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Helminths of wild ungulates living in different regions of Belarus

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Abstract

The purpose of the research is to study of the features of the fauna of wild ungulates helminths on the different regions of the Belarus.

Materials and methods. The research was carried out in the State Research-Production Association "The Scientifically-Practical Center of the National Academy of Sciences of Belarus for bio-resources" and in forestry farms of Belarus. The distribution of ungulates in winter was studied using winter route counts. GPS receivers were used for a reliable assessment of biotope confinement. We used the method of counting game animals by year-round mapping of encounters and tracks with the help of thermal imagers. To assess the seasonal distribution, the structure of the biocenosis was compared with the distribution of wild ungulate species on it. To assess the species selectivity of a certain biocenosis, the share of the species in the biotope and the share of this biotope in the farm were determined. The G-test was used to analyze the obtained materials. Animal feces were examined using the McMaster, sedimentation, and flotation methods.

Results and discussion. It is determined that in the model forest areas, the red deer dominates in the structure of ungulates. Biotopes with stand density above 0.6 ungulates sem. Reindeer are used to an insignificant extent (K = -0.2, G = 42.7, P = 0.03). The biotopic distribution of roe deer in spring and autumn does not differ significantly (G = 116.7, P = 0.01). At this time, animals prefer areas with a predominance of broad-leaved species (D or.) (K = 0.86, G = 53.1, P < 0.01). During the rutting season, pine-moss forests are preferred (G = 37.4, P < 0.01). In the warm season, the red deer prefers forests with a predominance of pine trees in the stand (K = 0.6, G = 37.4, P < 0.01). Bilberry pine forests are preferred by females in spring and summer (adults and semi-adults) (K = 0.42, G = 32.4, P <0.01), males – mossy pine forests during the growing season (K = 0.22, G = 28.91, P = 0.03). In the parasitological situation in the red deer population, representatives of the Cestoda class are replaced by representatives of the Trematoda class. Representatives of the class Nematoda, genus Dictyocaulus sp. remain dominant. Representatives of the genus Strongylata, Trichostrongylus and Protostrongylus are constantly present. The genera Chabertia, Neoascaris, Cooperia are replaced, of the Nematoda class into the following genera: Oesophagostomum, Capillaria, *Muellerius capillaris* of the same class. The coefficient of common species composition of red deer and European roe worms is 46%, European roe and elk – 18, red deer and elk – 22%. On the territory of the Republic of Belarus, a rich species composition of helminths was revealed in European bison and a high degree of occurrence of helminths in this host. More than half of the animals in bison populations are carriers of infection with helminths: Belovezhskaya – 51.3, Polesskaya – 89.05%. Moreover, most of them have one type of helminths (from 50.0 to 66.7%) or two types of helminths (from 25.0 to 38.0%). Three or more types of helminths recorded simultaneously are rare. Representatives of the Nematoda class are 6 times superior to other classes of parasitic helminths (G = 39.8; P < 0.01).

Keywords: wild ungulates, helminth fauna, species composition, Belarus

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Научная статья

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Гельминты диких копытных, обитающих в разных районах Беларуси

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Аннотация

Цель исследований: изучение особенностей гельминтофауны диких копытных в различных регионах Беларуси.

Материалы и методы. Исследования проводили в Государственном научно-производственном объединении «Научно-практический центр НАН Беларуси по биоресурсам» и в лесхозах Беларуси. Изучение распределения копытных зимой проводили с помощью зимних маршрутных учетов. Для надежной оценки биотопической приуроченности использовали приемники GPS. Применяли метод учета охотничьих животных путем круглогодичного картирования встреч и следов с помощью тепловизоров. Для оценки сезонного распределения структуру биоценоза сравнивали с распределением на нем видов диких копытных. Для оценки видовой избирательности определенного биоценоза определяли долю вида в биотопе и долю этого биотопа в хозяйстве. Для анализа полученных материалов использовали G-тест. При изучении паразитофауны фекалии животных исследовали методами Мак-Мастера, осаждения и флотации.

Результаты и обсуждение. Установлено, что в лесных массивах из копытных доминирует благородный олень. Биотопы с плотностью популяции выше 0,6 у копытных сем. Олени встречаются не часто (K = -0,2, G = 42,7, P = 0,03). Биотопическое распределение косуль весной и осенью существенно не различается (G = 116,7, P = 0,01). Представители класса Cestoda в популяции благородного оленя сменяются представителями класса Trematoda. Представители класса Nematoda, рода Dictyocaulus остаются доминирующими, родов Strongylata, Trichostrongylus и Protostrongylus – постоянно присутствующими. Из класса Nematoda гельминты родов Chabertia, Neoascaris, Cooperia заменяются на *Muellerius capillaris* и представителей родов Oesophagostomum, Capillaria. Коэффициент общности видового состава благородного оленя и европейской косули составляет 46%, европейской косули и лося – 18, благородного оленя и лося – 22%. На территории Республики Беларусь выявлен богатый видовой состав и высокая степень встречаемости гельминтов у зубра. Более половины животных в популяциях зубра заражены гельминтами: в Беловежской пуще – 51,3, в Полесском заповеднике – 89,05%. При этом у большинства из них зарегистрирован один вид гельминтов (50,0–66,7%) или два (25,0–38,0%). Одновременно три и более видов гельминтов встречаются редко. Представители класса Nematoda встречаются в 6 раз чаще других (G = 39,8, P < 0,01).

Ключевые слова: дикие копытные, фауна гельминтов, видовой состав, Беларусь

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Introduction

The habitat, the area of distribution of various species of wild ungulates, their territorial interference is important in the structural organization of wild ungulates in the territory of Belarus. Due to the creation of new and the development of existing populations of wild ungulates, the occurrence of territorial competition between them is possible. This process affects the natural settlement of red deer in places where they live together with European bison. In 2013, the process of depopulation of wild boar in the habitats of the species has begun owing to the outbreak of African swine fever in Belarus. With the rapid decrease in the number of wild boars, as the major food item of predators, the process of changing the number of roe deer is ongoing. This leads to a change in the structure of ungulate animal communities and may affect interspecies relationships.

Wild ungulate communities' structural organization determines the constancy of helminths fauna complexes. Changes in the structure of ungulate communities' lead to the occurrence of parasitic succession.

Helminth's fauna of wild ungulates is an important role in the formation of biocenoses. Any infection affects the condition and stability of the population. Helminths are one of the determining factors in the reproduction and vitality of young animals. Many types of helminths cause diseases leading to a deterioration of the physiological state and death of animals [16]. The high number of animals contributes to infection with helminths and increases their epizootic and epidemiological significance.

The total elimination of wild boar in the Republic of Belarus led to changes in biocenoses and had an impact on the parasitological situation in wild animal populations. This has caused to do helminthological research focused on studying the formation of parasitic succession of wild ungulates.

Evaluation of species composition of helminths of wild ungulates in view of the structural organization, the regularity of formation and functioning of ungulates' communities is a scientific basis for the preservation of their sustainability and biodiversity.

European bison (Bison bonasus) is a rare species of the world theriofauna living in a number of countries and on the territory of the Republic of Belarus. To further increase the size of its population, conservation and management measures have been developed. These measures are aimed at preserving the existing European bison population and enriching the population with new individuals as a result of the importation of animals from other countries.

At present, the problem of parasitoses is very relevant. In Belarus work is under way not only to conserve bison but also to acclimatize other animals for further breeding. Therefore, it is necessary to have complete information about the species of helminths that may impact on the viability of bison and to know factors affecting the viability of helminthosis. One of these factors is the transmission of helminths from one organism to another. And for that reason, it is important to know helminths of what animals can get on another animal and can them to adapt parasitizing in the future.

Materials and methods

Scientific research was carried out in The State Research-Production Association "The Scientifically-Practical Center of the National Academy of Sciences of Belarus for bio-resources" and in forestry farms of Belarus (fig. 1) in period from 2008 to 2019. They are located in different regions of the Republic of Belarus. Negoreloe experimental forestry farm is in the central region. Ostrovec forestry farm is in the northwest region. Polessky radiation-ecological reserve is in southeast region, Belovezhskaya Pushcha National Park – in the southwestern region of the Republic of Belarus.

Fig. 1. Forestry farms

According to recommendations, the winter distribution of ungulates was studied using winter route censuses. Assessment of the structure population of Cervidae was carried out on longterm accounting transects. The width of the accounting strip where excrement is being evaluated has a projection 2 meters wide, censuses was carried out by quarters and sections being allocated according to forest inventory materials (type of forest, composition, age and thickness of stand). GPS receivers were used for a reliable assessment of biotopic confinement. The distribution of ungulates in the warm season was studied using the methods of fixing traces of vital functions on the substrate. The method of accounting of game animals was used by year-round mapping of encounters and tracks using thermal imagers. The accounting of game animals by the method of year-round mapping of encounters and traces is based on year-round registration of encounters of ungulates at stations that allows establishing the number and distribution of large animals living there. The basis for this is the regular registration, mapping and research of animal encounters, traces of their vital functions and other monitoring. For this, the places of meeting of animals by species, their tracks on snow or soil, traces of their vital activity are registered. For this, the places of meeting of animals by species, their tracks on snow or soil, traces of their vital functions are registered. When registering an animal, a binding was carried out using GPS equipment to a certain quarter and allotment.

Visual observation was carried out using thermal imaging devices with detailed fixation of the place, date, time, type of animal, their number, and, if possible, gender and age (age group). For moose and deer, age groups were indicated whenever possible: underyearlings, yearlings, and adults. For roe deer, only fingerlings and adults are indicated.

To assess the seasonal distribution, the structure of the biocenosis (according to the stations' forest taxation description) was compared with the distribution of wild ungulate species on it. To assess the selectivity of species of a certain biocenosis, the share of the species in biotope and the share of this biotope in the farm were determined. Such studies were carried out for the winter, spring and rutting seasons. The G-test was used to analyze the obtained materials.

To study the parasite fauna, laboratory methods of sedimentation and flotation were used. The study of the occurrence, composition, degree of infection, the coefficient of commonness of wild ungulate helminths, helminthocoproscopic (ovoscopy and larvoscopy) research, cultivation of ruminant strongylates, cultivation and identification of invasive nematode larvae were carried out according to the Lynn Shore Garcia [8] methodology. Parasitological studies were carried out according to the McMaster test, mastered within the framework of participation in the BIOGEAST program (The Seventh Framework Program of Marie Curie - People, International Research Staff Exchange) (2015). The McMaster test was carried out as follows: 3 g of fresh feces were thoroughly mixed with 42 ml of water and filtered through a 100-mesh sieve into a crucible. The filtrate was placed in 2 centrifuge tubes and centrifuged for 3 min. The supernatant was discarded and the precipitate was again diluted with saturated saline solution and thoroughly mixed. The suspended sediment was collected from each test tube by a Pasteur pipette and filled in each chamber of the MacMaster glass. Following this, the slide is examined under the × 4 lenses of the microscope objective and all parasite eggs and larvae in each chamber are counted. This number is multiplied by 50, which gives the number of eggs and larvae per gram of feces.

Results and discussion

A complex of factors influences the dynamics of the number of ungulates. The structure of phytocenoses is an essential factor determining the seasonal distribution of ungulates. Due to the decrease in the number of wild boars in 2013, some regularities were noted in the change in the structure of populations not only of wild boar, but also roe and elk. This process is quite interesting from both theoretical and practical (hunting) point of view and requires a detailed investigation.

In Italy, an analysis of the distribution patterns between sex and age classes of fallow deer (Dama dama) was carried out in addition to modifying the aggregation patterns as a function or degree of coverage in different habitats in the coastal sub-Mediterranean environment. The animals preferred large open meadows, small clearings, forests and swamps. Choice of habitat varies greatly depending on gender and age [1].

The distribution of forest formations on the territory of the Palush Forestry in the Ostrovets Forestry Enterprise is given in Table 1. Among the forested lands, conifers are dominant: they account for 69.3% of the area, among them pine forests occupy 59.3%, and spruce – 10.0%. Partially ripe and ripe prevail in the stand. The stand is mainly represented by the following species: pine, birch, black alder, aspen, maple, oak, hornbeam and others are present in small quantities. There are very well developed European and warty euonymus, goat willow, hazel, wild apple and others in the undergrowth. The cover contains forbs, which are also well developed. Open areas account for 37.7%.

The ecological structure of forest ecosystems is quite similar. On the territory of all model farms, pine forests noticeably predominate over other types of forest ecosystems (table 1). As a rule, these are middle-aged forest complexes, about 50 years old. The territory is dominated by uplands, and the share of coniferous biotopes, on average, is 63.7%, small-leaved forests occupy about 28.2% of the area of stations.

Table 1

Ecological structure of forest ecosystems of the Negorelsky experimental forestry farm and Ostrovets forestry farm

Predominant tree species	Negorelsky experimental forestry farm, %	Ostrovets forestry farm, %
Pine	40.17	60.39
Birch	20.05	17.54
Spruce	12.62	9.78
Black alder	19.78	1.64
Broad-leaved formations	1.30	0.14
Aspen	0.51	1.54
Others	5.57	8.97

In assessing the spatial biotopic distribution, the following seasons were identified: winter, spring, summer (rutting period for roe deer), autumn or rutting period. For convenience and clarity of presentation of the materials, the following tables show data on the distribution of ungulates of the deer family in the territory of the stations by the prevailing species. In the text, additional materials will be provided by forest types. The analysis for each species is carried out separately for stations. The combined group “others” in the table on the seasonal distribution of ungulates includes willows, fellings of different ages. For elk and roe deer, these biotopes are quite important, and play a significant role in the warm season, accounting for 38.8 and 42.8% of all registrations on average (G = 0.2, P > 0.05). The share of this group of biotopes when registering the distribution of red deer is not so great, 21.2% (G = 5.24, P < 0.05 and G = 7.44, P > 0.01, respectively).

For all forests, biotopes with a growing density of more than 0.6 are used by ungulates of the Deer family to an insignificant extent (K = -0.2, G = 42.7, P = 0.03), regardless of the abundance of forage.

Before the beginning of the biological year 2016, the density of red deer in the Ostrovets forestry farm in the territory of the Palushy forestry was 5.2, elk - 0.6, European roe deer 6.5 individuals per 1000 hectares of land.

In this forestry, elk prefers forest complexes with a predominance of aspen and gray alder forests and nettle forest types with rich herbage already in April (K = 0.48, G = 42.7, P = 0.03). These biotopes, as well as willows, play an essential role and dominate in the warm season. In general, the distribution of elk at the station significantly differs from its ecological structure in spring (G = 137.3, P < 0.01), summer (G = 160.3, P < 0.01) and autumn (G = 141.5, P < 0.01). The most similar indicators of the distribution of elk in summer and during the rut (G = 13.7, P = 0.05). In the autumn period, a preference for sphagnous pine forests was noted (table 2).

An analysis of the relationship between population density and habitat characteristics is important for assessing the ecological needs of a species, its potential impact on ecosystems, and its interspecific interactions [4].

Various methods are used to obtain information on the distribution and use of the habitat of local ungulate populations. Aerial photography from the air over closed coniferous forests is unreliable due to the invisibility of animals. Snow footprint surveys can be used to determine the distribution of animals in midwinter and their habitat in dense forests. Deer tracks are recorded on straight transects and habitat areas are measured at 50-meter intervals [3].

Age ratios are regularly used to monitor ungulate populations. However, it remains unclear what conclusions can be drawn from this index, as multiple life cycle changes can affect the observed ratio. All vital signs can influence the ratio of calves to adult females [7].

Research results have shown that males can influence the population dynamics of ungulates by being a component of population density, and

Table 2

Seasonal distribution of populations of wild ungulates in the Ostrovets forestry, %

Predominant tree species Pine	Spring			Summer			Autumn		
	Elk	Deer	Roe	Elk	Deer	Roe (rutting season)	Elk (rutting season)	Deer (rutting season)	Roe
Pine	8.0	44.44	18.18	5.26	38.71	26.09	5.88	56.52	8.33
Birch	4.0	5.56	4.55	0.0	9.68	0.0	0,0	2.17	2.78
Spruce	0.0	2.78	0.0	0.0	0.0	0.0	5.88	2.17	2.78
Black alder	20.0	2.78	4.55	15.79	6.45	0.0	11.76	4.35	0.0
Broad-leaved formations	16.0	19.44	31.82	21.05	12.90	17.39	11.76	17.39	38.89
Aspen	24.0	5.56	9.09	10.53	3.23	4.35	23.53	2.17	2.78
Others	28.0	19.44	31.82	47.37	29.03	52.17	41.18	15.22	44.44

considering the mechanisms by which males can actively influence the demographic indicators of females, it is confirmed that the choice of measure density is important [9].

Currently, the topical issue is the creation of free-living and dynamically developing populations of fallow deer. Fallow deer has a very wide range of forages, but is prone to consumption. She prefers an easily digestible, less coarse and lignified food that is rich in nutrients and water, in contrast to elk and red deer. For free-living animals living in Western Europe, such stations are open mosaic areas of the territory - small island forest areas, with an area of about 1.5-2 hectares among large agricultural fields, as well as large meadow complexes with bushy areas. The most optimal areas are forest complexes with an area of 50-180 hectares, with a long forest edge. Animals prefer overgrown areas of clearings, which are 12-20 years old. Such territories are characterized by rich undergrowth and an abundance of herbaceous vegetation. The fallow deer avoids large forest complexes with small undergrowth. In forest complexes, animals choose areas with young forest crops. Deciduous and broad-leaved forests are also favorable. The most preferred areas for deer are areas with a share of open field areas of about 60-70%.

"Explanations” for sexual segregation of ungulates are no more than prerequisites for habitat segregation, because they do not include a competitive habitat selection model. One factor is proposed based on the ideal free distribution of mutually competing, optimally foraging individual animals [5].

The main part of the population, including free-living individuals of this species, is concentrated in the western part of Poland. This may be due to the high proportion of agricultural landscapes in the area under consideration. In the non-growing season, animals prefer to concentrate on fields with winter wheat, alfalfa, corn, sugar beet, clover, winter rape. Sometimes such herds in the autumn-winter period can include 18-24 individuals. When carrying out measures to form free-living populations of this species, it is necessary to take into account the potential for competition of fallow deer and roe deer for habitable biotopes.

The availability and availability of food is essential in the formation of free-living populations. As an example, let us give the formation of a free-living population of fallow deer on the territory of Boranovichi forestry farm. When 30 individuals of fallow deer were released in March 2012, the main part of the herd migrated to the floodplain areas of the Shchara River into the upland coniferous forest complex. The distance was about 16 km currently, on the territory of the Baranovichi forestry, the population is located in the same area of the territory where the feeding conditions are quite favorable, and the pressure of predators on animals is not significant. Since the release of animals to the land, the number of fallow deer has not changed. The lack of feed, combined with other factors, led to a slowdown in the growth rate of this group. These features of the formation of the free-living population of the fallow deer, as well as the influence of predators on it, were the basis for developing recommendations for creating a similar grouping of the species on the territory of the Ostrovets forestry farm.

Competitive interactions between different species of ungulates are an important aspect of the formation of their stably developing populations. Biotopic competition is the most significant for free-living populations. The presence of animals in different biotopes, as well as their seasonal change, is the most important parameter in assessing this type of relationship [13]. The annual load on various components of biocenoses can be judged by the most used biotopes. Besides this, an assessment of the impact of each species on individual biotopes provides information on interspecific interactions [15].

When studying the effect of group size on feeding behavior and the level of synchronization of movements among females of the fallow deer population in Central Italy, it was found that the proportion of foraging and synchronization of movements decreased with increasing group size. The proportion of foraging was higher in animals at the edge of the group than in animals in the center of the group; hence, there seems to be a trade-off between protection from predators and foraging interventions, both of which diminish as the food supply decreases [6].

The influence of the density of individual species on the components of biocenoses is considered in the work of R. J. Putman [14]. Studies have shown that even species that are similar in lifestyle (different species of deer) are not able to compete with each other when using different components of the same resource (food preferences). However, with an increase in the density of individuals of the species, a complete overlap of the used food objects occurs, which leads to the use of atypical habitats (field ecotype of roe deer), or migration.

The main difficulty is assessing the density of interacting species in different biotopes throughout the year. The most preferred period for collecting baseline data is winter with stable, but not high, snow cover. When conducting research at unfavorable times, only the potential for competition can be identified.

Interesting results on the spacing and interference between roe deer *Capreolus capreolus* and fallow deer *Dama dama* in natural conditions. These two species most often use similar biotopes: ecotonic areas between forest and field. The large groups, occupying ecotonic and forest areas of the territory, formed by fallow deer in the inhabited places by them. There is a small population of roe deer in such areas and it prefers open field biotopes. The density of roe deer is higher in areas where the population of fallow deer is small or do not occur, i.e., where food resources are sufficient for each species and there is no trophic competition [2].

We studied the effect of changes in the density of red deer on the formation of parasitic succession. The helminth fauna of wild animals of the Deer family is diverse. Natural and climatic conditions of the Republic of Belarus are favorable for the development of helminthoses in wild ungulates. The composition of helminths and infection by them are different and depend both on the specificity of the parasite and on biotic and abiotic factors, on the geographical distribution, nutritional characteristics.

Moderately warm summers, atmospheric precipitation and rather mild winters have a positive effect on the circulation and preservation of the invasive beginning in the external environment.

Helminths' locations are closely related to their hosts and geographic environment. Depending on the animal's visits of the lands, humidity, plant species composition, and additional reservoir hosts, the intensity of infection external environment and other factors can be identified dangerous, safe and medium-dangerous biocenosis. Dangerous biocenoses include young deciduous forests, old mixed forests with a well-developed herbaceous cover and deciduous undergrowth, forest and floodplain meadows, meadow bogs. The safest for wild ungulates are boggy deciduous forests, sphagnum bogs, young forest stands, old dry and sphagnum pine forests, since the passage of the full life (reproductive) cycle of the helminth is impossible here. Medium hazardous areas include soils with a neutral pH index, with a well-developed herb cover, an average density of middle-aged plantations, suitable for the development of trichostrongylids, protostrongylids, trichocephalids, etc. They also include dry mixed forests, old spruce, young coniferous forest.

One of the most important factors that form the helminth fauna of animals is the possibility of interchange of parasites between individuals of different ungulate species. Helminth eggs together with animal feces enter the external environment, thereby contributing to its pollution and the spread of helminthiases among other animals.

Currently, one of the main factors in the formation of helminthic-faunistic complexes is a human activity, which resulted in the reduced role of land as a natural forage reserve for ungulates, but increases the value hunting farms and veterinary prophylactic measures, which are aimed at maintaining the strength and health of the herd. As a result of acclimatization and introduction, there is an expansion of the species composition and an increase in the number of animals, but the analysis and registration of the helminthological composition of the imported individuals is not carried out, which leads to the appearance of new types of helminths on the territory of Belarus, often pathogenic for aboriginal species. The continuously increasing anthropogenic impact makes it relevant to carry out an integrated assessment of the state of the environment, analysis of the formation and development trends in red deer populations.

Also, a factor that forms the helminth fauna of animals is the possibility of interchange of parasites between individuals of different species of ungulates.

Helminthological studies of mouflon and European fallow deer were carried out in the Ostrovets forestry in 2016. Both species – captive type of keeping where you create the most favorable conditions for the existence of the animal, resulting in an increase in their numbers, which increases their economic importance. With an increase in the density of ungulates, the depletion of young animals is observed, the structure of the population is disturbed, the reproductive capacity decreases, which leads to intensive infection with helminths and outbreaks of helminthosis, to significant changes in the ecology of all joints of biogeocenoses, against which there is an increase in the number of diseases of various etiologies, which inevitably affects the state and the size of the ungulate population.

Ostrovets forestry is located in the temperate zone of the so-called Atlantic-continental region. The climatic conditions of this zone are created mainly under the influence of the sea and continental air of temperate latitudes. The winter is relatively mild, with frequent thaws; such conditions have a positive effect on the circulation and preservation of the invasive beginning in the external environment. Accordingly, the fallow deer parasite fauna closely correlates with environmental conditions in individual hunting farms.

When assessing the infection of the European fallow deer in winter, it was found that the total extensiveness of the infection is 71.4%. The helminth fauna is represented by the class Nematoda. The study identified 8 genera of helminths: Dictyocaulus, Strongylata, Trichostrongylus, Protostrongylus, *Muellerius capillaris*, Cooperia, Ostertagia, Oesophagostomum. The dominant genus is Dictyocaulus (dominance index (DI) – 32.5%) and *Muellerius capillaris* (DI – 31.25%) (table 3).

Representatives of two classes Trematoda and Nematoda have been identified in the mouflon in the Ostrovets forestry. The total infection rate was 66.7%, which is lower than that of the fallow deer population in the same aviary. The dominant species in the mouflon population is *Muellerius capillaris* (DI – 61.5%), as in the case of the European fallow deer population (table 4).

The appearance of nematodes of the genus Paramphistomum and the specie *Fasciola hepatica* in biosamples of mouflon in winter with an infection rate of 4.7% and 9.5%, respectively, due to colonization by imaginal paramphistomas of the body and the attainment of a new generation of puberty by trematodes. Trematode of the genus Paramphistomum and the specie *Fasciola hepatica* develops with the participation of a mollusk, an inhabitant of deep-water bodies of water with a moderate current with well-developed aquatic vegetation. The active life of mollusks begins in the second half of April – the first ten days of May, and continues until the onset of autumn frosts.

When introduced, animals acquire indigenous parasites, while infecting territories with new species of helminths imported together with acclimatizers, some of which cannot adapt to new conditions of existence for one reason or another, while others find their owners. European fallow deer, like European mouflon, and like other species of acclimatized and re-acclimatized animals, getting into new ecological conditions, lose part of the species diversity of parasites. This is facilitated by the absence of intermediate hosts of certain types of parasites, specific vectors, changes in climatic regimes, changes in diet and other factors. On the other hand, animals in new conditions can be invaded by parasites that were not characteristic of them earlier due to direct contact with the inhabitants of the new region.

According to the data of the study, it was found that worms of the nematode class are the most common in fallow deer and mouflon. The following genera predominate: Dictyocaulus, Muellerius capillaris, Protostrongylus, Oesophagostomum (table 5). The specie *Muellerius capillaris* occurs in all seasons with predominance in winter – the extensiveness of infection is 38.6±4.3, a gradual decrease in the spring period is 17.5±4.45, and the

Table 3

European fallow deer helminths in Ostrovets forestry farm (winter 2015–2016)

Genus/Species of helminth	Ostrovets forestry farm			
	Occurrence, %	Abundance index, specimens	Dominance index, %	Infection intensity
Dictyocaulus	31.4	0.74	32.5	2.5±0.6
Strongylata	2.9	0.03	1.25	1
Trichostrongylus	5.7	0.09	3.75	1.5±0.5
Protostrongylus	71.4	0.2	11.4	1.75±0.25
Muellerius capillaris	34.3	0.71	31.25	2,18±0.21
Cooperia	2.8	0.03	1.25	1
Ostertagia	5.7	0.2	8.75	2.33±0.33
Oesophagostomum	17.14	0.2	8.75	1.17±0.17

Table 4

Fauna of mouflon helminths in Ostrovets forestry farm (winter 2015-2016)

Genus/Species of helminth	Ostrovets forestry farm			
	Occurrence, %	Abundance index, specimens	Dominance index, %	Infection intensity
Nematoda				
Dictyocaulus	23.8	0.52	9.4	2.25±0.9
Strongylata	4.7	0.05	0.08	1
Trichostrongylus	4.7	0.05	0.08	1
Protostrongylus	14.3	0.57	10.3	4±2.1
Muellerius capillaris	42.9	3.43	61.5	7.64±3.36
Oesophagostomum	4.7	0.1	1.7	1
Trematoda				
Paramphistomum	4.7	0.1	1.7	1
Fasciola hepatica	9.5	0.33	6	3.5±0.5

Table 5

Dominance Index (DI) and occurrence (Oc) of helminths in European fallow deer and Mouflon in 2015–2016

Genus/Species of helminth	Fallow deer						Mouflon					
	Winter		Spring		Summer		Winter		Spring		Summer	
	DI, %	Oc, %	DI, %	Oc, %	DI, %	Oc, %	DI, %	Oc, %	DI, %	Oc, %	DI, %	Oc, %
Dictyocaulus	32.5	31.4	-	-	-	-	9.4	23.8	35.7	13.3	18.75	12.5
Strongylata	1.25	2.9	-	-	87.2	46.7	0.08	4.7	-	-	-	-
Trichostrongylus	3.75	5.7	73.5	11.1	-	-	0.08	4.7	-	-	31.25	12.5
Protostrongylus	11.4	71.4	-	-	4.5	20.0	10.3	14.3	-	-	-	-
Muellerius capillaris	31.25	34.3	35.3	22.2	0.4	6.7	61.5	42.9	35.7	13.3	12.5	8.3
Ostertagia	1.25	2.8	0.41	-	-	6.7	-	-	-	-	18.75	12.5
Oesophagostomum	8.75	5.7	-	-	-	-	1.7	4.7	-	-	-	-
Cooperia	-	17.5	7.4	-	-	20.0	-	-	-	-	-	-
Capillaria	-	31.4	-	-	-	-	-	-	21.4	13.3	12.5	8.3
Paramphistomum	-	2.9	-	-	-	-	1.7	-	-	-	-	-
Fasciola hepatica	-	5.7	-	-	-	-	6.0	-	-	-	-	-
Moniezia expansa	-	71.4	-	-	-	-	-	-	7.1	6.7	-	-

extent of infection is reached in the summer period – 7.5±0.8. Studies have also shown a certain resistance of larvae to low temperatures, which is evidence that some of the non-infective nematode larvae can remain viable during the winter and induce spring infection of intermediate hosts (terrestrial molluscs) immediately after their release after hibernation.

The coefficient of species composition commonality of fallow deer and mouflon is 60%. There is no data on the species typical for the territory of Belarus only for European fallow deer and mouflon. Thus, we can conclude that the modern fauna of fallow deer and mouflon helminths on the territory of the Republic of Belarus is formed on the basis of the interchange of parasites between individuals of different ungulate species.

In 2014–2016, helminthological studies of European roe deer were carried out in the Negoreloye Experimental Forestry farm. During the helminthological study, it was carried out that in winter roe deer have helminths of 2 classes: Nematoda and Cestoda; Strongylus sp. class Nematoda. EI is 12.8% (II – 1–4 lv. in f.z.m.). In spring, the studied animals were infected with 8 species of nematodes. Class Cestoda representatives were not observed. The occurrence of Dictyocaulus sp. amounted to 17.9% (II – 1–5 lv. in f.z.m.). In summer, 2 classes of helminths: Nematoda and Cestoda were registered in roe deer. 9 nematode species and 1 cestode species are of them. The maximum occurrence was observed for Dictyocaulus sp. –17.9% (II – 1–2 lv. in m.f.v.) In the autumn period, *Moniezia expansa* appears, the occurrence of which is 12.8% (II – 1–4 ov.in m.f.v) (fig. 2).

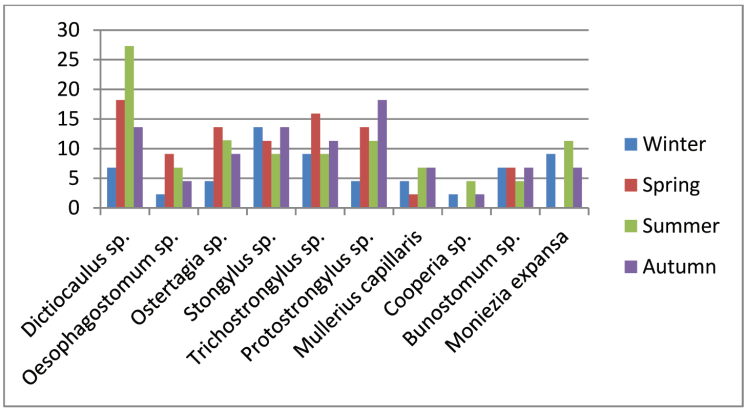

Fig. 2. Occurrence of helminths in *Capreolus capreolus* in the Negoreloye experimental forestry farm in different seasons

A coproscopic study of biosamples in winter revealed two classes of helminths: Nematoda and Trematoda. The maximum extensiveness of the infection of Parafasciolopsis fasciolaemophora is 45.5% (II – 3–6 lv.in m.f.v.). In the spring period, the studied animals also had two classes of helminths: Nematoda and Trematoda. As in the winter period, the maximum EI was observed in *P. fasciolaemophora* and amounted to 55.5% (4–9 lv. in m.f.v.). In summer, trematodes of the species *P. fasciolaemophora* prevailed over other species. EI – 90% (II – 4–8 lv.in m.f.v). The trematode *P. fasciolaemorha* develops with the participation of the mollusk *Planorbarius corneus* (horny coil), an inhabitant of deep-water bodies with a moderate watercourse with well-developed aquatic vegetation. In such reservoirs, the elk finds salvation from bloodsuckers, finds food and watering place. Infection of animals occurs when drinking or eating aquatic plants. In the autumn, the infestation of *P. fasciolaemophora* decreases. The extensiveness of the infection is 44.4% (IS – 3-8 lv. in m.f.v.) (fig. 3). We have found that P. fasciolaemophora is currently found in Belarus only in elk, which confirms its status as the main host.

The identification and study of the species composition of helminthoses in the summer-autumn period in red deer was carried out on the territory of the Negoreloye experimental forestry and the aviary of the Ostrovets forestry farm. Representatives of 5 genera of helminths have been registered in the noble deer of the Negoreloye Experimental Forestry farm. Representatives of 5 genera of helminths have been registered in the noble deer of the Negoreloye Experimental Forestry farm. On the territory of the aviary of the Ostrovets forestry farm, 5 genera of helminths were also identified, which were different in their composition (table 6).

The results of our research show that the characteristics of the helminth fauna depend on the

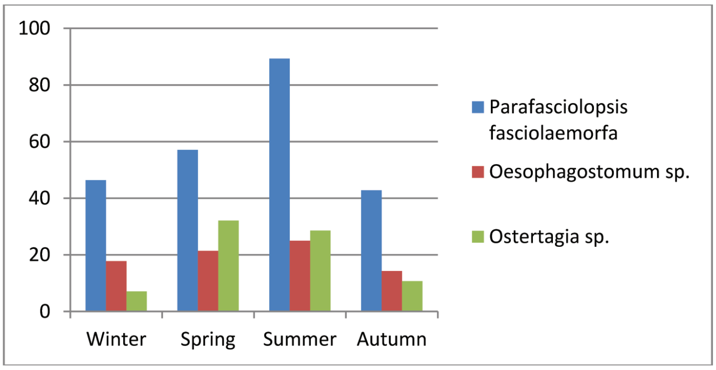

Fig. 3. Occurrence of elk helminths (*Alces alces*) in the Negoreloye experimental forestry farm in different seasons

Table 6

Fauna of red deer helminths in forestry in the summer-autumn period

Genus/Species of helminth	Ostrovets forestry farm	Negoreloye Experimental Forestry farm
Dictyocaulus	16.7/0.17/17	27.8/0.39/47
Strongylata	66.7/1.7/62.5	11.1/0.17/20
Trichostrongylus	16.7/0.17/17	5.6/0.06/7
Protostrongylus	16.7/0.17/17	5.6/0.06/7
Muellerius capillaris	-	11.1/0.17/20
Cooperia	33.3/0.33/12.5	-

Note. Occurrence, % / abundance index / dominance index, %

nature of the territories and environmental conditions (climate, diet, geographical distribution, contact with other ungulates and contact with livestock [10].

The transmission factors of helminths are water, soil, feed. The data from the study of soil, plants and standing water bodies are given in table 7, from which it follows that the contamination of biological samples with eggs and helminth larvae correlates with the fauna of helminths in animals in the summer-autumn period. The maximum number of Strongyloides sp. observed near territories where wild ungulates graze (50 m from the edge of the forest) 9%. Near the population of wild ungulates, the level of infestation of territories by helminths increases. The number of eggs Oesophagostomum sp. prevails and amounts to 13.4%. Also, near the population of wild ungulates, the contamination of plants with pathogens of helminthoses is 37.5%. With the onset of favorable conditions and the establishment of an optimal temperature regime, the contamination of biological samples increases. Consequently, soils, water bodies and plants serving as food for wild ungulates play an essential role in the formation of the helminth fauna.

We found that in the Negoreloye experimental forestry farm, the occurrence of helminths in European roe deer and elk has a apparent dependence on the season. In European roe deer, the minimum occurrence of helminths is observed in winter (23.1%). By the spring, the occurrence increases and is 25.6%, reaching maximum values in summer (28.9%). From autumn to winter, the frequency of occurrence decreases and is 25.7%. The occurrence of helminths in elk has the same tendency as in roe deer – an increase from winter to summer, with a decrease in autumn. The percentage of occurrence of helminths in elk in all seasons is higher than in roe deer and deer, and amounts to 63.6–83.3%.

In red deer, the occurrence of helminths in different seasons of the year in Negoreloye experimental forestry farm varies insignificantly. There is a decrease in it from the winter period (41.7%) to spring (38.1%), a gradual increase in the summer (44.4%) and a slight decrease in autumn (42.9%) (fig. 4).

Contacts of wild ungulates in pasture areas lead to a common composition of helminths, which is found during coproscopic reseach.

The total destruction of wild pig as a preventive measure to control the spread of the pathogen of African pig fever has led to an increase in the number of red deer and a gradual stabilization of its population density. There is also a gradual increase in the number of European roe deer. The number of elk was not significantly changed. In the parasitological situation in the red deer population, representatives of the Cestoda class are replaced by representatives of the Trematoda class (fig. 5).

In the dynamics of representatives of the fauna of wild ungulate helminths, researcher [17, 18] noted significant fluctuations in the occurrence of

Table 7

Contamination by helminths of territories near the distribution of populations of wild ungulates in the summer-autumn period

Biological sample	Helminths species		
	Close to wild ungulate populations	Biotope of wild ungulates (50 m from the edge of the forest)	Biotope of wild ungulates (200-500 m from the edge of the forest)
Soil	Strongyloides sp. – 1.2%	Strongyloides sp. – 9%	Strongyloides sp. – 5.3%
Standing water bodies	Nematodirus sp. – 1% Oesophagostomum sp. – 13.4% Ostertagia sp. – 11.8% Trichostrongylus sp. – 4.2% Paramphistomum sp. – 6.8%	Not found	Trichostrongylus sp. – 3.6%
Plants	Strongyloides sp. – 6.8% Dictyocaulus sp. – 16.4% Oesophagostomum sp.– 14.3%	Not found	Strongyloides sp. – 7.4% Dictyocaulus sp. – 4.8%

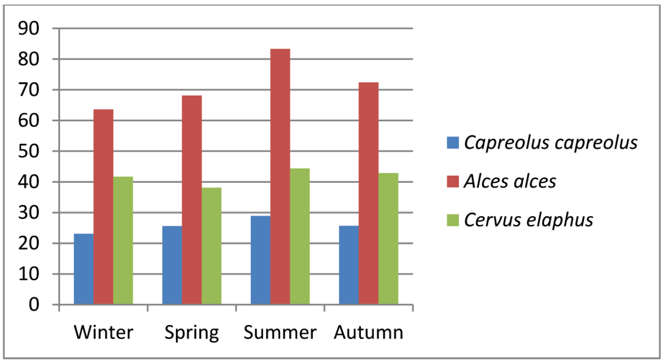

Fig. 4. The occurrence of helminths in animals of the Deer family in the Negoreloye experimental forestry farm in different seasons

the main species of helminths, when some fell out and others became widespread. Dominating are the representatives of a class Nematoda genus Dictyocaulus, representatives of the genus Strongylata, Trichostrongylus, Protostrongylus are constantly present. The genera Chabertia, Neoascaris, Cooperia of class Nematoda are replaced by the following genera: Oesophagostomum, Capillaria, Muellerius of the same class. At the same time, the coefficient of common species composition of red deer and European roe is 46%, European roe and elk – 18%, red deer and elk – 22% (fig. 6).

In a resich of samples of red deer in the Belovezhskaya Pushcha on the territory of the Republic of Belarus it was found that there are worms Classes Nematoda and Trematoda. The total occurrence of helminths in red deer was 53.8%. On average, there were 1.5±0.5 types of helminths per infected individual. Representatives of the Trematoda class dominated. Dominance index of Paramphistomum sp. amounted to 55.6% (table 8).

In a resich of samples of red deer in the Belovezhskaya Pushcha on the territory of the Republic of Poland, it was found that the occurrence of helminths is 73.3%. They belong to the class Nematoda. On average, there were 2.1±0.5 types of helminths per infected individual (table 9).

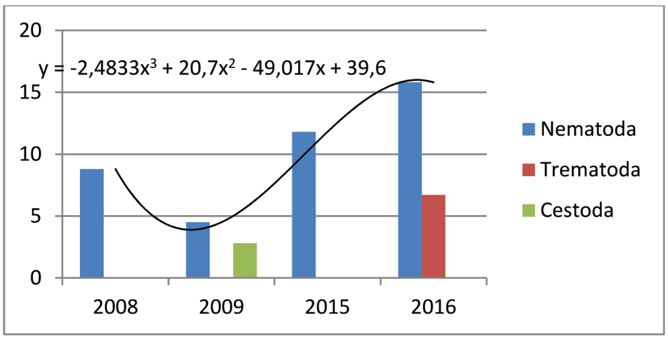

Fig. 5. Changes in the occurrence of helminth class by red deer in the territory of the Negoreloye experimental forestry farm for the period from 2008 to 2016

Polesskiy radiation-ecological reserve appeared in the Republic of Belarus in 1988 shortly after the Chernobyl disaster. This is the Belarusian exclusion zone with an area of 217 thousand hectares. The reserved zone occupies part of the Bragin, Khoiniki and Narovlya districts of the Gomel region. On the territory of the Polesskiy Radiation-Ecological Reserve, which is located in the southern region of the Republic of Belarus, the occur-

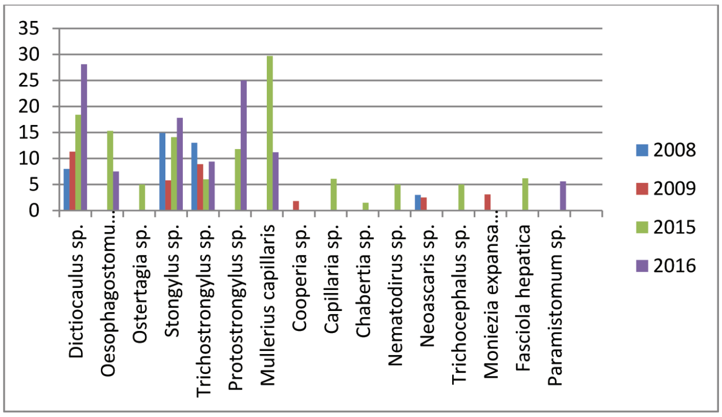

Fig. 6. Changes in the occurrence of helminths in red deer by genus on the territory of the Negoreloye experimental forestry farm over the period from 2008 to 2016

Table 8

Fauna of red deer helminths in Belovezhskaya Pushcha on the territory of the Republic of Belarus (2015)

Genus/Species of helminth	Occurrence,%	Abundance index, specimens	Dominance index,%
Nematoda			
Dictyocaulus	7.7	0.08	11.1
Strongylata	7.7	0.08	11.1
Muellerius capillaris	15.4	0.15	22.2
Trematoda			
Paramphistomum	30.8	0.38	55.6

Table 9

Fauna of helminths and occurrence of helminths in red deer in Belovezhskaya Pushcha on the territory of the Republic of Poland (2015)

Species of helminths	Occurrence,%,	Intensity of helminth infection, specimens
Nematoda		
Dictyocaulus sp.	20.0	1-2
Muellerius sp.	20.0	2-5
Oesophagostomum sp.	20.0	1-2
Ostertagia sp.	33.33	1-8
Trichostrongylus sp.	13.33	2-4
Strongyloides sp.	6.7	2
Capillaria sp.	6.7	3

rence of helminths in European roe deer is 97.4%, with mixed invasion dominating. On the territory of the reserve, in European roe deer registered 18 species of helminths (table 10) belonging to three classes: Trematoda – 4 species (22.2%), Cestoda – 3 species (16.6%) and Nematoda – 11 species (61.1%).

On the territory of the Polesie radiation-ecological reserve, the occurrence of helminths of different species in a wild horse is different. The dominant species is Parascaris equorum, which belongs to the class Nematoda. The specie Anoplocephala perfoliata, a member of the Anoplocephalidae family of the Cestoda class, and the specie Delafondia vulgaris of the Strongylidae family of the Nematoda class, are rare. In total, in the wild horse 6 species of helminths belonging to two classes: Cestoda – 1 species and Nematoda –5 species were registered of the reserve territory (table 11).

At the end of the last century, more than 60% of the world population of bison was kept in Belovezhskaya Pushcha (Belarusian and Polish parts), which determined the need for international research on its conservation, dispersal and use. In 1991, on the territory of the Republic of Belarus, there were 3 populations of European bison - Belovezhskaya, Borisov-Berezinskaya and Ozerskaya. There were 353 animals in them. In the same year, the Nalibok group with a herd of 15 animals was added to the existing populations. In 1996, 17 bison were brought to the Polesie Radiation and Ecological Reserve, establishing the

Table 10

Species composition of helminths, occurrence and intensity of infection of helminths of European roe deer in the Polessky Radiation-Ecological Reserve of the Republic of Belarus

Species of helminths	Occurrence, %	Intensity of helminth infection, specimens	Localization, organ
Fasciola hepatica	12.5	1-3	Biliary tract of the liver
Dicrocoelium dendriticum	6.3	1-4	Biliary tract of the liver
Parafasciolopsis fasciolaemorpha	43.8	10-42	Biliary tract of the liver
Liorchis scotiae	18.8	5-65	Rumen
Taenia hydatigena larvae (*Cysticercus tenuicollis*)	15.7	1-2	Serous membrane
Echinococcus granulosus larvae	15.7	1-2	Liver parenchyma
Bunostomum trigonocephalum	28.1	2-37	Small intestine
Moniezia expansa	3.2	1	Small intestine
Ostertagia ostertagi	15.7	13-103	Abomasum and small intestine
Haemonchus contortus	25.0	11-170	Abomasum and small intestine
Trichostrongylus capricola	9.4	1-7	Abomasum and small intestine
Trichocephalus ovis	9.4	3-7	Large intestine
Oesophagostomum venulosum	31.3	2-19	Large intestine
Chabertia ovina	18.8	44-148	Large intestine
Protostrongylus sp.	3.2		Bronchi and bronchioles
Varestrongylus capreoli	3.2		Bronchi and bronchioles
Dictyocaulus eckerti	21.8	5-17	Bronchi and bronchioles
Setaria labiato-papillosa	6.3	1-2	Thoracic cavity and abdominal cavity

Table 11

Species of helminths, the occurrence and intensity of infection of helminths in wild horses in the southern region of the Republic of Belarus

Species of helminths	Occurrence of helminths,%	Intensity of helminth infections, specimens
Anoplocephala perfoliata	2.1	2-4
Oxyuris equi	13.2	5-20
Parascaris equorum	53.4	3-11
Strongylus equinus	28.7	6-15
Delafondia vulgaris	2.1	2-4
Alfortia edentatus	15.6	2-4

Polesie population. Then, every year, one after another, Osipovichskaya (initially 15 animals), Ozyorskaya (18), and Naydayan (13) began to appear. After a break, in 2005 the Lyaskovichi micropopulation of 14 individuals was formed. The last two of those listed are created in the Pripyatsky National Park. By that time, the total number of bison in the country had doubled to 680. Almost 10 years later, in 2014, 50 animals were introduced into the Krasny Bor hunting farm, which gave rise to a new local group. In 2018, 20 forest giants became the ancestors of the Dyatlov micropopulation. In 2019, the total number of the species reached 2043 heads. The optimal number for the Republic of Belarus is 1500 individuals. There is already a lot of bison available for our territory, and today there is no acute problem of preserving the species – there is a question of its genetic diversity. In some of the 11 existing groupings, the number of animals is double the optimal habitat. So, most of all bison in the Belovezhskaya population is 593. In second place in their number is Osipovichskaya (470), in third – Ozyorskaya (378). This is followed by Krasnoborskaya (190) and Polesskaya (174). All other groups have not increased even 100 animals over the years. But the worst of all is in the Borisov-Berezinsky population, where there are currently only 15 animals – exactly 11 fewer than in the initial population in 1994. Currently, it is planned to create a new Cherikov group of European bison in the lands of the Cherikov forestry with hornbeam-oak-dark coniferous forests over 40 years old, with glades, meadows, wetlands and reclamation canals. The floodplains here are rich, the food supply is sufficient. The minimum area is 30,000 hectares, where at least 10,000 hectares are covered with forest crops. Also, this territory does not experience a strong anthropogenic pressure in the form of agriculture.

One of the most important aspects of ecological research in the Republic of Belarus is the study of bison helminths as a factor influencing the stability of its population.

Helminths disrupt homeostasis and cause the emergence and development of pathological states of organs and systems of the animal body [12]. In this regard, the degree of infection of bison with various helminths, which also serve as the gateway for the penetration of pathogenic microflora into the tissues of the body, is of interest. Animals not only become more susceptible to infectious diseases, but also harder to tolerate adverse climatic conditions.

Parasitological surveys of the Bialowieza bison population showed that the occurrence of helminths in this population is 51.3%. The frequency of occurrence by class in infected animals is: Cestoda – 5.0%, Trematoda – 30.0%, Nematoda – 90.0%. Representatives of 6 genera are registered. Representatives of two genera are dominant: Dictiocaulus and Neoascaris.

The occurrence of helminths among bison in the Porozovskoye forestry is higher than in the Sukhopolskoye forestry. The species richness was authentically 5 and 7 species, respectively. In both forestries, representatives of the genus Dictiocaulus dominated, the occurrence of which was 34.28 and 30.00%, respectively. Worms Fasciola hepatica have been registered among bison in the Beliansskoye forestry of Belovezhskaya Pushcha. Infection rate is 80%, the intensity of infection is up to 55 specimens. In the Korolevo-Mostovskoye forestry of Belovezhskaya Pushcha, eggs and larvae of helminths of two classes were found: Nematoda and Trematoda. The extensiveness of infection is 66.6%. In the Nikorskoye forestry of Belovezhskaya Pushcha, the extensiveness of infection is also 66.6%. Registered helminths belong to two classes: Nematoda and Trematoda. Intensity of infection in this forestry is not high (table 12).

Table 12

Fauna of helminths and their occurrence in European bison in the forestries of Belovezhskaya Pushcha

Species of helminths	Porozovskoe forestry of Belovezhskaya Pushcha		Sukhopolskoye forestry of Belovezhskaya Pushcha		Belyanskoe forestry of Belovezhskaya Pushcha		Korolevo – Mostovskoe forestry of Belovezhskaya Pushcha		Nikorskoe forestry (white forest) of Belovezhskaya Pushcha	
	O	II	O	II	O	II	O	II	O	II
Dictyocaulus sp.	30.0	1-2	34.28	2-4	-	-	-	-	20.0	1-2
Oesophagostomum sp.	7.8	2	-	-	-	-	-	-	20.0	1
Ostertagia sp.	4.4	1	8.6	3-8	-	-	33.3	11	-	-
Neoascaris sp.	17.8	1-2	17.1	2-9	-	-	33.3	1	-	-
Trichostrongulus sp.	4.4	1	-	-	-	-	16.6	1	-	-
Fasciola hepatica	28.9	1-7 (2)	5.7	1-6	80.0	1-55 (17)	33.3	1-3	40.0	1-3
Paramphistomum sp.	7.8	1-12	11.4	2-6	-	-	16.6	2	13.3	1-2
Dicrocoelium sp.	-	-	-	-	-	-	16.6	2	6.6	2
Ashworthius sidemi	-	-	-	-	-	-	8.3	9-12	-	-

Note. O – the occurrence of different species of helminths, %; II – intensity of infection by helminths (Min-max (X)), specimens

European bison (17 animals) was brought to the Polesie State Radiation-Ecological Reserve in 1996. The peculiarity of the ecological habitat of bison in the reserve (large territory, strict protection regime, removal of almost all types of anthropogenic load, significant areas of former farmland), the nature of forest vegetation, regional climate features favor the habitation of these wild. Helminthological studies in this area showed that helminths of various families are recorded in bison of the Polissya population (table 13). Nematodes accounted for 78.6%, trematodes – 12.3% and cestodes – 7.1%. Dominated were *Capillaria bovis, Oesophagostomum venulosum, Oe. radiatum*, and trematode *Paramphistomum cervi*. The subdominant specie is *Setaria labiato-papillosa*. The extent of bison helminth infection varied from 89.05%. One species of helminth is found in

24.7% of bison. In animals, two species are found simultaneously, which is 51.8% and three species – 11.7%, less often – 4 species – 7.1%, 5 species – 3.5% and 6 species – 1.2%. *Nematodirus helvetianus* is more common in young bison.

The largest number of helminth species was recorded in Belovezhskaya population of European bison – 37 species, the helminth fauna of which has already formed [11]. In Polesie State Radiation-Ecological Reserve, 15 species of helminths have been recorded among European bison (table 13). The formation of the fauna of helminths in this area continues.

Table 13

Fauna of helminths and occurrence of helminths of European bison of the Polissya population

Species of helminths	Occurrence of helminths, %
Fasciola hepatica	13.45
Paramphistomum cervi	18.7
Moniezia expansa	7.65
Dictyocaulus viviparus	5.35
Neoascaris sp.	10.6
Nematodirus helvetianus	11.8
Capillaria bovis	22.4
Trichocephalus ovis	4.3
Bunostomum trigonocephalum	12.5
Haemonchus contortus	13.4
Setaria labiato-papillosa	3.8
Ostertagia ostertagi	15.2
Oesophagostomum radiatum	22.0
Oe. venulosum	22.0
Cooperia oncophora	11.5

Conclusions

The study of the species composition and factors influencing its formation in farms in different territories allows predicting the appearance of certain helminths in wild ungulates, identifying the most common and pathogenic species and developing measures to control and prevent these helminths.

In model forestrys, red deer dominates of the total number of registrations on average. Ungulates of the Deer family use biotopes with a stand density above 0.6 to an insignificant extent (K = -0.2, G = 42.7, P = 0.03).

The biotopic distribution of roe deer in spring and autumn does not differ significantly (G = 116.7, P = 0.01). At this time, animals prefer areas with a predominance of broad-leaved species (D or.) (K = 0.86, G = 53.1, P < 0.01). During the rutting season, pine-moss forests are preferred (G = 37.4, P < 0.01).

In the warm season, the red deer prefers forests with a predominance of pine trees in the stand (K = 0.6, G = 37.4, P < 0.01). Bilberry pine forests are preferred by females in spring and summer (adults and semi-adults) (K = 0.42, G = 32.4, P < 0.01), males - mossy pine forests during the growing season (K = 0.22, G = 28.91, P = 0.03).

In the red deer population, representatives of the Cestoda class are replaced by representatives of the Trematoda class. Representatives of the class Nematoda, genus Dictyocaulus remain dominant. Representatives of the genus Strongylata, Trichostrongylus, Protostrongylus are constantly present. The genera Chabertia, Neoascaris, Cooperia are replaced of the Nematoda class into the following genera: Oesophagostomum, Capillaria, *Muellerius capillaris* of the same class.

The coefficient of common species composition of red deer and European roe worms is 46%, European roe and elk – 18%, red deer and elk – 22%.

On the territory of the Republic of Belarus, a rich species composition of helminths was revealed in European bison and a high degree of occurrence of helminths in this host. More than half of the animals in the bison populations are carriers of helminths: Belovezhskaya – 51.3%, Polesskaya – 89.05%. Moreover, most of them have one species of helminths (from 50.0 to 66.7%) or two species of helminths (from 25.0 to 38.0%). Three or more species of helminths recorded simultaneously are rare. Representatives of the Nematoda class are 6 times superior to other classes of parasitic helminths (G = 39.8, P < 0.01). The bison helminth complex differs in different populations, as it is at the stage of formation in some of them. During the acclimatization of bison in new faunistic complexes, they, along with other members of the biocenosis, begin to participate in the circulation of local helminth species.

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