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Ants trapped for years in an old bunker; survival by cannibalism and eventual escape

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Abstract

Successful evacuation of a peculiar 'colony' of the wood ant *Formica polyctena* Först., for years trapped within an old bunker previously used for storing nuclear weapons (see Czechowski et al. 2016), is reported. Using an experimentally installed boardwalk, the imprisoned ants managed to get through the ventilation pipe to their maternal nest on the top of the bunker. In our previous report, we left open the question of how the 'colony' could survive seemingly without food. Here we show that the 'colony' in the bunker survived and grew thanks to an influx of workers from the source nest above the bunker and mass consumption of corpses of the imprisoned nestmates.

Keywords

Adaptability, *Formica polyctena*, marginal habitats, scarce food resources, wood ants

Introduction

In a recent paper (Czechowski et al. 2016), we described a unique accumulation of workers (for convenience called a 'colony') of the wood ant *Formica polyctena* Först., trapped within an old bunker in western Poland, used in the Soviet time for storing

nuclear weapons. The source of this 'colony' was a large colony nesting outdoors, on top of the bunker. The nest was located on the outlet of the bunker's ventilation pipe. Ants which had dropped through the pipe to the bunker were not able to reach the outlet, located in the ceiling, to return to the mother nest. The size of the bunker 'colony' of *F. polyctena*, known since 2013, has been estimated at close to a million, and the contents of 'cemeteries' at ca. two million corpses. Neither before (Czechowski et al. 2016), nor in the time considered here were queens or offspring seen in the bunker, not even empty cocoons – only workers were present.

After our previous study (Czechowski et al. 2016), we started to contemplate on possible means to help the imprisoned ants to find their way out of the bunker. In practice, the only way to free the ants from the bunker would be to enable their spontaneous return migration to the maternal nest through the ventilation pipe – assuming that the rusty pipe interior is coarse enough for that (see fig. 5 in Czechowski et al. 2016). We were helped by a serendipitous observation: we noticed that a piece of board accidentally leaning against the wall became a starting point of an ant route leading up along the wall (Fig. 1), ending just under the ceiling where the ants dispersed, not reaching the pipe outlet (Fig. 2). Thus it might suffice to provide the ants with direct access to the outlet.

Our previous study also left open, how the bunker colony could survive and grow without access to foraging grounds. One evident means could be cannibalism. It is known that wood ants consume dead bodies of their conspecifics left in masses on the ground during spectacular 'ant wars' early in the season. The function of such wars is to settle the borders of neighbouring conspecific colonies, but the corpses also add substantially to the scarce food resources available when the colony lives commence after winter (Mabelis 1979).

Here we report our successful trial to re-connect the imprisoned ants with their maternal colony. We also studied possible consumption by the bunker ants of their dead nestmates which seemed to be the only food resource available to keep the 'colony' alive such that it could grow through the years.

Methods

As a first step in freeing the captive ants, in spring 2016, we took a group of ca 100 ants from the bunker and let them free on the outskirts of the mother nest, to check relations between the two partly isolated entities. As expected, no aggressive behaviour was observed. Subsequently, on 18th September 2016, we constructed a ca 3-metre long vertical boardwalk with one end burrowed in the earthen mound of the bunker colony and the other one tucked inside the ventilation pipe (Fig. 3). It was meant to serve as an escape route, allowing the ants to leave the bunker. At that time, the mound in the bunker was fully inhabited by ant workers (Fig. 4) – as in previous years (see figs 2 and 6 in Czechowski et al. (2016).

To study possible cannibalism as a means of survival in the resource-scarce bunker, we collected corpses of *F. polyctena* from waste piles ('cemeteries') in the bunker,

Figure 1. A piece of board leaning against the wall initiated an ant trail leading upwards. Photo taken on 18.09.2016 (Wojciech Stephan).

Figure 2. The upper part of the ant trail in Fig.1; the ants (on the left) were unable to move along the ceiling and thus could not reach the outlet of the ventilation pipe. Photo taken on 18.09.2016 (Wojciech Stephan).

to be analysed in the laboratory for signs of cannibalism. More than 150 workers were investigated carefully under a binocular (Olympus DF Planapo IX SzH 10, using a magnification of 10×). By identifying the presence of a gnawed hole (mostly on the abdomen) and signs of biting we could recognise a corpse as consumed. Only corpses with abdomen, or detached abdomens, were counted, to avoid recording the same corpses twice. If a corpse was highly destroyed or broken into very small pieces, it was not considered.

Results

Soon after the boardwalk had been installed, single ants started to inspect it. The next opportunity to check the situation of *F. polyctena* in the underground arose when bats overwintering in the bunkers were counted. On 11th February 2017, the mound was almost deserted, only a few ants being present close to the base of the boardwalk (Fig. 5); no live ants were seen elsewhere in the bunker chamber. To compare the situation with that in the former winter, when the bunker mound and the whole chamber was filled with ants, see figs 2 and 7 in Czechowski et al. (2016).

Of the corpses collected from 'cemeteries', a vast majority (93%) bore traces of bites, and also fret holes were seen on their abdomens – typical signs left when the contents have been consumed.

Figure 3. The boardwalk just assembled, to provide the ants a means to reach the ventilation pipe. Photo taken on 18.09.2016 (Wojciech Stephan).

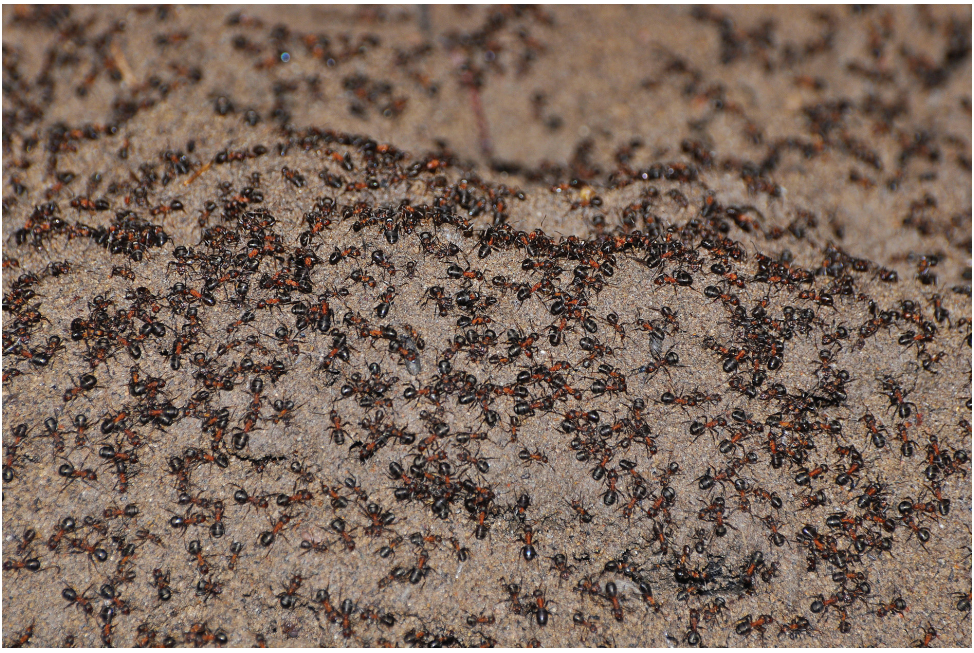

Figure 4. On the earth mound in the bunker, the density of ants was high on the day when the boardwalk was put. Photo taken on 18.09.2016 (Wojciech Stephan).

Figure 5. The earth mound, almost deserted by the ants, at the bottom of the bunker in winter, four months after setting the boardwalk. 'Ant cemeteries' are visible around the mound and next to the walls. Photo taken on 11.02.2017 (Wojciech Stephan).

Discussion

The most interesting lesson taught by the *F. polyctena* 'colony' studied here is, how monumental potential wood ants have to maintain self-organisation even under conditions going far beyond the limits of the survival of the species (for details see Czechowski et al. 2016). More generally, the present case adds a dimension to the great adaptive ability of ants to marginal habitats and suboptimal conditions, as the key to understanding their unquestionable eco-evolutionary success (see Hölldobler and Wilson 1990).

A pivotal question, considered in this report, is what the ants in the bunker ate to survive, as the only possible food source that seemed to occur there in a sufficient amount (not counting occasional dead mice or bats) consisted of corpses of dead nestmates. Cannibalism may serve as a means of survival when other food is scarce. Despite being widely documented in the animal kingdom, cannibalism is relatively poorly known in social insects (Lopez-Riquelme and Fanjul-Moles 2013; Sun and Zhou 2013). In termites, besides corpse burial, cannibalism is one of the most important ways of corpse disposal (Lopez-Riquelme and Fanjul-Moles 2013; Sun and Zhou 2013) – in this way the consumer also benefits from important protein and nitrogen of the corpses consumed (Chouvenc and Su 2012; Sun et al. 2017). Among ants, wood ants are notoriously well known of their 'ant wars'; e.g. in *F. polyctena*, intraspecific territorial fights often occur in early spring when protein food is scarce and fresh corpses resulting from the conflicts are dragged in large numbers into the nests, to feed the developing offspring (De Bruyn and Mabelis 1972; Mabelis 1979; Driessen et al. 1984). Recent research has also shown that corpse consumption in *F. polyctena* is more common than it was previously thought, and nestmate corpses can serve as an important food source not only in periods of food shortage (Maák et al., in press). In the light of the above, and the clear signs of mass consumption of the *F. polyctena* corpses in the bunker with practically no other organisms able to do it (see Czechowski et al. 2016), we can safely deduce that the bunker 'colony' survived on cannibalism, by consuming dead nestmates.

Summing up, the ecological and behavioural flexibility of the wood ants (Seifert 2018) may allow them survival even in unexpectedly suboptimal conditions (e.g. Czechowski and Vepsäläinen 2009). The survival and growth of the bunker 'colony' through the years, without producing own offspring, was possible owing to continuous supply of new workers from the upper nest (Czechowski et al. 2016) and accumulation of nestmate corpses. The corpses served as an inexhaustible source of food which substantially allowed survival of the ants trapped down in otherwise extremely unfavourable conditions.

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