described a great natural dam across the valley of the Great Valley Creek, near Peth, where the moraine stretches across the valley from side to side; and he spoke of the contrast between the numerous drainage valleys which drained the waters of the melting ice into the Allegheny River, and those valleys which took their rise south of the moraine, and were free from all drift.

After giving some details of the western lobe of the ice-sheet, and dwelling upon the agricultural significance of the moraine, he spoke of some curious deposits of glaciated material which occurred in a narrow strip of ground immediately in front of the moraine, and which he had named the 'fringe.' These deposits consisted of bowlders of Canadian granite, and other rocks, which he found perched upon the summits of hills, sometimes as far as five miles in front of the moraine, though never farther. This glacial 'fringe,' confined to the western part of the state, was found to increase in width from two miles in Warren county to five miles on the Ohio line, and was at first a puzzling phenomenon. The hypothesis suggested was, that, like breakers on the seashore, the top of the ice overreached the lowest strata by the width of the 'fringe,' and that while the moraine marked the halting-place of the bottom of the ice, by which it was formed, the far-transported bowlders were carried on more rapidly in the top strata of the ice, and were dropped outside of the moraine to form the 'fringe.' It was stated that the striae in the western part of the state all pointed south-east, being at right angles to those in the eastern part of the state, but, like them, pointing always towards the moraine.

In conclusion, the author reviewed the more important facts discovered during his exploration of the line of the moraine, dwelling upon the character of the moraine where crossing river-valleys, the absence of proof of any tongues of ice down such valleys, the absence of glacial drift south of the moraine, the very slight erosion caused by the passage of the glacier, and especially upon the deflections, large and small, in the line of the moraine, which were inexplicable on any other hypothesis than that the moraine now described was pushed out at the foot of a continuous ice-sheet of immense extent.

## *LETTERS TO THE EDITOR.*

### Change of birds' notes.

FOR some years it has been known to many about here, that in one locality the cardinal bird (Cardinalis virginianus) has been in the habit of imitating the notes of the whippoorwill (Antrostomus vociferus). From articles I have read from time to time in various scientific journals, I infer that it is not generally known that birds ever, in the wild state (especially cardinalis), change their song. I therefore thought it well to report this case. I have in several instances known this bird to change its song, under confinement, for one entirely different; but this is the only case I have ever known where such a thing has occurred in the wild state. I have known of this case for about ten years.

F. O. JACOBS.

Newark, Licking county, O.

### St. David's rocks and universal law.

The article with the above heading in SCIENCE of June 15, by Dr. M. E. Wadsworth, has just come under my observation; and, as it refers to questions which have arisen chiefly in consequence of my researches among those rocks, I shall deem it a favor if you will allow me space in SCIENCE for a few remarks in explanation. Professor Geikie's paper was written with, as he states, 'a sense of duty' to 'defend the views of his predecessors;' and it is perfectly certain, from the hasty manner in which the work was gone over by Professor Geikie and his two assistants, that the object was to vindicate the work of the Geological survey of thirty or forty years ago, rather than to apply the knowledge gained by the work of many independent observers since that time to correct the errors well known to have been committed by the surveyors, which remain as blots on the maps even now issued by the Geological survey. In the district of St. David's, these maps show a great intrusive mass passing under the city of St. David's, about eight miles in length, and with an average width of about a mile. The southern portion is called syenite, and the other felstone. The rocks lying along the north-western edge for about a mile in width are colored as altered Cambrian, presumably as the result of the intrusion; but on the south-east the rocks of the same age are supposed to be in contact with the mass in an unaltered condition, and without even a line of fault to separate them. These appearances were curiously anomalous if true: hence I felt it necessary to go very carefully into the question. My large acquaintance with the district, and the knowledge I had obtained in my explorations among the lower fossiliferous rocks of the area, enabled me to do this with some advantage. I had also, from time to time, much valuable assistance from Professors Harkness, Hughes, and Bonney, and from Mr. T. Davies of the British museum, Mr. Tawney, etc.

I found that under the same name, rocks of very different characters had been grouped together. The so-called syenite ridge was seen to consist in part of granitoid rocks, but also of quartz-felsites, of hälleflintas, of breccias, and of porcellanites freely traversed by intrusive dikes of various kinds. The so-called metamorphic Cambrian on the north-west was soon discovered to be an entirely distinct series from any Cambrian rocks known in the district, or, indeed, anywhere in Wales, and to be largely made up of volcanic rocks; and the basal Cambrian conglomerate, as marked on the survey-maps, was shown to overlie the granitoid, the quartz-felsite, hälleflinta, and the volcanic schistose and brecciated series unconformably, and to be mainly made up of fragments derived from those series. From the examination of the conglomerates also, it was seen that there were distinct evidences of their having been deposited along old coast-lines, and that their materials varied with the rocks upon which they reposed; also that these pre-Cambrian rocks must have been much in the condition in which they are now found, before the Cambrian conglomerates were deposited upon them. Curiously, also, I found that many of the masses colored as intrusive greenstones on the survey-maps were highly *acid* rocks, and others indurated volcanic ashes of pre-Cambrian age. Indeed, nearly all the so-called intrusive masses marked so abundantly on the survey-map among the older rocks in the St. David's area have been proved beyond doubt to be the result of erroneous observation; and yet we are told by the present director-general that little or no change is required in these maps, and that he

feels it his duty to 'defend the views of his predecessors' as there indicated. There is a still larger area of the Dimetian rocks about ten miles to the east of St. David's; and there, as at St. David's, these granitoid rocks underlie the lowest Cambrian beds without producing the slightest alteration in the latter. Indeed, I have now found no less than six areas in Wales where typical Dimetian granitoid rocks occur under the Cambrian or pre-Cambrian rocks; and in neither of these areas, though several excellent observers have, in addition to myself, searched the boundaries carefully, have we found the slightest indications of their being intrusive in those rocks, though they are all colored as intrusive rocks in the survey-maps. In several of these areas the fact that they must be pre-Cambrian rocks is rendered perfectly certain, as large fragments of the granitoid rocks in exactly the same condition in which they are now found occur in the basal conglomerates of the Cambrian. In one area only, in Wales, have I found Dimetian rocks entirely surrounded by rocks newer than the Cambrian; and here the Llandovery conglomerates and sandstones repose upon them, and are largely made up of materials derived from the Dimetian. In the other areas newer rocks than the Cambrian are found occasionally in contact with limited portions of the Dimetian exposures; but these effects are clearly seen to have been produced by faults.

In his paper to the Geological society, referred to in SCIENCE, Professor Geikie maintained "that the 'Dimetian group' is an eruptive granite which has disrupted and altered the Cambrian strata, even above the horizon of the supposed basal conglomerate." The evidence adduced to support this view was from a section at Ogof-Llesugn, where, as he supposed, "the conglomerate had been torn off and enclosed in the granite, and has been intensely indurated so as to become a sort of pebbly quartzite." Professor Hughes and myself, along with a number of other competent observers, have since examined this spot; and we found that the conglomerate lies quite loosely upon the Dimetian, that at almost every point we could pass our hand between the conglomerate and the granitoid rock, and that the Cambrian conglomerate had no change whatever induced in it beyond that common to it in all parts of the district. Two other sections were mentioned, and drawings exhibited to show the 'Dimetian' intrusive in the Cambrian, and as having eaten deeply into the series at Porthclais. These sections I knew perfectly well, at the time, to be in the lines of faults; but for greater satisfaction I asked Professor Hughes and party to re-examine these with me. The result proved that I was entirely right, and that Professor Geikie and his assistants had mistaken a junction produced by well-marked faulting for an intrusion, and the beds which he supposed had been eaten away had simply been dropped by the fault. He could not produce a single specimen showing contact alteration between the granitoid (Dimetian series) and overlying rocks. His evidence, therefore, fails utterly, on examination; and the pre-Cambrian age of the granitoid rocks of St. David's is rendered, if possible, more than ever certain. An attempt was made to show that the quartz-porphyries which I had pointed out as being intrusive in the Pebidian rocks, which alter the rocks in their immediate vicinity, were just such rocks as might be apophyses of the 'granite,' but, with a curious want of knowledge of the fact that these quartz-porphyries are common to many other parts of the area far distant from the granitoid series, that they also actually in some places cut across the latter.

As Professor Geikie did not spend the time necessary to examine the area where the Arvonian rocks are chiefly exposed, but hastily arrived at the conclusion, without seeing them, that the hälleflintas, breccias, and porcellanites must be intrusive felstones, I need scarcely refer to Professor Geikie's views on this point. I shall refer fully to this question in my paper, in reply, to the Geological society. I may, however, mention, that I exhibited a series of magnificent breccias from this group, and showed large masses of the Cambrian basement conglomerates from Ramsey Island, consisting almost entirely of the rocks of the Arvonian group upon which they repose. The latter are colored in the survey-map as *intrusive* in beds high up in the Silurian (fossiliferous Arenig).

The Pebidian, Professor Geikie says, 'forms an integral part of the Cambrian system.' He acknowledges that it underlies the Cambrian conglomerate, but says the latter rests quite conformably upon the former. In the survey-map these Pebidian beds are supposed to be Cambrian beds higher than the conglomerate, but altered by the so-called intrusions. Here, therefore, some modification of the map is acknowledged to be necessary. Had Professor Geikie and his assistants used ordinary care in examining these conglomerates, they would have seen also that they are constantly in contact with different members of the underlying rocks, that they lie unconformably on the edges of those beds, and also that they are very largely made up of the rocks below.

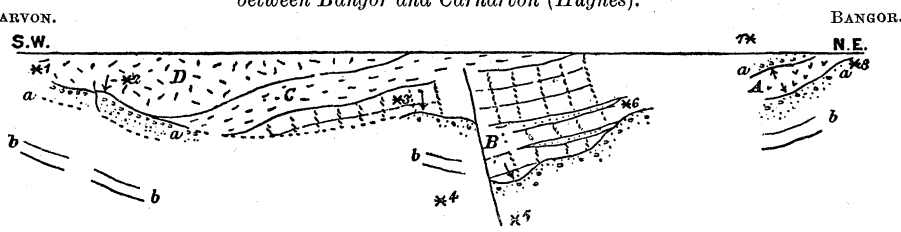
Professor Geikie did not refer to North Wales in his paper; but as the facts are, if possible, clearer there than in South Wales, I may be allowed to call the attention of the readers of SCIENCE to some sections just published by the Geologists' association of London, preparatory to the visit to be paid by the members to Carnarvonshire and Anglesey, July 23–28. These sections show in a very clear manner how the Cambrian conglomerates creep over the Dimetian, Arvonian, and Pebidian rocks in that area. The rocks of the first two and lowest groups are in that area, as at St. David's, colored as intrusive rocks in the survey-maps, and the last as altered Cambrian and Silurian rocks.

The sections have been prepared by Prof. T. McK. Hughes (Woodwardian professor of geology at Cambridge, and formerly of the Geological survey), who has carefully worked out the geology of this district. He and I were the first to point out, in the year 1877, the similarity of the conditions exhibited here to those at St. David's; and since then he has devoted much time to the elucidation of the facts bearing upon the questions in that area.

In a diagram (no. 1) he shows how the basement conglomerate of the Cambrian, between Bangor and Carnarvon, creeps over no less than four sub-groups of the archean rocks: viz., at Bangor, over the Bryniau beds (Pebidian); at Brithdir, the Dinorwig beds (Arvonian ?); at another part farther south, the Crug beds (upper Dimetian); and at Tut Hill, the Carnarvon beds (lower Dimetian). In section 2, the unconformable overlap of the Cambrian over the Pebidian near Bangor is clearly shown; and in no. 3, a diagram section showing the sequence of the rocks from Carnarvon to Snowdon, the basement beds of the Cambrian are shown rolling over the Carnarvon and Dinorwig groups at different points.

Altogether, the evidence afforded by these sections is of the most conclusive kind; and it seems impossible to believe that the surveyors, when they have seen and examined these sections, and have had more experience with the Welsh rocks, can still cling to the antiquated faith that all these pre-Cambrian rocks

*1. — Diagram plan showing how the Cambrian basement beds creep over the various divisions of the archean between Bangor and Carnarvon (Hughes).*



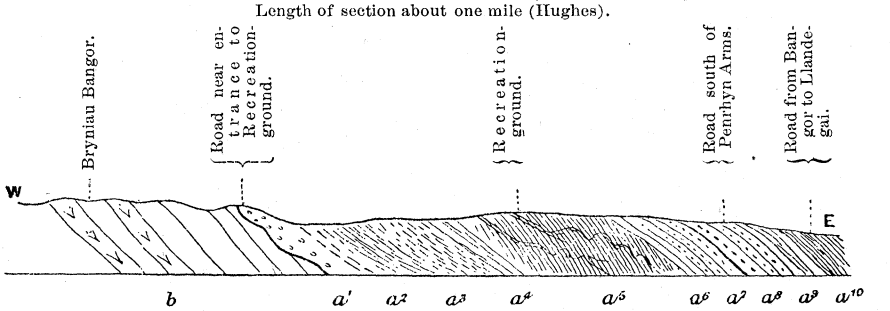

*Cambrian.*
*b*, Sandstone and shale of Cambrian.
*a*, Conglomerate and grit of Cambrian basement beds.

*Archean.*
*A*, Bryniau beds } Bangor group (= Pebidian, etc.).
*B*, Dinorwig beds }
*C*, Crug beds } Carnarvon group (= Dimetian).
*D*, Twt beds }

*1, Twt Hill; *2, Yscyborwen; *3, Careggoch; *4, Llandeiniolen; *5, Tymawr; *6, Brithdir; *7, Hendrewen; *8, Bryniau Bangor.

*2. — Diagram section east and west across Bryniau Bangor.*

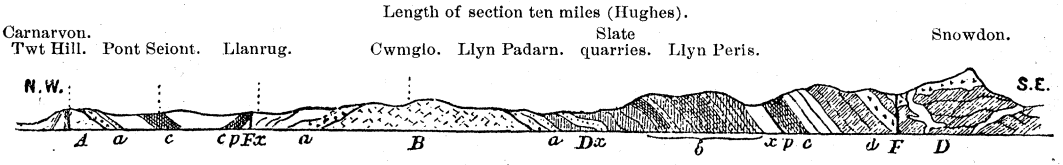
Length of section about one mile (Hughes).




*b*, Bangor beds (upper Pebidian); $a^1$, Conglomerate and sandstone (basement bed of Cambrian); $a^2$, Sandy mudstone; $a^3$, Finer felspathic mudstone; $a^4$, Pale green felspathic mudstone; $a^5$, Cleaved and contorted felspathic mudstone; $a^6$, Purple and green fine mudstone and slate; $a^7$, Fine sandy flags, like the Bray beds, purple, and here and there green, passing up into brown; $a^8$, Even-bedded thin gray sandstones; $a^9$, Banded flags, passing up into $a^{10}$, Black slates.

*3. — Diagram section showing the sequence of rocks from Carnarvon to Snowdon.*

Length of section ten miles (Hughes).




*Archean.*
*A*, Carnarvon group (Dimetian); *B*, Dinorwig group.

*a*, Conglomerate and sandstone (basement bed of Cambrian); *b*, Lower and middle portions of Cambrian, not subdivided, but probably including Harlech, Menevian, Lingula flags, and Tremadoc beds; *c*, Arenig; *p*, Pisolitic iron ore; *d*, Bala group, with subordinate volcanic beds; *F*, Faults; *x*, Broken ground; *D*, Dikes.

are merely intrusive masses or altered beds of Silurian and Cambrian age. The basal conglomerate in this area consists in places almost entirely of quartz-felsites, at other points of a mixture of granitoid (true Dimetian) and felsite rocks, and in some cases of schists. I may further mention with regard to the crystalline schists in Anglesey and in Scotland, supposed by the Geological survey also to be of Cambrian and Silurian age, that the recent researches of Bonney, Callaway, Lapworth, and myself, tend to make it certain that they are all, like the similar rocks in America described by Dr. Sterry Hunt and others, of pre-Cambrian age. HENRY HICKS.

Hendon, N. W., London,
July 5, 1883.

## Silurian strata near Winnipeg.

Presuming that it may be of interest to some readers of SCIENCE to read something on the geology of a locality near Winnipeg, I take pleasure in furnishing information, hitherto unpublished, concerning an outcrop of Silurian strata in this part of the north-west. This interesting exposure occurs a short distance from Selkirk, situated some twenty-one miles north of Winnipeg on the Canadian Pacific railway, and near the Red River.

At this place a quarry was opened about a year ago, which, on examination, affords many attractions to a student of science. Fossils belonging to some sixteen species are readily obtained, not only in the