	*	*	*	*	...	*	*
Holocephalina	*	...	*	*	*	*	*	*	*	...	*	*
Olenus	*	*	...	*	*	*	*	*	*	...	*	*
Parabolina	*	...	*	*	*	*	*	*	*	...	*	*
Peltura	*	...	*	*	*	*	*	*	*	...	*	*
Sphærophthalmus	*	...	*	*	*	*	*	*	*	...	*	*
Neseuretus	*	...	*	*	*	*	*	*	*	...	*	*
Niobe	*	...	*	*	*	*	*	*	*	...	*	*
Psilocephalus	*	...	*	*	*	*	*	*	*	...	*	*
Asaphus	*	...	*	*	*	*	*	*	*	...	*	*
Angelina	*	...	*	*	*	*	*	*	*	...	*	*
Dikelocephalus	*	...	*	*	*	*	*	*	*	...	*	*
Cheirurus	*	...	*	*	*	*	*	*	*	...	*	*
Ampyx	*	...	*	*	*	*	*	*	*	...	*	*
Ogygia	*	...	*	*	*	*	*	*	*	...	*	*
Trinucleus	*	...	*	*	*	*	*	*	*	...	*	*
Ægina	*	...	*	*	*	*	*	*	*	...	*	*
Calymene	*	...	*	*	*	*	*	*	*	...	*	*
Dionide	*	...	*	*	*	*	*	*	*	...	*	*
Barrandea	*	...	*	*	*	*	*	*	*	...	*	*
Phacops	*	...	*	*	*	*	*	*	*	...	*	*
Placoparia	*	...	*	*	*	*	*	*	*	...	*	*
Illænus	*	...	*	*	*	*	*	*	*	...	*	*
Illænopsis	*	...	*	*	*	*	*	*	*	...	*	*
Homalonotus	*	...	*	*	*	*	*	*	*	...	*	*
Lichas	*	...	*	*	*	*	*	*	*	...	*	*
Acidaspis	*	...	*	*	*	*	*	*	*	...	*	*
Leperditia	*	*	...	*	*	*	*	*	*	*	...	*	*
Entomis	*	...	*	*	*	*	*	*	*	...	*	*
Primitia	*	...	*	*	*	*	*	*	*	...	*	*
Beyrichia	*	...	*	*	*	*	*	*	*	...	*	*
Lingulocaris	*	...	*	*	*	*	*	*	*	...	*	*
Hymenocaris	*	*	...	*	*	*	*	*	*	...	*	*
Ceratiocaris	*	...	*	*	*	*	*	*	*	...	*	*

		Order of the Succession of Life on the Globe.	Localities where the Formations are Exposed.	
LOWER CAMBRIAN. CAMBRIAN.	LOWER CAMBRIAN (Hicks).	LONGMYND GROUP.	Trilobites, graptolites, bryozoa, sponges, corals, etc.	
		MENEVIAN GROUP.	Trilobites, graptolites, bryozoa, sponges, corals, etc.	
	UPPER CAMBRIAN (Hicks).	LINGULA-FLAG GROUP.	Trilobites, graptolites, bryozoa, sponges, corals, etc.	
		TREMADOC GROUP.	Trilobites, graptolites, bryozoa, sponges, corals, etc.	
	LOWER SILURIAN (Murchison).	ARENIG GROUP.	Trilobites, graptolites, bryozoa, sponges, corals, etc.	
		LOWER SILURIAN (Lyell &c.).	Trilobites, graptolites, bryozoa, sponges, corals, etc.	
	UPPER CAMBRIAN (Sedgwick).	BALA GROUP.	Trilobites, graptolites, bryozoa, sponges, corals, etc.	
		LLANDEILO GROUP.	Trilobites, graptolites, bryozoa, sponges, corals, etc.	
	LAURENTIAN ?			St. Davids.

* These succeeded ash and tuff.
† The black

Table showing the Order of the Succession of the Strata in Wales and Shropshire.

		Lithological Characters.	Thick-ness of Strata.	Fossil Contents.		Number of Fossils which range from lower to higher groups †.		Order of the appearance of Life upon the Globe.	Localities where the Formations are Exposed.			
				Genera.	Species.	Genera.	Species.					
UPPER CAMBRIAN (<i>Sedgwicki</i>).	BALA GROUP.	Upper Caradoc	Shales and flags. Sandstones, shales, grits, calcareous bands, and interbedded ash.	feet. *4000 to 12000	120	565	.....	.....	Caradoc, Horderley, Bala, Snowdon, Llandeilo, and East Pembrokeshire.	
		Lower Caradoc	15	3			
	LLANDEILO GROUP.	Upper	Slates and flags, with interbedded traps.	*2000	20	24	.....	.....	Builth and St. David's.	
		Middle	Calcareous beds. Also black ferruginous slates with calcareous bands.	1000	13	23	.....	.....		
		Lower	Black slates, with interbedded felspathic ashes and tuffs.	*500 to 7000	17	24		Aran, Arenig, and Ffestiniog mountains, Shelve, Builth, and St. David's.		
	ARENIG GROUP.	Upper	Shales and slates	1500	36	65	.....	.....	West of Arenig, Shelve, and St. David's.	
		Middle	Slates, flags, flaggy sandstones, and grits.	1500	22	28		Carnarvonshire, Stiper stones, and St. David's.		
		Lower (Upper Tremadoc Rocks).	Iron-stained slates and flags.	1000	23	40		Portmadoc and St. David's		
	TREMADOC GROUP.	Tremadoc Rocks.....	Dark earthy slates and flaggy sandstones.	1000	24	45	Hydrozoa Lanellibranchiata, Ctenoidea, Asterozoa, Cephalopoda, Plantæ?	Neighbourhoods of Portmadoc and Dolgelly, North Wales; and Ramsey Island and St. David's, in South Wales.		
		LINGULA-FLAG GROUP.	Upper. (Dolgelly Rocks and Malvern Shales.)	Soft black and bluish slates and shales.	600	10	18	Neighbourhoods of Portmadoc and Dolgelly, North Wales; and Malvern.
			Middle. (Ffestiniog Rocks and Hollybush Sandstone.)	Grey arenaceous and micaceous flags.	2000	6	6	.....			.....		Heteropoda .....
	Lower. (Maentwrog Rocks.)		Bluish slates and flags, sandstones and shales.	2500	4	8	.....	.....	Phyllopora	
MENEVIAN GROUP.	Upper	Dark slates and flags.	600	23	52	.....	.....	Cystoidea	St. David's in South Wales, and neighbourhoods of Dolgelly and Maentwrog, North Wales.	
	Lower	Dark blue and grey flags.	.....	.....	.....	.....	.....
LONGMYN GROUP.	Harlech Grits and Llanberis Slates.	Grey grits, purple and green sandst. nes, slates, and conglomerates.	8000	17	25	.....	.....	Pteropoda, Spongia, Trilobita, Entomostraca, Brachiopoda, Polyzoa, Amelida.	St. David's, Harlech, Bangor, Llanberis, and the Longmynd.	
	LAURENTIAN ?	Quartz conglomerate and dark green shales.	St. Davids.	

* These series vary considerably in thickness in different districts in consequence of the unequal distribution of interbedded ash and tuff.
 † The black figures indicate the total number ranging up from the main groups.

EXPLANATION OF PLATES.

PLATE VIII.

Map and sections showing the arrangement of the ancient rocks of St. David's.

- Fig. 1. Geological Map of the neighbourhood of St. David's. Scale 1 inch to 1 mile.
2. Section from Point St. John, by St. David's, to a point near Solva Harbour.
 3. Section across the N.N.E. end of Ramsey Island.
 4. Section from the valley south of Tygwyn to the cliff north of St. David's Head.
 5. Section from Tretio to the coast, on the east side of Aber-pwll in Aberceiddy Bay.
 6. Section from Cwm-wdig to the cliff of Barry Island in a line with the Geological-Survey section No. 1, Sheet 1.

PLATE IX.

- Figs. 1, 2. *Placoparia cambriensis*, sp. nov. From Llanvirn Quarry: Upper Arenig.
- 3, 4. *Phacops llanvirnensis*, sp. nov. Ditto: ditto.
 5. *Ilænopsis acuticaudata*, sp. nov. Ditto: ditto.
 6. *Trinucleus Etheridgei*, sp. nov. Ditto: ditto.
 7. *Ilænus Hughesii*, sp. nov. Ditto: ditto.
 8. *Barrandea Homfrayi*, sp. nov. Ditto: ditto.

PLATE X.

- Figs. 1, 2. *Trinucleus Ramsayi*, sp. nov. From Porth-hayog, Ramsey Island.
3. *Æglina obtusicaudata*, sp. nov. Llanvirn Quarry: Upper Arenig.
 - 4, 5. *Calymene Hopkinsoni*, sp. nov. Ditto: ditto.
 6. *Dinobolus? Hicksii*, sp. nov. Ditto: ditto.
 7. *Ampyx Salteri*, Hicks. Whitesand-Bay Slate Quarry: Middle Arenig.
 8. *Ampyx Salteri*, Hicks. Ditto: ditto (in Mr. Homfray's collection).
 - 9, 9a. *Æglina Boia*, Hicks. Ditto: ditto (in Cambridge Museum).
 10. *Agnostus hirundo*, Salter. Ditto: ditto (in Cambridge Museum).
 11. *Theca Harknessi*, Hicks. Ditto: ditto (in Cambridge Museum).

PLATE XI.

- Figs. 1, 2. *Bellerophon llanvirnensis*, sp. nov. From Llanvirn Quarry: Upper Arenig.
3. *Ophileta*, sp. Ditto: ditto.
 4. *Pleurotomaria llanvirnensis*, sp. nov. Ditto: ditto.
 - 5, 6. *Conularia llanvirnensis*, sp. nov. Ditto: ditto.
 7. *Theca caereesiensis*, sp. nov. Ditto: ditto.
 - 8-10. *Orthoceras caereesiense*, sp. nov. Ditto: ditto.

DISCUSSION.

Prof. RAMSAY complimented the author on having brought forward a paper so well worked out. He gave an account of his own early geological work in Wales, and stated that he had mapped the rocks referred to by Mr. Hicks in 1841. He differed from the author in believing his supposed Laurentian rocks to be igneous. They were metamorphosed Cambrian deposits which had lost all traces of their aqueous origin. In 1841 no fossils had been found below the Llandeilo Flags in any part of the series described by Mr. Hicks; and then there was no ground for establishing those palæontological

divisions in the series which were indicated in the present paper. He stated that he traced the line between the blue flags and the Cambrian slates, and believed that an unconformity probably exists between the Tremadoc slates and the Lower Llandeilo.

Prof. HUGHES observed that the fossils by which the rocks under discussion were subdivided did not occur all through the several groups, but only in widely separated zones, and that between those zones sometimes one line and sometimes another had been taken as the arbitrary boundary, often to be shifted in consequence of the discovery of other fossiliferous bands. The line referred to by Prof. Ramsay as that which he was tracing in North Wales for the base of his Llandeilo, was a most useful line to draw, as helping to trace horizons, but was not shown to be coincident with any great break in succession. The Silurian system had not, and, after several changes, has not for its upper boundary a line representing any break in the continuity of deposition. Nor had it at first nor has it now, after much modification, any well-defined natural boundary for its base-line. The only break in it is that which occurs at the base of the May-Hill Sandstone; and that was unrecognized till pointed out by Prof. Sedgwick many years after the publication of the 'Silurian System,' the author of which, seeing that his system had no base on which to rest, took in group after group of the underlying series, and to justify himself had to prove at each step that as yet no break had been found in the series; till at length he got down to the lowest Cambrian, part of which he included in his Primordial Silurian. It was now well known, and that chiefly through the labours of Mr. Hicks, that no strong line could be drawn there, and we must therefore take it down to the bottom of the Cambrian conglomerate, or up to the base of the May-Hill Sandstone. Between these horizons lie the Cambrian rocks of Prof. Sedgwick, a well-defined natural group and an ancient name, which, following the true principles of classification and justice in our nomenclature, we must adopt.

Mr. ETHERIDGE remarked that several species pass up from the Tremadoc into the Llandeilo, and that the line between the Tremadoc and the Llandeilo of Sedgwick was not settled. In all cases of this kind stratigraphical or palæontological evidence alone was not sufficient, the two required to be concordant. He entered at some length into the palæontological statistics of the deposits under discussion, and dwelt especially on the fact that of 70 species of fossils found in the Tremadoc, only 4 pass up into the Arenig. The break at the top of the Tremadoc was thus palæontologically of great importance, although not apparent stratigraphically. Hardly any of the Lower Llandeilo (or Arenig) species agree with those of the Llandeilo Flags. The species at the top of the Stiper have a peculiar facies of their own, and would not be recognized as Arenig.

Prof. SEELEY said that the subdivisions of the Cambrian series of Sedgwick were based solely on palæontological evidence, and that to the physical geologist the deposits formed a single series, which

Fig. I. GEOLOGICAL MAP of the neighbourhood of ST DAVID'S PEMBROKESHIRE by HENRY HICKS F.G.S.

Scale of one Inch to a Statute Mile. Furlongs 8 7 6 5 4 3 2 1 0 Miles

- Llandalo Group: Interbedded Felspathic Trap, Greenstone, Felspathic Trap and Porphyry, Faults, Chief Localities of Fossils, Pre-Cambrian. Arenig Group: Greenstone. Tremadoc Group: Felspathic Trap and Porphyry. Lingula flag Group: Faults. Menevian Group: Chief Localities of Fossils. Longmynd Group including altered beds. Pre-Cambrian.

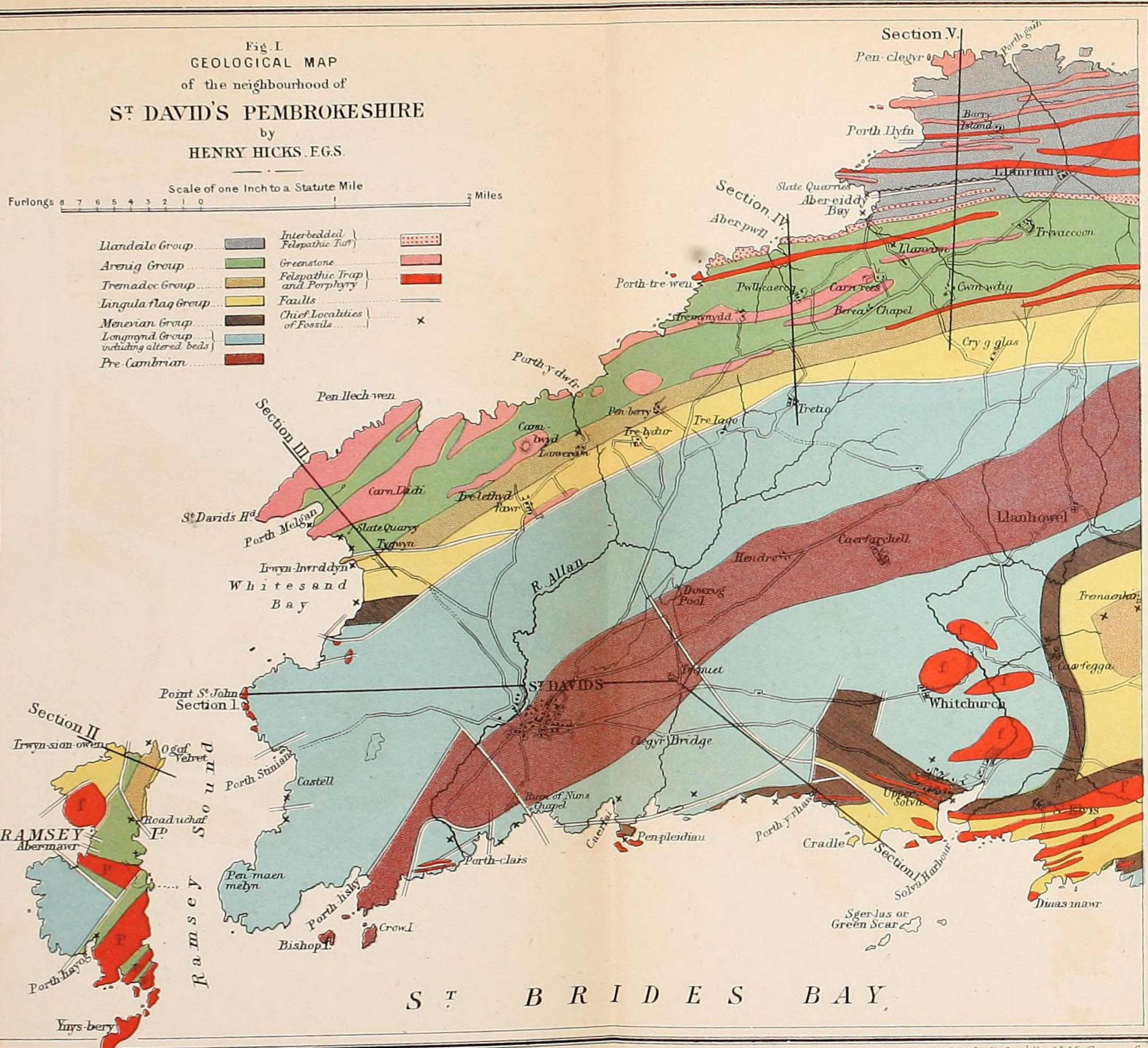


Fig. 2. Section I. from Point St John W by St David's E. to a point near Solva Harbour S.E.

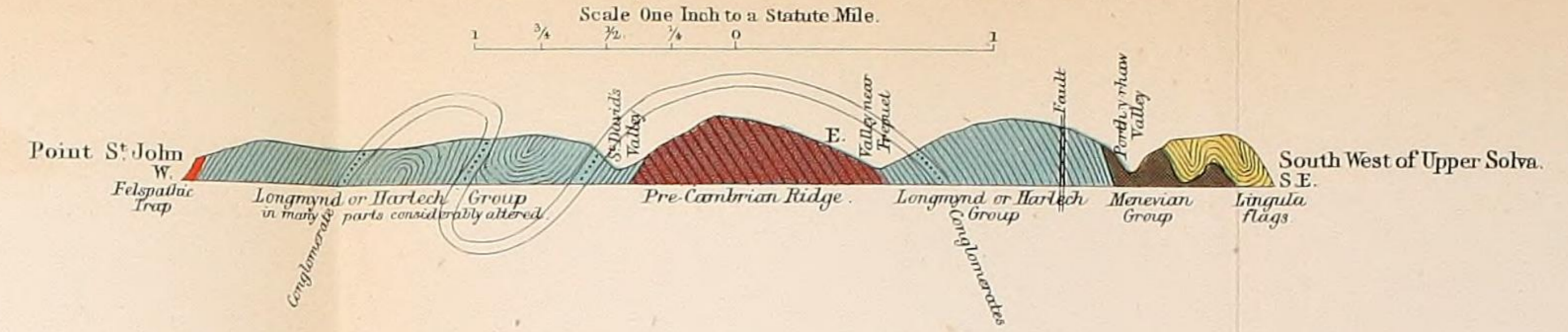


Fig. 3. Section II. across the N.N.E. end of Ramsey Island.

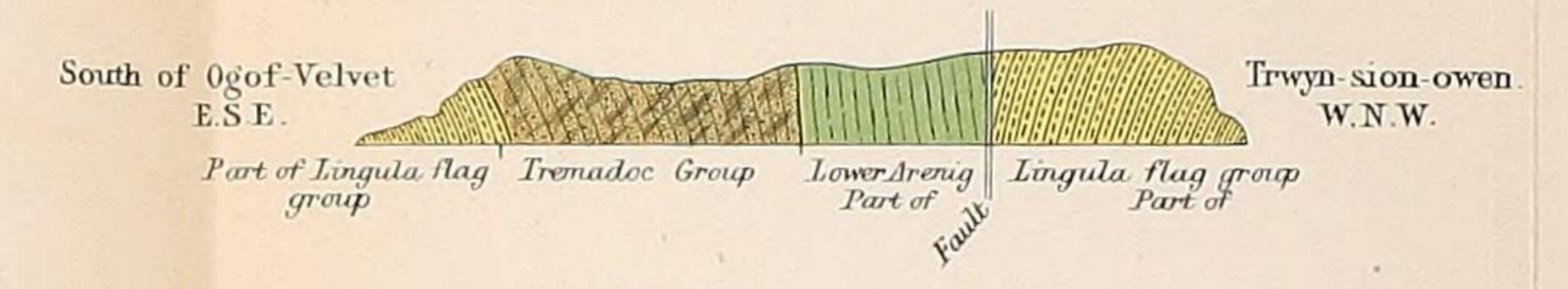


Fig. 4. Section III from the Valley South of Tygwyn to the cliff North of St David's Head.

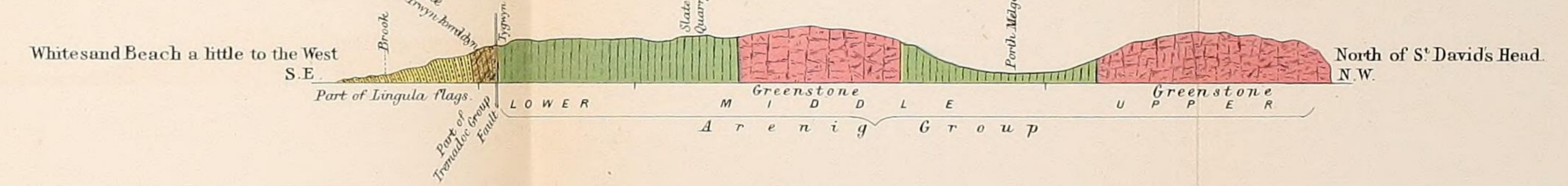


Fig. 5. Section IV from Tretio to the coast, on the East side of Aber-pwll, in Aber-eddy Bay.

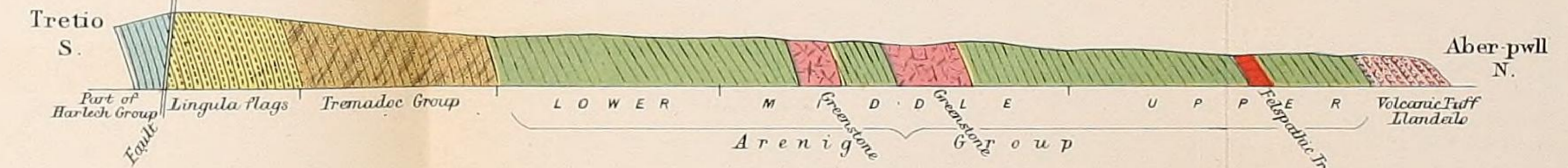
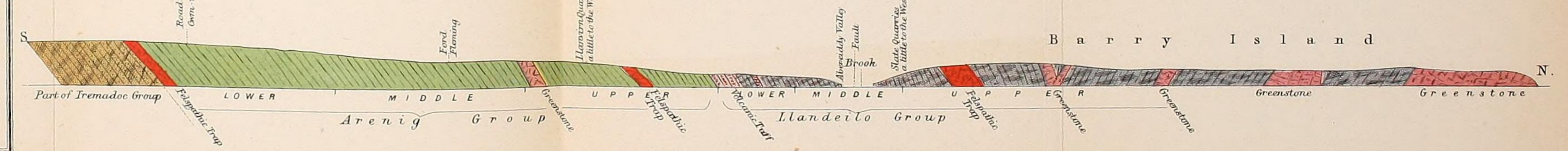


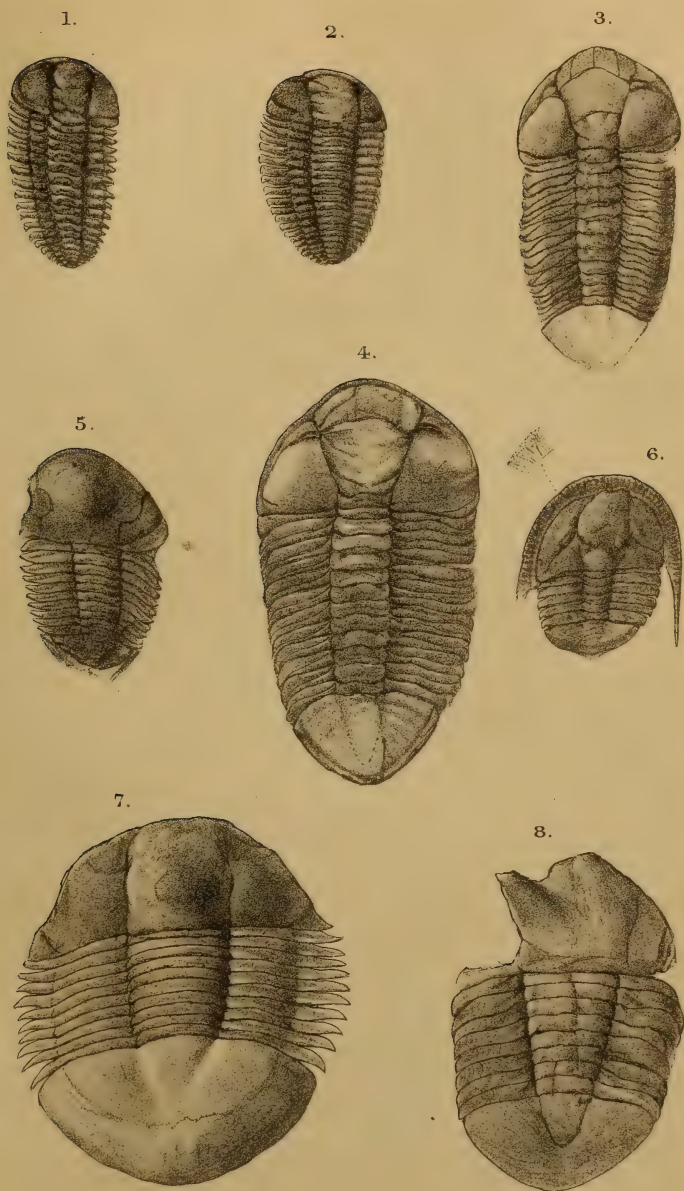
Fig. 6. Section V. from Cwm-wdig to the Cliff of Barry Island in a line with the Geological Survey Section N. 1. Sheet 1.

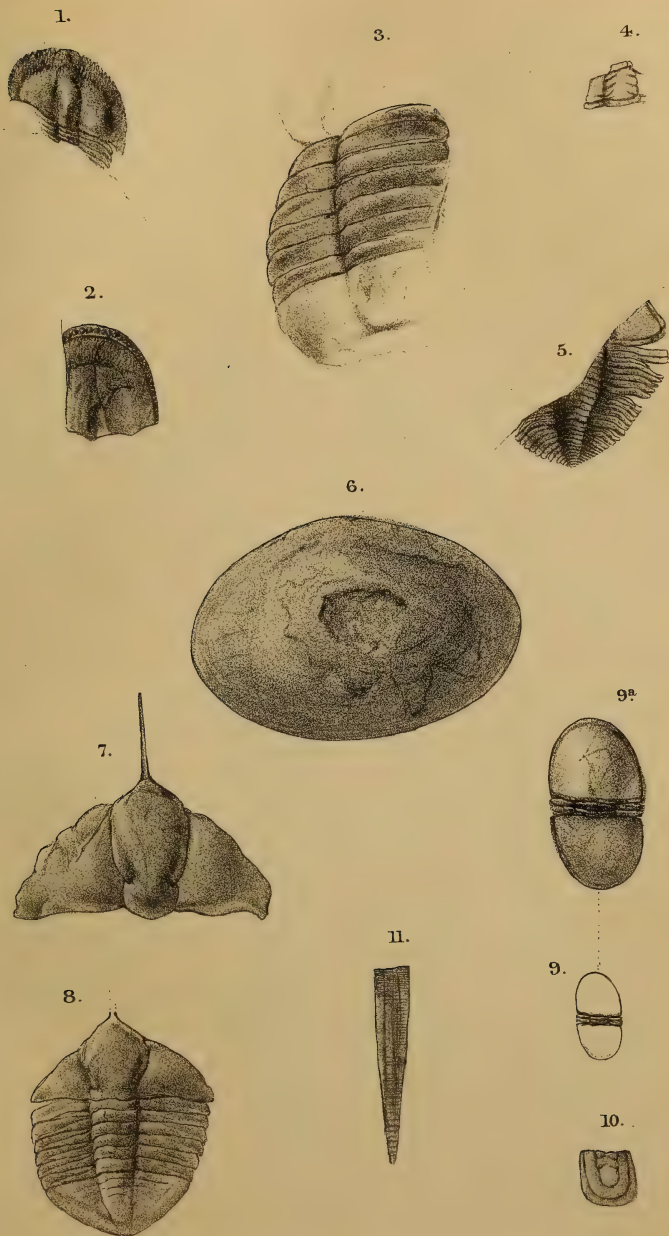


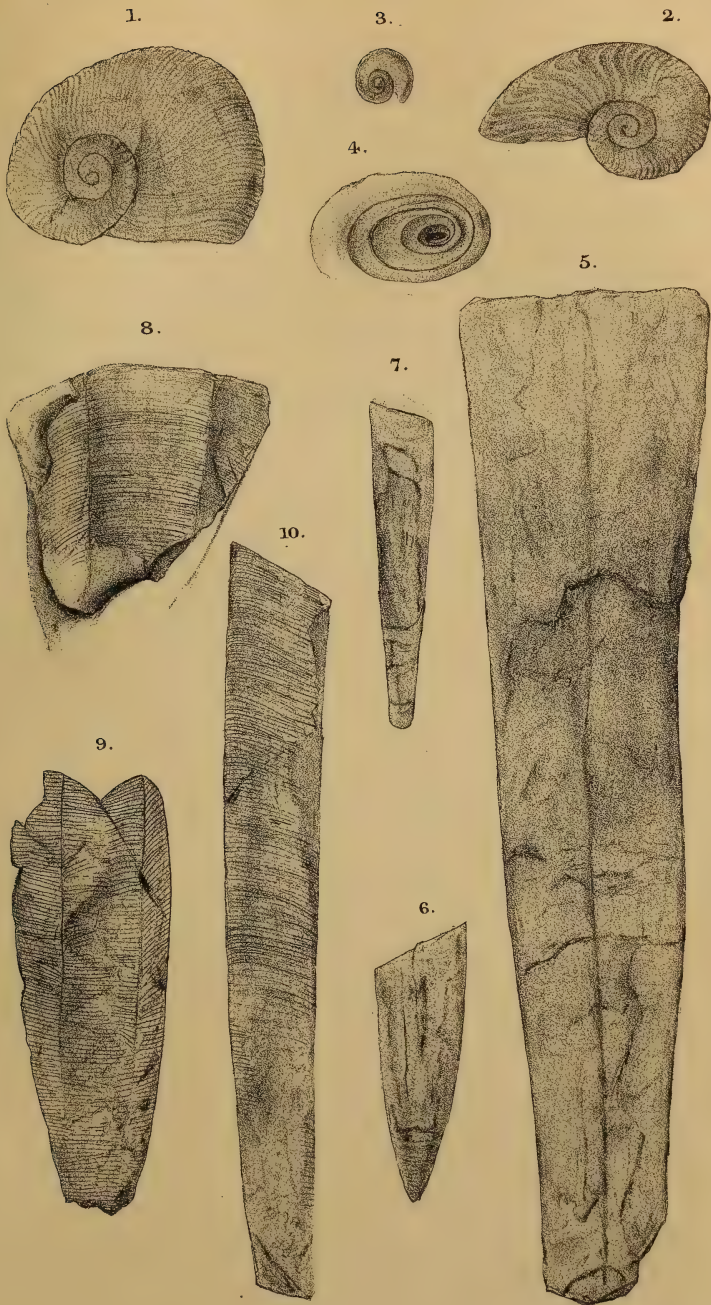
Scale of Sections II, III, IV, V. Six Inches to a Statute Mile.

0 1 2 3 4 5 6 7 8 Furlongs

Stanford's Geog. Instab. 55 Charing Cross.







could be subdivided upon stratigraphical grounds. But although there was no evidence of unconformity between the strata, he thought that the fact of different groups of fossils succeeding each other in the same area showed that those groups existed in neighbouring seas, and had been driven, by upheaval of the sea-bottom on which they lived, into the region in which they are found. Hence he maintained that a change in the forms of life is evidence of unconformity in an adjoining area.

Mr. MAW remarked that under the Cambrian rocks at Llanberis there are unconformable beds, which may be the equivalents of the so-called greenstones of St. David's.

Mr. HICKS admitted that the subdivisions at present in use may need to be modified. He thought that the greatest break is between the Menevian and the Lingula Flags, few species passing from one to the other. He regarded the upper and lower portions of the Tremadoc as really distinct.