AN EXPLANATION OF THE CAPACITY OF ORIENTATION OF BIRDS

By

GY. GORZÓ

Institute of Systematic Zoology of the University Szeged, Hungary

The great number of hypothesis relating this subject (KRAMER, 1953; MATTHEWS, 1955; TALKINGTON, 1956; YEAGLEY, 1947, 1951;) indicates extremely different opinions. It seems proved above all the orientation on the basis of the sun and stars. Author's experiments established the essential role of the shadow of the pecten. The shadow of the pecten is grated, serrated at the top and it covers constantly the same area of the retina. The construction of the retina of the birds (FRANZ, 1934) makes possible the perception of the movement of the sun (MATTHEWS, 1955). The perception of this movement is highly promoted by the shadow of the pecten; it has a primary role in the orientation. The picture of the sun moves along a straight line on the retina. If this line is vertical, then the head is in the north-south direction. When the line is not vertical, then the direction of the head deviates from the north-south direction. It is necessary to use a basic direction in the orientation, this is probably the north-south direction for the birds. The bird stands in the basic direction and it turns the head along the horizontal long axis till the picture of the sun gets on the tooth or grate of the pecten which lies in the rectilinear elongation of the motion of the picture of the sun. In consequence of the apparently displacement of the ecliptic, each position of it have a corresponding tooth or grate on the pecten.

With the aid of this simple mechanism the bird can determine any geographical position as compared to that of its home. Change of the latitude is indicated by the displacement of the ecliptic. The picture of the sun, correspondling to the degree of the change of the latitude, gets on an other tooth or grate of the pecten. This horizontal displacement is the latitude component of the orientation. From the displacement on the pecten-teeth the bird can determine how far is it north or south of its home. The evaluation of the longitude happens with the comparison of the home-time indicating internal clock and the position of the sun indicating the new position. This longitudinal component forms an angle with the former horizontal component depending on the basic direction. When

this basic direction is meridional, the two components are perpendicular to each other.

By the determination of the position the bird obtains the two perpendicular sides of a triangle. The horizontal side is given by the displacement of the picture of the sun on the teeth of the pecten (latitude), while the other one by the time-difference (longitude). The direction to the home may be obtained by turning the head till the direction of the motion of the sun coincides with the hypotenuse.

The determination of the position and direction may be performed separately too. It is also possible the evaluation of a known direction without the knowledge of the position of the goal.

On the basis of this mechanism the experiments relating to the conversion of the internal clock and the constant deviations demonstrated may be explained too (HOFFMANN, 1954; SAINT-PAUL, 1953, 1956;).

Author in his experiments stitched up the eyes of carrier-pigeons. The animals had good eyes but the picture of the sun did not reach the shadow of the pecten. They were incapable of orientation. After some time they regained the orientation capacity because the picture of the rising sun reached the shadow of the pecten. Similar results were obtained by stitching up of the eyes in vertical direction. All these prove the essential role of the shadow of the pecten in the determination of geographical position and direction.

The hypothesis based on the shadow of the pecten may be applied also to the orientation at night.

References

MARSHALL A. J.: (1961). Biology and Comparative Physiology of Birds Academic press, New York and London.

MATTHEWS, G. V. T.: (1955). "Bird navigation" Cambridge Univ. press, London and New York.

TEMBROCK, G.: (1961). Verhaltensforschung Jena.