FLYING-FISH AERODYNAMICS

Further Notes on a Controversial Subject

By C. H. LATIMER-NEEDHAM, M.Sc. (Eng.), F.R.Ae.S., M.S.A.E.

THOUGH not of direct aeronautical interest, a recent short article in these pages has aroused so much discussion that we consider this further contribution is well worth presentation, especially in view of the identity of its author. Mr. Latimer-Needham, who is chief engineer of Flight Refueling, Ltd., and director of Luton Aircraft Ltd., is a light-aircraft and sailplane designer of long experience, and combines these interests with a keen insight into the phenomena of natural history.

CORRESPONDENCE has recently appeared in Flight under the heading “Can Fishes Fly?”, the meaning given to the word “Fly” being flight under power and the means of propulsion being by flapping of the wings or, rather, pectoral fins. Several tentative theories concerning the phenomenon have been propounded from time to time, but they have been conflicting and often contradictory. Thus, the British Museum Guide* states: “The question whether flying-fishes really fly, whether, that is to say, their pectoral fins are moved as organs of flight like the wings of birds and bats, is a subject of much contention.”

Some writers have maintained that flight is accompanied by rapid beating of the fins, whilst others discount this with statements to the effect that the fins are quite still during flight. Others, again, contend that lift is obtained over the crest of each wave, that is by soaring flight, which, however, Hankin finds unsatisfactory, as not being applicable in all cases. “The suggestion,” he states, “that flying-fishes get energy by meeting upward currents at the top of each wave obviously does not explain a flight of half a mile over a smooth sea where there are no waves. . . As a matter of fact and observation, flying-fishes may fly long distances along the trough of a wave or along the leeward side of a wave at high speed.” Such a theory cannot, then, be accepted as the proper solution, although this is not to say that the duration of flight is never prolonged by the presence of rising currents.

Probably, the suggestion most nearly correct was put forward by Ahlborn, who believed that the flight was merely a prolonged glide with the incidence of the wings gradually increased to compensate for loss of speed until the final stalling back into the water.

Hankin discarded this also on the strength of observations which did not appear to disclose a gradual lowering of the tail. It should, however, be recognized that the rate of tail lowering would be much more noticeable towards the end of a flight, on account of the variation of lift with the square of the speed; and, furthermore, the initial speed is relatively high, which permits of a quite small angle of attack over the earlier part of a flight. Moreover, incidence can be increased by rotation of the pectoral fins whilst keeping the body horizontal, and it may well be that the tail lowering is done solely in order to get the tail fin into the water for control purposes.

Considerable evidence exists, apart from personal observation, to show that the tail is lowered prior to the descent (Jordan, Ahlborn, etc.) and this is confirmed by Hankin with such entries as: “Just before plunging, it somewhat slowly lowered its tail.” (Italics not in original.)

Before proceeding farther, it might be as well to marshal the facts known about fish flight so that a proper perspective may be gained. There are several species of flying-fish which live for the most part in tropical or sub-tropical seas and rivers. The largest, of about 1 lb weight, is roughly 18 in long, with a span of about 2 ft and a wing loading of 2 lb or so per square foot.

The pectoral fins act as aerofoils and the pelvic fins as stabilizers. The fins are ribbed on the underside, without doubt for considerations of strength; the ribs running from the roots outward, or radially, and this would appear to be an adverse factor aerodynamically.

In considering the problem of flapping flight, Hankin states that: “The weight of the flying-fish is about eight times as great as that of a bird of similar size. . . [but] the muscles for moving the wings . . . are at least five times smaller than those of a bird, according to measurements given by Moebius.” The muscles attached to the pectoral fins are more developed than those of fish incapable of flight, but it seems fairly certain that they are insufficiently powerful for flight purposes, except perhaps as an auxiliary means of providing thrust. The American freshwater flying-fish (Gastropteleus), which is found in the rivers of Guiana, has a deep sternum, or keel, to which muscles (comprising roughly one quarter of the total weight) are attached. These muscles compare favourably with those of birds, but in this species the wings are small and the method of propulsion is by beating the water with their wings.

Most, if not all, of the salt-water species have the lower lobe of the tail fin considerably enlarged (see diagrams) and on rising from the surface of the water the tail is always wagged vigorously from side to side with a sculling action. The duration of flight may be anything up to half a minute, or even more, whilst the distance covered above water varies between 300 and 3,000 ft or so. Flight generally takes place

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*British Museum (Natural History) "Guide to Specimens Illustrating Flight" (1913).