

ON SOARING FLIGHT

by E. C. Huffaker

with an introduction by S. P. Langley

EDITOR'S NOTE: *With the kind permission of the Smithsonian Institution we are reprinting this remarkable paper on soaring flight, first published in the Smithsonian Report for 1897.*

It is generally known that birds sustain themselves in the air in two distinct ways:

First. By the direct exercise of mechanical power, as in a large class of birds that flap their wings. Although the exact motions and power of the wing have not yet been studied exhaustively, there is nothing in this method of support, considered as a mechanical contrivance, in apparent contradiction to known principles.

Second. Another and important class of birds, including the largest, can fly without flapping the wings, and are able to glide over the landscape (sometimes from horizon to horizon), on nearly motionless pinions, in a manner and with an effect which is not easily explained on known mechanical principles and which is in striking contrast with the labored way of other birds. This manner, which has never yet been completely accounted for, and which is called "soaring flight," forms the special subject of the following article.

In this latter case the bird is in some way held up, as though by an invisible hand, upon the thin and yielding air, on which it seems to float almost like a ship, although its specific gravity is nearly a thousand times as great as that of the air, far greater, in proportion, than that of a ship of solid lead or gold would be to water.

There is no obvious explanation of this soaring flight, nor has any yet been offered which is not open to some objection. Passing by the childish idea of the support being derived from the lightness of the birds' hollow bones, or quills, we find ourselves restricted to a very few hypotheses indeed.

Perhaps the first of these is that the bird is everywhere upborne by invisible ascending currents. Without in any way denying that such currents exist or that the bird may frequently utilize them, it seems almost superfluous to enter upon a refutation of the idea that these are universally present, even if we allow that they can have ascensional force sufficiently to sustain such masses in the air. "What goes up must come down," and there must be areas where the currents are descending to supply the void. But perhaps a better answer lies in the citation of the simple and most familiar fact of observation; that the great soaring birds (which are chiefly of the vulture class) are found uniformly suspended, frequently in large numbers, above the carrion or other object of their interest, wherever it lies, and it is too grotesque a supposition that an ascending current capable of sustaining them should always emanate from such a source. The hypothesis of such ascending currents is not, then, irrational as a partial explanation, but wholly insufficient as a complete one.

The next which arises, and which to an observer untrained in mechanics seems extremely plausible, is that

the wind holds the bird up as it bears up a kite. The sight, familiar from childhood, of kites sustained at great heights in the air without any power emanating from themselves is perhaps responsible largely for this delusion; for it is one to suppose that the bird, not upheld by any string, visible or invisible, actual or virtual, can sustain itself in a wind, at least if the wind be what it has until lately been treated as being, a nearly homogeneous moving mass of air, with occasional little eddies or disturbances which do not affect its fundamental quality of a current flowing altogether, like a river or a tide.

It is absolutely contradictory to mechanical principles, however, that in such a uniformly moving mass of air a kite or any other body without internal power or external support, or any bird on rigidly extended pinions, can sustain itself except momentarily, any more than in an absolute calm. The fact, however, that the soaring birds very rarely indeed perform their special evolutions except in a wind, and do have to resort to flapping their wings in a calm, is so obvious that many writers have tried to persuade themselves that in some way or other well-known laws can be evaded, and that the birds can continuously soar in such a wind by a power derived in some way from it. I think it superfluous to do here more than repeat that such action is mechanically impossible.

Next, it is indeed true that if there be two winds, or two strata of a wind, moving at different velocities, it is in this case mechanically possible that the evolution can be performed, and this Lord Rayleigh has pointed out. Though this is a true cause as far as it goes, it seems hardly necessary to say that it can account but for a very limited portion of the actual phenomena.

Another hypothesis, in accord with mechanical principles, and by which the work of supporting the bird can be derived from the wind in which it moves, has been put forth by the writer, after a study of the internal movements of the wind, which he has shown by much experiment, are incomparably more complex than had been supposed before attention had been brought to them; movements whose possible effect may be illustrated in this untechnical article, by saying that if we could see the wind, it would not appear a smooth-flowing tide like the Gulf Stream, but rather seem broken into infinitely varied internal¹ movements like the rapids below Niagara, some of which are often opposed to the movement of the main current which bears them on, and by means of which internal movements it is quite possible in theory that work may be done sufficient to bear a vessel against the main current itself.

The attention of the reader who is interested in the matter may be again called to the fact that the present writer does not conceive this to be the sole sufficient cause, in the sense that the bird uses it to the rejection of

¹ The "Internal Work of the Wind." Smithsonian Contributions to Knowledge, Vol. XXVII, 1893. No. 884.