

and no attempt to use the old units or to return to the old system was made.

In the United States, where a system founded on the English units exists, a Commission is at present engaged in an investigation of the same character as that with which the Committee was charged, and the Federal Government has this year passed an Act rendering the metrical system compulsory for pharmaceutical purposes.

The Committee believes that the adoption of the metrical system by England would greatly tend to render that system universal.

It is recommended:—

(a) That the metrical system of weights and measures be at once legalised for all purposes.

(b) That after a lapse of two years the metrical system be rendered compulsory by Act of Parliament.

(c) That the metrical system of weights and measures be taught in all public elementary schools as a necessary and integral part of arithmetic, and that decimals be introduced at an earlier period of the school curriculum than is the case at present.

### SCIENCE IN THE MAGAZINES.

THIS month's *Contemporary Review* is remarkably rich in articles of scientific interest. Mr. Herbert Spencer's third paper on professional institutions deals with the "Dancer and Musician." So far back as 1857, Mr. Spencer showed that, excluding movements which are reflex and involuntary, muscular movements in general are originated by feelings in general. "As a consequence of this psycho-physical law, the violent muscular motions of the limbs which cause bounds and gesticulations, as well as those strong contractions of the pectoral and vocal muscles which produce shouting and laughter, become the natural language of great pleasure." From the ways in which children manifest their joy were evolved the expressions of elated feeling with which peoples meet their conquering chief or king, and eventually the natural displays of joy came "to be observances used on all public occasions as demonstrations of allegiance, while, simultaneously, the irregular jumpings and gesticulations with unrhythmical shouts and cries, at first arising without concert, gradually by repetition became regularised into the measured movements we know as dances, and into the organised utterances constituting songs. Once more, it is easy to see that out of the groups of subjects thus led into irregular ovations, and by-and-by into regular laudatory receptions, there will eventually arise some who, distinguished by their skill, are set apart as dancers and singers, and presently acquire the professional character." In support of this interpretation evidence obtained from many nations is adduced, and the separation and secularisation of the twin professions of dancing and music are traced. Mr. G. F. Scott-Elliott writes in the same review on "The Best Route to Uganda." He is in favour of a route following the line of the African lakes. The route enters the Zambesi at Chinde, and continues up the Zambesi and Lower Shiré as far as Chiromo, from whence a railway of approximately 120 miles would be required across the Shiré Highlands to Matope, from which point the Upper Shiré is navigable, and goods can be carried to the north end of Lake Nyassa. Here another railway would be required from Karonga to South Tanganika (240 miles). From the north end of Tanganika a line would run to Kagera. The Kagera river rises on the easterly flanks of the mountains to the east of Tanganika, and eventually falls into the Victoria Nyanza. A cataract is said to exist on the river, but even if this is so, and a length of line is required to avoid it, the cost of the whole line would only be about £1,700,000, or one-half that necessary for the Mombasa railway. Other considerations point clearly to the Lake route as the better of the two suggested lines. Prof. Lombroso contributes a paper on "Atavism and Evolution." He gives a number of instances of what he regards as atavistic phenomena in social life. "England," he says, "has succeeded in establishing a form of monarchy the most liberal in Europe; and is working out without disturbance the aims of Socialism. But, at the same time, she not only maintains the privileges of her Peers, but actually dresses them up, as well as her judges, in the wigs and robes of the Normans; and still uses, on ceremonial occasions, the language of her ancient conquerors. . . . Then this very positive and practical nation insists on retaining a system of weights, measures, and coins, which is opposed to that of all modern Europe, and is an obstacle

both to commercial exchange and to scientific research." He classifies recent inventions which are shown to be old as evidence of atavism, and explains the duplication by the dislike with which, according to him, human nature regards novelties. Too rapid advance in the arts provokes reaction and causes the tide of progress to ebb when it should be flowing. A sensible article on the "Physiology of Recreation" is contributed by Mr. Charles Roberts, in the course of which he gives the following classification of physical recreations according to their physiological value. Outdoor: running, athletics, games, skating, skipping, &c.; riding, rowing, swimming, walking, cycling, marching. Indoor: fencing and other military exercises with arms, boxing and wrestling, dancing, billiards, dumb-bells, machine gymnastics, trapeze and high gymnastics, singing and reading aloud, playing musical instruments. Recreations of a leisurely sort, physiologically considered, are:—Outdoor: natural history, gardening and farming, carpentry and other technical work. Indoor: reading; chess, draughts, and cards; music. Another paper in the *Contemporary*, entitled "The Origin of Man and the Religious Sentiment," by A. Fogazzaro, invites criticism from the standpoint of evolution.

Prof. Case, Professor of Moral and Metaphysical Philosophy in Oxford University, champions the cause "Against Oxford Degrees for Women," in the *Fortnightly*. He holds that the admission of women to University examinations has brought out the difficulties of teaching mixed classes, and that a mixed University is not desirable, especially at Oxford. Let women have facilities for higher education, by all means, thinks Prof. Case, but let these opportunities be afforded by a University especially founded for women. Mr. Grant Allen writes on "The Mystery of Birth," in the same review, the object of his article being to raise the question, "Is there any real and essential difference between the transmission of functionally-acquired modifications to offspring, and their registration or persistence in the individual organism?" Disciples of Weismann, and biologists generally, will be interested to know that Mr. Allen proposes "to throw back upon assimilation, in its widest sense, the burden of the mystery hitherto attached to the reproductive function."

The *Reliquary and Illustrated Archaeologist* has among its articles one by Mr. H. W. Young, on the discovery of an ancient burial-place and a symbol-bearing slab at Easterton of Roseisle. A large number of flint instruments, such as arrow-heads, axes, scrapers, &c., found associated with the remains, make the discovery interesting and important, especially in relation to the geology of the "Laich of Moray."

Natural science predominates in *Science Progress* this month. The pathological results of the Royal Commission on Tuberculosis are discussed by Dr. Sidney Martin, and Mr. Arthur Keith uses Dr. Dubois' *Pithecanthropus Erectus* as a text for a helpful review of human fossil remains. The geology of the Sahara forms the subject of a paper by Mr. Philip Lake. As in July 1894, Mr. Chree shows, in an extremely valuable table, the recent values of the magnetic elements at the principal magnetic observatories of the world. In an article entitled "A Type of Palæozoic Plants," Mr. A. C. Seward directs attention to the histological structure and affinities of the genus *Calamites*, and finally Dr. W. D. Halliburton describes the formation of lymph.

Among the articles in *Knowledge*, we notice "The Sugar Cane," by Mr. C. A. Barber; "Scorpions and their Antiquity," by Mr. Lydekker, illustrated by two fine pictures of the giant sand-scorpion of Namaqualand, reproduced from photographs, and "The Great Nubecula," by Mr. E. W. Maunder. There are also articles on the field of diameter of the field of view of a telescope, Dr. Roberts' photographs of star-clusters and nebulae, the cause of earthquakes, and on Prof. Fraser's experiments to find a cure for snake-bites.

*Blackwood's Magazine* contains a paper in which Colonel Knollys dwells upon public school and Army competitive examinations. He holds that the imperfections of the training at our public schools, and the character of some of the examination papers, are responsible for the cramming now so common with candidates for the Army. Two other articles, in which our readers may be interested, are "Mountaineering Memories," by Mr. H. Preston Thomas, and "The Territorial Waters and Sea Fisheries."

A passing notice must suffice for the remaining articles of scientific interest in the magazines and reviews received by us. The *Century* has an article on "Picturing the Planets," by Prof. J. E. Keeler; the article is illustrated by views of Jupiter,

Mars, and Saturn, obtained at the Lick Observatory. To the *English Illustrated*, Mr. Grant Allen contributes another "Moorland Idyll"; and the inhabitants of "The Monkey House in the Zoo" are described and illustrated by Mr. F. Miller. In the *Humanitarian*, Mr. J. G. Raupert has a pseudo-scientific article upon "Some Results of Modern Psychological Research"; and in *Chambers's Journal*, there are articles worth reading on death from snake-bite in India, the Carstairs Electric Light Railway, and citric acid. Geographers will be interested in a paper on "England and France in the Nile Valley," contributed by Captain F. D. Lugard to the *National*. Here we may also mention that the *Geographical Journal* contains a valuable paper in which Dr. H. R. Mill describes his bathymetrical survey of the English lakes. *Good Words* has an illustrated article upon the manufacture of coal-gas, but neither *Scribner* nor the *Sunday Magazine* have articles calling for comment in these columns.

## THE RELATION OF BIOLOGY TO GEOLOGICAL INVESTIGATION.<sup>1</sup>

### I.

#### THE CHARACTER AND ORIGIN OF FOSSIL REMAINS.

IN prosecuting the study of the fossil remains of animals and plants, the investigator may have either one or the other of its two leading objects in view; but each being so closely related to the other, it is always essential that they should be pursued with direct relation to each other. In the first case, the leading object to be attained is the extension of our knowledge of the animal and vegetable kingdoms far beyond that which may be acquired by the study of living animals and plants; and in the second case, it is to apply that knowledge to the study of structural and systematic geology. The object in the first case is purely palæontological; in the second, it is not only to acquire palæontological knowledge, but to apply it to various branches of geological investigation.

There are seven different natural conditions in which fossil remains are recognisable, three of which relate to substance, three to form, and one to both. To those relating to substance the terms permineralisation, histometabasis, and carbonisation are here applied; to those relating to form, the terms moulds, imprints, and casts; and to the one relating to both form and substance, the term pseudomorphism.

The term permineralisation applies to that condition of fossil remains of animals which differs least from their original condition as parts of living animals; such, for example, as bones of vertebrates, shells of molluscs, tests of crustaceans, &c. The term histometabasis is applied to that condition of fossilisation in which an entire exchange of the original substance for another has occurred in such a manner as to retain or reproduce the minute and even the microscopic texture of the original. Pseudomorphism of fossils is so nearly like that of mineral crystals, that this term is equally applicable to both. It consists in the replacement of the original substance of the fossil by a crystallisable or crystallised mineral, such, for example, as calcite, pyrite, quartz in the form of chalcedony, &c., the original form of the fossil being perfectly retained. The term carbonisation is applied in this connection only or mainly to such masses of vegetable remains as coal, lignite, and peat. Moulds are cavities in sedimentary rocks which were originally occupied by fossils, the latter having been subsequently removed by the percolation of water containing a solvent of the fossils but not of the rock. Imprints do not differ materially in character from moulds, the former term being usually applied to impressions left in the rock by thin substances like leaves of plants, wings of insects, &c., after their removal by decomposition. Sometimes, however, the moulds of shells and other fossils have been reduced to the character of imprints by the extreme pressure to which the strata containing them have been subjected. Casts are counterparts of fossils, having been produced by the filling of moulds with a substance other than that of the original fossil. These are the principal conditions in which fossils occur, or by which they are represented, but one occasionally finds specimens which indicate certain conditions that are not fully recognised in the foregoing descriptions.

<sup>1</sup> By Charles A. White. (Abstract of a series of eight essays published in the Report of the United States National Museum.)

#### SEDIMENTARY FORMATIONS, THEIR CHARACTER AND LIMITATION.

There has been much difference of custom among geologists as regards the use of the term formation, some applying it to the smallest assemblages of strata which possess common characteristics, while others designate by the same term those series of formations for which the word system has been generally used. That is, some apply the term formation to local or limited developments of strata, while others apply it to such systems as the Devonian, Carboniferous, Cretaceous, &c. This term has generally been confined to the stratified rocks, but by a few authors it has been applied to the eruptive, and also to the great crystalline, rock masses. In this paper, however, the use of the term formation is not only confined to the stratified rocks, but it is restricted to those assemblages of strata which have common distinguishing characteristics, whether they have little or great geographical extent, or whether they aggregate a few feet or thousands of feet in thickness. That is, the use of the term is confined to those assemblages of stratified rocks of sedimentary origin<sup>1</sup> to which many authors have applied the term group, and others the term terrane.

The foregoing remarks concerning the characterisation of formations have been made with special reference to those which are more or less fossiliferous. It sometimes happens, however, that fossils do not exist, or are not discovered, in certain formations which are evidently of sedimentary origin. This may have been due in some cases to the uncongeniality, as a faunal habitat, of the waters in which the formation was deposited, and in others to their failure to receive any fossilisable remains of animals and plants from the land. In other cases, the absence of fossils may have been due to their destruction or obliteration. The latter has probably been the case with many metamorphic rocks and with the great pre-Cambrian series of stratified rocks generally. In all these cases the formations, while they may possess more or less distinct physical characteristics, lack the chief characteristics of sedimentary formations, namely, the biological.

The occurrence of an unfossiliferous sedimentary formation as a member of an otherwise fossiliferous series is unusual, but in such a case its definition and limitation would be effectually accomplished by the underlying and overlying formations. In the case, however, of a great unfossiliferous series of stratified rocks like the pre-Cambrian it is necessary to adopt a method for their study and classification based wholly upon physical data, after the fact that they are pre-Cambrian has been determined from biological data. Such a method of classifying and characterising those unfossiliferous stratified rocks as they occur in North America has been proposed by Prof. R. D. Irving<sup>2</sup> and afterwards elaborated by others. This great series of rocks, as it is developed in America, has such distinguishing general characteristics and such magnitude and geographical extent, that some geologists have thought it worthy of being assigned to a special division of study, but because no certain traces of organic forms have been discovered in them, they have, so far as it is now known, only the indirect relation to biological geology that has just been referred to. Still it is not improbable that those strata were once fossiliferous, and that the great series was once made up of formations similar to those which have been already defined, but it does not necessarily follow that the divisions which are now recognisable by physical characteristics correspond to those formations. It is probable that they more nearly correspond to systems or to the larger divisions of systems as they are recognised in the great scale of the fossiliferous rocks of the earth.

The following conclusions concerning formations are deducible from a consideration of the available facts:—

While formations are physical objects and have only a physical existence, their proper characterisation is chiefly biological.

They are characterisable mainly by the fossil remains of aquatic faunas.

Neither their physical nor biological limits are sharply defined except as a result of accidental causes.

Their geographical limitations are indefinite except those which were occasioned by shore lines.

<sup>1</sup> To avoid frequent repetition, the terms sedimentary formation and stratified formation are used interchangeably when applied to formations as defined above. The terms sedimentary rocks, stratified rocks, and fossiliferous rocks are also used interchangeably, but with a somewhat more general meaning than is intended by the two former terms.

<sup>2</sup> Irving, R. D.: "Classification of the Early Cambrian and Pre-Cambrian Formations." (Seventh Ann. Rep. U.S. Geol. Survey, pp. 371-399.)