



## Eco-Faunistic Review of the Silphidae Family (*Coleoptera: Silphidae*) of the Greater Caucasus

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### ABSTRACT

The paper presents the results of 23 years of research on the fauna of the carrion beetles (*Coleoptera: Silphidae*) of the Greater Caucasus. The author compiled an ecological-faunistic review of 27 species and 4 subspecies of silphids.

**Keywords:** *carrion beetles, Silphidae, Greater Caucasus.*

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### INTRODUCTION

The fauna of the silphids, in contrast to that of large families such as Carabidae, Chrysomelidae, Scarabaeidae, Staphylinidae, has not been the subject of special study. Due to the peculiarity of the Caucasian fauna, an inventory of species and subspecies of Silphidae in the Caucasus is an important task requiring an in-depth taxonomic approach, the availability of comparative material from adjacent and more distant regions, and in some cases the study of nomenclature types. We tried to cover the collections and studies in Caucasus, and reviews of the family [1, 2] and papers [3-15] related to the Caucasian and adjacent territories' fauna, that allowed us to systematize the available data. Also, our previous works [3-9, 16-18] were related to faunae of silphids and necrobiotic insects in Caucasian areas.

Despite the absence of special studies, during the period from the beginning of the 19<sup>th</sup> to the 90s of the 20<sup>th</sup> century, information was collected on the fauna

of the region. The first information about the dead-eaters of the south of Russia was provided by Pallas [19]; he noted 6 species. Reliable references on the fauna of Silphidae in Ciscaucasia and northwest Caucasus are available in papers [20-22]. The *Coleoptera* fauna of the Caucasus has been studied previously [10, 23-26]. In the catalog [11], 24 species and 5 subspecies were indicated for the study area within the modern borders.

Zaitsev [12] noted an overview of the fauna of Caucasian and adjacent areas. However, several errors of his work were included in a revision by Shavaller [27]. For example, Zaitsev reduced endemic Caucasian *Thanatophilus armeniacus* Reitter 1912 to be synonymous with *T. porrectus* Semenov 1891 [27]. In specifying the species for Armenia, an analogy is seen with the description of the lamellar beetle from the genus *Trochaloschema* Reitter endemic for Hissar-Darvaz, that is This *T. armeniaca* Brenske, 1897 [2]. Probably both species were described from the same mislabeled material, from the same source. Several names incorrectly interpreted [28]; the name *Silpha*

*obscura nitida* Portevin 1907 was imported from the Himalayas and is therefore not suitable for caucasian subspecies; a number of names proposed by Menetries (*S. obscura* var. *costata* Men. 1832; *S. obscura* var. *striola* Men. 1832) belong to the forms from the Caucasus and Transcaucasia, and therefore, cannot be assigned to the nominative subspecies. As the name *Silpha costata* Men 1885, according to E. Reitter [10], belongs to one of intraspecific forms of *Silpha tristis*, serves for the Caucasian subspecies name *S. obscura striola* Menetries 1832 (syn: *S. obscura nitida* Portevin, 1907; Schawaller, 1980) [2]. Brief review of propagation of *Nicrophorini* Palaearctics is given in [29]. Papers [30, 31] studied the territory of Ciscaucasia. Based on them, there is no analysis of species distribution, ecological features, and synonymy, which led to a number of inaccuracies. *Aclypea sericea* Zubk., *A. tomentifera* Rtt. are common in the mountainous regions of the Caucasus and Transcaucasia for the Rostov region. The forest moisture-loving species *Nicrodes littoralis* L., and *Nicrophorus humator* Gleditsch are found in Kalmykia semi-arid areas. According to the latest revision [32], the genus *Ablattaria* includes 4 species. Notwithstanding, according to [2], most of them do not deserve the status of species and really. In the Caucasus, 1 polytypic species is common. It is not possible to draw a clear line between the areas of subspecies. Each individual specimen with separate larger than the rest dots on elytra are rarely found in Crimea; as we move to the east, such instances occur more often, and in the district of Grozny, to our knowledge, there is only typical instances of *A. laevigata cribrata* (Mén., 1832). The major point of the elytra is several times larger than the other points. The imago and dead-eating larvae are an important link in the trophic relationships of terrestrial biotopes of temperate latitudes. In the arid regions, representatives of the genera *Silpha*, *Thanatophilus*, and *Nicrophorus*, the families are inferior in competition for the food item to the skin-eaters, and other xerophilous scavengers of the families Trogidae and Nitidulidae. Silphidae are noted as primary consumers, predators, and necrophages, that participate in the phoresis of nematodes and gamasid mites. They control the number of lazy insects and molluscs (*Dendroxena*, *Ablattaria*, and *Phosphuga*), pests of fields and forests, and take part in soil formation (*Nicrophorus*) [3-9].

## MATERIAL AND METHODOLOGY

The work is mainly based on our own material collected in different regions of the Caucasus during 23 field seasons (from 1994 to 2017) in the spring-autumn period. The alpine part of the region was investigated during several walking routes that covered the main mountain ranges of the Caucasus from the foot to the subnival belt.

An effective method of collection was manual collection on corpses (for necrobionts). Bait traps gave a good result. At the same time, we used simple entomological tools: an entomological sieve, a spatula, a knife, and tweezers. All species of loose (soil, moss, wood dust) or semi-liquid (excrement, rotting mushrooms, semi-decomposed corpses) substrates were disassembled on a polyethylene film (1m<sup>2</sup>). "Barber" traps (soil traps) were used; they served as plastic cups (0.5 L) with a fixing liquid (80% ethanol solution).

### Ecological faunistic review of species of the family

The study of dead-eaters in the Greater Caucasus allows us to name 27 species and 4 subspecies. The following is a systematic list.

*Oiceoptoma thoracicum* (Linnaeus, 1758); *Ablattaria laevigata cribrata* (Ménétriés, 1832); *Nicrodes littoralis* (Linnaeus, 1758); *Thanatophilus rugosus* (Linnaeus, 1758); *T. sinuntus* (Fabricius, 1775); *T. terminatus* (Hummel, 1825); *T. dispar* (Herbst, 1793); *Silpha obscura striola* (Ménétriés, 1832); *S. tristis* (Illiger, 1798); *S. carinata* (Herbst, 1783); *Dendroxena quadrimaculata* (Scopoli, 1772) = *Silpha quadripunctata* (Schreber, 1759) (non Linnaeus, 1758) [Madge, 1980]; *Phosphuga atrata* (Linnaeus, 1758); *Aclypea opaca* (Linnaeus, 1758); *A. undata verrucosa* (Ménétriés, 1832); *A. sericea* (Zoubkoff, 1833); *Nicrophorus germanicus fascifer* (Reitter, 1884) = *N. armeniacus* (Portevin, 1923) [Madge, 1980]; *N. g. germanicus* (Linnaeus, 1758); *N. humator* (Gleditsch, 1767); *N. vespillo* (Linnaeus, 1758); *N. vestigator* (Herschel, 1807); *N. antennatus* (Reitter, 1884); *N. nigricornis* (Falderman, 1838); *N. fossor* (Erichson, 1837); *N. vespilloides* (Herbst, 1784); *N. investigator* (Zetterstedt, 1824); *N. i. funeror* (Reitter, 1884); *N. sepultor* (Charpentier, 1825); *N. confusus* (Portevin, 1924).

Below we present the ecological characteristics of the silphid fauna of the Caucasus. *O. thoracicum* was noted everywhere. *A. l. cribrata* was found in open biotopes, *N. littoralis* in humid places, *T. rugosus* throughout the territory in humid places, especially

in the forests of the foothill zone, steppes, and cities. *T. sinuntus* is a eurybiont. *T. terminatus* was found in arid zones, *T. dispar* in forests, only on the northern slopes of the Greater Caucasus. *S. obscura* represented Caucasian subspecies *S. o. striola* which is a mesoxerophilic species. *S. tristis* was found in the meadows, *S. carinata* in steppes. *D. quadrimaculata* which is a forest stenobiont, reaches the greatest number in forests of at least 300 years old. *P. atrata* was found in forests, rarely rising to 2600-3000 m. *A. opaca* is often found in agrocenosis throughout the territory. *A. undata* was represented in the Caucasus by the subspecies *A. u. verrucosa* that was found from the foothills up to 1400 m. *A. sericea* that is a rare species is known to us from the mountainous Dagestan. *N. germanicus* represented in the Caucasus subspecies of *N. g. fascifer* and the rest of the nominative subspecies *N. g. germanicus*. In habits steppe biotopes. *N. humator* was found in forests, *N. vespillo* as eurybiont, *N. vestigator* in ecotones bordering of the forest, and *N. antennatus* in open biotopes (often in agrocenosis). *N. nigricornis* is a forest species. *N. fossor* is a mesoxerophilic species. *N. vespilloides* distributed from the foothills to the mid-mountain forest belt. *N. investigator* lives on the northern slopes of the Greater Caucasus. *N. i. funeror* replaces the nominative subspecies in the Caucasus: Georgia, north to the spurs of the Greater Caucasus, and Armenia. *N. sepultor* is a mesophilic species. *N. confusus*, which was found in mountain-steppe, is moderately xerophilous species, and prefers agrocenosis - fields of wheat, oat and, as well as hay in meadows and deposits. *N. confusus* was noted by J.S. Dzhambazishvili in Akhaltskhe Akhalkalaki Georgia, but instead, he noted that *N. sepultor* was not found in the Caucasus. According to modern concepts, the distribution of this species to the north is limited to the southern spurs of the Caucasus Range [2]. We did not find it in North Ossetia. Currently, there are no reliable indications of the location of *N. confusus* in the territory of Russia. Propagation of *N. nigricornis* is bounded by the midlands of the Caucasus. The peak of activity falls in June and July. *N. confusus* lives in an open low- and mid-mountain area (at altitudes of 800–1500 m), more often it is located in intermontane basins protected from torrential streams. It was recorded on stony pasture meadows up to 3000 m (Georgia, Trialeti mountain range), and with an increase in height it is superseded by the subspecies localized in the Caucasus (*N. i. funeror*). Widely widespread type of Central and Southern Russia - of *N. sepultor* south of the Caucasus Range was not found.

*N. littoralis*, *O. thoracica*, *D. quadripunctata*, and *P. atrata* were found in forests. *N. littoralis* was found in moist biotopes. *P. atrata* and *D. quadripunctata* were found in the forest-steppe near forest stands. This is due to the features of the hydrothermal regime and the availability of food. So, *Dendroxena* lives in those places where leaf-eating pests (caterpillars of *bur-laris*, gold-winged grubs) develop in large numbers, i.e. in old forests prone to drying out [1]. *Phosphuga* is noted as a widespread genus, living in places of high humidity, which are created in the steppe and forest-steppe zones under the forest canopy, or near-water biotopes. It occurs at a height of 2500-3000 m. *A. l. cribrata* was noted in steps Caucasus; Stavropol Upland is one of the northern boundaries of *A. l. cribrata*. More widespread *A. l. laevigata* were found in the virgin steppe. In the district of the Stavropol Territory border and Chechnya 2 subspecies were found, as we moved to the east only subspecies *A. l. cribrata* was found.

When studying species of *Silpha*, it was observed that the proliferation of *S. carinata*, *S. obscura* depends on the hydrothermal factors: species do not live in the east of the Caspian. H and meadows Caucasian have *S. tristis*. The genus *Silpha* is very variable, so there are many morphs and aberrations of species. In particular, [33] noted wide variability of *S. obscura*, offering to use it as a bioindicator of agrocenosis. *The S. obscura* according to [34], is a mass species in the steppe areas suffering from overgrazing. The Caucasus and the countries of the Caucasus inhabit the *S. striola*. *Aclypea* is widely distributed in this territory. Some species are rare in the foothill landscapes and meadows. *A. serecea* is known from the Western and North-Western regions of Ciscaucasia, more often found in Dagestan and Transcaucasia.

Nutritional specialization is a factor that influences the statistical confinement of many species. The most numerous is a group of necrophagous, only on the corpses of large mammals (cattle, wild ungulates) live *Nicrophorus*, *Necrodes*. This is due to the fact that on large corpses these species simply feed. Oviposition takes place at the "buried" corpses of small mammals as a result of which *Nicrophorus* is difficult to observe. *Necrodes* lays eggs on corpses of medium size (up to 15 kg.), and as a rule, these are birds. Phytophagous species of *Aclypea* eat plants, and sometimes, especially in dry years are harmful to row crops. The group of zoophages is represented by the genera *Dendroxena*, *Ablattaria*, and *Phosphuga*. Optional predation has been reported for many genera. Of particular note is the competition for a food item be-

tween obligate necrobionts. Beetles feed on the corpse with dipterous larvae; older larvae also predate on the corpse. Often one species displaces another on the corpse. The trophic specialization of dead-eaters is still poorly studied, so according to our observations, many species in the imaginal phase pass to different types of nutrition. The larva of *Phosphuga atrata* is marked as a phytophage. *Necrodes* and *Nicrophorus* eat the larvae and eggs of Diptera. Often during overpopulation of the corpse, cannibalism is observed in *Thanatophilus*, and *Silpha*. Fungifagia was noted by us in *Necrodes*. Cases of coprophagy were observed in *Phosphuga Oiceoptoma*, but they are episodic in nature. On pellets of birds, we found *S. carinata*, and *Oiceoptoma*. The indications of some authors [35] on phytophagy in *Ablattaria* are, in our opinion, erroneous. *T. sinuatus* and *S. obscura* in the summer months pass to polyphagy. In [33, 36] were honored but the attack *Silpha* on slugs her, hearts her and soft-bodied invertebrates.

Based on the obtained materials, we have identified the following landscape-ecological complexes. *Eurytopobiontic species*. These include *T. sinuatus*, *A. undata*, *N.vespillo*, and *N. humator*. In the biotopes of the Caucasus, these are among the most dominants. *Stenotopic species*. Forest complex including *Oiceoptoma*, *Dendroxena*, *S. tristis*. The complex includes species that live in the forests and forest-steppes of Russia, and are confined to the forest belt of the Caucasus. *Steppe species*. These include *A. cribrata*, *N. sepultor*, and *N. germanicus*. The species are confined to open landscapes, avoiding both forests and sand dunes. *Forest-steppe species* including *Ph. atrata*. *Piedmont species* including *N. investigator*, *N. nigricornis* that are inhabitants of the foothills of the Caucasus. *Mountain views species* including *N. funeror*, *N. confusus*. In *anthropogenic* landscapes, we have identified 11 species. However, not a single species was synanthropic, and as in other regions of Russia, it does not pass to a synanthropic lifestyle.

### CONCLUSION

The dependence of the species composition of the Silphidae beetles on temperature parameters is determined by the limiting effect of low and high temperatures on the rate of development of larvae. Silphids are characterized by a one-year developmental cycle, with wintering at the pupal stage [36]. Humidity, to a large extent, determines the distribution of species closely associated with carrion. Drying too quickly does not allow the use of the substrate as

food for larvae, which inhibits the penetration into the dry zones of species that quickly dry out in an arid climate. A comparison of the fauna of the dead-eaters of the Caucasus with other adjacent territories clearly illustrates its exceptional wealth. It is determined by many factors including the diverse topography of the region, as well as its southern and simultaneously coastal geographical position. Probably one of the most important factors that contributed to the formation of the rich fauna of the Caucasian silphids was the effective refuges that existed there, which allowed stenotopic, thermophilic, and species with a narrow ecological valence to survive the climatic fluctuations of the Pleistocene.

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