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Coleoptera Species Associated with Nesting Birds of the Northern Caucasus

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ABSTRACT

This paper provides a faunistic inventory of Coleoptera species from 13 families, including 40 species collected from the nests of 24 bird species in the North Caucasus. Compared to our previous data, the list of beetle species has been expanded by 2 more species. Around 20 species were identified as accidental visitors to the bird nests, but these are not discussed further in this paper. The remaining species show intricate biocenotic interactions with their host nests. The process of adaptation of species to the nest environment, a form of microbiocenosis, represents a significant evolutionary development that requires further investigation. Geographically, the North Caucasus serves as a refugium for birds, with many species remaining year-round. As a result, the biodiversity of nidicolous Coleoptera is notably higher in this region compared to more northern areas. The data presented here has contributed to a database of beetle species inhabiting bird nests, which will facilitate future studies on the seasonal dynamics of populations and their associations with specific hosts. This research is particularly relevant in light of recent findings on climate change and human impact on natural ecosystems. As bird species decline and the prevalence of synanthropic species increases, it is possible to predict changes in the populations of nidicolous species, some of which have significant sanitary and epidemiological importance.

Keywords: Coleoptera, Birds nest, Nidicolous, Beetles

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Introduction

Beetles were among the first non-parasitic arthropods to be studied concerning nidicolous animal fauna [1-10]. As early as the previous century, beetles were identified as inhabitants of bird nests [1, 2, 4-8, 11-13]. Initial efforts to examine beetles in bird nests and explore the biological connections between the nest owners and their nest-dwelling residents were made in the works of various researchers [1-7, 14-19]. Our contributions to this field have been published in several articles [20-25].

Currently, over 200 beetle species have been recorded with known infestations of helminth larvae [3-7, 14-16, 26], increasing the focus not only on identifying beetle species but also on studying their role in the nest microbiocenosis. Research has shown that Dermestidae species can serve as vectors for pathogen transmission [8, 24, 25]. Gamasid mites often found phoretically attached to necrobiont beetles, have been identified in our studies, including *Poecilochirus necrophori* and *Parasitus* spp., which are capable of carrying rickettsioses [24, 25].

A promising avenue for further research could involve examining the role of birds as vectors for the spread of non-native beetle species, such as Dermestidae, that are associated with bird nests. This could include comparing the primary habitats of these beetles, observed as phoronts, with bird migration patterns. This article provides a faunistic inventory of Coleoptera species from 13 families, comprising 40 species collected from the nests of 24 bird species in the North Caucasus.

Materials and Methods

The material was collected from various regions in the North Caucasus, including the Stavropol Territory (Novoaleksandrovsk, Krasnogvardeisky, Izobilnensky, Shpakovsky, Kochubeevsky, Andropovsky, Grachevsky, Mineralovodsky, Predgorny, Levokumsky, Ipatovsky districts), Krasnodar Territory (Novopavlovka village), Rostov Region (Rostov-on-Don, Rasypnoe village, Zhukovskoe village), North Ossetia (Mozdok town), and Kalmykia (Khurulyun estuary, Tsaryk lake, Solenoe village, Lake Manych). Stationary research was conducted in the Stavropol Upland region between 2000 and July 2020. This study presents data on beetle species from 13 families, which form the core of the nidicolous beetle fauna in the study area. Other coleopteran species found in the nests are not included in this work but are considered nidicolophilic factors in the biology of these species.
To better understand which bird species are most frequently visited by Coleoptera, we have reviewed various ornithological studies [27-37].

Results and Discussion

It should be emphasized that environmental pollution contributes to a decline in the population of nesting birds, which in turn negatively impacts the beetle species that are nidicolous [11, 12, 19, 26-29, 38-40]. Beetles were collected from bird nests **(Table 1)**, with a total of 390 nests examined. In all, 2,711 beetles, three hundred fifty larvae, and 42 pupae were gathered. The distribution of species across host nests is presented in **Table 1**. In certain instances, the presence of insects in the nests is difficult to explain and is likely due to random factors. When classifying the identified beetles by their feeding habits, it was found that 24 species are polyphages, 20 are necrophages, 20 are keratophages, 16 are coprophages, 20 are detritophages, and 8 are saproxylophages. The trophic preferences of preimaginal stages may vary, with cannibalism being typical in species from the genera *Thanatophilus* and *Dermestes* [19, 25].

Table 1. The confinement of beetles to bird nests (North Caucasus)

List of beetle species	**Host species in a systematic manner**																							
	Anser fabalis	***Anas platyrgynchos***	***Pernis apivorus***	***Circus macrourus***	***Accipiter gentilis***	***Falco subbuteo***	***Perdix perdix***	***Columba livia***	***Streptopelia decaocto***	***S. turtur***	***Otus scopus***	***Merops apister***	***Ptyonoprogne rupestris***	***Hirundo rustica***	***Galerida cristata***	***Lanius collurio***	***Pica pica***	***Corvus frugilegus***	***C. cornix***	***Sylviacommunis***	***Passer domesticus***	***P. montanus***	***Emberiza calandra***	***E. citrinela***
Silphidae																								
Nicrophorus vespillo L.				+		+					+					+								
N. fossor Er.				+																				
N. vespilloides Hbst.						+					+					+								
Silpha obscura L.					+				+										+					
Silpha obscura (larva)	+									+					+	+	+			+		+		+
S. carinata Hbst.		+				+																		
S. carinata (larva)	+									+				+			+					+		
Tanatophilus sinuatus F.			+			+	+				+								+					
T. sinuatus (larva)				+		+		+	+	+														
T. terminatus Humm.					+		+																	
Dermestidae																								
Dermestes frischi (larva)			+			+		+			+	+	+	+	+	+	+	+	+	+		+	+	+
D. bicolor (larva)					+						+	+				+		+	+		+			
D. bicolor (pup.)					+						+					+			+		+			

D. bicolor F.					+						+		+	+		+	+	+	+		+			
D. coronatus Stev.				+		+		+	+		+		+		+	+						+		
D. lardarius L.																								
D. murinus L.																					+			
Attagenus schaefferi Hbst.																								
A. sylvaticus																								
Anthrenus scrophulariae L.									+															
Orphilus niger Er.																								
Trogidae																								
Trox scaber L.						+																		
T. hispidus niger Rossi			+																					
T. eversmanni Kryn						+				+			+	+				+						
T. eversmanni (larva)								+										+						
Scarabaeidae																							+	
Aphodius putridus Fourcroy											+			+			+							
Onthophagus vitulus F.												+				+	+	+	+					
O. leucostigma Stev.			+		+							+												
Catopidae						+			+		+	+							+					
Catops picipes F.		+																						
C. fuscus Panz.				+	+																			
Catops sp. (larva)	+		+								+	+				+					+			
C. coniciollis Rtt.						+			+	+									+					
C. nigrita Er.									+	+						+	+							
Ptinidae	+															+		+						
Ptinus fur L.	+					+																		
Niptus holoieucus Fald.																								
Byrrhidae	+					+						+					+							
Byrrhus pilula L.																			+					+
Hydrophilidae			+														+							
Sphaeridium scarabaeoides L.		+												+				+						
Histeridae												+					+		+					
Hister helluo Truqui,		+			+									+				+						
Paralister carbonarius Ill.,								+								+								
Margarinotus bipustulatus		+												+				+						
Schrnk.				+																				
Cryptophagidae											+													
Cryptophagus acutangulus																							+	
Gyll.			+			+				+			+							+				
Nitidulidae	+																							+
Necrobia violacea L.,							+																	
Nitidula bipunctata L.,									+						+									
Tenebrionidae																					+			
Tribolium confusum Duv.,																						+		
Tenebrio molitor L.																								

The reproductive cycles of the beetle species identified show that 48% follow a spring-summer cycle, 44% have a summer cycle, and 8% exhibit multi-seasonal reproduction. Breeding activity begins earlier in the semi-desert and steppe regions of the research area.

Most beetle species exhibit morning-evening activity (8-10 AM; 6-9 PM), with *D. bicolor* displaying twilight activity (6-8 AM; 7-10 PM) [9, 41]. The presence of adults, larvae, and pupae in nests throughout all seasons indicates their strong adaptation to a nidicolous lifestyle (feeding and reproduction) within the unique conditions of the nest microbiocenosis.

Species from the genera *Anthrenus*, *Attagerus*, and *Trox* have evolved distinct morphological and behavioral traits suited to life in bird nests, with *D. bicolor* being a notable example that remains in the nest at all times. During our study, we discovered 298 larvae of *D. bicolor* in the nest of *Otus scops*. *Nidicolous* beetles often serve as prey for their avian hosts. We observed feeding interactions with *S. obscura*, *S. carinata*, *T. sinuatus*, and *D. frischi* species, which were preyed upon by bird species such as *Corvus frugilegus*, *Pica pica*, *Corvus corax*, and *Garrulus glandarius*. The specific associations between beetle species and their host nests are summarized in **Table 1**.

Nidicolous beetles are often seen as guardians in bird nests, but when their numbers and nest density increase, they may become aggressive towards young chicks, particularly those that are weak or inactive (1-2 days old). These beetles, both in their adult and larval stages, may enter the chicks' ear and eye openings, leading to their death. The remains of dead chicks and abandoned eggs attract necrophagous beetles like *Nicrophorus* to the nests. While these beetles feed on the carcasses, they do not reproduce in the nests, which has been observed in the nests of large birds of prey (which were not part of our study). Detritivores and saproxylophages feed on the leftover food in the nest, while coprophages consume droppings and bird pellets, and keratophages target feathers, down, and feather sheaths.

As adults, beetles from *Attagenus* and *Anthrenus* genera require additional nourishment from flowering plants. Our nest inspections displayed that the species and number of beetles are primarily influenced by the nest's structure and the types of food available. Dermestidae and Trogidae favor enclosed nests, where larvae are better protected from external factors, with more stable temperatures, less temperature fluctuation, consistent humidity, and improved conditions for winter diapause. In contrast, Silphidae and Catopidae are more common in open nests near bodies of water. Scarabaeidae can be found in various nest types. The material used to construct the nest also plays a key role. Dermestidae do not inhabit nests made from plant matter, except in birds of prey nests. Families such as Ptinidae, Byrrhidae, and Hydrophilidae are part of the saproxyl population, relying on plant-based protein, while species from the Tenebrionidae family can consume animal-based protein.

Nidicolous insects are inherently linked to their host’s life cycle, though this relationship is more tightly integrated in species of *Dermestes* than in keratophages (such as *Attagenus*, *Anthrenus*, and *Trox*) and other groups. This stronger bond is due to *Dermestes* species primarily feeding on food brought to the chicks, which is available only while the chicks are in the nest. As a result, the developmental cycle of *Dermestes* beetles coincides with that of the host nest. This is why *Dermestes* species are typically univoltine; their larvae develop while chicks are being fed, and the newly emerged beetles only begin reproducing in the spring of the following year.

In contrast, keratophages and other groups are less reliant on the host’s life cycle. Keratophages feed on wool and feathers, which remain in the nest for extended periods, especially in steppe and semi-desert regions. These beetles typically enter the nest soon after its construction and continue to reproduce throughout the warm season. The feeding on keratin allows for the possibility of larvae developing over two years. Another noteworthy group is the Nitidulidae family, which feeds on the food brought to the nest but also actively searches for additional food sources beyond the nest.

At first, it might seem unusual that larvae from different nidicolous species coexist in such confined environments as nests, all developing on the same food. One might expect intense competition among these groups, potentially causing the displacement of one group of beetles. However, a closer examination of the nests, particularly within the Dermestidae and Trogidae families, sheds light on this apparent paradox. It was found that, despite the nests' small size, adult and larval beetles of *Dermestes*, *Anthrenus*, *Attagenus*, and *Trox* species are spatially segregated within the nest. The larvae of *Trox* species inhabit the lower, more compact layers, where their fusiform body shape helps them move. In contrast, *Anthrenus* larvae and adults are more frequently found in the upper, looser layers of the nest substrate, closer to the surface. *Dermestes* beetles occupy the outermost parts of the nest, living along the outer boundaries or within the litter on the nest's walls. *Trox* beetles are found throughout the entire perimeter of the nest. Although beetles from other families might leave the nest temporarily, they always return.

Our observations reveal that Catopidae species, such as *Catops picipes* and *C. nigrita*, develop in decaying and spoiled eggs. The adult beetles lay their eggs inside the eggs, and the larvae feed on the egg contents, remaining inside the shell until they pupate. The synanthropic beetle *Dermestes lardarius* is commonly found in urban areas, particularly in the nests of synanthropic birds and in the attics of buildings where the temperature remains above +11°C. It has been observed laying eggs as late as December. Mrochkovsky (1955) reported the significant harm caused by these synanthropic beetles in pigeon and chicken coops in Poland [17]. This species is often found in attics, where it can continue to develop throughout the year. We expect our collection to be expanded further by Latridiidae species, as noted by the writers of the article [37, 41, 42].

Conclusion

The shift to nesting microbiotopes, in our view, involved the development of new ecological niches and the establishment of novel interspecific interactions. This process was characterized by rapid speciation, resulting in the emergence of new ecobiomorphs—nidicolous species that are uniquely adapted to the specific conditions of nests and the food available within them. *Nesting microbiocenoses*, as fundamental systems within the supraorganism framework, provide valuable insight into biocenotic structures at their most basic level.

In the subsequent article, we will explore the mechanisms behind the division of ecological niches among nidicolous organisms, as well as the evolutionary pathways of the nidicolous fauna [33-36].

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