ment and lateral movement, sometimes excessively intense, giving indications of their being carried either to the right or to the left of the picture by horizontal currents.

Such then is a first preliminary survey of the method of observing the chemistry of the sun, not as a whole, but of each particular little bit of the sun, chosen here and there, and brought upon the slit of the spectroscope.

J. NORMAN LOCKYER

SOME OBSERVATIONS ON THE MIGRATION OF BIRDS[1]

WHILE showing some friends the astronomical observatory and accessories connected with the College of New Jersey at Princeton, on the night of October 19, 1880, after looking at a number of objects through the 9½-inch equatorial, we were shown the moon, then a few days past its full phase. While viewing this object my attention was at once arrested by numbers of small birds more or less plainly seen passing across the field of observation. They were in many cases very clearly defined against the bright background; the movements of the wings were plainly to be seen, as well as the entire action of flight. In the same way the shape of the head and the tail were conspicuous, when the bird was well focussed. As the moon had not been very long above the horizon the direction of observation was consequently toward the east, and the majority of the birds observed were flying almost at right angles to the direction in which the glass was pointed.

Here then was opportunity for the determination of two points—the kind of birds that were flying, and the general direction in which they were moving. Respecting the first, it was comparatively easy to decide as to what families the species belonged. This point was gained by observing the general shape of the birds, their relative size, the motion of their wings, and their manner of flying; that is, whether the flight was direct or undulating, by continuous strokes of the wings or by an intermittent motion of those members.

Most of the birds seen were the smaller land birds, among which were plainly recognised warblers, finches, woodpeckers, and blackbirds; the relative numbers being in the order of kinds above named. Among the finches I would particularly mention *Chrysomitris tristis*, which has a very characteristic flight; and the blackbirds were conspicuous by the peculiar shape of the tail, from which characteristic I feel most positive in my identification of *Quiscalus purpureus*. I mention such details to explain just how observations were made and conclusions arrived at.

In regard to the second point, with rare exceptions the birds were found to be flying from north-west to south-east. I do not mean that this was absolutely the direction, but that it was the approximate and general one.

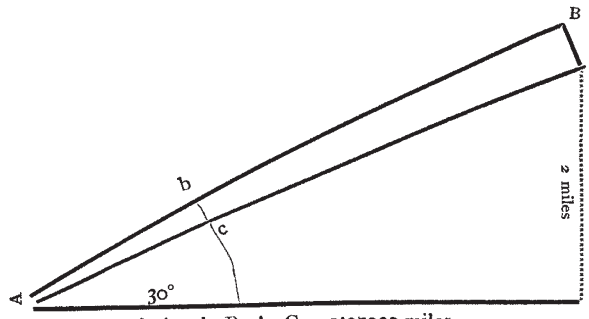
It is not within the scope of the present paper to do more than give details on two other points, namely, the estimated number of birds passing through a given space during a given time, and the height at which the birds were most abundant. For the basis of the first of these points it was necessary to note, first, how many birds passed through the field of observation per minute, and second, how near or how far distant from the glass the birds would have to be in order to be seen at all, that is to be in focus.

The height of the moon above the horizon in degrees and the two limits of the area of observation—that is how near or how far the birds noted were from the glass—supply the data for determining how high the birds seen were flying, and this, combined with the number noted as passing per minute through the field of observation, gives the basis for computing how many birds were passing through a square mile in a given time.

In this connection it may be well to specify how the two limits of observation were defined. The inferior limit, that is, the nearest point where objects could be seen with distinctness, was easily determined by the power of the glass; this is about one mile distant. The superior limit, or the most distant point, is provisionally assumed to be not more than about four miles away, on the hypothesis that the birds would not fly at a greater height than ten thousand feet. It may appear, as future observations are made, that this last limit is not correct, but the reasons for assuming such a height as the superior limit are sufficient to warrant its use in this case, for birds were observed on this same night at a late hour when the height of the moon above the horizon would make the point at which the birds were noted almost at this great elevation, viz. ten thousand feet.

I am greatly indebted to Prof. Charles A. Young for assistance in these observations, and with his aid have arrived at the conclusion that the average number of birds passing through the field of observation per minute was four and a half. Prof. Young has also kindly assisted me with the details of the problem in regard to the limits and area of the field; and the following diagram and computations are from his study of the matter.

Moon's altitude = 30°; moon's semi-diameter = 15′ 05″. The area of observation is a flat triangle = B, A, C. From this must be deducted the small triangle b, A, c, the area within a mile of the glass. The flight of the birds is thought to be nearly at right angles to the field of observation.



Area of triangle B, A, C = 0·07020 miles.
Area of triangle b, A, c = 0·00439 miles.
Therefore b, B, C, c = 0·06581 = $\frac{1}{15\cdot2}$ mile.
Distance from A to B = four miles.
Number of birds seen per minute = 4½.
Number of birds per square mile per minute = 68.

W. E. D. SCOTT

[Mr. Scott's novel and important observations definitely establish on a scientific basis several points in relation to the migration of birds that have heretofore rested almost wholly on conjecture and probability.

We have, first, the fact that the nearest birds seen through the telescope must have been at least one mile above the earth, and may have ranged in elevation from one mile to four miles. It has been held that birds when migrating may fly at a sufficient height to be able to distinguish such prominent features of the landscape as coast lines, the principal watercourses, and mountain chains over a wide area. Of this, thanks to Mr. Scott, we now have proof. It therefore follows that during clear nights birds are not without guidance during their long migratory journeys, while the state of bewilderment they exhibit during dark nights and thick weather becomes explainable on the ground of their inability to discern their usual landmarks—points that have been assumed as probable, but heretofore not actually proven.

These observations further indicate that many of our smaller birds migrate not only at night but at a considerable elevation—far beyond recognition by ordinary means of observation. A promising field is here opened up, in which it is to be hoped investigation will be further pushed, not only by Mr. Scott but by others who may have opportunity therefor.—J. A. ALLEN.]

ON THE EQUIVALENTS OF THE ELEMENTARY BODIES CONSIDERED AS REPRESENTING AN ARITHMETICAL PROGRESSION DEDUCIBLE FROM MENDELEEFF'S TABLES

THE relatively quick succession of new elementary bodies which has marked the last decade of scientific progress and which must be considered as the result of chemical research, pioneered and guided by spectroscopic study, has brought very prominently into notice Mendeleeff's most remarkable law of the periodicity of the chemical elements.

Originally published in Russian in 1871, his memoir has since been translated and reprinted by the author in the *Moniteur Scientifique* (July, 1879), and thence has been translated into some of the English journals.

[1] From the *Bulletin* of the Nuttall Ornithological Club for April.