ORDINARY GENERAL MEETING.

John Daglish, Esq., Hetton, Durham; Griffith Davies, Esq., 17 Cloudesley Street, Islington; John Walter Lea, Esq., B.A., The Grange, Shepperton Green, Chertsey; and Henry Michael Jenkins, Esq., Assistant-Secretary of the Geological Society, 22 St. George's Road, London, were elected Fellows.

The following communications were read:—

1. *On the LOWER CARBONIFEROUS BRACHIOPODA of NOVA SCOTIA.*

By THOMAS DAVIDSON, Esq., F.R.S., F.G.S., &c.

[PLATE IX.]

At the request of Dr. J. W. Dawson, F.R.S., F.G.S., Principal of McGill University, Montreal, I have examined the *Brachiopoda* collected by him from the Lower Carboniferous formation of Nova Scotia, as well as those obtained by Sir C. Lyell during his first journey in America, and I now submit the result of this examination to the Geological Society.

The geology of Nova Scotia has already received the attention of several distinguished observers; and I may mention that, although prior to Sir C. Lyell's visit to the country in question Mr. R. Brown had described the limestone of East River and Cumberland as Lower Carboniferous, the limestones of Windsor and Shubenacadie were at that time regarded as "New Red Sandstone" or "Permian." Sir C. Lyell was the first to maintain that the whole was of Carboniferous age; and, by so doing, he unravelled a complication which might for a time have involved the geology of the country in much confusion. He may therefore justly claim to have been the first geologist who was able to determine the geological age of the Gypsiferous strata of Nova Scotia, which he considered to be a member of the Carboniferous group instead of the Triassic or the Permian, or both of them, as previously conjectured*. Dr. Dawson informs me that his first papers on the subject were the results of investigations which he made to test Sir C. Lyell's views, and that Mr. Brown and he followed up these observations, and accumulated a vast number of facts subsequently published in his '*Acadian Geology*,' and from which I extract the following synopsis of the Carboniferous rocks of Nova Scotia†, in order to point out the horizons at which the *Brachiopoda* have been obtained.

Upper or Newer Coal-formation.

Greyish and reddish sandstones and shales, with beds of conglomerate, and a few thin beds of limestone and coal; the latter not of economic importance. Thickness, 3000 feet or more.

Fossils:—Coniferous wood, *Calamites*, Ferns, &c.

* See Sir C. Lyell's '*Travels in North America, with Geological Observations on the United States, Canada, and Nova Scotia*,' vol. ii. p. 204, 1845.

† "*An Account of the Geological Structure and Mineral Resources of Nova Scotia*," &c. 1855.

Localities:—Cumberland, north of the Cobequid Mountains; Northern Colchester, Pictou; well exposed on the Joggins coast, and on the coast of Northumberland Straits, west of Pictou Harbour.

Lower or Older Coal-formation.

Grey and dark-coloured sandstones and shales, with a few reddish and brown beds; valuable beds of coal and ironstone; beds of bituminous limestone, and numerous under-clays with *Stigmaria*. Thickness, 4000 feet or more.

Fossils:—*Stigmaria*, *Sigillaria*, *Lepidodendron*, *Poacites*, *Calamites*, Ferns, &c., erect Trees *in situ*, remains of Ganoid Fishes, *Cypris*, *Modiola*, and three species of Reptiles.

Localities:—Cumberland, north of Cobequid Mountains, Pictou, especially East River, Port Hood, Inhabitants' Basin, and other places in Inverness and Richmond; eastern part of Cape Breton; parts of Colchester, south of Cobequid Mountains. The finest exposures are in the South Joggins, and near Sidney, Cape Breton.

Lower Carboniferous or Gypsiferous Formation.

Great thickness of reddish and grey sandstones and shales, especially in the upper part; conglomerates, especially in the lower part; thick beds of limestone (with marine shells) and of gypsum. Thickness, 6000 feet or more.

Fossils:—*Productus*, *Terebratula*, Encrinites, Madreporae, and other marine remains in the limestone. Coniferous wood, *Lepidodendron*, *Poacites*, &c., in the shales and sandstone. Scales of Ganoid Fishes very abundant in the shales associated with the lowest beds, in which are also coaly seams and bituminous beds.

Localities:—Northern Cumberland, Pictou, Colchester, and Hants; Musquodoboit, in Halifax county; Guysboro (in part), parts of Inverness, Richmond, Cape Breton, and Victoria.

All the *Brachiopoda*, with one exception, are stated to have been derived from the Lower Carboniferous or Gypsiferous formation; and, although the fossiliferous rocks submitted to my examination vary considerably in composition and texture, it is evident that the larger number of the species continued to live together for a considerable period of time. There is a compact, light-yellowish-grey limestone, full of *Spirifera glabra*, *Terebratula sacculus*, *Productus Cora*, &c.; while some limestones, with the same fossils, are almost black in colour; others are arenaceous, yellow, and full of small cavities, the interior of the shells being often hollow; and, again, other limestones, as that of Brookfield, are formed almost entirely of shells, *Bryozoa*, &c., so closely packed that there appears in some cases to be hardly any cementing material or intervening matrix. Some shales also contain flattened valves of *Streptorhynchus crenistria*. Dr. Dawson believes that this remarkable lithological difference in the Lower Carboniferous rocks of Nova Scotia may have been caused through the limestones having been deposited in limited basins or narrow straits, and probably at a time of much volcanic disturbance;

hence the great local diversity. He is, moreover, inclined to consider that in each locality the "Lower Limestones" are darker in colour, more laminated, and less fossiliferous than the upper; also that the individual beds become darker, more impure, and less fossiliferous as they approach the high lands which formed the old shore-lines; but that there are, of course, exceptions to these statements.

The very remarkable shell-rock above described occurs at Brookfield, a little east of the Shubenacadie River; it was first discovered by the late Mr. G. Dunkin, and by him made known to Dr. Dawson. It is in the line of strike of the Shubenacadie beds, and is doubtless a continuation of them. This rock has such a great general resemblance to certain Permian shelly limestones, with which I am acquainted, that, had the specimens been submitted to me without any indication as to their geological age, I should certainly have felt somewhat puzzled to determine whether I had to deal with a Permian or a Carboniferous rock and its fossils; and, indeed, when M. de Verneuil determined these fossils for Sir C. Lyell in 1845, he enumerated, among others, *Terebratula elongata* and *T. sufflata*, Schl., *Spirifera cristata*, Schl., *Avicula antiqua*, Münster, a *Modiola*, a *Littorina*, and one or two other fossils which he considered to be common to both the Permian and the Carboniferous strata. Although I may modify to some extent the lists of species published by Sir C. Lyell and Dr. Dawson, I quite coincide with what is stated by the former author, at p. 205 of his 'Travels,' viz., "That geologists should at first arrive at this result (of considering the rocks in question as the equivalents in age of the Permian of Russia) will surprise no one who is aware how many of the fossils of our Magnesian Limestone and Coal resemble each other, or who studies the lists given at p. 218, in which several species both of shells and corals from Nova Scotia, identical or closely allied to well-known Permian or Magnesian Limestone forms, are enumerated."

This is important to note: for it was written in 1845, just at the time the celebrated authors of the great work on Russia in Europe and the Ural Mountains (published in 1845) arrived from that country; and it denotes how strongly impressed they were that a certain number of Carboniferous species had continued to exist during the Permian period. Subsequent researches have confirmed this view, and considerably multiplied the number of species common to the two epochs; and it has been proved in the most satisfactory manner that the Permian formation is the natural continuation of the great Carboniferous system, of which it composes the upper portion, although it is desirable to distinguish the group by the separate designation of "Permian." It is not the *Mollusca* and *Plants* of the Permian period alone which, as M. Marcou supposes, have a Palæozoic aspect, but, as M. de Verneuil*, Mr. Kirkby†, and others have already shown, the whole bulk of the animal and vegetable remains found in the Permian rocks bear the most unmistakable Palæozoic stamp. But, again, it would be fallacious to

* Bulletin de la Soc. Géol. de France, 2^e sér. vol. xix. pp. 599, 627 (1862).

† Annals and Mag. Nat. Hist. 3rd Series, vol. x. Sept. 1862.

suppose, as many have done, that at the expiration of each of the supposed great divisions of the sedimentary crust of the earth, namely, the Palæozoic, Mesozoic, and Cainozoic, there was a complete extinction and renewal of life. Such an idea in 1863 would be completely out of place; for it has been shown over and over again that many Palæozoic genera have not only continued to be represented during a greater or less portion of the Mesozoic time, but also throughout the entire geological sequence of sedimentary strata. It is also quite evident that the admirable science of palæontology, notwithstanding its rapid strides and great discoveries, is far from having revealed all its secrets, and is still in its youth. It cannot, therefore, be expected that those who are now endeavouring to decipher its difficult language can yet be in a position to furnish the key to the genealogy of the numerous forms they daily meet with in almost every rock and latitude, or that they can link together the multitudinous and varied forms composing any class, and far less the whole animal kingdom.

It is quite true that, in the present state of our knowledge, there appears to exist between the Palæozoic and Mesozoic divisions or periods a much wider break or difference in the life-groups than between the individual systems of which these divisions are composed. It is, however, highly probable that, when our science is more advanced, a closer agreement will be obtained. Experience has taught us that no genus or species, once become extinct, is ever recreated; and it is to my mind quite certain that, as long as the same genus is represented in any successive geological formations, this alone is a positive proof that life was not interrupted during that period. We are all aware that a certain number of *genera* of different classes passed from the Palæozoic into the Mesozoic period; but I will not at present enter into the discussion of this subject further than to mention that, among the BRACHIOPODA, *Terebratula*, *Spirifera*, *Spiriferina*, *Cyrtia*, *Athyris*, *Rhynchonella*, *Leptæna*, *Crania*, *Discina*, and *Lingula* passed from the Palæozoic into the Mesozoic division. The Triassic species have not yet been sufficiently compared with those from our Palæozoic deposits; but a glance at some of the St. Cassian forms, or even at Klipstein's and Münster's figures, will suffice to remove the idea that there was a complete extinction of life at the close of the Palæozoic period and an *entire* renewal of species at the commencement of the Mesozoic epoch.

Geologists and palæontologists are fully aware that the Permian fauna is not nearly so rich in species as that of the Carboniferous period. When we, therefore, compute the percentage of species common to the two, the Permian fauna must be taken as the standard, not the Carboniferous. The subject of the recurrence of Carboniferous species in the Permian period is far from having been completely worked out; but, since 1845, it has attracted the attention of several competent observers, amongst whom I may mention Messrs. de Verneuil, Brongniart, Göppert, Gutbier, Geinitz, Kirkby, King, Howse, Rupert Jones, and myself, in Europe; Messrs. Meek and Hayden, Swallow and Hawn, Dr. Shumard and Mr. Newbury, in America.

M. de Verneuil informs us* that Dr. Gœppert is of opinion that, in general, the Permian flora offers in its composition a great resemblance to that of the Coal-formation, fourteen or sixteen species being common to the two. I shall not pretend to offer a complete list of those hitherto recognized, but shall merely quote the following:—

1. *Calamites approximatus*, Schloth. Tynemouth; Manchester.
2. — *Cistii*, Schloth. Tynemouth.
3. — *nodosus*?, Schloth. Tynemouth.
4. — *Suckovii*, Brong. Tynemouth; Manchester.
5. *Sigillaria reniformis*, Brong. Tynemouth.
6. *Odontopteris Schlotheimi*, Brong. Tynemouth.
7. *Neuropteris Soretii*?, Brong. Tynemouth.
8. — *angustifolia*, Brong. Tynemouth.
9. *Cyatheetes arborescens*, Schloth.
10. — *villosus*, Brong. Manchester.
11. — *Oreopteridis*, Gæpp. Manchester.
12. *Alethopteris Mertensioides*, Gutb.
13. — *Lonchitidis*, Sternb. Manchester.
14. *Sphenopteris latifolia*, Brong. Tynemouth.
15. — *irregularis*, Sternb. Manchester.
16. — *coralloides*, Gutb. Manchester.
17. *Walchia piniformis*, Schloth.
18. *Guglielmites umbonatus*, Sternb.
19. *Trigonocarpum postcarbonicum*, Gumbel.
20. — *Næggerathi*, Lindl. & Hutt. Tynemouth.
21. — *oblongum*, Lindl. & Hutt. Tynemouth.
22. *Cyclocarpon marginatum*, Artis, sp.
23. — *tuberosum*, Gein. †
24. *Næggerathia palmæformis*, Gæpp. Tynemouth.
25. *Araucarites Schrollianus*, Gæpp.
26. — *Brandlingi*, Lindl. & Hutt. Tynemouth.
27. *Sagenaria dichotoma*, Sternb. Manchester.
28. *Dictyopteris neuropteroides*, Gutb. Manchester.

The thirteen species to which the locality “Tynemouth” is attached were identified by Mr. R. Howse as common to the Lower New Red, or Rothliegende, and the Coal-measures of the north of England, the former of which he thinks should more properly be considered as the upper portion of the true coal-measures. Seven, namely Nos. 13, 14, 16, 17, 18, 21, and 23, are mentioned by Dr. Geinitz as common to the German Rothliegende and Steinkohlen-formation. Mr. Binney has also recorded the occurrence of common coal-plants of the genera *Sigillaria*, *Lepidodendron*, and *Calamites* in the Lower Permian strata of the north-west of England. Those to which I have appended the word “Manchester” are taken from p. 313 of Dr. Geinitz’s valuable work ‘Dyas.’

Among the *Entomostraca*, Messrs. Rupert Jones and J. Kirkby have identified the following species as being common to both periods in Britain:—

1. <i>Cythere elongata</i> , Münster, 1830.	4. <i>Cythere</i> (<i>Bairdia</i>) <i>plebeia</i> , Reuss.
2. — <i>inornata</i> , M’Coy, 1844.	5. — (<i>Bairdia</i>) <i>Schaurothiana</i> ,
3. — (<i>Bairdia</i>) <i>gracilis</i> , M’Coy, 1844.	Kirkby.

Among the *Annelida*, Mr. R. Howse informs me that *Microcon-*

* Bull. Soc. Géol. Fr. 2^me sér. vol. xix. p. 600.

† Mr. Howse considers these so-called fruits to be fish-scales (*Holoptychius*? sp.).

chus carbonarius, Murch., has been found in the "New Red" of Tynemouth, as well as in the Coal-formation.

Mr. J. Kirkby has also recognized the *Bryozoon*, *Fenestella plebeia*, McCoy, as common to both periods in England; and, although Mr. Salter seems to doubt the identification of the Carboniferous form above named, it is quite evident that the *Fenestella* discovered by Mr. Kirkby in our Permian deposits is also represented by the same species in the Carboniferous strata of this country.

Among the *Pisces*, *Gyracanthus tuberculatus*, Ag. (*G. formosus*, Howse, Cat. Perm. Foss., non Ag.), has been stated by Mr. R. Howse to be common to the Lower New Red and the Coal-measures of England, and he considers that a species of *Holoptychius*? has been found in the Rothliegende and the Coal-measures of Germany.

It has been very justly observed that, with the Plants, the *Brachiopoda* have, up to the present time, received the greatest attention; and it has appeared to Mr. Kirkby and myself, after a minute and lengthened examination, that, out of the eighteen or nineteen species of British Permian *Brachiopoda* hitherto discovered, half at least, or 50 per cent., are common to the Permian and Carboniferous periods; and in support of this statement I must refer the reader to pages 266-270 and 279-280, and Plates 54 and 55 of my Monograph of Carboniferous *Brachiopoda*, in addition to Mr. Kirkby's paper already mentioned.

To the following list I have added, between brackets, the names of those palæontologists who have acknowledged the recurrence:—

1. *Terebratula sacculus*, *Martin*, 1809, C. = *T. sufflata*, *Schloth.*, 1816, P. (King, De Verneuil, Kirkby, Davidson, Salter.)
2. *Athyris Royssii*, *L'Eveillé*, 1835, C. = *A. pectinifera*, *Sow.*, 1840, P. (De Verneuil, Kirkby, Davidson.)
3. *Spirifera Urii*, *Flem.*, 1828, C. = *Martinia Clannyana*, King, 1848, P. (Davidson, Kirkby, De Verneuil, Salter.)
4. *Spiriferina octoplicata*, *Sow.*, 1827, C. = *Sp. cristata*, *Schloth.*, 1816, P. (De Verneuil, Davidson, Kirkby, Salter.)
5. *Camarophoria crumena*, *Martin*, 1809, C. = *T. Schlotheimi*, *Buch*, 1834, P. (Morris, Davidson, Kirkby, King, De Verneuil, Salter.)
6. *Camarophoria globulina*, *Phil.*, 1834, P. = *T. rhomboidea*, *Phil.*, 1836, C. (Davidson, Kirkby.)
7. *Discina nitida*, *Sow.*, 1812, C. = *D. Koninekii*, *Geinitz*, 1848, P. (Davidson, Kirkby.)
8. *Lingula mytiloides*, *Sow.*, 1812, C. = *L. Credneri*, *Geinitz*, 1848, P. (Kirkby, Davidson.)

It may be further observed, that it is hardly possible to distinguish the Permian *Crania Kirkbyi*, Dav., from the Carboniferous *Crania quadrata*, McCoy; and it is almost certain that *Spiriferina multiplicata*, King, occurs likewise in our Carboniferous strata. *Strophalosia Morrisiana*, so characteristic of the Permian period in Europe, has been found by Mr. Purdon (and described by myself in this Journal*) in the Carboniferous limestone of the Punjab, as well as another larger species, which closely resembles the Russian *Aulosteges Wangenheimi*, Vern. (*A. variabilis*, Helmersen). Mr.

* Quart. Journ. Geol. Soc. vol. xviii. p. 32.

Kirkby has also recently found, in the Lower Permian limestone of Hartley Quarry, Sunderland, a species of *Chonetes*, which I believe will turn out to be identical with the Carboniferous *C. Hardrensis*. It must also be remembered that M. de Verneuil has stated, in the work on Russia, that *Chonetes sarcinulata* has been found to range throughout the whole Silurian, Devonian, Carboniferous, and Permian periods; but it is probable that the Carboniferous and Permian form is more properly referable to *C. Hardrensis* than to the Silurian species (?); so that we may further estimate that out of the eighteen or nineteen British Permian species, eleven are common to the two periods. Now of the remaining seven.

Terebratulæ elongata has often been considered to be Carboniferous as well as Permian, but of the absolute identity of the two forms I do not profess to feel quite certain.

Spirifera alata has not hitherto been positively recognized in rocks older than the Permian; but there are certain Devonian and Carboniferous Spirifers to which it is somewhat related.

Cammarophoria Hambletonensis, Howse, has not hitherto been found except in Permian rocks.

Streptorhynchus pelargonatus, Schloth., bears much resemblance to certain varieties of *Strept. crenistria*, although probably specifically distinct.

Productus horridus and *P. latirostratus* are not known up to the present time, except in Permian rocks; but in their shape and character they are not extremely distant from certain Carboniferous forms.

Strophalosia Goldfussi is still characteristic of the Permian period.

This rapid examination of British Permian *Brachiopoda* will, I trust, suffice to show that there exists not only a general close affinity between the Permian and Carboniferous *Brachiopoda*, but also that the majority of the species of the former period are identical with some of the latter: and I may likewise mention, that although the Permian rocks of Russia, Germany, Spitzbergen, and other places present us with a few distinct forms, even some of these recall to mind certain Carboniferous species; nevertheless I dare not pronounce them identical; and it will require much further examination before they can be considered entirely distinct.

The *Gasteropoda* and *Conchifera* that occur in the Permian rocks are few in number, and have not yet been carefully compared with those of the Carboniferous period. Mr. Howse has informed me that the *Anthracosia aquilina*, Sow., sp., found by him in the Lower New Red of Tynemouth, is the same as that which occurs in the Coal-formation of England. Mr. Rupert Jones has also recently been able to add another link between the two formations in *Estheria tenella*, which is common to the Permian and Carboniferous rocks of Germany. M. de Verneuil observes, in his excellent paper published in the 'Bulletin de la Soc. Géol. de France,' 2^{me} sér. vol. xix., that, among the *Pteropoda*, there exist a species of *Theca* and one of *Conularia* so nearly related to certain Devonian (Carboniferous?) forms of the same genera, that it requires great attention to be able

to distinguish them; and that, in addition to these, a species of *Bellerophon* and a Trilobite of the genus *Phillipsia* have been found by Messrs. Meek and Hayden in the Permian rocks of New Mexico, &c.

Although palæontological research is not in so advanced a state in America as in Europe, and though the species of that continent will require to be very carefully studied and compared with those of Europe before being definitely recognized, still it is probable that the relations between the Carboniferous and Permian deposits of the States of Kansas and New Mexico are very close, and that there exists no marked line of break between them. A single investigator might be mistaken; but it is hardly likely that Messrs. Meek and Hayden, Swallow and Hawn, and Shumard and Newbury, who have examined for themselves, should all be in error!

The species recorded by these American geologists and palæontologists as being common to the Carboniferous and Permian periods are the following; but I append their list with the greatest possible reserve on my part, and solely on their authority, as it is certain that several of their identifications will require revision prior to being definitely admitted:—

1. <i>Productus semireticulatus</i> , <i>Martin</i> .	9. <i>Orthisina Missouriiana</i> , <i>Swallow</i> .
2. — <i>Rogersii</i> , <i>Norwood & Pratten</i> .	10. <i>Rhynchonella Osagensis</i> , <i>Swallow</i> .
3. — <i>aquicostatus</i> , <i>Shumard</i> .	11. <i>Terebratula</i> (?) <i>subtilita</i> , <i>Hall</i> .
4. <i>Spirifera camerata</i> , <i>Morton</i> .	12. <i>Myalina recta</i> , <i>Shumard</i> .
5. — <i>plano-convexa</i> , <i>Shumard</i> .	13. — <i>subquadrata</i> , <i>Shumard</i> .
6. — <i>pectinifera</i> , <i>Sow</i> .	14. — <i>Kansasensis</i> , <i>Shumard</i> .
7. <i>Chonetes Flemingii</i> , <i>Norwood & Pr</i> .	15. <i>Allorisma Minnahaha</i> , <i>Swallow</i> .
8. <i>Orthisina umbraculum</i> , <i>Buch</i> .	16. <i>Naticopsis Pricei</i> , <i>Shumard</i> .

Dr. Shumard mentions also that *Productus Calhounianus*, *Swallow*, has been found in both formations.

However imperfect may be the lists I have given of the recurrent species, it cannot be denied that, both by their genera and species, the life-groups of the Carboniferous and Permian periods are closely related, and that although the Permian epoch possesses a large proportion of species peculiar to itself, yet the general aspect of its fauna greatly resembles that of the Carboniferous period.

The immense material now in hand is piled up and carefully stored, but we have not yet had time to sort our treasures. The time and research hitherto required in the preparation and illustration of the Monograph entrusted to my care by the Palæontographical Society, and the necessity of keeping my collections for that purpose geologically and geographically arranged, have retarded the special investigation of the class I am desirous of attempting in order to respond to the request made me some time ago by Mr. Darwin, namely, "that I should endeavour to exemplify and work out in some detail, and with some single group, the theory of descent with modification, so as to test the value of his theory." It appears to me, however, preferable, and more advantageous to the point in view, that I should continue and complete my Monograph prior to rearranging my whole collection in a purely zoological order, and irrespective of all geological divisions. By this last operation, all the forms that most re-

semble each other, as well as those which gradually diverge, will be placed in regular order; and it will then be in my power to show, to a certain extent, what the *Brachiopoda* may do for the theory of descent with modification. The difficulties to contend with in such an investigation are, however, far greater than they are generally supposed to be; but it is quite evident, and my daily experience (which, as far as the *Brachiopoda* are concerned, exceeds twenty years) teaches me, that the number of supposed distinct species has been wonderfully exaggerated, and that a vast number of them are in all probability, and in many cases certainly, mere modifications in shape, or varieties in the Darwinian sense, which palæontologists will sooner or later be able to link together. Indeed, are we not continually puzzled to know how to find words or characters to distinguish our nearly related species? Are not our supposed distinctions often exceedingly uncertain? and are we not generally far more pre-occupied with the desire to find out trifling differences than to examine whether a closely related form might not be due to descent with modification? To what extent variation has extended, our knowledge will not enable us to determine; and, therefore, we cannot pretend to know whether a supposed new form is in reality the result of a distinct and original creation. We may suppose it so, with more or less reason, founding the supposition on the imperfect state of the science, which leaves us no other alternative than to consider new that which we cannot connect or identify with what is already known. What, again, adds to the difficulty is the imperfect knowledge we possess as to what is really the value of the term "species,"—for on that primary question naturalists are far from unanimous*. I am of opinion that there has never been a total extinction of life since its first appearance, and consequently no sudden renewal of the entire fauna at any geological period. It is likewise quite certain that species have gradually and continually become extinct from the date when the first form was created, and that perhaps new species have appeared in the same ratio, to suit the different conditions of sea and land in which they had to exist†. It is also highly probable, if not quite certain, that there never has

* In 1860, Prof. Suess registered 1934 species of *Brachiopoda*; and this is far short of the total number that have been described; but it would be most erroneous to suppose that these 2000 or more names represent as many independently created species, a large proportion being either synonyms, varieties, or modifications in shape, of a limited number of original types.

† M. Deshayes states that "it is an *absolute* palæontological demarcation which serves to clearly separate the geological formations; that at St. Cassian not a single species has been known to pass from the Triassic into the Jurassic formation; and that the same thing takes place between the five great series of formations which he admits." (Bull. Soc. Géol. France, 2^{me} sér. vol. xix. p. 397, 1862.) I am sorry to be obliged to dissent from this view, which is entirely in opposition to my experience; I neither believe in the existence of five *absolute* series of formations, or in any *absolute* palæontological demarcation between any geological systems that have been hitherto proposed, and for the reasons above specified. On the contrary, I entirely concur with M. de Verneuil while stating that he attaches less importance than do many geologists to those geological and palæontological divisions of the crust of the globe, which are

been a complete discontinuance of sedimentary deposition over the whole surface of the globe since the time when the first sediment was formed,—that there has always existed a sea somewhere or other upon the surface of the world, and that this sea has always been inhabited. It is also certain that a number of favoured species did escape for a time those local geological convulsions which have taken place at numerous intervals; for the idea that universal geological revolutions have ever taken place is now an all but exploded theory. Those hardy and favoured species have migrated (as M. Barrande and others have so clearly shown), and continued to exist, if not in their original home, in some other more distant place, for a greater or less lapse of time, while the larger number of the others may have been suddenly or gradually destroyed by those great changes in the configuration of land and sea which have no doubt taken place gradually or periodically.

It is not, therefore, surprising to find certain forms of an older period in newer strata, or to find certain species striving to exist for a greater or less extent of geological time, irrespective of the geological system in the strata of which they are imbedded.

Time and assiduous research will show how far we may speculate upon the origin of species; but, in the present state of palæontological science, all theories built upon such subjects, however admirably handled, as is that by Darwin, must, before admission, be tested by more unmistakable evidence than science is at present in a condition to offer.

We cannot tell, in the present state of our knowledge, whether the species of any class, be it *Echinodermata*, *Brachiopoda*, *Crustacea*, *Pisces*, or any other, have been derived from a single or a hundred original progenitors. I will not say that future researches may not simplify the question, but in the present state of our experience we are very far from having arrived at any such conclusion. A similarity of original type has sometimes, by exception, occurred during a very prolonged period: thus, for instance, we have certain forms of *Lingula*, *Crania*, *Discina*, *Rhynchonella*, &c., which, to all outward appearance, appear to have varied but little during all the sequence of geological time; there is one form of *Crania*, for example, which occurs in the Silurian, Devonian, Carboniferous, Permian, Jurassic, Cretaceous, and Tertiary strata, and in the recent state, which, although possessing as many distinct denominations, is hardly specifically distinguishable, while other species of that genus varied considerably in the different geological periods.

But to return to the more immediate subject of this communication, I may observe that, although I quite agree with M. Marcou that there exist in the Permian formation some few forms which may recall to mind some which existed in the Mesozoic period, it must be allowed that that number forms the minority, and that, on the contrary, the great bulk of the Permian species, to whatever class

perhaps more in our idea than in nature, and conforming more to the actual state of science than to its complete development. (Bull. Soc. Géol. France, 2^{me} sér. vol. xix. p. 612, 1862.)

they may belong, bears the most positive Palæozoic stamp, and that the species are in many cases the same that lived in the Carboniferous era, and some even in the Devonian.

Having sent my plate of Nova-Scotian species to Prof. de Koninck, he wrote back:—"It is to be remarked that all this little fauna completely recalls that of the Carboniferous limestone of Visé in Belgium;" and this urges me to remind the Society that it has been already shown by several palæontologists that there exists a great general similarity in the Carboniferous fauna in almost every portion of the globe where the rocks of that period have been discovered; and I have myself been able to confirm and extend this fact by the lengthened examination I have made of the *Brachiopoda* of that period from Europe and from many distant regions. It would, however, be hazardous in the extreme to affirm that the species found in one particular bed or at one horizon of the Carboniferous period of Nova Scotia were strictly contemporaneous with the same rock or forms found, for instance, at Visé in Belgium or elsewhere. They may, perhaps, have been so, but we have no direct means of arriving at so positive a conclusion; but, from the difference in the size of the specimens, we may say, for example, that the Carboniferous sea of the Punjab, where many of the same species are found, was much more favourable to the development of the species than was that of Nova Scotia, where, as a general rule, the shells were all very much smaller; and I quite coincide with Prof. Huxley when he asserts that the term "contemporaneous" cannot always be made use of in its absolute or literal meaning. For instance, it is highly probable that in some portion of the world the Lower Carboniferous animals may have continued to exist unmolested, and to have been gradually imbedded, up to the time when the Permian era commenced; and by this means some of the species of the older formation may have been transferred to the newer; and all this whilst in other parts of the world the Middle and Upper Carboniferous sediment was being deposited. Two series of Carboniferous strata containing the same animals may, therefore, not be strictly contemporaneous, although they may both belong to the Lower Carboniferous series: the term should therefore be made use of in its widest and most general acceptance.

At pages 220-222 of his 'Travels,' Sir C. Lyell gives a list, with and without names, of sixteen species of Lower Carboniferous Brachiopods as having been found in Nova Scotia, namely, *Terebratula elongata*, *T. sufflata*, *Spirifer glaber*, *Sp. cristatus*?, *Sp. minimus*, *Sp. octoplicatus*, *Producta Martini*, *P. concinna*, *P. Lyelli*, *P. Scotica*, *P. spinosa*, *P. antiquata*, and four undetermined. But as several of the designations enumerated are synonyms, the number of determined species would be reduced to five; and, even of these, three names will require to be altered.

The study I have made of Dr. Dawson's and Sir C. Lyell's specimens has, however, enabled me to determine fourteen species, or in reality nine more than had been recorded by M. de Verneuil, and it is pro-

bable that a further search among the Lower Carboniferous rocks of that country may bring to light a larger number; and, indeed, there existed in the collections above named specimens of one or two more species, which I could not venture to determine on account of their imperfect preservation.

As a rule, the *Brachiopoda* of Nova Scotia are small when compared with the same species from some other countries—a result perhaps of the conditions, already described, under which the beds were deposited. I must not omit to mention that there occurs no marine limestone, with which Dr. Dawson is acquainted, over the productive coal-measures, except at one place, Wallace, where there is a thin band of limestone in the upper coal-strata, which contains a *Productus*; but this was found in too incomplete a condition to admit of determination.

1. *TEREBRATULA SACCULUS*, Martin, sp., 1809, and varieties. Pl. IX. figs. 1, 2, 3.

Terebratula elongata and *T. sufflata*, De Verneuil, in Sir C. Lyell's Travels in North America, vol. ii. p. 220, 1845, and in Dawson's Acadian Geology, p. 219, fig. 27, 1855.

All the *Terebratulae* from the Lower Carboniferous strata of Nova Scotia that have been forwarded to me by Dr. Dawson, as well as those brought from that country by Sir C. Lyell, are variable in shape, but are evidently referable to a single species. M. de Verneuil has identified this shell with Schlotheim's *T. elongata*, and mentions that a "gibbous variety of the preceding one" is referable to *T. sufflata* of the same author.

During a lengthened examination of *T. hastata* and *T. sacculus* from the Carboniferous rocks of Great Britain, as well as of *T. elongata* and *T. sufflata* from the Permian strata of the same kingdom, I was led to the conclusion that the specific identity of *T. sacculus* and *T. sufflata* was clearly established; and, when treating of the Carboniferous *T. hastata* and of the Permian *T. elongata*, I observed that, although it was an unquestionable fact that some specimens of these two so-called species could not be distinguished, more difference is shown between the greater number of *T. hastata* and *T. elongata*, and that the strong resemblance appeared to be the exception. It must also be allowed that it is often impossible to distinguish certain examples of *T. sacculus* and of *T. hastata*, which forms appear to merge the one into the other, and that the same may be said sometimes with reference to *T. sufflata* and *T. elongata*. All this proves how intimately connected are the British forms of Carboniferous and Permian *Terebratulae*.

But to return to the Nova-Scotian specimens, I could not perceive in any of them the wide and gradually depressed or shallow sinus, which, in the larger valve of all well-shaped examples of *T. elongata*, commences towards the middle of the valve and extends to the front, and which produces in the frontal margin a convex curve. In nearly every specimen the ventral valve is uniformly convex or but very slightly depressed near the front, as is the case with the larger num-

ber of *T. sacculus* and of its synonym *T. sufflata*. I think, therefore, that it will be perhaps preferable to refer the Nova-Scotian *Terebratula* to Martin's *T. sacculus*; and in this view I am supported by Prof. de Koninck, notwithstanding some examples may resemble certain specimens of *T. elongata*, *T. fusiformis* (Vern.), or *T. hastata*. The largest specimen I have seen was not quite an inch in length, and the greater number were much smaller. The interior, with its perfect, short, simple loop, is often found, and is exactly similar to the one we find in Martin's species. Sir C. Lyell mentions that he obtained this shell at Windsor, Brookfield, Shubenacadie, Gay's River, Debert River, Middle River, and Cape Breton. Dr. Dawson obtained it in the same localities, to which he has added Pugwash, East River of Pictou, Lennox Passage, &c.

2. *ATHYRIS SUBTILITA*, Hall, 1852. Pl. IX. figs. 4, 5.

Athyris subtilita, in Howard Stansbury's Exploration of the Valley of the Salt Lake of Utah, p. 409, pl. 2. figs. 1, 2.

The Nova-Scotian specimens all appear to be small in size, but are exactly similar (except in dimensions) to those found in other parts of America and Europe. The spiral processes are often preserved.

This shell occurs by millions in the Lower Carboniferous limestone of Shubenacadie, Brookfield, &c.

SPIRIFERÆ.

The four so-termed species referred to in the lists given by Sir C. Lyell and Dr. Dawson appear to belong to two, or at most three (?), species.

3. *SPIRIFERA GLABRA*, Martin, sp. Pl. IX. figs. 9, 10.

Conchyliolithus Anomites glaber, Martin, Petrif. Derb. pl. 48. figs. 9, 10, 1809.

Spirifer glaber, De Verneuil, in Sir C. Lyell's Travels in North America, vol. ii. p. 221, 1845, and in Dawson's Acadian Geology, p. 376, 1855.

This appears to be a common fossil in the Lower Carboniferous limestone of Nova Scotia. It is identical in character with those found in Great Britain; one example brought home by Sir C. Lyell measured 13 lines in length by about 17 in breadth.

It occurs at East River of Pictou, Mabou, Cape Breton, Windsor, Brookfield, Merigomish, &c.

4. *SPIRIFERINA CRISTATA*, Schlotheim. Pl. IX. fig. 6.

Spirifer octoplicatus, Sow., Min. Conch. pl. 562. figs. 2, 3, 4; Dav. Mon. Carb. Brach. p. 38, pl. 7. figs. 37, 47.

At p. 221 of his 'Travels,' Sir C. Lyell mentions *Spirifer cristatus*, Schl., *Sp. minimus*, Sow., and *Sp. octoplicatus*, Sow., as having been found in the Lower Carboniferous limestone of Nova Scotia; but it is probable that at least two of the shells so termed, namely *Sp. cristatus* and *Sp. octoplicatus*, are referable to a single species. The

Nova-Scotian specimens of the shell under notice are all very small, none of those that have come under my notice exceeding 4 lines in length by 5 in width; they exactly resemble some specimens of the same species found in the Carboniferous shales of Capel Rig, East Kilbride, Scotland.

Sir C. Lyell mentions having found this shell at Windsor, Brookfield, Shubenacadie, and Debert River, in Nova Scotia; and Dr. Dawson adds East River, but that it is nowhere so plentiful as in the shell-conglomerate of Brookfield.

5. SPIRIFERA ACUTICOSTATA, De Koninck. Pl. IX. figs. 7, 8.

Spirifer acuticostatus, De Koninck, Description des Animaux Fossiles qui se trouvent dans le Terrain Carbonifère de la Belgique, p. 265, pl. 17. fig. 6.

Shell small and transversely oval; valves convex and ornamented with from twelve to fourteen small angular ribs. The mesial fold is comparatively wide, flattened, and longitudinally grooved along the middle. The sinus in the ventral valve has a small median angular rib, which commences at about the middle of the valve and extends to the front. Beak small, incurved; area triangular and of moderate dimensions. Length 4 lines, width 5 lines, depth 3 lines.

Upon sending a proof of the plate illustrating this paper to Prof. de Koninck, he wrote back that figures 7 and 8 were referable to his *Sp. acuticostatus*; and, except in size, they certainly resemble those given by the distinguished Belgian Professor. It must, however, be remembered that in some specimens of *Sp. cristatus*, or of its Carboniferous representative, *Sp. octoplicatus*, the mesial fold is flattened along its middle, and even possesses in some cases a shallow groove along its centre, as seen in De Koninck's *Sp. acuticostatus*. All these modifications in British specimens have been described and illustrated at pages 38 and 226 of my Monograph of British Carboniferous Brachiopoda.

This small shell is very abundant in the shell-limestone of Brookfield, Shubenacadie, and in some other localities in Nova Scotia, where it is always associated with *Sp. cristatus*, of which it may perhaps after all be no more than a modification.

CAMAROPHORIA and RHYNCHONELLA.

The specimens referable to these genera sent me by Dr. Dawson, as well as those brought to England by Sir C. Lyell, are generally very small, and not in all cases sufficiently complete to warrant a satisfactory determination. I have, however, carefully represented the principal forms.

6. CAMAROPHORIA? GLOBULINA?, Phillips. Pl. IX. figs. 11, 12.

Terebratulina globulina, Phillips, Encycl. Metr., vol. iv., Article "Geology," pl. 3. fig. 3, 1834.

Terebratulina rhomboidea, Phillips, Geol. Yorksh. vol. ii. p. 222, pl. 12. figs. 18-20, 1836.

Hemithyris longa, M'Coy, British Pal. Foss. p. 440, pl. 3. D. fig. 24, 1855.

Of this very small shell I have been able to examine only three specimens; but it is stated to be abundant in a yellow arenaceous limestone at De Bert River, where, according to Dr. Dawson's experience, it is always small. I have also felt somewhat puzzled in the determination of this fossil; but, after having consulted Prof. de Koninck, I concluded to refer the specimens represented in figures 11 and 12 to the same species, notwithstanding the apparent difference they present. Prof. de Koninck referred fig. 12 to *T. rhomboidea*, Phillips, which is a synonym of *Camarophoria globulina*; and, after minutely comparing the Nova-Scotian specimens with the Carboniferous and Permian types, I could perceive no difference sufficient to warrant the creation of a new species. The three specimens were exactly of the same size, namely 3 lines in length by 3 in width and $2\frac{1}{2}$ in depth. The uncertainty which both Prof. de Koninck and myself have experienced refers to fig. 11, which much resembles, in miniature, a form of *Rhynchonella acuminata*; but when we remember that Phillips himself figures a specimen of his *Terebratula rhomboidea* with a simple mesial fold, we need not be surprised to find the same peculiarity in one of those from Nova Scotia. Indeed, after carefully examining the three examples forwarded by Dr. Dawson, I cannot bring myself to believe that they should be specifically separated. It is well known that the same peculiarity occurs with *Rhynchonella acuminata*; and any one who examines plates 20 and 21 of my Monograph of British Carboniferous Brachiopoda must feel surprised at the immense variability of which some species are susceptible.

7. *RYNCHONELLA DAWSONIANA*, n. sp.? Pl. IX. figs. 13, 14.

Shell very small, almost circular, a little wider than long; dorsal valve moderately and uniformly convex to about half its length from the umbone, at which point a very slightly elevated and flattened mesial fold begins to rise, and extends to the front; the surface of the shell is also either almost entirely smooth or ornamented with from eight to twelve slightly marked ribs. The ventral valve is gently convex, with a wide sinus; beak small and incurved. Length $3\frac{1}{2}$ lines, width 4 lines, depth $2\frac{1}{2}$ lines.

This small species does not appear to be rare in a black Lower Carboniferous limestone at Lennox Passage, and is not unlike, except in size, certain examples of M. de Verneuil's *Terebratula superstes*; but this last-named Permian shell belongs to the genus *Camarophoria*, while the one under description belongs to *Rhynchonella*. I have compared it with a number of equally small young examples of *Rhynchonella pugnus*, from which it appears to differ.

8. *RYNCHONELLA ACADIENSIS*, n. sp.? Pl. IX. fig. 16.

Shell small, obscurely rhomboidal, about as wide as long; dorsal valve rather more convex than the ventral, and presenting, when viewed in profile, a regular curve. The mesial fold commences towards the middle of the valve, while the surface is ornamented with

twelve or thirteen small radiating ribs, of which four or five occupy the surface of the fold. The sinus in the ventral valve is of moderate depth, and the surface is ornamented as in the dorsal valve. The beak is gently incurved, and exhibits a small circular foramen under its angular extremity. Length 5 lines, width 5 lines, depth 3 lines.

Of this shell I have seen but two specimens, which I detached from a lump of the Brookfield shell-limestone, and of which one exhibited the two curved internal lamellæ characteristic of the genus *Rhynchonella*. It is quite distinct from young shells of *Rhynchonella pugnus* and *R. pleurodon*. In the last-named species the ribs that adorn the lateral portions of the dorsal valve are very much curved, while those of the ventral are nearly straight, with their extremities bent upwards; in addition to which, the ribs begin to be longitudinally grooved along their median portion at some distance from the margin. None of these characters are observable in the small *Rhynchonella* under description.

9. RHYNCHONELLA, sp. Pl. IX. fig. 17.

Upon some fragments of Lower Carboniferous limestone brought from Nova Scotia by Sir C. Lyell are several imperfect, undeterminable valves of a *Rhynchonella* which differs from the preceding species by its size, as well as by the number of its small radiating ribs. Of these last I have counted as many as thirty-five or forty upon each valve. In size it appears to have measured about 7 or 8 lines in length by 9 in width. I abstain from proposing for it a specific denomination, as the material is so imperfect. The specimen belongs to the Geological Society.

In fig. 15 is represented another *Rhynchonella*, also undeterminable.

10. RHYNCHONELLA PUGNUS?, Martin, sp., Petrif. Derb. tab. 22. figs. 4, 5, 1809.

Two or three very small specimens, received from Dr. Dawson after my plate had been completed, much resemble certain young shells of Martin's species; they are derived from the Lower Carboniferous limestone of Windsor and East River.

11. STROPHOMENA ANALOGA, Phillips. Pl. IX. fig. 18.

Producta analoga, Phillips, Geol. Yorksh. vol. ii. pl. 7. fig. 10, 1836.

Upon a specimen of dark, impure limestone brought from Nova Scotia by Sir C. Lyell, and now in the Society's Museum, I found a well-characterized example of this species, which, in Sir C. Lyell's list, had been confounded with *Productus Martini*.

12. STREPTORHYNCHUS CRENISTRIA, Phillips. Pl. IX. fig. 19.

Several crushed valves, referable to this species, occur on a specimen of Carboniferous shale from Shubenacadie, for which I am indebted to Dr. Dawson. These valves exactly resemble certain small specimens found in several British Carboniferous shales. Their surfaces are covered with numerous radiating raised striæ, with a

smaller rib between the larger ones, the whole being closely intersected by fine concentric lines, thus giving to the longitudinal ribs a crenulated appearance. Prof. de Koninck coincides in my identification.

PRODUCTUS.

Although Sir C. Lyell and Dr. Dawson mention seven species of this genus as having been found in the Lower Carboniferous rocks of Nova Scotia, all these, as well as the specimens I have been able to examine, can be referred to two species only, namely *P. semireticulatus* and *P. Cora*; and I may mention that Prof. de Koninck coincides in this view.

13. *PRODUCTUS SEMIRETICULATUS*, Martin. Pl. IX. figs. 20, 21.

Anomites semireticulatus, Martin, Petrif. Derb. pl. 32. figs. 1, 2, and pl. 33. fig. 4, 1809.

This species is so well known, that all I shall require to state is, that the Nova-Scotian specimens are exactly similar to those found in Europe. *Producta Martini*, *P. concinna*, *P. antiquata*, *P. Scotica*, mentioned by Sir C. Lyell at p. 220 (vol. ii.) of his 'Travels in America,' as well as by Dr. Dawson in various pages of his 'Acadian Geology,' belong to a single species, namely *Productus semireticulatus*, Sow. The "*P. spinosa*, Sow. ? var. of *P. Martini*," of Sir C. Lyell's list, belongs likewise to the species under description; but *P. spinosa*, Sow., specimens of which I have not seen from Nova Scotia, is a distinct species. Sir C. Lyell mentions Windsor, Brookfield, Shubenacadie, East River, Debert River, and Minudie. Dr. Dawson states that the shell is found almost everywhere, at Pugwash, near Amherst, Boulardarie, Cape Breton, Horton Bluff, Gray's River, &c.

The largest specimen measured one inch and a half in length by about the same in width. The variety *Martini* is also found in the same locality.

14. *PRODUCTUS CORA*, D'Orbigny, 1842. Pl. IX. figs. 22, 23.

Productus Cora, D'Orbigny, Paléont. du Voyage dans l'Amérique Mérid. p. 55, pl. 5. figs. 8, 9, 10, 1842.

P. comoides and *P. Scoticus*, De Kon. 1843 (not of Sow.).

Producta corrugata, M'Coy, Synopsis of the Carb. Limest. Fossils of Ireland, pl. 26. fig. 13, 1844.

P. Lyelli, De Verneuil, Sir Charles Lyell's Travels in North America, vol. ii. p. 221, 1845.

P. tenuistriata and *P. Neffedievi*, De Vern., Russia and the Ural Mountains, 1845.

P. Cora, De Koninck, Mon. du Genre *Productus*, pl. 4. fig. 1, 1847.

P. pileiformis, M'Chesney, Descr. of New Species of Fossils from the Palaeozoic Rocks of the Western States of America, p. 40, 1849.

P. Lyelli, Dawson, Acadian Geology, p. 219, fig. 9, 1855.

P. Cora, Dav., Mon. Carb. Brach. pl. 36. fig. 4, pl. 42. fig. 9, 1861.

After a very careful examination of nine or ten specimens of *P.*

Lyelli from the Lower Carboniferous Limestone of Nova Scotia, I have reluctantly been obliged to place *M. de Verneuil's* species among the synonyms of *P. Cora*, the latter name (as may be seen by the list of synonyms above given) claiming three years' priority. All the Nova-Scotian specimens I have been able to examine were small, not exceeding about 11 lines in length by some 12 or 13 in width. But it must be remembered that, as a general rule, the Nova-Scotian species and specimens, although adult, are small, and in this respect are exactly similar to those we find in Scotland. The surface is covered with numerous longitudinal, straight, or slightly flexuous, narrow, thread-like, rounded striæ, with sulci, or interspaces, of rather less width; smaller striæ are also here and there intercalated between the larger ones. The ribs are also regularly and closely crossed by small concentric lines.

P. Cora is a widely spread Carboniferous species, having been found in many parts of America, India, Europe, &c.

Sir C. Lyell found this shell at Windsor, Horton Bluff, Shubenacadie, Gay's River, Minudie, and Cape Breton, in Nova Scotia. Dr. Dawson states that it occurs almost everywhere—at Pugwash, on the eastern coast of Cumberland, at Lennox Passage, Mc'Kenzie's Mill at the eastern extremity of Wallace Harbour, &c.

EXPLANATION OF PLATE IX.

- Figs. 1, 2, 3. *Terebratula sacculus*, Martin.
- " 4, 5. *Athyris subtilita*, Hall.
- " 6. *Spiriferina cristata*, Schlotheim.
- " 7, 8. *Spirifera acuticostata*, De Koninck.
- " 9, 10. *Spirifera glabra*, Martin.
- " 11, 12. *Camarophoria? globulina?*, Phillips.
- " 13, 14. *Rhynchonella Dawsoniana*, n. sp.?
- " 15. *Rhynchonella* (undeterminable).
- " 16. *Rhynchonella Acadiensis*, n. sp.?
- " 17. *Rhynchonella* (undeterminable).
- " 18. *Strophomena analoga*, Phillips.
- " 19. *Streptorhynchus crenistria*, Phillips.
- " 20, 21. *Productus semireticulatus*, Martin.
- " 22, 23. *Productus Cora*, D'Orbigny.

2. On the GRAVELS and other SUPERFICIAL DEPOSITS of LUDLOW, HEREFORD, and SKIPTON. By T. CURLEY, Esq., C.E., F.G.S.

THE plans and geological sections which I have now the honour to lay before the Geological Society are those of three towns recently drained by me, namely, Ludlow, Hereford, and Skipton.

Ludlow.—The Upper Ludlow rocks are, in my opinion, thrown up against the Old Red Sandstone by a fault running east and west, and taking the line of the Old Town ditch, below the Church and the Castle, as marked on the plan (p. 177). The relations of the intermediate "passage-beds," which connect the Silurian and Old Red systems, and are so well developed in the immediate neighbourhood of the