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WIND AND THE DIRECTION OF INSECT FLIGHT

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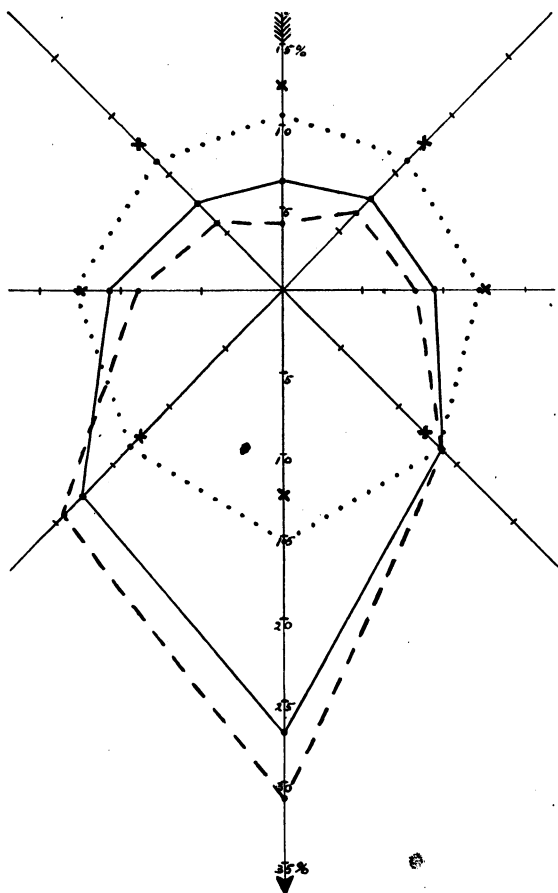
It has been rather widely accepted that insects, when flying, tend to go with the wind. The question is of importance, not only when considering the extension of the range of species but also in such problems as the attendance of insects upon flowers. The question can not, of course, be settled by watching insects whose flight is being directed by odor, since, in that case, the stimulus, odor, is itself being influenced by the air currents.

During the past summer guests at the American Museum's Station for the Study of Insects, particularly Coolidge Alden. Dr. F. W. and Mr. F. M. Brown, Frank B. Lutz and Albert Redmond, helped in the construction and care of an apparatus designed to furnish data on this point. It was an octagonal trap, really a circle of eight traps. An electric light in the middle of the apparatus furnished an equal lure in each individual trap and was uninfluenced by wind. This combination of eight traps was suspended from a horizontally placed wheel having ball-bearings. A wind-vane was so arranged that each trap was always in the same position with reference to the wind: one, up-wind; one down-wind; two cross-wind; and four quartering. The front and back of each trap being made of wire netting, wind blew directly through the apparatus.

In the six weeks between July 18 and August 29 about ten thousand insects were caught. If the wind had had no part in determining the direction of flight or, at least, the alighting from flight, there would have been approximately 12.5% of these 10,000 in each trap. However, 27.0% were in the trap that must have been entered by flying against the wind or, at least, by landing on the lee side of the apparatus, and only 6.6% were in the trap that must have been entered by flying with the wind. Taking into account the quarter-wind traps, the three-eighths of the octagon that faced in the direction toward which the wind was blowing caught 58.4%, while the opposite three-eighths caught only 21.5%. More detailed data are given by the accompanying graph.

Nearly three-fourths of these insects were Diptera and most of the remainder were Lepidoptera. Other orders were too feebly represented

to furnish independently trustworthy statistics. The accompanying table gives the weekly and total distribution among the traps of the two principal orders. See also the graph. The difference between up-wind



A circular graph showing the percentage distribution among the eight traps of the season's total of Lepidoptera (.....), Diptera (---), and of all insects (——). The radiating ordinates are marked in 5% divisions. The 12.5% points (expectation for random distribution) are marked with crosses. One pair of ordinates is drawn as an arrow flying with the wind.

and down-wind is more marked for the Diptera than for the Lepidoptera but even the latter in no week had as many individuals entering the three traps toward which the wind was blowing as would be expected

| | LEPIDOPTERA | | | | | | | | | DIPTERA | | | | | | | | |
|----------------|-------------|------|------|------|------|------|------|------|-----------|---------|------|------|------|------|------|-----|-----|-----------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total No. |
| Trap No. | | | | | | | | | | | | | | | | | | |
| July 18-25 | 12.1 | 10.6 | 12.5 | 14.3 | 13.9 | 14.1 | 11.6 | 11.0 | 1028 | 8.3 | 12.3 | 13.3 | 24.4 | 13.7 | 11.6 | 8.8 | 7.5 | 1888 |
| July 25-Aug. 1 | 12.4 | 15.2 | 14.2 | 19.8 | 6.9 | 9.6 | 11.6 | 10.2 | 303 | 9.0 | 11.5 | 12.5 | 30.1 | 16.0 | 9.5 | 6.5 | 4.8 | 755 |
| Aug. 1-8 | 9.8 | 12.5 | 19.6 | 14.8 | 14.8 | 8.3 | 8.6 | 11.6 | 337 | 13.8 | 12.9 | 22.5 | 17.2 | 10.2 | 7.8 | 8.7 | 6.8 | 835 |
| Aug. 8-15 | 12.4 | 12.9 | 13.4 | 11.3 | 16.1 | 14.0 | 9.7 | 10.2 | 186 | 9.2 | 13.2 | 10.7 | 13.8 | 17.6 | 17.6 | 8.3 | 9.6 | 448 |
| Aug. 15-22 | 9.8 | 11.3 | 9.8 | 14.4 | 15.5 | 17.0 | 12.9 | 9.3 | 194 | 7.6 | 8.5 | 10.3 | 26.7 | 22.3 | 10.6 | 6.4 | 7.6 | 816 |
| Aug. 22-29 | 4.3 | 17.0 | 14.2 | 18.4 | 13.5 | 14.2 | 9.2 | 9.2 | 141 | 1.5 | 1.9 | 13.9 | 45.0 | 26.8 | 8.0 | 1.8 | 1.1 | 2622 |
| Total | 11.1 | 12.2 | 13.8 | 15.2 | 13.4 | 12.8 | 10.9 | 10.6 | 2189 | 6.5 | 8.2 | 14.0 | 31.1 | 19.4 | 9.9 | 5.7 | 5.0 | 7364 |

Table showing the total numbers of Lepidoptera and Diptera caught in the eight light-traps and the percentages in each trap. Traps 2 and 6 were cross-wind; trap 4 was on the lee side of the apparatus and was entered by going against the wind which blew through the netting; trap 8 received the insects which came directly with the wind; the others were quartering the wind in the order indicated.

from random distribution—to say nothing of the expectation if they tended to fly with the wind—and each week more entered the apparatus by flying against the wind than would be expected from random distribution.

So far as we could determine, there was no other factor than wind to account for these results. The traps were each of the same size (about a foot square in front) and shape; the light was equally strong in each; and, while there were trees and a building near the apparatus, the wind probably shifted enough to equalize these conditions. Of course, there is no proof that the insects were not flying about in a random fashion and merely entered the lee side of the apparatus because it was the easiest side on which to make a landing¹ but there is equally no evidence to the contrary.

Many observations indicate that insects are blown long distances by wind but, even so, it may be that they are flying against the wind at the same time and are making a negative progress in the direction of their flight. At any rate, the present evidence is that at least night-flying Diptera and Lepidoptera tend to stop their flight on the lee side of a light and it somewhat favors the notion that, in general, they tend to fly against the wind.

¹This idea was emphasized in connection with flower-visiting insects (Lutz, 1924. *Annals N. Y. Acad. Sci.*, XXIX): "Not only do most insects come up-wind to flowers, but when they come down-wind they usually pass the flower, hover a bit, then turn and come up-wind to it. . . . As to those individuals that pass a flower and then turn to make a landing, they may have been doing just that. In other words, it is doubtless easier for any flying creature or flying machine to land up-wind than down-wind." Fritz Knoll's comment (1926, *Abhand. Zool.-Botan. Gesellschaft Wien*, XII, p. 575) on the passage is: "Da diese Verallgemeinerung bestimmter Einzelfälle nach meinen Erfahrungen nicht berechtigt ist, haben die von Lutz daraus gezogenen Schlüsse keinen Wert."