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Use of Population Indicators of Beetle (Coleoptera, Silphidae, Dermestidae) in Bioindicacion of the Environmental Status

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ABSTRACT

Response of necrophagous beetles to the effects of environmental pollution, allows us to accurately determine the presence of a particular type of pollution in a natural object. However, the evaluation of this effect requires a detailed study. Material for the article was obtained using standard methods of entomological research.

Keywords: *Silphidae, Dermestidae, bioindicators, environment.*

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INTRODUCTION

Pollutants and types of technological pollution are estimated in thousands of items. Therefore, it is impossible to determine the content of a particular pollutant in various components of the environment and evaluate its toxicity. In this regard, it becomes necessary to use integral indicators of environmental quality, in particular, biological indicators (organisms and their presence or absence, number, and characteristics of their development according to specific environmental conditions). The literature highlights the responses of insects to environmental pollution at the levels of the organism, population, and biocenosis [1, 2].

Evaluating the population status of synanthropic species according to their biological parameters and organizing research on natural populations after their adaption to laboratory conditions allows the effects of pollutants and their toxicity to be determined over the course of two generations.

Among bioindicators, dead-eating beetles, as well as skin-eaters such as synanthropus are suitable for an integrated assessment of the quality of the human environment, because they are affected by the same pollutants and are very sensitive to environmental pollution.

The aim of this work was to evaluate the state of the populations of *Demestes lardarius L.* and *Thanatophilus sinuatus F.* collected in the territories of various settlements of Stavropol Territory, and establish a relationship between the degree of pollution and population indicators (e.g. egg viability and fertility of beetle populations) to trace the effect of pollutants on the mentioned species [3].

MATERIAL AND METHODOLOGY

D. lardarius was caught on the territory of the cities: Stavropol, Izobilny, Solnechnodolsk; sat: Hope, Tatar; country cooperative "Energetik". After this, the beetles were placed in cages. Eggs were received throughout the life cycle of adults. Each sample consisted of 20 individuals. *Th. sinuatus* was caught in Stavropol and was compared with natural populations from different regions of the study territory. The obtained indicators were translated into the relative units, in which those of the control populations were taken as 100%. A study was conducted to determine the effect of metal salts and insecticides on adults [4-7].

The assessment of the state of bioecosystems was based on an analysis of the abundance and density of the indicator species under specific conditions [4]. The indicator models are widely used in the practice of modeling the state of natural objects (geosystem monitoring) [8]. Natural objects obey the laws (normal for undisturbed systems), therefore, it is possible to predict the behavior of the system in specific conditions for several years ahead, based on the number of indicator species in a natural object.

RESULTS AND DISCUSSION

Table 1. The effect of livestock grazing on the frequency of the occurrence of / H / and / P / dead-eaters and skin-eaters (OO-abundant above 50%, O-normal 10-50%, H-often occurring 1-10%, P-rare 1%, E - single, - absent) *.

Species	Before grazing		1-year grazing		2-year grazing	
	H	P.	H	P.	H	P.
Dermestidae						
Dermestes murinus L.	R	1	E	<1	E	<1
D. fricshi Kug.	O	4	H	3	H	2
D. lardarius L.	-	-	E	<1	R	1
D. coronatus stev.	H	2	H	2	H	2
D. laniarius Ill.	H	3	H	2	H	2
D. maculatus Deg.	O	4	H	2	H	2
Orhpilus niger Rossi.	R	1	-	-	-	-
Silphidae						
Nicrophorus germanicus L.	H	3	R	1	-	-
N. humator F.	R	1	R	1	-	-
N. vespillo	H	2	H	2	H	2
N. antennatus	H	2	R	1	-	-
Necrodes littoralis L.	R	1	-	-	-	-
Thanatophilus rugosus L.	O	4	H	3	H	2
Th. sinuatus F.	OO	6	O	5	H	3
Th. dispar hbst.	O	4	H	2	H	2
Silpha carinata Hbst.	H	3	H	2	H	2
S. obscura M e n.	H	3	H	2	H	2
Phosphuga atrata L.	R	1	E	1	-	-
Ablattaria laevigata F.	R	1	-	-	-	-
A. cribr ata Men.	R	1	-	-	-	-

* note: density —ex./m^2, frequency of occurrence — the proportion of the species in the sample in %%.

The results of long-term observations reflecting the effect of unsystematic cattle grazing on the species composition of *Silphidae*, *Dermestidae* are presented in Table 1.

Haphazard grazing leads to the destruction of vegetation, the disappearance of rags (a hallmark of the "ecological health" of the biocenosis), and loosening of soil, which subsequently undergoes erosion. This leads to a depletion of the species composition of the plant and animal components of the biocenosis, in particular, dead-eating beetles and skin-eaters.

The analysis of the data presented in the Table shows that the species composition, abundance, and density of carrion beetles are reduced, with a slight increase in carpet beetles, which is generally explained by the release of econiches and higher kserofilizatsiya of the biocenosis.

As can be seen in Table 1, this grazing leads to the disappearance of indicator models of Silphidae, which indicates a violation of the ecosystem integrity.

We evaluated beetles from Stavropol in three series of experiments to assess the quality of three environments: the first series in the adjacent villages, the second series in the Abundant and summer house cooperative "Energetik", and the third series in Solnechnodoloska. The results of the experiments are presented in Table 2.

As a result, the dependence of fertility on the degree of contamination with various sets of pollutants was established. In terms of egg viability, the same pattern was observed. In the populations of necrobiontic species in the cities of Stavropol Territory, more or less pronounced "nanism" was noted. Dwarfism was observed in other species living in urban environments.

Table 2. The state of the viability of eggs and larvae, and fertility in the natural populations of *D. lardarius* from points differing in the degree and quality of pollution

Series	Population	M ± Δ		
		egg viability, %	average number, %	fertility eggs (pieces)
1	Stavropol:			
	- center;	74.0 ± 2.2	75.0 ± 1.5	90.0 ± 2.0
	- outskirts;	78.5 ± 2.3	76.5 ± 1.5	92.0 ± 2.0
	Hope;	81.0 ± 1.95	80.0 ± 1.90	95.0 ± 1.95
	Tatar;	89.5 ± 1.90	82.0 ± 2.0	100.0 ± 1.90
2	Abundant;	70.0 ± 2.50	73.5 ± 1.95	89.0 ± 1.0
	Power engineer;	71.0 ± 1.90	72.5 ± 1.90	91.0 ± 1.0
3	Solnechnodolsk.	73.0 ± 2.50	74.5 ± 2.0	90.0 ± 2.5

Th. sinuatus was collected in Stavropol and compared with natural populations [7]. The data obtained more clearly characterized the influence of environmental pollution on the development of species; egg viability: 59.5 ± 1.01%, fertility: 15 ± 1 eggs.

According to our observations, Cd salts lead to the abnormal development of elites. This is apparently caused by the mutagenic effect of salts. In addition, W and Mo salts lead to the mutation of elytra (twisted lower ends of the elytra). The use of new pesticides including Dursban, Diazole, Bazudin, and Bi-58 for pest control of agricultural products leads to a significant decrease in the fields and near species of the genera: *Silpha, Phosphuga, Thanatophilus, Dermestes, Nicrophorus,* and *Necrodes.*

Larvae emerging from eggs were characterized by low viability, 20% died without pupation. The adults were slightly smaller than the average size (8.9 mm).

A new generation of insecticides -Bio Kill, Desirol Killer- are effective in combating many harmful insects. According to the observations, the exposure of *Silpha obscura L* to one of the drugs began to appear on the 4th day when the body was dried up, the limbs became brittle, and the elites split; and the insect died on the 7th day. In this regard, the question arises of the correct dosage of drugs [7, 9-13].

Table 3. Frequency of occurrence /H./ and density /P./ of the species of dead-eating beetles and skin-eating beetles during the period of application of the stool and after *

Species	9.10. 2011		2012		2013	
	H	P.	H	P.	H	P.
Dermestidae						
Dermestes murinus L.	O	4	R	1	H	2
D. fricshi Kug.	OO	6	O	4	O	5
D. lardarius L.	-	-	-	-	E	<1
D. coronatus stev.	O	4	H	3	H	2
D. laniarius Ill.	H	3	H	2	R	1
D. maculatus Deg.	O	5	H	3	O	4
Orhpilus niger Rossi.	H	3	R	1	E	<1
Silphidae						
Nicrophorus germanicus L.	H	2	E	<1	-	-
N. humator F.	R	1	-	-	E	<1
N. vespillo	H	3	R	1	R	1
N. antennatus	H	3	R	1	R	1

Necrodes littoralis L.	H	3	H	2	H	3
Thanatophilus rugosus L.	O	4	H	2	H	3
Th. sinuatus F.	OO	7	O	4	O	4
Th. dispar hbst.	O	4	H	3	H	3
Silpha carinata Hbst.	O	4	O	4	O	4
S. obscura M e n.	H	3	H	2	H	3
Phosphuga atrata L.	H	2	R	1	H	2
Ablattaria laevigata F.	H	2	-	-	E	<1
A. cribrata Men.	R	1	-	-	-	-

* designations as in Table 1.

In recent years, steppes have often been used in the steppe to control weeds, which cover vast areas (especially on windy days), leading to the destruction of the natural community. The study of this anthropic factor on the state of the bioecosystem was carried out in the steppe biotopes in the vicinity of the cities of Stavropol, Solnechnodolsk, and Izobilny. When fallen, rags disappear from the surface of the soil, places that are not overgrown with vegetation appear, and the species composition of animals is reduced. The fauna of *Silphidae is* most affected by the relative stability of *Dermestidae* (Table 3).

CONCLUSION

The haphazard grazing par with bollards is a major factor leading to the impoverishment of the ecosystem (Engl. Ecosystem pauperization).

Table 4. List of synanthropes and eurytopobionts

Synanthropes	Eurytopobionts
Anthrenus museorum, Dermestes lardarius.	*Anthrenus scrophulariae, A. verbassci, Attagenus unicolor, Dermestes maculatus, D. frischi, D. sibiricus, Necrodes littoralis, Thanatophilus rugosus, Th. sinuatus.*

Table 5. Assessment scale of "ecological health" of forest systems *

Species	Forest Bioecosystems													
	Mamaisky Forest		Tamanskaya forest-cottage		Russian forest		Lopatinsky forest		Dark forest		Victory Park		Park Center	
	H	P	H	P.	H	P	H	P	H	P.	H	P.	H	P.
Oiceoptoma toracica	O	4	O	4	O	5	O	5	O	6	H	3	R	1
Necrodes littoralis	O	4	H	3	O	5	O	6	O	7	O	4	H	2
Nicrophorus humator	H	3	H	2	O	6	O	6	O	7	H	2	H	2
Average value (H)	3.66		3		5.33		5.66		6.66		3		1.66	
Preservation degree on a 7 point scale	4		3		5		5		5		3		2	

* Note: The degree of safety; 2:unsatisfactory; 3:satisfactory; 4:good; 5:excellent.

Paving roads and trampling trails lead to changes in the structural integrity of the biocenosis. The corpses of animals are concentrated on roads and along with them. Animals die as a result of a collision with vehicles and at the hands of humans. On the footpath there is a burying beetle (*Nicrophorus*) “desert” - these bugs do not bury the corpse on compacted soil. In the food substrate dominated polyphages (*Silpha, Thanatophilus*), rare highly specialized monophages (*N. germanicus*) and *Ablattaria, Oiceoptoma.* In these stations, a large number of eurytopobiontic species of the genera *Dermestes, Thanatophilus* are large, but they are not able to quickly eliminate animal corpses. Therefore, in anthropogenic cenoses there are many "unclaimed" burying beetles of corpses that become "inhabited" synanthropic animals (including vertebrates).

In anthropogenic systems (city, village), synanthropic groups of necrophages and the most plastic species in food and environmental terms have spread (Table 4). In forest bio-ecosystems, it is advisable to conduct monitoring using the abundance and density of the following indicators: *Oiceoptoma toracica, Nicrophorus humator,* and *Necrodes littoralis.* Based on our original studies, we developed a scale for assessing the state of forest bio-ecosystems (Table 5).

Thus, necrophagous beetles, especially necrobiont synanthropic, can be used as biological indicators of the environmental quality in terms of fertility and egg viability. The methodology for determining these indicators is simple, affordable, and economical; it can be included in the environmental monitoring system to assess the degree of industrial pollution and the quality of the human environment.

Conflict of interest

The work was carried out by the authors on their own without the use of any support.

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