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THE SPOONBILL

VOLUME XI No.4

AUGUST 1962

(Rec'd 8/27)

 * "Do you ne'er think what wondrous beings these? *
 * Do you ne'er think who made them, and who taught *
 * The dialect they speak, where melodies. *
 * Alone are the interpreters of thought? *
 * Whose household words are songs in many keys, *
 * Sweeter than instrument of man e'er caught! *
 * Whose habitations in the tree tops even *
 * Are half way houses on the road to heaven!" *
 * *
 * The Birds of Killingworth Longfellow *

PUBLISHED BY THE ORNITHOLOGY GROUP, OUTDOOR NATURE CLUB, HOUSTON, TEX.

COMING EVENTS

September 8 (Saturday) - FIELD TRIP, Brazoria, to be led by Leota Stilwell. Meet at 10:00 A.M. at intersection of Hwys 36 and 332. Destination is Sargent's Beach and places unknown. Bring enough food etc. for a full day.

October 4 (Thursday) - O. G. Meeting, 8:00 P.M., Fondren Library, Rice U. Dr. Hardin Craig will show Audubon slides.

NOTICES

Your editors are going on a short vacation after Labor Day so would appreciate having all SPOONBILL material here by Sept. 1.

Mrs. Charles Hamilton is anxious to have Vol. I of THE SPOONBILL for the Rice Library - either as a gift or to photostat. Send to her c/o Fondren Library, Rice U., Houston.

DO YOU WANT TO BE ON THE GRAPEVINE? We are setting up a telephone alerting system for notifying ardent birders in our area concerning good migrants, rare birds, or especially large numbers of any particular species. If you are on the Grapevine, besides being notified, you, in turn, must call three other birders. If you want to be on the Grapevine please write your name, address, and telephone no. and send to: Miss Thelma Smith, Branard Court North, Apt. 2, Wilshire Village Apts. All names must be in by Sept 1 as the list will be published in the next SPOONBILL. The sooner your name comes, the higher you will get on the list. A form follows to be clipped and used for your convenience.

I wish to take part in the telephone alerting system.

Name _____

Address _____

Telephone no. _____

PEOPLE ARE TALKING ABOUT

The hot, hot, dry weather more typical of the desert than Houston! Are you putting water out for the birds? Even a little pan under the shade of a tree has its merits. Despite the unpropitious weather some migrants are coming through.

The forthcoming announcement on the waterfowl hunting season! The Central Flyway Council recommends loosened restrictions, the National Audubon Society requests that the season be closed, and the U. S. Fish and Wildlife hints that rules will be about the same as last year. The goose season shows excellent prospects, but ducks are estimated at 58% below the peak year of 1958, 17% below last year.

HERE AND THERE

A flicker and a Bobolink were seen last month, will the lucky viewers please send dates and details?

Drew Snyder had the unique experience of having a Carolina Wren fly in and sit on his shoulder while he was working under our deck. L. S.

MIDNATS report their BIRD OF THE MONTH - a visiting Catbird, way off its normal range.

RECENT THEORIES AND EXPERIMENTS ON HOW BIRDS NAVIGATE DURING MIGRATION
by Drew Snyder

Part II

Theories of Navigation

From the preceding summary of some of the aspects of migration, it is easy to see that a bird encounters many problems in flight. The most complex one, navigation, has yet to be discussed. The problem turns out to involve two questions, neither of which has answers now. Naturalists must ask both ecological questions about the environmental cues which guide the migratory bird and also physiological questions about the sensory mechanisms by which these environmental cues may be recognized and channeled into the central nervous system. The closest these questions come to being answered rests in the theories that have been postulated. These theories are classed as either those which assume nothing of the types of generally recognized biological mechanisms, or those which assume nothing but the types of physiological machinery that are well-known in all higher vertebrates. Many theories have been propounded on the basis of sensory perceptions which are not at present known to exist. The other class of theories is based mostly on those environmental cues perceptible to both birds and man. Man does, however, have quite an apparent advantage over birds in some of these perceptions. For instance, man can accurately locate himself by sun-arc determinations; but this procedure requires instruments, calculations and advanced mathematics. It is possible that a bird does exactly the same thing without any of the great effort, expense and time.

Theories Concerning Mechanical Forces. The possibility that the navigation of birds is based on their perception of mechanical forces related to the rotation of the earth is a recent consideration. But from this possibility scientists have formulated three related theories, which are rather difficult to comprehend.

One effect of the earth's rotation upon any flying object is a small change in its weight with latitude. To explain this phenomenon, some explanation of centrifugal force must be presented. Any body which is rotating in a circle about an axis is propelled outward from the center of rotation by centrifugal force. The magnitude of this force is determined by the equation

$$C = mv^2/R$$

where R is the radius of the circle; m , the mass of the object; and v , the object's velocity about the axis. Because the bird's velocity of flight either adds to or subtracts from the velocity of its rotation about

the earth's axis, the centrifugal force is also altered. A change in the centrifugal force of a bird changes the gravitational force, which determines weight. This change in the gravitational force is given approximately by the equation

$$W = -2U\Omega \cos \phi$$

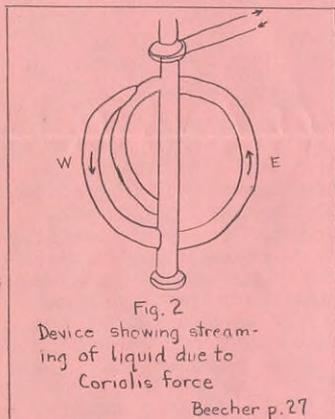
where U is the easterly component of the bird's velocity (cm/sec); Ω , the angular velocity of the earth's rotation (7.3×10^{-5} radians/sec); and ϕ , the latitude. As an example, a bird flying east along the equator at 40 mph would find its weight changed by one part in 2000 if it turned westward. It is therefore possible for birds to determine direction from sensing their greatest apparent weight when flying west.

The flow of fluids through a tube and the apparent force acting upon the fluid as a result of the tube's motion over the earth produces a second effect. A small portion of such a fluid is given a lateral acceleration, relative to the tube in accordance with the equation

$$A = 2U\Omega \cos \phi$$

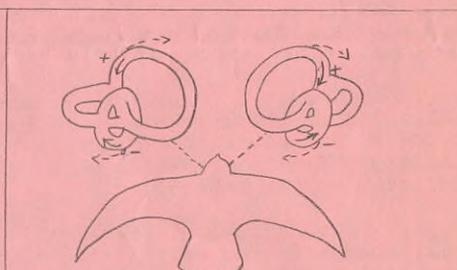
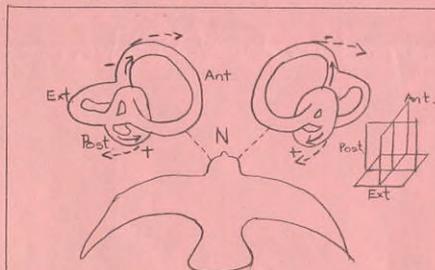
(the same equation given above). This apparent lateral force for one gram of fluid moving along the equator at 40 mph is $1/3800$ grams. From this phenomenon it is possible that the flow of blood in arteries against sensitive pressure receptors gives a bird his direction.

The Coriolis effect is a force caused directly by the rotation of the earth of its axis. The result of the horizontal component of this force is a deflection of any moving object about the earth's surface relative to the surface of the rotating world. This effect can also be seen in the draining of a bathtub and the flowing of trade winds or ocean currents. The vertical component of the Coriolis force is not as easily



perceptible since it does not create such obvious results. A bird detects the component as a streaming in the semicircular canals when the head is rotated horizontally through a narrow arc. This streaming has been measured with a fluid-filled glass tube bent into loops, as shown in Fig. 2, and turned through 6° ; it has been found to be 2×10^{-15} ergs for a ring 1 cm in diameter and 1 mm^2 in cross-section.

The device used to measure this force is very similar to the semicircular canals of the ears. On each side of the head are three tubes occupying three dimensions in space - the external, anterior and posterior canals. The two external canals are horizontal and record the velocity and amplitude of head turning as they were primarily designed to do. The other four canals are vertical and determine the vertical component of the Coriolis force. The reception center for each of the six canals is an enlarged sensory ampulla (membranous sac) which discharges constantly. When the head rotation is such that the flow of endolymph is toward an ampulla, the discharge is enhanced with a burst of sound. Flow away from an ampulla inhibits discharge. An enhanced discharge is represented by a plus (+); and an inhibited flow, by a minus (-).



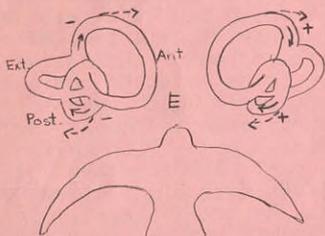


Fig 5

Theoretical resolution of Coriolis force
(vertical) in vertical semicircular canals
for bird flying east

Beecher p.29

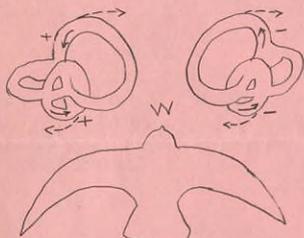


Fig 6

Theoretical resolution of Coriolis force
(vertical) in vertical semicircular canals
for bird flying west

Beecher p.29

If a bird flying north turns its head clockwise through a narrow horizontal arc, the flow of endolymph is upward in the segment of the canal moving east and downward in the part moving west. As shown by Fig. 5, the flow will be away from the ampullae of the left and right anterior canals (-), and toward those of the left and right posterior canals (+). For a counterclockwise rotation of the head, the signs and directions of discharge are reversed. Flying southward with a clockwise rotation of the head (Fig. 4), a bird receives the enhanced discharge (+) in the left and right anterior canals. The inhibited discharge (-) is therefore in the left and right posterior section. Again the signs and directions are reversed if a counterclockwise rotation of the head is made. In flying east a clockwise rotation induces the flow away from the ampullae of the left anterior and posterior canals (-). The right side receives both of the enhanced discharges. The directions of flow for the eastward and westward flights are shown in Figs. 5 and 6 respectively. In the case of a westward flight with clockwise head rotation, the enhanced discharge occurs in the left vertical canals.

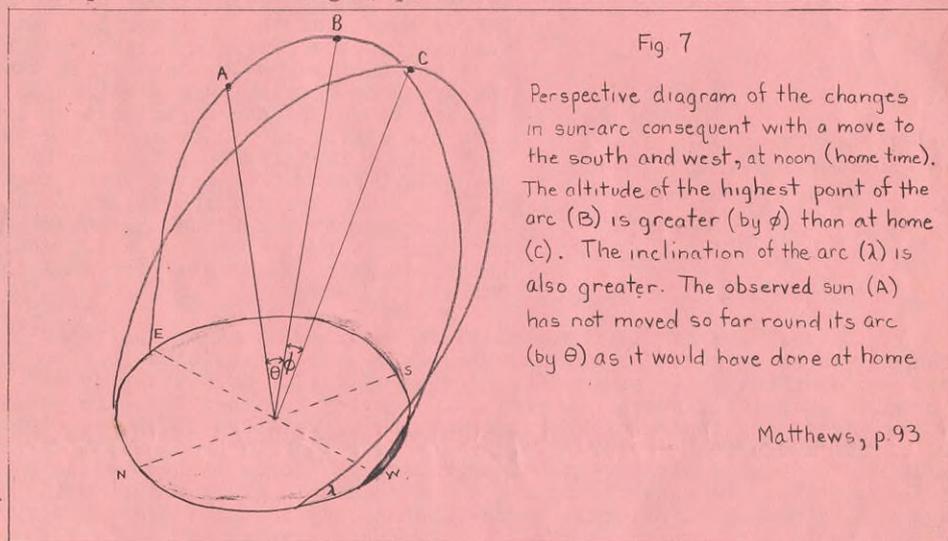
Assuming all the different combinations of discharges, it is theoretically possible for a bird to determine his deviation from a given course by the discharge bursts of the four vertical ampullae. Such a determination cannot be made constantly for the same reason that the eye cannot focus on a small object for any length of time. In most other ways the structure of the ear indicates that this principle of navigation is possible. Naturalists have found that all migrating vertebrates either lack an outer ear or can close the inner ear off from external pressure, which would interfere with the minute forces of the Coriolis effect.

In the case of all three of these theories based on the interaction of the earth's rotary motion with the motion of the bird, the forces act upon the sense organs and nervous system in a qualitative way. The crucial questions, whose answers could destroy the theories, are quantitative ones: Are these forces large enough (a) relative to the absolute limit of the mechanical receptors and (b) relative to the mechanical forces from which the bird would have to discriminate the force caused by the earth's rotation? In considering all the mechanical forces which could change a bird's weight, naturalists have found that most of them are very likely to be larger than the one part of 2000 differences caused by the earth's rotation. Some of these variable forces are caused by change in air speed and variations in the lift or drag on either wing. Naturalists doubt the theory based on the flow of fluids because it is known that the fluctuations of hydrostatic pressure caused by the beating of the heart exceed the crucial pressures generated by the earth's rotation many hundreds of times. The same problem exists with the theory based on variations in the Coriolis effect; the force which the bird must rely on is so minute that it is impossible to detect with human sensory mechanisms. The only other evidence that might disprove this theory is that birds, revolved on a turntable until their orientation through the semicircular canals must surely be deranged, seem to have no difficulty in immediate reorientation.

Theory concerning Sun-Arc Determination. Many ornithologists now believe from thorough experimentation that diurnal migrants navigate by sun-arc determination. One of these believers, a German scientist, demonstrated recently that birds orient in relation to the sun. With a house that had windows only in the roof, Kramer tested this effect of the sun on migratory birds. He found that individuals oriented themselves to a given position regardless of the time of day. If he shut the sunlight out, the birds became confused and oriented at random. When an artificial light source was substituted for the sun, the birds oriented as if the light were the sun. Other experiments correlating the sun with navigation involve transporting birds away from their home and releasing them. The percentage of these birds orientating immediately to the right direction for a homing flight was markedly greater when the sun was shining. The proper orientation normally occurred within three minutes on clear days.

In order to use the sun for navigation, birds must have the sun-arc characteristics at their home mastered well. They must also have an accurate chronometer mechanism and eyes capable of measuring small angles. Satisfactory evidence now exists for the belief that birds do have a very keen sense of time. The eyes of birds are also known to be very well developed and capable of taking small angular readings with great accuracy. And if birds do possess these things, the sun-arc theory also explains the purpose, cause and guide for migration. In an earlier section of the paper, the cause and stimulation of migration are attributed to a lengthening of day. This increase or decrease is now considered as a rising or sinking of the sun-arc, and hence the correlation between navigation by sun-arc determination and the stimulation for migration is established.

The sun-arc is the apparent arc that the sun describes in moving across the sky. In navigation by the sun, latitude is determined by the difference in the inclination of this sun-arc as compared with the arc at a reference point, which is usually home. A bird probably measures the angle by observing the sun for a short time and extrapolation (extending) to complete the arc. Fig. 7 pictures two sun-arcs and difference in



inclination (angle) of the arcs. By noting the differences in noontimes (through extrapolation) due to changes in time with longitude, the bird determines its latitude. Thus with a complete grid, a navigational system is possible.

Theory concerning Celestial Fixes. It wasn't until the 18th century that ornithologists realized birds flew at night. The real awakening of scientists to nighttime migration occurred in 1898 when a student at Wasburn Observatory estimated 9000 birds per hour were flying overhead.

In the sixty years that have followed, the theory of navigation by celestial fixes has become probably the strongest and best supported belief yet. Much of the work that has been done to substantiate this theory comes from the recent experiments of a German naturalist. Young warblers were placed in a cage with only a glass opening at the top. When the migratory season came, the individuals grew very restless and desired to face one direction all the time. Even when their perches were rotated, the birds returned to their original orientation. This direction, if flown, would have put the individuals on their proper flight path for migration. Since no other part of the environment was visible except the sky, it is hard to believe that any other factor enabled the birds to orient.

Further experiments were conducted by Sauer in a Planetarium which enabled him to change the north-south declination (latitude) and the east-west height (longitude). A White-throat, which normally flies south-east from Germany to the Nile and then due south, orients in a southeastern direction when placed in the planetarium. As the sky was shifted to a more southern latitude, the bird turned more and more southward until at 15° east (the bird's turning point at the Nile River) it changed to its southern course. In another attempt to fool the White-throat, the longitude was changed to a time which was 5 hours and 10 min earlier. The bird was deeply disturbed; but after a minute of consideration, it flew westward to correct its course. Once back to the original starting place, the White-throat again oriented in a southeastern direction.

Many facts drawn from these experiments indicate the use of stars for navigation. For example, meteors streaking across the sky distracted individuals, but only momentarily. Secondly, cloudy nights caused great confusion and disorientation since no reference stars were visible. Light reflecting off of rivers and mountains seems to be the guiding factor on cloudy nights. Only in a completely overcast sky do birds become hopelessly lost.

The following quotation summarizes the feelings of many ornithologists on both solar and stellar navigation:

Whatever may still be learned, those who for the last 15 years have been devoting intense study to the problem of bird navigation are agreed about this basic fact: some apparatus exists in each migratory bird's tiny brain at birth which, by putting him in complex relation to the lights that pass across the sky, makes him at home on earth as man, with all his inventions, will never be.

Eastman

To be continued

CLEARING HOUSE

July, 1962

Pelican, White (50-200) most days Bayshore LS
 Brown (NC) 21 Galveston "A"
 Egret, Cattle (14) 21 Cove AKM; (NC) 21 Galv. "A"
 Reddish (NC) 21 Galv. "A"
 Ibis, Wood (9) 19 Cove AKM
 Wh.-faced (NC) 21 Galv. "A"
 White (NC) 21 Galv. "A"
 Roseate Spoonbill (3) 6, (40) 30 Cove AKM; (NC) 21 Galv. "A"
 Duck, Mottled (NC) 21 Galv. "A"; (85, 1 with ducklings) 30 Cove AKM
 Pintail (1) 30 Cove AKM
 Lesser Scaup (NC) 21 Galv. "A"; (1) 29 Nav. District EM; (1) 30 Cove AKM
 American Coot (NC) 21 Galv. "A"
 Semipalmated Plover (NC) 21 Galv. "A"; (3) 30 Cove AKM
 Long-billed Curlew (8) 4 Galv. EM; (NC) 21 Galv. "A"
 Upland Plover (18) 30 Cove AKM

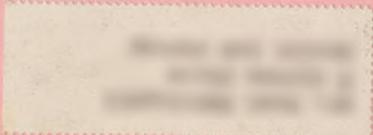
Spotted Sandpiper (NC) 21 Galv. "A"; (2) daily from 25, (6) 27 Bayshore LS;
 (1) 30 Cove AKM
 Solitary Sandpiper (NC) 21 Galv. "A"; (1) 29, 30 Cove AKM
 Yellowlegs, Greater (NC) 21 Galv. "A"; (3) 30 Cove AKM
 Lesser (NC) 21 Galv. "A"; (20) 30 Cove AKM
 Pectoral Sandpiper (5) 30 Cove AKM
 Dowitcher, species (60) 30 Cove AKM
 Long-billed (NC) 21 Galv. "A"
 Stilt Sandpiper (2) 30 Cove AKM
 Tern, Gull-bill. (2) 30 Cove AKM
 Owl, Screech (1-3) most days Bayshore LS; (pair fed young about house) all
 of July Cove AKM
 Grt. Horned (1) 28, 31 Cove AKM
 Chimney Swift (nest with 4 imm.) 2 Cove AKM
 Ruby-thr. Hummingbird (1) 1-20 Cove AKM; (1-2) from 10 Bayshore LS
 Pileated Woodpecker (1) 13, 26 Cove AKM
 Swallow, Tree (2) 30 Cove AKM
 Rough-wing (12) 9 Cove AKM
 Barn (1) 30 Cove AKM
 Starling (NC) 21 Galv. "A"
 White-eyed Vireo (1) 30 Bayshore LS
 Orchard Oriole (6) 9, (1-10) frequent, (35) 21, (20) 25, (25) 26 Cove AKM;
 (NC) 21 Galv. "A"

Credits

"A" O.G. Field Trip AKM Arlie K. McKay
 EM Elric McHenry LS Linda Snyder

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