

Monitoring of Beetles Associated with Fungi Using Kaila Traps

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Received May 19, 2011

Abstract—In the present work, we tested the possibilities of using modified window-flight Kaila traps for studying insects associated with fungi. Criteria allowing us to reveal the character of association between an insect and fungus have been developed. We analyzed the association between Staphylinidae and a species of polypore fungi. We assessed the suitability of Kaila traps for studying beetles associated with fungi, as well as their selectivity; we give recommendations on their use.

Keywords: monitoring, insects associated with fungi, polypores, ecology, Staphylinidae.

DOI: 10.3103/S0096392511040043

INTRODUCTION

Important components of forest ecosystems are Coleoptera associated with fungi. A special place among them is occupied by Staphylinidae beetles associated with polypore fungi, facilitating their dispersion and decomposition. Besides, they can serve as indicators of biodiversity of forest ecosystems subject to anthropogenic pressure [1].

There are different methods of studying insects associated with fungi. One of them is rearing insects developing in polypore sporocarps. This method takes into account species whose development takes place within a sporocarp. However it leaves out insects that are associated with fungi only trophically or topically and whose development takes place outside. Another method is collecting polypore sporocarps and extracting insects from them directly. The drawback of this method is that sporocarps get destroyed, thus preventing one from conducting long-term studies of insect population dynamics. For long-term monitoring of fungi-associated insects, window-flight traps are used [2–4]. Kaila trap is a modification of such traps [5] that allows one the possibility to perform research on the same specimens of polypores during a number of years [6]. However, these traps have not yet found widespread application in entomological studies. That is why the aim of our work was to study the suitability of Kaila traps for monitoring of beetles associated with fungi.

We used artist's bracket *Ganoderma applanatum* (Pers.) Pat. (*G. lipsiense* (Batsch) G.F. Atk.) as a model object. This is a perennial fungus with cosmopolitan distribution. For a model group of beetles associated with fungi we chose the Staphylinidae family. Eighteen

staphylinid species were known before to be associated with *G. applanatum* [7–9].

MATERIAL AND METHODS

The research was conducted in 2005–2007 in the arboretum of the Botanical Garden of Moscow State University and in a mixed spruce-broadleaf forest in the vicinity of Zvenigorod biological research station of Moscow State University.

In each research location, five Kaila traps were set. Each trap was a transparent plastic sheet permeable for UV rays (1.5 × 200 × 300 mm) affixed vertically to the fungus sporocarp. A funnel with upper and lower cuffs was placed under the plastic sheet. Three-millimeter iron wire was put through the funnel's cuffs. A plastic jar with a screw top with a hole in it was attached to the lower cuff. The lower part of the funnel was put through this hole. There were perforations in the upper part of the jar for removing the excess of preserving agent (20% solution of NaCl). A drop of liquid detergent (Fairy Antibacterial) was added to the agent to decrease surface tension. Insect collection and preserving agent change were conducted once every fortnight from early April to late October in 2005 and 2006. Insects were extracted from traps using Vlieseline filters and then stored in a freezing chamber.

Selectivity of Kaila traps in relation to insects associated with fungi was assessed in the control experiment, where two traps were set in the Botanical Garden of Moscow State University in conditions as similar as possible, but one on a sporocarp of an artist's bracket and the other on a bole of a tree free of poly-

Dominance classes of Staphylinidae beetles collected in Russia and Finland in 2005 and 2006

Species	Dominance class		
	subdominant (4–12.4%)	dominant (12.4–39.4%)	superdominant (39.5–100%)
<i>Atheta crassicornis</i>	+		
<i>Atheta fungi</i>	+		
<i>Atheta picipes</i>	+		
<i>Atheta sodalis</i>	+		
<i>Bolitochara obliqua</i>	+		
<i>Dinaraea aequata</i>	+		
<i>Gyrophana affinis</i>	+	+	
<i>Gyrophana fasciata</i>	+		
<i>Gyrophana joyi</i>	+		
<i>Gyrophana joyioides</i>	+		
<i>Gyrophana manca</i>	+		
<i>Haploglossa villosula</i>	+	+	
<i>Lordithon lunulatus</i>	+	+	+
<i>Lordithon speciosus</i>	+		
<i>Oxyporus maxillosus</i>	+		
<i>Philonthus tenuicornis</i>	+		
<i>Quedius mesomelinus</i>	+		
<i>Quedius xanthopus</i>	+	+	
<i>Sepedophilus bipustulatus</i>		+	
<i>Sepedophilus littoreus</i>	+		
<i>Sepedophilus testaceus</i>	+		

pores. The traps were checked six times in May, June, and September 2007 with intervals of two weeks.

RESULTS AND DISCUSSION

A total of 2172 staphylinid specimens from 148 species were collected in 2005 and 2006 with Kaila traps. The proportion of the species associated with fungi was 63 and 58% in 2005 and 2006 respectively. The rest of the species were those found on fungi seldom or temporarily. Thus, selectivity of Kaila traps for the purposes of fungi-associated staphylinid census was 61%. In Müller's research [10], where polypores were collected manually, the percentage of fungi-associated staphylinids was 27% of the total number.

In the control experiment, 77% of staphylinids collected with the trap set on a polypore sporocarp belonged to species associated with fungi, while such species were not found in the trap set on a polypore-free tree.

Comparison of species collected in our study with the species found on the *G. applanatum* in previous studies [7, 8, 11] revealed the following common species: *Atheta crassicornis*, *A. euryptera*, *A. fungi*, *A. pallidicornis*, *A. paracrassicornis*, *A. pittionii*, *A. sodalis*, *A. subtilis*, *Bolitochara obliqua*, *Dinaraea aequata*,

D. linearis, *Gyrophana fasciata*, *Lordithon thoracicus*, and *Sepedophilus constans*.

To elucidate which staphylinid species are associated with *G. applanatum* trophically or topically, the criteria of dominance degree and constancy of occurrence were used. Dominance classes were distinguished according to Engelmann's classification [12], and constancy of occurrence was assessed with Dajoz's formula [13].

We found 21 staphylinid species associated with fungi to be dominant, which means that the probability of them being actually associated with the artist's bracket is the highest (table).

In our research, *L. lunulatus* was a superdominant, the same as in Kaila's work [5, 14], although the traps were set on sporocarps of other polypore species in the latter research. This suggests that *L. lunulatus* can be called mycetophylic polyphage [15–17].

We believe that the probability of staphylinid species being associated with fungi is high enough if the species was found in 50% of traps or more (constantly occurring species). Thirty-five species can be put into this group: *Atheta crassicornis*, *A. fungi*, *A. sodalis*, *A. subtilis*, *Bolitochara obliqua*, *B. pulchra*, *Dinaraea aequata*, *D. linearis*, *Gabrieus splendidulus*, *Gyrophana affinis*, *G. bihamata*, *G. boleti*, *G. fasciata*, *G. joyi*,

G. joyioides, *G. manca*, *G. minima*, *Haploglossa villosula*, *Leptusa fumida*, *Lordithon lunulatus*, *L. speciosus*, *Megarthritis depressus*, *Omalium caesum*, *Oxypoda acuminata*, *O. alternans*, *Oxyporus maxillosus*, *Philonthus tenuicornis*, *Phloeocharis subtilissima*, *Quedius mesomelinus*, *Q. plagiatus*, *Q. xanthopus*, *Rugilus rufipes*, *Sepedophilus bipustulatus*, *S. testaceus*, and *Tachinus laticollis*.

Thus, 37 of 148 collected staphylinid species are associated with artist's bracket. For 19 species, association has been found for both criteria; for two species, association has been found for dominance criterion; and for 16 species, association has been found for constancy of occurrence. For 29 of these species, the association with *G. applanatum* was found for the first time.

Thus, Kaila traps are suitable for the purposes of monitoring beetles associated with fungi. These traps allow a researcher to collect a great volume of comparable material in different biotopes. The method also allows one to assess the amount of species and individuals and to monitor their dynamics. For better preservation of the material, some other agent may be used because insects do not stay preserved for very long in NaCl solution. Research of ecology and life history of insects associated with fungi should be complemented by field observations on concrete species and by rearing imagines from larvae found in the fungi under study.

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