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Epidemiological and epizoological characteristics of rodent (Mammalia: Rodentia) helminths in Lankaran natural region of Azerbaijan Republic

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Abstract. 9 species of rodents belonging to the families Muridae and Cricetidae have been caught in different habitats of Lankaran natural region (dry steppe semi-desert habitats, humid subtropical temperate climate habitats, humid subtropical medium climate habitats, warm broad-leaved forest habitats, mountain forest steppe habitats and mountain steppe habitats) and dissected according to the complete helminthological autopsy method developed by K. I. Skryabin. These rodents are: brown rat *Rattus norvegicus*, house mouse *Mus musculus L.,* wood mouse *Apodemus (sylvaemus) sylvaticus L.,* grey hamster *Cricetulus migratorius,* Persian jird *Meriones persicus,* Tristram's jird *M. blackleri*, European water vole *Arvicola terrestris L.*, common vole *Microtus arvalis* and social vole *M. socialis*. We found members of 47 helminth species in the dissected rodents, including 7 species of trematodes, 14 species of cestodes, 25 species of nematodes and 1 species of acanthocephalus. Of these, 26 species were biohelminths and 21 species were geohelminths. For these helminth species, we conducted epidemiological and epizootological potential assessment; 10 helminth species were found to be of epidemiological and epizootological significance, because they infect humans and domestic animals. Out of all the trematodes, *Gastrodiscoides hominis* has epidemiological significance for humans and epizootological significance for domestic pigs, while *Echinostoma mijagawai* has epizootological significance for domestic waterfowl (ducks and geese). Among the cestodes, adult *Taenia hydatigena* and *Alveococcus multilocularis* have epizootological significance for dogs and cats, while their larvae have epidemiological significance for humans and epizootological significance for even-toed ungulates; *Hydatigera* taeniaeformis has epidemiological significance for humans and epizootological significance for dogs and cats; *Taenia pisiformis* has epizootological significance for cats*; Hymenolepis diminuta* has epidemiological significance for humans. One of the nematodes, *Hepaticola hepatica,* has epidemiological significance for humans and epizootological significance for dogs and cats. *Syphacia obvelata* has epidemiological significance for humans; one type of acanthocephalus — *Moniliformis moniliformis* — has epidemiological significance for humans and epizootological significance for dogs and cats.

Keywords: rodents, helminths, biohelminth, geohelminth, epidemiology, epizoology.

Эпидемиологическая и эпизоотологическая характеристика гельминтов грызунов (Mammalia: Rodentia) Ленкоранской природной области Азербайджана

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Аннотация. Во время исследований в различных ландшафтах (сухой степной полупустынный, влажно-субтропический, тепло-влажный субтропический, умеренно-теплый широколиственный, лесостепной, горно-степной) Ленкоранской природной области методом полного гельминтологического вскрытия К. И. Скрябина были исследованы 9 видов грызунов: серая крыса – *Rattus norvegicus*, домовая мышь — *Mus musculus L.*, лесная мышь — *Apodemus (sylvaemus) sylvaticus L.*, серый хомячок — *Cricetulus migratorius*, персидская песчанка — *Meriones persicus*, малоазийская песчанка — *M. blackleri*, водяная полевка — *Arvicola terrestris L.*, обыкновенная полевка — *Microtus arvalis*, общественная полевка — *M. sociali*. В результате исследований у них выявлено 47 видов гельминтов. Гельминтофауна была представлена 7 видами трематод, 14 цестод, 25 нематод и 1 видом акантоцефала. Из них 27 видов являются биогельминтами, 20 видов геогельминтами. Выявленные гельминты были характеризованы с эпидемиологической и эпизоотологической точки зрения, и выяснилось, что 10 видов гельминтов, заражающие человека и домашних животных, имеют эпидемиологическое и эпизоотологическое значения. Из трематод *Gastrodiscoides hominis* имеет для людей эпидемиологическое, а для домашних свиней эпизоотологическое значение; *Echinostoma mijagawai* для домашних водных птиц (утки и гуси) эпизоотологическое значение; из цестод *Taenia hydatigena, Alveococcus multilocularis* в половозрелой стадии для кошек и собак эпизоотологическое, а в личиночной стадии для людей эпидемиологическое, для парнокопытных животных эпизоотологическое значение; *Hydatigera taeniaeformis* для людей эпидемиологическое, для кошек и собак эпизоотологическое, *Taenia pisiformis* для кошек и собак эпизоотологическое значение; *Hymenolepis diminuta* для людей эпидемиологическое; из нематод *Hepaticola hepatica* для людей эпидемиологическое, для кошек и собак эпизоотологическое значение; *Syphacia obvelata* эпидемиологическое значение для людей; 1 вид акантоцефал — *Moniliformis moniliformis* эпидемиологическое значение для людей, для кошек и собак эпизоотологическое значение.

Ключевые слова: грызуны, гельминты, биогельминт, геогельминт, эпидемиология, эпизоотология.

Introduction

The environmental conditions of the Lankaran natural area are favourable for rodents and rodent-eating carnivores, as well as helminth species that parasitize these animals, leading to their populations increasing in numbers and spreading. This area also hosts internationally popular resorts and other tourism and industrial facilities, with a part of the International "Silk Road" passing through this area. Lankaran also includes an internationally important Kyzylagach State Reserve, Hirkan Reserve and various other nature reserves, which increases the amount of contact between humans and domestic animals on one side, and wild animals — which includes rodents — on the other.

Rodents are one of the most numerous groups of mammals and are widespread in all landscapes and habitats of the Lankaran natural region. They are an important link in various food chains in the region's natural habitats and are a part of the diets of both wild

and domestic carnivorous animals. They enter habitats through regular seasonal migrations and expand their contact with humans and domestic animals through biocenotic routes. Occasionally, helminth invasion from wild mammals, including rodents, to humans or their pets may occur during such contacts, if veterinary and health and safety regulations are not strictly followed.

Many rodent species are primary or intermediate hosts of helminths significant for domestic animals and humans. Rodents are also carriers and transmitters of helminthiasis natural foci. For this reason, rodents are likely to play an important role in the transmission of helminthic pathogens that have epidemiological and epizootological significance for humans, animals and birds.

Although there has been some prior research on rodent helminths in different regions of Azerbaijan, the epidemiological and epizootological significance of dangerous helminths of the Lankaran natural region has not been sufficiently studied (Fataliyev 2009; Fataliyev, Aslanova 2015; 2019; Fataliyev 2015; Mustafayev 1965; Sadykhov 1981).

Therefore, we aim to study and analyse the epidemiological and epizootological significance of rodent helminths widespread in various habitats of the region in order to determine the role of rodents in the transmission of some major helminthic pathogens to humans and domestic animals.

Materials and methods

From 2013 to 2019, 572 rodents of 7 genera and 9 species in 2 families were investigated in order to study the epidemiological and epizootological significance of rodent helminths. The rodent species in question are as follows: the brown rat *Rattus norvegicus*, house mouse *Mus musculus L.,* wood mouse *Apodemus (sylvaemus) sylvaticus L.,* grey hamster *Cricetulus migratorius,* Persian jird *Meriones persicus,* Tristram's jird *M. blackleri*, European water vole *Arvicola terrestris L.*, common vole *Microtus arvalis* and social vole *M. socialis*.

We collected specimen from different habitats of the Lankaran natural region and examined them according to the complete helminthological dissection method developed by K. I. Skryabin (Skryabin 1928).

The animals were captured with Gergo and Sherman traps. The collected helminths were treated as follows: trematodes, cestodes and acanthocephalus were fixed in 70% alcohol, and nematodes in Barbagall solution.

The staining method commonly used in parasitological studies was employed to identify trematodes and cestodes in rodents. After washing in distilled water, the nematodes were transferred to a glass slide, put under a microscope, cleared by adding a few drops of a 50:50 glycerine and lactic acid mixture and covered with a cover glass.

The helminth species composition was determined according to the relevant designation books (Ryzhikov et al. 1978; 1979).

Results and their discussion

In our study, we found 47 helminth species in rodents, including 7 species of trematodes, 14 species of cestodes, 25 species of nematodes and 1 species of acanthocephalus.

Let us now discuss the distribution of 10 helminth species of different epidemiological and epizootological significance found in rodents in different habitats and their causes (tabl. 1).

Gastrodiscoides hominis (Lewis et Mc. Connall 1876) specimens were found in small numbers (2–3 individuals) in two of the nine water voles caught in dry steppe semi-desert habitats and in relatively high numbers (3–12 individuals) in 29 voles (27.6% of the total number) caught in temperate humid subtropical habitats.

This species is a biohelminth. This helminth's development cycle normally ends with nutria, water vole and rarely wild boar or human as the final host, while freshwater snails serve as intermediate hosts.

This parasite is typical for rodents (water voles, nutria). There is also a risk of human or domestic animal infection if veterinary and health and safety regulations are not followed.

Echinostoma mijagawai (Ischii 1932). A significant number of specimens (5 individu-

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Table 1

Helminth species of epidemiological and epizootological significance present in the Lankaran region

Таблица 1

Виды гельминтов, имеющие эпидемиологическое и эпизоотологическое значение в Ленкоранской природной области

Helminth species	The stage of development found	Epidemiological significance	Epizootological significance	Significant stage
Gastrodiscoides hominis	adult	+	domestic pigs	adult
Echinostom amijagawai	adult	–	ducks, geese, chicken	adult
Hymenolepis diminuta	adult	+	–	adult
Taenia pisiformis	intermediate larval stage	–	dogs, cats	adult
T. hydatigena	intermediate larval stage	+	dogs, cats, domestic pigs, ungulates, camels	adult, larvae
Hydatigera taeniaeformis	intermediate larval stage	+	dogs, cats	adult
Alveococcus multilocularis	intermediate larval stage	+	dogs, cats, ungulates	adult, larvae
Hepaticola hepatica	egg	+	dogs, cats	adult, egg
Syphacia obvelata	adult	+	–	adult
Moniliformis moniliformis	adult	+	dogs, cats	adult

als) were found in one of nine water voles caught in humid subtropical habitats. It was more prevalent in the temperate humid subtropical habitats: a high number of individuals (4–34) were found in 14 of the 29 voles (48.3%) caught there. The range of the species includes biotopes where water bodies and swamps are present.

This species completes its development with water voles, American sable, chicken, duck or goose as the final host and starts with freshwater snails as the first and second host. Both the first, intermediate and final hosts are widespread in the area of the study.

Hymenolepis diminuta (Rudolphi 1819) is a widespread rodent parasite and has been repeatedly found in humans in various regions (Alibekov 2011; Kirillov, Kirillova 2014). This species is found everywhere.

In Lankaran natural region, it is present in 7 species of rodents: brown rat, house mouse, wood mouse, grey hamster, Persian jird, Tristram's jird and water vole. It is present in 15.2% of rodents caught in dry steppe semi-desert habitats, in 19.7% in humid subtropical habitats, in 14.6% in mild warm broad-leaved mountain-forest habitats, in 13.7% in forest steppe habitats and in 17.8% in mountain steppe habitats. The final host of this species is normally a rodent and sometimes a human, while intermediate hosts are a variety of insects and worms. Both the final and intermediate hosts of this species are widespread in the region. Therefore, this species is more likely to spread among humans. Human infection with this parasite occurs when the intermediate hosts of this helminth are accidentally ingested with food. Rodents are infected by ingesting host invertebrates. Therefore, health and safety requirements must be strictly observed in all the economic activities conducted in the region.

Taenia pisiformis (Bloch 1780) (=*Cysticercus pisiformis*). The larvae of this cestode were found in rodents such as brown rat, house mouse, wood mouse, grey hamster and water vole. It was found in 9.7% of rodents caught in the dry steppe semi-desert habitats, in 16.6% in the mild humid subtropical habitats, in 14% in the humid subtropical habitats, in 12.5% in moderate-warm broad-leaved mountain-forest habitats, in 10.7% in forest-steppe habitats and in 3.9% in mountain-steppe habitats.

This species' developmental cycle ends with a dog, jackal, wolf, fox or domestic cat as the final host, while larva hosts are rabbits (grey rabbits or rabbits) and various species of rodents.

Research shows that this species is widespread in the wild in Lankaran and other parts of the country, including in wild dogs and cats, and among stray dogs and cats in synanthropic environments, so it is likely to be widespread among domestic predators (dogs and cats). For this reason, veterinary, health and safety and hygiene rules must be strictly observed when keeping dogs and cats at home, in the yard or on a farm.

Taenia hydatigena (Pallas 1766) (=*Cysticercus tenuicollis*). Records of the adult stage of this cestode found in various domestic and wild animals of Azerbaijan has been reported by many authors (Fataliyev 2009).

In our study, relatively high incidence of larvae was found in the rodents of forest steppe habitats (16.6%), temperate warm broad-leaved mountain-forest habitats (11.7%) and dry steppe semi-desert habitats (11.4%), with relatively low incidence in other habitats.

The developmental cycle of this species ends with domestic and wild losers and cats as the final hosts, while the larvae use domestic and wild ungulates, rodents and rabbits as hosts. The larvae of this species have also been found in apes and humans.

Hydatigera taeniaeformis (Batsch 1786) (=*Strobilocercus fasciolaris*). Out of all the cestodes, the larvae of this species — which is widespread among rodents — have the highest epizootiological significance. The larvae of this species were found in 5 rodent species studied by us: grey hamster (27.3%), house mouse (14.2%), woodmouse (14.4%), Persian jird (10.9%) and common vole (20.0%).

H. taeniaeformis larvae have been found in large numbers (1–5) in rodents caught in moderately humid subtropical habitats (28.2%) of the Lankaran natural region, and in smaller numbers in the temperate subtropical (7.2%) and mountain steppe (6.8%) habitats.

This species is a biohelminth; its final hosts are domestic and wild losers, cats, humans, while its intermediate hosts are rodents, rabbits and insectivores.

Alveococcus multilocularis (Zeuckard 1863) (=*Alveococcus multilocularis*). We have observed the larval stage of this species in house mice (2.7%) and wood mice (4.7%) caught in the dry steppe semi-desert habitats; in wood mice caught in the temperate humid subtropical (11.1%) and humid subtropical (10.5%) habitats and in Persian jirds caught in the temperate warm broad-leaved mountain forest (6.8%) and forest steppe (12.5%) habitats.

This species is a biohelminth; its development cycle ends with domestic and wild predators, including cats, as the final hosts, while its intermediate hosts are rodents, ruminants and humans.

As discussed above, we found larvae of *T. psiformis, T. hydatigena, H. taeniaeformis* and *A. multilocularis* in rodents. Throughout their development, these cestodes infect a variety of intermediate and final hosts. They are also quite resilient to various adverse biotic and abiotic factors. The final hosts are infected when they swallow invasive helminth eggs with their prey. Rodents play an intermediate role in completing the development cycle of these species. The reason rodents are infected with these species' larvae is that they live in the same area as wild and domestic carnivorous animals and enter various biocenotic relationships.

Hepaticola hepatica (Bancroft 1893) parasitizes a wide range of mammals, primarily rodents. In some regions, this species also infects humans (Kirillov et al. 2014).

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We have recorded this species in brown rats, house and wood mice, grey hamsters and common voles. The rodent infection rate is 8.4% in dry steppe semi-desert habitats, 17.5% in temperate humid subtropical habitats, 19.1% in temperate warm broad-leaved mountain forest habitats, 26.3% in forest steppe habitats and 16,6% in mountain steppe habitats.

By developmental cycle, this species is a geohelminth; its development takes place in the external environment and ends in the bodies of rodents. Nematode eggs released into the environment develop to the invasive stage when exposed to favourable environmental conditions, and infection occurs when such eggs are ingested by the final host along with the feed. Humans may be infected after ingesting fruits and vegetables contaminated with helminth eggs at the invasive stage, if those fruit and vegetables have not been properly washed in water.

Syphacia obvelata (Rudolphi 1802). This species is the most common rodent parasite. In our study, the house mouse infection rate was 8.1% in dry steppe semi-desert habitats, 60.0% in temperate humid subtropical habitats and 3.7% in forest steppe habitats; wood mouse infection rate was 19.0% in dry steppe semi-desert habitats and 27.0% in temperate humid subtropical habitats; social vole infection rate was 24.3% in dry steppe semi-desert habitats.

Notably, *S. obvelata* is widely distributed among house and wood mice in the dry steppe semi-desert, temperate humid subtropical and forest steppe habitats of the Lankaran natural region, with high numbers per individual rodent.

By development cycle, this species is a geohelminth. The environmental factors that are necessary for its development invariably occur.

Moniliformis moniliformis (Bremser 1811). It is a unique type of helminth and has been reported to parasitize various mammals (Sadykhov 1981).

We observed this species in wood mice with 14.2% infection rate in dry-steppe semi-desert habitats, 11.1% in temperate humid subtropical habitats, 16.6% in humid subtropical habitats and 7.6% in mountain steppe habitats; and in Persian jird with 20.0% infection rate in humid-subtropical habitats and 13.8% in temperate warm broad-leaved mountain forest habitats.

This one type of acanthocephalus found during the study is a biohelminth. Its intermediate host is the black beetle, while the final hosts can be a variety of rodents. For this species, birds and humans play the role of optional hosts.

The mentioned 10 species of helminths were analysed in terms of their epidemiological and epizootological significance. It was found that *G. hominis* has epidemiological significance for humans and epizootological significance for domestic pigs. *E. mijagawai* has epizootological significance for domestic waterfowl (ducks, geese). Adult *T. hydatigena* and *A. multilocularis* have epizootological significance for dogs and cats, while their larvae have epidemiological significance for humans and epizootological significance for ungulates. *H. taeniaeformis*, *M. moniliformis* and *H. hepatica* have epidemiological significance for humans and epizootological significance for dogs and cats. *T. psiformis* has epizootological significance for dogs and cats; *H. diminuta* and *S. obvelata* have epidemiological significance for humans. These species have been repeatedly found in adults both in Azerbaijan and in other countries (Kirillov, Kirillova 2014; Sadykhov 1981).

The results of our research show that rodents play an important role in the conservation of helminthic pathogens of epidemiological and epizootological significance in nature, their transmission to the synanthropic environment and their distribution among humans and domestic ungulates. Therefore, it is necessary to constantly monitor and regulate the numbers of wild predators — especially wild dogs and cats — in nature and the numbers of dogs and cats in synanthropic environments. The numbers of stray dogs and cats should not be allowed to get out of control, especially in residential areas and farms.

Rodents also play an important role in the food chain of various predators and birds in natural habitats. Therefore, it can be concluded that preventive control measures should be increased in synanthropic environments in order to prevent helminthiasis in humans, domestic predators, even-toed ungulates and birds.

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