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Invertebrate animals of landscape gardening lawn cenoses of the city of Karaganda (area of the South-East)

Urbanization of territories leads to the formation of ecosystems that are significantly different from natural ones. Invertebrates are the most effective and promising group of bioindicators of anthropogenic impact on natural and urban ecosystems. However, very little work has been done to study the fauna of urban ecosystems in Kazakhstan. The article presents research data on invertebrates of the Karaganda region by specialists of the Department of Zoology of Karaganda State University, carried out in different years and during periods of field practice. Analysis of invertebrate lawn communities showed the dominance of insects, in particular hymenopteran genera *Formica, Myrmic, Camponotus*. In second place in terms of numbers are coleoptera, among which ground beetles and staphilins prevail, as characteristic inhabitants of the city. The predominance of insects is a zonal sign. Among them there are dangerous pests: larvae of nutcracker beetles, black beetles, and lamellar beetles. Soil worms include earthworms: *Lumbricus rubellus, Eisenia nordenskioldi, Appropriateode caliginosa f. typica*. Predators dominate the trophic structure of lawn inhabitants, which is very characteristic of urban cenoses. The high number of predatory forms, the diversity of orders and families testifies to the favorable ecological regime of the studied lawn cenoses as a result of their long existence.

Keywords: urban area, lawn and park lawn, invertebrates, insects, Barber traps, catch ability, soil samples, trophic structure.

Introduction

Due to the increase in the area of urbanized territories, as well as the increased concentration of various hazardous industries, several tasks were promoted, among them there is a forecast of the development of cities and zones of their influence, as well as an assessment of the state of the environment. Urban ecosystems may differ in some environmental indicators (for example, humidity of air and soil, seasonal and daily temperature dynamics, etc.) from zonal non-urban and suburban ecosystems [1]. Such differences are closely related primarily to mechanical transformations and huge flows of energy in cities that are associated with human activities. To carry out environmental assessment of urban areas, it is important to select reliable criteria for assessing their condition and identify indicators of anthropogenic impact [2]. Among the most promising indicators of anthropogenic impact are soil invertebrates, herpetobionts, characterized by a change in the population and a change in the species composition of the population due to their high sensitivity to the state of environmental parameters [3, 4].

Invertebrates occupy an important position in urban ecosystems, maintaining their stability. They perform the functions of pollination, process plant debris, intensify soil formation, etc. Scientific works of the Department of Zoology of E.A. Buketov Karaganda State University (further KSU) from the day of its formation was devoted to the study of the animal world of the Central Kazakhstan. Since the 70s of the last century, the entomological direction has been intensively developed. Under the direction of Ph.D. N.P. Shlykova, and later Doctor of Biological Sciences, Professor N.G. Skopina, Ph.D., Associate Professor

N.P. Slavchenko students specializing in the Department of Zoology were engaged in the study of individual families of beetles. Significant collections of swimming beetles, ground beetles, black beetles, barbell, and territory of the Central Kazakhstan and the CIS were collected. Today, these collections are part of the entomological fund of the Museum of Nature of KSU and have scientific value. The scientists of the department conducted long-term environmental and biological studies of the territory of the Karaganda region, these studies became the starting point for writing many dissertation works and collections of scientific papers: Ecology of the Central Kazakhstan (2001); Rare and endangered animals of the Kazakh small hills (2005); Karaganda. Karaganda region: Encyclopedia (2008). The obtained data allowed the department specialists to participate in solving environmental and agricultural problems of the Karaganda region. However, the fauna of the city of Karaganda still needs to be investigated. We need more complete information about dendrobionts, herpetobionts, and soil invertebrates. All of the above has determined our interest in studying invertebrates of various ecosystems in the city of Karaganda.

Materials and methods

The city of Karaganda is located in the center of Kazakhstan, in the natural zone of the steppes. It is located on a slightly wavy inclined plain with elevations not exceeding 160 m. The climate is sharply continental with severe winters, sultry summers and low annual rainfall. The typical climate of cities is characteristic of the city of Karaganda: higher temperatures (comparing with the suburbs), low relative humidity, increased frequency of local fogs and light winds, changes in the conditions of the city under conditions of light and radiation conditions, chemical composition of air, condensation of water vapor, groundwater and surface sediments near the city and adjacent territories [5]. The relief territory of the city of Karaganda is part of the Kazakh small hills and is located within the Kengiz-Balkhash watershed space. In general, the relief of the site is a wavy plain complicated by small hills. In the north, low hills are developed. The rest of the territory is characterized by a flat relief [6]. Based on information from the authors R.T. Bakeeva and S.N. Atikeyeva [7] the Central Kazakhstan is in fourth place in terms of the number of endemic plant species, since there are no large river or mountain territories in this territory that could serve as a safe isolating factor for dynamic speciation.

The city of Karaganda is made up of two parts — «New City» and «Old City». The so-called «Old City» includes mines and processing plants (very extensive), and the «New City» contains multi-storey office buildings of various kinds, shopping centers, as well as universities — this is the most comfortable and convenient region of Karaganda. The industrial area is divided by the valley of the Big Bukpa River [8]. The city has a large number of transport, educational and scientific enterprises, culture and communications. Also in the city there are operating large coal mining enterprises, metal working, engineering and food enterprises. Today, the city of Karaganda is one of the largest economic, industrial, cultural and scientific centers of Kazakhstan.

The following sites of the city of Karaganda were chosen as places for research and collection of invertebrate animals: the closest to the city center; remote from the center; forest biotopes (with a high density of trees and predominantly having spontaneous formation of vegetation); courtyards (consisting of fragments of grass vegetation and wood surrounded by buildings); gardens (summer cottages, horticultural, experimental and educational sites); meadows (mainly containing perennial mesophilic and hygrophilic herbs) [9]. The choice of sections of the city involves determining the degree of influence of urbanization on the community of a given territory. Grassy and arboreal communities of the Central park culture and leisure of Karaganda city are the most extensive and long-standing. The history of the city's culture and leisure park began in 1935 with the construction of a reservoir, sanitary cleaning of this territory and its improvement, as well as the creation of a forest. By 1941, a birch grove and a poplar massif were formed, filled with a pond with locks, and banks were arranged. The Central Park of Culture and Leisure of the city of Karaganda opened in 1946. In the central park there are a huge number of trees, playgrounds with attractions, several fountains, and cafes [10].

To collect the primary material, we used standard techniques for fishing and recording invertebrates, including Barber traps, which are most convenient for research in the city [11]. In addition, registration and collection were used for route excursions around the city, on sites and adjacent territories, lawns and sidewalks. A decision was made on the subsequent use of environmentally friendly methods [12]. The use of such techniques and the use of gentle traps (a net with springs, a micro-net, a clamp for soft retention of invertebrate animals, a vacuum «magnet», and a multi-capacity exhauster) will reduce the death of useful spe-

cies of invertebrate animals in our study. The rejection of fixing substances in a modern environmental protection technique allows the release of animals after accounting.

Results and discussion

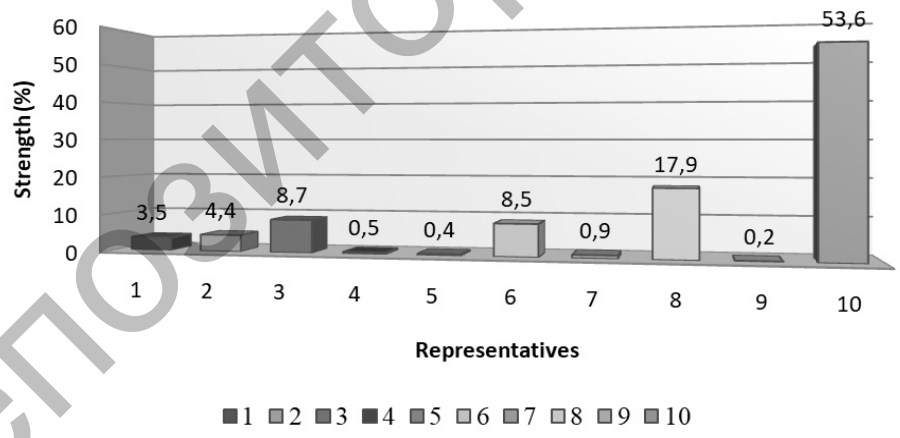
As a rule, the analysis of the herpetobiont population in the city in a broad (biocenotic) sense involves taking into account the abundance of earthworms (*Lumbricidae*), wood lice (*Isopoda, Oniscidea*), spiders (*Aranei*), hayfields (*Opiliones*), millipedes at the squad level, cockroaches (*Blattoptera*), earwigs (*Dermaptera*), orthoptera (*Orthoptera*), bugs (*Heteroptera*), cicadas (*Auchenorrhyncha*), beetles at the family level.

In a narrow sense, herpetobia includes woodlice, spiders, hayfields, cockroaches, earwigs, bedbugs, ground beetles (*Carabidae*), staphylinids (*Staphylinidae*), black beetles (*Tenebrionidae*), dead-eaters (*Silphidae*), and pill. The complex of herpetobionts is described by catch ability (the number of individuals per 100 traps per day).

Information about invertebrates of the city of Karaganda is poorly presented in print media. Basically, these data were used to write the thesis of the Department of Zoology of KSU. Currently, they are being summarized and systematized. One example of a generalization of many years of research by entomologists of the university is the site http://butterflies.kz/, which collected information on a lepidopteron squad in the Karaganda region.

Period 2000–2012. The initial stage of work was carried out to study the population of soil invertebrate summer cottages, as well as pine forest plantations in the vicinity of the city of Karaganda [13]. Since 2016, these studies have been continued by us in the biotopes of urban landscape gardening lawns (area of the South-East).

The inhabitants of the lawn soils of the Southeast region were represented by two types of invertebrates: annelids and arthropods. The number of earthworms was 11 plus minus 0.3 ex / m². Arthropods are assigned to 4 classes, in which 11 orders were identified, which indicate the diversity of the mesofauna of the soils of the studied cenoses. Insects predominate in numbers. Background detachment is *Coleoptera* including 17 families. Analysis of the total number of individuals per biotope showed that the ants of the genera *Formica, Mirmica,* and *Camponotus* account for 53.6 % of all arthropods, and the hard-winged animals account for 17.9 % (Fig. 1).



1 — Diptera, *2* — Hemiptera, *3* — Aranei, *4* — Litchobiomorpha, *5* — Orthoptera, *6* — Isopoda, *7* –Lumbricimorpha, *8* — Coleoptera, *9* — Lepidoptera, *10* — Hymenoptera

Figure 1. The total number (in %) of soil invertebrates (mesofauna) in the biotopes of landscape gardening lawns in Karaganda (area of the South-East)

Among beetles, ground beetles are dominated by ground beetles (*Carabidae*), 35±0.5 ex./m² and staphylins (*Staphilinidae*), 20±0.3 ex./m². Nutcracker beetles (*Elateridae*), weevils (*Curculionidae*), lamellar beetles (*Scarabaeidae*), carnivores (*Silphidae*), moths (*Pselaphidae*) and other beetles were much less common. Associated groups are spiders (*Arnei*) and homoptera (*Homopter*).

In the first 2000 studies for some lawn areas, it was noted that the soil population is concentrated at a depth of 5 cm. According to later soil excavations, invertebrates are concentrated in the upper soil layers to a

depth of 15 cm. Moreover, hard-winged and ants dominate the litter/ground layer. In the 0–10 cm layer, the proportion of beetles and earthworms increases. The long existence of lawn plots has a certain relationship with a more even distribution of invertebrates over soil horizons, their development of new life niches, and stabilization of the development cycle.

The registration of surface dwelling invertebrates, carried out using soil traps with grooves, did not reveal new dominant groups. Hymenoptera (ants, 60±1.7 specimens per trap/day) and coleopterans (ground beetles 21±0.6 specimens per trap/day) still remain with them. The codominants are spiders, homoptera and dipterans. Small groups are half-winged centipedes, orthoptera, and lepidoptera. Among the microfauna objects, tail tails are taken into account. Ants also dominate in traps without grooves, but their number increases to 130±3.8 specimens per trap/day. Codominant groups also maintained their ratio, but their numbers were 32 % lower than in traps with grooves.

The methods, used to determine the total catch, according to our results, need to be adjusted in accordance with weather conditions. Herpetobionts are sensitive to disturbance of the structure of the soil cover by traps with grooves. But with sharp changes in temperature and humidity, the grooves serve as a shelter and help to increase catch ability.

For example, ten-day observations during the month showed that the total catch (U) in traps without grooves fell during the observation period: I decade — 217±6.8 ex. per trap / day; II decade — 195±5.7 ex. per trap / day; III decade — 196 plus minus 5.6 ind. per trap / day. In traps with grooves, the catch ability increased: I decade — 151±4.4 ex. per trap / day; II decade — 169±5 ex. per trap / day; III decade — 173±5.1 ex. per trap / day (Fig. 2). Changes in catch ability occurred against the background of lower temperatures and an increase in rainfall. It follows from the foregoing that when determining the dynamics of the number of herpetobionts, it is better to use generalized data.

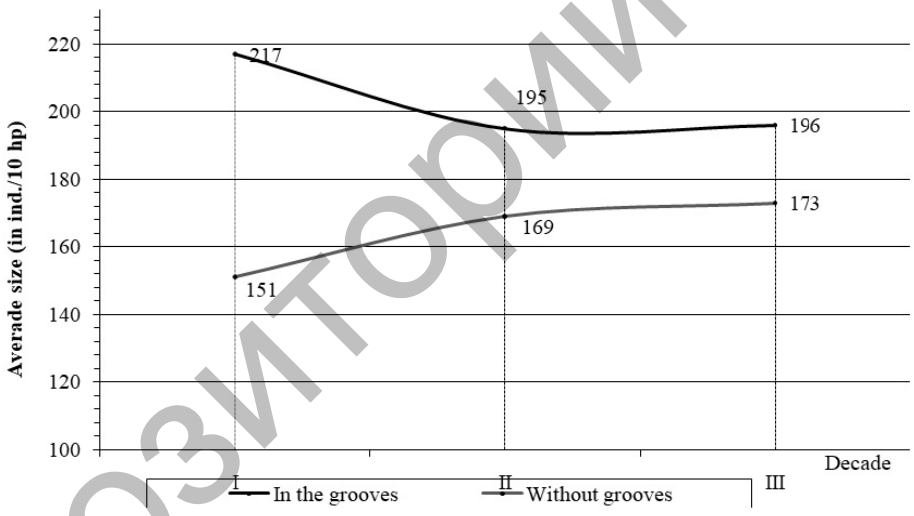


Figure 2. The ten-day average abundance of herpetobionts in traps located in and without grooves

Initial route studies of invertebrates, the inhabitants of lawns, revealed that phytophages prevail in the trophic structure of communities. In the future, the use of Barber traps showed the presence of a larger proportion of predatory forms (47.4 %), and phytophages was significantly less (22.9 %). The proportion of saprophages amounted to 18.8 %, and saprophytophages — 10.9 % of the total number of invertebrates.

Accounting for soil and soil animals using the soil excavation method revealed an even larger proportion of predatory invertebrates (61.5 %). Not taking into account the number of collembolans, pronounced monodomination of ants was noted with the general equalized number of other families.

Phytophages combining adult and larval forms of beetles and other insects (18.5 %), as well as earthworms as saprophages (15.6 %), showed similar ratios of trophic groups of invertebrate lawns. The increase in the specific gravity of phytophages and predators is considered as a zonal feature of the dry steppes. Soil inhabitants such as phytophages, saprophages and sapro-phytophages take a large part in the disposal of organics. The phytophage insects of the aboveground tier of the biogeocenosis accelerate the descending branch of the substance cycle. In the case of the prevalence of phytophagous beetles in the biocenoses and a decrease in the number of saprophages, it is possible to slow down the processes of humification of plant

residues. The data obtained allow us to consider the ecological regime of the studied urban lawns relatively favorable.

The general predominance of predatory forms is very characteristic of urban cenoses. As an example, the following can be cited: staphylinids (*Staphylinidae*), spiders (*Aranei*) and ground beetles (*Coleoptera, Carabidae*) constitute the foundation of the soil invertebrate population in all biotopes of the city of Kaluga. Meadow biotopes are characterized by a large number of cicadas, spiders, bugs, as well as a low number of drupes, catopids, and diplopods. Garden plots (with woody vegetation) differ from other biotopes, their difference lies in their high ability to catch ground beetles, spiders, nutcrackers and leaf beetles. Biotopes of yards do not differ from forest biotopes [14].

Herpetobia in urban areas of Siberia is also based on predatory insects, most often ground beetles (*Coleoptera, Carabidae*). At the same time, ground beetles remain one of the little-studied groups of urban fauna.

Coleopterans are the dominant group of insects in the herpetobia of cenoses in Kharkov, which in some cases is consistent with our results. According to the data of soil traps, they amounted to 81.5–92.6 %, and about 60 % of the total recorded entomofauna at trial sites [15].

High mosaic conditions in the city contribute to the formation of a relatively diverse and rich fauna. Green areas of the city, which are surrounded on all sides by industrial and residential quarters, are considered as island habitats and correspond in many environmental parameters [16].

We compiled a chart of the average catch ability of Barber traps in and outside the city in order to analyze and compare our data with the results of other studies (Fig. 3).

According to Figure 3, (*Coleoptera*) in particular the families *Carabidae, Staphylinidae*, are most often found in the «forest» biotopes of cities. In the meadows, representatives of the orders are common: *Isopoda, Heteroptera, Coleoptera* (family *Tenebrionidae, Staphylinidae*), *Auchenorrhyncha*. In the yards of city blocks, the following units are taken into account: *Dermaptera, Auchenorrhyncha*, *Coleoptera* (family *Staphylinidae*). *Coleoptera* (family *Carabidae*) is more common in the gardens. In the central part of the city, detachments are noted: Isopoda, *Coleoptera* (family *Staphylinidae*). In courtyards and the central part of the city, in contrast to forest and meadow biotopes, fewer herpetobiont invertebrates live. n large urban parks, or in areas that are not subject to any mechanical influences, the population density of invertebrate herpetobionts in the litter and soil is close to the density in suburban forests. These are the most general patterns of the distribution of invertebrates within the various biocenoses of cities.

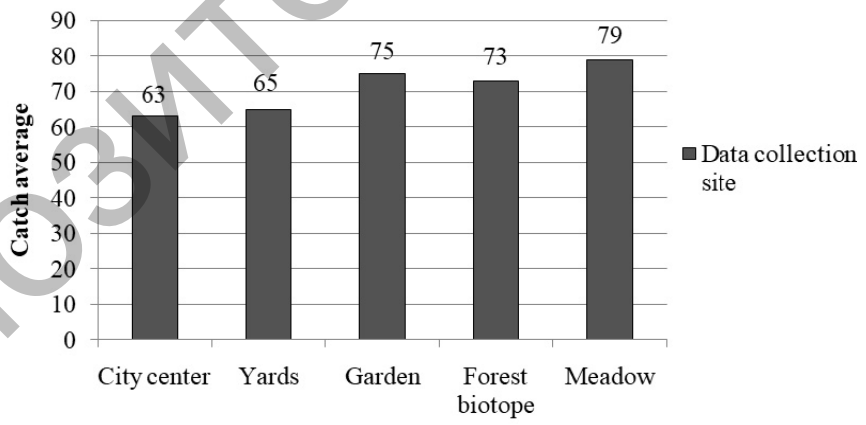


Figure 3. The average number of catching barber traps in the conditions of the city and outside it (according to the analysis of literature)

The frequency of mowing the grass stand has a negative effect on the herpetobiont community in cities, and the increasing humidity, height of the grass stand, and the duration of the biotope have a positive effect [17, 18]. Humidity and duration of existence are the main factors that must be taken into account when analyzing the biodiversity of urban cenoses.

Conclusion

Thus, the study showed that the invertebrates of the lawns of the city of Karaganda (area of the South-East) are represented by two types: *Annelida* and *Arthropoda*, four classes: *Oligochaeta*, *Archnida*,

Myriapoda, *Insect* and ten orders. Insects predominate, which is a zonal sign. Among them there are dangerous pests: larvae of nutcracker beetles, black beetles, and lamellar beetles. Soil worms include earthworms: *Lumbricus rubellus, Eisenia nordenskioldi, Appropriateode caliginosa f. typica*. Analysis of the total number of individuals in the lawn communities showed that the ants of the genera *Formica, Myrmica,* and *Camponotus* dominate. In second place in terms of number are hard-winged. Among beetles, ground beetles predominate (266 ex./m²), accompanied by staphylins (102 ex./m²), as characteristic inhabitants of the city. Lamellar beetles, grinders, narrow-winged wings, nares, leaf beetles are also found, but their number was 0.5 % of the total number of collected insects. The trophic structure of the inhabitants of lawns is formed by saprophages, phytophages, sapro-phytophages and predators. In herpetobia and among the mesofauna of the soil, the proportion of predators was higher. The high number of predatory forms, the diversity of orders and families indicates a favorable ecological regime of the studied cenoses, as a result of their long existence as a landscape gardening lawn. For a detailed description of the species composition and distribution of invertebrates, further studies will be conducted.

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Қарағанды қаласының саябақ көгалдары ценоздарындағы омыртқасыз жануарлар (Оңтүстік-шығыс аймақ)

Аумақтарды урбанизациялау табиғи жүйелерден едәуір ерекшеленетін экожүйелердің қалыптасуына әкеледі. Омыртқасыздар — табиғи және қалалық экожүйелерге антропогендік әсер ететін биоиндикаторлардың ең тиімді және перспективалы тобы. Алайда Қазақстандағы қалалық экожүйелердің фаунасын зерттеу бойынша аз жұмыс атқарылған. Мақалада Қарағанды университетінің зоология кафедрасының мамандары әртүрлі жылдарда және далалық практика кезеңінде жасаған Қарағанды облысының омыртқасыздары туралы зерттеу мәліметтері берілген. Көгалдардағы омыртқасыздардың қауымдастығын талдағанда, жәндіктердің, атап айтқанда жарғақ қанаттылар *Formica, Myrmic*, *Camponotus* тұқымдарының басым екенін көрсетті. Саны жағынан екінші орында — қатты қанаттылар, олардың ішінде қаланың тән тұрғындары ретінде жер қоңыздары мен стафилиндер басым. Жәндіктердің басым болуы — аймақтық белгі. Олардың арасында қауіпті зиянкестер бар: Щелкун қоңыздарының балаңқұрттары, қара қоңыздар, ламель қоңыздары. Топырақ құрттарының құрамына мына топырақ құрттары жатады: *Lumbricus rubellus, Eisenia nordenskioldi, Apporrectodea caliginosa f. typica*. Жыртқыштар көгалдар тұрғындарының трофикалық құрылымында басым, бұл қалалық ценоздарға өте тән. Жыртқыштар санының көп болуы, жасақтар мен тұқымдастардың әртүрлілігі олардың ұзақ өмір сүруіне зерттелген көгалды ценоздардың экологиялық режимде қолайлы екенін көрсетті.

Кілт сөздер: қала аумағы, көгалдар мен саябақ көгалдары, омыртқасыздар, жәндіктер, Барбер тұзақтары, ұстамалар, топырақ үлгілері, трофикалық құрылым.

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Беспозвоночные животные садово-парковых газонных ценозов города Караганды (район Юго-Востока)

Урбанизация территорий приводит к формированию экосистем, значительно отличающихся от естественных. Беспозвоночные являются наиболее эффективной и перспективной группой биоиндикаторов антропогенного влияния на естественные и урбанизированные экосистемы. Однако работ по изучению состояния фауны городских экосистем Казахстана проведено очень мало. В статье приведены данные исследований беспозвоночных Карагандинской области специалистами кафедры зоологии Карагандинского университета, проведенных в разные годы и в периоды полевых практик. Анализ беспозвоночных газонных сообществ показал доминирование насекомых, в частности, перепончатокрылых родов *Formica*, *Myrmica*, *Camponotus*. На втором месте по численности — жесткокрылые, среди которых преобладают жужелицы и стафилины, как характерные обитатели города. Преобладание насекомых является зональным признаком. Среди них есть опасные вредители: личинки жуков-щелкунов, чернотелок, пластинчатоусые жуки. К почвообразователям относятся дождевые черви: *Lumbricus rubellus*, *Eisenia nordenskioldi*, *Apporrectodea caliginosa f. typica*. В трофической структуре обитателей газонов доминируют хищники, что очень характерно для городских ценозов. Высокая численность хищных форм, разнообразие отрядов и семейств свидетельствуют о благоприятном экологическом режиме исследованных газонных ценозов как результате их длительного существования.

Ключевые слова: урбанизированная территория, садово-парковый газон, беспозвоночные, насекомые, ловушки Барбера, уловистость, почвенные пробы, трофическая структура.

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