REVIEWS

Bird Navigation.—G. V. T. Matthews. Cambridge, Cambridge University Press. vi + 141 pp., 33 figs. in text. 1955. Price 12s 6d.

Travels and Traditions of Waterfowl.—H. Albert Hochbaum. Minneapolis, University of Minnesota Press. x + 301 pp., 26 figs. and many interpretive sketches in text. 1955. Price $5.00.

These two books will both be valuable additions to the library of all ornithologists whose interests in birds extend beyond the label on a specimen or the tally at the bottom of a check-list. Each presents in authoritative fashion an important segment of the available knowledge of migration and navigation in birds. Both authors write from extensive experience with living birds, and both have taken full advantage of the published work of others. Although they approach these central problems of ornithology from quite different points of view, their books are complementary in the best sense; and the appearance of two such books during a single year demonstrates that real progress is being made in this field.

By the title "Travels and Traditions of Waterfowl" Hochbaum emphasizes the importance of individual experience and learning by the example of other birds of the same species. Much of his book is based directly on personal knowledge of ducks and geese in the Prairie Provinces, and he builds a convincing case for the development of long-distance migrations out of shorter flights on the breeding grounds. Local topographic factors, the learning of visual landmarks, and the influence of weather conditions are considered in sensible perspective, and general considerations are always tempered by numerous detailed accounts of specific first-hand observations. Some intriguing and original experiments with blindfolded birds released out-of-doors are described here for the first time. And finally there is a thoughtful discussion of the probable role in waterfowl of "tradition," the acquisition of behavior patterns and flight paths by learning from other more experienced birds.

Matthews' approach has been wholly an experimental one, and his book summarizes important contributions of information and theories concerning the sensory basis of orientation during the flights of birds over long distances, including both homing pigeons and wild birds such as the Manx Shearwater. As if to demonstrate that homing experiments can yield wonders equal to those observed in nature, Matthews presents the details concerning a Manx Shearwater which returned in twelve days from Boston, Massachusetts, to its home off the coast of Wales. Still more impressive has been the demonstration by Matthews and Kramer that Manx Shearwaters and certain colonies of homing pigeons consistently head in the home direction very soon after release in unfamiliar territory, regardless of the direction of transportation away from home. Matthews reviews all other homing experiments with birds, together with all important theories that have been advanced to account for bird navigation, although one could have hoped for a more adequate presentation of the important contributions of Kramer and his associates. Matthews then presents his own theory of sun-arc navigation, and closes with this evaluation of it: "No theory of the physical basis of bird navigation remains in the field except that involving the sun. This the evidence strongly supports, and the only type of sun navigation that fits the observed facts and is satisfactory from the logical point of view is that proposed by the sun-arc hypothesis. Even if future work proves this particular hypothesis faulty, it seems fairly certain that the final solution will have to be a reinterpretation of the way in which the sun's position in the sky can serve to give the bird its position relative to home."

The hypothesis which Matthews thus advances as a complete, if tentative, explanation for bird navigation is stated elsewhere in his book as follows: "The essential feature is the *sun arc.* This is inclined at an angle from the horizontal which is constant for a given place and is a measure of the latitude of that place. . . . The speed at which the sun moves round its arc is, for practical purposes, constant, at 15° an hour. When it has reached a particular point on its arc at home, it will have advanced further to an observer in the east, and less far to one in the west, the difference in arc angle (the angle round the arc from the noon position) being directly proportional to the change in longitude. At home the bird will become familiar with the features of the sun arc, and the sun's position on it at different (local) times. These will be related to the internal 'chronometer' which is also an essential part of the hypothesis. In unfamiliar surroundings the bird will have to construct the sun-arc from observation. The suggestion is that it observes the sun's movement over a small part of its arc and extrapolates to obtain the highest point. Measurement of the altitude of this point, the angle from the horizontal, and comparison with the remembered value for home, say, the previous day, will give the latitude change. The arc angle from the observed sun to this highest point when compared with that obtained at home for the same chronometer time will give the longitude change."

Many will find it difficult to believe that birds carry out so precise a kind of celestial navigation; and this point of view has been well stated by Aldous Huxley in an article in Life magazine which attempts to make a case for mental telepathy and the like: "there is the hypothesis that pigeons navigate by means of the sun. If they do, they must possess, built into their nervous systems, the equivalents of a chronometer, a sextant, navigational tables and a calculating machine for correlating the solar data observed at the point of release with those at the loft." It is at this point that Hochbaum's book makes one of its most important contributions to a more widespread understanding of such matters, and in particular to a more general escape from the pitfalls of inappropriate semantics. While Matthews uses the language of the navigator, albeit in simplified form, Hochbaum translates the same ideas into homely terms of the everyday lives of men or ducks, as in the following passage: "the traveler (like Joshua) perceives the sun moving relative to the earth. . . . A traveler who in autumn has moved several hundred miles toward the equator, for example, perceives that the sun rises at a steeper angle from the east, follows a higher arc across the sky, and drops more abruptly into the west. . . . A traveler accustomed to breakfast at sunrise, dinner at high noon, and supper at sunset would find that . . . if he went west from home, . . . the stomach would call for its dinner before the sun had gained its zenith."

If we are to think sensibly about these problems, we must strive somehow to bring together the analytical thinking typified by Matthews and the feeling for the realities of birds' lives so well expressed by Hochbaum's words and sketches. We must also avoid limiting our thinking by assuming that if birds orient with reference to celestial cues they must therefore employ the same mental processes as those used by the human navigator. The essential question is whether or not a given environmental cue, such as the sun's arc through the sky, is in fact perceived and used by birds to determine the direction of their flight.

Huxley succeeds brilliantly in confusing the issue. Imagine, for example, a full, technical statement of all of the physiological events which occur with split-second precision as a man plays tennis or a phoebe catches a flying insect. These events could easily be made to sound far more complex than the hypothesis of sun-arc navigation by birds.

Matthews' hypothesis will stand or fall as a result of the further experimentation which it will certainly help to stimulate. Among the essential questions still to be answered are these: Can birds judge the sun's altitude above the horizon with a precision of perhaps one minute of arc? Can they determine the slope of the sun's path across the sky with the required precision, even when they see it for only a minute or two before flying off from the release point in approximately the home direction? Does their "internal chronometer" have the necessary accuracy? And finally, the largest question of all from the point of view of the field ornithologist, what about migratory flights at night or under an overcast?

The first two of these questions should be susceptible to direct, experimental test, especially if those interested in these problems can take advantage of modern techniques of conditioning birds in order to bring out their full sensory capacities. Human and avian visual acuity certainly approaches or even exceeds plus or minus one minute of arc (see for example Donner, K. O. Acta Zoologica Fennica, **66:** 1–40, 1951). But these values have been obtained in experiments where the bird or man was asked merely to distinguish two points from one, or thin black and white stripes from a uniform gray which results when their width subtends too small an angle at the observer's eye. It is quite another matter, for a human observer at least, to judge with equal precision a large visual angle, such as the altitude of the sun above the horizon.

Regarding the "internal chronometer" there has been available for a long time substantial evidence that birds and many other animals keep track of the time of day under constant environmental conditions, in the sense that they become active at a definite time even in the absence of external indications of time. This evidence is well reviewed in Matthews' book, insofar as it applies to birds; and, more recently still, significant experiments have also been described by Hoffmann (Naturwissensch., **40:** 608–609, 1953), and Rawson (Zeitschr. f. Tierpsychol., **11:** 446–452, 1954). A fairly accurate internal time-keeping process seems the most plausible of Matthews' assumptions.

To the obvious difficulty that much migration and homing occur when the sun is not available to view, Matthews replies by pointing out that in some of his experiments homing was very poor indeed during several days of constant overcast. He goes on to suggest, "The fact that migrants continue to pass over in the 'standard' direction when the sky is overcast is no real objection. The direction could well have been determined by an earlier view of the sun and maintained in the cloudy interval with reference to general topography." On the whole, Matthews' theory stands as a provocative challenge for future investigations; but until its foundations are bolstered by more substantial evidence it can scarcely be accepted as more than a partial explanation of bird navigation.—DONALD R. GRIFFIN.

Sea Birds.—James Fisher and R. M. Lockley. Houghton Mifflin Company, Boston. xvi + 320 pp., 40 black and white plates, 9 color plates, 66 text-figures. Price $6.00.—This excellent book deals with the 85 "primary" sea birds (procellariiform, pelecaniform, and some charadriiform species) and also with the 31 "secondary" sea birds (gaviiform, anatid, and phalaropodid species) inhabiting the North Atlantic Ocean as breeding populations. The authors are well-known British specialists on oceanic birds. Slightly more than half the book is devoted to consideration of problems investigated by modern ornithologists; chapters include material on the North Atlantic as bird environment, evolution in sea birds, demographic phenomena, movements, navigation, and social and sexual behavior. The remainder of the text proper is concerned with life history information presented group by group.

Appendicular material is composed of a distributional list of sea bird species, a selective bibliography, and indices to authorities and vertebrate species mentioned in text.

One way this book could be improved would be to increase its size. As it is, however, all important fact, knowledge, and hypothesis concerning North Atlantic sea birds as of 1954 is within the covers, and an increase in size would simply afford fuller documentation, not to mention more good reading.—RICHARD F. JOHNSTON.

Variation, Relationships and Evolution in the *Pachycephala pectoralis* Superspecies (Aves, Muscicapidae).—Ian C. J. Galbraith. Bull. Brit. Mus. (Nat. Hist.), Zool. Ser., London, vol. 4, no. 4, pp. 133–222, maps. September, 1956. Price, one pound four shillings.—An evolutionary review of geographical variation in the bird that is commonly said to have more subspecies than any other. The author finds that variation patterns are best shown after suppressing slight subspecies, and suggests that this may be true of birds in general. Some forms of *pectoralis*, known to intergrade, are much more distinct than are some full species of the same genus that live side by side on New Guinea. Clines, presumably adaptive, are visible on continents (Australia) but barely hinted at in island populations, which vary more sharply and irregularly. Many other interesting suggestions and conclusions.—DEAN AMADON

Methods and Principles of Systematic Zoology.—Ernst Mayr, E. Gorton Linsley, and Robert L. Usinger. (McGraw-Hill, New York), ix + 328 pp., 45 figures in text. Price, $6.00.—Too few non-systematists understand the job of the systematist. Briefly, it is to fit a man-made system of taxonomic categories or pigeon-holes to a world of organisms whose kinds span an immense range of diversity. The inherent difficulties of trying to fit this rigid system to a natural phenomen as plastic as the world of life have been the cause of many controversies among systematists, and these in turn have given outsiders the impression that taxonomy, as it is practiced now, is more of an art than a science. For a long time, we have needed a text in which the fundamentals of both the theory and practice of taxonomy are set forth. Mayr, Linsley, and Usinger have designed a book to fill this gap. They begin with a short history of taxonomy and discussions of taxonomic categories. The largest part of the book is nearly equally divided between a series of chapters on taxonomic procedure and a series on zoological nomenclature. A bibliography, a glossary, and an index complete the work.

This text is addressed to students of systematics, but it will also be a valuable source of information to the non-systematist who wants to gain an understanding of the theory and practice of taxonomy.—ROBERT W. STORER.

A Laboratory and Field Manual of Ornithology.—Olin Sewall Pettingill, Jr. (Burgess Publishing Co., Minneapolis), viii + 379 pp. 1956. Price, $5.00.—This well-known manual has been carefully revised, greatly enlarged, and brought up to date. The approach, as before, is one of "classical" ornithology, and consequently, several important aspects of avian biology, such as myology, displays, convergent evolution, and adaptation (beyond the foot-and-bill level) are treated inadequately or are omitted entirely. The extensive list of references to the literature of ornithology will prove particularly valuable for the beginner, and the work will undoubtedly be used even more than it has been in the past for the teaching of ornithology.—ROBERT W. STORER.