mixed floras will be found in intermediate regions, and they, too, will play their part in confirming or confuting the conclusions I have drawn before—though, I believe that they, like the flora referred to by Dr. Walton, will support and not oppose those views.

H. DIGHTON THOMAS.
Department of Geology,
British Museum (Natural History),
Cromwell Road,
London, S.W.7,
Sept. 25.

Statistics and Biological Research.

IN a letter to NATURE of Aug. 17, Dr. R. A. Fisher has given a clear statement of his reasons for believing that the methods set out in his "Statistical Methods for Research Workers" are adequate to deal with all problems arising in biological research as ordinarily conducted. Those statisticians who, like "Student", feel that there is need for the study of non-normal distributions particularly in connexion with small samples, might perhaps state their position as follows. In the first place, from their own experience they do not feel so confident as Dr. Fisher that the normal distribution and tests based upon it are adequate in *all* forms of biological work; in the second place, they are concerned with many non-biological problems in which forms of variation occur ranging from very slight to extreme degrees of a-normality. It is not, therefore, an academic but a very real problem for them to obtain some more exact appreciation than seems hitherto to have been reached, of the point at which a-normality of distribution renders the tests of 'normal theory' inaccurate or inefficient.

Turning to the more theoretical aspect of the problem, no one who appreciates the lines along which Dr. Fisher has developed the theory of sampling will deny that as the form of variation deviates more and more from the normal, not only may (*a*) the frequency constants or 'statistics' cease to be distributed in random samples according to the 'normal theory' law; but also (*b*), even if they are still approximately so distributed, they begin to lose their efficiency as discriminating criteria. For each form of variation there exists in theory different 'statistics' leading to the most efficient tests for the significance of differences observed on samples. The subject is one of extreme interest, but, as Dr. Fisher writes, this new realm of statistical theory is at present scarcely opened. But whether it were opened or not, I am inclined to think that a fundamental difficulty would still be present. It is this.

In practice the worker in small samples can rarely be certain from the evidence available of the exact form of variation in his population; he must, therefore, use some standard form of analysis, and if he believes from previous experience that deviations from normality if existing are unlikely to be great, he will naturally use the 'normal theory' tests. But, logically, confidence in his results is then only justified if he is certain that deviations from normality of this order will not introduce the difficulties (*a*) or (*b*) above.

As a concrete example, suppose that a biologist wishes to compare the eggs of two groups of a species of bird living in different habitats. He has collected and measured an egg from each of some ten or a dozen nests from both groups. The numbers are small, but would be of value at any rate in a preliminary inquiry. May he now compare the means and standard deviations of, say, length and breadth of eggs, for the two groups, using Dr. Fisher's t and z tests? His samples are too small to give him any information on this point, but he may turn to literature containing egg measurements on a large scale and see whether the variation in length and breadth of eggs is generally normally distributed. He would find, for example, in *Biometrika*:

Length of cuckoo's egg, 1572 cases. Frequency constants $\beta_1 = \cdot0044$, $\beta_2 = 3\cdot3483$
Breadth of common tern's egg (1914), 1592 cases. Frequency constants. . . . $\beta_1 = \cdot2618$, $\beta_2 = 3\cdot5315$
Breadth of common tern's egg (1920), 956 cases. Frequency constants. . . . $\beta_1 = \cdot1624$, $\beta_2 = 3\cdot9276$
(From *Biometrika*, iv. p. 368, xii. p. 348, xv. p. 337 respectively.)

The constants for the common tern's eggs differ significantly from the normal values of $\beta_1 = 0$, $\beta_2 = 3$. If, however, the biologist knew that for deviations from normality as great or even greater than these the t and z tests were still adequate, he would apply them with some confidence to his own data. But at present is there any published evidence which will assist him in deciding this point?

It is not questioned that in a very wide field of biological work the normal distribution is adequate. Those who work within its bounds are fortunate, but they should admit the possibility that others may meet in practice cases of distinctly non-normal variation; and therefore wish to know more precisely at what point the criteria based on means, standard deviations, and correlation coefficients fail to be distributed in sampling according to 'normal theory', and to understand a little more clearly the nature of the consequences of the inefficiency introduced by using these 'statistics'.

A-normality may arise in an infinite number of ways; it is only humanly possible to explore a few of these, but each fresh piece of information makes us more certain of the strength or weakness of our tools. By representing populations by some variable system of mathematical curves, it is possible to examine certain typical forms of deviation from the normal. But it certainly is not claimed that such an exploration would be exhaustive.

EGON S. PEARSON.
University College, London, W.C.1,
Sept. 30.

West Indian Biota in New Caledonia.

WHEN visiting New Caledonia last year, my attention was directed to the varied representation of the fauna and flora of the West Indies to be found in the island. New Caledonia is a French colony, and is visited by steamers which go round the world, calling at French ports. There has been commerce by way of the French Antilles, and some of the species accidentally brought from thence have been described as supposedly endemic members of the New Caledonia fauna.

(1) The slug *Veronicella plebeia* was described from New Caledonia by P. Fischer in 1868. It is very common in the lowlands of the island; I found it particularly abundant at Bourail. In 1925 Grimpe and Hoffmann decided that it had an extensive synonymy, and existed in localities so remote as Tahiti, Mauritius, Brazil, and the West Indies. I sent Bourail specimens to Dr. H. B. Baker of Philadelphia, and he finds them practically identical with *V. dubia* Semper of the Lesser Antilles. He remarks that all of its near relatives are neotropical. Thus it appears to have been carried from the West Indies to New Caledonia in the early days of the colony, but the earliest and valid name is that based on New Caledonia specimens.

(2) At various places, but in great abundance on