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Ecologic and Zoogeographic Characteristics of the Genus *Orphilus* Er. (*Coleoptera: Dermestidae*) in Palearctic Zone

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ABSTRACT

The article discussed the distribution of species in the Palearctic zone. Long-term observations of species biology were provided. The material will be useful both to entomologists studying the problems of wood decomposition in nature, and to biologists studying the ecological and biological characteristics of beetles participating in the destruction of organic matter.

Keywords: *Palearctic zone, organic matter destruction, Orphilus spp.*

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INTRODUCTION

Insects represent the richest group in species, and play several key roles [1]. They colonize a broad range of substrates [2], and use these substrates as food source, their shelter and their place of development, mating or laying [3]. The genus *Orphilus*, which forms the monotypic subfamily *Orphilinae*, until recently included 3 species. One species (*O. dubius* Wickham) is known from the Miocene sediments (USA). *Orphilus ater* Er. and *O. subnitidus* Lec. are found in North America. *Orphilus niger* Rossi is widely distributed in Northern and Southern Europe, the Mediterranean region, Caucasus, and the mountains of Central Asia. It has been reported from Asia Minor [4, 5], but the study of specimens from Turkey by Zhantiev showed that the species in this region is *O. beali* [6].

The biology of the skin eaters of the genus *Orphilus* are poorly understood. It was considered that, all species feed on flowers [7, 8]. However, larvae of one species were found in oak wood [9]. *Orphilus subnitidus* was reported from dead insects collected in the building [10]. Later, larvae of this species were found in the dead branches of strawberries [11]. Our research has shown that in the territory of Ciscaucasia O*. niger* is often found in the fruiting bodies of old mushrooms.

The collections of adults and larvae were carried out by the author in the Crimea, Ukraine (the cities of Donetsk, Kirovograd, and Odessa), and Russia (Rostov Region, Krasnodar, Stavropol Territories, Dagestan, and Karachay-Cherkessia). In addition, the collection materials of the Museum of the Department of Zoology in Rostov State University (RSU), the Kirovograd Museum of Local Lore (Kirovograd, Ukraine), and the Museum of Odessa State University (Odessa, Ukraine) were studied. The following entomologists kindly provided part of the material: Samoilenko A. A. (Moldova), Duz S. A. (Transcaucasia), Drach D. A (Ukraine), and Arzanov Yu. G. (Russia).

ECOLOGY

The paper presents a generalized characteristic species, as well as data obtained in the course of laboratory breeding of *O. niger*.

Adults appear on flowers in the beginning - in the middle of May (earlier in the southern regions) and occur until mid-August. Under laboratory conditions, life expectancy reaches 3.5 months (at 20-28 °C and relative humidity of 55-70%). On the flowers, they feed on nectar and pollen. Liquid food is trapped by maxillae, which are periodically pushed forward. Thick bundle of hairs on top of Galea wet and then pressed their inner mouthpart structures [6].

To collect pollen, imagoes constantly move around the inflorescence to find a stamen. After feeling the stamen filament with maxillary palps, they move from the base to the anther. Pollen is collected by maxillae, which in this case do not move longitudinally (as in other skin eaters), but has oncoming movements. Mandibles do not participate in pollen capture, but perform oscillatory motions that do not coincide in phase with maxillary motions. This helps to promote dust gical in the oral cavity and its molar chafing between the projections. Beetles feed on flowers only in the morning until 14-15 hours in the plain and up to 15-16 hours in the mountains, after which they burrow into inflorescences. Under laboratory conditions, they bury themselves in a substrate, or hide in shelters.

Females look for areas of wood (boughs, stumps, hollows) devoid of barks that are saturated with hyphae of fungi that form destructive (brown) rot. Eggs are laid in cracks or indentations. Attempts by different authors to force females of *O. niger* to lay eggs on dry insects have not yielded positive results [7, 8, 12]. The incubation period lasts from 10 to 15.5 days and depends on the temperature of the substrate and its humidity. Larvae of 0.85-1.05 (± 0.24) mm long emerge from eggs. Larvae move slowly (speed is about 9-12 mm per minute). After the first molt, they begin to bite into the tree sinus. They often form groups of 3-4 individuals, gnawing in close proximity to each other. In this case, the larvae periodically come to the surface and are interchanged. As a result, they form a small common cavity with multiple inlets and "guts", which later transform into individuals née moves. The larvae show sensitivity to light and avoid bright surfaces (negative phototaxis). This is indicated by weak pigmentation of the cheeks, on which the larvae of other skin eaters have organs of vision. Under natural conditions, the larvae come to the surface at night. Brown, or destructive, rot is formed by fungi that hydrolyze fiber and consume up to 65-70% of wood. The remainder consists of lignin and similar substances [12, 13]. Conventional dendrobionts, for example Cerambycidae larvae, cannot develop vatsya in such timbers [6]. The larvae of the genus are obligate users of this substrate. They are able to develop on it after the death of mushrooms and drying of wood, as evidenced by the growing of larvae on willow wood, stored in the laboratory for 10 years [6]. Larvae are periodically bite off a portion of the substrate using the mandible, and then commits 8-30 (±7) chewing movements providing crushing of food between the molar protrusions. Microscopic analysis of nibbling sawdust and excrement gives reason to believe that the larvae predominantly consume fungal hyphae and are substantially mitse tofagami [7, 8]. They do not swallow the denser particles of wood, but turn them into drill flour, which is partially displaced onto the dorsal surface of the body, where it forms a very dense shell. Their retention is facilitated by hooked curved hairs on the dorsal surface of the body, as well as the adhesive properties of the cuticle covered with secretions. This shell is formed after the start of gnawing and remains when the larvae exit the passages, making them difficult to be distinguished on the surface of the substrate.

Dry insects (small dipterous, Coleoptera) placed on the surface of the substrate in our experiments did not attract larvae. After the second molt, they usually did not appear on the surface. The diameter of the inlets of larvae of the 2nd age is 0.4-0.6 mm. As they grow, round passages in the section expand and reach 2-2.2 mm in diameter. Throughout its length, there is closed, tightly compacted cuttings and ekskre cops. The moves of most of the larvae are located close to each other. They often intersect, as a result of which the wood acquires a spongy structure. Individual larvae can move away from the colony, but they also make passages with numerous blind branches. Favorable for the development of the larvae of wood section is populated for multi fir years, which leads to its total destruction.

The development of the larvae lasts 1.5-2 years and depends on the availability of a suitable substrate. Phenology of *O. niger* is shown in Table 1. Larvae molt 6–7 times (6 for males and 7

for females). The larvae of the last sage prepare a special chamber to pupate. They go to the surface of the wood or into the cavity opening outward and gnaw out a direct passage with a length of 18-25 (±2) mm and a diameter of about 2-2.5 (±0.25) mm. At its end, the larva turns its head to the exit and pupates. The space separating the chrysalis from the exit is filled with tightly compressed drill flour. The young beetle paves the way to the surface, loosening and moving this substrate from the front to the rear end of the body. Most of the bugs copes with this task, however, we found bugs that died near the exit.

Due to the peculiarities of biology, species of the genus possess a complex of autapomorphies. The adults and larvae retained a combination of plesiomorphic characters such as the imaginal eye and urohomph of the larvae [6, 14]. Thus, *Orphilus* differs sharply in morphological and biological characteristics from other species of the Dermestidae family. These facts have led to [9] to suggest a kinship between *Orphilus*, in particular *O. niger*, with Cucujoidea. The phylogenetic analysis of dermestids allowed us to put forward a strict and clearly justified family system [6, 14], which removed all these doubts.

Table 1. Phenology of *O. niger* in the North Caucasus.

Months of first year											
I	II	III	IV	V	VI	VII	VIII	IX	X	Xi	XII
(-)	(-)	(-)	- 0								
				+	+ *	+ *	+				
					-	-	-	-	(-)	(-)	(-)
Months of second year											
I	II	III	IV	V	VI	VII	VIII	IX	X	Xi	XII
(-)	(-)	(-)	-	-	-	-	-	-	(-)	(-)	(-)
Months of third year											
I	II	III	IV	V	VI	VII	VIII	IX	X	Xi	XII
(-)	(-)	-	- 0	0							
				+	+ *	+ *	+				
						-	-	-	(-)	(-)	(-)

+: imago; -: larva; (-): the larva is in an inactive state; *: an egg; 0: a pupa.

The ancestors of this group (as well as all receptive skin eaters) were xerophilous dendrobionts, feeding on the corpses of arthropods. The gypsum of the mushrooms forming brown rot could initially be a source of moisture, then additional food, and finally became the main food substrate. In the early stages, the larvae feed on the surface of the substrate, as is done now masks kin first ages *Orphilus.* Particles of gnawed wood stuck between the thick hairs on the head and tergites, creating an additional protective shell. Going deeper into a soft substrate, the larvae find not only fresh food, but also additional protection from predators and parasites. A shell of drill flour is also preserved, allowing the larvae to move in the labyrinths of passages in the substrate or to come out from time to time to the surface. Unlike true dendrobionts, they retained signs of superficially living larvae. This property of them is especially pronounced in the method of pupation. Typical dendrobionts pupate at the end of litchi night running, almost near to the surface. For this, *Orphilus* larvae make a special passage from the surface like other skin eaters.

However, it should be recognized that, in general, Orphilinae is a highly specialized group with a number of apomorphic characters. Their complete list is given in [7]. The larvae have curved hattes, a molar protrusion on the mandibles and modification of the structure of the 9th segment of the abdomen, while adults have a bare surface of the cuticle, additional articulation of the anterior coxae, digging tibia, etc.

Curved hairs provide the formation and retention of the shell of drill flour and excrement. The long thin hairs located between them perform a mechano-sensory function. Reduction of vision organs has caused the formation of a color shell. Molar protrusion on mandibles of larvae differs them from all other carpet beetles. However, the

mycetophage larvae exist in many coleopteran families used to crush food substrate, predominantly consisting of mycelia. The presence of this formation in adults *Orphilus* until labor but to explain. We can assume that in the past the beetles also feed on mushrooms and they began to use molar projections for grinding pollen. The morphological adaptations of the larvae (sclerotization of sternites and pleurisy, reduction of the spiracles, and modification of the 9th segment of the abdomen) are associated with the need to move and densify pollen particles of drill flour. The bulk of this material get flattened under the ventral surface, and then tamps inrush caudal structures, having a shape similar to "wheelbarrow" bark. Urogomfy is used for fixation of the body and moves forward with the traverse. Such a strong transformation of the 9th abdominal segment led to the reduction of the 10th segment and the displacement of the anus into the articular region between the 8th and 9th sternites.

The most interesting feature of imago of *Orphilus* is the structure of the front basins, having a second complement articulated with prothorax [6, 14]. This structure is not observed in other Coleoptera. This neoplasm allows them to stabilize the axis of rotation of the elongated basin at a given angle to the body or to strengthen the movement of the legs when the beetle passes through a narrow passage. This is facilitated by other structural features including the smooth devoid of hat and hair cuticle surface, as well as flattened lower leg, equipped with spines.

Limiting factors. Pesticide treatment of forests, falling of old trees [15].

Security measures. Preservation of old trees, reduction of anthropogenic pressure on forestation [15].

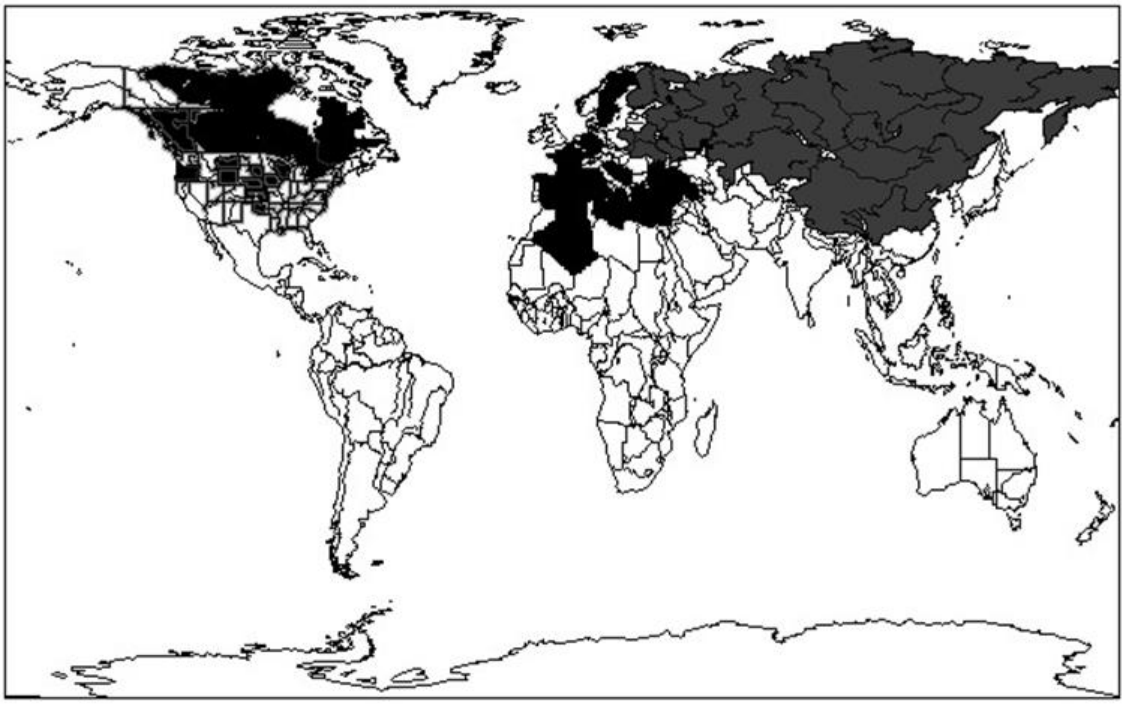

Fig. 1. Map of the distribution ranges of species of the genus *Orphilus* Erichson: 1- *Orphilus ater*, 2- *Orphilus subnitidus*, 3- *Orphilus beali*, 4- *Orphilus niger*.

ZOOGEOGRAPHIC CHARACTERISTICS AND CATALOG OF WORLD FAUNA

Below we provided a catalog of the subfamily of the world fauna, both existing and extinct taxa:

Subfamily Orphilinae Le Conte, 1861: 107.

Type genus: *Orphilus* Erichson, 1846: 424 (Synonymy: *Orphili* Le Conte, 1861: 107; *Orphilini* Casey, 1900: 140) [16].

Genus *Orphilus* Erichson, 1846: 424.

Type view: *Byrrhus niger* Rossi, 1790: 39.

List of Species:

Orphilus ater Erichson, 1846: 463 (Synonymy: *Orphilus glabratus* var. *Ater* Jayne, 1882: 373;

Orphilus subnitidus Rauterberg, 1885: 59) [17]. Distribution: Canada (Ontario); USA (North American view). Fig. 1 (1).

Orphilus beali Zhantiev, 2001: 612. Distribution: Europe (Cyprus, France, Greece, and Turkey), and Asia (Israel and Syria). The species range is apparently limited to the Mediterranean countries (although the possibility of importation into other regions is not excluded) [6, 14, 18]. Fig. 1 (3).

Orphilus dubius Wickham, 1912: 15 [19]. Distribution: America: Colorado (Fossilia: Miocene). The only known fossil species of the genus.

Orphilus niger Rossi, 1790: 39 (Synonymy: *Byrrhus niger* Rossi, 1790: 39; *Anthrenus glaber* Creutzer in Panzer, 1796: 11; *Anthrenus glabratus* Fabricius, 1801: 109; *Ophilus niger* Reitter, 1891: 170) [20]. Distribution: Europe (Ukraine, Moldova, Russia, and Turkey), Africa (Algeria, Egypt, Morocco, and Tunisia), and Asia (Caucasus, Tajikistan, and Uzbekistan). The species range is limited to the Palaearctic region. Figure 2 is a photograph of an imago.

Orphilus subnitidus Le Conte, 1861: 109 (Synonymy: *Orphilus glabratus* Le Conte, 1878: 471; *Orphilus glabratus* var. *Subnitidus* Jayne, 1882: 373; *Orphilus chalybaeus* Casey, 1900: 164; *Orphilus aequalis* Casey, 1900: 164; *Orphilus niger* Spencer, 1942: 27) [21, 22]. Distribution: Canada, and East USA (North American continent). Fig. (1. 2).

Fig. 2. Photograph of the collection material.

Conflict of interest

The work was carried out by the author without any support.

REFERENCES

1. Hafid H, Allaoua N, Hamlaoui A, Rebbah AC, Merzoug D. Structure and diversity of arthropod communities in the Jebel SidiR'ghiss Forest (Oum El Bouaghi) North East Algerian. World Journal of Environmental Biosciences. 2018; 7 (4): 95-101.
2. Cabrido C, Demayo CG. Antimicrobial and cellular metabolic effects of the ethanolic extract of the Dallas red variety of Lantana camara. Pharmacophore. 2018; 9 (1): 10-18.
3. Ayoub H, Seghir MM, Kamel BM, Ismahane L, Laid OM. Effects of the allelochemical compounds of the Deglet Nour Date on the attractiveness of the caterpillars of ectomyelois Ceratoniae (Lepidoptera: Pyralidae). World Journal of Environmental Biosciences. 2017; 6 (1): 7-12.
4. Reitter E. Bestimmungs-Tabellen der europäischen Coleopteren. III Heft. II. Auflage. Enthaltend die Familien: Scaphidiidae, Lathridiidae und Dermestidae. Mödling. 1886. 40-74.
5. Heyden LV, Reitter E, Weise J. Dermestidae. Catalogus Coleopterorum Europeae, Caucasi et Armeniae Rossicae. Deutsche entomologische Zeitschrift. 1891. 420 pp
6. Zhantiev RD. Zhuki-kozheedy roda Orphilus Er. (Coleoptera, Dermestidae) fauny Palearktiki. Entomologicheskoe Obozrenie. 2001; 80 (3): 611-619.
7. Pushkin SV. Environmental group Necrophilous and Necrobionts Beetles (Insecta; Coleoptera) of the south of the Russia. Entomology and Applied Science Letters. 2015; 2 (4): 1-9.
8. Pushkin SV. Discoveries of Carpet Beetles (Coleoptera: Dermestidae) of the South of Russia. Entomology and Applied Science Letters. 2017; 4 (2): 29-31.
9. Paulian R. Larvae of the sub-family Orphilinae and their bearing on the systematic status of the family Dermestidae (Col.). Annals of the Entomological Society of America. 1942; 35: 35-46.

10. Spencer GJ. Insects and other arthropods in buildings in British Columbia. Proceedings of Entomological Society of British Columbia. 1942; 39: 23-29.
11. Beal RS. Review of Nearctic species of Orphilus (Coleoptera: Dermestidae) with description of the larva of O. subnitidus LeConte. Coleopterist´s Bulletin. 1985; 39: 265-271.
12. Jacobson GG. Beetles of Russia and Western Europe. Devriena company. 1913. 824-832.
13. Vanin SI. Lesnaya fitopatologiya (Forest phytopathology). 4th ed. Goslesbumizdat Publishing House. 1955. 416 pp.
14. Zhantiev RD. Classification and Phylogeny of Dermestids (Coleoptera, Dermestidae). Zoologicheskii Zhurnal. 2000; 79 (3): 279-311.
15. Pushkin SV. Rare and endangered insects of the Central Ciscaucasia. Moscow: Direct Media. 2015; 105 pp.
16. Casey TL. Review of the American Corylophidae, Cryptophagidae, Tritomidae and Dermestidae with other studies. Journal of New York Entomological Society.1900; 8: 51-172.
17. Rauterberg F. Coleoptera of Wisconsin. Proceedings Natural History Society. Wisconsin. 1885. 58-59.
18. Fabricius JC. Entomologia systematica emandata et aucta. Secundum classes, ordines, genera, species adjectis synonimis, locis, observationibus descriptionibus. impensis CG Proft. 1801. 506 pp.
19. Wickham HF. A report on some recent collections of fossil Coleoptera from the Miocene shales of Florissant. Bulletin from laboratories of natural history of the State University of Iowa. 1912; 6: 3-38.
20. Rossi P. Fauna Etrusca, sistens Insecta, quae in provinciis Florentina et Pisana praesertim collegit. Thomae Masi & Sociorum. 1790. 272 pp.
21. Jayne HF. Revision of the Dermestidae of the United States. Proceedings American Philosophical Society, Philadelphia. 1882; 20: 343-377.
22. Le Conte JL. Classification of the Coleoptera of North America. Part I. Smithsonian Institution, Washington. 1861. 348 pp.