time still undiscovered) with the cycloidal-scaled members of the *Crossopterygidæ*. And although he was not fully aware of the extreme closeness of the relationship between the recent Sirenoids and one of his Crossopterygian families, the *Ctenodipterini*, he, nevertheless, touched the spring which subsequently disclosed to us the true position of that family, when he compared the teeth of *Lepidosiren* with those of *Dipterus*.

On the other hand the American bony pike or *Lepidosteus*, is made the living type of another great assemblage, of which the Old Red Sandstone genus *Cheirolepis* "ought perhaps to be regarded as the earliest known form." To this sub-order of *Lepidosteidæ* merely a passing and imperfect notice is accorded, but it is nevertheless clear that the author means it to embrace both the heterocercal *Palæoniscidæ* of the upper palæozoic rocks, and that great array of semi-heterocercal rhombic-scaled forms (*Lepidotus*, *Dapedius*, *Pholidophorus*, &c.), which in mesozoic times constituted the great bulk of the Ganoid order.

These two great sub-orders of *Crossopterygidæ* and *Lepidosteidæ*, with the addition of the recent *Amiadæ*, are equivalent to Müller's *Ganoidei Holostei*. The other sub-order of the Berlin anatomist, that of the *Chondrostei* or sturgeons was accepted, and to it the remarkable Old Red family of *Cephalaspidæ*, referred, provisionally at least, while into a fifth sub-order was erected the problematic group of *Acanthodidæ*, which, in their organisation, seem to combine so many of the characters both of ganoids and of sharks.

Undoubtedly, the weakest point in Prof. Huxley's "essay" is the attempt which he made to show, by comparison of the exoskeletal plates of *Coccosteus* with the bones visible on the exterior of the skeleton of many recent siluroids, that there was a possibility at least of the enigmatical group of *Placodermata* turning out to belong to the great order of *Teleostei*, or ordinary bony fishes, "hitherto supposed to be entirely absent from formations of palæozoic age." Recent discoveries in the palæozoic rocks of America point, as we shall presently see, to another, and perhaps more probable, solution of the question.

Mr. Powrie, of Reswallie, has contributed several papers on the fishes of the Old Red Sandstone of Forfarshire, and to him we owe the definition of the genus *Euacanthus*, comprising four species, and also of a new species of *Parexus*. The remarkable group of *Cephalaspidæ* has been monographed by Prof. E. Ray Lankester in the volumes of the Palæontographical Society for 1868 and 1870.

The true affinities of the Old Red Sandstone genus *Dipterus*, and the carboniferous *Ctenodus*, foreshadowed by Mr. Huxley in 1861, were thoroughly cleared up by the discovery of the living *Ceratodus Forsteri* in the rivers of Queensland. The *Ctenodipterini* were definitely placed among the *Dipnoi* by Dr. Günther in his account of the structure of *Ceratodus* (*Phil. Trans.*, 1871), and subsequent observation has amply confirmed the correctness of his views on this point.

The discovery in the Devonian rocks of North America of the gigantic Placoderm, named by Prof. Newberry *Dinichthys*, seems at last to throw some light on the position of that remarkable group of extinct fishes. In *Dinichthys* we have a form, apparently closely allied to *Coccosteus*, but also possessed of a dentition in many respects resembling that of the recent *Lepidosiren*. It seems, therefore, not unlikely that the *Placodermata* will eventually turn out to have been an aberrant group of loricated *Dipnoi*.

Recent progress with regard to the structure and affinities of Scottish Carboniferous fishes is so inseparably connected with the study of the fishes of the same great period in England, that here the sister kingdoms cannot easily be treated separately, except as regards local and stratigraphical lists of genera and species. Descriptive papers dealing with English specimens are of equal importance to the student resident in Scotland. Scottish fossil ichthyology is therefore equally indebted to Prof. Young for his descriptions (published in 1866) of the remarkable Platysomid genera *Amphicentrum* (= *Cheirodus*, M'Coy) and *Mesolepis*, as well as of the little *Platysomus parvulus*, a species named but not described by Agassiz, as all of them occur in the Scottish coal-measures, although Prof. Young's descriptions were taken from the more perfect examples furnished by the North Staffordshire district. Prof. Young, in the same paper, also correctly pointed out the affinity to *Mesolepis*, and consequently also to *Platysomus*, of our well-known Scottish Lower Carboniferous genus *Eurynotus*, but I fear we cannot accept his sub-order *Lepidopleuridæ*, in which he sought to include both the Platysomid and Pycnodont fishes. His paper on "Carboniferous Glyptodipterines" (*Rhizodopsis*, *Rhizodus*, &c.), also published in 1866, deals largely with Scottish specimens, and with forms which constantly come under the notice of the Scottish collector. Prof. Young has given, besides, several other notices of fish remains from the Carboniferous rocks of the West of Scotland, as has also Mr. James Thomson, of Glasgow, among whose contributions may be specially mentioned his description and figure of an enormous *Acanthodes* from the Palace Craig Ironstone of Lanarkshire. Of purely local work, a very creditable example, though requiring some revision, is the list of carboniferous fishes in the "Catalogue of the Western Scottish Fossils," compiled by Messrs. Young and Armstrong, published first in the *Transactions* of the Geological Society of Glasgow, and afterwards issued as one of the "British Association Guide Books" on the occasion of the meeting of that body at Glasgow in 1876.

Here we must for the present take leave of our subject. Much remains still to be done both as regards general research into the structure and classification of palæozoic fishes, and as regards the rectification of species, and the compiling of reliable catalogues of those which occur as well in Scotland as in other divisions of our common country of Great Britain. The work must, however, necessarily be slow, as nothing is more injurious to the cause of palæontology than undue haste, whether in descriptive work or in attempted generalisation.

THE STRUCTURE AND ORIGIN OF STRATIFIED ROCKS[1]

IN his address last year the author treated exclusively of the structure and origin of limestones, and now confined his remarks to the structure and origin of all other stratified rocks. In the first place he considered the question of the origin in crystalline rocks of the material, and described those peculiarities in external form and internal structure, which would enable us to determine the true nature and origin of the grains of sand and other materials met with in stratified rocks. He next considered the formation of the very fine-grained particles met with in clays and mud, as derived from the mechanical wearing down of minerals like quartz, which cannot be decomposed, or from the chemical decomposition of others like felspar and hornblende. The materials thus formed mechanically and chemically by the complete weathering of crystalline rocks are to a great extent in a state of equilibrium, and not prone to undergo further change, whereas the minerals in volcanic ash are to a considerable extent in a state of such unstable equilibrium that they soon undergo further important changes. A deposit of this nature might thus soon be more altered than one of the other type in vast geological periods. Amongst other facts of the like kind it may be named that the large amount of very fine-grained micaceous mud deposits found in some of our earlier strata was shown to be in all probability derived from certain quartz felsites, in which the base is to a large extent composed of very minute crystals of mica.

Having thus traced the origin of the material, the method of observing loose unconsolidated deposits was described, and afterwards the general conclusions so far arrived at. In the case of quartz sands it was shown that, though they might appear almost identical to the naked eye, they may be divided into five well-marked varieties, which however pass gradually one into the other. These five types are as follows:—

1. Normal, angular, fresh-formed sand, as derived almost directly from granitic or schistose rocks.

2. Well-worn sand, in rounded grains, the original angles being completely lost, and the surface looking like ground glass.

3. Sand mechanically broken into sharp, angular chips, showing a glassy fracture.

4. Sand having the grains chemically corroded, so as to produce a peculiar texture of the surface, differing from that of either worn grains or crystals.

5. Sand in which the grains have a perfect crystalline outline, in some cases undoubtedly due to the deposition of quartz over rounded or angular nuclei of ordinary non-crystalline sand.

On the whole, then, we may say that these different types are due to different kinds of mechanical or chemical changes, affecting grains originally derived from crystalline rocks.

In further considering sands more or less worn mechanically,

[1] Abstract by the Author of the President's Address at the anniversary meeting of the Geological Society, February 20, by H. C. Sorby, LL.D., F.R.S.

it was shown that for fair comparison the coarser and the finest particles should be separated by sieving and washing, so as to obtain clean grains having on an average a diameter of about $\frac{1}{100}$th of an inch. On examining such sand from different deposits and different localities, it is seen that the amount of wearing varies very greatly. Much remains to be learned respecting the detail, but the observations made hitherto show that certain deposits are as if derived almost directly from crystalline rocks, that a very considerable amount of mechanical action is required to round angular grains of quartz $\frac{1}{100}$th of an inch in diameter, and that in proceeding from the apparent source in crystalline rocks the amount of wearing increases, until, when the sand has been drifted for 100 or 200 miles, about one-half of the grains are well worn and rounded. The uniformity in character over wide districts is sometimes remarkable and very characteristic.

Certain special questions connected with the structure of fine-grained deposits were then considered, amongst which may be specially mentioned the lamination of shales. It was shown that after complete subsidence such fine-grained muds contain so much included water that if squeezed out by the vertical pressure of superincumbent strata, the bulk would be reduced to at least $\frac{1}{4}$th, which would necessarily develop a fissile structure in the plane of stratification, analogous to, but much less perfect than, the transverse cleavage of slates due to lateral pressure.

The nature of the more characteristic materials of fine-grained slates was next considered, and it was shown that they must originally have often differed very greatly from the more modern deposits of granular mud to a great extent derived from the decomposition of granitic rocks, this difference being mainly due to their having been derived to a large extent from the decomposition of the fine-grained basis of certain felsitic ashes. On the contrary, the characteristic features of the green slates of the English Lake District are mainly due to the material having been derived from a mere doleritic type of ash. One of the most striking facts is the great amount of true pumice, the originally empty cells of which are now filled with calcite or with various green minerals, in the same manner that the cells of foraminifera are often found filled with glauconite.

The author then pointed out how some difficulties connected with the mechanical origin of slaty cleavage could be easily removed, and traced the gradual passage from an ordinary stratified, non-cleaved slate to one with an imperfect cleavage due to the development of close joints or planes of discontinuity, and finally to a perfect cleavage, when the yielding of the mass to lateral pressure was sufficiently great.

The next questions which claimed attention were connected with the chemical changes that have occurred in the rocks since they were deposited. These have often given rise to a well-marked group of minerals, of several different kinds, but usually of green colour, and their development has played an important part in strata of nearly every age, resulting in the formation not only of the green grains of the green sand, but also in the analogous green constituents of many slates.

The author then discussed very carefully the gradual development of mica-schist, tracing it from what might be called its very germs, in grains only $\frac{1}{500}$th of an inch in diameter, formed *in situ* in some slates, to cases in which the whole of the original constituents of the slate have re-crystallised *in situ* into mica and quartz. In rocks of this type we can clearly see that the foliation is not due to deposition, but to crystallisation, which has been greatly influenced, not only by the previously existing structures due to stratification, but also by those due to cleavage previously developed by lateral pressure. Such fine-grained connecting links between slates and schists differ from true schists only in being of finer grain, which is sometimes so fine that with the naked eye it would be almost impossible to distinguish between them and slates, though the microscope shows that true slates have been deposited as mud, whilst the fine-grained schists have re-crystallised *in situ*.

The author concluded by specially considering what evidence remained in the most typical schistose rocks of the former presence of the grains of sand and of the fine granular particles found in slates, and showed that although they could sometimes be detected, yet in many cases the whole rock is so completely crystalline, that all evidence had been obliterated. The proof of crystallisation *in situ* is, however, very complete, so that, though we can see clearly that the original rock must have been greatly changed, we cannot really prove from its structure what the rock originally was—whether it was detrital or a mass of small crystals. This re-crystallisation of the material *in situ* is more especially proved by the structure of those schists which possess *cleavage foliation*. This differs most characteristically from *stratification foliation*, and clearly proves that before crystallisation took place the structure of the rock had been altered by lateral pressure.

It will thus be seen that the main object of the address was to trace the origin of the constituents of modern or more ancient sand and mud from pre-existing crystalline rocks of different types, and to show the correlation of the most modern and the most ancient deposits, and finally to trace the changes that have occurred since deposition, until they reach their extreme in the reproduction of crystalline rocks, thus completing the entire cycle of chemical and mechanical changes.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE petitions of Owens College and Yorkshire College relative to the creation of the "Victoria" University, have been printed as a parliamentary paper, with the draft of the proposed charter, the main heads of which we have already given. We believe this draft now only awaits the sanction of Parliament to become law.

DR. WILLIAM RAMSAY, of the chemical laboratory of the University of Glasgow, has been appointed to the Chair of Chemistry in University College, Bristol, in room of Dr. Letts, who has succeeded Dr. Andrews in Queen's College, Belfast.

MR. T. J. PARKER, B.Sc. (Lond.), son of Prof. W. K. Parker, F.R.S., has been selected for the Professorship of Biology in the University of Otago, New Zealand, and Curatorship of the Otago Museum. Mr. Parker has for some years been Demonstrator of Biology in the laboratory of the Royal School of Mines, South Kensington. We understand that three Commissioners were appointed by the University Council to report on the qualifications of candidates. The candidates, we believe, were numerous and highly qualified.

PROF. LÖWIG, who occupies the chair of chemistry at the University of Breslau, celebrates on April 7 the fiftieth year of his doctorate. As his laboratory courses have always been largely attended by pharmaceutical chemists, of whom over 1,000 have pursued their studies under his guidance, a movement has been set on foot to endow in honour of the occasion a pharmaceutical scholarship, to bear the name of the veteran professor. Although the University of Breslau occupies by no means the first rank among German universities, still the salary and fees falling to the share of the occupant of the chair of chemistry, form a sum far in excess of that received by any other professor of chemistry in the empire. Second on the list in this regard is the professorship of chemistry at Würzburg, now held by Prof. Wislicenus. In both cases the fact is mainly due to the large affluence of medical students who are forced to take courses of chemical lectures.

THE authorities of the Zurich Polytechnic are making preparations to celebrate next August the twenty-fifth anniversary of the foundation of the institution. In view of the widespread influence which the Polytechnic has exerted on the recent development not only of the canton but of the entire republic the occasion will be one of no slight interest.

THE *Neue Freie Presse* makes the following comparison of schools and school attendance in different European countries:—Germany, with a population of 42,000,000, has 60,000 schools and an attendance of 6,000,000 pupils; Great Britain and Ireland, with a population of 34,000,000, has 58,000 schools and 3,000,000 pupils; Austria-Hungary, with a population of 37,000,000, has 30,000 schools and 3,000,000 pupils; France, with a population of 37,000,000, has 71,000 schools and 4,700,000 pupils; Spain, with a population of 17,000,000, has 20,000 schools and 1,600,000 pupils; Italy, with a population of 28,000,000, has 47,000 schools and 1,900,000 pupils; and Russia, with a population of 74,000,000, has 32,000 schools and 1,100,000 pupils.

SCIENTIFIC SERIALS

THE *Journal of the Royal Microscopical Society*, containing its transactions and proceedings and a record of current researches relating to invertebrata, cryptogamia, and microscopy, Feb