

IS PHOTOPERIODISM A FACTOR IN THE MIGRATION
OF BIRDS?¹

BY G. EIFRIG.

IN an article published in the 'Journal of Agricultural Research,' March 1, 1920, by W. W. Garner and H. A. Allard of the Department of Agriculture "data were presented tending to show that the length of day may exercise a remarkable regulatory action in initiating or inhibiting sexual reproduction in plants." This they supplemented by an account of extremely interesting and clever experiments which prove beyond cavil that length of day has much more to do with the time of flowering and fruiting of plants than had hitherto been supposed. This is in the 'Yearbook' of the Department of Agriculture for 1920, published 1921. It had been thought, and perhaps most people still think, that the flowering and fruiting of plants are purely a matter of temperature, moisture, soil ingredients and soil structure, plus internal causes in the plants themselves. But by placing plants daily for seven to twelve hours in the light and then into a dark shed they were able to induce plants like golden rod, cosmos, bidens or beggarticks and others that normally flower in September and October, to do so in July or earlier, and vice versa by subjecting to light such plants as poppies, iris, rhododendron, columbine, etc., they forced them to flower in mid-winter. Needless to say they had control beds of the several species under experimentation under normal conditions. Their technique was so simple that one is forced to admit that they proved their point. In the number of 'Science' of June 2, 1922, the authors propose to call this phenomenon photoperiodism, the response of the plant to length of day and night. There it is stated that the varying amount not only determines the quantity of photosynthetic material elaborated by the plant, but also the use the plant can make of this material.

The purpose of the present paper is to show that this same phenomenon plus the actual cause of it, the moving of the sun's rays

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from the Tropic of Capricorn to the Tropic of Cancer and back probably is a factor in the migration of birds, and possibly a more potent one than we would suspect.

Let me quote a few sentences from the 'Yearbook,' p. 379: "Change in temperature fails to explain why plants, flower and fruit at certain periods; that is to say, even though the appropriate temperatures are provided out of the regular flowering and fruiting season, as a rule the flower and fruit fail to appear except in their usual seasons." "There are no temperature differences during the summer months which could explain these differences in time of flowering; and, since "internal causes" alone can not be accepted as furnishing a satisfactory explanation, some external factor other than temperature must be responsible." "Some other factor is responsible for the failure of cosmos to blossom during the summer months. In this respect the behavior of cosmos is just the opposite of that observed in iris." Similarly one who watches the coming and going bird cannot but feel that there must be other factors, impulses and stimuli than those usually assigned. Occasional occurrences in the migration stand out in bolder relief than others and make one ponder what hidden influences can be at work here.

What are the causes usually given for the wonderful phenomenon of bird migration? For the southward migration in the northern hemisphere it is the failing food supply due to the approach of winter. And there can be no doubt that the hosts of waterbirds, that remain in the north as long as they can, are forced south by the freezing over of the waterbodies and swamps, their source of food. For the northward migration in spring the causes usually given are the physiological changes going on within their bodies, mainly in the sexual organs, coupled with a love of the home they were born in, plus a desire for greater privacy in their domestic affairs during nesting time. Aside of the fact that the last two reasons assigned are too anthropomorphological, too much patterned after our human feeling and sentiment, to be scientific, if their love of the home of their youth is so great, why do so many leave it in summer the first chance they get, even deserting their young, when they are not yet able to go on the journey? However, let us reserve this phase for later. The first reason, the physio-

logical changes no doubt holds good in those species that arrive here already mated, as some of the ducks.

But what about the vast number of species in which the reasons given either for the southward or northward migration, or for both, clearly cannot apply? The occurrence that forced such a conclusion on me is this. Our autumn in the Chicago area is usually remarkably fine, sunny, mild, open for a long time, but the fall of 1920 was so to an extraordinary degree. It seemed as though frost and winter wanted to stay away entirely. The hosts of Juncos, Tree Sparrows and Fox Sparrows, and others, arrived from the north as usual, and filled our woods. And yet, although the temperature remained abnormally high for weeks, higher than the average, although there was more sunshine and less wind than other seasons, and the food supply seemed undiminished, they drifted southward, their flocks thinned out, our woods became deserted as usual, when all conditions are more unfavorable. Finally a few stragglers only were left behind. What made these armies leave when all conditions were so favorable and unchangingly so? The decreasing length of day, the beckoning of the sun going south, I say.—On the 2nd of July last year there were numbers of northern shore birds at Hyde Lake, in the southeastern part of Chicago, such as Pectoral and Least Sandpipers, Lesser Yellowlegs, Jacksnipes, etc. On July 10th, there were flocks of Pectoral Sandpipers along Salt Creek, Addison, near Chicago, still in their nuptial plumage and the same can be observed every year. Why are the Warblers and Shore Birds so anxious to leave their northern home in July, that they in most cases cannot take their young along on the trip, these being yet too weak to embark on such a journey? No one can say it is because of lack of food, for the food supply is then at its height. Neither can it be said that they are fleeing before the approach of winter, because then for a while the temperature is on the increase rather than decrease. Is it coincidence that they leave as soon as possible after the sun has reached its northernmost point over the Tropic of Cancer on June 21st, or is there a causal connection? Similarly the Swallows, Flycatchers and even the Blackbirds, begin to get restless and drift southward. May not the shortening of the day due to the sun's traveling toward the equator be the answer to the problem?

When unusually large numbers of the erratic northern winter visitants come into our latitude, such as the Pine and Evening Grosbeak, the Bohemian Waxwing, the two Crossbills, we are prone to say that this is owing to a failure of their food supply in the far north, of the pine seeds and mountain ash berries. Who is then so far north to reliably investigate and report on this? May it not be that the extreme shortness of daylight in the far north does not leave them enough time to satisfy their usually voracious appetite? May not that be the physiological, material background to the situation, that urges the birds southward into a region of longer days in winter and again northward into the region of longer sunlight in summer?

Let us now scrutinize the northward migration in spring more closely. Hereabouts Bluebirds, Robins, Meadowlarks and others often arrive during the second half of February; the Prairie Horned Lark (*Otocoris alpestris praticola*) at the same time at Ottawa, Canada; there I have also seen the Tree Swallow arrive in numbers on the 28th of March, when there was little to show that spring had come except that the days were getting longer. No one can say that such early comers, that nest two or three months later, are urged so early by physiological stimuli. At least dissection does not show it. Specimens taken of such early arrivals show as little enlargement of the sexual organs as do specimens taken in fall. Again, may not the lengthening of day be the stimulus urging them northward in addition to some of the reasons usually given?

We know how unfavorable weather conditions may retard the spring migration. This is especially noticeable in those species that do not leave the country in winter, not so much in those that come from South America. We can easily see how the former can sense unfavorable meteorological conditions that are spread over a large part of the United States. The latter arrive later in the season on our shores, by which time unseasonably cold weather occurs more rarely. But when such is the case, as in that memorable spring of 1907—I remember that on a visit to St. Louis from Canada that spring I found people in that southerly metropolis wearing heavy overcoats and furs on the 19th of May, when usually it is quite warm there—the birds, even the tender warblers, will finally break through without waiting for a change in temperature,

as though some force compelled them, often to their own undoing, as in that year, when untold numbers of warblers perished from here northward. And year after year you can find species such as the Vesper, Chipping and Field Sparrows, the Flicker and others appearing here on about the same days as in other years, even though the weather is raw and cold and has been so for some time back. All such cases can be explained beautifully on the assumption that the lengthening of day is one of the compelling and controlling factors.

Finally—but this is only a by-product, so to say—would it not be a grandiose conception, the finding of a new chord in the grand harmony of the universe, if it could be assumed that the great, majestic source of life on earth, the efficient regulator of mundane things, the sun, were also the regulator, the driving force in this wonderful phenomenon, the migration of birds! There the sun is on the 21st of December over the Tropic of Capricorn in the southern hemisphere and then slowly starts on its journey northward, taking along with it wave after wave of feathered denizens of light and air. On March 21st, the vernal equinox, it is over the equator, where there are twelve hours daylight and twelve hours night throughout the year. Now the days are rapidly lengthening in the north until June 21st, the summer solstice, when we have daylight from 16 to 24 hours in the northern hemisphere. Then also comes the climax in the life activities of our birds, the nesting period. But before this is entirely over in many species, a change becomes noticeable again, the days are becoming shorter, for the sun has started toward the equator, again taking millions of Warblers and Shore-birds along with it southward, before the young birds are able to go along. It must be a potent factor that urges them to seemingly forget their young. We know that in September even certain insects like the Monarch Butterfly and the Migrating Dragonfly (*Aeschna heros*), migrate south in vast armies, and we certainly cannot ascribe much thinking capacity or sentiment to them. If the sun is potent enough to bring from their hibernating places in the mud of ponds and swamp bottom the millions of frogs and turtles, and from their burrows, oft deep underground the innumerable rodents, I see no reason why it should not be potent enough to influence and regulate the move-

ment of the bird armies. When the sun is able in spring to loosen the tiny spark of life in the billions of seeds of plants in the ground, why should it not be equally able to turn the direction of the movement of birds into the direction of its own movement?

*Concordia Teachers College,
River Forest, Ill.*

THE SONG OF THE SONG SPARROW.

(A SYSTEMATIC STUDY OF ITS CONSTRUCTION.)

BY WILLIAM C. WHEELER AND JOHN T. NICHOLS.

ALL field ornithologists are familiar with the great variation in the song of the Song Sparrow. We are not aware, however, that any analytical statistical study thereof has been published. It therefore seems worth while that we place on record a summary of our graphic interpretation of 197 different Song Sparrow songs. These were obtained (W. C. W.) through many hours of careful listening to Song Sparrows in the field, all within a single song season (1923) and, furthermore, all in eastern Massachusetts. Since then this mass of material has been analyzed and studied (J. T. N.), with a view to determine what bearing it might have on current theories and hypotheses regarding bird song.

A few words as to our method of setting down each song graphically: Musical notation is almost out of the question in a case of this sort. Such notation does not clearly show the construction of the songs. It is the construction which the ear uses in differentiating one song from another, and which it is possible to represent graphically in a moderately satisfactory way. The individual bird is capable of modifying both pitch and quality to some extent. Of the four elements found in a Song Sparrow's song, namely, time, pitch, quality, and construction, although construction may be somewhat variable, we believe it is the most reliable factor on which to base a critical study. In making a graphic record of song, we have found the symbols shown in figure 1 of the accompanying chart most satisfactory for this particular species.