to these points. The effect probably would be concentrated on the surfaces of maximum strain and shear.

The results of this enquiry may be of fundamental significance in theories of the origin of oil. The writer will appreciate any information thereon.

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THE CAUSES AND PREVENTION OF AFTER CORROSION ON THE BORES OF FIREARMS[1]

THE report of an experimental study, containing also a careful review of the scientific, patent, and trade literature and a compilation of empirical experiences which have variously attributed after-corrosion on oiled bores as due to powder acids, diffusing gases, primer acids, metal fouling, and chlorides.

Humidity relations, chemical examination of the corrosive residue, special ammunition, and a study of many so-called "gun oils" and "nitrosolvents" showed:

The infantry service cartridge leaves no nitrocellulose or acid residue. The after-corrosion is caused by (1) the deposition of a water soluble salt or salts capable of giving corrosive solutions, (2) the presence of a humidity high enough to form a liquid film, and (3) the presence of oxygen. In the service ammunition, the decomposition of the chlorate of the primer furnishes the only water soluble salt. Pits and tool wounds retain this, so that it can not be removed mechanically. It may be dissolved by water. Corrosion may also be prevented by stoppering the bore or by altering the composition of the primer. A number of the non-aqueous compositions sometimes recommended for cleaning rifles are of no value. Their virtues apparently rest on tests conducted at humidities so low that no corrosion could occur.

The paper is illustrated with photographs and photomicrographs. It presents a simple test for differentiating between worthless and useful "nitrosolvents" and also discusses the corrosive effects of black powder and low pressure nitrocellulose powders.

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1 Published by permission of the director of the U. S. Bureau of Mines.

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SCIENTIFIC BOOKS

An Introduction to Entomology. By JOHN HENRY COMSTOCK, Professor of Entomology and General Invertebrate Zoology, Emeritus, in Cornell University. Ithaca, N. Y., Comstock Publishing Company. 1920, xviii + 220 pages, 220 figs.

The dean of American entomologists has just issued the first part of a second edition, entirely rewritten, of his long-known text-book called "An Introduction to Entomology." It covers the structure and metamorphosis of insects, and it covers these subjects in such complete and thoroughgoing way and, at the same time, in such compact manner, as to make the book by all odds the very best of extant texts to put into the hands of entomological and zoological students. It will be indispensable for beginning students; it will be very useful for advanced ones.

Such large compendiums as Berlese's (as yet only available in the original Italian), and Sharp's (in the English "Cambridge Natural History") and Packard's "Text-book of Entomology," are all of a character which limits their use in the laboratory to that of reference books; they are too extended and expensive, to say nothing of their less adapted organization and general make-up, to permit their use as actual individual laboratory handbooks. Comstock's book fills exactly the long-felt need. It contains all the knowledge up to the very present, carefully analyzed, sifted, and a great part of it actually contributed or tested by Comstock and his students, that the general student of insect structure and post-embryonic development needs to know. And it is all packed away, in perfect arrangement, with elaborate analytical contents, sufficient index and bibliography and carefully chosen illustrations, in about two hundred pages, clearly printed on good paper, and substantially bound in convenient format. The experience of a veteran text-book maker and user shows in every feature of this book's construction.

The new book is "affectionately inscribed" to the author's "old students whose youthful enthusiasm was a constant inspiration" during a long period of service as teacher, as an effort to further aid them, though they are now gone from his classrooms and laboratories. Professor Comstock may rest assured that his greeting will be quite as affectionately returned, and that his latest effort will be as gratefully received by his many scattered students, mostly now no longer youthful, as were his earlier efforts to instil in them that love of nature and passionate interest in learning to know nature's works which have been for so many years beautifully characteristic of their beloved mentor. These old students will be greatly helped by this effort in their attempts to carry on to new students the Comstock tradition. And American entomology has not had, nor will ever have, any finer tradition.

Vernon Kellogg

SPECIAL ARTICLES

"PHYSICAL CONSTANTS" PERTAINING TO THE OCEAN

An important object of the science of physics is description of the behavior of different substances. Expression in mathematical form of such descriptions requires the use of one or more "physical constants," such as the coefficient of elasticity, conductivity, etc. Constants thus obtained are generally regarded as intrinsic, or peculiar to the substance. The extensive list of "physical constants" already determined bears witness to the achievements of physics, and constitutes fundamental quantitative data of the science.

Application of the methods of physics to terrestrial phenomena taking place on a correspondingly immense scale, has likewise resulted in physical laws or descriptions capable of expression in mathematical form. But the corresponding "physical constants" can not be evaluated by means of experiments necessarily limited to much smaller dimensions. The influence of the enormous magnitudes involved in many terrestrial phenomena can be determined only by observing the phenomena as they take place in nature. It is impossible, for example, to determine in detail the motion of the water particles in the convective circulation of even a limited part of the sea. But this would be necessary in order to resolve the water mass into sufficiently small portions to justify the assumption, made in laboratory experiments, of flow in plane layers. Even if this resolution of the complex motion into its elements were possible, there would still be the impracticable task of summing up the effects of the correspondingly complex and irregular system of forces in order to obtain the resultant effect. The only recourse is to observe the system as a whole under the actual conditions of the sea. For example, a decade ago, the Swedish physicist, V. W. Ekman, applied the classical hydrodynamical equations to certain ocean current observations, but replaced the viscosity coefficient by a constant representing the integrated effect of the complex system of frictional forces. The value of this constant is thousands of times greater than the coefficient of viscosity of sea-water. A generation ago, a German mathematician, Zöppritz, developed an elaborate mathematical theory of ocean currents, but used laboratory values of the physical constants. Consequently his theory disagreed widely with subsequent objective knowledge. Such results emphasize the fact that physical constants are dependent not only upon the nature of the substances, but also upon the corresponding external conditions, and must therefore be determined under the conditions prevailing where they are to be used.

Progress in laboratory investigations is continually demonstrating the variability of quantities originally regarded as physical constants. Further refinement often requires the substitution of a variable, dependent upon additional conditions, for constant quantities of earlier formulæ. This is also true in