Theory of Errors and Least Squares. A Text-book for College Students and Research Workers. By LeRoy D. Weld, M.S. New York, The Macmillan Company, 1916. 8vo. Pp. xii + 190.

The two pages of "Preface" of this book made a very unfavorable impression on the reviewer. It would take too much space to point out the expressions that seemed catchy but meaningless or non-committal. It gave the impression that possibly the author had not caught the fundamental purpose and nature of the method of computation discussed in the volume. The idea of having the theory for its amateurish "satisfaction" and of getting it "in an evening or so and then put it into immediate practise" did not at all harmonize with the reviewer's knowledge that only a fairly experienced observer has much real use for the method of least squares in his computations.

As a text-book for "undergraduates," unless they are classed with the "casual readers," it presupposes a half-year at least of training in the calculus. Compare pages 54, 57, 60, 67, 71, 90 and others. Any student of the desirable amount of inquisitiveness would like to know under what conditions and to what extent he may play such tricks of the calculus as he sees, *e. g.,* following equation (h) on page 181; and it would take considerable advanced calculus to make it all clear to him.

As a book for "handy reference" it would be vastly more useful by having a carefully prepared, detailed index. This need is partially met by "Appendix F. Collection of Important Definitions, Theorems, Rules and Formulas for Convenient Reference," pp. 185 sq. Throughout, references are made to Article, Equation (number), or even to Chapter, without adding the page, which would facilitate the use of the book, since only page numbers appear on the tops of the pages. It would help much to have the number of the page on which each formula originally appears given as well as the number of the formula on pp. 188–190, and elsewhere.

Happily, the "Preface" is the poorest part of the whole book and that may be omitted by the reader. On pages 17 and 28 the author states clearly the "special office of the method of least squares," yet he nowhere emphasizes the fact that he is dealing with a method of *computation.* He does not make use of the splendid opportunity of forcing and fixing upon the attention of the reader the facts that the method does not improve the quality of poor or careless observations, and that only the beginning student carries readings as of grams out to six or seven decimal places (see any reference to grams, *e. g.,* p. 155). It further would not be difficult and much worth while to point out that in the formula $y = ce^{-h^2x^2}$ (24), p. 56, the exponent must be an abstract number so that $1/h$ and x must be measures in the same unit. The types of readers for whom the book is intended are the very ones that should have these matters indelibly impressed upon them. Although it is sometimes stated that illustrations are from students' work, it is passing strange that the author should have let such matters escape his notice.

Barring two cases of questionable English, pp. 65, 170, that only a purist might notice, the book is quite free of errors of speech and of typography. The treatment is remarkably clear and well-ordered. The topics are nicely correlated. Especial attention should be called to Chapters IV. and VIII., and to Art. 27 of the former chapter in particular. Lucid is not too strong to describe some portions of the book. On the whole, readers who want only a general idea of what the theory is about can scarcely find a more concise and clear presentation for that purpose. The numerous, excellent, well-chosen exercises at the end of each chapter will, if solved, greatly enhance the permanent value of the book.

The adverse criticism is herein placed first so that the reader may finish the review with the desire to get and read the book, and find it as interesting and profitable as the reviewer has found it.

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ARISTOTLE'S ECHENEIS NOT A SUCKING-FISH

In the course of a rather extensive series of researches on the shark-sucker, it has been found necessary to trace this fish back to Aristotle, the Father of Natural History, with the interesting result that it has become very evident that Aristotle's *Echeneis* was not a sucking-fish at all.

The first reference in question is in the "Natural History of Animals," Book II., 14; 505 *b*, 19–22; and, as rendered in Professor D'Arcy W. Thompson's scholarly translation (Oxford, 1910), it reads:

> Of fishes whose habitat is in the vicinity of rocks, there is a tiny one, which some call the *Echeneis* or shipholder. . . . Some people assert that it has feet, but this is not the case: it appears, however, to be furnished with feet from the fact that its fins resemble these organs.

A fair acquaintanceship with the sucking-fish and a somewhat extensive reading of the literature fail utterly to substantiate these statements. It is true that, blindly following Aristotle, a number of the medieval writers on natural history, or more properly pseudo-natural history, speak of the *Echeneis* as given to laying fast hold on to rocks at the approach of storms and staying there until the return of fair weather. St. Ambrose in his "Hexameron," written in the fourth century A.D., seems to have been the first to set forth this story of the *Echeneis* as a rock-holder and weather prophet. However, this is plainly an echo of Aristotle and there is no ground whatever, so far as I know, for any such belief, or for thinking that it dwells among rocks.

Further, it is not a "tiny fish." Adult Echeneises run in size from 15 to 36 inches, and adult Remoras from 10 to 15 inches in length. It might be well just here to state that *Remora* is not only the smaller of the sucking-fishes, but is generally of a dark uniform brown color. *Echeneis,* on the other hand, is not only much larger, but is of a slaty-brown or black color, and is easily recognized by the broad black stripe edged with white extending from the angle of the mouth back through the eye along the mid-lateral line to the base of the caudal fin. Both fishes have on the top of the head and on the back-of-the-neck region a haustellum or sucker made up of the modified spinous dorsal fin. This sucker consists of a circumferential rampart of soft tissue forming an ellipse divided into compartments by numerous crosswise partitions and having a single lengthwise partition running from end to end in the longest diameter of the ellipse, which is also the median dorsal line of the fish. This sucker is under muscular control, and when applied flat to an object and then raised a partial vacuum is created and the sucking-fish clings fast.

Last of all, no sucking-fish has fins even distantly approaching the form of feet, the pectoral and pelvic fins being of the ordinary teleostean type and showing no special modification whatever. Many authors have thought that in this last sentence Aristotle was describing an Antennariid fish, of which the Sargassum fish, *Pterophryne histrio,* not uncommon in our waters, is a good example. Such fish have the pectoral fins modified to form organs not superficially unlike a hand. However, in endeavoring to identify Aristotle's fish we must take into consideration his whole description. His fish I believe to have been a goby, for the following reasons: gobies are "tiny fish which live among rocks," and which have their pelvic fins united to form a cup-like adhesive organ, which is placed on the thorax, in order that they may adhere to the rocks among which they live.

In another place, however, Aristotle does refer to a fish which in my judgment is an *Echeneis,* or sucking-fish, though he does not he writes:

> In the seas between Cyrene and Egypt there is a fish that attends on the dolphin, which is called the "dolphin's louse." This fish gets exceeding fat from enjoying an abundance of food while the dolphin is out in pursuit of its prey.

This fish Professor Thompson identifies with the pilot-fish, *Naucrates ductor,* which is represented in our Atlantic coastal waters by the very beautiful little Carangid fish, *Seriola zonata.* This "dolphin's louse," however, I identify as the sucking-fish. The first evidence to be presented is found in the context. This last reference to Aristotle comes in a section given over to a consideration of various sucking parasitic insects, lice, ticks, fleas, etc., and ends with a description of those crustaceans parasitic on fishes to which the name "sea lice" is given. This internal evidence certainly lends itself to the view that the dolphin's louse was a sucking fish.

In working up the literature, two references of marked interest just here have been found. Hasselquist, the friend and pupil of Linnæus, in his "Reise nach Palæstina" (published in 1762) refers to an *Echeneis neucrates* (an old spelling of *naucrates*) collected at Alexandria and records that the Arabic fishermen there called it *Chamel el Ferrhun*. This term Dr. Frank R. Blake, of the Johns Hopkins University, very kindly translates for me as the "louse of the terrible one"—*i. e.*, a shark.

Another like name is to be found in the writings of another eastern traveller, Forskäl, likewise a pupil of Linnæus. He collected on a shark at Djidda, a town situated about half way down toward Aden on the eastern shore of the Red Sea, an *Echeneis neucrates* which the natives there called *Kaml el Kersh*, and which he translates the "louse of the shark." Dr. Blake kindly writes me that this term is more properly to be rendered "the louse of the fish of prey" (which Forskäl tells us was a *Carcharias* shark). From all of which we see that in the east, where habits and customs and even names change slowly, the sucking-fish was still called "the louse" some 2,000 years after Aristotle.

We now come to the most interesting point of all in this discussion, which is that if one reads Aristotle closely he will be convinced that the Father of Natural History never saw the shark-sucker. Aristotle's descriptions of other fishes are very clear, evidencing keen powers of observation, and it is not to be thought that, having ever seen and examined the sucking-fish, he could have failed to give an explicit description of the sucking disk. Note also that his words are ". . . which some call the *Echeneis* or ship-holder." He is quoting from some one else and in the judgment of the present writer never saw the *Echeneis*.

E. W. Gudger

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SPECIAL ARTICLES

ANTAGONISM AND WEBER'S LAW

When toxic substances act as antidotes to each other this action is called antagonism. It is usually found that when antagonistic substances are mixed in various combinations there is one proportion which is more favorable than others. If this favorable proportion be maintained it is well known that considerable variation in the concentration of the antagonistic substances is permissible for many plants. It has been pointed out by the writer[1] that while variations in concentration affect the form of the antagonism curve they do not in general affect the proportions which are most favorable for life processes.

It is therefore evident that if we wish to preserve the favorable character of a mixture when the concentration of any antagonistic substance is increased we must at the same time increase the concentration of the others in the same proportion. The law of direct proportionality found in such cases is in reality Weber's law, as Loeb[2] has pointed out in discussing his experiments on animals. In regard to the significance of this Loeb says:

> Since this law underlies many phenomena of stimulation it appears possible that changes in the concentration of antagonistic ions or salts are the means by which these stimulations are brought about, as suggested by my ion-protein theory and by the investigations of Lasareff.

In view of the importance of these relations it seems desirable to ascertain, if possible, what mechanism exists which makes one proportion better than others and preserves this preeminence in spite of variations in concentration.

The writer has formulated a theory[3] involving precisely this kind of mechanism. According to this theory the electrical resistance and the permeability of protoplasm are determined by a substance M which is formed and decomposed by the reactions

$$A \rightarrow M \rightarrow B$$

Under normal circumstances M is formed as

1 *Botanical Gazette*, 58, 367, 1914.

2 *Proc. Nat. Acad. Sciences*, 1: 439, 1915.

3 *Proc. Am. Phil. Soc.*, 55, 1916.