



OUR TEACHERS IN SAILING FLIGHT.

BY OTTO LILIENTHAL.

Translated from Prometheus.

I HAVE recently seen such wondrous feats performed in sailing flight that, as I now sit at my table to write, I do so with more enthusiasm than ever before; for the things which I have seen prove clearly and definitely that flight must be much easier than it is generally believed to be, if we only, with suitable wings, boldly trust ourselves to the wind. All perplexities concerning light motors, and speculations on the amount of power required for flying, are relegated to the background by the fact that the power of the wind alone is sufficient to effect any kind of independent flight.

If we had not those magnificent models in flying, those large and heavy birds which, without a flap of the wing, allow themselves to be borne by the wind, doubters would be justified, and we should lack the courage to attempt the solution of the problem with the perseverance which is necessary; but, as it is, the tangible results cannot be denied, there is a flight which does not require any effort, where only the shape and position of the wings must be right in order to float, circle, or sail in the air at any height or in any direction desired; therefore our confidence, notwithstanding many vain attempts, is always renewed.

But which are the birds best fitted as models in soaring flight? How can we best find a position for making fruitful observations?

If we go through the fields in summer, we see now and then a bird of prey circling about; then a swamp bird, of the larger kind, passing along arrests our attention: yet if one goes out on purpose for such observations, it may be that he will lie in

wait for days in vain, or if a sailing bird comes in sight, it is very likely high up in the heavens and far away, so that little can be learned from it.

The Americans are proud of their buzzard which gives them such exhibitions in the art of soaring, but in order to observe this near at hand and to be able to study the effect of soaring, places of concealment must be arranged in the tops of trees and in rocks from which the observer may watch the motions of flight.

Things are easier for people living on the coast; the graceful soaring flight of the gulls can be frequently observed near at hand, as these birds are not very timid, from their being so seldom hunted. But the best opportunity for studying soaring flight is to be had in the lowlands of Northern Germany, in the villages, where the stork lives his family life on the low roofs, unconcernedly showing off his art close above the heads of observers, and by his size giving the observer the clearest impressions of the shape and position of the wings.

But even at these stork nests it is tedious to wait for the moment when the old birds return with food for their young; it is generally only for a short moment, in the quick coming and going, that one can observe closely the flying or the soaring stork.

Observation is more productive when the young birds are fledging. As soon, however, as they have learned to soar, which soon happens in windy weather, they do not remain in the vicinity of the nest, and one can look for them a long time in vain.

Being convinced that Father Longlegs is just made for our instructor in flying, I kept a great many young storks some years ago, whose attempts at flying have given me many explanations in flying technics. As soon, however, as their proficiency extended to soaring, when rising above the tree-tops, they felt the magnificent bearing-effect of the wind, and ventured into higher regions, they joined other wild storks, and so ended all further observation.

While on a journey to procure these young storks a friendly man told me that there could be no better place for observing

these birds than the village of Vehlin, near Glöwen, on the Berlin-Hamburg railroad, for there there were on every roof two or three stork nests, and hundreds of storks circled above them.

This address slumbered, probably, seven years in my notebook, till last Easter I made use of the fine days to take a trip, in company with my two boys, to Vehlin. The road — a two hours' walk — from the station of Glöwen led us through villages in no way distinguished by a wealth of storks. I began to think the good man had played us a joke. But on approaching the village of Vehlin, my two boys cried out, "Why, there is a stork's nest!" "There's another!" "And another!" "There are two on one roof!" "Yonder are two more!" Our friendly adviser was quite right, for on the forty houses of this little village were no less than fifty-four storks' nests, about some of which the single pairs were yet fighting, while in some the process of hatching had already commenced.

With the exception of an interesting combat between the male storks which, rolled up like a ball, often rolled off the roof, only separating in a fright on dropping into the yard, there was not much to be seen that day. Yet I was glad to know of a place where in mid-summer, when the young storks are fully grown, the most magnificent exercises in flying would be observable. I was not mistaken. On going again to Vehlin in August, almost the entire army of storks was to be seen in the air over the village. The day was sunny and windy, just suitable for studying the soaring of these immense birds.

My observations result, so far, in ascertaining that in windy weather, when the air in the lower strata has a velocity of about six to eight metres, the stork does not move its wings at all, and proceeds soaring or sailing in the air.

This soaring took place not only close above the roofs of the houses, but also at so great a height that it was difficult to follow the birds' motion with the naked eye. The birds flapped their wings only when moving between the houses or trees — that is, in places protected from the wind. They soared in any direction they pleased, against the wind, with the wind, or side-

wise. They circled in order to ascend quickly to higher air strata.

When instructing their young the storks fly mostly in smaller or larger companies, at different heights, flying over the village alternately with or against the wind. In some of the nests young birds were standing, which did not yet take part in the exercises. As soon as these latter saw their relatives fly away above them they would greet them in their own peculiar language, by laying their heads on their backs and rattling with their beaks. Generally some of those flying would descend from the rest to their young ones in the nest. If the flight in doing this had to be made from a great, windy height, it gave the impression that the stork found the descent more trying than the ascent.

To descend more rapidly the stork employs various manœuvres. The simplest is that of letting the legs hang, thus lessening the soaring effect by a resistance to the air. With a good sailing-wind, however, these means are insufficient, and head and neck have to be lowered, at the same time the wings are bent so low down as to form the perfect shape of a bell. This position, however, appears to cause the stork an effort, as it soon changes again to the outspread position. On attaining this, however, it again commences to ascend, and then it is seen, after a few vain efforts to come down quickly from the height, to employ a radical means for rapid descent. This consists of placing itself in a vertical plane; that is, with the point of one wing underneath, the point of the other above. In this manner it can, of course, shoot downwards like an arrow. In its downward rush, however, it changes several times from the right position to the left. Finally it takes once more the position of the bell, till it lands on the nests, where it is always received, after such feats of prowess, with a joyful rattle.

A good deal could be said about these drops, often from a height of several hundred metres, but we have less interest in the descent from the height than in the art of balancing in the air simply by means of outspread wings.

In order to observe this proficiency frequently close to, we

chose a point of observation on a farm which was blest with five stork-nests, and from where we could oversee a dozen others.

The only means of lifting the last veil from the mystery of soaring is to be able to frequently observe large birds at a near distance in their soaring flight.

Three things are essential for soaring: a correct shape of wing, the right position of wing, and a suitable wind. In order to judge of these three factors and their changeable effect, we have nothing but our practised eye to depend upon.

Just how much the cross-section of the wing is arched when the stork is resting on the wind can be determined only by eye measurement; similarly the position of the wing to the direction of the wind and to the horizon. But when hundreds of storks give one the opportunity to observe the same in clear weather close at hand, what is seen is impressed so indelibly on the mind that it enables one to draw correct conclusions as to the existing laws.

In general, one can say that when the stork flies with wings spread horizontally and allows itself to be borne by the wind alone, it is but seldom that a stronger gust of wind causes the stork to draw in its wings.

The parabolic profile of the wings has a depth which I consider to be about $\frac{1}{10}$ of the breadth of the wing. The pinions are mostly spread out, but do not lie in one plane; but the more they are to the front, the higher are the points, certainly because they would otherwise hinder one another in their bearing capacity.

When in this position the stork passes slowly against the wind above the observer, the head and neck are, as a rule, stretched straight out; but if one imagines that soaring is possible in this position, that it causes little resistance, he will be surprised to see a stork, sailing in this manner, suddenly, without changing its position, lay its head back and rattle joyously. While we human beings are striving to find the proper shape for the wings, building theory on theory, flying takes place in nature in a wondrously simple way, quite as a matter of course.

It is ever with a large surplus of flying capacity that nature has equipped her subjects. A stork which has lost some of its largest pinions does not for that reason sail less gracefully than its comrades.

Storks are not particular in the way they hold their pointed beaks and long necks, as has been observed already. One after the other sailed over our heads; one held itself to one side, the other kept to the other side, without any change in their flight. Here comes another one very slowly against the wind; just as it stands over our heads it bends its head to the left to take a minute survey of its wings, on which it puts its head quite to one side and begins in a most leisurely way to put the feathers on its left wing in order with its beak; meanwhile its graceful sailing-flight does not suffer the slightest interruption. We looked at one another surprised by this sight, as if we would say, "That is beyond everything! For thousands of years we human beings have racked our brains to unravel the mysteries of flight, and we feel happy when we drink mere drops from the Fount of Knowledge, and here the storks seem to run riot in the art of flying, as if nothing in the world were easier." ¹

Afterwards I found out that a stork, putting beak, head, and neck back quite to the left, certainly changes the left wing a good deal more, but that, in this position, wherein head and neck are directly in front of the arm of the wing, to a certain extent a broadening of the left wing and therefore an increase in the bearing capacity of the same takes place.

One might therefore not be at all surprised if the balance in soaring be not disturbed. The young storks, which are known by their gray legs, betray themselves also in the air by their less sure flight; in soaring they are sometimes thrown here and there by the wind, and therefore take more frequently to flapping their wings than their red-legged parents, which understand in a masterly way how to meet every gust of wind.

¹ Wir Menschen quälen uns seit Jahrtausenden, hinter die Räthsel des Fluges zu kommen und sind schon froh, wenn wir tropfenweise aus dem Born der Erkenntniss schöpfen können, und hier wird von den Störchen in einer Weise mit dem Flugvermögen gewuchert, als gäbe es in aller Welt nichts Leichteres als das Fliegen.

Whoever observes minutely a stork, which is proficient in flying, sailing along at a moderate height, will notice a limited but almost uninterrupted turning and moving of the wings which apparently serve to exactly meet the pressure of the wind. Our eyes are riveted with admiration and wonder on each of these birds as they pass along. They skim and sail in the air, and their bodies, weighing four to five kilograms, appear to be borne by a magic power. Their whole behavior indicates that a flight like this is no labor, but rather akin to resting; their tameness lets them pass close to us; we can recognize each feather of their outspread wings. All deception as to the real cause of sailing flight appears excluded. That which is possible to these storks must also be possible to any other similarly formed flying body.

As the little swallow, which just now sails over the farm-yard through the broken window into the cow-shed, understands soaring on the same principles as the stork, so must, on the other hand, a larger apparatus, capable of bearing up a man, be able to sail on the wind, if it be of the right shape.

Of course such an apparatus alone cannot equip us for flying; the capability of using it, which is inborn with the stork, must be gained by us by laborious training, but even in this we can trust ourselves fully to our long-legged instructor. It shows us with what facility one can change the irregular blowing of the wind into bearing-power, provided we have the necessary practice. When the stork sails over the roofs of the houses one can see how it applies every gust in the air to its advantage. The higher it circles, the more tranquil and certain its flight becomes in proportion to the increasing uniformity of the wind.

A particularly fine spectacle is a stork remaining for a great length of time floating (remaining stationary) at one point in the air. This feat also, where all the forces are equally balanced, I saw performed by older storks only. These masters in the art of flying understand how to keep their position at one point even in high winds, as well as to shoot along with high velocity, all of which they perform by careful adjustment of their outspread wings.

The simplicity of the instruments with which nature obtains these wonderful effects in flying gives us hope that we shall come to a satisfactory solution of the problem.

Whoever needs incentive to labor with zeal ought to look up the little village of Vehlin in Ostprignitz in mid-summer, when the magnificent birds in their fine black and white garments sail majestically overhead, and are seen against the blue of heaven like emblems of liberty.