

I have recently been carrying out experiments with a machine that, in some degree, possesses the faculty of soaring, and, in the examination of the atmospheric conditions that make possible soaring flight, I have come to much the same conclusions as those reached by Dr. Hankin.

In the first place I find that air currents are not the direct cause of "soarability," and, in fact, tend to interfere with the buoyancy of the mass of air. Naturally a species of lift, or soaring effect, is produced by a head draft in the line of gliding flight when the gliding surface already possessed an impetus, but this relates to the force and angle of the air current impinging on the gliding surface, and in no way adequately accounts for the phenomenon of "soarability," although to the casual observer it may appear so to do.

The long-distance soaring flight of birds apparently takes place in the entire, or almost entire, absence of air-currents, and evidently has a direct relation to the sun's rays—and that not through any feeling of elation on the part of the bird through the sun's presence, as has been most ludicrously suggested. Nor does the interdisposition of clouds necessarily produce non-soarability, although the continued presence of heavy clouds tends in almost every case to reduce the buoyancy of the atmosphere, for the same reason that the air at night possesses under ordinary conditions less buoyancy than during the day. In both cases the sun's rays are intercepted, in one case more or less partially, and in the other more completely.

As I have been carrying out my experiments with a machine, I have had more opportunity of observing the atmospheric conditions that give "soarability" than is possible in the observation of the flight of birds, and there seems to be a factor in the case that Dr. Hankin and some other observers have overlooked, which is the presence of moisture or water vapour in the air. I have found that the maximum of soarability is reached with the sun in evidence and at its zenith and after light showers of rain. Soarability is also manifested in a marked degree on a bright and warm morning following a dewy night.

The poet has also observed that the birds soar away blithely in the morning and flap home wearily at night. The *Manchester Guardian* will no doubt argue that it is depression of spirit, due to the gathering gloom, that causes the home-going bird to exercise its weary self in flapping flight, but I think we will give the bird credit for more sense and less sentimentality.

The bird generally makes the best of atmospheric conditions in the endeavour to cover the greatest area of observation in its search for food, and when full up—unlike some human beings—gets home as quickly as possible at night.

There is some direct scientific relation between the soaring tendency of the morning bird and the flapping tendency of the evening bird, and all my observations trend towards the conclusion that these varying phenomena are due to the expansion and condensation of the moisture carried by the atmosphere and produced by the presence and relative absence of sun rays.

Now Dr. Hankin has concluded—and I think rightly—that a species of "explosion" takes place beneath the wing of the soaring bird, due to the disturbing of the atmosphere at its entering edge, and also possibly to the vibration of certain feathers in its under surface; but I further conclude that the "explosion" is that of the particles of water vapour that, when struck, change into more rarified gases, and may even be to some extent decomposed into their component parts of hydrogen and oxygen. Moreover, in all species of evaporation electricity is generated and this may also be a factor in the buoyancy of the air when evaporation is taking place, and may also have some relation to the volatilisation or decomposition of the moisture beneath the wing of the soaring bird.

The rapid evaporation, or expansion, that takes place when a boiling liquid is stirred, or when steam is beaten by a fan, is in a degree analogous to the result produced by the impact of the bird's wing against the rising particles of moisture in the air; and as a current of air may either chill or assist the expansion of steam, according to its temperature and rate of travel, so air currents are likely to adversely affect the soarability of the air, either by condensing the moisture in suspension in it or by effecting the explosion, or expansion, of the water particles in a manner similar to the action of the bird's wing.

Whether this force given to the water particles by the sun agrees with Dr. Hankin's conception of "ergaer" and whether this extended theory agrees with his observations I will leave for him to decide; however, my experiments, in a small way, with dry air tend to show that it is absolutely unsoarable.

C. WALPOLE DRURY.

[It is as well that our columns should afford an outlet for the free expression of opinion and thought, more particularly on a subject like flight, which admittedly is in a very undigested condition. But, we could wish to see more scientific criticism of Dr. Hankin's suggestion that "ergaer" is something other than the energy of air moving in

mass, because we feel that it is much easier for Dr. Hankin to answer questions on matters relating to his observed facts than it is to deal seriously with vague speculation. Dr. Hankin alone knows precisely what he has seen, and not even the closest student of his articles can possibly have in mind the actual facts of the case so clearly as he. Moreover, Dr. Hankin was very careful to insist that he used the term "ergaer" as implying a subject *to be investigated* and it is certainly not the best way of getting at the root of the matter to accept the inference that "ergaer" is a new force before we have thoroughly satisfied ourselves that all the old theories are inadmissible.

Besides, it does not seem to have occurred to a number of our readers that the existence of a new force would complicate rather than simplify the problem, inasmuch as the bulk of the force manifested in the phenomenon of soaring is admittedly the result of a "mass-acceleration" reaction. For example, suppose the bird has a gliding angle of only one in five, then it will require a propulsive force equal to only one-fifth of its weight to maintain it in horizontal flight. The weight of the bird itself is supported by the dynamic upward reaction of the air mass in downward acceleration caused by the wings acting as cambered planes.

If a wind is blowing and the wind has an upward trend, coupled with a sufficient velocity to cause the vector representing the resultant pressure on the bird's wing to incline forward instead of backwards from the vertical, then there will be a component of pressure in the line of flight sufficient to balance head-resistance, and, therefore, to enable the bird to maintain its state of relative motion without loss of height, *i.e.*, to soar. It is, of course, immaterial whether the bird moves in relationship to the earth or not; if the wind conditions are suitable, soaring may manifest as hovering over a certain spot. If the wind is horizontal and pulsating, soaring is also possible under certain conditions; but if a horizontal wind does not pulsate, then soaring is impossible. Meteorologists have for a long time emphasized the fact that no natural wind is uniform either in direction or speed.

When we speak of wind, it is usually assumed that the motion the air is sensible to the human body, but Dr. Hankin's observations once more raise the question as to whether it is not possible to have vertical up-currents that are imperceptible to any ordinary observation, but are nevertheless sufficient to maintain soaring flight. We have already explained that very low velocities are sufficient to account for the phenomenon, as for instance, if a bird having a gliding angle of one in five is observed to have a soaring speed through the air of 30 ft. per second, then an up-current of 6 ft. per second would be sufficient to prevent the bird from losing altitude.

The new factor introduced by Dr. Hankin's research is the association of soarability with sunlight, coupled with the observation that the existence of visible heat eddies when sunlight is not present does not cause soaring to take place and in fact seems to be inadequate to create a "soarable" atmosphere. Dr. Hankin concluded from these observations, together with a variety of others that corroborated them in respect to the significance of sunlight, that there might be some cause at work other than the movement of air in mass due to the heating effect of the sun's rays.

Before accepting the necessity for an alternative solution, however, it is necessary that the established conception should die a harder death, and it is for those fully conversant with the structure of the atmosphere and the influence of the sun's rays on its movements to say how far the actual shining of the sun might cause the immediate strengthening of upward air currents as compared with those that could be maintained by the natural heat of the ground that is temporarily in shadow. Then again, if it is a case of heated air rising, there is the question as to the manner in which the colder air from the upper levels may be falling to take its place and why, if these contrary movements are existing in the same field, the upward energy in the one mass should be superior to the downward energy in the other. This aspect of the subject is one on which there ought to be, and probably is, some information within the possession of our readers—particularly those who are meteorologists—whose evidence might go a long way to settling the mystery of soaring in apparent calm.—ED.]

Otto Lilienthal.

[1512] I am writing to inform you of an incident which I believe is not generally known. Twenty-two years ago, at the firm of Messrs. Simpson, Strickland and Co., the well-known engineers and launch builders, there were employed two fitters named Lilienthal or Lewenthal, of German nationality. These brothers spent a great part of their spare time in building gliders. One of them, named Otto, essayed to glide across the Dart, but failed. Can it be that these were the famous Otto Lilienthal and his brother? A photo of a memorial medal appeared in FLIGHT some time ago, bearing the effigy of Otto Lilienthal. This I showed to two of our