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The influence of climate factors on the incidence of associative invasions with pathogenic *Eimeria* in small ruminants in Azerbaijan

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Abstract

Pathogenic *Eimeria* species were appointed in sheep and goats in the Mountainous Shirvan and Shirvan-Salyan economic regions located in different reliefs of Azerbaijan, the incidence of the infection was researched and analyzed. İn 4,905 (61.3%) out of 8,000 sheep researched in the Mountainous-Shirvan, was detected the infection with pathogenic *Eimeria* species. 4 pathogen species belonging to the genus of *Eimeria* were noted in sheep - *E. ahsata*, *E. crandallis*, *E. ovinoidalis*, *E. arloingi*. The infection with pathogenic *Eimeria* species was detected in 3,303 (55.0%) of the 6,000 goats researched in this economic region. 5 pathogen species belonging to the genus *Eimeria* noted in goats - *E. ninakohlyakimovae*, *E. hirci*, *E. chistenseni*, *E. arloingi* and *E. caprina*. In 5,059 (50.5%) out of 10,000 sheep researched in the Shirvan-Salyan economic region, were noted the infection with the pathogenic *Eimeria* species. 3 pathogenic species belonging to the genus of *Eimeria* were noted in sheep - *E. ahsata*, *E. ovinoidalis*, *E. crandallis*. The infection with the pathogenic *Eimeria* were noted in 1,693 (42.3%) out of 4,000 goats researched in this economic region. 2 pathogenic species belonging to the genus of *Eimeria* were noted in goats - *E. ninakohlyakimovae* and *E. hirci*. The incidence of the infection with the pathogenic *Eimeria* species was higher and followed in associative form in lambs and kids up to 1 year old, and the clinical eimeriosis was noted in kids. In the Mountainous Shirvan economic region, in lambs, the pathogenic *Eimeria* species were followed in an associative form with *Moniezia expansa*, in kids the pathogenic *Eimeria* species were followed in an associative form with *Moniezia benedeni*, respiratory and gastrointestinal nematodes. In the Shirvan-Salyan economic region, in lambs, the pathogenic *Eimeria* species were noted in an associative form with the gastrointestinal nematodes, in kids, the pathogenic *Eimeria* species were noted in an associative form with the *Trichuris* sp. and *Dicrocoelium* sp. helminths.

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Introduction

Sheep and goats are important food crops that contribute significantly to the food security and economy of the developing countries (Thlama *et al.*, 2016). Sheep are considered a potential livestock species bred in various regions of the world for meat and wool production. Goat production is an important component of the livestock sector, contributed to the food and nutrition security and sustainable agriculture, especially in the developing countries (Namutosi *et al.*, 2019).

There are many problems that affect the development of sheep and goat farms and the healthy breeding of the animals, including abiotic and biotic factors as well as invasion diseases belong to here (Pezzanite *et al.*, 2022). The internal parasites - endoparasites, including protozoa (coccidia) of the various taxonomic groups, infect the ruminants and cause coccidiosis disease (Verocai, 2020). Coccidiosis is a widespread disease in farm animals worldwide and causes significant economic losses (Bangoura and Bardsley, 2020; Sufi *et al.*, 2017).

These host-specific protozoa of the *Eimeria* genus of the Coccidae family, localize in the small and large intestines of small ruminants. The disease observed among the animals usually varies between 10-40%, and cases of casualties often exceed 10% (Albayati *et al.*, 2020). The disease is observed clinically with the symptoms such as diarrhea, subclinical poor weight gain and failure to thrive. Subclinical coccidiosis manifests in relatively old small ruminants, while clinical coccidiosis manifests mainly in lambs and kids under 1 year of age (Nurdianti, 2023). The eimeria invasion is a serious obstacle to the health and productivity of the farm animals in the tropical and subtropical regions of the world (Kumar *et al.*, 2016). They cause high morbidity, weight loss, poor reproductive status and probable casualties in livestock (Mohammed and Alobaidii, 2021). The intensive infection cases of the farm animals with the coccidiosis have caused serious economic losses in the United States, it is recorded at high indicators of up to 341 million dollars every year (Macedo *et al.*, 2019).

In the animals, the associative infection cases of infection with 3 or more pathogenic species belonging to the genus of *Eimeria* are also noted intensively. The global spread of eimerias is high, the invasion is widespread in all the ruminants and the most invasions involve several species (Bangoura and Bardsley, 2020).

Often, at the same time, mixed *Eimeria* species exist in the host that it also causes the intensive observation of any symptoms. The lambs are more susceptible to the coccidiosis disease. In particular, when they infected with the different parasites, more complications are observed in their condition (Martins *et al.*, 2020). In addition to this, in the recent years, an intensification of the associative infections with the endoparasites belonging to the different species are noted. It is noted that, in the North-East of Colombia, in sheep, the intensive infections with the helminths and coccidia increases. In particular, when the associative infections with the helminths occur, a sharp decrease in the productivity of sheep and goat flocks and loss is noted. The researchers note that the associative infection cases of *Eimeria* species with the helminths are detected more frequently in the agricultural animals (Lam *et al.*, 2020). In the researches conducted 10 years ago, it was noted that the infection with eimeria was detected more often in winter and summer (Jawasreh and Qader, 2013). In the recent years, the climate change - intense precipitation, favorable conditions have a positive effect on the development cycle of these protozoan parasites, and infection cases are noted intensively in spring, summer and autumn and more often in association with the helminths (Azizova, 2022). In our researches on the parasitic fauna of small ruminants, it was confirmed that the protozoans belonging to the genus of pathogenic *Eimeria* are distributed intensively. Taking this into account, in the Mountainous-Shirvan and Shirvan-Salyan economic regions located in different reliefs, in sheep and goats, the species composition of the pathogenic eimeria are studied and the infection incidence was researched and analyzed.

Materials and methods

The research work was conducted in 2012-2023 on the small ruminants in the individual and farm livestock farms of the Ismayilli, Shamakhi, Agsu, Gobustan, covered the the Mountainous Shirvan economic region, which is located in different reliefs and has different climates, and Neftchala, Bilasuvar, Salyan, Hajigabul, Shirvan regions, covered the Shirvan-Salyan economic region. The pathological-anatomical materials were collected from the ecological landscapes (mountains, foothills, plains) of each region, and the results were analyzed accordingly to this. During the 10-year research period, 8,000 sheep, 6,000 goats were researched in the Mountainous Shirvan economic region, and 10,000 sheep, 4,000 goats in the Shirvan-Salyan economic region. The examination of feces taken from the intestines is the basis for the detection of the parasites. The faecal parasitological tests are classified broadly as qualitative or quantitative (Verocai, 2020). The eimeria diagnosis usually depends on the morphological detection of oocysts by light microscopy (Mohamaden *et al.*, 2018). The pathology samples were researched by the Fullerborn-Darling method for to detect the eimerias of the primary intestinal parasites, and the samples were stored in potassium bichromate solution for 3-5 days for the observation of sporogony. The examinations were conducted on the animals of different age groups (up to 1 year, young animals between 1 and 2 years old, and animals over 2 years old). The species were determined based on the oocyst morphology (color, shape index, shape, residual as well as the presence or absence of the oocyst mass, the presence or absence of micropyle and its cap, polar and stied bodies) and time of sporulation. The pathogenic species were identified in one animal, and the average relative coefficient of the infected animals was calculated based on the "Student's t-test".

Results

The infection with the pathogenic *Eimeria* species was detected in 4,905 (61.3%) out of 8,000 sheep researched in the mountainous, foothill and plain landscapes of the Mountainous Shirvan economic region. 4 pathogen species belonging to the Eimeria genus were noted in sheep - *E. ahsata, E. crandallis, E. ovinoidalis, E. arloingi* (Fig. 1).

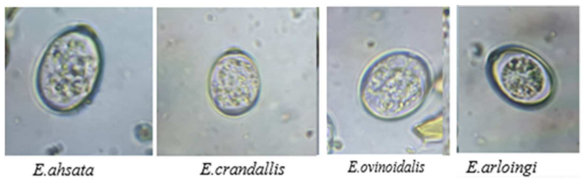

Fig. 1. The pathogenic *Eimeria* species in sheep (10x40)

The researched 8,000 animals were divided into age groups, 2,500 of which were lambs up to 1 year old, 3,000 between 1 and 2 years old, and 2,500 over 2 years old. The infection with the pathogenic eimeria was noted in 2,225 (89.0%) of 2,500 lambs, in 1,845 (61.5%) of 3,000 sheep between 1 and 2 years old, and in 835 (33.4%) of 2,500 sheep over 2 years old. High infection was noted in lambs, relatively low in sheep between 1 and 2 years old, and low infection in animals over 2 years old. The infection incidence of all the age groups of animals with the pathogenic eimeria is shown in the table (Table 1).

Table 1. The infection incidence with the pathogenic *Eimeria* species in sheep in the Mountainous Shirvan economic region

The species of *Eimeria*	Sick lambs – 2225 heads		Patients from 1 to 2 years old - 1845 heads		Patients over 2 years old – 835 heads	
	Head /%	İİ	Head /%	İİ	Head /%	II
1 *Eimeria ahsata* 34.2 ± 23.2	1811/81.4	7-25	1191/64.6	5-14	177/21.3	3-5
2 *Eimeria crandallis* 29.7 ± 22.3	1773/79.7	9-23	1177/63.8	7-13	199/23.8	3-6
3 *Eimeria ovinoidalis* 24.8 ± 20.6	1619/72.8	5-13	1042/56.5	4-9	145/17.4	2-5
4 *Eimeria arloingi* 27.1 ± 22.1	1495/67.2	3-8	902/48.9	2-6	97/11.6	1-3

In the researched lambs, the extensiveness of the infection with the pathogenic species was noted highly - *Eimeria ahsata* 81.4% (higher), *Eimeria crandallis* 79.7% (higher), *Eimeria ovinoidalis* 72.8% (high), *Eimeria arloingi* 67.2% (high). In the animals aged 1-2 years, the infection with *Eimeria ahsata* 64.6% (high), *Eimeria crandallis* 63.8% (high), *Eimeria ovinoidalis* 56.5% (moderately), *Eimeria arloingi* 48.9% (moderately). In the animals older than 2 years, the infection with the pathogenic eimerias was noted with a low incidence: *Eimeria ahsata* was noted 21.3%, *Eimeria crandallis* 23.8%, *Eimeria ovinoidalis* 17.4%, *Eimeria arloingi* 11.6%. When comparing by age, the infection extensiveness and intensity with the pathogenic species were noted with higher indicators in lambs. Also in sheep between 1-2 years old, the extensiveness of the infection was estimated higher than in older sheep. When comparing the infection status of the animals with the pathogenic eimeria by the species, the *Eimeria ahsata* species was observed with a high indicator in the animals of all age groups. In the animals of all age groups, the infection with the pathogenic eimeria was noted in association with 2 or more, and sometimes with each 4 pathogenic *Eimeria* species (Fig. 2).

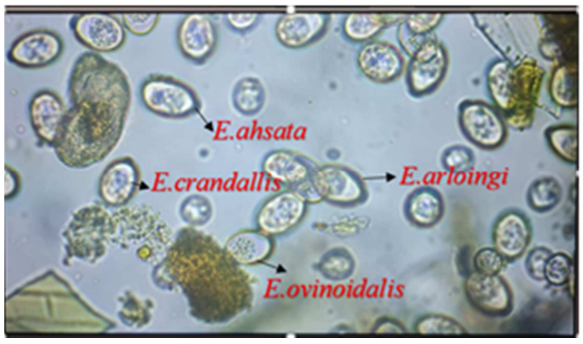

Fig. 2. The infection with the pathogenic *Eimeria* species in the associative form in lambs (10×40)

In general, although the clinical eymeriosis was not observed in sheep of all three age groups, the signs of the subclinical eymeriosis were noted in lambs. In our experiments, although the pathogenic eimeria species were detected intensively in newborn lambs, the clinical eymeriosis was not observed. But after these lambs are out on the pastures, they ingested the intermediate hosts (oribatid mites) of the cestodes, the infection cases with the monesiosis were observed, in lambs, the serious complications were manifested, the mortality were followed (Fig. 3).

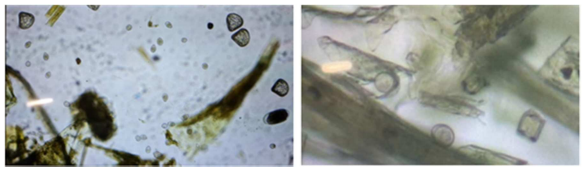

Fig. 3. The associative infection with the pathogenic *Eimeria* and *Moniezia* species in lambs (10×10)

The infection with the pathogenic eimeria species were detected in 3303 (55.0%) out of 6000 goats researched in the mountainous, foothill and plain landscapes of the Mountainous Shirvan economic region. Five pathogens belonging to the genus of *Eimeria* were noted in goats-*E. ninakohlyakimovae, E. hirci, E. chistenseni, E. arloingi, E. caprina* (Fig. 4).

The infection with the pathogenic eimeria species were noted in 1583 (85.6%) of 1850 kids, 1440 (58.8%) of 2450 goats aged 1-2 years, and 280 (16.5%) of 1700 old goats out of 6000 researched animals. High infection with eimeria was observed in kids. The infection incidence with the pathogenic eimeria in all the age groups of the animals is noted (Table 2).

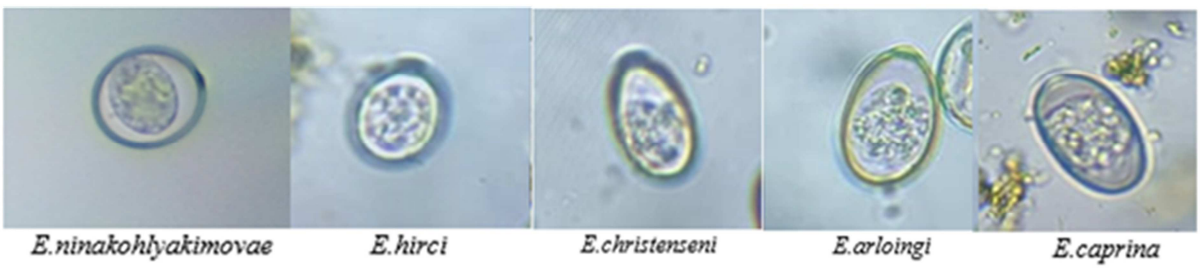

Fig. 4. The pathogenic *Eimeria* species in goats (10×40)

Table 2. The infection incidence of goats with the pathogenic *Eimeria* species in the Mountainous Shirvan economic region

	The species of *Eimeria*	Sick kids – 1583 heads		Patients from 1 to 2 years old – 1440 heads		Patients over 2 years old – 280 heads	
		Heads /%	İİ	Heads /%	İİ	Heads /%	II
1	*Eimeria ninakohlyakimovae* 47.4 ± 34.1	1450/91.6	7-18	697/48.4	3-7	127/45.4	1-3
2	*Eimeria hirci* 44.5 ± 32.7	1352/85.4	3-11	657/45.6	2-5	111/39.6	1-3
3	*Eimeria chistenseni* 38.7 ± 26.9	1148/72.5	6-14	575/39.9	3-6	105/37.5	1-2
4	*Eimeria arloingi* 34.1 ± 22.3	956/60.4	2-7	456/31.7	1-4	80/28.6	0-2
5	*Eimeria caprina* 15.9± 11.6	503/31.8	1-5	300/20.8	1-3	52/18.6	0-1

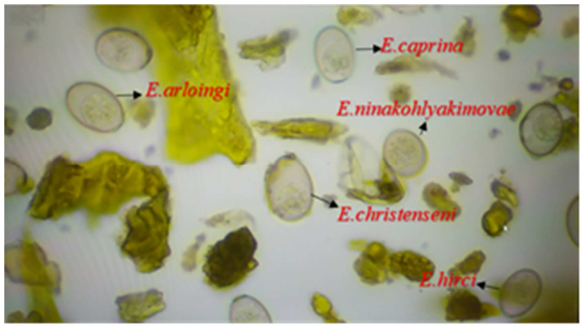

Fig. 5. The infection with the pathogenic *Eimeria* species in the associative form in kids (10×40)

In the researched kids, the infection extensiveness with the pathogenic eimeria species was noted with different indicators. *Eimeria ninakohlyakimovae* was noted (high) 91.6%, *Eimeria hirci* 85.4% (high), *Eimeria chistenseni* 72.5% (high), *Eimeria arloingi* 60.4% (moderate), *Eimeria caprina* 31.8% (weak). In kids, the infection was followed in an associative form with several pathogenic species. In goats aged 1-2 years, the infection extensiveness with the pathogenic eimeria species was assessed moderately. *Eimeria ninakohlyakimovae* was 48.4%, *Eimeria hirci* 45.6%, *Eimeria chistenseni* 39.9%, *Eimeria arloingi* 31.7%, *Eimeria caprina* 20.8%. In goats over 2 years old, *Eimeria hirci* was noted 39.9%, *Eimeria chistenseni* 37.6%, *Eimeria arloingi* 28.4%, *Eimeria ninakohlyakimovae* 27.3% and *Eimeria caprina* 19.5%. In goats aged 1-2 years and over 2 years old, the infection with the pathogenic species was followed with similar indicators, but with relatively weak, non-pathogenic species were followed more intensively. The clinical eimeriosis was not followed in goats of this age group. In goats and goats aged 1-2 years old, the pathogenic *Eimeria* ninakohlyakimovae species caused high extensiveness and intensity of the infection. In goats over 2 years old, the extensiveness of the infection with the pathogenic *Eimeria hirci* species was noted with high indicators. When compared by age, in kids, the extensiveness and intensity of the infection with the pathogenic species was higher and in an associative form (Fig. 5).

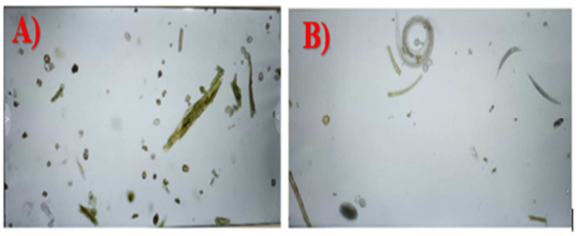

Fig. 6. A) The infection with the pathogenic *Eimeria* and *Moniezia* species in the associative form in kids (10×10); B) The infection with the pathogenic *Eimeria*, respiratory and gastrointestinal nematodes in the associative form in kids (10×10)

Goats aged 1-2 years and older are susceptible to the subclinical eymeriosis. In our experiments, in newborn kids, the pathogenic *Eimeria* species were detected intensively and the clinical eymeriosis was followed. 4-5-month-old kids are susceptible to the clinical eymeriosis, in the animals, diarrhea, poor weight gain, feed refusal are observed. In kids released to the pastures, the associative infection cases with *Eimeria* and helminths were followed. In kids, the associative infection with the *Moniezia*

species, respiratory and gastrointestinal nematodes is followed that lat this time the complications manifest in the animals (Fig. 6).

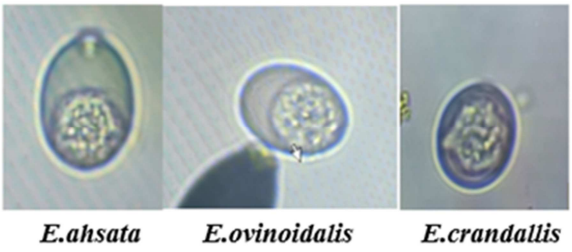

Fig. 7. The pathogenic *Eimeria* species in sheep

The infection with the pathogenic eimeria species is noted in 5,059 (50.5%) out of 10,000 sheep researched in the desert, semi-desert and plain landscapes of the Shirvan-Salyan economic region. 3 pathogenic species belonging to the *Eimeria* genus were noted in sheep - *E. ahsata, E. ovinoidalis, E. crandallis* (Fig. 7).

The infection with the pathogenic eimerias is noted in 2,103 (70.1%) of 3,000 lambs, 2,212 (55.3%) of 4,000 sheep aged 1-2 years, 744 (24.8%) of 3,000 sheep over 2 years out of 10,000 researched animals studied. The infection incidence with the pathogenic eimerias in all the age groups of the animals is noted (Table 3).

In the researched lambs, the infection with the pathogenic species was noted with high extensiveness - *Eimeria ahsata* was noted 65.4% and *Eimeria ovinoidalis* 58.1%, *Eimeria crandallis* 57.5%. In sheep aged 1-2 years, *Eimeria ahsata* was 41.5% and *Eimeria ovinoidalis* 43.7%, *Eimeria crandallis* 39.8%. In sheep over 2 years old, the infection with the pathogenic species was noted weakly - *Eimeria ahsata* was 14.1% and *Eimeria ovinoidalis* 17.4%, *Eimeria crandallis* 13.8%. When compared by age, in lambs, the infection extensiveness and intensity with the pathogenic species were noted with high indicators also in this economic region. In sheep aged 1-2 years, the extensiveness of the infection was assessed moderately. The clinical eimeriosis was not observed in lambs. High infection cases with the pathogenic *Eimeria ovinoidalis* (65.4%) species are noted more intensively. In this economic region, lambs are infected with the gastrointestinal nematodes in an associative form with the pathogenic eimeria species. The pathogenic eimeria species are noted more intensively with the nematode of *Nematodirus* sp. in an associative form (Fig. 8).

Table 3. The infection incidence of sheep with the pathogenic *Eimeria* species in the Shirvan-Salyan economic region

	The species of *Eimeria*	Sick lambs – 2103 head		Patients from 1 to 2 years old – 2212 head		Patients over 2 years old – 744 head	
		Head /%	II	Head /%	İİ	Head /%	II
1	*Eimeria ahsata* 30.7 ± 20.6	1375/65.4	5-17	918/41.5	5-14	105/14.1	3-5
2	*Eimeria ovinoidalis* 38.1 ± 24.7	1222/58.1	7-21	967/43.7	4-19	129/17.3	2-5
3	*Eimeria crandallis* 29.8 ± 21.9	1209/57.5	3-15	880/39.8	7-13	103/13.8	3-6

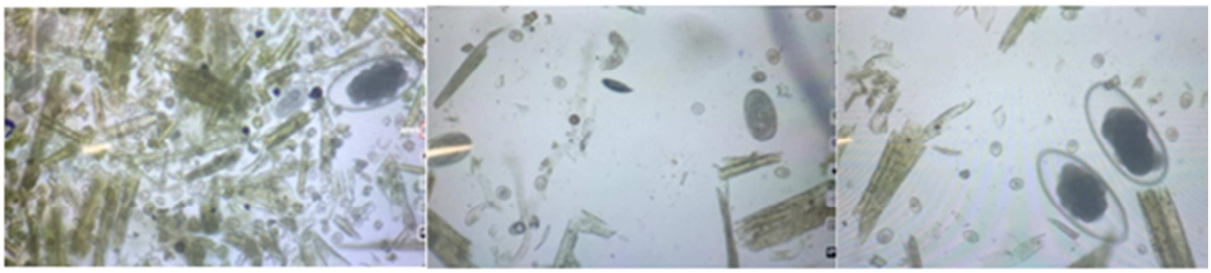

Fig. 8. The infection with the pathogenic *Eimeria* and gastrointestinal nematodes in the associative form in lambs (10×10)

The infection with the pathogenic eimerias was noted in 693 (42.3%) out of 4000 goats researched in the desert, semi-desert and plain landscapes of the Shirvan-Salyan economic region. 2 pathogenic species belonging to the Eimeria genus were noted in goats-*E. ninakohlyakimovae* and *E. hirci* (Fig. 9).

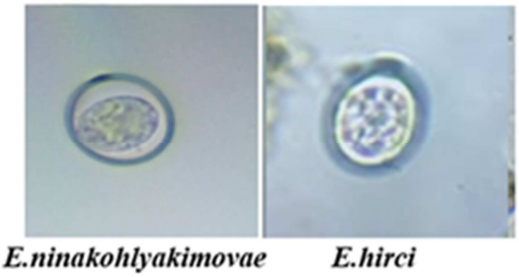

Fig. 9. The pathogenic *Eimeria* species in goats

The infection was noted in 672 (67.2%) of 1000 kids, 817 (52.4%) of 1560 goats aged 1-2 years, and 204 (14.2%) of 1440 old goats out of 4000 researched animals. The infection incidence with the pathogenic eimerias in all the age groups of the animals is noted (Table 4).

In the researched kids, the infection cases with the pathogenic eimeria species-*Eimeria ninakohlyakimovae* 73.7% (high) and *Eimeria hirci* 54.6% (moderate) were noted. In goats aged 1-2 years, the pathogenic *Eimeria ninakohlyakimovae* was 46.4%, *Eimeria hirci* 44.2%.

In old goats over 2 years old, *Eimeria ninakohlyakimovae* was noted 23.7% and *Eimeria hirci* 18.5%. In goats over 2 years old, the infection with the pathogenic species was followed with the weak indicators. When compared by age, in kids, the infection extensiveness and intensity with the pathogenic species were noted with higher indicators. In goats aged 1-2 years and older, the infection extensiveness and intensity did not differ significantly. The clinical eimeriosis was not followed in goats of this age group. The intensive infection with the pathogenic eimeria was followed in the coprological samples of kids up to 1 year old, which observed the clinical signs such as short-term (2 days) increase in temperature and diarrhea. In kids, the disease was accompanied by refusal to feed, weakness, in the animals, a slowdown in height and weight gain were followed. In the Shirvan-Salyan economic region, in kids detected the clinical eimeriosis, the associative infection with the *Trichuris* sp. and *Dicrocoelium* sp. helminths were noted (Fig. 10).

Table 4. The infection incidence of goat with the pathogenic *Eimeria* species in the Shirvan-Salyan economic region

	The species of *Eimeria*	Sick kids – 672 head		Patients from 1 to 2 years old – 817 head		Patients over 2 years old - 204 head	
		Head /%	II	Head /%	İİ	Head /%	II
1	Eimeria ninakohlyakimovae 27.1 ± 21.3	495/73.7	7-19	381/46.6	4-8	48/23.5	2-4
2	Eimeria hirci 25.6± 21.4	367/54.6	3-12	361/44.2	3-6	37/18.1	2-4

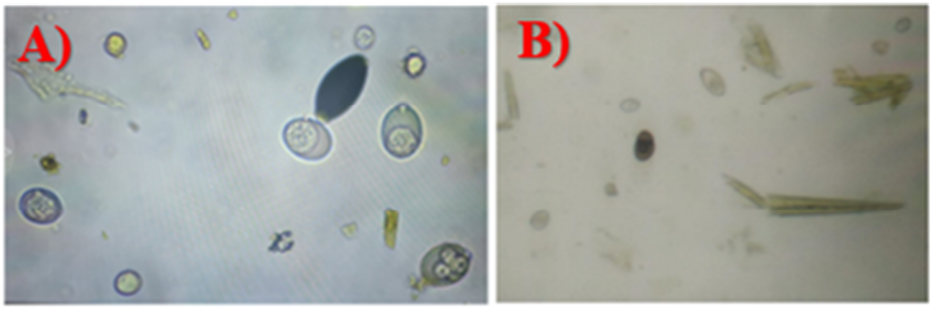

Fig. 10. A) The infection with the pathogenic *Eimeria* and *Trichuris* sp. in the associative form in kids (10×40); B) The infection with the pathogenic *Eimeria* and *Dicrocoelium* sp. in the associative form in kids (10×10)

Discussion

In two economic regions located in different reliefs, the infection incidence of small ruminants with the pathogenic eimeria species showed different results. So in Mountainous Shirvan, in sheep, 4 pathogen species - *E. ahsata, E. ovinoidalis, E. crandallis, E. arloingi* are noted, and in Shirvan-Salyan, 3 pathogen species - *E. ahsata, E. ovinodalis, E. crandallis*. In Mountainous-Shirvan, in goats, 5 pathogen species - *E. hirci, E. arloingi, E. caprina, E. ninakohlyakimovae, E. chistenseni* are noted, and in Shirvan-Salyan, 2 pathogen species-*E. hirci* and *E. ninakohlyakimovae*. The infection extensiveness and intensity of sheep and goats with the pathogenic eimeria species were noted higher in the Mountainous-Shirvan economic region. In Shirvan-Salyan, in small ruminants, the species composition of the pathogenic Eimeria species is noted little, and the extensiveness and intensity are noted weakly. In this economic region, In the recent researches, in goats, the pathogenic *E. arloingi* species has not been detected. As can be seen, the pathogenic eimeria species of sheep and goats are richer in the Mountainous Shirvan region. The different results are directly related to the ecological conditions and climate of the economic regions located in different reliefs.

Thus, in the Mountainous-Shirvan region located in the mountainous landscapes, there are favorable conditions for the development of *Eimeria* in the external environment, so that the animals are subject to reinvasion in all the seasons. The favorable climatic conditions (optimal temperature and humidity) - the intensive precipitation in the summer season, frost-free weather in winter in recent years, caused to the infection with the *Eimeria* species and resulted with the infection of the animals of all age groups all year round. And when the general results are analyzed, although the pathogenic eimeria species are not noted rich in sheep and goats in the Shirvan-Salyan economic region, the infection is observed intensively.

In the recent years, the climate change in the world - the intensive precipitation, favorable conditions have had a positive effect on the development cycle of these primitive parasites, caused to a wide spread of the disease cases in small ruminants in both economic regions.

The non-pathogenic species have also been determined in the researches. In Mountainous Shirvan, in sheep, 7 non-pathogenic species - *E. faueri, E. granulosa, E. intricata, E. bakuensis, E. parva, E. ellipsoidalis, E. cylindrica* were noted more intensively. In this economic region, in goats, 4 non-pathogenic species - *E. alijevi, E. jolchijevi, E. caprovina, E. apsheronica* are noted. In Shirvan-Salyan, in sheep, 6 non-pathogenic species - *E. intricata, E. parva, E. bakuensis, E. pallida, E. ellipsoidalis, E. cylindrica* are noted, in goats, 4 non-pathogenic *E. jolchijevi, E. caprovina, E. alijevi, Eimeria absheronica* species are noted. The non-pathogenic species of goats were the same in both economic regions, but the differences were observed in intensity.

Conclusion

In our 10-year researches, in the last 5 years, the sharp changes were followed in the infection case of sheep and goats with the pathogenic species belonging to the genus of *Eimeria*, the invasion of the animals with eimeria was noted with high indicators. The immunity is formed in the animals infected the disease and they become the invasion carriers, because during repeated invasions with the pathogens of eymeriosis, they do not get sick, release the oocysts into the environment (under the favorable conditions, the sporulation occurs - that is, the formation of the spores and sporozoites). The unfavorable storage conditions also effect directly to the incidence of the pathogenic eimerias. Thus, in young animals, the intensive infection with the pathogenic eimeria species causes to weakening of the animal's immunity, lack of feed, weakness, and these cause to the infection with the other endoparasitic helminths. This results with the complications in the animals. In small ruminants, in spring, summer and autumn seasons, infection is observed in the associative form (eimeria-helminths). In the economic regions, when

we analyze the infection situation of small ruminants with the pathogenic eimerias, we come to the conclusion that in both regions, in the animals, the infection with the intestinal parasites and in the associative form with the nematodes, cestodes and trematodes is observed with different intensity throughout the year. In small ruminants, the intensification of the associative infection cases with the pathogenic eimeria species, as well as with the endoparasitic helminths, is directly related to the fact that the infection is noted in all the seasons, the climate change that has occurred in the recent years, and the presence of a favorable ecological environment for parasites to survive in nature and cause reinvasion. In order to follow the infection cycle of the animals with the associative invasion, to determine the dominant species, an unhealthy farm was selected and 2 newborn lambs were kept under the control. The fecal samples were examined regularly. In lambs kept in the stable conditions, the infection with eimeria was noted starting from the 25th day, and with the nematodes on the 30th day. In lambs that were put out to the pasture with their mothers after 1 month, the infection with the trematodes (*Dicrocoelium*) was noted from the 55th day, and with the cestodes from the 60th day (*Moniezia*).The analysis of the results shows that in unfavorable farms, the animals are infected firstly with the primary intestinal parasites, then with the nematodes, and in the pasture conditions with the trematodes and cestodes. In other experiments, during the associative infection (eimeria and helminths), the blood samples of sick sheep were examined according to the morphological parameters. Our goal was to determine the morphological parameters of the blood in this form of the invasion. For this, 3 lambs aged 6 months to 1 year, which were subjected to the natural associative (mixed) invasion, were selected. The lambs were infected with the *Dicrocoelium lanceatum* trematode, gastrointestinal and respiratory nematodes and *Eimeria* species in an associative form. The blood parameters of the sick animals were examined starting from the 15th day. The serious changes were observed in the composition of the formed elements of the blood - hemoglobin, erythrocytes, leukocytes. This condition reached a peak on the 45th day. The animals were subjected to the treatment, and after treatment, the morphological parameters of the blood were examined on the 50th and 90th days. In experimental sheep, the morphological parameters of the blood were not the same as in healthy animals 50 and even 90 days after treatment. This also indicates the serious pathological consequences of the parasites in the associative invasions and accordingly, the delaying of the rehabilitation processes in sick animals. When the animals are subjected to the associative invasion, a long period of time is required for the recovery of their organisms.

In the associative invasions, in sheep, the changes in the morphological parameters of the blood are directly proportional to the dynamics of the development of pathology caused by parasites in the host organism. In the associative invasion, the main factor influenced the changes of the morphological parameters of sheep blood is the intensity degree of the parasites. As this indicator increases, the more changes occur in the morphological parameters of the blood. And this is a criterion for the assessing of the parasite-host relationships. In small ruminants, the second main reason of the intensification of the disease cases is non-compliance with the sanitary and hygienic rules in the farms - anthropogenic factors. In sheep and goats, the factors such as storage conditions and food rations also play an important role in the intensive spread of the pathogenic species. The storage in closed conditions, population density, mainly non-compliance with the sanitary and hygienic rules in the farms and all the stress causes (physiological, nutritional, etc.) include to the risk factors for the intensive infection. In order to prevent diseases from resulting in serious losses, compliance with the preventive measures against the risks is a more effective preventive control method. Taking this into account, the farmers should regularly take preventive measures against the risks which will occur and protect the animals from the infection.

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