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НАО «КОСТАНАЙСКИЙ РЕГИОНАЛЬНЫЙ УНИВЕРСИТЕТ ИМЕНИ АХМЕТА БАЙТУРСЫНОВА»

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АЗИЯ ДАЛАЛАРЫНДАҒЫ БИОЛОГИЯЛЫҚ ӘРТҮРЛІЛІК

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В сборнике опубликованы материалы IV Международной научной конференции «Биологическое разнообразие азиатских степей». В докладах рассмотрены итоги исследований и перспективы сохранения биологического разнообразия степных экосистем, островных и ленточных лесов и водно-болотных угодий степной зоны Евразии, охраны природных территорий и популяций видов особого природоохранного значения, формирования экологической сети и вклад вузов в изучение биоразнообразия, вопросы интеграции естественных наук и образования. Книга предназначена для ученых и практиков, работающих в области изучения и сохранения биологического разнообразия, преподавателей вузов, аспирантов, студентов, работников природоохранных учреждений.

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ABUNDANCE AND STRUCTURE OF SOIL INVERTENRATES (MACROFAUNA) OF THE VIRGIN STEPPE OF THE SOUTHERN CHERNOZEM ZONE (KOSTANAY REGION)

Численность и структура почвенной макрофауны (беспозвоночных) целинной степи на южном черноземе Костанайской области

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Аннотация. Топырақ фаунасы – топырақтың негізгі тірі компоненттерінің бірі, оның жұмысында маңызды рөл атқарады. Біздің зерттеулеріміздің мақсаты Қостанай облысының оңтүстік қара топырақты аймағының тың топырақтарындағы топырақ мезофаунасы қауымдастықтарының санын, құрылымын және мекендеу орындарын талдау болды. Топырақ микробты түрлендірілген органикалық заттар мен метаболикалық катиондардың жоғары құрамымен сипатталады. Топырақ омыртқасыздарының (мезофаунаның) қауымдастықтарында жәндіктер басым болды (89,0%), олардың арасында колеоптера басым болды (54,0%). Эврибион түрлерінің басым болуы климат пен өсімдіктердің алуан түрлілігін көрсетеді.
Түйінді сөздер: мезофауна, жәндіктер, омыртқасыздар, Қостанай ауданы, тың, оңтүстік қара топырақтар.

Аннотация. Почвенная фауна представляет собой один из основных живых компонентов почв, играющий важную роль в ее функционировании. Целью наших исследований был анализ численности, структуры и местообитаний сообществ почвенной мезофауны на целинных почвах южной черноземной зоны Костанайской области. Почва характеризуется высоким содержанием микробно преобразованного органического вещества и обменных катионов. В сообществах почвенных беспозвоночных (мезофауна) преобладали насекомые (89,0%), среди которых доминировали жесткокрылые (54,0%). Преобладание эврибионтных видов отражает особенности климата и разнообразие растительности.
Ключевые слова: мезофауна, насекомые, Костанайский район, целина. Южные чернозёмы.

Abstract. The soil fauna represents one major living constituent of soils, being important for the functioning of soils. The goal of our research was to analyze the abundance, structure and habitat of soil macrofauna communities on virgin soils of the southern chernozems zone of the Kostanay region. The soil is characterized by high contents of microbially transformed organic matter and of exchangeable cations. Soil invertebrate communities (macrofauna) were dominated by insects (89,0%), among which Coleoptera predominated (54,0%). The predominance of eurybiont species reflects the peculiarities of the climate and the diversity of vegetation.
Key words: macrofauna, Insects, Invertebrates, Kostanay region, virgin soil, Southern chernozems.

Introduction.

Soils are the vulnerable skin of the Earth, being connected to all neighboring spheres by energy and matter exchange. Soils have always been the most important natural productive resource of human societies as they are the basis of food production. In recent years, other services of soils are considered important, including their role in mitigating climate change, in

buffering pollutants and being a source of biodiversity. Hence, soils have long been the subject of studies, dealing with issues such as conservation and restoration of this resource.

Soils can be considered as living metaorganisms, being formed by biotic processes and at the same time providing the habitat for life. Thus, soils are inhabited by a diverse community of organisms [4-7], which directly or indirectly depend not only on the habitat, but also on the food resource.

The most important soil properties largely depend on the vital activity of soil organisms, which are an essential component of soil ecosystems. At the same time, the soil macrofauna is greatly influenced by the physical and chemical properties of soils, for example, the granulometric composition, soil aggregation, the content and nature of plant residues, the amount of humus, acidity, carbonate content, hydrological and salt regimes.

This paper presents the results of a study of the species composition, structure and habitat of the soil macrofauna (invertebrates) of virgin lands on the southern chernozems of the Kostanay district of the Kostanay region (Kazakhstan).

Material and methods. The study was carried out on the virgin steppe on the southern chernozem of Kostanay oblast on May-June 2019. The northern parts of the Kostanay oblast is located in the northern flat part of the Turgay Valley, in the zone of its confluence with the southern outskirts of the West Siberian lowland. Compared to other plains in the south of Western Siberia, Kostanay is relatively elevated and better drained. The absolute heights of flat undulating interfluves range from 170-230 m with. The study site is located 5 km to the west from the village of Aleksandrovka, 43 km north of Kostanay. The geographical coordinates are 53˚31' N, 64˚47' W (Fig. 1), and the site is located is at an altitude of 510 meters above sea level. The relief at the investigated plots is slightly undulating.

Figure 1 – Location of the study in the norther part of the Kostanay oblast, Kazakhstan

According to the data КАЗГИДРОМЕТ (Kazhydromet) [9], the average annual temperature for the Kostanay district is +2.8° C. The average temperature of the coldest month (January) is – 16.4°C, and on some days in the most severe winters, the temperature drops to -

44°C. The warmest month is July, with an average temperature of 20.5°C, and in some years, the daytime air temperature rises to up to 42.5°C. The average annual rainfall is about 330 mm. The precipitation is more abundant in warm period (April-October) than the in colder one; summer precipitation amounts to about 130 mm on average. The growing season is about 170 days.

The plant association is fescue- feather grass-cereal (*Stipa lessingiana – Festuca valesiaca*) virgin steppe [1].

To characterize the soil in the study area, a soil profile was dug down to 1 m depth, characterized by field methods. The description of the soil profile was carried out with the registration of the following characteristics: coordinates, relief, vegetation, land cover, climate, parent material. Afterwards, a record was made of the distribution along the horizon of such indicators as colour, moisture, pores and cracks, texture (FT), rooting depth, root distribution and soil structure. The colour was determined according to the Munsell soil color scale. After soil description, samples were taken by horizon (in the satellite samples in depth increments of 0-10 cm, 10-20 cm, 20-30 cm), the excavated soil was refilled and the pits were carefully closed again.

The samples were air-dried and subsequently analyzed for texture determined in the laboratory (LT), analysis for carbonate content using the Scheibler method, cation exchange capacity with the Hendershot and Duquette (1986) [2] method with extraction by $BaCl_2$ and measurement of the cations by ICP-OES (inductively coupled plasma-optical emission spectrometry), pH and electrical conductivity. In addition, three satellite samples with 3 depths 0-10 cm, 10-20 cm and 20-30 cm were taken to assess soil organic matter of the A horizon. The satellite samples were dried at 60°C and measured for C, N, $\delta^{13}C$ and $\delta^{15}N$ on an element analyser coupled to an isotope ratio mass spectrometer (EA-IRMS). Before analysis, carbonate was removed by vaporization over 37% HCl for 48 h.

The soil classification was done according to the World Reference Base for Soil Resources (WRB) [3].

The landscape with its vegetation in which the soil profile is located is shown in Fig. 2.

Figure 2 – Plant association of research site: fescue – feather grass – cereal (*Stipa lessingiana – Festuca valesiaca*)

Soil invertebrates (macrofauna) were selected by the method of soil-zoological sampling in the field [8]. Before sampling, the vegetation was cut from the sampling spot, a litter layer transferred onto a plastic sheet and sorted the visible invertebrates manually. After that, a soil block of 25 cm x 25 cm and 10 cm thickness as excavated every 10 cm by cutting along edges first and avoiding cutting inside a block down to a depth of 30-50 cm. Each soil block was distributed on a plastic sheet, manually sorted invertebrates were recovered and placed in labeled plastic or glass containers. After that, the sorted soil was returned into the soil pit and the spot as left in an undisturbed state. All objects were labeled and placed in test tubes with 90–99% ethanol. Further, in the Research Center for Ecology and Biology of the Kostanay Regional University named after A. Baitursynov, all invertebrates underwent a morphological determination. In the process of studying soil invertebrates, 429 objects of the different systematic groups were processed from 16 samples. Groups of invertebrates, the relative abundance of which was more than 10% of the total number of collected invertebrates, were classified as dominants, 5-10% – as sub-dominants.

Results and discussion. The soil profile is shown in Fig. 3 and consists of four horizons [3].

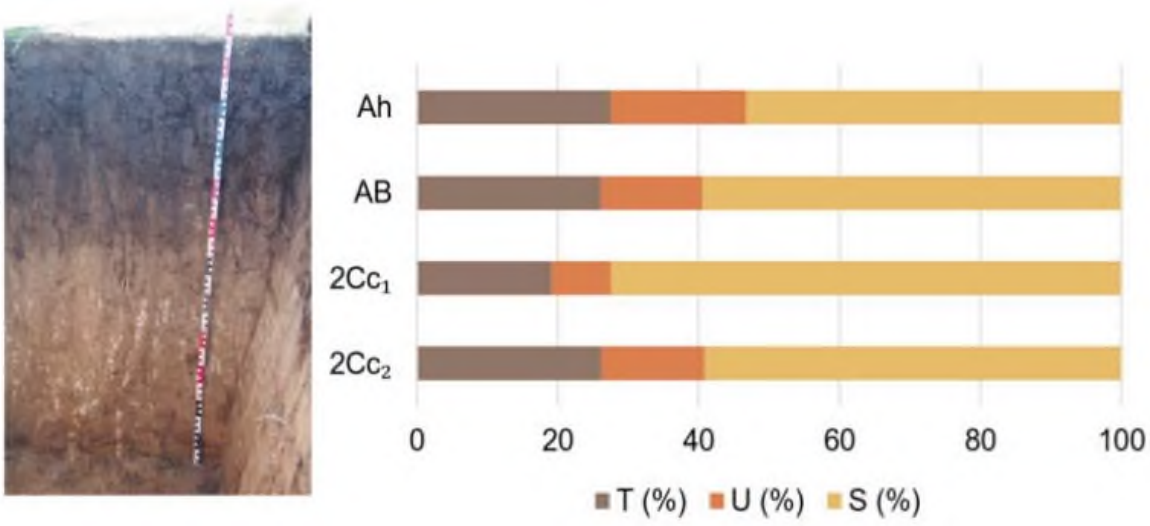

Figure 3 – Texture and photo of profile

Horizon 1 – Ah, was 33 cm, with a wavy and diffuse horizon boundary. The colour of the first horizon corresponds to the Munsell colour scale of 10YR 2/2. The soil was moist and the aggregate structure was subangular blocky. There were dry cracks and the texture was classified as sandy clay loam (FT). In this horizon the fine root density was high.

Horizon 2 – AB, was 19 cm, with some tungues stretching into the horizon underneath. The colour of the horizon corresponds to the Munsell colour scale of 10YR 2/2 and 10YR 2/3. The soil was dry and the aggregate structure was clumpy to sub angular blocky. The texture (FT) was classified as sandy clay loam, and the fine root density was intermediate.

Horizon 3 – 2Cc1, was 13 cm, with a clear boundary to the horizon underneath. The colour of the horizon corresponds to the Munsell colour scale is 10YR 4/4 and 10YR 2/3. The soil was dry and the aggregate structure was sub angular blocky. The texture (FT) was classified as sandy loam, and the horizon had a intermediate fine root density.

Horizon 4 – 2Cc2, was 49+ cm. The colour of the horizon corresponds to the Munsell colour scale is 10YR 4/4 and 10YR 7/3. The soil was very dry and the aggregate structure was

weak subangular blocky. The texture (FT) was classified as sandy clay loam with much carbonate and carbonate concretions. In this horizon a weak fine root density was given.

In view of the results presented, the soil can be classified is a Southern Chernozem, and according to WRBB [3] as a Caclic Chernozem (Arenic, Tonguic).

Table 1 – Results of pH and conductivity, shown is the course of the pH-values in $CaCl_2$ solution and distilled water depending on soil horizons

№	horizon	pH $CaCl_2$	pH water	Electrical conductivity [µS cm^{-1}]
1	Ah	6.1	6.5	67.3
2	AB	6.8	7.3	40.8
3	$2Cc_1$	8.9	8.6	91.6
4	$2Cc_2$	8.3	8.7	109.2

Laboratofy texture data (LT) confirm field analysis, and showed an increase in the sand content and a decrease in the clay and silt content from the Ah horizon to the $2Cc_1$ (Fig. 3). In the horizon $2Cc_2$ the sand content decreases and the clay and silts content increased. Analysis of the obtained data shows that the soil type is sandy clay loam and in Cc_1 sandy loam.

The pH and conductivity are important parameters for many chemical and biological processes in the soil, as they are the main variables for nutrient availability and salinity. Result of pH and conductivity are shown Table 1.

The soil showed slightly acidic conditions in the Ah horizon, neutral pH in the AB horizon, and slight to moderate alkalinity in the subsoil; the electrical conductivity absence of salinity.

The results of the study of nutrients and the base saturation as well as the effective cation exchange capacity are presented in the Table 2.

Table 2 – Results of exchangeable nutrient; shown are effectiv cation exchange capacity (CEC_{eff}) with the exchangeable nutrients Ca, Mg, K, and Na (all parameters in $cmol_c\ kg^{-1}$), and base saturation (BS; %) in the soil horizons

№	horizon	CEC_{eff} [$cmol_c\ kg^{-1}$]	Ca [$cmol_c\ kg^{-1}$]	Mg [$cmol_c\ kg^{-1}$]	K [$cmol_c\ kg^{-1}$]	Na [$cmol_c\ kg^{-1}$]	BS [%]
1	Ah	21.9	18.0	3.5	0.4	0.0	100
2	AB	18.0	14.7	3.1	0.1	0.0	100
3	$2Cc_1$	11.0	9.5	1.4	0.1	0.0	100
4	$2Cc_2$	16.1	11.8	4.1	0.1	0.0	100

The effective cation exchange capacity was 21.9 $cmol_c\ kg^{-1}$ in the topsoil, which is relatively high, and decreased moderately ith soil depth. Carbonates were only identified in the subsoil, and according to Scheibler analysis had a content of 4% in $2Cc_1$ horizon and 7.3% in the $2Cc_2$ horizon.

Organic carbon (OC) and total nitrogen (TN) are important parameters for determining soil quality and degradation grade. The average value and the standard mixture of the parameters organic carbon (C_{org}), total nitrogen (N), C/N, $\delta^{13}C$ and $\delta^{15}N$ are presented in Tab. 3.

Table 3 – Organic carbon (OC) and total nitrogen (N) contents, C/N ratios, and $\delta^{13}C$ and $\delta^{15}N$ values of the soil. Mean (n=3) and standard deviation are shown.

depth [cm]	**OC**		**TN**		**C/N**		**$\delta^{13}C$**		**$\delta^{15}N$**	
	mean [%]	standard deviation [%]	mean [%]	standard deviation [%]	mean [%]	standard deviation [%]	mean [‰]	standard deviation [‰]	mean [‰]	standard deviation [‰]
0-10	2.8	0.4	0.2	0.0	12.0	0.7	-25.4	0.2	6.2	0.4
10-20	2.2	0.4	0.2	0.0	11.7	0.7	-25.1	0.3	6.8	0.4
20-30	1.7	0.3	0.2	0.0	11.3	0.7	-23.0	0.4	7.0	0.4

The soil organic matter is one of the most essential elements of life on Earth and it is a master variable for water content and nutrient storage. In general, the OC content is moderate and a decrease of the organic carbon content from 2.8% to 1.7% with soil depth can be seen. The carbon stock shows to what extent the soil serves as a carbon sink, and was calculated as 92.0 t ha^{-1} for the first 30 cm of the soil.

Nitrogen belongs to the macro nutrients, therefore it is essential for plant growth. Total N content was 0.2% and total nitrogen stock was 7.9 t ha^{-1}. When considering a mineralization rate of 0,5% per year, this corresponds to a release of mineral nitrogen of about 40 kg ha^{-1}.

The C/N ratio provides information on the activity of the microorganisms and the fertility of the soil. The C/N ratio is quite narrow and slightly decreased with soil depth, indicating a high microbial contribution to the soil humus.

The natural abundance $\delta^{13}C$ and $\delta^{15}N$ ratios also indicate microbial transformation of the organic matter. The $\delta^{13}C$ increased from -25.4‰ to -23.0‰, indicating a C3 plant origin of the organic matter and its pronounced microbial transformation, thus agreeing with the narrow C/N ratios. Also the high $\delta^{15}N$ ratios of 6.2‰ to 7.0‰ suggests pronounced microbial recycling

The total density of soil invertebrates in the virgin steppe soils were 187 individuals/m^2 excluding ants (Table 4) and 1085.0 individuals/m^2.

Table 4 – Composition, density (individuals/m^2), abundance (% of total abundance), mass (g/m^2) of soil invertebrates (excluding Formicidae) of a virgin steppe soils in the subzone of the southern chernozems of Kostanay district of Kostanay oblast. May – June, 2019

Composition	Population density (individuals/m^2) / % of the total number excluding ants
1	2
ARANEI	11.0/5.9
HETEROPTERA	47.0/25.1
COLEOPTERA	101.0/54.0
- Carabidae, imago	14.0/7.5
- Elateridae	23.0/12.3
- Scarabaeidae, imago	2.0/1.1
- Chrisomelidae	1.0/0.5
- Curculionidae	49.0/26.2
- Coccinelidae, imago	4.0/2.1
- Staphilinidae, imago	7.0/3.7

- Other beetles	1.0/0.5
DIPTERA	20.0/10.7
LEPIDOPTERA	3.0/1.6
HYMENOPTERA (without Formicidae)	1.0/0.5
TOTAL (individual /m^2) without ants	183.0
Quantity per sample (individuals/0,0625 m^2) without ants (M ± m)	11.69 ± 1.40
TOTAL (individuals m^{-2}) with ants	**1085.0**
CV (%) (coefficient of variation)	47.97
TOTAL mass (g/m^2)	3.35
g / 0.0625 m^2 (M ± m)	0.21 ± 0.07

The dominant taxa were Coleoptera (54.0%), Heteroptera (25.1%) and Diptera (10.7%), and a sub-dominant taxa were Aranei (x.y%). In the structure of the Coleoptera, the dominants were representatives of such families as Elateridae (12.3%), Coccinelidae (26.2%), and the co-dominants were Carabidae (7.5%). Other Coleoptera accounted for 0.5-3.7% of the total number of beetles.

Conclusion. In this paper, for the first time, information on the properties of virgin soils of the southern chernozems of the Kostanay region is presented. Soil invertebrate communities (macrofauna) were dominated by insects (89.0%), among which Coleoptera predominated (54,0%). The density of the soil macrofauna community in the studied area was 1085.0 individuals/m^2, and its biomass was 3.35 g/m^2. The ecological structure of the soil macrofauna of the study area is characterized by the predominance of eurybiont species. This is due to the peculiarities of the climate and the diversity of vegetation.

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ОПЫТ ОПРЕДЕЛЕНИЯ ПОРОДЫ МЕДОНОСНОЙ ПЧЕЛЫ *APIS MELLIFERA* LINNAEUS, 1758 В КОСТАНАЙСКОЙ ОБЛАСТИ ПО ЖИЛКОВАНИЮ КРЫЛА С ПОМОЩЬЮ КОМПЬЮТЕРНОЙ ПРОГРАММЫ А.Б. КАРТАШЕВА

The experience of determining the breed of the honey bee Apis mellifera Linnaeus, 1758 in Kostanay region by wing venation using the A.B. Kartashev computer program

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Аннотация. Бұл жұмыста Apis mellifera Linnaeus 1758 бал араларының тұқымдық құрамын Карташевтің А.Б. "Қанаттары бойынша тұқым" компьютерлік бағдарламасын қолдана отырып және TpsDig2 морфометриялық өлшеу бағдарламасын қосымша қолдана отырып, қанаттың сыртқы белгілері бойынша анықтау әдісі мен зерттеу нәтижелері келтірілген. Бұл жұмысты жазу үшін жеке далалық зерттеулердің материалдары, Apis mellifera Linnaeus 1758 түрлерінің таралуы туралы коллекциялық және әдеби мәліметтерді талдау пайдаланылды. Жүргізілген жұмыстардың нәтижесінде екі үлгінің Apis mellifera mellifera Linnaeus 1758 бал араларының орталық орыс тұқымына жататындығы анықталды.
Түйінді сөздер: бал арасы, Қостанай облысы, тұқым, анықтау, компьютерлік бағдарлама.

Аннотация. В настоящей работе представлена методика и результаты исследований определения породной принадлежности медоносных пчел Apis mellifera Linnaeus 1758 по экстерьеному признаку жилкования крыла с использованием компьютерной программы Карташева А.Б «Порода по крыльям» и дополнительным применением программы для морфометрических измерений – TpsDig2. Для написания данной работы были использованы материалы собственных полевых исследований, анализ коллекционных и литературных данных по распространению видов рода Apis mellifera Linnaeus 1758. В результате проведенных работ была установлена принадлежность двух экземпляров к среднерусской породе медоносных пчел Apis mellifera mellifera Linnaeus 1758.
Ключевые слова: медоносная пчела, Костанайская область, порода, определение, компьютерная программа.

Annotation. This paper presents the methodology and results of studies of determining the breed affiliation of honey bees Apis mellifera Linnaeus 1758 by the external sign of wing venation using the