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ХАРАКТЕРИСТИКА ЗАРАЖЕННОСТИ И СТРУКТУРА ГЕЛЬМИНТОКОМПЛЕКСОВ ЛОШАДЕЙ В ПРОВИНЦИЯХ ГОРНОГО АЛТАЯ

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Целью исследования явилось изучение зараженности и структурных особенностей гельминтокомплексов лошадей в провинциях Горного Алтая, существенно отличающихся природно-климатическими и орографическими условиями местности. Пробы фекалий от спонтанно инвазированных гельминтами животных Центрального, Северного, Западного и Юго-Восточного Алтая исследовали оволярвоскопическими методами с последующим расчетом показателей встречаемости (экстенсивность инвазии – ЭИ, уровень экстенсивности инвазии – $ЭИ_у$), интенсивности заражения (индекс обилия – ИО, уровень индекса обилия – $ИО_у$) и индекса паразитокомплекса (ИП). Результаты многолетних исследований (2019–2023) свидетельствуют о том, что в формировании гельминтокомплекса пищеварительной системы лошадей Горного Алтая участвуют паразиты двух классов: Nematoda (подотряды Strongylata, Ascaridata, Rhabditata, Oxiurata) и Cestoda (подотряд Anoplocephalata). Во всех провинциях в нозологическом профиле гельминтозов доминируют стронгиляты, зараженность ими животных и их доля в гельминтокомплексах (ЭИ = 68,6–93,1%, ИП = 86,0–90,5) значительно превышают эти показатели для нематод подотряда Ascaridata (ЭИ = 6,2–16,5%, ИП = 4,6–8,1) и для цестод подотряда Anoplocephalata (ЭИ = 2,5–11,8%, ИП = 2,1–5,8). На фоне повсеместного распространения основных гельминтозов желудочно-кишечного тракта лошадей в условиях физико-географических провинций наблюдаются отличия в структуре гельминтокомплексов и интенсивности инвазированности животных гельминтами. Уровень зараженности лошадей Центрального Алтая стронгилятами достоверно выше относительно зараженности животных Северного и Западного Алтая. Инвазированность однокопытных Юго-Восточного Алтая стронгилятами (ЭИ = 68,6%) и аноплоцефалятами (ЭИ = 2,5%, ИП = 2,1) минимальна и соответственно в 1,5 и 2,8–4,7 раза ниже, чем в других провинциях. Однако здесь выявлены существенные внутризональные отличия в инвазированности лошадей нематодами – зараженность ими в горно-лесной зоне Юго-Восточного Алтая сопоставима с зараженностью в Центральном Алтае и значимо выше, чем в высокогорной степной зоне. В то же время показатели $ЭИ_у$ и $ИО_у$ для лошадей высокогорной степной зоны Юго-Восточного Алтая статистически ниже, чем у животных Северного и Центрального Алтая. Установлено, что уровень зараженности и структура гельминтокомплексов лошадей в основном обусловлены разнообразием природно-климатических и орографических характеристик горных территорий.

Ключевые слова: гельминты пищеварительной системы, лошади, структура гельминтокомплекса, экстенсивность и интенсивность инвазии, физико-географические провинции

CHARACTERIZATION OF INFESTATION AND STRUCTURE OF HORSE HELMINTH COMPLEXES IN THE PROVINCES OF THE ALTAI MOUNTAINS

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The purpose of the study was to investigate the infestation and structural features of the helminth complexes of horses in the provinces of the Altai Mountains which differ significantly in natural,

climatic and orographic conditions of the area. Fecal samples from spontaneously helminth-infested animals of the Central, Northern, Western and South-Eastern Altai Mountains were examined by ovolarvoscopic methods with the following calculation of occurrence indices (invasion intensity – II, level of invasion intensity – II_{level}), infestation intensity (abundance index – AI, level of abundance index – AI_{level}) and parasitocomplex index (PI). The results of long-term studies (2019–2023) indicate that parasites of two classes are involved in the formation of the helminth complex of the digestive system of horses in the Altai Mountains: Nematoda (suborders Strongylata, Ascaridata, Rhabditata, and Ochycrata) and Cestoda (suborder Anoplocephalata). Strongylates dominate in the nosological profile of helminthoses in all provinces: the degree of their infestation among animals and their proportion in the helminth complexes (II = 68.6–93.1%, PI = 86.0–90.5) are significantly higher than the same indicators for the suborder Ascaridata (II = 6.2–16.5%, PI = 4.6–8.1) and for the cestodes of the suborder Anoplocephalata (II = 2.5–11.8%, PI = 2.1–5.8). Against the background of ubiquitous distribution of the main helminths of the gastrointestinal tract of horses in the conditions of physiographic provinces, differences in the structure of helminth complexes and intensity of helminth infestation of animals are observed. The level of infestation of horses in the Central Altai with strongyles is significantly higher relative to the infestation of the animals in the Northern and Western Altai. The infestation of ungulates of South-Eastern Altai with strongylates (II = 68.6%) and anoplocephalates (II = 2.5%, PI = 2.1) is minimal and, respectively, 1.5 and 2.8–4.7 times lower than in other provinces. However, there are significant intrazonal differences in the nematode infestation of horses – their infestation in the mountain-forest zone of the South-Eastern Altai is comparable to that in the Central Altai and is significantly higher than in the high-mountain steppe zone. At the same time, the II_{level} and AI_{level} indices for horses of the high-mountain steppe zone of the South-Eastern Altai are statistically lower than in the animals of the Northern and Central Altai. It was found that the level of infection and the structure of helminth complexes of horses are mainly determined by the diversity of natural-climatic and orographic characteristics of mountainous territories.

Keywords: helminths of the digestive system, horses, structure of helminthocomplex, extensiveness and intensity of infestation, physico-geographical provinces

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Conflict of interest

The authors declare no conflict of interest.

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INTRODUCTION

The natural climatic conditions of the Gorno-Altai region are favorable for the development of horse herd farming. Nevertheless, parasitic infestations, including gastrointestinal helminthic diseases, are the factors limiting the increase in the number and productivity of animals.

Gastrointestinal helminths in horses are characterized by a significant diversity of species and are the most common and significant multicellular parasites of horses worldwide[1, 2] [1–6]. In the populations of whole-hoofed animals, complex mixed invasions caused by the parasitism of helminth agents manifest as diarrhea, colic, decreased performance, and in some cases, can lead to a lethal outcome[3, 4] [7].

The issues of epizootiology of invasive diseases in horses have been discussed in many works, but most of the research has only considered individual species or groups of parasites and used data from the western part of Russia[5, 6] [8–10]. Publications on this issue based on the materials from the Siberian region are limited, and the helminthiases prevalent in this territory, including the Gorno-Altai region, are insufficiently studied[7] [11.

The purpose of the study is to characterize the infection and structural features of horse helminth complexes in the Gorno-Altai provinces, which significantly differ from each other in natural-climatic and orographic conditions.

MATERIAL AND METHODS

The study was conducted in 2019-2023 in the farms of nine administrative districts located in four physiographic provinces of the Gorno-Altai region: Northern (Maiminsky, Choisky districts, part of Shebalinsky district), Central (Chemalsky, Ust-Koksinsky, Ongudaisky, Shebalinsky districts), Western (western part of Ust-Kansky district and Charishsky district of the Altai Territory), and Southeastern Altai (Kosh-Agachsky, Ulagansky districts).

Fecal samples obtained from spontaneously helminth-infected horses were examined using classical parasitological methods - helminthocoproscopic according to Fülleborn and helminthocopro-larvoscopy according to Berman-Orlov. Differential diagnosis of nematodes was carried out taking into account the morphometric features of eggs and invasive larvae (third stage). Identification of tapeworms was based on the size of eggs and characteristics of the pear-shaped apparatus[8, 9] [12]. In total, 1963 samples of biomaterial were studied, including 1053 and 910 samples by coproovoscopy and copro-larvoscopy methods, respectively.

The structural features of the gastrointestinal helminth complexes of whole-hoofed animals from different natural-geographical provinces of the Gorno-Altai were determined using the parasite complex index (PCI), reflecting the importance of the species, genus, or other taxon in the helminthological profile of animals[10]. When

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[2]*Matto T.N., Bharkad G.P., Bhat S.A.* Prevalence of gastrointestinal helminth parasites of equids from organized farms of Mumbai and Pune // Parasitic Diseases, 2015, vol. 39, pp. 179–185.

[3]*Lyons E.T., Drudge J.H., Tolliver S.C.* Larval cyathostomiasis // Veterinary Clinics of North America: Equine Practice, 2000, vol. 16, N 3, pp. 501–513.

[4]*Mair T.S., Sutton D.G., Love S.* Caecocaecal and caecocolic intussusceptions associated with larval cyathostominosis in four young horses // Equine Veterinary Journal, 2000, vol. 32, pp. 77–80.

[5]*Kanokova A.S., Mashukov A.V., Isakov R.L., Dzodzaeva A.H., Chapaev M.B., Shkhagapsoeva A.M.* Helminths of horses of the Kabardino-Balkar Republic // Russian Journal of Parasitology, 2008, N 2, pp. 48-51.

[6]*Khasanova R.I.* Distribution of parascaridosis of horses under different housing technologies in the East Caucasus // Russian Journal of Parasitology, 2013, N 4, pp. 59-61.

[7]*Ponamarev N.M.* Timing of development of larvae strongylates of horses in the external environment in the Altai // Theory and practice of parasitic disease control, 2005, Issue 6, pp. 285-287.

[8]*Kapustin V.F.* Atlas of the most common helminths of farm animals, Moscow: Selkhozgiz, 1953, 140 p.

[9]*Cernea M., Madeira de Carvalho L.M., Cozma V., Raileanu S., Cristina L., Silberg R.* Atlas of Diagnosis of Equine Strongylidosis, Cluj-Napoca, 2008, pp. 71–109.

[10]*Marchenko V.A., Efremova E.A., Vasilieva E.A.* Structure of helminthocenosis of cattle in the Altai Mountains // Russian Journal of Parasitology, 2008, N 3, pp. 18-23.

calculating the PCI, only parasites that are most common and pathogenic for horses, as well as reliably identifiable based on the morphometric features of their propagative forms - eggs or invasive larvae, were considered.

The assessment of animal infection with helminths was carried out based on the results of coprological studies and the calculation of the following indicators:

1) extensiveness of invasion (EI, %) – the proportion of infected animals among those examined;

2) intensity of invasion (II, eggs/g, larvae/g) – the average number of eggs/larvae per one infested animal in 1g of feces;

3) abundance index (AI, eggs/g, larvae/g) – the average number of eggs/larvae per one examined animal in 1g of feces;

4) level of invasion intensity (II_{level}, %) – the average value of II indicators in samples (tests);

5) level of abundance index (AI_{level} AI_{level}, eggs/g, larvae/g) – the average value of AI indicators in the samples.

The significance of differences in the infection of animals was established by comparing the values of II_{level} and II_{level} with the calculation of the Mann-Whitney *U*-test.

RESULTS AND DISCUSSION

In the territory of the Gorno-Altai, gastrointestinal helminthiases in horses are widespread and occur in the form of mixed infections (see Tables 1, 2). Formation of the gastrointestinal helminth complex in horses involves parasites from the classes Nematoda and Cestoda, including five suborders - Strongylata, Ascaridata, Rabditata, Oxiurata, and Anoplocephalata (Cestoda, Cyclophyllidea). Due to the fact that a specific method for diagnosing oxiurates was not used in the study, the indicators of their infection have a random character and are not reflected in the subsequent analysis. Ascaridates are represented by a single species, *Parascaris equorum*, which is widespread. Nematodes of the suborder Rhabditata (Schitwood, 1933) – *Strongyloides westeri* – were found in horses in the Central and Western Altai. The community of nematodes of the suborder Strongylata, family Strongylidae, is characterized by significant taxonomic diversity and includes representatives of the subfamily Strongylinae, including nematodes of the genera *Strongylus, Craterostomum, Triodentophorus, Oesophagodontus*, as well as strongylates of the subfamily Cyathostominae (Trichonematidae), including *Gyalocephalus, Poteriostomum*. In addition, in the examined fecal samples, larvae of strongylates from the family Trichostrongylidae were identified as *Trichostrongylus axei*. According to literature data, trichostrongylosis in horses is widespread[11, 12] [13, 14], but it is registered in the Gorno-Altai region for the first time. The infestation of horses with trichostrongylids in the Central, Northern, and Southeastern Altai is low, at 9.8%, 4.1%, and 27.6%, respectively. In the literature, there is also no mention of the distribution of triodontophores, esophagodonts, craterostomes, gyalocephals, and poteriostomes in the region.

It has been found that in all the provinces, representatives of the class Nematoda with slight zonal variability of the PI indicators (94.1–97.9) dominate in the helminth complexes of horses. Among nematodes, parasites of the suborder Strongylata prevail. The infection of animals with them and their share in helminth complexes not only in the republic (II = 86.8–86.9%, PI = 87) but also in all physiographic provinces of Altai (II = 68.6–93.1%, PI = 86.0–90.5) significantly exceed these indicators for the suborder Ascaridata (II = 13.2%, PI = 7.8 and II = 6.2–16.5%, PI = 4.6–8.1) and for cestodes of the suborder Anoplocephalata (II = 8.8%, PI = 5.2 and II = 2.5–11.8%, PI = 2.1–5.8).

The core of the gastrointestinal helminth complexes consists of cyathostomins, characterized by maximum indicators of horse infestation

[11] *Rehbein S., Visser M., Winter R.* Prevalence, intensity and seasonality of gastrointestinal parasites in abattoir horses in Germany // Parasitology Research, 2013, vol. 112, N 1, pp. 407–413.

[12] *Skryabin K.I., Shikhobalova N.P., Schultz R.S.* Fundamentals of nematodology. Trichostrongylidae of animals and man. Moscow, 1954, vol. 3, pp. 43-55.

and maximum PI values (see Tables 1, 3). At the same time, lower indicators characterize the representatives of strongylins of the genus *Strongylus – Strongylus (Alfortia) edentatus*, *Strongylus equinus*, with minimum values for *Strongylus (Delafondia) vulgaris*: II = 4.5–16.3%, PI = 3.7–8.0 (see Tables 2, 3).

The data obtained by us are consistent with the results of many researchers who note that the distribution of strongyles of the family Strongylidae ("large strongyles"), especially representatives of the genus *Strongylus* spp., and the infestation of horses with them are significantly lower. Currently, cyathostomins, on the contrary, are considered the main agents of equine helminthiases and are widespread worldwide[13-15].

Significant species diversity of strongylates, their ability to complete their life cycle without the involvement of an intermediate host, and the resistance of their propagative forms to adverse environmental factors explain the widespread distribution of the representatives of this suborder and the maximum indicators of animal infestation by them.

Regarding tapeworms, based on the morphometric characteristics of their eggs, they were classified into two species: *Anoplocephala perfoliata*, which is widespread, and *Paranoplocephala mamillana*, which was registered only in the Central and Northern Altai in one and two samples, respectively. Such results are consistent with the data of other researchers confirming the dominant position of *Anoplocephala perfoliata* among tapeworms (see footnote 15).

In the provinces with differing natural-climatic and orographic conditions, quantitative indicators of infestation by major helminth species are not identical.

The conditions in the Central Altai, where horse breeding is more developed and 49.1% of the total horse population of the republic is concentrated[16], are the most favorable for the life cycle of helminths. In this province, extensive areas of mid-mountain landscapes with modifications of steppe, forest, and meadow landscapes are presented, characterized by rich botanical composition of grass and snow-poor pastures. In this territory, the infestation of animals with

Табл. 1. Инвазированность лошадей в провинциях Алтая гельминтами желудочно-кишечного тракта (овоскопия)

Table 1. Infestation of horses in the Altai provinces by gastrointestinal helminths (ovoscopy)

Province	II, %				AI, e/g	*N*	II_{level}, %	AI_y, e/g
	Total	ST	PAR	ANOPL			ST	
Central Altai, *n* = 491	93,3 ± 1,1	93,1 ± 1,1	16,5 ± 1,6	11,8 ± 1,4	562,8 ± 35,1	19	89,6 ± 4,9	503,2 ± 74,3
Northern Altai, *n* = 312	93,6 ± 4,3	92,6 ± 1,5	12,5 ± 1,9	7,1 ± 1,5	311,2 ± 29,8	15	92,4 ± 3,3	328,2 ± 57,1
Western Altai, *n* = 129	78,9 ± 4,0	78,7 ± 4,1	6,2 ± 2,1	7,8 ± 2,3	202,9 ± 40,7	7	85,4 ± 6,8	299,9 ± 138,4
South-Eastern Altai, *n* = 121	68,6 ± 4,2	68,6 ± 4,2	9,1 ± 2,6	2,5 ± 1,4	565,2 ± 102	8	73,2 ± 9,1	429,6 ± 218,2
Republic of Altai, *n* = 1053	87,5 ± 1,0	86,9 ± 1,0	13,2 ± 1,0	8,8 ± 0,9	422,3 ± 22,8	49	83,3 ± 6,9	410,6 ± 186,1

Note. N – number of samples; n – number of tests; ST – helminths of the suborder Strongylata; PAR –Parascaris equorum nematodes; ANOPL – cestodes of the suborder Anoplocephalata.

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[15]*Ryu S.H., Bak U.B., Kim J.G., Yoon H.J., Seo H.S., Kim J.T., Park J.Y., Lee C.W.* Cecal rupture by Anoplocephala perfoliata infection in a thoroughbred horse in Seoul Race Park, South Korea // Journal of Veterinary Science, 2001, vol. 3 (2), pp. 189–193.

[16]Statistical Yearbook of the Altai Republic. Gorno-Altaisk, 2016, 41 p.

Табл. 2. Инвазированность лошадей в провинциях Алтая стронгилятами желудочно-кишечного тракта (лярвоскопия)
Table 2. Infestation of horses in the Altai provinces by gastrointestinal strongyles (larvoscopy)

Province	II, %					AI, l/g	*N*	II_{level}, %	AI_{level}, l/g
	Total	Cyatho-sto-minae	Strongylinae						
			St. equin.	*St. edent.*	*St. vul.*				
Central Altai, *n* = 417	94,9 ± 1,1	93,0 ± 1,2	33,8 ± 2,3	31,9 ± 2,3	16,3 ± 1,8	15,5 ± 1,9	18	89,9 ± 4,2	14,7 ± 3,5
Northern Altai, *n* = 255	85,1 ± 2,2	84,7 ± 2,3	24,7 ± 2,7	20,0 ± 2,5	6,7 ± 1,6	9,4 ± 1,2	14	85,0 ± 7,0	10,6 ± 2,6
Western Altai, *n* = 127	74,8 ± 3,8	74,8 ± 3,8	18,1 ± 3,4	18,9 ± 3,5	8,7 ± 2,5	4,2 ± 0,6	7	78,1 ± 9,7	3,7 ± 1,1
South-Eastern Altai, *n* = 111	73,8 ± 4,2	69,4 ± 4,4	23,4 ± 4,0	13,5 ± 3,3	4,5 ± 1,9	10,9 ± 4,9	8	75,4 ± 8,1	12,1 ± 5,4
Republic of Altai, *n* = 910	86,8 ± 1,1	85,3 ± 1,2	27,8 ± 1,5	24,5 ± 1,4	10,2 ± 1,0	10,5 ± 0,8	47	82,2 ± 1,1	10,3 ± 2,3

Note. N – number of samples; n – number of tests; types: St. equin. – Strongylus equinus, St. edent. – Strongylus edentatus, St. vul. – Strongylus vulgaris.

Табл. 3. Структура гельминтокомплекса лошадей в провинциях Алтая (лярвоскопия)
Table 3. Structure of the helminth complex of horses in the Altai provinces (larvoscopy)

Province	PI					
	Cyatost.	*St. equin.*	*St. edent.*	*St. vul.*	PAR	ANOPL
Central Altai, *n* = 417	45,7	16,6	15,7	8,0	8,1	5,8
Northern Altai, *n* = 255	54,4	15,9	12,8	4,3	8,0	4,6
Western Altai, *n* = 127	55,6	13,5	14,1	6,5	4,6	5,7
South-Eastern Altai, *n* = 111	56,7	19,1	11,0	3,7	7,4	2,1
Republic of Altai, *n* = 910	50,2	16,4	14,4	6,0	7,8	5,2

Note. *n* – number of samples; strongyles: Cyatost. – subfamily Cyathostominae, *St. equin*. – *Strongylus equinus, St. edent. – Strongylus edentatus, St. vul. – Strongylus vulgaris*; PAR – nematodes *Parascaris equorum*; ANOPL – cestodes of the suborder Anoplocephalata.

strongyles, according to ova-larval research, is the highest – 93.1% and 94.9%, and the indicators of the abundance index (AI) and AI_{level} are also the highest – 562.8 eggs/gram, 15.5 larvae/gram, and 503.2 eggs/gram, 14.7 larvae/gram (see Tables 1, 2). Horses in this province are more infected with Parascaris (II = 16.5%, PI = 8.1) and cestodes of the suborder Anoplocephalata (II = 11.8%, PI = 5.8) than in other areas (see Tables 1, 3).

The infestation of equids with intestinal nematodes as a whole, including strongyles (93.6% and 85.1%) and ascarids (II = 12.5%, PI = 8.0), in the horse farms of the Northern Altai does not significantly differ from the level of infestation in the Central Altai. However, the AI and AI_{level} indicators for nematodes of the suborder Strongylata are 1.5–1.8 times lower – 311.2 and 328.1 eggs/gram, respectively. The infestation with Anoplocephalidae is also almost 2 times lower here (II = 7.1%), and the share of cestodes in the helminth complex structure is 4.6.

In the Western Altai, the infestation of animals with ascarids, anoplocephalids, and strongyles was 6.2 (PI = 4.6), 7.8 (PI = 5.7), and 74.8%, respectively. The degree of infestation of horses with nematodes of the suborder Strongylata (AI = 202.9 eggs/gram, AI_{level} = 299.9 eggs/gram) in this territory is 3.0 and 1.5 times lower than in the Central and Northern Altai. The re-

sults of ova-larval research are supported by larvalscopy data (see Table 2), which also indicate significant differences in the intensity of infestation of the horse population in the provinces.

The most pronounced changes in the structural-functional characteristics of helminth complexes are recorded in horses in the Southeastern Altai. In this area, the infestation of animals with strongyles and anoplocephalids is minimal compared to other provinces. The infestation of equines with intestinal nematodes, including strongyles, is 68.6 and 73.8%, and with tapeworms (Cestoda) – 2.5% (PI = 2.1), which is 1.5 and 2.8–4.7 times lower, respectively, than in other provinces (see Tables 1–3).

According to the results of ova-larval research, on the territory of the Southeastern Altai, despite lower extensiveness of equid infestation with strongyles, the intensity of infestation (AI_{level}) is 429.6 eggs/gram and 12.1 larvae/gram, which is comparable to similar indicators of animal infestation in the Central Altai – 503.2 eggs/gram and 10.6 larvae/gram. This fact is explained by the non-uniform intra-zonal distribution of strongyles, which is due to significant natural-climatic differences in the territory, where all natural zones from high-mountain forests and meadow landscapes to semi-deserts and tundra are represented. The infestation of one-toed ungulates in the mountain-steppe zone with nematodes of the suborder Strongylata (II = 62.4%, AI = 144.1 eggs/gram and II = 66.2%, AI = 4.7 larvae/gram) is 1.3 and 4.0–6.3 times lower than in animals in the mountain-forest zone (II = 83.3%, AI = 903.6 eggs/gram and EI = 89.2%, AI = 18.6 larvae/gram).

At the same time, the values of II and PI are comparable to II_{level} and AI_{level} values, which confirm our conclusions about the influence of the diversity of natural-climatic conditions within the highest-altitude province of Altai on the infestation of animals by helminths. Unlike other provinces, Southeastern Altai shows a wide range of infestation values in the samples (ova microscopy: II = 40.0–100.0%, AI = 7.4–1758.5 eggs/gram; larval microscopy: II = 45.0–100.0%, AI = 0.6–44.5 larvae/gram). Furthermore, in this province, all indicators of infestation of animals by nematodes of the suborder Strongylata in the mountain-forest zone (valleys of the Argut and Chulushman rivers) are significantly and significantly higher than in the high-mountain steppe zone. At the same time, the level of extensiveness of infestation (EI_{level}) and the level of intensity of infestation (II_{level}) of horses in the high-mountain steppe zone of Southeastern Altai are statistically lower than in the animals from Northern and Central Altai (see Table 4).

It has also been found that in the structure of the helminth complexes of horses in the highland steppes and highland forests of Southeastern Altai, despite the clear dominance of cyathostomes with PI of 58.3 (II = 59.5%) and 56.9 (II = 89.2%), subdominants are Parascaris (PI = 11.6, EI = 11.8%) and Trichostrongylus (PI = 13.8, II = 21.6%).

In contrast to other provinces, where the structure of the whole-hoofed animals helminth complex has a ratio of 16.2–20.7: 1.0-1.7: 1.0–1.2 for strongyles, ascarids, and anoplocephalids, in Southeastern Altai, the proportion of strongyles and Parascaris is significantly higher, resulting in the following ratio – 46.6: 3.5: 1.0.

The low values of PI (2.1) and infestation (2.5%) by anoplocephalids in horses in the high-mountain territories of Southeastern Altai, characterized by the lowest heat supply and low precipitation levels compared to other physiographic provinces of the region, are most likely determined by the low population density of oribatid mites - intermediate hosts of cestodes.

Overall, there are no significant differences in the extensiveness of infestation between the provinces of the Altai Mountains according to ova microscopy. However, the level of abundance of helminth eggs in the samples obtained from horses in Central Altai is significantly higher than in animals living in Northern and Western Altai (see Table 5). Additionally, it is established that the results of larval microscopy are comparable to ova microscopy data (see Table 5).

We have also not recorded significant differences in the values of EIu in horses from different provinces. However, the indicators of the abundance of helminth larvae and eggs in the samples from equids of Central Altai are significantly higher than in samples from animals in

Табл. 4. Достоверность различий показателей уровня зараженности лошадей Юго-Восточного Алтая кишечными стронгилятами по *U*-критерию Манна–Уитни ($U_{эмп}/U_{крит}$), оволярвоскопия
Table 4. Reliability of differences in the level of infestation of horses in the South-Eastern Altai by intestinal strongyles according to the Mann–Whitney *U*-test (U_{emp}/U_{crit}), ovolarvoscopy

Natural zone	*n*	Ovoscopy				Larvoscopy			
		II_{level}, %	U_{crit}	AI_{level}	U_{crit}	II_{level}, %	U_{crit}	AI_{level}	U_{crit}
Mountain-forest (middle mountains)	3	100,0	0/1**	928,8	2/3*	100,0	0/1**	24,4	1/3**
Mountain-steppe (highlands)	4	57,1		186,5		60,7		4,6	

Note. *$p \le 0,05$; **$p \le 0,01$; *n* – the number of samples.

Табл. 5. Достоверность различий показателей уровня зараженности лошадей кишечными стронгилятами по *U*-критерию Манна–Уитни ($U_{эмп}/U_{крит}$)
Table 5. Reliability of differences in the levels of infestation of horses with intestinal strongylates according to the Mann–Whitney *U*-test (U_{emp}/U_{crit})

Province	Northern Altai	Central Altai	Western Altai	South-Eastern Altai
	n = 15	*n* = 19	*n* = 7	*n* = 8
		Ovoscopy		
Northern Altai	0	141/94	37/28	35/33
Central Altai	94/94*	0	39/37	49/44
Western Altai	40/28	36/37*	0	23/13
South-Eastern Altai	48/33	60/44	25/13	0
		Larvoscopy		
Northern Altai	0	122/82	39/26	41/31
Central Altai	110/82	0	49/35	49/30
Western Altai		31/35*	0	24/13
South-Eastern Altai		61/41	22/13	0

Note. *$p \le 0.05$; *n* – number of samples; data above zero row – level of invasion extensiveness; data below zero row – level of abundance of helminth eggs (ovoscopy) and larvae (larvoscopy).

Western Altai (see Table 5).

On the territory of the Altai Mountains, parasitic infestations of horses occur in the form of mixed infestations. At the same time, the mosaic of ecological conditions in the mountainous region determines the structural features of the nosological profile of animal helminthiases and the degree of infestation by helminths in individual provinces.

CONCLUSION

In the structure of the helminth complexes of the digestive system of horses in different physiographic provinces of the Altai Mountains, strongyles dominate. The infestation of animals with strongyles (II = 68.6-94.9%, AI_{level} = 299.9-503.2 eggs/gram) and their proportion in helminth complexes (PI = 86.0-90.5) significantly exceed the corresponding indicators for the nematodes of the suborder Ascaridata (II = 6.2-16.5%, PI = 4.6-8.1) and cestodes of the suborder Anoplocephalata (II = 2.5-11.8%, PI = 2.1-5.8). Equine infestations are widespread, but differences in the intensity of animal infestation by helminths of individual taxonomic groups and in the structure of helminth complexes are recorded within provinces, with the most pronounced differences observed in horses from Southeastern Altai. Here, the infestation of horses with strongyles (68.6%) and anoplocephalids (2.5%) is 1.5 and 2.8-4.7 times lower than in other provinces, but the intensity of infestation with strongyles is maximal (AI = 565.3 eggs/gram, AI_{level} = 429.6 eggs/gram), which is due to intra-zonal differences in the ecological conditions of the highlands.

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