The results shown by this brief study would indicate that strontium chloride sprays have a definite value for peach leaves under certain conditions. Leaves benefited showed a definite pattern of chlorosis and a relatively small amount of strontium in the ash. It is believed that new growth stimulated by sodium nitrate application forced a deficiency which otherwise might not have revealed itself.

The response of plants to strontium has been reported by several authors (*2–4*). It has been indicated that in some of this response strontium took the place of calcium when the latter element was present in short supply. In the particular peach orchard where we obtained response to a strontium chloride spray, the calcium as measured by rapid soil tests (*1*) was 450 lbs/2,000,000 lbs of soil, or a comparatively poor test for calcium. It is of interest to note that the ash of normal leaves contained 0.9% calcium, whereas that of chlorotic leaves contained 0.04%, or about 1/20 as much. It is possible that here, too, strontium was replacing calcium, although calicum in the nutrient spray and 450 lbs soluble calcium in the soil failed to bring about normal growth.

The failure of calcium in both the spray and the soil to correct the condition noted raises the question as to whether strontium has specific value to the plant. If it does, is it then possible that we are adding large quantities of calcium in the form of lime, etc., in order to supply a small amount of strontium as well as calcium and to influence pH? Spectographic analyses of limes and gypsum have revealed the presence of strontium as an impurity. These analyses indicate that it is possible to add significant quantities of strontium to the soil by large applications of lime or gypsum. (For example, a ton application can easily supply about 2 lbs of strontium.)

These facts may help to explain why large quantities of calcium in the soil are usually associated with higher yields. Best yields are associated with calcium in amounts of several thousand pounds per acre, and yet most crops remove less than 50 lbs calcium/acre. The value of calcium in the form of gypsum or lime as soil conditioners is not lost sight of. However, it would be of interest to determine whether the extra value of calcium is due in part to the strontium carried as an impurity.

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Comments and Communications

The Role of Vision in the Alighting of Birds

ALIGHTING is a critical point in the flight of birds. Only precise control can prevent destruction when a body designed for swift travel in a gaseous medium is brought into contact with solid earth, and both birds and aircraft approach a landing point into the wind to decrease landing speed. But, whereas conventional airplanes need to make landing runs at relatively high speed, the mobile wings of birds actually permit alighting motions functionally equivalent to those of a helicopter's rotors. In fact, the landing speed of a bird *must* be low, because it has no wheels to roll on and take up the alighting impact on a shock-absorbing landing gear.

This paper concerns the means of determining wind direction that may be available to an alighting bird. Whenever the wind approaches 10 mi/hr, birds turn into the wind at the moment of contact with the earth. Do they do so visually (a pilot without special instruments observes a wind sock at the airport), or do they feel the wind on their feathers or on their very large eardrums?

Here it must be pointed out that a bird aloft is part of the airstream, a fact missed by the writer in a recent paper(*1*). It feels no wind, whether it is in a hurricane or a light breeze. Aircraft navigation proves that ground speed is obtained from air speed by simply adding or subtracting the wind vector. A bird flying at an air speed of 30 mi/hr, with a 20-mi tail wind, is making a ground speed of 50 mi/hr—with a 20-mi head wind, 10 mi/hr. There is a theoretical weakness, therefore, in the idea that flying birds "feel" the wind, so it was decided to test the role of vision in alighting. If wind direction were determined visually, birds would have no way of knowing on a dark night if they are flying 50 mi/hr or 10 mi/hr, yet this would be very important in alighting. In the former case, when the bird had reduced its air speed to zero, it would still have a ground speed of 20 mi/hr from the tail wind, and it might be killed.

In an effort to solve this problem, 21 birds were flown blindfolded: 16 pigeons (*Columba livia*), 3 English sparrows (*Passer domesticus*), and 2 juncos (*Junco hyemalis*). The most effective blindfold was a narrow sleeve of thin black rubber, drawn over the head. A long, light cord was tied to one leg to prevent an occasional individual from flying off. The birds were flown in unfamiliar surroundings on dull days and were hand-released at heights of 6′ or so. Three pigeons and 2 English sparrows flew straight up and attempted to escape blindfolded, but tired of this shortly and fluttered to the ground like the rest. The wind exceeded 5 mi/hr but was probably not much more than 10 mi/hr. Each individual was released repeatedly from all four quarters of the compass until a consistent behavior pattern for that individual seemed evident.

Upon release no birds consistently altered course to alight either with or against the wind. Several regularly hovered instead of alighting immediately, and these, as well as several others, spiraled in the air before alighting, not generally changing direction more than 180°. Different individuals consistently spiral either clockwise or counterclockwise, without respect to wind direction, and this is interpreted as normal spiral movement, characteristic of free-moving organisms (*2*). A bird released into the wind and rotating 180° would cover about 25′ before alighting, because of the tail wind most of the way, and would come in contact with the earth with too much velocity (perhaps 15 mi/hr). The same individual, released with the wind and spiraling about 180° into the wind, would make a short, hovering flight of about 5′, alighting at near zero velocity. Generally, the birds simply fluttered to the ground in the direction released, regardless of wind direction. They obviously did not know how near to the ground they were at the instant of impact, and sprawled with wings and tail outspread.

The eardrum, only thinly screened by the auricular feathers, and with an area in small birds up to 10 times the relative area in man, may probably be eliminated from any role in detecting wind direction. The sparrows, juncos, and 3 pigeons were flown with auricular feathers removed, and no change in behavior was noted whether the ear was covered by the blindfold rubber or not.

These experiments should be repeated by investigators with larger numbers of species and individuals available. Interpretation of this kind of behavior is somewhat subjective, and a larger number of trials might result in different conclusions.

However, our results indicate that birds alight by visual cues. They normally turn to alight into the wind whenever it reaches velocities approaching 10 mi/hr. It is also known that, although birds hold their heads in a characteristic position of rest in arising and maneuvering, they turn them intently downward upon alighting. I believe they are observing the let-down point, in most cases binocularly. If they sense that their speed is too high, they know the wind is behind them and make a sharp turn of 90° to 180°, alighting the instant the wind cancels forward movement. If the wind is less than 5 mi/hr, they pay no evident attention to it, alighting indiscriminately from any direction.

The importance of vision in the alighting of birds may explain migration catastrophes like the one that occurred on the night of March 13–14, 1904, when millions of migrating Lapland longspurs encountered a cold front with heavy snow and were killed in violent collision with the earth. Most small birds migrate at night, feeding and resting by day; a migratory flight launched on a dark night may actually be unable to land safely until daylight. In fact, the well-known visual acuity of birds is largely due to the great cone-density of the retina, which is generally so poor in rods as to be inferior even to the human retina for night vision.[1]

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[1] For help in obtaining and flying birds I am indebted to R. Marlin Perkins, J. Lear Grimmer, Robert Smolker, and Karl Bartel.

Insect Resistance to Insecticides

THE problem of the development of resistance to insecticides among insects is becoming increasingly important. In laboratory studies and observations on the development of such resistance, advantage is taken of the dosage response, and it is generally assumed that individuals surviving high dosages of toxicants are inherently resistant. If chemically selected individuals are bred generation after generation, a resistant strain should be developed. This has indeed been demonstrated in some instances, but not in others. The development of resistance by physiologic mutation is a very real possibility, but it has not been possible to distinguish positively between mutation and selection of an existing natural resistance, as has been done with bacteria.

Some toxicologic data being prepared for publication elsewhere could not be explained satisfactorily on the basis of the variation expressed by the slope of the dosage-response curve. This variation relates directly to the standard deviation and can be viewed as the range of individual responses about the mean of the test group. In addition, there appear to be types of variation, not expressed by the dosage-response curve, which have been largely neglected in selecting for resistance, and which may be far more critical in the understanding of how resistance is developed.

One type of variation is that of the individual insect. The belief that an individual maintains a static position in the population of which it is a member, and hence that those individuals surviving chemical treatment are genotypically resistant, is probably without foundation. There is no way of knowing, of course, how all individuals would respond to a second administration of the toxicant when death is the criterion of response. If recovery time following the administration of a stupefacient (carbon dioxide, nicotine, cyanide) is used as a measure of susceptibility, it is found that a dynamic variation exists among the insects tested (*Galleria* larvae, *Oncopeltus* adults, *Habrobracon* adults). An individual recovering rapidly from one exposure may be slow to recover from the next, and vice versa. If a series of tests is made, each individual responds by recovering in times