SHORT COMMUNICATION

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Debris removal by head-pushing in *A. florea* Fabr. honeybees

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Abstract The nest of the dwarf honeybee *A. florea* Fabr. consists of a single comb attached to a tree branch. Recruitment dances take place on the upper surface of the comb that must therefore be kept clear of debris. We report here, for the first time, a behaviour that serves for removing leaves and other foreign objects from the surface of the comb. Individual workers crawl under the object and lift it with their heads, pushing it towards the rim where it eventually slides off the comb. Objects that are heavier or fixed at one end such as leaves are nevertheless lifted and kept away from the surface for up to several minutes. This “head-pushing” is frequently performed without the aid of mandibles, and individuals performing it maintain a distinctive posture, holding the forelegs at an angle without touching the object. Repeated involvement of particular individuals indicate that head-pushers might form a distinct task group.

The Asian dwarf honeybee *Apis florea* Fabr. is an open nesting species which constructs a single comb usually hanging from the branch of a tree or bush. Unlike the nests of cavity-dwelling honeybees, the colony is thus directly exposed to the environment and to predators. Considering the high energy investment that goes into the construction of the wax comb, the production of

brood and the storage of honey and pollen, it is therefore not surprising that *A. florea* exhibits a number of specialized behavioural adaptations evolved in response to environmental stress and high risk of predation. Workers of *A. florea*, for example, arrange themselves over the surface of the comb in a roof-tile fashion to shelter it from the rain and fan the surface to protect it from overheating (Dyer and Seeley 1991; Lindauer 1956). Vigorous sideward body shaking, performed in concert by groups of workers, discourages other species of insects from landing on the comb (Koeniger and Fuchs 1975; Seeley et al. 1982). Mammals and birds may be threatened by stinging or warned away by the production of hissing noises (Koeniger and Fuchs 1973; Seeley et al. 1982).

A. florea colonies are threatened not only by the weather and predators but also by less obvious disturbances: impediments to free movement on the comb surface can come in the form of leaves or twigs that drop on or touch the comb. Accumulation of debris could be a serious problem especially on the flat top of the comb which serves as the dance floor. If not removed, such objects would form barriers in the path of the dancers and the followers. Twigs or leaves from the surrounding branches might come so close to the comb that they could be used as transient bridges by ants to bypass the protective bands of propolis that the bees construct round the supporting branch (Lindauer 1956; Seeley et al. 1982).

We have observed a distinct behaviour pattern in workers of *A. florea*, employed both to remove accumulated debris from the comb and to break contact between the comb and objects which come to lie against it to form bridges. Quite simply, workers bring their heads underneath the objects and push it upwards. Such head-pushing is applied not only against natural debris such as leaves and twigs touching the nest surface, but can be readily elicited by experimentally placing objects of any kind on the nest.

The head-pushing behavior is accompanied by a pronounced elevation of the anterior end of the body.

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Fig. 1 Three *A. florea* workers press their heads against a leaf to hold it away from the nest surface. (Photo by S. Fuchs)

Should a leaf sink down onto the nest, one or several workers raise the leaf on their heads and hold it away from the nest by adopting a curious stance in which the first pair of legs no longer touch the substrate, but are held stretched out to the side (Cover and Fig. 1), occasionally touching the object. Workers can maintain this body position over a considerable timespan. The end of a wooden strip of $90 \times 15 \times 2$ mm, leaning against the comb and pressing down on it with a mass 0.9 g, was elevated about 5 mm above the upper comb surface by two workers for 9 min, and then by one for another 3 min. In nine individuals observed to head-push a paper strip (4–6 mm wide, 19 mm long) the median duration of 29 head-pushing bouts was 4 min (mean 12.2, range 1–40). An example of head-pushing in natural conditions was observed in a colony on a mango tree branch with a large leaf from the branch pressing down on the side of the comb. Over a period of 12 days we frequently observed the leaf being lifted away from the comb by bees head-pushing; however, there were prolonged intervals when no bee was holding up the leaf.

The same basic pattern of head-pushing is seen when loose debris drops onto the nest. Workers slide under the object, push their head against it and lift it up, directing their effort so that the object is tilted to-

wards the rim of the comb. Repeating this process and allowing the object to fall results in its movement towards the rim of the comb from which it finally slips off. This process is shown in a sequence taken from a video in Fig. 2, where a 10×15 mm plastic tag was placed on the top of the comb, and which the bees subsequently removed. The mandibles usually remain closed during head-pushing, but occasionally the bees also grasp the object at the edges with their mandibles. In one case from more than 30 observations we saw a very lightweight 10×10 mm piece of paper being carried off in the mandibles of a worker, and then only after it had initially been moved by head-pushing.

Debris removal by head-pushing is rapid and can be completed within seconds. It is particularly fast if an object falls on the bodies of the bees without getting down to the comb surface, slipping down within a few seconds as if shrugged off by the movements of the worker bodies beneath it. A small flat plastic tag as in Fig. 2 was removed on average within 8.7 s ($n=5$). Heavier objects take longer to move. A coin weighing 3.7 g took the bees 12 min to remove. One weighing 7.9 g was not moved at all after 20 min.

Some workers appeared to be particularly eager and persistent head-pushers, and each leaf lifting and object removal that we saw was performed by one or only few individual bees. In two recorded series, the removal of a plastic tag from the comb surface was due almost entirely to the efforts of a single individual.

In an experiment in which a transient bridge to the comb was constructed from a 19×4 mm strip of paper attached to a meter scale, 166 head-pushers were marked over a period of 7 days. Although marked individuals comprised a minor proportion of the bees on the top of the comb, 36.5% (19 of 52) of the head-pushers observed on the 8th day were from the marked group and performed 43.5% of the head-pushing during the 3 h of observations. One individually marked bee was observed to head-push a paper strip (19×4 mm and weighing 4 mg) for a total of 107 min in 1 day (observations of 3 h) and 39 min the following day, distributed into 12 bouts of head-pushing (min. duration 1 min, max. duration 40 min), interrupted by pauses of similar duration. Head-pushing behavior

Fig. 2 Removal of debris from the top of an *A. florea* nest. A worker lifts a small plastic tag by pressing from underneath with the head and the closed mandibles. Repeatedly, the tag falls back flat on the surface and is again lifted, but successively moved towards the rim of the comb where it eventually falls off (last picture). To keep track of the movement, the picture frame is shifted to the left by 15 mm at the start of the 2nd row

could be a distinct behavioural task for workers in *A. florea* bee colonies comparable to the nest cleaning behavior in *A. mellifera* (Visscher 1983).

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