glaciated surface, the same numerous lakes, as in Canada, both regions of the earth claiming to be the land of the many thousand lakes. At the border of both regions the horizontal Paleozoic strata begin with an escarpment which is pronouncedly developed south of Lake Erie and south of the Gulf of Finland, called here the "glint," and we shall keep this expression to designate similar escarpments. These strata continue far into the interior of Eurasia, and they do the same in North America.

And again:

It is very interesting to see how the Appalachian region ends at Newfoundland, forming the projecting eastern corner of North America, and just opposite in south Ireland, in south Wales, in Cornwall and in Brittany the belt of the old Hercynian Mountains of Europe begins. One seems to be the continuation of the other, and such an excellent geologist as Marcel Bertrand maintained that *we have here to deal with the two ends of one very extensive belt of mountains which extended through the North Atlantic Ocean. But we must not forget that the missing link between both ends of these supposed mountain chains is longer than their known extent.* (The italics are mine.)

It seems to me that these and other parts of his lecture throw an interesting light on the theory of the moon's terrestrial origin. In brief, the theory is that when the earth had cooled from its molten condition sufficiently to have a crust of solidified matter something like thirty miles thick over its entire surface, it was revolving so rapidly that gravitational attraction and centrifugal force practically balanced each other. For some reason, perhaps some vast and sudden cataclysm, a large portion of this crust was thrown off the earth, and by tidal action was forced gradually outward in a spiral path. In order to form the moon, a mass of this crust about thirty miles thick and of area nearly equal to the combined areas of the present oceans on the earth must have been thrown off. It is supposed that this immense amount of crust was largely taken from the present basin of the Pacific, and that the remaining parts of the earth's crust, while it still floated on a liquid interior, split along an irregular line into two pieces which floated apart, and the gap between these two parts was later filled with the waters of the Atlantic. Many reasons are advanced for the probability of this theory—the fact that the two coasts of the Atlantic have the same contour, the identity between the density of the moon and that of the earth-crust, etc. Professor Penck is evidently not considering this theory at all in his lecture, and yet it seems that what he, approaching the problem from a geographical standpoint, has to say about it, lends a greater probability to the theory. As he says, the Appalachian region ends at Newfoundland, about the latitude of 50° north, and just opposite, in Great Britain, on the same latitude, the same region seems to continue. If the theory of the terrestrial origin of the moon, outlined above, be accepted, we can explain this phenomenon much more simply than did Bertrand, and need not suppose the range to extend across the bed of the Atlantic at all.

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SCIENTIFIC BOOKS

Scientific Ideas of To-day. A popular account of the nature of matter, electricity, light, heat, etc., in non-technical language. By CHARLES R. GIBSON. Pp. 344; illustrated. Philadelphia, J. B. Lippincott Company. 1909.

This book is one which would justify a favorable estimate from almost any other point of view than that which the present reviewer chooses to take. Thus, William E. Rolston gives a favorable estimate of the book in his review of it in *Nature;* indeed many sections of the book are such as to demand a favorable estimate from any point of view. For example, the description in terms of the electron theory of what takes place when glass is rubbed with silk or when zinc is dissolved in a voltaic cell (see pages 73–79) is as clear as any one could wish to have it; and in many cases the "scientific ideas of to-day" which are elaborated in the book are applied at once to the analysis of actual phenomena. But some weeks after looking over the book, I came upon what to me seems to be a very significant paper by Professor William James, "On a

Very Prevalent Abuse of Abstraction,"[1] which happens to express precisely what I wish to say concerning the book and the kind of popular scientific writing which it represents. Professor James says that "to be helped to anticipate consequences is always a gain, and such being the help that abstract concepts give us, it is obvious that their use is fulfilled only when we get back again into concrete particulars by their means." By far the greater portion of the book under review fails to meet this condition of utility, and on the whole the book can not be looked upon as a preliminary step towards a subsequent realization of this idea of utility.

One phase of the author's point of view may be seen in the following quotations: "Water is nothing more or less than a chemical combination of two gases" (page 25); "Chemical affinity is nothing more or less than electrical attraction between different atoms" (page 29); "An electron is nothing more or less than electric charge in motion" (page 51); "An electric current is nothing more or less than an electron current" (page 75); "Light is simply waves in the ether" (page 153); "It must be clearly understood that all atoms of matter are made up of a number of electrons revolving in regular orbits, and that we can not in any way disturb these arrangements" (page 157). As if one could be placed under obligations to clearly understand any physical fact in terms of an extremely vague hypothesis!

Professor James gives the name "vicious abstractionism" to this mode of using concepts. He says:

> We can see a concrete situation by singling out some salient or important feature in it, and classifying it under that; then, instead of adding to its previous characters all the positive consequences which the new way of conceiving it may bring, we proceed to use our concept privatively; we reduce the originally rich phenomenon to the naked suggestions of that name abstractly taken, treating it as a case of "nothing but" that concept, and acting as if all the other characters from out of which the concept is abstracted were expunged. Abstraction functioning in this way becomes a means of arrest far more than a means of advance in thought.

The viciously privative employment of abstract characters seems to be the greatest infirmity of the average mind in scientific work, and books like this of Mr. Gibson's stand for the extension to a wide circle of readers of a hopelessly sterile philosophical by-product of the modern physical sciences.

The authors of such books as "Scientific Ideas of To-day" stand before us, indeed, chiefly in the rôle of teachers; but the teaching of the physical sciences is to a very great extent a matter of exacting constraint, and it can not be accomplished in a manner which is pleasant and popular.

> Da wird der Geist Euch wohl dressiert
> In spanische Stiefeln eingeschnürt.

The teaching of physical sciences is indeed a compelling insistence upon precise ideas, a forcible "making up" of a student's mind, as it were; for, as Whewell says, nothing is so essential in the acquirement of exact and solid knowledge as the possession of precise ideas, not, indeed, that a perfect precision is necessary as a means of retaining knowledge, but that nothing else so effectually opens the mind for the perception even of the simplest evidences of a subject.

In speaking of the constraint that is involved in genuine science teaching I do not refer to the necessity of overcoming indifference, but to a condition which is real in the face of any amount and any quality of enthusiasm. Every one is of course familiar with the life history of a butterfly, how it lives first as a caterpillar and then undergoes a complete transformation into a winged insect. It is of course evident that the bodily organs of the caterpillar are not at all suited to the needs of a butterfly, the very food (of those species which take food) being entirely different. As a matter of fact, almost every portion of the bodily structure of the butterfly is dissolved into a formless pulp at the beginning of the transformation, and the organization of a flying insect then grows out from a central nucleus very much as a chicken grows in the food-stuff of an egg. So it is in the development of a scientifically trained mind. In early

[1] *Popular Science Monthly*, May, 1909.

childhood, if the individual has been favored by fortune, he exercises and develops more or less extensively the primitive instincts and modes of the race in a free out-door life, and the result is so much mind-stuff to be dissolved and transformed with more or less coercion and under more or less constraint into a mind of the twentieth-century type. The period during which a young man is receiving his scientific and professional training is indeed analogous in many respects to the period of complete reorganization of bodily structure, and in the other we have a reorganization no less complete of mental structure; in the one the reorganization is wholly dependent upon and determined by internal energies, but in the other the reorganization is largely dependent upon and determined by external constraint.

It is a remarkable thing this changing of men into bees and butterflies! and the operation is indeed severe. But perhaps the most remarkable thing about it is that it is elective in particular, but apparently in our day a dire necessity in general, somewhat like the curious transformation of the axolotl, which lives always and reproduces his kind as a tadpole unless a stress of dry weather annihilates his watery world when he lops off his tasseled gills, develops a pair of lungs and embarks on a new mode of life on land.

A severe operation! And usually for the individual a change, like that of the axolotl, from a fluid world to a rigid one! I remember as a boy a sharp contest in my own mind between an extremely vivid sense of things physical and the constraining function of precise ideas. This contest is perennial, but it is not by any means a one-sided contest between mere crudity and refinement, for refinement ignores many things. Indeed precise ideas not only help to form our sense of the world in which we live, but they tend to inhibit sense as well, and a world in which their rule is unchallenged becomes indeed a dry and rigid world.

Every student should realize two things in connection with his science study; the first is that the study of the physical sciences is exacting beyond all compromise, involving as it does a degree of coercion and constraint which it is beyond the power of any teacher greatly to mitigate; and the second is that the completest science stands abashed before the infinitely complicated and fluid array of phenomena of the material world, except only in the assurance which its method gives. And both of these things are obscured by books like "Scientific Ideas of To-day," books that know nothing of exacting constraint nor ever stand abashed. The attempt to set forth in an easily plausible style the conceptual structure of modern physical science is one of the most troublesome perversions with which one has to deal in the attempt to contribute towards the solution of what is to be perhaps the greatest problem of the twentieth century, namely, the making available to all men of the simpler phases of the logical structure of the sciences in order to give to all men some measure of that clear insight into nature which contributes so greatly to the ordering of one's daily life.

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Normentafel zur Entwicklungsgeschichte des Menschen. By FRANZ KEIBEL and CURT ELZE. 4to, 314 pp., 6 pls., and numerous text figs. Jena, Gustav Fischer. 1908.

This eighth volume in Professor Keibel's series of "Normentafeln" is much larger than any of its predecessors, thus reflecting the special interest which mankind takes in human embryology. Like the earlier numbers it consists essentially of a tabular description of embryos, with plates showing their external form, and a classified bibliography. The titles of papers relating to human embryology occupy 150 quarto pages, and yet, of the publications dealing with malformations, only the more comprehensive have been included. The bibliography is so thorough and useful that it renders this "Normentafel" indispensable to every student of vertebrate embryology. The plates are excellent, and show embryos from 1.17 to 24 mm. in length, seen in several positions. The text figures include numerous single sections, and several partial reconstructions of the embryos described. A