

of the mollusca inhabiting the mountain country, and the molluscan fauna of the great delta of the Ganges and Brahmaputra had its origin in the Himalayan slopes, although they have occupied their present quarters for sufficiently long a period to become specifically distinct. (BV)².

WATER AND THE PUBLIC HEALTH.

- (1) *The Value of Pure Water.* By George C. Whipple. Pp. viii+84. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1907.) Price 4s. 6d. net.
- (2) *The Bacteriological Examination of Water Supplies.* By Dr. William G. Savage. Pp. xvi+297. (London: H. K. Lewis, 1906.) Price 6s. 6d. net.

(1) THIS little book is planned on novel lines and deserves recognition. An extract will best serve to define its scope.

"Given two water sources equally available to a city for purposes of supply, both safe to drink, but one high coloured and soft, the other colourless and hard—which is the better selection? A water-works plant is to be appraised: structurally the system is a good one, but the quality of the water is unsatisfactory because of its excessive colour or turbidity—how much should be deducted from the value of the works because of the bad quality of the water? The water-works owned by a private company are to be purchased by the city; the city has a high typhoid fever death-rate, due unquestionably to the water supply—how much less should the city pay because of that fact? A city is using turbid river water—how much can it afford to pay to filter it? A city is using a water so heavily laden with Anabæna that it is nauseous to drink—how much can the city afford to pay to procure a new supply?"

An attempt is made from available data to establish formulæ which may be employed to calculate the allowable depreciation due to sanitary quality, physical characteristics (colour, odour, &c.), hardness, &c., of a water supply.

The following example is a calculation in the case of typhoid fever. The financial loss to the community for each death from typhoid fever is assumed from various data to be equal to 10,000 dollars. A proportion of the death-rate is due to the disease transmitted by means (shell-fish, flies, &c.) other than water. Assuming that all typhoid in excess of N is due to the water supply, that the daily consumption of water is 100 gallons per capita, and that T is the total typhoid death-rate per 100,000, then (T-N) 10,000=loss to the community in dollars for 365 × 100 × 100,000 gallons of water, or

$$D = \frac{(T - N)10000}{365} = 2.75(T - N),$$

where D stands for the loss in dollars per million gallons of water used. The author is quite alive to the fact that local and other conditions must modify his conclusions, and recognises that more data are required before finality is reached in the elaboration of the formulæ. The book is suggestive and stimulating reading, the

various tables add to its value, and we heartily commend it to the sanitarian and water engineer.

(2) This book by Dr. Savage, who has made many important contributions to the subject on which he writes, gives an admirable survey of the present position of the bacteriology of water supplies. Successive chapters deal with the bacterial content of waters and the influences affecting it, excreta, sewage, and soil in relation to the bacteriological examination, the characters of the intestinal bacteria, bacterial evidences of pollution, and full details of the methods employed in the bacteriological examination of water. The chapter on the interpretation of results is particularly to be recommended. A full bibliography is appended. The medical officer of health, the analyst, and the bacteriologist will find this book a trustworthy and useful guide.

R. T. HEWLETT.

THREE MATHEMATICAL TRACTS.

Quadratic Forms and their Classification by Means of Invariant Factors. By Prof. T. J. I'A. Bromwich, F.R.S. Pp. viii+100. (Cambridge: The University Press, 1906.) Price 3s. 2d. net.

The Axioms of Projective Geometry. By Dr. A. N. Whitehead, F.R.S. Pp. viii+64. (Cambridge: The University Press, 1906.) Price 2s. 6d.

The Axioms of Descriptive Geometry. By Dr. A. N. Whitehead, F.R.S. Pp. viii+74. (Cambridge: The University Press, 1907.) Price 2s. 6d.

THESE are Nos. 3, 4, and 5 of the Cambridge Tracts in Mathematics and Mathematical Physics, which are intended to help students by providing them with brief and readable introductions to mathematical theories which are important in themselves, and yet for various reasons do not appear in the ordinary text-books. If they serve their purpose they will induce their readers to follow up the paths they indicate, and try to explore still further the mazy garden of the mathematical muse.

The present state of the theory of quadratic forms illustrates very well how much interest there may be in the particular cases of a problem which, in its so-called "general form," has a trite and familiar solution. To put the matter into a geometrical shape; when there are four homogeneous variables, let $S=0$, $T=0$ be the equations of two quadratic surfaces; then in general the family $S+\lambda T=0$ will have a common self-conjugate tetrahedron, and by taking this as a tetrahedron of reference, S and T assume a well-known standard form. But there are thirteen other cases to consider, for each of which there is a distinct reduced form of $S+\lambda T$; for instance, if S and T intersect in a cuspidal quartic, the reduced form is

$$2(\lambda + a)xy + 2yz + b(\lambda + a)z^2 + c(\lambda + d)t^2.$$

If we consider the small oscillations of a dynamical system with four degrees of freedom, we are confronted by precisely the same analytical problem of reduction; the algebraical classification is the same, but certain cases are ruled out by the condition that