RECENT LITERATURE.

Walter on Bird Migration.[1]— After presenting several pages of general comment, the author proceeds to treat of bird migration under the two questions, "I. How do Birds find their way in Migration?" and "II. Why do Birds migrate?" under which he reviews, in the main to condemn, various theories that have been put forth in answer, and announces as his 'conclusion': "There still remains an immense halo of mystery around bird migration because there are so many things we do not know. We not only do not know *why* birds migrate but as yet we do not know *how* they migrate except in a general way."

Under the first question he properly condemns the "instinct theory" as a confession of ignorance. The "magnetism theory" of von Middendorff and the "semicircular canal theory" of Mach-Bruer are both found wanting, the latter having been thoroughly refuted by the experiments of Exner upon pigeons. He deals a little more kindly with the "sense of direction theory," but as it lacks the demonstration of a "physical basis," he deems it "is hardly better than the instinct theory since it gives the answer to the problem in unknown terms."

The "landmark theory," he states, has rather more to recommend it. Thus, he says: "Exner came to the conclusion that carrier pigeons find their way home by seeing familiar landmarks and when such landmarks are not visible the birds explore until landmarks are found. This explains how his pigeons, whether whirled, galvanized or narcotized, were quite as well able to get home as those which had not undergone such interference with their sensory impressions upon the outward journey." But he adds: "The objection must be raised to the landmark theory, however, that many birds do not follow river valleys, coast lines or mountain chains in the way they might be expected to do if they were guided by what appear to us to be the most obvious landmarks." It does not follow, however, that because birds do not always follow river valleys or mountain chains, but pursue courses more or less divergent from them, that they do not serve them as landmarks for their journeys. The recognition of such landmarks would be sufficient for their guidance whether their lines of migration are parallel or more or less oblique to the general trend of mountain ranges or river valleys.

He concludes that in the case of carrier pigeons "the successful individuals are those who have been trained over the course, that is, those who have learned the way either by seeing landmarks for themselves or by following a trained companion. There is no mysterious sixth sense of direction, no crossing of imaginary magnetic lines, no intricate automatic

[1]Theories of Bird Migration. By Hubert Eugene Walter, Ph. D., Brown University. Reprinted from 'School Science and Mathematics,' April–May, 1908. 8vo., 16 pp., *without pagination.*

registry of distance and direction by means of the semicircular canals. It is simply a case of a home-loving animal away from home putting its wits and senses and experiences together to get back to its home and in this case these known resources are sufficient for the task. Why may not this also," he reasonably asks, "be the true explanation of the manner in which birds find their way on those greater pilgrimages we call migration?"

The "follow-the-leader theory" is accorded "a large element of probability," for which he argues at considerable length. Thus he concedes that "it seems reasonable to believe that the manner in which it [migration] is carried out, the way in which the path is followed, may find an adequate explanation in the temporary leadership of some individual within sight or hearing of the others, who knows at least a fraction of the way by experience or who strikes out a safe path by means of landmarks."

Under the second question "Why do Birds migrate?" various hypotheses are weighed, only to be found wanting. Decrease of temperature does not satisfactorily explain fall migration, because "the fall migration is largely completed before the weather becomes cold"; but scarcity of food, dependent upon the low temperature of winter, is admittedly an important factor.

The "premonition theory" of Brehm, which, he says, "at first thought seems entirely fanciful," in reality "contains a large element of probability," since by virtue of their peculiar anatomical structure — large lungs, pneumatic bones, and internal air sacs — they "are, to a remarkable degree, living barometers, responding with great delicacy to changes in barometric pressure." Yet "that birds can anticipate winter and as a result make an effort to avoid its disastrous effects, is beyond demonstration and seems quite unlikely."

The "short day theory" also "suffers, as does many another, because of a few obtrusive incontrovertible facts," as "the migration south begins before the days are perceptibly shorter." In reality, however, this is hardly true, even in the far north, whatever there may be in the theory.

In this connection he again recurs to the "food supply theory," to which he objects on the ground that "it must be admitted that a large per cent. of migrating species leave for the south in the very height of the seed and insect harvest." Yet, he adds, "upon the ground of food supply, natural selection would promptly eliminate those who did not go south and would tend at the same time to favor the perpetuation of those who varied in the direction of southern migratory habits, whatever the cause of those variations might be." What he intends the reader to infer from these statements as to his position on the "food supply theory" is not very clear.

The author now proceeds to consider the theories to account for the spring migration, giving attention first to "the instinct theory," of which he says: "That it is a bird's *instinct* to go north in the spring is no better an explanation of the origin of migration than it is of how a bird finds its way during migration" — a truism no one will question. Then are taken

up in turn "the homesick theory," "the desire to disperse theory," "the nestling food theory," "the safe nesting theory," all of which are given short shrift, mostly with reason. Some half-dozen "ancestral-habit" theories are also cited and summarized. Many of the postulates attributed to the authors mentioned did not, however, originate with them nor at the dates implied, but were of much earlier origin and in a measure common property long before the implied dates. The principal factor put forward by Marek in 1906, that of the influence of barometric pressure — birds migrating from areas of high barometric pressure to areas of low barometric pressure — was stated in substance, and nearly in the same terms, by Cooke a dozen years before; and so with the main points of other recent theories here summarized, some of which were brought out by American writers twenty years before the implied date of origin here given. This is not said in disparagement of the later authors cited by Mr. Walter. For example, Marek's explanations of how and why birds migrate is based on his own independent and extended original investigations of the movements of birds in Europe, and is none the less interesting and valuable because it is in the main confirmatory of earlier investigations and conclusions made elsewhere, and for many years more or less generally accepted by those who are best acquainted with the real facts of migration. Thus, Walter says: "From his [Marek's] point of view there is no necessity for referring the habit of migration to hypothetical ancestral behavior, nor for endowing birds with such human attributes as love of home or the memory of previous successes. The streaming northward of birds in the spring and their return southward in the fall are both primarily dependent upon the same observable external factors as those which cause the flow of the air in the form of prevailing winds, northward in the spring and southward in the fall."

While no facts in relation to the habits and behavior of animals are in the main better established than the above, Mr. Walter is able to see only "an immense halo of mystery around bird migration." This is perhaps due to his having overlooked a principle of prime importance, or to which at least there is no allusion in his very interesting summary of the subject. This is the intimate interrelation of the impulse of migration and the function of reproduction. As we stated the case some fifteen years ago: "If we consider that migration consists really of two movements — that is from the breeding station to the winter quarters and then back again — and that the one movement is the necessary complement of the other, it is hardly necessary to seek for a separate cause for the two movements; the two together constitute migration in a complete sense, which, as already explained, is an inherited habit,— an inherent, irresistible impulse, closely blended with the function of reproduction. The promptings which lead to the migratory movement, respectively in fall and spring, have unquestionably a different origin; the autumnal movement being doubtless [at least primarily] prompted by a reduction of temperature and

a failing food supply, while the spring movement is incited by the periodic activity of the reproductive organs, resulting in the necessity for the return of the species to the peculiar conditions and surroundings to which for long ages it has been undergoing special adaptation — in other words, to its home."[1] This is not, however, necessarily the place of origin of the species, which, in the case of many of our Warblers, Tanagers, Flycatchers, etc., may well have been within tropical latitudes, which are now merely their winter resort and not their *home* or place of reproduction.

In the discussion of migration the great fundamental fact that the life of animals, and especially of migratory animals like birds, is made up of annual cycles, as is the life of plants, which have their fixed and determinate seasons for flowering and fruiting, is generally overlooked. Attention was long since directed to this factor by Chapman, but it seems not to have received the attention to which it is entitled. After referring to the fact that many animals manifest a desire for seclusion during the period of reproduction, and that "many species of tropical sea-birds resort each year to some rocky islet, situated perhaps in the heart of their habitat, where they may nest in safety," he continues: "This is not migration in the true sense of the word, but nevertheless the object is the same as that which prompts a Plover to migrate to the Arctic regions, and, be it noted, is just as regular. . . . As in the case of a Warbler which nests in Labrador, they are all affected at nearly the same time by an impulse which urges them to a certain place. This impulse is periodic and is common to all birds. . . . It is evident, therefore, that external conditions have not created this impulse, though it is possible that in many instances they may have governed its periodicity. On the contrary, its causes are internal. In the case of the sea-birds, for example, dissection will show an enlargement of the sexual organs and it is this physiological change which warns the birds that the season of reproduction is at hand."[2] And, it may be added, prompts them to seek their accustomed breeding resorts, be they nearby rocky islets or remote arctic or subarctic latitudes. We have here the key to the impulse of the spring migration, of which the return migration in the fall is the necessary complement, inasmuch as in most instances the winter conditions of the breeding grounds of most species are prohibitive of their continued residence therein throughout the year.

How they find their way in their migrations is certainly remarkable and implies wonderful gifts of which we have no intimate knowledge, but enough, it would seem, fairly to remove the subject from the realms of that complete mystery so many writers seem to take pleasure in involving it. In addition to keen powers of vision and a retentive memory, which together enable them to distinguish landmarks, and a remarkable sensitiveness to meteorologic conditions, they may also possess a, to us, mysterious sense of direction, as shown by the recent experiments of Dr. J. B. Watson with Noddies and Sooty Terns. Dr. Alfred G. Mayer, Direc-

[1] Auk, X, 1893, p. 104.
[2] Auk, XI, pp. 13, 14.

tor of the Department of Marine Biology of the Carnegie Institution of Washington, in his annual report for 1907, states, in reference to the work of Prof. John B. Watson of Chicago University on the behavior of Noddy and Sooty Terns, that "Among other things, he demonstrated that if sooty terns and noddies were taken to Cape Hatteras and there liberated they would return to their nests on Bird Key, Tortugas, a distance of 850 statute miles from their place of liberation." Prof. Watson's full report on these experiments has not yet appeared, but Mr. Chapman gives some of the details and comments on the matter in 'Bird-Lore' for May–June, 1908 (p. 134) as follows:

"We have before referred to the studies of Noddies and Sooty Terns by Prof. John B. Watson on Bird Key, Tortugas, during the nesting season of 1908, and in the annual report of Dr. Alfred G. Mayer, Director of the Department of Marine Biology of the Carnegie Institution, under the auspices of which Professor Watson's researches were made, there appears a preliminary report of this work. The final report will appear during the year, and we will call attention here, therefore, only to Professor Watson's supremely interesting tests of the homing instincts of Noddies and Sooty Terns. Fifteen marked birds were taken from the Key and released at distances varying from about 20 to 850 statute miles, thirteen of them returning to the Key. Among these thirteen were several birds which were taken by steamer as far north as Cape Hatteras before being freed.

"This experiment is by far the most important in its bearing on bird migration of any with which we are familiar. It was made under ideal conditions. Neither the Noddy nor Sooty Tern range, as a rule, north of the Florida Keys. There is no probability, therefore, that the individuals released had ever been over the route before, and, for the same reason, they could not have availed themselves of the experience or example of migrating individuals of their own species; nor, since the birds were doubtless released in June or July, was there any marked southward movement in the line of which they might follow. Even had there been such a movement, it is not probable that it would have taken the birds southwest to the Florida Keys, and thence west to the Tortugas. This marked change in direction, occasioned by the water course, which the birds' feeding habits forced them to take, removes the direction of the wind as a guiding agency, while the absence of landmarks over the greater portion of the journey, makes it improbable that sight was of service in finding the way. Professor Watson presents, as yet, no conclusions, but, while awaiting with interest his final report, we cannot but feel that his experiments with these birds constitute the strongest argument for the existence of a sense of direction as yet derived from the study of birds. With this established, the so-called mystery of migration becomes no more a mystery than any other instinctive functional activity."— J. A. A.