Monitoring Foraging Range of *Apis mellifera* in the Central District of Tokyo through Dance Communication

Naoko Ichikawa, Masami Sasaki* and Hiromichi Obata***
*Lab. of Entomology, Dept. of Agriculture, Tamagawa University, Machida, Tokyo, Japan,
**Mishima Food Technology Co., Shinano Machi, Shinjuku, Japan

In the centre of downtown Tokyo there is an apiary. It is only a few kilometres away from Shinjuku business district, one of the busiest areas of the city. However, the apiary produces as much as 1000 kg of honey each year from every 20 *A. mellifera* colonies. We tried to make clear the background of such high yield in the central district of Tokyo, Shinjuku, focusing on the following points.

- How far do bees forage?
- From which plants do they gather food?
- How do they adapt to the urban environment?

The results were compared with the similar research made on Tamagawa University Campus, which is located in a suburban housing area of Tokyo, relatively rich in green vegetation (Sasaki et al. 1993).

Materials and Methods

A glass-walled observation hive was set up in a house adjoining the Shinjuku apiary for one year (August 1995 to August 1996). Foraging sites of the colony in the observation hive were inferred and plotted on a map by reading the recruitment dances made. The angle between the direction of tail-waggling run and that of gravity, and the

Proboscis extension reflex (PER) for bee odour and non-volatile surface wax components: analysis of nestmate discrimination

M. Sasaki*,**, M. Fujiwara* and Y. Numaguchi*
**Laboratory of Entomology, Department of Agriculture, Tamagawa University, Tokyo, Japan*
***Brain Science Research Centre, Tamagawa University, Tokyo, Japan*

Memory/learning are extensively involved in honeybee social life. PER was adopted to analyse 'nest-mate discrimination' as an important function of the colony system. 1.5M sucrose solution was used as reward (positive unconditioned stimulus: US+) and 2M NaCl solution as punishment (US−) to let the bees discriminate odour or non-volatile surface was (conditioned stimulus). As conditioned stimuli, substrances washed out from workers of *Apis mellifera* (CS+) and *A. cerana japonica* (CS−) were used. Workers of *A. mellifera* could read, memorise, and discriminate odours of self-synthesised and environmental origin, both of which are absorbed temporarily on to body surface and dispersed spontaneously. Bees could also discriminate non-volatile (treated under *vacuo*) crude wax compounds of *A. mellifera* and *A. cerana japonica*. In these wax components, acidic fraction contaning free fatty acids was more readily memorised than hydrocarbon and neutral-alkaline fraction.

duration of waggle run were evaluated to estimate the location of the foraging site. An equation for Japanese *A. mellifera* calculated in a previous study was used for converting duration to distance (Sasaki *et al.* 1993).

Results

The average distance to foraging sites was 0.9 km. The most frequent distance plotted by reading the dances of the foragers was within 100 m. In comparison, the average foraging distance of a colony on Tamagawa University Campus was estimated at 2.1 km.

The foraging sites of the Shinjuku colony changed from season to season. Workers expanded their foraging range up to 2 km in September when flowers are scarce. However, they foraged within 0.8 km in October and November when various autumn flowers bloom. The same is the case in spring. When cherry blossoms come out in abundance in April, they foraged within 0.3 km. Thus, their foraging activity changed according to blooming season of the forage sources.

On Tamagawa campus, on the contrary, the average foraging distance increased to 2.5 km in April and May, and to 2.6 km in the blooming season of November. The foraging range in the central city of Tokyo is significantly narrower than that of the suburbs.

Bees forage towards promising sites. Most of the flights (47 %) were made between north and east of the apiary where there are some old residential quarters left among the busy streets and tall buildings. In the limited space, people grow flowers and flowering trees around their houses. Although large natural green area is scarce in the central city, honeybees bring their locating ability into full play to concentrate their foraging activities on good sources.

Discussion

What are possible reasons that allow an urban environment to have high honey productivity?

Rich food sources

The shorter foraging range raises the colony's foraging efficiency. For example, it is known that honeybees forage only several hundred metres in a food-rich environment, while where resources are poor, they fly as far as 14 km. It is true that foraging resources in Shinjuku is quite limited and patchy, but the bees' foraging range turned out to be narrower than that in Tamagawa. The suburban Tamagawa University Campus has more green vegetation, but the food sources that are favoured by honeybees are not always rich there. In short, more profitable food sources could be found and exploited in a closer range in the urban city than in the suburbs throughout a year.

Competition for flower resources

Poor pollinator fauna such as other bees, syrphid, flies, butterflies and beetles probably result in the lower competition for nectar and pollen sources in the city. Also in Tamagawa Campus, a large number of hives (ca. 100 colonies) might also increase competition between honeybees, in addition to other pollinators. These competitors will lower the colony's foraging efficiency and force them to forage to distant flowers.

Adaptation to spacio-temporally scattered resources

It is generally believed that honeybees, especially temperate *A. mellifera*, prefer large patches of flowers such as a plantation. However, the results from a survey of foraging sites suggest that the colony in the city efficiently utilised the highly scattered patches of flowers of street trees, parks, schools and small flower pots planted by residents. These flower sources are scattered both spatially and temporally (seasonally).

On the basis of the present results, we confirmed an advantage of scattered apiary allocation to secure efficient honey production.

Reference

Sasaki, M., Takahashi, H., and Sato, Y. 1993. Comparison of the dance dialect and foraging range between *Apis mellifera* and northern most subspecies of *A. cerana* in Japan. *Honeybee Science*, **14**(2): 49–54.