# ADDITIONAL EXPERIMENTS ON THE HOMING OF CARPENTER- AND MINING-BEES

PHIL RAU

*Kirkwood, Missouri*

## MINING BEES

In a paper on the homing of bees (Jour. Comp. Psychol., 1929, ix, 35–70) I have shown that young Anthophora bees become lost, and middle-aged bees find their way home in 49 per cent of the cases. The test for old bees should, theoretically, have given us 100 per cent returns, since they were well acquainted with the neighborhood. Actually, the old bees gave us only 34 per cent returns. I attributed this low per cent of successful returns to the infirmities of old age, and the heavy rains which occurred during the experiments with the old bees; hence I repeated this part of the experiments in 1929, to see if in fair weather, I could get the old bees to return home somewhere near my theoretical 100 per cent.

When I came to the clay bank at Wickes, the same place where the previous experiments had been carried on, I found only twelve mothers of *Anthophora* at work; this small number remaining out of a large population assured me that these were very old bees, the last of a waning population. Of course what is gained in the wisdom of old age may be counterbalanced by senescence. When we wait until we are sure that all the individuals involved have attained old age with all its wisdom, we must realize that the chances are great that some of them will fall dead or become exhausted at any hour.

Two days were spent in the early part of July in liberating and watching for the return of ten individuals of *A. abrupta* and *A. raui*. They were liberated at points 1 and 2 miles south of Wickes, the same stations (Montebello and Kimmswick) as recorded in the publication cited. The results were as follows.

*Two-mile flight.* Five bees were liberated; of these, 4 returned the same day. None returned the next day. Thus 80 per cent returns in four or five hours is very good.

*One-mile flight.* Five bees were liberated, 3 of which returned. Thus more of these fell by the way-side, but 2 of those which finished the trip came in at greater speed ($1\frac{1}{2}$ and $1\frac{3}{4}$ hours), while the third was overtaken by night but came in after six hours flying time.

These numbers are too small to bear analysis, but they indicate a marked improvement over the 34 per cent returns, recorded under conditions of bad weather. This vindicates my theory that 100 per cent of young bees become lost when taken far from home; by middle age 50 per cent of them can find their way back home, and by ripe old age they have the mental ability (if not the physical strength) to find their way home in a proportion approaching 100 per cent.

## CARPENTER BEES

At the time of publication of the homing experiments on the Carpenter bee, it was not known whether the bees hibernated as adults, or emerged into adulthood early in spring. I state (loc. cit., p. 37) "the age of these creatures must have been at least forty days" when the experiments were tried. Subsequent studies on hibernation, when it was possible to rip open the boards to study this problem, have revealed that *Xylocopa* assumes adulthood in August and spends the early autumn in and outside the nest getting acquainted with the environs. Hence, when my experiments were carried on, the carpenter bees were more nearly six months than forty days old. This latter fact is all the more important when one tries to account for the fact that some bees found their way home from a distance of nearly eight miles. My interpretation in the aforementioned paper was that they did so because they had had at least forty days in which to become acquainted with the country. Now with renewed assurance I can say that they were successful because they had had a much greater time in which to acquire their education, August and September, before they went into hibernation, and April and May of the spring before I came upon the scene. Had I carried

on the work with young bees in August or September, they would have become hopelessly lost; I describe elsewhere[1] their stupidity, even in leaving the nest, at that age. So these new discoveries regarding juvenile experiences only add strength to the already stated theory, that age and experience determine their success.

To discover whether one colony will differ from another in homing tests, the following two-mile flight experiment was tried on members of a carpenter-bee colony at the Concord Farmers' Club, about fifteen miles distant from the Wickes colony tested eight years previously.

At Wickes, *Xylocopa* bees were liberated at a distance of two miles south of their nests. The bees, 11 in number, all returned home in from 45 minutes for the fastest flyer to 32½ hours for the slowest one. I suspected that their eminent success was due to the fact that the river and the railroad tracks pointed their way like an arrow. Hence I wondered if the same experiments in another location would yield the same results in percentage of returns, as well as length of time consumed in flight.

A colony of bees was found occupying an old, open-faced wagon-shed belonging to the Concord Farmers' Club, near Kirkwood. This shed was 150 feet long and faced the south; this and the large yellow club building adjacent, both situated in a large farming area, could easily become conspicuous landmarks for bees flying a little above the tree-tops, but they were not near the river or conspicuous roads.

The distance chosen was two miles. The experiments were begun at 10:30 a.m. June 22, and terminated at noon June 23. Twenty bees were liberated, and all but 3 returned before I left the field. Had I been able to remain on watch longer, probably these 3 also would have returned to join the ranks of successful flyers.

The first one to return made the two-mile flight in 28 minutes, and her second trip in 31 minutes. Another bee made the flight in 41 minutes, while a third did it in 43 minutes. These figures are interesting in comparison with the two-mile trip made at

[1] Details in paper soon to appear in Annals Entomological Society of America.

Wickes, experiment II (loc. cit., p. 43), when the shortest time for a two-mile flight was 45 minutes. The 17 bees which returned while I was on watch did so in the following periods, in comparison with the Wickes bees:

| TIME | NUMBER OF BEES THAT RETURNED | |
|---|---|---|
| | Concord | Wickes |
| *hours* | | |
| Less than ½ | 1 | 0 |
| ½–2 | 3 | 3 |
| 2–4 | 5 | 3 |
| 4–6 | 1 | 0 |
| 6–12 | 1 | 0 |
| 12–18 | 1 | 3 |
| 18–24 | 5 | 0 |
| 24–36 | 0 | 2 |

Thus the abilities of the two colonies of bees seem equal and constant, and it appears that there is little difference between the two types of landmarks.

My main object in carrying on the experiments with these bees was to see if, when liberated repeatedly, the factor of profiting by experience would bring them home in progressively shorter time. By always liberating bees at the same point two miles from home, they should eventually learn to make the trip in less and less time.

There were only 5 bees which made two or three two-mile trips during the time at my disposal. Their time in hours and minutes is recorded below. An absence of more than twelve hours means that they remained out over night; hence a deduction of 11 or 12 hours, their usual sleeping time, should be made for each night, to learn their time in action.

| W.* | B. | Y. | G. | R. |
|---|---|---|---|---|
| :28 | 5:30 | 2:32 | 6:20 | 19:33 |
| :31 | 19:56 | 5:28 | 1:26 | 1:21 |
| 2:18 | | 13:20 | | |

* Refers to color mark borne by each bee, W. = white, B. = blue, etc.

Improvement and regression are about equal, so we can make no deductions from these few results. After a week's rest, the best flyer, W., was given the opportunity to repeat the same two-mile flight to her nest. This time she made the trip in 3:06, a little more than her former time. On the other hand, G., which had previously made the trip in 16:07 (about five hours flying time) made it now in 1:28.

Thus it appears that these bees are making flights in as good time, on an average, as they are capable. Of course it is hard to single out one factor, such as their intellectual ability, in such tests as these, because it cannot be separated from other conditions. We are already convinced that age and education affect the accomplishments of these bees, but we have not been able to measure fatigue; neither have we been able to command the bees to give entire attention to our tests when they are out of our sight. I feel sure that fatigue modified the results in some cases, because some of the bees which did come in collapsed and died soon after their arrival. Moreover, recent studies in the metabolism of bees have revealed that bees in action live only a few hours without food; hence if they do not arrive home within that limited time, they must either collapse or turn aside for foraging, however well their intellectual faculties may be functioning in bringing them home. It seems logical to assume that these delays for nourishment or from fatigue would figure more in the second or third successive flight than in the first.