

Helminth biodiversity and spread peculiarities of helminthiasis of domestic artiodactyls in the Caspian Depression ecosystems

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Abstract. The Caspian Depression is situated on the flat eastern territory of the North Caucasus. According to the soil and climatic conditions, different ecosystems are neighboring in the Caspian Depression: lowland moistened areas (up to 30% of the territories), plat steppes (more than 50%), salt marshes (up to 10%), and semi-deserts (up to 10%). The majority of the Caspian Depression territories are used for domestic animal grazing, where more than 3 million sheep, goats and up to 150 thousand heads of cattle are contained. 46 nosological units of helminthiasis agents are parasitized on domestic ruminants, including 37 species of sheep and 38 of cattle. The average temperature in winter is up to +12°C; in summer – up to +45°C (210-220 days a year). This region is characterized by year-round use of land and an increase in zootechnical standards for keeping animals per unit of pasture (up to 8 heads of sheep and 3 heads of cattle). Moreover, it has a rich variety of pathogens of helminthiasis, the similarity of most types of helminths for domestic ruminants, a high number of invasive stages in biotopes, and up to 95% of the prevalence of mixed invasions of dangerous parasitoses.

1 Introduction

The Caspian Depression pastures are unprofitable due to helminthiasis of animals. The biodiversity of pathogens of this parasitosis group in the region is represented by 46 nosological units, with which cattle are intensively infected in the second half of spring, summer, autumn and early winter. Annually, ruminants are intensely infested with fascioliasis, dicroceliosis, paramphistomatidosis (focal), monieziasis, tenuicole cysticercosis, larval echinococcosis, chabertiosis, bunostomosis, trichostrongylosis, haemonchosis, nematodyrosis, dictyocaulosis, and gongylonemosis. The infestation of animals with pathogens of these helminthioses ranges from 16.6 to 63.3%, with the number of specimens from 23 to 3240 [1-9].

Helminthiasis is the largest pathology among invasive diseases in all natural and climatic zones of the south-east of the North Caucasus. Under the Caspian Depression conditions, 28 nosological structures were recorded among ruminants. They, exactly, cause

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63 types of the pathogen [1, 4, 7]. The domestic ruminants are infected with helminths from April to October and sometimes even in November, when the ambient temperature varies up to +12 °C or more. This is promoted by almost year-round open grazing system of livestock. The pastures are actively seeded annually by the invasive onset of helminthiasis, with the exclusion of semi-desert and salt-marsh lands [3, 7].

There are limited number of bovine cysticercosis, cencurs, esophagostomas, brown stomach worms, maramostrongilus, marshalagia, cooperia, some taxones of nematodirus, and setaria.

The complexity of the epizootological situation under these invasive pathologies in the region is worrying and suggests the need for regular study of the situation, respectively, conducting preventive medical measures, as well as pasture prevention measures.

The most efficient measure of animal protection in helminthiasis is currently the use of broad-spectrum anthelmintics. Under the regional conditions, pathogens of trematode infection, cestodiasis, and nematodosis simultaneously parasitize in the body. Therefore, it is essential to consider the spread of these pathologies, the biology, ecology of pathogens, their infection rates, paying attention to the dominant forms. Prophylactic and therapeutic treatment of animals should be combined with pasture prevention measures.

An efficient control measure is the development of vaccines against the most dangerous helminthiasis of animals, providing reliable protection of livestock from these pathologies, as well as strengthening the immune system of the body.

The aim of the study. The aim of this paper was to identify the biodiversity of domestic ruminant helminths in the Caspian Depression with an extensive system of animal husbandry and year-round use of pastures.

This aim requires to solve a number of tasks:

- to investigate the range of pathogens of these parasite pathologies in ruminants and the frequency of their occurrence on ecologically different types of pastures.
- to determine the proportion of infection of domestic ruminants and the minimum and maximum number of instances of helminthiasis pathogens, as well as frequently occurring nosological forms;
- to determine the frequently registering associations in the helminth biodiversity in domestic ruminants;
- to study comparatively the outcomes of annual monitoring analyses in the region, respectively, to advertise the timing and frequency of preventive and curative deworming.

2 Materials and methods

The pathologies were studied in the region from 1984-2018. These articles are based on the autopsy findings of 120 sheep and 120 cattle. The work was conducted in winter, spring, summer, and autumn. The study included young animals of the first and second years of life, as well as animals of the 3rd year and older. The paper uses the outcomes of lifetime coprologies of 1500 samples.

The paper uses classical methods, lifetime and postmortem studies adopted in the domestic helminthology according to K. I. Scriabin (helminthoovoscopy and larvosopia).

The postmortem studies were conducted by a complete helminthological autopsy of animals and humans according to academician K. I. Scriabin, as well as sequential washing of feces, flotation with a saturated solution of ammonium nitrate, and Berman-Orlov technique.

3 Results

A large collection of helminths accumulated over 34 years allowed us to identify 46 nosological units in domestic ruminants kept on the territory of the Caspian Depression, respectively: 37 in sheep and 38 in cattle.

Taxonomically, the pathogens of helminthiasis are represented by 5 species of the class Trematoda, 6 - Cestoda, 35 - Nematoda. Out of 46 species of biological diversity of helminths, 44 infest at the stage of sexual maturity, 2 larvae of echinococcus, thin-necked flukes. From 35 species of nematodes, 23 are representatives of the suborder Strongylata Railliet et Henry, 1913, including 17 parasites in the digestive tract and 6 in the respiratory tract.

Flukes: *Fasciola hepatica* L., 1758, *F. gigantica* (Cobbold, 1856), *Dicrocoelium lanceatum* (Stiles et Hassal, 1896), *Paramphistomum cervi* (Zeder, 1990), *Calicophorum calicophorum* (Fichoeder, 1901); the ruminants were infected 4,4-63,3%, with the number of specimens in the body 18-1840. Fascioles and dicrocoelium are more often recorded in biodiversity, 12.2-63.3% and with the number of rogues from 18 to 1840.

Cestodes: *Moniezia expansa* (Rud., 1810), *M. benedeni* (Moniez, 1879), *Avitellina centripunctata* (Rivolta, 1874), *Thysaniezia giardi* (Moniez, 1879), *Taenia hydatigena* (Pallas, 1766) larvae, *Echinococcus granulosus* (Batsch, 1786) larvae; ruminants are infected with them by 7.7-53.3%, with the number of rogues from 2 to 96.

Nematodes: *Chabertia ovina* (Fabricius, 1788), *Bunostomum trigonocephalum* (Rud., 1808), *B. phlebotomum* (Railliet, 1900), *Trichostongylus axei* (Cobbold, 1879), *T. capricola* Ransom, 1907, *T. colubriformis* (Giles, 1829), *T. skrjabini* Kalantarian, 1928, *T. vitrinus* Looss, 1905, *Ostertagia ostertagi* (Stiles, 1892), *O. circumcincta* (Stadelman, 1894), *Haemonchus contortus* (Rud., 1803), *Cooperia oncophora* (Railliet, 1898), *C. punctata* (Linstow, 1906), *Nematodirus filicollis* (Rud., 1802), *N. helvetianus* May, 1920, *N. oiratianus* Rajevskaja, 1929, *N. spathiger* (Railliet, 1896), *Dictyocaulus filaria* (Rud., 1809), *D. viviparus* (Bloch, 1782), *Protostrongylus kochi* (Schulz, Orlov et Kutass, 1933) Chitwood et Chitwood, 1938, *P. hobmaieri* (Sch., Orl. et Kut, 1933), *Cystocaulus nigrescens* (Jerke, 1911) Sch., Orl. et Kut, 1933, *Mullerius capillaris* (Mul., 1889) Camer., 1927, *Neascaris vitulorum* (Goeze, 1782), *Thelazia rhodesi* (Desmarest, 1827), *Th. gulosa* Railliet et Henry, 1910, *Th. skrjabini* Erschov, 1928, *Gongylonema pulchrum* (Molin, 1857), *Onchocerca gutturosa* (Neumann, 1910), *O. lienalis* (Stiles, 1892), *Stefanofilaria assamensis* Pande, 1936, *S. stilesi* Chitwood, 1934, *Trichocephalis ovis* Abilgaard, 1795, *T. skjabinii* (Baskakow, 1924), *Strongyloides papillosus* (Wedl., 1856). Domestic ruminants are infested by these species 2,1-39,4%, with the number of rogues - from 2 to 3240.

Fascioles, dicrocoelia, moniesia, echinococcus larvae are often registered in biodiversity; *Bunostomum trigonocephalum*, *Trichostongylus axei*, *T. capricola* Ransom, 1907, *T. colubriformis* (Giles, 1829), *T. vitrinus* Looss, 1905, *T. vitrinus* Looss, 1905, *Haemonchus contortus* (Rud., 1803), *Nematodirus filicollis* (Rud., 1802), *N. helvetianus* May, 1920, *N. oiratianus* Rajevskaja, 1929, *N. spathiger* (Railliet, 1896), *Dictyocaulus filaria* (Rud., 1809), *Gongylonema pulchrum* (Molin, 1857) from 16.6 to 63.3%, with the rogues from 9 to 3240.

Ruminants are poorly infected with species of **Oesophagostomum**, *Ostertagia*, *Cooperia*, *Onchocerca*, *Stefanofilaria*, *Trichocephalis*, *Protostrongylus*, *Cystocaulus*, *Mullerius*, *Neascaris* up to 6.6%, with the rogues up to 24.

The larvae of *Multiceps multiceps* (larvae) Küchenmeister, 1853 are found less often; 1-2 cases of lambs per 1000 sheep and *Taeniarhynchus saginatus* Weinland, 1858 (larvae) in cattle (1-2 sufferers per 10 thousand heads).

The number of species in the biodiversity of helminths of ruminants varies from 4 to 17, where the pathogens of dangerous parasitoses noted above are the background ones -

fascioliasis, microceliosis, monieziasis, larval echinococcosis, and strongylatosis of the digestive and respiratory tracts.

In the helminth biodiversity, avitellina worms, tizania, ostertagia, lungworms and protostrongylus worms are infested only in sheep, ascaridates and spirurids, respectively, in cattle.

In accordance with the soil-climatic and ecological conditions, the Caspian Depression pastures can be divided into four types.

The first is lowland moistened areas in the interfluvies of the lower reaches of the Kuma, Talovka, Sulak, and Terek. The domestic ruminants on these pastures are infected with the above-mentioned 46 types of helminths, with an infection rate of 4.4-63.3%; the number of specimens is 3-3240. In the biotopes of pastures, a high number of invasive origin is developed annually (adolescariae, trematode metacercariae, cestoda proceroid, invasive nematode larvae). Accordingly, ruminants are intensely infested by them from April to the end of November and later. The epizootic process in most helminthiasis develops intensively, with consistently high infection rates.

The second type is upland plain steppes. The domestic ruminants are infested with the majority of helminth species on these lands, but with low rates of infestation up to 23.8% and at 2-140 specimens. In the biotopes of these pastures, ruminants are free from *F. gigantica*, paramphistomatid species, *A. centripunctata*, *T. giardi*, *Trichostongylus skrjabini*, *Ostertagia*, *Cooperia*, *Marshallagia*. The invasive onset develops on these biotopes in the second half of spring and autumn. In summer, the development of invasion in the external environment is sharply limited owing to high temperatures up to +45°C and droughts. Therefore, the intensity of the epizootic process in helminthiasis is sharply limited.

The third type is salt marshes, where the quality parameters of infection are sharply limited; only 14 species are typical for the region, respectively; the infection rate is 2.0-14.0%, with the number of specimens: from 2 to 39.

Probably, the pH of salt marshes in combination with the high temperature mentioned above and drought has a sharply negative effect on the exogenous development of helminths in biotopes and in intermediate hosts.

The infestation of helminths is mainly concentrated near water sources. On these areas, the epizootic process develops in a limited and sluggish manner.

The fourth type is semi-desert pastures, where 12 species were found in domestic animals. Animals are infected with these types of pathogens by 2.0-8.0%, with a number of specimens: from 2 to 16. The focus of pathogens are registered only near the sources of watering. Low rates of infection of animals with helminths, their limitation in the external environment do not provide standard threshold values for the development and functioning of the epizootic process in helminthiasis.

Therefore, the biodiversity of helminths of domestic ruminants in the ecosystems of the Caspian Depression is presented by 46 species, 37 of which are recorded among sheep and 38 in cattle. The infection rate of animals varies from 2.2-63.3%, the number of specimens is 2-3240.

The combined invasions are always followed by severe, often irreversible, pathological consequences in the organs and systems of the animal. Therefore, this feature must be considered when selecting broad-spectrum anthelmintics for preventive deworming.

The presented data demonstrate that in the Caspian Depression conditions, a complex epizootic situation develops annually for helminthiasis of domestic ruminants, while infected cattle constantly experience "parasite loads", and the external environment is actively seeded with an invasive onset. In most helminthiasis, actively functioning foci have been formed, creating a constant infection threat of animals.

Considering our long-term observations, anoplocephalic species, most of the strongylata of the digestive tract are eliminated after 4-6 months, but the infestation of animals with

pathogens in late autumn and early spring does not allow the body to recover from the consequences of the parasite “invasion” of last year. These are the epizootic process features, in case of helminthiasis of domestic ruminants in the regions.

This species ratio in the helminth biodiversity in ruminants in the Caspian Depression conditions results in an epizootic process. It contains a large number of taxons in the second half of summer and autumn. All the age groups, especially the livestock of the second year of life and older, which graze on lowland moistened and steppe pastures, are involved.

The host-parasite relationships are particularly formed in fascioliasis, dicrocioliasis, and protostrongilidosis, when pathogens infest in places of localization in the body of animals from 4 to 7 years old and the epizootic process develops with an annual accumulation of pathogens. Consequently, if the animals suffer from these helminthiasis, it is essential to perform targeted treatment of the sick livestock with broad-spectrum anthelmintics in the autumn after surveillance of the epizootic situation. That is the aim of the results of our research.

The natural and climatic feature of the region's ecosystems is favorable conditions for the exogenic development of invasion in biotopes which occurs about 60% of the time a year. In this regard the animals are infested with helminths. In November, December, and sometimes January, the temperature is +10-12°C. In this time the animals are infested with *fasciola adolescaria*, paramphistomatids, strongylate larvae, and taeniidae. In the conditions of lowland moistened and steppe territories of the region, the epizootic process develops intensively with high infection rates of 16.6-32.7% and the number of specimens is 8-3240. The epizootic process evolves when the intermediate hosts: freshwater, land mollusks, oribatid mites are infected with the aggressive onset of helminths from 1.5 to 38.0%; when per 1 m² pastures are registered in the soil and if there are from 50 to 300 specimens of strongylate larvae. In the region, year-round grazing of animals is practiced, which creates a constant risk of infecting animals with the invasive onset of helminths. Meanwhile, the animals infected with helminths have constant "parasite loads", however, the imago of anoplocephala and strongylatosis worms of the digestive tract are eliminated from the intestines of the final host after 4-5 months. In late autumn and early winter, the infestation of animals with helminths in the ecosystems of the region does not give the body a chance to weaken the “parasite loads” by spring. It always accompanied by the stratification of infestations of different years. It should be mentioned that a certain part of the Caspian Depression pastures is not sanitized in the summer, when the sheep are driven to mountain lands (anthropogenic factor), which is provided for in the conditions of driving-pasture keeping of livestock. Meanwhile, all the modes of pasture prevention are violated, which is one of the reasons for the development of a complex epizootic situation in the region for helminthiasis.

4 Conclusion

1. According to the soil-climatic, ecological conditions in the Caspian Depression, four types of pastures are identified, where the epizootic process with helminthiasis develops intensively. These areas are a lowland moistened and steppe lands. This process is very sluggish in saline and semi-desert ecosystems.
2. Spring, summer, and autumn are the seasons when animals are infected with helminthiasis pathogens.
3. The associative course of helminthiasis is their main form. In combined invasions, the number of species varies from 4 to 17 and almost always have severe pathological consequences for sufferers

4. A stable-working foci of helminthiasis have been formed in the conditions of the region. The infected animals experience large “parasite loads” during the year, which require autumn preventive deworming of the livestock.
5. Annually, a difficult epizootic situation develops in the region. It demands constant control of the situation and conducting two-time preventive deworming of sheep and goats in October, December, and cattle only in October.

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