A PRECISE CRITERION OF SPECIES.

To the Editor of Science: Your note in Science No. 178 on the recent paper by Dr. Davenport and Mr. Blankinship on a 'Precise Criterion of Species' raises a question which I think you do not follow to its necessary conclusion. That the criterion of species is a problem largely made up of psychological elements seems an almost self-evident proposition, and as I understand the paper in question its object is simply to tabulate these psychological elements and draw from them an exact statement of accepted current usage. From this tabulation it appears that in America, during the present decade, groups of animals whose differences may be expressed by one kind of curve are currently regarded as species, while those whose differences give another curve are looked upon as subspecies. But why should the question be left here? If the curves were made from data furnished by determinations current in America during the past decade or in Europe now they would be strikingly different from those actually obtained by Dr. Davenport. An almost equally noticeable discrepancy would occur between the curves furnished by the work of certain American and European systematists at the present day as compared with those of some of their respective compatriots.* Furthermore every individual worker passes through phases of opinion in each of which his work would give appreciably different curves. It appears to me, therefore, that Dr. Davenport and Mr. Blankinship have elaborated not so much a precise method of distinguishing between species and sub-species as for graphically representing the opinions of different times and individuals. In other words, they have shown how to make a Linnæus-curve, a Brehm-curve, an America-curve or an 1898-curve—which when compared together have an undoubted psychological interest—but they have not furnished a criterion which will be of actual service to working systematic zoologists. The reason for this failure is partly, as Dr. Davenport suggests in his letter in Science No. 179, due to the complexity of the method, but more especially to the fact that systematists, from the very nature of their work, must hold themselves ever ready to accept new points of view and new standards of value.

* I write from the standpoint of mammalogy and ornithology.

Gerrit S. Miller, Jr.
U. S. National Museum.

SCIENTIFIC LITERATURE.

A Text-book of Entomology, including the Anatomy, Physiology, Embryology and Metamorphoses of Insects, for use in Agricultural and Technical Schools and Colleges, as well as by the working Entomologist. A. S. Packard. Macmillan Company. 1898. 8vo. Pp. 729. 654 figs.

Students of entomology who began their work some fifteen or twenty years ago often found Professor Packard's 'Guide to the Study of Insects' the only accessible American book of reference on the subject of general entomology. It was a large volume, containing much valuable material, but it never seemed to satisfy one even on minor questions. It contained anatomy, physiology, embryology and taxonomy in a somewhat undifferentiated condition. The redeeming feature of the work was the wide philosophical interest that its pages inspired. This interest had its source in Professor Packard's own industrious and enthusiastic study of the subject of entomology, a study which he has extended without interruption during the thirty years that have elapsed since the publication of the 'Guide.' The results of this long study now lie before us in this able text-book.

The recent publication of Comstock's 'Manual' and Sharp's volume on insects in the 'Cambridge Natural History' has evidently led Professor Packard to exclude a consideration of the taxonomy of insects and to confine his treatment to the morphological and physiological aspects of the subject—a task surely very great even as thus limited. He takes up in succession the anatomy, embryology and metamorphoses of insects, giving more or less attention to the physiological aspect as he proceeds. His presentation of this last aspect is, perhaps, the weakest portion of the book, because Professor Packard has not made special up-to-date studies in this field. He omits all mention of several interesting physiological facts, such as Professor J. Loeb's interesting experiments on the heliotropism and stereotropism of insects.

He moves somewhat more securely over the ground of histology and embryology, although we find an occasional lapsus or deficiency. As an example of a histological lapsus Professor Packard's account of the origin of the tænidia of the tracheæ (p. 449) may be mentioned. He describes the spiral thread of the chitinous trachea as originating from nuclei (!) and gives two figures to illustrate this remarkable contention. But if these figures show anything they show that the tænidia arise from the cytoplasm of the tracheal hypodermis and not from nuclei.

The embryologist may object to Professor Packard's heading a section (p. 126) with the words 'Embryonic development of the wings.' In accepting Weismann's observations, published in 1864, that the imaginal discs of the legs and wings of the blow-fly are formed before the hatching of the embryo, Professor Packard does not stop to consider that these observations were necessarily unsatisfactory because the method of sectioning the egg was not in vogue at the time. Moreover, an examination of the concluding paragraphs of Graber's study of the embryology of the fly (1889) and of the accompanying figures of sections would have convinced Professor Packard of the uncertainty of the statement that the wing-germs are formed in the embryo, and he would have avoided a misleading heading. Several cases of a similar incautious haste in accepting the statements of authors could be pointed out.

On the whole the complicated subject of insect morphology is handled with a good sense of proportion. We could have wished for longer chapters and more instructive figures illustrating the fascinating subjects of phosphorescence, stridulating organs, compound eyes, etc. Stridulating organs are not even figured. The vast literature on the compound eyes of insects must surely furnish much better figures than those employed by Professor Packard, and a few good sections of one of our common fireflies would furnish better drawings of the phosphorescent organs than the one taken from Emery's paper.

In the embryological division of the subject there are many little inaccuracies, as *e. g.* (p. 525) when Professor Packard says: "The germinal vesicle of the ripe insect egg lies in the center of the yolk, where it appears as a large vesicle-like cell-nucleus containing a few chromatine elements." If Professor Packard had ever spent hours, days, or even weeks, searching for the germinal vesicle in a ripe insect egg, he would not describe it as a 'large vesicle-like' structure in 'the center of the yolk.' The envelope formation and revolution of the insect egg admits of a more interesting comparative treatment than that employed by Professor Packard. In this connection we venture to say that the inversion of the figures of the *Œcanthus* embryo (p. 545), taken from Ayers, will only serve to perpetuate an unfortunate blunder in the orientation of the embryo with respect to the egg.

It is to be regretted that Professor Packard could not omit all reference to Neo-Lamarckianism. In the closing paragraph of the portion on insect metamorphosis we find the following sentence: "The sudden or tachygenic appearance of temporary structures, such as hatching spines, various setæ, spines, respiratory organs, so characteristic of dipterous larvæ and of the protective colors and markings of caterpillars and which are discarded at pupation or imagination, are evidently due to the action of stimuli from without, to the primary neolamarckian factors, the characters proper to each larval stadium and to the pupal and imaginal stadia, characters probably acquired during the lifetime of the individual, becoming finally fixed by homochronous heredity." Such language is out of place in a text-book, unless the other side of the question is also presented. In certain respects insect metamorphosis is one of the least favorable subjects for the study of the 'primary Neo-Lamarckian factors.' The Neo-Lamarckians have yet to demonstrate how, *e. g.*, many chitinous structures, such as hairs, scales, etc., which are really *dead* or fixed before they begin to function in the imago, and which have certainly undergone specific or even generic variation since complete metaphosis was acquired in the common ancestor, can be due to the direct action of external stimuli becoming finally 'fixed by homochronous heredity.'

It would be possible to cite several cases of inaccuracy in Professor Packard's book, were

it not more important to commend the great labor which he has bestowed upon it, than to search for the little errors that are unavoidable in every attempt to cover a field extending so far beyond the possible limits of any one entomologist's experience. Our critical inclination gives way to our gratitude to Professor Packard for having accomplished so well what very few would have the courage to undertake, and fewer still the ability and preparation to execute. With the books of Professors Packard, Comstock and Sharp on his shelves, the beginning entomologist of to-day will find before him a short and pleasant path to a knowledge of his subject instead of the long and tortuous course which many American entomologists have had to pursue. With these works the 'modern morphologist,' who is often not a little proud of knowing nothing about Hexapods, can fill a gap in his library, if not in his information. The wide-awake morphologist or physiologist who turns the pages of these works will see suggestions of many great problems and of greater opportunities for work than he may be able to find in the more limited and more nearly exhausted fields of annelid and vertebrate morphology. Insects have been long and lovingly studied, but we have scarcely begun to know more than a few superficial facts concerning them. Professor Packard's book, we venture to predict, will, in the course of time, attract many American students to the study of the intricate organization and development of insects and thereby lead indirectly but surely to an increase of our knowledge.

William Morton Wheeler.

Pasteur. By Percy Frankland and Mrs. Percy Frankland. New York, The Macmillan Company. 1898. Pp. 224. Price, $1.25.

Of few men of science can it be said more truly than of Pasteur that the story of his life is found in his work. Judged by ordinary standards his life itself was not an eventful one, and the simple record of his scientific achievements constitutes perforce the larger part of any biography. In order to understand what significance these achievements possessed for Pasteur's contemporaries and what they mean to his successors it is necessary to correlate the discoveries made by Pasteur both with the condition of science in his time and with our present knowledge, and the deftness with which such a relation is traced becomes a fair measure of the biographer's success. For this task the present biographers are unusually well equipped, and they have approached the subject with an appreciation of the simplicity of the man and the dignity of his undertakings that has given us a most readable account of the life-work of the great master.

Louis Pasteur was born at Dôle on the 27th of December, 1822, and was of humble origin, his father being the owner of a small tannery. By dint of great sacrifices on the part of his parents, Louis was given early opportunities for study, and the boy soon attracted the attention of his teachers through his great diligence, energy and enthusiasm. When he was twenty-one years of age he went up to Paris to the École Normale and threw himself almost at once into the work of investigation. He fell first under the influence of Biot and began that study of the crystals of tartaric acid which led to the remarkable discovery of the spatial relations subsisting between the atoms within the molecule and blazed the way for the fruitful generalizations of stereo-chemistry.

M. Duclaux, in his admirable book, 'Pasteur: Histoire d'un Esprit,' has recently grouped Pasteur's researches under eight heads: Studies in Crystallography, The Lactic and Alcoholic Fermentations, Spontaneous Generation, Researches upon the Diseases of Wine and Vinegar, The Silkworm Disease, Studies on Beer, The Etiology of Infectious Diseases and Researches upon Vaccines, and our authors have in the main followed this grouping. It may be doubted if the history of science offers a better illustration of the way in which scientific research carries a worker irresistibly along on its own current, sometimes rendering him a foiled, circuitous wanderer, sometimes, as with Pasteur, leading from one channel into another with the horizon always widening out as the water deepens around him.

That perennially interesting subject, Pasteur's controversy with Liebig over the theory of fermentation and decay, is treated by our