

addition to the *Systema Naturæ*, however, demands some modification, although maybe very little, in the diagnoses of previously recognized species, and there comes a time when a revision of a whole group, a genus or a family, must be taken in hand if the system is not to fall into confusion. When an author is courageous enough to attempt such a revision for an extensive group, it is often hard to find a periodical in which it can be published,

especially if it is to be adequately illustrated. It has not infrequently happened that such a revision has been laid aside for years after being completed in default of any means of giving it to the world. It is, therefore, a hopeful sign of reviving interest in systematic zoology that a journal should have been established in which important and lengthy memoirs of this kind may find a place.

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Indeterminism and Psychology

Déterminisme et variabilité dans le comportement des organismes

(Exposés de biométrie et de statistique biologique, 7.) Par Prof. W. J. Crozier. (Actualités scientifiques et industrielles, 261.) Pp. 57. (Paris: Hermann et Cie., 1935.) 15 francs.

THE physicists have gone on strike against determinism and have called on the psychologists to come out in sympathy, but the psychologists can see no logical connexion between the physical problem and the psychological problem. It appears that the physicist can never know the facts about a single electron and can only predict the behaviour of aggregates. An individual animal represents a large aggregate of electrons and other units, and the fact that the behaviour of the individual units cannot be predicted does not necessarily imply that the behaviour of the aggregate is not governed by laws as rigid as those which govern the behaviour of a similar mass of inanimate matter. The difficulties of prediction appear to be due to the complexity of the problem rather than to any fundamental obstacle to observation. The psychologist is presented with a glut of facts about each individual and can see no reason why he should not explain the processes which govern individual behaviour, but such knowledge is likely to play a less important part in the world than a knowledge of the behaviour of aggregates of animals. Prof. Crozier, of Harvard, who has devoted the last ten years to the study of the behaviour of aggregates of rats, has published the summary of his results now under notice.

The evidence may be illustrated by describing a typical experiment. A rat is placed on an inclined plane in the dark, and its movements are recorded by photographing the movements of a patch of luminous paint on the rat's back. The rat knows that a suitable reward awaits it at the top of the inclined plane, and it therefore runs uphill in a series of short straight dashes. The

angle between the movements of the rat and a horizontal line in the inclined plane (θ) measures the accuracy of the rat's judgment, which must depend on sensations in the muscles of the rat's legs. When the results obtained from a large number of rats are averaged, their behaviour is found to be governed by laws. For example, the component of gravity in the direction of maximal slope will be proportional to $\sin \alpha$. As the slope increases, the accuracy of the rat's judgment increases in such a way that, like other similar curves depending on sensation, the curve connecting θ and $\log \sin \alpha$ is shaped like a prolonged *S*, being approximately straight in the middle range.

The curve obtained from a homozygous colony of rats is constant and typical of that colony. If two colonies interbreed, the factors on which the position of the curve depends are inherited according to Mendelian laws. The variability of the animals was estimated by calculating the standard deviation of the observed values of θ . Various conclusions are reached regarding the correlation between variability and slope. Different homozygous colonies of rats showed characteristic different degrees of variability, the inheritance of which has been studied.

Prof. Crozier discusses the philosophical implications of his results, which he considers to be opposed to the opinions of those physicists who would extend the principle of indeterminism to vital phenomena. On the other hand, he does not claim to be able to predict the behaviour of an individual rat any more than the physicist can predict the behaviour of an individual electron. He can, however, predict the behaviour of the average rat just as the physicist can predict the behaviour of the average electron. If methods such as those of Prof. Crozier can be extended to predict the behaviour of the average man, they may play an important part in deciding the destinies of nations.