Climaxodus ovatus, sp. nov. The specimen is perfect, the length being one inch, width at broadest part seven-tenths, and at narrow posterior end five-tenths; the crown is crossed by five transverse ridges, the distance between the ridges uniformly diminishes from front to back of tooth; the crown is considerably convex except between the first transverse ridge and the anterior edge of the tooth, where it is slightly concave; the summit of each ridge is marked at right angles to the ridges, or from front to back of the tooth with close, nearly parallel lines consisting of a cream-coloured iridescent substance. The tooth is attached to a long plate, the length of which is one-third greater than that of the tooth, and towards the posterior part of the tooth the supporting plate presents a root-like appearance; the thickness of the tooth is one-tenth of an inch, that of the plate to which it is attached one-eighth of an inch. The structure of the bony plate is open and reticulated, closely resembling in structure the base of the palatal teeth of the *Ctenodi*.

In a lecture which I delivered to the members of the Mechanics' Institution, Newcastle-on-Tyne, on 28th September, on the Fauna of the Low Main Coal-shale, I described and named the only specimen then in my possession as *Climaxodus ovatus*. To-day (October 10) I have heard that Mr. Atthey, of Gosforth, read a paper before the members of the Tyneside Naturalists' Field-club yesterday, the 9th, and described a similar tooth found by him during his long and painstaking researches in this department of palæontology. How many specimens Mr. Atthey has in his possession, or what is their state of preservation, I have not been informed.

In order to obtain reliable information respecting fish and reptile remains found in the Coal-measures, I have found it necessary to search many works, generally inaccessible to most local geologists. It has occurred to me that a popular exposition of the fishes and reptiles of the Coal-measures, with a few typical illustrations, taking each genus in its order, might prove of great service to those readers of the GEOLOGICAL MAGAZINE who have not made Carboniferous fossils a speciality, and who desire a popular exposition of the fossils that are now becoming somewhat plentifully distributed throughout the kingdom. I commend this suggestion to those of your contributors who have made the Carboniferous system a study, and who have access to the most recent specimens and works upon the subject.

IV.—THE RANGE AND DISTRIBUTION OF BRITISH FOSSIL BRACHIOPODA.

By J. LOGAN LOBLEY, F.G.S.

IN the following brief remarks on the range and distribution of *Brachiopoda* in British strata, and in the accompanying tables, the classification of Dr. Davidson has been mainly followed; and the calculations of the numbers have been principally based on the researches of that great authority, though the recent discoveries of Mr. C. Moore and others have been duly taken into consideration. These numbers must, of course, only be regarded as showing the present state of knowledge on the subject, as the active search which many observers are making will doubtless materially alter the figures here given.

The class *Brachiopoda* is represented in British rocks by 47 genera and sub-genera, of which a complete list is given in the following table. The generic names are arranged in the order of the incoming or earliest appearance of each genus, and the table shows the number of species of each genus in each of the great groups of British strata in which it has been found. The asterisks indicate the genera which are living in the present seas of our globe.

GENERA.	Cambrian.	Silurian.	Devonian.	Carboniferous.	Permian.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Recent.
<i>Lingulella</i>	1	3	...	...	...	...	...	...	...	...
<i>Obolella</i>	?	4	...	...	...	...	...	...	...	...
<i>Discinia</i>	?	10	1	2	1	...	7	?	1	*
<i>Orthis</i>	...	45+7v.	5	4	...	...	...	...	...	...
<i>Lingula</i>	...	21	1	6	1	...	2	2	2	*
<i>Kutorgina</i>	...	1	...	...	...	...	...	...	...	...
<i>Obolus</i>	...	2+3v.	...	...	...	...	...	...	...	...
<i>Siphonotreta</i>	...	2	...	...	...	...	...	...	...	...
<i>Leptæa</i>	...	13	3	...	...	...	7	...	...	...
<i>Strophomena</i>	...	21	1	1	...	...	...	...	...	...
<i>Acrotreta</i>	...	1	...	...	...	...	...	...	...	...
<i>Crania</i>	...	7	...	3	1	...	7	4	...	*
<i>Orthisina</i>	...	2	...	...	...	...	...	...	...	...
<i>Atrypa</i>	...	7+1v.	5+1v.	...	...	...	...	...	...	...
<i>Meristella</i>	...	9	...	...	...	...	...	...	...	...
<i>Rhynchonella</i>	...	18	15+1v.	14	...	...	37	17+4v.	1	*
<i>Spirifera</i>	...	7+2v.	19	27	2	...	8	...	...	...
<i>Pentamerus</i>	...	7	2	...	...	...	...	...	...	...
<i>Stricklandinia</i>	...	2	...	...	...	...	...	...	...	...
<i>Porambonites</i>	...	2	...	...	...	...	...	...	...	...
<i>Chonetes</i>	...	3	2	7	?	...	...	...	...	...
<i>Athyris</i>	...	3	8	9	1	...	...	...	...	...
<i>Retzia</i>	...	2+2v.	1	3	...	...	...	...	...	...
<i>Orbiculoides</i>	...	2	...	...	...	...	...	...	...	...
<i>Nucleospira</i>	...	1	...	...	...	...	...	...	...	...
<i>Streptorhynchus</i>	...	...	6	4	1	...	...	...	...	...
<i>Spiriferina</i>	...	...	2	4+1v.	2	...	3	...	...	...
<i>Cyrtina</i>	...	...	4	2+?	...	...	...	...	...	...
<i>Terebratula</i>	...	...	4	3+1v.	1+1v.	...	44	23	2	*
<i>Merista</i>	...	...	1	...	...	...	...	...	...	...
<i>Uncites</i>	...	...	1	...	...	...	...	...	...	...
<i>Cammarophoria</i>	...	...	1	5	3	...	...	...	...	...
<i>Davidsonia</i>	...	...	1	...	...	...	...	...	...	...
<i>Productus</i>	...	...	4	41	2	...	...	...	...	...
<i>Stringocephalus</i>	...	...	1	...	...	...	...	...	...	...
<i>Rensseleria</i>	...	...	1	...	...	...	...	...	...	...
<i>Strophalosia</i>	...	...	1	...	2+3v.	...	...	...	...	...
<i>Thecidium</i>	...	...	...	...	...	...	14	1	...	*
<i>Zellania</i>	...	...	...	...	...	...	6	...	...	...
<i>Argiope</i>	...	...	...	...	...	...	3	2	1	*
<i>Terebratulina</i>	...	...	...	...	...	...	2	3+2v.	2	*
<i>Waldheimia</i>	...	...	...	...	...	...	1	8	...	*
<i>Terebratella</i>	...	...	...	...	...	...	3	4	...	*
<i>Megertia</i>	...	...	...	...	...	...	...	1	...	*
<i>Terebrirostra</i>	...	...	...	...	...	...	...	1	...	...
<i>Trigonosemus</i>	...	...	...	...	...	...	...	2	...	...
<i>Magas</i>	...	...	...	...	...	...	...	1	...	...

Of the species composing these genera and sub-genera, very few have a range extending through more than one or two formations, while several, as *Terebratula fimbria* for example, characterise a particular zone or stratum of, in some instances, not more than a few inches in thickness. The elaborate works of Dr. Davidson, however, give with so much minuteness the range of particular species that I will pass on to a brief consideration of the range and distribution of the genera and sub-genera.

The oldest of all the Brachiopods is the *Lingulella*—*L. ferruginea* having been found by Dr. Hicks in Cambrian rocks. This genus ranges through the Primordial Silurian group, giving name to the Lingula flags, in which *Lingulella Davisii* is exceedingly abundant. Above the Tremadoc slates, *Lingulella* has not, with certainty, been found. *Obolella* having recently been found in the Upper Longmynd rocks, must be placed next. This genus, like *Lingulella*, attains its maximum development in the Primordial Silurian; and dies out in the Llandeilo rocks, in which only one species has hitherto been discovered.

A *Discina* has, it is said, been also found in older rocks than any having a right to a place in the Primordial Silurian, and therefore that genus is entitled to the third place. *Discina*, however, has a much greater range than the two previously mentioned genera, since it is found in Palæozoic, Mesozoic, and in Cainozoic strata, and is, moreover, a living genus at the present day, though it has been searched for in vain in many formations both in the Palæozoic and Mesozoic groups. The greatest number of species of *Discina* have been taken from Caradoc strata, though not more than five well-marked species have been discovered in these rocks.

The very important genus *Orthis* is represented by no less than 30 species in the Caradoc rocks, but its range has not been found to extend further than from the Primordial Silurian to the Carboniferous Limestone.

Lingula, of which *Lingulella* may be termed perhaps rather a sub-genus than considered a separate genus, appears next, and has a range from the Primordial Silurian to the latest formations, and lives in the present seas of the world. It is not, however, in any formation represented by many species, and in not any of the Mesozoic or Cainozoic rocks do we find more than one species. The genus attained its maximum development in the Llandeilo rocks, in which eight species have been discovered.

Crania will be seen to have a very long range, but it is represented by very few species.

The important genus *Rhynchonella* commences in the Caradoc and ranges to the present time, *R. psittacea* being found living in the Northern seas. It is largely represented in Silurian, Devonian, Carboniferous, Oolitic, and Cretaceous rocks, but only one species has been found in Tertiary strata.

Spirifera, the next genus, has its maximum number of species in Carboniferous rocks, in which we find no fewer than 27 well-marked species. Mr. C. Moore has discovered two species in the Inferior Oolite, in which this genus appears to have died out.

Passing over several genera which have comparatively short ranges, we find the well-known *Terebratula* commencing in the Middle Devonian, having a great development in Oolitic and Cretaceous strata, and continuing to the present time.

We next find *Merista* and *Uncites* with one species each in the Middle Devonian, *Camarophoria* next, and then *Davidsonia*, of which one species only has up to the present time been discovered in British strata.

Productus has a very remarkable range and distribution. The first species we find in Middle Devonian, three in Upper, and no less than 41 in Carboniferous Limestone; after which only two species appear, and these are in the Permian Magnesian Limestone.

Stringocephalus and *Rensseleria*, two genera with only one species to represent each, are also in the Middle Devonian.

Strophalosia we find in Upper Devonian strata, and this is the last of the Palæozoic Brachiopods.

In Mesozoic rocks, *Thecidium*, *Zellania*, *Argiope*, *Terebratulina*, and *Waldheimia* all commence in the Lias, *Terebratella* in the Great Oolite, and *Megerlia*, *Terebrirostra*, *Trigonosemus*, and *Magas* in Cretaceous formations, the last-named genus not being found lower than the Chalk; and as no genus is known to commence its range in Cainozoic strata, *Magas* may be considered, according to our present knowledge, the newest of British fossil Brachiopoda.

Eleven genera are represented by species now living in the seas of our globe, and are therefore recent as well as fossil genera. Of these *Discina*, *Lingula*, *Crania*, *Rhynchonella*, and *Terebratula*, range upwards from Palæozoic rocks.

The genera *Leptaena*, *Spirifera*, and *Spiriferina*, range from Palæozoic into Mesozoic, but do not reach Cainozoic strata, while there are no less than twelve genera, each of which is characteristic of a single formation, or minor group of strata.

The following is a list of the species of these twelve genera with the names of the formations, or groups, characterised by them. It will be seen that only two of these genera, *Orthisina* and *Orbiculoidea*, are represented by more than one species each.

<i>Kutorgina cingulata</i> , Bill.,	Primordial Silurian.
<i>Acrotreta Nicholsoni</i> , Dav.,	Llandeilo.
<i>Orthisina ascendens</i> , Pander	} Caradoc.
<i>Scotica</i> , McCoy	
<i>Orbiculoidea Beckettiana</i> , Dav.	} Wenlock.
<i>Forbesii</i> , Dav.	
<i>Nucleospira pisum</i> , Sow. sp.,	Wenlock.
<i>Merista plebeia</i> , Sow.,	Middle Devonian.
<i>Uncites gryphus</i> , Schl.,	Middle Devonian.
<i>Davidsonia Verneuilii</i> , Von Buch,	Middle Devonian.
<i>Stringocephalus Burtini</i> , Def.,	Middle Devonian.
<i>Rensseleria stringiceps</i> , Roem,	Middle Devonian.
<i>Terebrirostra lyra</i> , Sow.,	Upper Greensand.
<i>Magas pumila</i> , Sow.,	Chalk.

Thirty genera are essentially Palæozoic, and eight genera have not been found in any other than Mesozoic strata, though four of these have living representatives, while not one genus can be considered characteristic of Cainozoic strata.

Proceeding now to the consideration of the range and distribution of the nine families in which all the British fossil *Brachiopoda* may be placed, we find that nearly every family has had a long range in time, and that six are represented by recent species.

The following table shows the number of species of each family in each System or principal group of British strata.

FAMILIES.	Cambrian.	Silurian.	Devonian.	Carboniferous.	Permian.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Recent.
<i>Lingulidæ</i>	1+1?	31+3v.	1	6	1	...	2	2	2	*
<i>Discinidæ</i>	?	15	1	2	1	...	?	?	1	*
<i>Strophomenidæ</i> ..	...	81+7v.	16	9	1	...	7		...	...
<i>Craniadæ</i>	...	7	...	3	1	...	7	4	...	*
<i>Spiriferidæ</i>	...	29+5v.	41+1v.	45+1v.	5	...	8		...	...
<i>Rhynchonellidæ</i> ..	...	29	18+1v.	19	3	...	37	17+4v.	1	*
<i>Productidæ</i>	...	3	8	48	4+3v+?	...	...		...	...
<i>Terebratulidæ</i> ..	...		6	3+1v.	1+1v.	...	59	45+3v.	5	*
<i>Thecididæ</i>	...		...	...	...	...	14	1	...	*
CLASS—										
<i>Brachiopoda</i>	1+2?	185+15v.	91+2v.	135+2v.	17+4v+?	...	141	69+7v+?	9	*

The family of *Productidæ*, represented by the *Chonetes* in the Llandovery rocks, greatly abounding in the form of *Productus* in the Carboniferous Limestone, dies out in the Permian, and is therefore a characteristically Palæozoic family.

Thecididæ, on the other hand, are characteristically Mesozoic, as they have not hitherto been found in strata older than the Middle Lias, or newer than the Chalk. We thus have one family essentially Palæozoic and one family characteristic of Mesozoic strata. Having no genus we have no family confined to Cainozoic strata, each great type of form in the Brachiopoda having come into existence long previously, the latest family being the *Thecididæ*.

Although not entirely confined to Palæozoic strata, the family of *Strophomenidæ* may almost be said to be characteristic of these rocks, since it is so largely represented in the strata below the Coal, and is only found in rocks newer than the Permian represented by a few species of one genus, *Leptæna*, found in the Lias.

Spiriferidæ, too, are very largely represented in Palæozoic strata, and very sparingly in Mesozoic, eight species only having been discovered in strata above the Permian.

The families which range from the Palæozoic rocks to the present time, and now represented by living species, are *Lingulidæ*, *Discinidæ*, *Craniadæ*, *Rhynchonellidæ*, and *Terebratulidæ*.

Of these the first, *Lingulidæ*, as we have before seen, is the oldest of all the families of *Brachiopoda*, and has been found in nearly every group of rocks from the Cambrian to the Eocene, though represented by very few species in any, the greatest number of species of *Lingulidæ* being found in the Primordial Silurian rocks, in which not more than ten well-defined species have hitherto been discovered.

If it be admitted that a *Discina* has been found in Cambrian strata, the range of the family of *Discinidæ* will be similar to that of *Lingulidæ*, since we find the genus *Discina* living in both the Atlantic and Pacific Oceans. This family is also represented by very few species in any formation, the maximum number being six in the Wenlock rocks.

The *Craniadæ* are even more sparingly represented than either the *Lingulidæ* or *Discinidæ* (there being only one genus), and they appear in a much smaller number of formations.

Rhynchonellidæ first appear in the Caradoc strata, represented by the typical genus *Rhynchonella*, and only one species. In the Llandovery strata, however, it is a much more important family; for in these rocks we find four genera and twenty species to represent it. In the Wenlock rocks the same number of genera and nineteen species have been found; but when we examine Ludlow strata, we only find two genera and seven species of *Rhynchonellidæ*. This important family is largely represented in the Devonian rocks, —the Middle Devonian especially, which has yielded three genera and eighteen species. The Upper Devonian beds do not contain more than four species, but in the Carboniferous rocks we have sixteen species. Three species have been taken from Permian rocks, above which all the generic forms except *Rhynchonella* are absent. The greatest number of genera of *Rhynchonellidæ* is to be found in the Llandovery and Wenlock rocks, but the greatest number of species in the Inferior Oolite, in which the typical genus *Rhynchonella* obtains a great development.

The family of *Terebratulidæ* is a very important one; not only from the abundance of the typical form *Terebratula* in many rocks, but also from the great number and interesting character of the genera into which the family has been divided. No less than twelve genera and sub-genera of British fossil *Brachiopoda* have been described as belonging to this family. Of these genera only three, *Terebratula*, *Stringocephalus*, and *Rensseleria*, are Palæozoic; *Stringocephalus* and *Rensseleria* being confined to the Middle Devonian, in which also the typical form *Terebratula* first makes its appearance. Six genera, *Terebratula*, *Zellania*, *Waldheimia*, *Terebratella*, *Terebratulina*, and *Argiope* appear in the Lower Mesozoic rocks, the greater number of generic forms of *Terebratulidæ* being found in Cretaceous strata; and in these rocks no less than nine genera have been discovered. We thus have the greatest number of genera of *Terebratulidæ* in Cretaceous rocks; but the greatest number of species in the Inferior Oolite, in which twenty-two species have been found. *Terebratulidæ* is very weakly represented in Cainozoic strata; *Terebratula*, *Terebratulina*, and *Argiope*, only having been discovered. These genera, with three others, *Terebratella*, *Waldheimia*, and *Megerlia*, existing in the present seas,

When we consider the range, distribution, increment, decrement, and maximum development of the class without reference to its separate genera or families, we find that the class *Brachiopoda* is represented in British strata by a very large number of species, some of which are found in almost every geological formation. Coming

into existence, as far as we yet know, in Cambrian times, *Brachiopoda* abounded in Silurian seas, but the class attained its maximum development in the Carboniferous period. A small number of species have been taken from Permian rocks, but Triassic strata have not hitherto yielded us any. When we examine Liassic and Oolitic strata, we find again a large number of species, which, however, become fewer as we ascend the scale, until we reach the Portland rocks, in which no Brachiopod has been discovered. The class again increases in importance in Cretaceous strata, and again diminishes in Tertiary formations, which have hitherto furnished us with not more than eight or nine species. Of living *Brachiopoda* seventy species have been described; these have a wide geographical range, and have been found both in littoral waters and in seas of great depth.

Although in British seas Brachiopods are very rare, yet they are by no means so in the seas of Southern latitudes, the bays and harbours of Australia swarming with *Waldheimia* and other forms of this interesting and remarkable class of the animal kingdom.

V.—ON THE CLASSIFICATION OF ROCKS.

By CAPTAIN F. W. HUTTON, F.G.S.

NO one, I think, will deny that geology is far behind all the other sciences in the classification of those substances which form its special study, viz., rocks. No two authors agree on the subject, and no one seems to have attempted to form a scientific classification, based on a natural system.

The reason perhaps is, that nearly all the classifications we have are from the hands of chemists and mineralogists rather than geologists; and no geologist, therefore, can admit their systems as natural, or as adapted to his purpose. How, for instance, could a geologist think of classifying an aphanite-slate, interbedded with quartzite and clay-slate, with an aphanite dyke cutting across the rocks in an uncertain direction? It is absolutely essential for him to determine to which class the piece of aphanite he may just have broken off with his hammer belongs, as it will make a vast difference in the structure of the country he is examining, and in the geological map of the district. Cotta, indeed, says that "we cannot lay down a logically complete system of classification, to embrace all rocks, on any principle." In this I quite agree with him; but any one principle means an artificial classification, and I believe that it is quite possible to form a natural system complete enough to answer all the wants of a geologist, and I hope that I shall not be considered presumptuous for having, with this view, drawn out the following table, in which I have tried to make the rocks fall into as natural groups as possible. That I have not succeeded in all cases I am the first to admit, but I hope that it will not be without its use in showing what appears to me to be the most natural system that we can adopt at present.

In drawing up this table I have tried to base the different divisions, etc., on facts well established, and not on debated theoretical points. This has led me to reject, after much consideration, some names in common use, such as "Igneous," "Intrusive," etc., and to substitute