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Records of Synanthropic Species of Alien Beetles (Coleoptera) in the Anthills of Genus *Formica*

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Abstract—For the first time, two alien species of beetles, obligate synanthropes, namely, *Attagenus smirnovi* Zhantiev, 1973 (Dermestidae) and *Lasioderma serricorne* (Fabricius, 1792) (Ptinidae), were revealed in anthills (genus *Formica*). These records widen the spectrum of biotopes inhabited by these species outside their native ranges and specify their adaptive abilities under the movement of invaders to the north.

Keywords: biotope, beetles, invasion, myrmecophiles, nidicols, Dermestidae, Formicidae, Ptinidae
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INTRODUCTION

Biological invasions are the introduction of alien species, one of the most serious environmental and economic problems of our time. Alien Coleoptera is the largest group of arthropods in Europe, the number of invasive species among which has recently grown significantly (Denux and Zagatti, 2010). For the European part of Russia, 183 species (including cryptogenic) alien beetles are now known (*Spravochnik*..., 2019), half of which are confined to synanthropic biotopes. A significant fraction of the species naturalized in natural habitats, but not one of them lost its connection with anthropogenic ones (Orlova-Benkovskaya, 2017). However, the basic laws of the process of invasion of beetles and their naturalization outside the native range remain insufficiently studied.

The aim of the main investigation was to study the fauna of myrmecophilous beetles in Yaroslavl oblast and its regional features.

MATERIAL AND METHODS

Samples were collected in spring 2019 from nests of two species of the genus *Formica* Linnaeus, 1758 (Hymenoptera: Formicidae) within the territory of Yaroslavl oblast in Russia. The substrate from different parts of the anthill dome was preliminarily sieved through a large sieve (mesh diameter 2 mm) and then transferred to the laboratory for a thermophotoelectric (combined action) installation described in the work of Golub et al. (2012). To avoid the ingress of foreign objects, nylon nets (mesh diameter of 50 μm) were put on top of the funnels with the substrate. In total, eight high-quality samples were taken from eight anthills: from three, *Formica truncorum* Fabricius, 1804; from three, *F. rufa* Linnaeus, 1761; and from two, *F. aquilonia* Yarrow, 1955.

A 96% solution of ethyl alcohol with glycerol was used as a fixative. The exposure time of the samples in the selector was 15 days.

Coleopteran taxonomy and data on the general distribution of species are presented according to the Palearctic catalog (*Catalogue*..., 2007). Determination of ants was carried out according to working individuals using a drawing key (*Atlas-opredelitel'*..., 2019) with the taxonomy adopted on the portal.

The material is stored in the collection of the Papanin Institute for Biology of Inland Waters, Russian Academy of Sciences.

RESULTS AND DISCUSSION

Among the processed coleopterological material from nests of ants of genus *Formica*, synanthropic species of alien beetles were discovered that were not previously observed for myrmecophilous communities.

Family Dermestidae Latreille, 1804

Attagenus (Attagenus) smirnovi Zhantiev, 1973

The body length of adults is 2.5–4.0 mm. The beetles are black, with light brown elytra; in females, the

top is in yellowish hairs; the last segment of the antennae of males is 4 times longer than the previous ones combined. Literature for determination: Zhantiev (1976).

Material: 1♂, Russia, Yaroslavl oblast, Nekouzsky district, village of Borok, shore of Barsky Pond, 58°03′41.4″ N, 38°14′43.4″ E, in a nest of *Formica rufa* Linnaeus, 1761, April 7, 2019, I.S. Turbanov leg.

The primary range of the species is in East Africa (Šefrová and Laštůvka, 2005), where it manifests itself as a nidicol, developing in the shelters of bats and bird nests (Zhantiev, 1976). Now it is widespread in the Palearctic, Afrotropical, and Oriental regions (*Catalogue...*, 2007). In the European part of Russia, it is an obligate synanthropic species (Zhantiev, 1976, 2009) and inhabits heated residential premises and outbuildings. It was introduced on the Commander Islands (Sazhnev, 2015) and in the city of Magadan (Kovalenko, 2019). It was first discovered in Russia in 1961 in Moscow (Zhantiev, 1973); for Yaroslavl oblast, it has been known since 1988, but judging by the widespread occurrence of the species in the late 1980s, it seems to have moved in earlier (Vlasov, 1995, 2008).

According to the published data (Kovalenko, 2019), the main vector of invasion of the species is unintentional introduction during transport of animal and plant products. In our case, self-distribution of the species is probably observed.

It is also noted that *A. smirnovi* outside of its native range is able to secondarily pass to nidicol in bird nests (Sazhnev and Matyukhin, 2019).

Family Ptinidae Latreille, 1802

Lasioderma serricorne (Fabricius, 1792)

Adult body length is 2.0–2.7 mm. The body is oval; the top is strongly convex, shiny. Coloring is light, reddish or yellowish brown. The head is large; together with the pronotum, it is able to bend strongly to the lower side. Antennas 11-segmented, moderate in length, saw-shaped. Literature for determination: Logvinovsky (1985), Toskina (2011).

Material: One specimen, Russia, Yaroslavl oblast, Nekouz district, near village of Bolshoi Chentsy, 58°03′52.2″ N, 38°11′38.5″ E, in a nest of *Formica aquilonia* Yarrow, 1955, May 8, 2019, I.S. Turbanov leg.

Cosmopolitan, from the beginning of the 20th century, it was introduced to all zoogeographic areas (Runner, 1919); natural range is unknown. Despite the fact that the species is described from North America, according to a variety of archaeoentomological evidence, *L. serricorne* presumably comes from the Mediterranean (Panagiotakopulu, 2000, 2001). In temperate latitudes, it manifests itself as an obligate synanthrope (Lefkovitch, 1967; Kovalev, 2019). The species entered Russia no earlier than the beginning of the 20th century (Logvinovsky, 1985). For Yaroslavl oblast, it has been known since the end of the last century; in particular, in the city of Yaroslavl, it has been found in large quantities since 1990–1993 (Vlasov, 2009).

The estimated invasion vector is unintentional introduction during transport of plant products, as well as self-distribution of the species (Kovalev, 2019).

In general, invasion of beetles is closely related to their synanthropization; however, the number of alien species is more dependent on biotopic confinement (Orlova-Benkovskaya, 2017) and the ability of invaders to settle in new territories and naturalize in natural biotopes.

Anthills have a number of features that allow them to be regarded as a consortium

—an element of the functional structure of biocenosis (Masing, 1966) with the participation of a determinant (species of ants) and consorts, among which there are myrmecobiont, myrmecophilous, and random species.

Ant buildings themselves are complexly organized structures with microclimatic features, for the genus *Formica* having both aboveground (dome) and underground parts with a diverse network of walkways and chambers. In our case, the base of the nest of *F. rufa* was a European spruce trunk (*Picea abies*), and the nest of *F. aquilonia* was formed at an aspen trunk (*Populus tremula*).

Both species of beetles found by us in the anthills of the genus *Formica* outside of their native ranges manifest themselves as obligate synanthropes; however, their presence in anthills at the northern boundary of distribution allows us to introduce several hypothetical assumptions about the features of the invasive process for these species.

It can be assumed that the finding of *A. smirnovi* and *L. serricorne* in ant nests is trophic in nature, that is, anthills are attractive as sources of organic remains of animal and plant origin; however, our findings are unique to myrmecophilous communities.

Another explanation may be due to the fact that *A. smirnovi* and *L. serricorne* could use nests of *Formica* as places for wintering. It is known that, in anthills, in particular, in wintering chambers, even in the Far North, the temperature in winter is much higher than that outside (Berman et al., 2007), which allows survival of not only ants but also a number of other invertebrates that are attracted to nests of *Formica*. Thus, the richest collections of optional myrmecophilous Coleoptera are in the early autumn and late autumn periods when the beetles leave and/or prepare for hibernation. Such an assumption broadens the list of biotopes for discovered invader species and suggests the possibility of their naturalization for limits of human habitation and residential landscapes, which opens up new opportunities for alien species when expanding their ranges, in particular, to the north.

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CONFLICTS OF INTEREST

The authors declare that they have no conflict of interest.

COMPLIANCE WITH ETHICAL STANDARDS

The article does not contain any studies involving animals in experiments performed by any of the authors.

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