ON A REMARKABLE ACTION-PHOTOGRAPH OF A MONTAGU'S HARRIER.

BY

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(PLATE 1).

THE unusual appearance of the upper wing-coverts of the Montagu's Harrier (*Circus pygargus*) shown in the accompanying photograph has aroused so much general comment that an attempt to explain how the erect position of these feathers fits in with our present knowledge of the laws of flight should prove to be not without interest to readers of *British Birds*.

The explanation divides itself naturally into two parts, the first dealing with the flow of air which causes the feathers to stand on end, and the second with the reasons for the wings being used in such a way as to bring about this particular form of air-flow.

At a casual glance, it looks as if the feathers had been blown forwards by a stream of air flowing across the wing from rear to front* and, according to what is now known of the behaviour of air which has been deflected by a wing, such a stream should exist under the circumstances depicted. To understand this, it is first necessary to realize that, both in normal gliding flight, and when a bird is making the power- or down-stroke of normal flapping flight, the angle at which the wings are presented to the air-stream (the draught felt by a wing owing to its movement) is fairly small —probably something under 20°. The wings are then really slicing their way through the air and cutting a narrow furrow in it. The air displaced from this furrow is deflected by the under-surface of the wing in a downward and slightly backward direction, while the stream of air which passes over the upper-surface of the wing is, as it were, drawn downwards by the attraction of the partial vacuum in the furrow. Strictly speaking, of course, a furrow cut in air is filled with "nothing"; that means that it is a region of "no pressure", into which air at atmospheric pressure expands. All this air which is made to move reacts upon that which causes it to move, producing a force on the wing inclined in an upward and forward direction. It is important to remember that the direction of reaction has been found by research to be always

* For the sake of simplicity in explaining, it is more convenient to think of the air as being in motion relative to a wing in flight, than of the wing as moving through the air.

Female Montagu's Harrier about to alight at the Nest.
(*Photographed by* Walter Higham).

at approximately 90° to the mean surface of the wing, and also that under conditions of normal flight the two streams of air (upper and lower) are not sharply deflected, and are therefore able to flow quite smoothly as shown in Fig. 1.

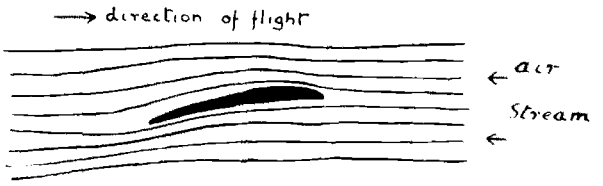

Fig. 1.
The flow of the air-stream round a wing, seen end on, in normal flight.

But if a wing, instead of being held at a small angle to the air-stream, is presented flat against the flow (as the Montagu's Harrier's wings appear to be) the air is then not deflected, but rather heaped up in front. From this heap two streams of air escape at high pressure, the one downwards, and the other upwards past the edges of the wing. Each stream, as it passes, finds that there is a region of low pressure (a broader form of the furrow) behind the wing. Flowing into this region the lower stream is moving forwards across the wing, and it can safely be assumed that it was such a stream that caused the phenomenon shown in the photograph.

With regard to the second part of the problem it is necessary to go a little deeper into the behaviour of the air-streams flowing round a wing which is set flat or at a large angle to its direction of movement. Having to turn a sharp corner to flow into the region of low pressure behind the wing, each stream, as it passes the edge, is set whirling; the two then meet in the middle, and a general mix-up ensues which is something like the turbulent wake left behind a broad object when it is dragged through water or as shown in Fig. 2. The

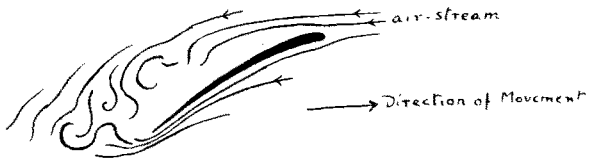

Fig. 2.
The flow of air round a wing, seen end on, in "stalled" flight.

wing is then in what is known as a " stalled " condition, and is not only pushing air along in front of it but is also dragging the turbulent wake along behind it. The reaction of the air upon the wing in the opposite direction is therefore backwards, once more at something like 90° to the mean surface. Now this Harrier, descending steeply on to its nest, would require above all else a strong force acting upwards and backwards along the path of descent in order to ensure a gentle landing; so its wings are held by the muscles at the only angle which can produce such a force—flat against the air-stream.

I feel pretty sure that at the moment the photograph was taken the wings were being flapped in a downward and forward direction, for, held steady, at the low speed required for landing, they would not displace air in sufficient quantity or at great enough velocity to produce the amount of reaction required. This downward and forward stroke would not greatly alter the speed of the air-stream over the inner parts of the wings, for the reason that, being close to the pivots at the shoulders, those parts cannot be moved very far; but towards the tips of the wings the reaction will be greatly increased. They are therefore the more important parts, and in this connexion it is interesting to note that the primary feathers are separated (owing to their being emarginated), forming a number of "slots". These slots greatly increase the efficiency of the wing-tips, just as the Handley-Page slot does for aeroplanes.

The actual manner in which the slots operate, and the several duties which they probably perform, can only be described at some length, and to attempt to do so here would merely entail tedious repetition of the paper which was published in *British Birds* for June and July, 1930. (Vol. XXIV., pp. 2–21, 34–47 and 58–65.)

It is probable that birds seldom require to use their wings as air-brakes in such a drastic manner as the Montagu's Harrier was evidently doing, but I have seen at least one other photograph in which the covert-feathers are similarly displaced. Air-brakes as well as slots are incorporated in certain of the latest designs of aircraft, notably the Puss Moth.

[EDITORS' NOTE.—We are greatly indebted to Mr. Walter Higham for allowing us to reproduce here this beautiful and interesting photograph of which Mr. Graham has given us so lucid an explanation. Concerning the taking of the photograph Mr. Higham writes as follows:—

" This flight-picture of the female Montagu's Harrier was obtained last summer in Norfolk. The result was achieved by constructing the ' hide ', or ' blind ', a considerable distance from the nest, much further than is customary in ordinary photography of birds at the nest.

This was done to enable the occupant of the ' hide ' to get a better view of the surroundings, and also to get a chance of the bird alighting in the front of the nest as well as from the sides and rear.

As readers no doubt know, the Montagu in practically every case alights against the wind, and once the direction of this has been discovered the photographer has a very good idea at which point the bird is likely to appear in the viewing aperture of the ' hide '.

This certainly makes it easier, but in the photograph in question it was difficult, as the slight breeze that was in evidence was blowing direct into the front of the ' hide '. As a consequence, the bird came from behind, right over the hide, and there was no warning of her approach except by watching the heads of the youngsters, which were scarcely old enough to take a great deal of notice of ' mother ' in the air.

The breeze was so slight that it was hardly perceptible and certainly did not unduly affect the plumage of the bird.* The explanation of the position of the wings and feathers I must leave to Mr. Graham, who, I feel sure, will be able to enlighten us on this interesting subject."]

* Mr. Higham's last paragraph raises a point about which there may be some doubt. No breeze can ever possibly blow a bird's feathers up from behind, because the bird is " carried " by the air and superimposes its own speed upon that at which the air is travelling. A bird in flight detects wind merely by the fact that it carries him in the direction in which it is flowing at the speed of the wind ; he does not feel it in the same manner as we do. All he actually feels is the " bumping " effect due to eddies in the wind, an effect which is familiar to all who fly in aeroplanes.—R.R.G.