Details of these isolations and further studies will be published elsewhere.

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References

1. ZEIDBERG, L. D., DILLON, A., and GASS, R. S. *Am. J. Pub. Health*, **41**, 80 (1951).
2. EMMONS, C. W. *Public Health Repts.*, **64**, 892 (1949).
3. STRAUSS, R. E., and KLIGMAN, A. M. (In press.)

Why Do Insects Have Six Legs?

WITH few exceptions, adults of the several million species of insects reputed to be in existence have three pairs of legs. This implies that this particular number of legs has some very general adaptive significance, or, to put it another way, in the vast majority of insects any deterioration in the genetic complex responsible for the production of three pairs of legs is promptly and effectively selected against.

Why three pairs of legs, and not two? Evidence from comparative morphology of the arthropods supports the concept that insects were derived from many-legged ancestors, perhaps centipedelike in appearance. Presumably the hexapod condition arose by gradual reduction of the number of legs. The reduction went no farther than three pairs, because locomotion on two pairs of legs is not efficient for a small animal encased in an exoskeleton. Normally, the insect walks by lifting two legs on one side and the middle leg on the other, sweeping these forward simultaneously and placing them down together, thus completing a single step. The other three legs furnish a tripod support while the step is taken. The center of gravity shifts out of the base of the tripod near the end of each step, and the insect falls onto the three legs just placed down. Thus, as the insect walks, it falls from one solid tripod support to another. Maintaining balance is an important problem in locomotion, and the smaller the animal, the more difficult it is. An illustration of one of the principles involved is shown by the ease with which a long stick can be balanced vertically on the end of one's finger, as compared with the difficulty of balancing a pencil. A contributing factor to this is that the pencil falls more quickly than the long stick. A large mammal has a comparatively long time to make the corrections necessary to maintain balance in the more precarious quadrupedal or bipedal locomotion, whereas a small insect has much less time, possibly not enough for nerve-controlled responses to operate. Another important factor in the difficulty of maintaining balance is the relative inflexibility of the trunk of the insect. Mammals can maintain balance by small, extremely varied movements of the trunk, and the even more flexible tail is an important balancing organ in many mammals. Insects can walk with one or two legs destroyed, but locomotion is then a slower and more uncertain process.

There are many aquatic, swimming insects which, as adults, cannot walk. The three pairs of legs invariably present in these forms could be explained on a similar adaptive basis, by assuming that in the terrestrial ancestors of these forms the number of walking legs was stabilized at six, and then that different auxiliary but important functions were assigned to different pairs of legs, such as antennae-cleaning, stridulating, elytra-cleaning, etc. Selection pressure then would operate to retain all three pairs. A similar explanation could be applied to other primarily nonwalking insects.

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Book Reviews

Population Genetics and Animal Improvement: As Illustrated by the Inheritance of Egg Production. I. Michael Lerner. New York: Cambridge Univ. Press, 1950. 342 pp. $5.50.

Although the author assumes that the reader has only an elementary knowledge of genetics and statistics, this book is primarily addressed to teachers, investigators, and advanced students of animal genetics. The treatment is nonmathematical. The biometric foundations of the book rest almost wholly on Sewall Wright and Lush and his school. The undercurrent of genetic theory is dominated largely by Mather's concept of polygenic inheritance (i.e., that genes acting on economic traits such as egg production are inherited in the Mendelian manner, but that variation due to them is small in relation to the total). The author's recent researches in the area of population genetics of egg production provide the principal source of illustrative material. Egg production is taken as the model trait to illustrate the principles of population genetics.

The first 4 of the 15 chapters in the book are introductory in nature. Chapter 2 gives a historical survey of the literature on the inheritance of egg production. The author points out the fallacy of the Mendelian approach which has been used to study the inheritance of egg production. He then sets forth arguments for the newer, more acceptable "polygenic" approach. Chapter 3 is devoted entirely to a biological analysis of egg production in the fowl. The 5 physio-

logical components of egg production originally suggested by Goodale are considered separately, and the logic of their use in setting up a production index (a criterion of selection for egg production and viability) is discussed. In Chapter 4 a description of the University of California flock is given as a case history. This is justified since the author's viewpoints and conclusions are largely based on data gathered from this flock.

Not until Chapter 5 does the author get down to the principal task—development of the subject of population genetics. Six fundamental postulates are listed on which applied population genetics is based. This chapter is also a brief preview of the material covered in subsequent chapters.

Chapters on heritability, principles of selection, and expected genetic gains follow in logical sequence. The reader will find Lerner's treatment of the problem of artificial selection for egg production especially interesting. He alludes to Mather's genetic balance and fitness concept. Under artificial selection genes are not in balance. Concomitantly there is a counterforce of natural selection for genetic balance most favorable to fitness (survival). These forces oppose one another.

The material covered in Chapter 12 on phenotypic and genetic correlations should serve to clear up much of the misunderstanding regarding these. Methods of estimating genetic correlations are discussed. Their use in constructing selection indexes is considered in Chapter 13. Considerable detail is devoted to the principles of constructing selection indexes.

Throughout the book the author points up important problems and suggests ways these might be solved. He classifies and discusses these problems under 6 headings in the last chapter.

A unique feature of organization is an appendix including a list of 44 numbered text formulas, together with a statement of what the formulas are, a glossary of symbols and definitions (8 pp.) and a bibliography and author index (17 pp.).

There is little question but what the book is a valuable contribution to the field of poultry breeding. The degree of success it will meet as a teaching text remains to be seen. Certainly its use would be on a graduate level. Yet the teacher would need to supplement the nonmathematical treatment showing the derivations of at least the most important formulas.

The author perhaps lays more stress on the polygenic aspect of population genetics than is justified. Certainly the consequences are no different than under the older multiple-factor concept of quantitative inheritance. The numerous cross references to which he alludes in this brief work hardly seem necessary, and this reviewer found the frequent interruptions and digressions from the central thought rather bothersome.

On the whole this monograph is well written, and the author deserves praise for a job well done. His important contributions to the population genetics of poultry and his bringing to focus many of the as yet unsolved problems doubtless will serve to stimulate old workers and recruit new ones to the field of population genetics.

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Learning Theory and Personality Dynamics: Selected Papers. O. Hobart Mowrer. New York: Ronald Press, 1950. 776 pp. $7.50.

This book contains data and ideas that must interest both the narrowly academic psychologist and the student of literature—from the trainer of animals to the parent who wants to know whether children should be punished or how to stop them from wetting their beds. Eight of the 24 papers are published here for the first time.

Persons interested in theory are likely to use this book with mixed feelings. Mowrer's views have not been static, and their development is evident in these papers. But the method of publishing has forced him into an elaborate set of commentaries on his own earlier writing. It surely could not have cost much more effort to produce a single coherent account of his present position, which would have meant a shorter book and one more easily read. Anything is unfortunate that detracts from a serious consideration of the material presented here.

To understand the book one must realize that Mowrer aims at a synthesis of psychoanalysis with "learning theory," which is a special brand of academic psychology. (He assumes, for example, only the primordial motives of hunger, pain, and sex, an assumption which leads to a completely inadequate account of emotion, in the reviewer's opinion, with disregard of established experimental fact.) By the time he has finished his synthesis, learning theory has become almost unrecognizable, and the analytically inclined may find the same thing true of his psychoanalysis. However, the bridge that Mowrer constructs between animal psychology, based on rigorous experiment, and the very unexperimental study of human clinical problems, represents genuine communication between the two areas, whether one accepts his theoretical ideas or not. This amalgamation is in itself an achievement.

Anyone who has any interest in psychological problems should read the last four or five chapters, including "The Life and Work of Edgar Allan Poe—A Study in Conscience-killing" and "On the Psychology of Talking Birds—A Contribution to Language and Personality Theory."

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