

THE FOUNDATION OF A TECHNOLOGICAL EDUCATION*

TECHNOLOGICAL education is taken up by many writers on the subject at the time when a youth is supposed to enter the School of Technology; and scientific men, as a rule, do not seem to set sufficient stress upon the necessity of laying the foundation for it at a much earlier age. It is not indeed scientific men alone who are interested in this question, but they are the authorities who should speak out upon it, for they alone are competent to pronounce an opinion upon the value of scientific education. It cannot be expected that men who themselves know nothing of science, care nothing for its progress, and recognise none of the obligations under which they lie to it, should favour its introduction into our schools, and thus depart from the stereotyped and antiquated system of education, that brings up our youth but partially fitted or altogether unprepared for a majority of the occupations they are destined to pursue, and exposed at every point to suffer from their own ignorance and the impositions of others. Every one now-a-days should have such a knowledge of scientific principles and methods as will enable him to form a just idea of the value of science, and to distinguish between knowledge and pretence—between science and quackery. The political economist, who has to legislate regarding the natural resources of the country; the capitalist, who invests in their development and manufacture; the lawyer, who has to conduct the numberless suits into which scientific questions enter; the journalist, who claims to enlighten and direct the masses; every one who uses manufactured products liable to adulteration; every one who values his health, or has to consult a medical man or other scientific expert; every father, and, what is still more important, every mother of a family; every youth that is making choice of an occupation for life; or, in other words, every member of a civilised community, ought to be acquainted with the elementary facts and principles upon which all the applications of science are based.

This knowledge, which should thus form an essential feature of general education, is also that which will form the very best foundation for technological purposes. In the first place, it will bring into technological schools a vast amount of excellent material that is now wasted elsewhere; for numbers of youths, with minds well adapted to such pursuits, would take to the practical applications of science, if they knew anything at all of science itself. Nor need there be any fear that the field will thereby be overcrowded; for so long as quacks and pretenders abound there is room for good men, and the difficulty at present is to obtain students who have a natural aptitude, or rather, we should say, an aptitude developed by early education for scientific work.

Secondly, and this is the really important aspect of the case, educators will have to deal with material prepared for their purposes, instead of, as now, receiving it not merely unprepared, but actually warped out of proper condition. For it is not too much to say that a youth who has had a purely academic education, on entering a technological institute has to devote a large portion of his time to mastering elementary ideas and principles, that he should have learned as a child; whilst the erroneous methods of instilling knowledge to which he has been subjected, will be a hindrance to him for years, if not for life. It is but a few days since that a freshman in such an institute gravely asked the writer "if a fish was not an animal," thus displaying, at the age of seventeen, a doubt of the meaning of a term that he should have accurately understood at the age of seven. Of a term, did we write? We mean of a fact; of one of the broadest generalisations of science. Now, what has not such a youth to learn of first principles? How utterly unprepared in the simplest rudiments of knowledge is he for a technological course! But when we come to the system of thought induced by the vicious methods of preparatory study, the case is still worse. Here we have the labour of driving practical instruction into the brain of a young man who, after having passed perhaps brilliantly through college, is now laboriously pushing his way through a technological course; he is now nominally near its close, yet three years of steady application have not divested him of the habit of learning by rote on the authority of others. He has no reliance on his own experiences, seeks no explanations by questioning his own reasoning powers, but prefers always to take another's opinion, instead of elaborating a judgment of his own. He is still in fact

utterly devoid of the first essentials of self-help in education, so completely have his natural abilities been misdirected in that first course, in which the amount of evil accomplished may be judged by the very brilliancy of his success in it. Such a student will never make a reliable scientific expert. We should not like to trust him even as a druggist's clerk; he should never have entered a technological institute, because he has never had any foundation laid for a technological education.

But in what is such a foundation to consist? and when is it to be commenced? What alterations are to be made in our recognised systems of instruction? Already there are more subjects to be taught than the child has time to learn. We reply, let this education commence in the very infant school; let the methods of instruction be rational, because natural ones; let the subjects be taught in their natural order; and we may very easily teach, or rather "educate," vastly more than we do now. At present beyond mere reading, writing, some mathematics, and something of languages, this child learns absolutely little, and that little superficially. It wastes its time largely in learning the theoretical use of these tools without being made to apply them in building up an education. This is not the way in which the carpenter instructs his new apprentice; if he did, neither would ever reap much benefit from his instruction.

Let the elements of the natural and physical sciences form a part of general education; let physical geography go before political; let the child learn that a history of the world precedes that of man; and at every point let him be familiarised with the intimate dependence between the truths of science and the fact of his own existence. Let these things be taught by a rational method of object teaching, not used to convey desultory information, but as a system of training, whereby the reasoning faculties may be rightly educated, at the same time that the memory is taxed with a stock of useful, because elementary and connected ideas. Let reading and writing sink to their proper rank, as means of education and not as objects of it; and let them, whilst being taught, be used to aid in the acquirement of real knowledge.

This may seem to demand a radical change in our system of preparatory education public and private; but if the technologist wishes to make the most of young minds, he must bend them to his purpose from their earliest years; nor will the community at large, when it understands that its interests in the matter are identical with its own, be averse to the change proposed, which is in accordance with its needs and the progressive spirit of the age. If the advocates of a liberal and enlightened system of popular education in England can succeed in tiding over the shortsighted opposition of sectarianism, as above sketched out, inaugurated there by the aid of its scientific men; the result will be, that the technological schools of Great Britain will be supplied with materials trained from their very infancy in science. Are there no scientific men in the country who will take up the subject here in the same wide-awake spirit?

MECHANISM OF FLEXION AND EXTENSION IN BIRDS' WINGS*

DR. COUES' proposition is, that flexion of the forearm upon the humerus produces flexion (adduction) of the hand upon the forearm, by osseous mechanism alone, and conversely: extension of the forearm causes extension (abduction) of the hand. The point of the article consists in a demonstration of the fact that, in spreading and folding the wing, the radius slides lengthwise along the ulna to a certain extent. Recapitulating certain points in the anatomy of the elbow and wrist, the author shows that this sliding is produced by the relative size, shape, and position of the humeral surfaces with which the radius and ulna respectively articulate; these being such, that in flexion of the forearm the radial surface is nearest the wrist-joint, and in extension the ulnar one; and consequently the two bones of the forearm occupy different relative positions in flexion and extension. In flexion, the radius is pushed forward, and projects somewhat beyond the end of the ulna, impinging upon the radio-carpal bone (scapholunar), and pushing the pignon around the centre of motion of the wrist-joint so that it is more or less flexed. In extension, the reverse motion takes place, from the pulling back of the radius. The proposition is carefully demonstrated, illus-

* Abstract of a Paper read at the Indianapolis Meeting of the British Association for the Advancement of Science, August 1871. By Dr. Elliott Coues. From the *American Naturalist*.

* By Mr. E. C. H. Day, reprinted from the *New York Technologist*.

strated with three figures, and likewise shown to be susceptible of ocular proof by direct experiment. Several interesting corollaries are also drawn. Some such mechanism is shown to be an anatomical necessity, from the structure of the wrist-joint, to provide for the extremes of adduction and abduction that take place in the wrist, without straining the joint. Another obvious purpose subserved is equalisation of muscular power, by relegating a part of the work, that the hand muscles would otherwise have to perform, to the larger flexors and extensor of the upper arm; and an actual saving of a certain amount of muscular effort, this being replaced by automatic movements of the bones themselves. Having seen no account of this mechanism, the author is inclined to think it may be unnoticed.* It is at any rate a new explanation of the design of the peculiar shape and position of the radial articulating surface of a bird's humerus, far more important than that hitherto assigned—viz., its causing simply the well-known obliquity of flexion of the forearm.

SCIENTIFIC SERIALS

THE number of the *Geological Magazine* for Dec. 1871 (No. 90) contains an unusual abundance of important interesting papers. The first is an article by Prof. Traquair on the genus of fossil fishes to which Prof. Huxley has given the name of *Phanero-pleuron*, with the description of new species (*P. elegans*) from the Lower Carboniferous limestone of Burdiehouse. The author describes some new points in the structure of the type-species of this genus (*P. Andersoni*) from the Devonian yellow sandstone of Dura Den), the most important being that the dorsal fin was in that fish continued as a "dorso-caudal" to extremity of the body as in *Lepidosiren* and *Ceratodus Forsteri*. Prof. Traquair gives a restored outline of *P. Andersoni* in accordance with his views, and also figures of two specimens of his new species.—Mr. T. G. Bonney contributes an interesting paper on a double "cirque" in the syenite hills of Skye, with remarks upon the formation of cirques, in continuation of his paper read before the Geological Society some time since.—From Mr. Carruthers we have descriptions of two previously unknown coniferous fruits from the Gault of Folkestone; one of them a magnificent cone, described and figured under the name of *Pinites hexagonus*; the other a smaller form called *Sequoites ovalis*. To this paper the author has appended a note on the structure of the scales of his *Araucarites sphaerocarpus*, with some judicious remarks on the caution which ought to be exercised by the student of fossil plants in determining the affinities of the often fragmentary remains with which he has to deal.—Mr. James Geikie publishes a first paper connected with that apparently inexhaustible subject, the climate of the glacial epoch. In this the author discusses the evidence furnished by the glacial deposits of Scotland with regard to the occurrence of warm interglacial periods, during which all or nearly all the snow and ice may have disappeared from the face of the country.—Mr. A. H. Green's notes on the geology of part of the county of Donegal contain an interesting account of the structure of the county, especially with regard to the relations of the granites and stratified rocks and to the glaciation of the surface.—And lastly, Mr. A. J. Browne, from an examination of the valley of the Yar in the Isle of Wight, throws out the suggestion that that valley and the other river-valleys of the island were originally occupied by continuations of the Hampshire rivers before the excavation of the Solent.—Among the miscellaneous notices we may call attention to an article by Prof. T. Rupert Jones and Mr. W. K. Parker on the Foraminifera from the chalk of Meudon, figured by Ehrenberg in his "Mikrogeologie."

Quarterly Journal of Microscopical Science, January.—"Notes of a Course of Practical Histology for Medical Students," given at King's College, London, by Dr. Wm. Rutherford, F.R.S.E., &c. This paper illustrates the author's method of teaching, the students preparing for themselves the series of specimens of the various tissues. After an enumeration of the tissues so prepared follow some general observations on Examination of Tissues, How to Harden Tissues, How to Soften Tissues, How to make Sections of Tissues, How to render Tissues Transparent, How to Stain Tissues, How to Inject, and How to Preserve Tissues, with notes on cells and cements.—"On the Peripheral Distribution

of Non-medullated Nerve-fibres," by Dr. E. Klein. Part II. This is the continuation of the paper commenced in the last number of this journal, and to be concluded in the next. It deals with the Nerves of the Nictitating Membrane and Nerves of the Peritoneum.—"Remarks on Prof. Schulze's Memoir on *Cordylophora lacustris*," by Prof. Allman, F.R.S.; "Size of the Red Corpuscles of the Blood of the Porbeagle, or Beaumaris Shark, *Lamna cornubica*," by George Gulliver, F.R.S. The mean long diameter of the corpuscles measured $\frac{2}{3}$ of an inch, and the short diameter $\frac{1}{1000}$, nearly alike in magnitude to those of the small dog-fish and other Selachii.—"A Note on some Circumstances affecting the Value of Glycerine in Microscopy," by Mr. W. M. Ord. This note suggests that from the action of glycerine on murexide and oxalate of lime, mounted for the microscope, it is impossible not to have some misgivings as to the results of its use in the preparation of tissues for the microscope.—"On Remak's Ciliated Vesicles and Corneous Filaments of the Peritoneum of the Frog," by Dr. E. Klein.—"On the Structure of the Stem of the Screw Pine," by Prof. W. T. Thiselton Dyer. Scleriform ducts were detected by the author in the branches of a *Pandanus*, and crystalline forms of two kinds in the tissues.—"On Students' Microscopes," by Mr. J. F. Payne, with a table of English and foreign microscopes, their features, powers, accessory apparatus, and prices.

Journal of the Quekett Microscopical Club, January.—"Notes on Podisoma," by Mr. M. C. Cooke. After describing the minute structure and mode of germination in these fungi, the author proceeds to detail the experiments of Prof. Oersted, from which it has been supposed that the identity of *Podisoma* with *Rastelia* has been established. The paper concludes with a critical examination of all the known species, one of which it referred to a new genus, and a different order, under the name of *Sarcostroma Berkeleyi*.—"On the so-called Boring or Burrowing Sponge (*Cliona*)," by Mr. J. G. Waller. The object of this paper is to call in question the burrowing proclivities of the sponges belonging to the genus *Cliona* of which *Hymeniacidon celata*, Bowerbank, is the type. This number completes the second volume of the journal.

SOCIETIES AND ACADEMIES

LONDON

Geologists' Association, January 5.—The Rev. J. Wiltshire, president, in the chair. "On the overlapping of several Geological formations on the North Wales border," by Mr. D. C. Davies, of Oswestry. The author stated that the Geological formations of the district ranged upwards from the Llandoello to the New Red Sandstone. Attention was directed to the way in which nearly every one of these overlapped the one below, hiding in its course many of the beds, amounting in some cases to 1,000 feet of strata, which at other points were exposed. The overlaps increase as a rule from north to south, except in that of the Bala and Caradoc beds by the Llandovery, which increase in an opposite direction. The author inferred that the conformability of strata at a given point did not necessarily prove the unbroken sequence or complete series of the beds at that point, and also that conformability between either two consecutive beds of the same formation, or between those of two distinct formations, was not to be expected to extend over a large area. Amongst other facts stated in this paper was the important one that coal seams occur in Permian strata in the neighbourhood of Ifton. The President remarked upon the enormous time required for the production of the phenomena described by Mr. Davies. Prof. Morris explained the geological and physical features of the district, and spoke of the high value of the paper.—"Report of the Proceedings of the Geological Section of the British Association at Edinburgh, 1871," by Mr. John Hopkinson, one of the deputation from the Geologists' Association. In this communication the author succinctly stated the more important features of the opening address by the president, Prof. Geikie, and of the many papers read before Section C at the meeting at Edinburgh last year, and gave interesting accounts of the two geological excursions under the direction of Prof. Geikie.—Mr. J. T. B. Ives communicated the interesting fact of an extensive bed of peat occurring under gravel between Finchley and Whetstone.—Fossils from the glacial deposits of Islington cemetery were exhibited by Mr. Caleb Evans.

* It is indeed not mentioned in the works of Cuvier, Meckel, Tiedemann, Wagner, and other distinguished authors; but Dr. Bergmann, of Göttingen (*Archiv. für Anat.*, 1839, 296), speaks of essentially the same thing, although the results of the mechanism are not so fully shown. —Eds. *Am. Nat.*