And I am convinced that the systematist who will thus treat his specimens as exponents of their environment will make a far more valuable contribution to biology than he who regards them merely as objects to be classified and named.

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DIVING OF GREBES AND LOONS.

BY CHARLES W. TOWNSEND.

MR. EDWARD H. FORBUSH in a preliminary paper in the 1921 Bulletin of the Essex County Ornithological Club, and in an extensive one,—Bulletin No. 8, 1922, of the Massachusetts Department of Agriculture,—has presented a great mass of evidence on the subject of the under-water use of the wings and feet in Grebes and Loons and some other birds as a result, mainly, of a questionnaire sent by him to "accredited observers of the Division of Ornithology, and Fellows, Members and Associates of the American Ornithologists' Union." One must conclude, if all this evidence is equally reliable, that it is a matter of indifference or of individual variation whether the feet alone or the feet and wings are used by Grebes and Loons, but that the majority use their wings under water. As I have studied this matter for some years and have published a paper on it in 1909,[1] I have been interested to analyze these reports of Mr. Forbush, for their perusal leaves one, I believe, in a confused and false state of mind, and I am sure that he would be glad to have this confusion cleared away, if possible. I am inclined to think I am anticipating him in this analysis for he calls even his Department Bulletin "a preliminary report."

Before attempting this analysis, which I have limited to Grebes and Loons, one should bear in mind several general considerations. A good observer should of course have no preconceived bias towards either side in a controversy, but, in observations of diving birds, which must be made in brief and often unexpected instants, he must hold clearly in mind the possibilities, else he may see only

[1] The Use of the Wings and Feet in Diving Birds. 'Auk' XXVI, 1909, pp. 234-248.

what he expects. It is a well known fact that many birds habitually use their wings under water. This is the case with the whole family of Auks and with many Ducks, and it is a common belief among gunners and guides that all diving birds "fly" under water. Some ornithologists entertain the same idea, and it is often difficult to give up preconceived ideas. For example the idea that Hawks and Pigeons in flight hold their feet in front is prevalent even among ornithologists, although it is a well known fact, easily established by careful observation, that the feet are as a rule stretched out behind.

Mr. Forbush believes that observations of captive birds in tanks, which all show that Grebes and Loons habitually use the feet alone, are of little or no value, for, he thinks, the limited space would prevent the free use of the wings or bursts of speed. He says: "This idea that a bird in a small tank will act exactly as it would when free and in deep water has caused ornithologists to draw false conclusions." and "One might as well study the habits of an Eagle in a flying cage."

To this, three ideas are pertinent: In the first place "it is a poor rule that does not work both ways" for birds like the Auks and certain Ducks may be seen to use the wings in diving even in a small tank. The only observation quoted by Mr. Forbush that controverts this statement is one on Guillemots in the London Zoo, as follows: "When feeding time came a bucket or two of dead or moribund small fish were emptied into the tank. The birds had to exert very little effort to secure their feed, and I noticed a few did not use, or hardly used, their wings under water, but could easily secure the fish with a few strokes of the feet. The keeper assured me that when first introduced the birds all used the wings when swimming below the surface." The value or lack of value of this observation is obvious Moreover in Mr. Forbush's reports are to be found observations of Grebes in small natural tanks in rocks or in the ice where, under the psychological effect of fright, to be explained later, the wings were actively used. Mr. Forbush does not consider these of little or no value.

In the second place, captive Loons, when thrown live fish, pursue them with the greatest eagerness, entirely unembarrassed by the presence of the observer, and it is reasonable to suppose they are making their best speed.

In the third place many of the tanks are of large size, particularly the one at Woods Hole, as will be shown later.

The psychology of fright must be understood. A child that has recently learned to walk or run, returns to a quadrupedal scramble under the influence of fright. A domestic fowl may be a fast runner, but, under the influence of fright is sure to use its wings also, even if it falls over in so doing. Birds that are cornered or chased, especially if in addition they are wounded, are obviously in a state of extreme fright.

Another way in which fright interferes with the best actions of birds is illustrated by the following from a recent letter from Mr. W. L. McAtee: "I have noticed that Grebes surprised by the sudden appearance of a hunter standing up in a blind near them foolishly and hysterically try to escape by their ineffective spluttering flight, when their perfectly good method of escape by diving was entirely forgotten."

On a calm day on the Labrador coast I watched twenty or thirty Loons trying to escape from the path of the steamer by attempting to rise into the air. After an interval of fifteen seconds to three and three quarter minutes they gave up their frantic floppings along the surface and dove. Only two succeeded in rising into the air.[1] Fright inhibited their higher centers, those last evolved. They "lost their heads" so to speak. One would infer from this that flight by wings in the air is more ancient than diving in the water. The earliest bird of which we have knowledge, Archaeopteryx, was arboreal.

Finally it is evident to all who have studied the habits of birds that it is never safe to say that a bird always does so and so or that it never does so and so. Pigeons and Gulls under certain circumstances carry their feet in front in flight. To a student of evolution and of structure certain tendencies or rules of conduct are often evident, to which, however, there may be more or less exceptions, for birds, like the rest of us, are not perfect machines.

It seems to me reasonable to suppose that birds that ordinarily swim under water with the feet alone, do, when terrified, return to the quadrupedal method, especially if it can be shown that the young of these groups use this method. It is even conceivable

[1] 'A Labrador Spring', 1910, pp. 51, 52.

that the quadrupedal method may be inferior for speed purposes to the perfected bipedal method. This, however, is another question merely touched on here, but referred to tentatively in my conclusions. It deserves careful study. I do not believe that the question can be answered, as Mr. Forbush has done, by showing that the wing-surface is at least three times as large as that of the feet, that the pectoral muscles are larger than the femoral and that the wing-beats are as rapid as the foot-strokes. There are other factors to be considered.

Some of those who report that Grebes or Loons dive by the use of the feet alone speak of their great speed through the water, sometimes of their "remarkable" or "incredible" speed. On the other hand many observers appear to assume *a priori* that in order to attain great speed the wings must be used to assist the feet. This assumption may or may not be correct. Careful experimentation is needed to determine this point.

It is evident that Grebes which carry their downy young under the wing in diving, do not, at these times, use the wings for propulsion.

One more very trite remark may be pardoned, namely, that all of us have more or less uncertain memories and, unless notes are taken at the time, our remembrance of the incident may be unreliable, especially if years have elapsed. In several of Mr. Forbush's reports the words "apparently" or "as he remembers" qualify the statement and many of the observations are remote in time, one having occurred fifty-seven years before.

Mr. Forbush in his first paper likens the position of those who maintain that the wings are not used to the Negro judge who, in trying a murder case, accepted negative evidence as equally valuable with positive evidence. This is hardly apposite for the observation of a bird swimming under water with its feet and holding its wings motionless is not negative but positive evidence.

Let us now examine the evidence in these papers. Some of the reporters are scientific ornithologists whose observations are of great value, but it is obvious that among the Associate Members of the A. O. U., although many may be excellent observers, the observations of others are comparatively worthless. It is impossible and it would be invidious to separate and discard the obser-

vations of the latter class. We are obliged to take them at their face value—a disadvantage that always applies to statistics obtained in this manner. We can, however, discard or rather place among the abnormal, all observations made where the bird was obviously frightened, especially where it is wounded. These cases all run true to the form expected. The birds use their wings as well as their feet in their frantic efforts to escape from man, the destroyer.

Many of the birds in Mr. Forbush's reports were chased in boats or cornered and escaped only by swimming under the boat; or they scudded under the bridge where the observer was standing; or they were discovered in small pieces of water on calm days when they were unable to rise into the air. Many were wounded. Only under very exceptional circumstances is an observer in the open near enough to observe the actions of a diving bird without causing it fright. One can easily imagine the frantic terror of a Grebe in a small lane of open water when an observer runs near it on the ice, as it repeatedly dives in its vain attempts to escape. Mr. Forbush's evidence is of great value in showing the effect of fright on these diving birds.

Then we can view with suspicion or perhaps discard cases where internal evidence shows that the reporter was in doubt, that his memory was hazy owing to lapse of time combined with absence of notes, or where he mentions poor visibility of the bird. Some cases may be discarded at once owing to contradictory statements, as when one reports that the feet were not used and in the next sentence says he could not see the legs.

There still remain a large number of cases in Mr. Forbush's reports that are clear statements, but where, owing to the absence of details, one does not know the conditions nor does he know whether the bird was frightened or not.

To clear up these cases, I have written where it was possible to the reporters for further details, and have questioned several in person. All the answers are quoted here.

Several observers say the wings are raised a little from the body. Dr. Walter H. Scudder made careful observations on an unwounded Pied-billed Grebe, kept in a tank eighteen or twenty feet long, four feet wide and from four to six feet deep. He writes: "It

would dive straight down to within a foot or eighteen inches of the bottom, its wings close to its side, striking the water alternately with its feet in diving. Then it would suddenly assume the horizontal position, raise its wings slightly from its sides and, keeping up the alternate motion of the feet almost faster than the eye could follow, swim with most remarkable swiftness through the water, which seemed to pass under the slightly raised wings at the shoulders and come out at the tail with a swirl, much as the water leaves the blade of a turbine waterwheel. There was absolutely no other movement of the wings.

"I once observed the same manner of swimming under water at a double canal lock in Akron, Ohio, . . . a large male Loon. . . . There was no movement of the Loon's wings except the slight raising of them as he came to the horizontal, then, using his feet exactly as did the Grebe, propelled himself with great swiftness through the water."

Mr. Charles W. Vibert writes that the Horned Grebe was remarkably tame and chased live fish put in its tank. In this pursuit, "he lifted the butts of his wings a trifle, using them apparently to maintain his balance as well as to aid him in his progress."

In what way the wings used thus would aid progress is a little obscure and needs further study, but these careful observations are of very great value. The following quotation from F. W. Headley[1] as regards Cormorants is pertinent here: "The Cormorant uses his feet alone to propel him (in diving) striking with both simultaneously, and holding his wings motionless, though slightly lifted from the body. The position of the wings must have given rise to the idea, common among fishermen, that the Cormorant flies under water . . . But when you see him in a tank you can have no doubt that the legs are the propellers."

Mr. W. L. McAtee of the Biological Survey, who reports the use of the wings by a Pied-billed Grebe, writes me that the "bird was rather cornered in a narrow inlet to a pond and, on coming up and seeing me, had to reverse its course and pass me to escape. Fright may have been the cause of its using its wings."

Mr. Charles L. Phillips writes: "The bird was doubtless frightened and made an extra effort to get out of sight and danger as rapidly as possible."

[1] 'Life and Evolution,' 1907, p. 125.

Dr. A. K. Fisher writes: "Many of the Grebes I saw flying under the water were after fish and were not aware of my presence. If I remember correctly, the first ones I ever saw were in the Adirondacks where I could see them plainly because I was standing on a high bluff overlooking the water. At Klamath Falls I have stood on a bridge and watched these birds in operation in the water below."

Mr. Robert O. Morris writes that the Grebe remained in the pond "for a number of weeks and became very tame. This occurred about a quarter of a century ago and my recollection regarding seeing it under water is rather hazy, but I think it used its wings in its movements, although I saw it only once when it was under water."

Dr. T. S. Palmer writes: "The birds [Loons] were considerably frightened as they were being pursued by several boats working in parallel lines and had been driven into shallow water where they had difficulty in diving."

Mr. Ludlow Griscom writes that the Horned Grebe "was *inside* the breakers in a place where the tide had fashioned a sort of pool with a bar running seaward. . . . As a result, the breakers running up the beach were given a strong spin westward, and I always supposed that this was why the Grebe was using its wings, —the feet only might not have given sufficient power to maintain speed and exact direction. It used its wings all the time it was in this pool. It is proper to add that on several other occasions I have undoubtedly seen Horned Grebes fishing, and they did *not* use their wings, but there never were the unusual tide and current factors to contend with."

Mr. Mark Robinson studied a Loon that was so tame that it came within ten feet of him. He writes that "when hunting he would use his feet only, to swim, but when a burst of speed was necessary, the wings opened slightly, the points of wings close to the body."

In Mr. Forbush's paper there are reports from Mr. Ralph Lawson of a diving Horned Grebe, and by Mr. George H. Mackay, Jr., of diving Loons where both wings and feet were used. I questioned both of these reporters and there seems no doubt but that the birds were normal and apparently under normal conditions. There

is also the report of the careful observation of a diving Horned Grebe using its wings by Mr. Ralph Holman, but no data as to the circumstances are given. Mr. Holman tells me he had shot the Grebe and was endeavoring to pick it up from the water with a paddle, when it revived and made a frantic and effectual attempt to escape.

Mr. E. S. Butler writes of the Pied-billed Grebe using its wings: "Upon my sudden appearance directly above, it dived and swam rapidly away, evidently frightened." Mr. C. K. Averill writes he has no reason for supposing the Loon that he reported was frightened. Mr. Wright M. Pierce writes that the Grebe he observed under thin ice "was very greatly frightened—it was certainly doing its best to get away from me."

Mr. Erle L. Browne writes: "The Loon I saw was in a fish weir and naturally would be a little scared; have seen Grebes a number of times using the wings under water and think they do it naturally scared or not."

Mr. Scott Harrison Lewis writes of Grebes: "We chased these birds quite a while and finally got to see one or two 'flying' under water. The wings appeared to move in a small radius, I could not observe the feet. There was one wounded one which also used its wings upon being chased. They were undoubtedly frightened."

Mr. J. K. Jensen furnished with his careful report sketches showing the use of the wings, but in this report, as given by Mr. Forbush, there is nothing to show whether the bird was at ease or not. Mr. Jensen writes me that "the Grebe I saw using its wings under water was frightened. I came upon the bird quite unawares . . . in a small pool formed in a depression in a rock ledge. . . . The bird dived at my approach, and circled the pool several times, using both feet and wings. After a little while it brought its bill above the water for breathing, dived again . . . I do not remember how long I watched the bird, but I stayed so long I was actually afraid the bird might drown. I could easily have captured it."

In Mr. Forbush's brief transcript of the observations of Mr. A. R. Cahn on a Holboell's Grebe in a pool in the ice twenty-five feet square, one could not say whether the bird was frightened and trying to escape, or at ease and in pursuit of fish. A reference to

Cahn's complete article[1] in 'The Auk' makes the matter clear. Here he says: "When approached, the bird dove, and remained under water nearly a minute. As soon as it came up, it would dive again on the instant so long as the observer remained near . . . After having been under water almost continually for over fifteen minutes, the bird was tired out, and finally came to the surface on the opposite side of the pond from the observer. Here, it drifted nervously about, giving its peculiar squawking note every few seconds. After being watched for some time, it was driven into the shallower water, where it suddenly dove and remained down over a minute. It reappeared finally over two hundred feet away, crawling up on the thin ice through a hole which it had made with its head and bill. The bird was taken from the ice without a struggle or attempt to escape." He states that "eleven beautiful specimens" in all were picked up. The resemblance between this report and that of Mr. Jensen's is striking. Both birds were practically in tanks and both were terrified.

Mr. Albert A. Cross who reports a Loon using its wings under water writes me that he had been driving the Loon by shooting at it whenever it appeared above the water, and that his partner, coming up from the other side, drove it back so that it swam close by through the "narrows." One reporter gives only second-hand observation, but he says the Loon was not frightened.

Mr. A. L. Clark writes: "The bird was not frightened except by finding itself in the narrow confines of the bay and possibly by seeing myself and two friends on the bridge apparently cutting off escape. It is also likely that the wings were brought into use in this case because of the current in the channel."

Mr. S. B. Jewett writes that the bird was probably a cripple. "It was certainly very much frightened as I was after it in a small pool of water where it had stayed after the tide had receded."

If we exclude from these reports all observations where the birds were wounded or frightened, or where internal evidence shows that the observations were of doubtful value, the proportion of the birds using their wings is very much reduced, but their still remains a small number of reliable observations under apparently favorable circumstances where the wings were used. I have no wish to discredit this evidence.

[1] 'Auk,' XXIX, 1912, p. 440.

It is important, in all statistics where a scientific truth is sought, not only to obtain reliable information but to analyze the answers, as has been attempted here, before they are published. Entirely erroneous impressions may otherwise be given, which are doubly dangerous because so many look on statistics—not as the vulgar joke labels them—but as infallible. Another important point in obtaining facts by the questionnaire method, is that no "leading" questions should be asked. The physician, who wishes to get at the truth of a patient's symptoms, avoids leading questions, and the lawyer is forbidden to use them in the first examination of the witness. When the observer is asked: "Have you ever observed any Loon, Grebe, Cormorant or Water Turkey making use of its wings in swimming under water,"? and finds no question on the use of the feet alone, the results of the questionnaire are liable to be biassed and limited.

Practically all the observations on captive birds in tanks and pools, considered of little or no value by Mr. Forbush, show that the birds do not use their wings. There is one exception published in my paper,[1] an observation by Mr. C. Wm. Beebe who wrote me that "Grebes and Loons do (use their wings) at times of emergency to turn quickly, or get up a burst of speed."

This use of the wings in balancing or turning is illustrated in one of Mr. Forbush's reports as follows: "Mr. Arthur W. Beckford, Danvers, Massachusetts, writes that he saw a Loon swimming in a narrow salt-water stream, and using its wings when followed by a power boat. Quick, short strokes were employed, but he believes that the wings were used more for the purpose of turning than for progression." This bird seems to have kept its head even when chased!

The pool where a tame Loon was studied in the New York Aquarium by C. H. Townsend was twenty-eight feet long and three feet deep. The tank at the Marine Biological Laboratory at Woods Hole is an outside enclosure or pool through which the tide freely flows. It is sixty feet long, thirty feet wide, and five feet deep. It is crossed by a bridge near one end from which observations can conveniently be made.

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[1] *loc. cit.*

In Mr. Forbush's second paper he quotes Professor Lynds Jones, who watched a Loon in this tank in 1904 that "never used its wings in swimming, although it swam with incredible swiftness." He also quotes Mr. Winthrop Sprague Brooks who "asserts that years ago he saw a Loon in a tank at Woods Hole, and that, as he remembers, it used its wings exclusively under water."

Mr. S. C. Brooks of the U. S. Hygienic Laboratory at Washington, while working at the Woods Hole Laboratory last summer, made some careful observations on a Loon in the tank. I quote from his letter to me of January 28, 1923: "After some days the bird became so tame as to accept food from the hand . . . he swam under water wholly with his feet . . . His usual food was *Fundulus heteroclitus,* the killifish . . . We sometimes threw in a fish and watched him chase it. I do not remember having seen him use his wings in any way in this process, unless possibly rarely opening them a little as he turned; certainly never in any way for propulsion."

It seems to me that careful observations such as these of birds in tanks, far from being of little or no value, are of the greatest value, for the birds are entirely at their ease and are not terrified by the presence of man as is generally the case in the open. Similar observations have been made by Beebe, C. H. Townsend, Evans, Lloyd Morgan, Lea and Headly.

A zoologist reconstructs an entire animal from a few bones. Not only that but he is able to describe its habits, whether, for example, the animal was a slow or fast runner, a climber of trees or a diver. If one compares the skeleton of a Penguin with that of a Loon, it is apparent that in the Penguin the fore limb is modified for locomotion under water, in the Loon the hind limb. The paddle wings of the Penguin can not be used for flying in air. The powerful legs of the Loon are set so far back as to be useless for walking on land. One would infer that the Penguin habitually used the wings, the Loon the feet, under water, but he would be rash to state that the Penguin never used the feet alone or the Loon the wings alone.

The most extreme case of specialization in the use of the feet alone in diving is that of Hesperornis of the Cretaceous period. Here the wings, which must have been a hindrance rather than a

help in diving, are reduced to vestiges, but the feet are large and powerful. The close resemblance in the pelvic girdle and the posterior extremities of Hesperornis and those of the Loon and Grebe are marked.

As Mr. Forbush does not refer to my paper[1] or observations, I may be pardoned for quoting briefly from its conclusions, which, to my mind, are confirmed by his evidence:

"It is possible that the occasional use of the wings observed in these birds (Grebes and Loons) may be explained by fright, which causes them to 'lose their heads,' and return to a reptilian scramble so to speak . . .

"In conclusion the following tentative inferences from these preliminary studies may be set down.

"1st. That progression by both wings and feet under water in diving birds is the primitive method, and is therefore to be looked for in beginners and young birds.

"2d. That specialization towards the use of the wings alone leads to a diminution in the size of the wings, and finally to a form of bird that is flightless in the air; for wings of flipper proportions, too small for aerial flight, are more efficient than large wings for subaqueous flight, as witness the Great Auk and Penguins.

"3d. That specialization towards the use of the feet alone is probably best adapted for the most rapid progression under water, and this method may leave the wings undiminished in size for use in the air. The apparent exception, Hesperornis, with powerful feet but wings degenerated to vestiges through disuse, serves but to confirm the inference of the superiority under water of feet action alone."

Finally, as a result of my former studies and of this analysis of Mr. Forbush's reports, I would conclude:

1st. That the structure and evolution of Grebes and Loons point to the use of the feet in diving.

2d. That observations under normal conditions show that as a rule the feet alone are used, although under some conditions the wings are slightly raised and in a few cases they are used vigorously.

3d. That in swift currents and in quick turns the wings are often used.

[1] *loc. cit.*

4th. That in case of fright, especially if the bird is wounded, the use of both wings and feet is the rule.

5th. That young birds habitually use both wings and feet.

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SOME NESTINGS OF THE CRESTED FLYCATCHER.

BY JOHN A. GILLESPIE.

Plate VI.

IT was my privilege during the present year to study intimately the nesting of the Crested Flycatcher (*Myiarchus crinitus*) and as my birds nested at a height of only four feet three inches from the ground, whereas most authorities give six to twenty feet as the usual nesting height, it seems worth while to place my observations on record, especially as the birds displayed a confidence in mankind both in selecting a nesting site and in their subsequent actions which seems unusual. This nest was located in a piece of hollow fence post about four and one half inches in diameter and twenty inches in depth—which I had nailed to the side of the house and which projected out at right angles therefrom. The purpose of the post was to serve as a food shelter and retreat for winter birds, and the possibility of its being utilized for a nest had never entered my mind. The construction of the nest took about ten days. Fine grasses and weed stalks were chiefly used. A piece of waxed paper was temporarily placed at the entrance to the nest by the Flycatchers, but was dispensed with five days later, when a piece of snakeskin some ten inches in length was substituted. This snakeskin was not in evidence when the nest cavity was examined subsequent to the leaving of the fledglings. As no trace of it could be found outside the cavity, the nest proper was examined and minute particles were found therein. As the weather was unusually hot at this time, the snakeskin no doubt became very dry and brittle, and was broke into smaller and smaller pieces, due to the resulting friction as the female came and departed. The sexes could be distinguished with ease as the male carried his crest erect while the female did