

**ЭМПИРИКАЛЫҚ ЗЕРТТЕУЛЕР
ЭМПИРИЧЕСКИЕ ИССЛЕДОВАНИЯ**

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**THE COMPARATIVE ANALYSIS OF THE SOIL
INVERTEBRATES COMMUNITIES (MACROFAUNA) ON VIRGIN AND
CULTIVATED LANDS OF KOSTANAY DISTRICT, KOSTANAY REGION****Abstract**

The soil population (macrofauna) is a good indicator of the ecological status of the ecosystem. Large soil invertebrates are sensitive to changes in the chemical and physical properties of soils, the reaction of soil solutions, which leads to changes in their population structure, abundance, and biomass. The purpose of this work is to analyze changes in the population structure of soil invertebrates (macrofauna) under the influence of prolonged plowing and fallowing of agricultural lands in conditions of southern black soil (chernozem) on loams. The material was collected using the method of soil and zoological samples. The composition and the population density of the macrofauna in the virgin land and agricultural clean cultivation fields were analyzed. Changes in the population structure on the virgin plot and on agricultural land with different modes of use are noted.

Key words: *soil invertebrate, macrofauna, southern black soil (chernozem), Kostanay region, virgin steppe, clean cultivation.*

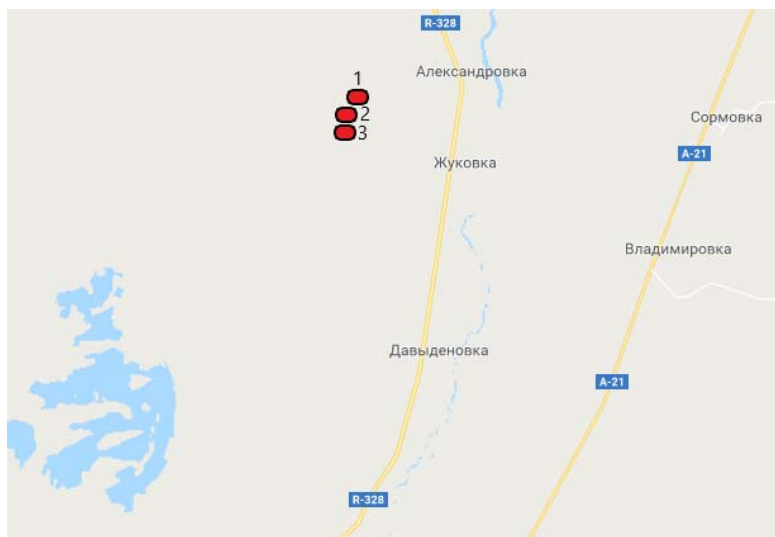
1 Introduction

Soil as habitat is a unite system with populations of various organisms inhabiting it. To assess the change of ecological state of natural and economically used ecosystems the various methods of analysis were used. Large invertebrate animals (Macrofauna) present a high indication value [1-3] because they respond to changes of chemical and physical features of soil, distribution, and composition of air, soil consistency, which, in turn, leads to changes in the structure of their population, abundance and biomass.

This paper is focused to the analysis of the comparative composition of the communities of soil invertebrates (macrofauna) on virgin and cultivated lands, which are located in the subzone of southern black soil (chernozem). There are a number of publications by Bragina TM, which reflect the issues of species composition, distribution, density and structure of soil invertebrates of the steppe areas of the Kostanay region [3-9].

2 Materials and methods

The works were carried out at three sites that are managed by Aleksandrovskoye LLP, Alexandrovsky Rural District, Kostanay District, Kostanay Region (Picture 1).



Picture 1 – Stationary sites of soil-zoological sampling. Kostanay district, Kostanay region. 2018
1 – virgin steppe; 2 – fertilized agriculture field with clean cultivation;
3 – non-fertilized agriculture field with clean cultivation

The geobotanical description of the work sites has been carried out.

The study of macrofauna was made by the method of soil-zoological samples [10]. A total of 16 samples of 25 cm x 25 cm in size were collected at each site up to the depth of occurrence of invertebrates. A total of 48 samples were collected and analyzed. Samples were collected by hand sorting layer by layer: 0-10 cm, 10-20 cm, 20-30 cm, 30-50 cm. All collected objects were fixed in 70% ethanol and labeled. Further processing and identification of invertebrates were carried out in the laboratory of the Research Center Problems of Ecology and Biology (SRC PEB) of the KSPU. Samples of the virgin steppe (first) site were taken on 22nd May, 2018, on cultivated lands with clean cultivation (second and third) on 6th June, 2018 and 6th June, 2018.

The following scale of dominance was applied for the analysis of the communities of soil invertebrates: invertebrates belonged to the group of dominants, the number of which was 10% or more of the total number of invertebrates collected, and subdominant groups included groups that ranged from 5% to 10% of the total number of invertebrates. Materials are processed statistically.

3, 4 Results and discussion

Description of the sites:

Site 1. The virgin steppe. The site is located on the territory of the Aleksandrovsky rural district of Kostanay district, 43 km north of Kostanay. The geographical coordinates are 53°53', 63°79'. The site has a slightly undulating relief. Fescue – feather grass – cereal (*Stipa lessingiana* – *Festuca valesiaca*) virgin steppe Community edificator (cop₃) is *Festuca valesiaca* Gaud. Coedificators (cop₁) are *Stipa lessingiana* Trin. & Rupr. and *Stipa capillata* L. *Phleum phleoides* (L.) Karst was marked in fewer cereals (sp). Motley grass in the community is represented by the following species: *Carex humilis* Leyss., *Artemisia dracunculus* L., *Artemisia austriaca* Jacq., *Potentilla argentea* L., *Galium ruthenicum* Willd., *Thymus marschallianus* Willd., *Thymus* sp., *Centaurea* sp., *Veronica incana* L., *Achillea millefolium* L., *Tanacetum* sp., *Plantago minuta* Pall., *Salvia* sp., *Nonea rossica* Steven, *Astragalus danicus* Betz., *Scorzonera* sp., *Euphorbia* sp. The soil is southern black soil (chernozem), light loamy.

Site 2. The clean cultivation since the 2017 year. The site is located on an agriculture field with a total area of 117 hectares (sector number 43). The geographical coordinates – 53°51', 63°78'. Applied fertilizer «Ammophos» (150 kg/ha). On this site in 2017 a subsurface tillage was carried out as follows:

➤ 1 tilling (after field-seeded, end of May) – Seeder-cultivator grain stubble (SZS-2,1) – depth 5 – 6 cm.;

- 2 tilling (middle of June) – Seeder-cultivator grain stubble (SZS-2,1 – depth 8–10 cm.);
- 3 tilling (beginning of July) – flat-top cultivator (KPSH-9) – depth 12–14 cm.;
- 4 tilling (middle of August) – fertilizer distribution SZS-2,1 (depth 14–16 cm.);
- 5 tilling late September after harvesting by subsurface plow PG 3-5 (depth 18–23 cm.).

In 2018, the field was sown with wheat. Before sowing, seeds were treated with «the Viking» systemic fungicide (WSC water suspension concentrate, carboxin 170 g/l + thiram 170 g/l) of controlling a complex of seed, soil and aerogenic infections in a volume of 10 l per 1 ton of seeds, consumption rate 2 l/ha.

Site 3. The clean cultivation since the 2017 year. The site is located on an agriculture field with a total area of 180 hectares (sector number 68). The geographical coordinates – 53°50', 63°78'. Fertilizers and chemicals and chemical weeding did not take place. Soilless tillage was carried out in 2017 according to the scheme of the previous field with the exception of fertilization:

- 1 tilling (after field-seeded, end of May) – Seeder – cultivator grain stubble (SZS-2,1) – depth 5–6 cm.;
- 2 tilling (middle of June) – Seeder-cultivator grain stubble (SZS-2,1 – depth 8–10 cm.);
- 3 tilling (beginning of July) – flat-top cultivator (KPSH-9) – depth 12–14 cm.;
- 4 tilling late September after harvesting by subsurface plow PG 3-5 (depth 18–23 cm.).

Before sowing, seeds were treated with «the Viking» systemic fungicide (WSC water suspension concentrate, carboxin 170 g/l + thiram 170 g/l) of controlling a complex of seed, soil and aerogenic infections in a volume of 10 l per 1 ton of seeds, consumption rate 2 l/ha.

In the period of research in the first site, the average daytime temperature was 18° C, night temperature 22° C. The average daily atmospheric pressure is 750 mm. Hg Art. During the period of work on the second and third sites, the average daily temperature was 30° C, and the nighttime temperature was 20° C. The average daily atmospheric pressure was 742 mm. Hg Art.

During the period of work, invertebrates belonging to 2 Phylum, 5 Orders were collected. The representatives of Class Insecta were the most diverse. The coleopterans was presented by 11–12 families (table 1).

In the virgin area the total density of the soil invertebrate community amounts to 112,0 ind./m² excluding ants (table 1), including ants 429,0 ind./m².

Table 1 – Comparative composition, density (individuals/m²), and abundance (% of total abundance) of soil invertebrates (macrofauna) on virgin and cultivated lands in the subzone of the southern black soil (chernozem) of Kostanay district of Kostanay region (excluding Formicidae). May-June, 2018 year

Composition	Population density (ind./m ²) / % of the total number excluding ants		
	Fescue – feather grass-cereal (<i>Stipa lessingiana</i> – <i>Festuca valesiaca</i>) virgin steppe. Southern chernozem. Light loamy. Kostanay district	Fertilized agriculture field with clean cultivation. Alexandrovsky rural district, Kostanay district	Non-fertilized agriculture field with clean cultivation. Alexandrovsky rural district, Kostanay district
ARANEI	9,0/8,0	3,0/3,1	7,0/4,1
MYRIAPODA	-	1,0/1,06	-
HETEROPTERA	25,0/22,3	7,0/7,4	20,0/11,9
COLEOPTERA	61,0/54,4	55,0/58,5	135,0/80,3
- Carabidae	12,0/19,6	25,0/45,4	90,0/66,6
imago	8,0	22,0	85,0
larvae, pupa	4,0	3,0	5,0
- Elateridae	16,0/26,2	16,0/29,0	18,0/13,3

- Scarabaeidae	10,0/1,6	4,0/7,2	4,0/2,9
imago	-	-	-
larvae, pupa	1,0	4,0	4,0
- Tenebrionidae	-	4,0/7,2	4,0/2,9
- Coccinelidae	13,0/21,3	2,0/3,6	2,0/1,4
- Chrysomelidae	6,0/9,8	1,0/1,8	6,0/4,4
- Curculionidae	4,0/6,5	1,0/1,8	5,0/3,7
- Staphylinidae	1,0/1,6	-	2,0/1,4
- Meloidae	-	-	2,0/1,4
- others coleopterans	8,0/13,1	2,0/3,6	2,0/1,4
DIPTERA	15,0/13,3	27,0/28,7	5,0/2,9
LEPIDOPTERA	1,0/0,8	-	-
HYMENOPTERA	1,0/0,8	-	1,0/0,5
TOTAL (ind./m²)	112,0	94,0	168,0
Quantity per sample (ind./0,0625 m ² M _m ± m)	7,0	5,88	10,5
CV (%) (coefficient of variation)	76,5	43,45	44,4

Taxonomic groups such as Coleoptera (54,4%), Heteroptera (22,3%) and Diptera (13,3%) dominated in the virgin area (site 1). In the structure of the Coleoptera order, the dominants were representatives of such families as Elateridae (26,2%), Coccinelidae (21,3%) and Carabidae (19,6%). Chrysomelidae (9,8%) and Curculionidae (6,5%) were sub-dominants. Scarabaeidae and Staphylinidae were accounted for 1,6% of the total number of beetles.

The density of soil invertebrates (macrofauna) community in the fertilized agriculture field with clean cultivation (site 2) was 94,0 ind./m². Coleoptera (58,5%) and Diptera (28,7%) is the dominant group. In the coleopteran order structure Carabidae made up 45,4% of the total number of individuals of the order, Elateridae – 29,0%, Scarabaeidae – 7,2% and Tenebrionidae – 7,2%, Coccinelidae – 3,6%, Chrysomelidae – 1,8% and Curculionidae – 1,8%. Representatives of the order Heteroptera are classified as subdominants (7,4%).

The population density of soil invertebrates (macrofauna) in the non-fertilized agriculture field with clean cultivation (site 3) was 168,0 ind./m². The dominants were represented by the following groups: Coleoptera (80,3%), Heteroptera (11,9%). Subdominants were not identified, since the remaining groups accounted for less than 5,0% of the total. Representatives of Carabidae (66,6%) and Elateridae (13,3%) dominated among Coleoptera. The order Heteroptera was represented by a group of Thyreocoridae.

According to the results of the work, it was found that during the study period, the highest density of macrofauna were observed in the virgin area and reached 429,0 ind./m² (excluding ants – 112,0 ind./m²), whereas on cultivated land ants were not observed.

The density of macrofauna (excluding ants) was higher in the non-fertilized site with clean cultivation due to the high activity of ground beetles' imago (Coleoptera, Carabidae), which accounted for up to 70,0% of the total number of collected invertebrates.

During the period of work in all three sites in the work area representatives of the Carabidae (127 ind., 18,3%) dominated; Elateridae (50 ind., 7,2%), Heteroptera (52 ind., 7,5 %) and Diptera (47 ind., 6,80%) were as sub-dominants; the remaining groups accounted for less than 3,0% of the total were noted. Larvae and imago of pests of the Elateridae (Picture 2) were found on agricultural fields, for example, *Selatosomus latus* and *Selatosomus aeneus* and *Agriotes sputator*.



Picture 2 – *Selatosomus latus* (site 2, Kostanay district, 06.07.2018)

The number of phyto-saprophagous (Scarabaeoidea, Tenebrionidae) – Scarabaeoidea – sharply decreased from 10,0 ind./m² in the virgin area to 4,0 ind./m² in the cultivated lands; Tenebrionidae – from 13,0 ind./m² to 2,0 ind./m² on the cultivated lands. On the other hand, the number of pests of agricultural crops did not change or became higher (from 16,0 ind./m² to 18,0 ind./m² in the site with clean cultivation). Generally, it consists of the previously obtained data for the subzone of dark chestnut soils in the region, where such changes were more pronounced [3 – 9].

5 Conclusion

Under the conditions of southern black soil (chernozem) on loams, the density of communities of the large soil invertebrates (macrofauna) in the late spring period (before planting crops) in 2018 ranged from 94,0 ind./m² on a clean cultivation site to 429,0 ind./m² (excluding ants – 112,0 ind./m²) on a virgin site with a fescue – feather grass – cereal (*Stipa lessingiana* Trin. – Rupr. + *Festuca valesiaca* Gaud.) virgin steppe.

The density of phyto-saprophagous (Scarabaeoidea, Tenebrionidae) – Scarabaeoidea – significantly decreased from 10,0 ind./m² in the virgin steppe to 4,0 ind./m² on the cultivated lands; Tenebrionidae – from 13,0 ind./m² in the virgin steppe to 2,0 ind./m² on the cultivated lands. At the same time, the number of pests of agricultural crops did not change or became higher (Elateridae – from 16,0 ind./m² to 18,0 ind./m² in the area with clean cultivation).

In the clean cultivation sites during this period no ants were observed. Apparently, they colonize them later. The survival refugium for ants is represented by preserved virgin steppe areas.

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ҚОСТАНАЙ ОБЛЫСЫ ҚОСТАНАЙ АУДАНЫНЫҢ ТЫҢ ЖӘНЕ ӨНДЕЛЕТІН ЖЕРЛЕРІНДЕ ТОПЫРАҚ ОМЫРТҚАСЫЗДАРЫНЫҢ (МЕЗОФАУНА) ОРНЫҒУЫН САЛЫСТЫРМАЛЫ ТАЛДАУ

Топырақ қауымдастығы (мезофауна) экожүйенің экологиялық жағдайының жақсы көрсеткіші болып табылады. Ірі топырақ омыртқасыздары топырақтың химиялық және физикалық қасиеттеріндегі өзгерістерге сезімтал, топырақ ерітінділерінің реакциясы, олардың қауымдастық құрылымында өзгерістерге, молшылыққа және биомассаға әкеледі. Осы жұмыстың мақсаты саздақтардағы оңтүстік қара топырақ жағдайында ұзақ жырты және ауыл шаруашылығы алқаптарының булануы әсерінен топырақ омыртқасыздары (мезофауна) қауымдастық құрылымының өзгеруін талдау болып табылады. Материал жинау топырақты-зоологиялық үлгілері әдісімен орындалды. Тың учаскесінде және бу астындағы ауыл шаруашылығы алқаптарында мезофауна қауымдастығының құрамы мен тығыздығына талдау жүргізілді. Қауымдастық құрылымында тың игеру жерлері мен әртүрлі пайдалану режимдеріндегі ауыл шаруашылық саздақтарда өзгеру анықталды.

Кілт сөздер: топырақты омыртқасыздар, мезофауна, оңтүстік қара топырағы, Қостанай облысы, тың дала, булау.

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СРАВНИТЕЛЬНЫЙ АНАЛИЗ НАСЕЛЕНИЯ ПОЧВЕННЫХ БЕСПОЗВОНОЧНЫХ (МЕЗОФАУНА) НА ЦЕЛИННЫХ И ОБРАБАТЫВАЕМЫХ ЗЕМЛЯХ КОСТАНАЙСКОГО РАЙОНА КОСТАНАЙСКОЙ ОБЛАСТИ

Почвенное население (мезофауна) является хорошим индикатором экологического состояния экосистемы. Крупные почвенные беспозвоночные чувствительны к изменениям химических и физических свойств почв, реакции почвенных растворов, что приводит к изменениям в структуре их населения, численности и биомассе. Целью данной работы является анализ изменений структуры населения почвенных беспозвоночных (мезофауна) под влиянием длительной распашки и парования сельскохозяйственных угодий в условиях южных черноземов на суглинках. Сбор материала проводился методом почвенно-зоологических проб. Проведен анализ состава и плотности населения мезофауны на целинном участке и сельскохозяйственных полях под паром. Отмечены изменения в структуре населения на целинном участке и на сельскохозяйственных угодьях с разным режимом использования.

Ключевые слова: почвенные беспозвоночные, мезофауна, южный чернозем, Костанайская область, целинная степь, парование.