EFFECT OF LOW TEMPERATURE NARCOSIS ON HONEY BEE (HYMENOPTERA:APIDAE) FORAGING BEHAVIOR

GENE E. ROBINSON AND P. KIRK VISSCHER
Department of Entomology
Cornell University
Ithaca, NY 14853 USA

Experiments with honey bees (*Apis mellifera* L.) often require that bees be immobilized for marking or other purposes. It is important, in most experiments, that the subsequent behavior and physiology of treated bees not be affected. Two methods frequently chosen to induce narcosis are exposure to carbon dioxide (CO_2) and to low temperatures. Both of these are convenient and non-hazardous to humans, but possible long-term effects on treated bees must be considered. CO_2 treatments longer than 15 sec (30 sec-2 min) impair worker orientation and memory, and decrease sugar syrup hoarding and pollen gathering activity (Beckmann 1974, Ebadi et al. 1980, Mardan and Rinderer 1980). In addition, exposure to CO_2 apparently ages honey bees: hypopharyngeal and wax glands develop abnormally, foraging begins prematurely, and longevity is reduced under both laboratory and field conditions (reviewed in Ebadi et al. 1980).

In the only published evaluations of low temperature narcosis, Mardan and Rinderer (1980) reported that exposing bees to —20°C for 3 min also depressed hoarding activity in the laboratory, but Ebadi et al. (1980) found no effect on orientation, memory, pollen gathering activity, nor on worker longevity under field conditions. This suggests that low temperature narcosis, unlike CO_2 exposure, may not artificially age honey bees, although most behavioral and physiological parameters associated with aging have not been examined.

Our study examines the effect of low temperature narcosis on age-specific orientation and foraging behavior of young honey bees. Our hypothesis was that if chilling prematurely ages bees, then we would expect to see these bees appearing at the colony entrance, taking orientation flights and foraging at an earlier age than unchilled controls.

We collected cohorts of 300 workers which had emerged from frames of capped brood placed in a 34°C incubator 24 h prior to collection. Half of each cohort was divided into groups of 6-10 individuals, confined in a screen cage (6 x 5 x 2.5 cm) and placed in a —20°C freezer for 2 min. Chilled and unchilled bees were individually marked with numbered, colored plastic tags and introduced into an observation colony. A total of 7 cohorts were introduced at 3 day intervals. We recorded the coming and going of marked workers in a 2.5 x 5 x 30 cm transparent entrance tunnel during two 1 h periods each day, beginning 4 days after the introduction of the first cohort and continuing for 15 consecutive days. For each marked bee seen, we calculated the elapsed time between walking outward and walking inward across a line in the middle of the tunnel. We used a dead bee trap (Gary 1960) to collect corpses of marked bees removed from the hives, in order to monitor the number of bees in each age cohort present in the hive during each observation period.

We compared the number of bees in each of the 2 treatments that were out of the hive for less than 2 min, 2 to 5 min, 5 to 10 min and more than

TABLE 1. NUMBER OF TREATED AND CONTROL BEES OF EACH AGE CLASS OBSERVED TO LEAVE HIVE FOR THE SPECIFIED AMOUNT OF TIME.

Flight time	Treatment	Age, days 1-4	5-9	10-14	15-19
0-2 min	Control	2	32	26	10
	Chilled	0	29	31	6
2-5 min	Control	0	15	7	3
	Chilled	2	5	7	1
5-10 min	Control	0	9	3	2
	Chilled	0	10	8	4
>10 min	Control	0	10	9	3
	Chilled	0	12	5	2
Sample size[1]	Control	2975	3482	2406	1269
	Chilled	2758	3119	2198	1225

[1]The sample size for each age and treatment class is the sum over all observation periods of the number of bees in the given class during each observation period.

10 min in each of 4 age categories (Table 1). Most short flights are probably for defecation or orientation, but some of the short times may have been of bees that walked out and back, without taking flight. Flights with a duration of at least 5 min largely represent foraging behavior (Ribbands 1952, Sekiguchi and Sakagami 1966, Winston and Katz 1982).

Table 1 shows that the foraging and orientation behavior of chilled and unchilled bees at all ages is very similar: for no age class is there a significant difference in the frequencies of the classes of flight behavior between different treatments (chi-square test, $p>0.10$). Our results suggest that low temperature narcosis does not affect the ontogeny of foraging behavior. Together with Ebadi et al's (1980) finding that exposure to low temperature had no effect on worker longevity, it is likely that this anesthetization technique does not cause premature aging in worker honey bees. In this respect, chilling is preferable to CO_2 narcosis for temporarily immobilizing bees.

Ebadi et al. (1980) reported that a 3 min exposure at —20°C was required to render foraging-age workers motionless for 30-60 sec, but in preliminary trials we found this treatment fatal to 85% of one-day-old workers. Teneral workers are apparently less cold resistant than old workers. It is advisable, therefore, to determine the minimum exposure time required to narcotize the particular bees employed in any experiment.

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REFERENCES CITED

BECKMANN, H. E. 1974. The damaging effect of supercooling, narcosis and stress on the memory of the honey bee. J. Comp. Physiol. 94: 249-66.

EBADI, R., N. E. GARY, AND K. LORENZEN. 1980. Effects of carbon dioxide

and low temperature narcosis on honey bees, *Apis mellifera*. Environ. Ent. 9: 144-7.
GARY, N. E. 1960. A trap to quantitatively recover dead and abnormal honeybees from the hive. J. Econ. Ent. 53: 782-5.
MARDAN, M., AND T. E. RINDERER. 1980. Effects of carbon dioxide and cold anaesthesia on the hoarding behaviour of the honeybee. J. Apicult. Res. 19: 149-53.
RIBBANDS, C. R. 1952. Division of labour in the honeybee community. Proc. Roy. Soc. London 140: 32-42.
SEKIGUCHI, K., AND S. F. SAKAGAMI. 1966. Structure of foraging population and related problems in the honeybee, with considerations on the division of labor in bee colonies. Hokkaido Natl. Agric. Exp. St. 69: 1-65.
WINSTON, M. L., AND S. J. KATZ. 1982. Foraging differences between cross-fostered honeybee workers (*Apis mellifera*) of European and Africanized races. Behav. Ecol. Sociobiol. 10: 125-9.

THE FLORIDA ATALA BUTTERFLY, *EUMAEUS ATALA FLORIDA* RUEBER (LEPIDOPTERA: LYCAENIDAE), IN DADE COUNTY, FLORIDA

P. J. LANDOLT
Insect Attractants, Behavior, and Basic Biology Research Laboratory, Agricultural Research Service, U. S. Department of Agriculture, Gainesville, FL 32604 USA

Although once abundant in areas of south Florida, the Florida atala butterfly, *Eumaeus atala florida* Rueber, was thought to be extinct (Klots 1951). It was not collected from 1937 (Comstock and Huntington 1943) until 1959 (Rawson 1961) and 1960 (Funk 1966). According to Baggett (1982) it now exists within the state only in a few isolated colonies in Dade County. Lenczewski (1980) reported it as absent from the Everglades National Park, but reestablished on Key Biscayne in 1979/1980. This note summarizes observations of the atala butterfly made from 1982 to mid-1984 in eastern Dade County, Florida.

Adult *E. atala* butterflies were seen on the grounds of the USDA Subtropical Horticulture Research Station, near Miami, Florida, during every month from August 1982 until March 1984. Total numbers sighted were as high as 75 on 24 January 1983 and 73 on 19 September 1983. Most were on flowers of *Bidens alba* De Candolle (Spanish needle) but others were observed on flowers of *Rhus copallina* L. (sumac), *Lantana* sp., *Persea americana* Miller (avocado), *Eupatorium odoratum* L., and *Dombeya* sp. Adults also were found by H. Von Wald (personal communication) on flowers of whitewood, *Schoepfia scheberi* Gmelin, in the Redlands area of Dade County, and by Campbell and Campbell (1983) on flowers of *Cordia globosa* Jaqs. near Homestead. Larvae and pupae of *E. atala* were found on *Zamia pumila* L. (*Z. integrifolia*) plants at the station. Two larvae, 2 pupae and 1 empty pupal case were found on *Z. pumila* plants on 4 January 1983. The pupae were suspended from frond midribs. One larva was found on 1 July 1983 and 17 on 30 September 1983. Two larvae collected