https://doi.org/10.29326/2304-196X-2025-14-4-362-371

Seasonal and age-related dynamics of buffalo fascioliasis in the Dagestan lowlands

Sadrutdin Sh. Kabardiev, Karine A. Karpushchenko

Caspian Regional Research Veterinary Institute – Branch of Dagestan Agriculture Science Center, ul. Dakhadaeva, 88, Makhachkala 367000, Republic of Dagestan, Russia

ABSTRACT

Introduction. Fascioliasis is highly prevalent in the North Caucasus lowlands, infecting 37–46% of adult buffaloes; however, the critical drivers of infection – seasonality and host age – are poorly understood.

Objective. Investigating seasonal and age-related fascioliasis dynamics in buffaloes kept in the lowland zones of the Republic of Dagestan.

Materials and methods. To investigate the spread of fascioliasis in the lowland Babayurt region, a total of 240 fecal samples from buffaloes aged one year and older, 20 liver samples, and 1,428 pond snails (*Lymnaea palustris, Lymnaea stagnalis, Lymnaea auricularia,* and *Lymnaea truncatula*) were collected. Parasites were detected using both antemortem (coproscopy) and postmortem (helminthological autopsy of the liver and gallbladder) methods.

Results. A high prevalence of fascioliasis was established in adult buffaloes of the lowland zone, a phenomenon attributable to the cumulative nature of parasitic infection. Infection rates demonstrated significant seasonal variation, peaking in December (60%) and reaching a minimum in June (40%). A marked increase in both prevalence and intensity of infection was observed from August to November, likely driven by a seasonal rise in the population of infected intermediate hosts on pastures. Among the gastropods studied (*L. palustris, L. stagnalis, L. auricularia*, and *L. truncatula*), larval stages of fasciola were found exclusively in the dwarf and great pond snails, confirming their role as the key intermediate hosts in this region.

Conclusion. Understanding the regional epizootology of buffalo fascioliasis is crucial for developing effective control strategies against this zoonosis. Our findings, which elucidate the local dynamics of the parasite's life cycle, provide a foundation for targeted prevention measures tailored to the specific conditions of the area.

Keywords: Republic of Dagestan, lowlands, fasciolasis, *Fasciola hepatica*, buffalo, infestation rate, invasion prevalence and intensity, seasonality, age-related dynamics

Acknowledgments: The work was conducted in compliance with Unified Governmental Information System of Recording (EGISU) 1022040700659-8-4.3.1 "Improvement of current measures used to control and prevent highly dangerous invasive diseases of agricultural animals and poultry in the Russian Caspian Region".

For citation: Kabardiev S. Sh., Karpushchenko K. A. Seasonal and age-related dynamics of buffalo fascioliasis in the Dagestan lowlands. *Veterinary Science Today.* 2025; 14 (4): 362–371. https://doi.org/10.29326/2304-196X-2025-14-4-362-371

Conflict of interests: The authors declare no conflict of interests.

For correspondence: Sadrutdin Sh. Kabardiev, Dr. Sci. (Veterinary Medicine), Chief Researcher, Head of the Laboratory for the Study of Invasive Diseases of Farm Animals and Poultry, Caspian Regional Research Veterinary Institute – Branch of Dagestan Agriculture Science Center, ul. Dakhadaeva, 88, Makhachkala 367000, Republic of Dagestan, Russia, *pznivi05@mail.ru*

УДК 619:616.995.122.21:636.293.2(470.67)

Сезонная и возрастная динамика фасциолеза буйволов в равнинной зоне Республики Дагестан

С. Ш. Кабардиев, К. А. Карпущенко

Прикаспийский зональный научно-исследовательский ветеринарный институт – филиал ФГБНУ «Федеральный аграрный научный центр Республики Дагестан» (Прикаспийский зональный НИВИ – филиал ФГБНУ «ФАНЦ РД»), ул. Дахадаева, 88, г. Махачкала, 367000, Республика Дагестан, Россия

РЕЗЮМЕ

Введение. В равнинных областях Северного Кавказа наблюдается высокая распространенность фасциолеза среди взрослого поголовья буйволов, показатели инвазированности варьируют от 37 до 46%. Сезонная и возрастная динамика зараженности буйволов фасциолами в данном регионе остается невыясненной.

Цель исследования. Изучение сезонной и возрастной динамики фасциолеза буйволов, содержащихся в равнинной зоне Республики Дагестан.

Материалы и методы. Материалом для исследования служили 240 проб фекалий буйволов (в возрасте от года и старше), 20 экземпляров печени и 1428 экземпляров моллюсков семейства прудовиков: *Lymnaea palustris, Lymnaea stagnalis, Lymnaea auricularia* и *Lymnaea truncatula*. С целью изучения распространения фасциолеза в равнинном Бабаюртовском районе проведены исследования с использованием прижизненных (копроовоскопия) и посмертных (гельминтологическое вскрытие печени и желчного пузыря) обнаружения паразитов.

Результаты. Установлена высокая степень инвазии взрослых буйволов в равнинной зоне республики. Данный факт объясняется кумулятивным характером заражения, то есть накоплением паразитов в организме животных. Сезонность оказывает значительное влияние на зараженность буйволов фасциолезом. Экстенсивность инвазии достигала пика в декабре (60%) и была минимальной в июне (40%). В период с августа по ноябрь наблюдался заметный рост экстенсивности и интенсивности инвазии, что, по-видимому, связано с увеличением численности промежуточных хозяев паразита на пастбищах в это время года. Взрослые буйволы, обитающие на равнинах, чаще всего и более интенсивно заражались фасциолами. В результате

проведенных исследований по инвазированности моллюсков *L. palustris, L. stagnalis, L. auricularia* и *L. truncatula* установлено, что только малый и обыкновенный прудовики были заражены личинками фасциол, в то время как другие виды лимнеид оказались свободны от этой трематодозной инвазии.
Заключение. Изучение краевой эпизоотологии фасциолеза буйволов позволит более успешно бороться с данным зоонозным биогельминтозом с учетом особенностей местности и видового состава возбудителей. Знание особенностей жизненного цикла трематод также является важной составляющей в проведении мероприятий по борьбе и профилактике паразитарных болезней.

Ключевые слова: Республика Дагестан, равнинная зона, фасциолез, *Fasciola hepatica*, буйвол, зараженность, экстенсивность и интенсивность инвазии, сезонность, возрастная динамика

Благодарности: Работа выполнена в соответствии с ЕГИСУ 1022040700659-8-4.3.1 «Усовершенствовать существующие меры борьбы и профилактики с особо опасными инвазионными болезнями сельскохозяйственных животных и птиц, с учетом эпизоотологических особенностей паразитов, в условиях Прикаспийского региона России».

Для цитирования: Кабардиев С. Ш., Карпущенко К. А. Сезонная и возрастная динамика фасциолеза буйволов в равнинной зоне Республики Дагестан. *Ветеринария сегодня.* 2025; 14 (4): 362–371. https://doi.org/10.29326/2304-196X-2025-14-4-362-371

Конфликт интересов: Авторы заявляют об отсутствии конфликта интересов.

Для корреспонденции: Кабардиев Садрутдин Шамшитович, д-р вет. наук, главный научный сотрудник, заведующий лабораторией по изучению инвазионных болезней сельскохозяйственных животных и птиц, Прикаспийский зональный НИВИ – филиал ФГБНУ «ФАНЦ РД», ул. Дахадаева, 88, г. Махачкала, 367000, Республика Дагестан, Россия, *pznivi05@mail.ru*

INTRODUCTION

Animal husbandry is a crucial branch of agriculture, important for a country's economy. The spread of infectious and invasive diseases in animal husbandry is a significant barrier to industry development [1, 2].

Trematodiases, particularly fascioliasis caused by the liver fluke *Fasciola hepatica*, represent a significant global health and veterinary concern. This helminth is a widespread parasite of numerous mammalian species, including both domestic livestock and wildlife within the Russian Federation and beyond. Infection with *F. hepatica* induces immunosuppression, heightening host susceptibility to secondary viral and bacterial infections, which can result in mortality [3, 4, 5, 6].

Episodic and incomplete anthelmintic treatment of livestock fails to significantly reduce the incidence of fascioliasis. The success of a deworming program is not absolute but is mediated by several critical variables. The local climate and habitat define the parasite's environmental viability, the parasite's development cycle in mollusks dictates transmission windows, and agricultural practices – notably the timing and length of grazing, which are often linked to rainfall – determine host exposure risk. Favorable environmental conditions stimulate pond snail population growth, which in turn increases the host population available for infection by larval fasciolids, facilitating parasite transmission. This, in turn, leads to a high incidence of livestock infection with trematodes. Consequently, current prophylactic and therapeutic strategies against fascioliasis do not consistently achieve the eradication of sexually mature parasites from livestock hosts [7, 8, 9, 10, 11].

Fascioliasis is a widespread parasitic disease of cattle, particularly in southern Russia and the North Caucasus region. Notably, the prevalence of infection on specific farms in the region can be as high as 54.7%. Concurrent infection with *F. hepatica* and *F. gigantica* is frequently observed in livestock populations of southern zones. Studies in Kalmykia indicate an average bovine fascioliasis prevalence of 17.8%, ranging from 15.9 to 20.8%. The highest levels are recorded during the winter, and both infection rate and the number of helminth eggs shed increase significantly with host age. The prevalence peak occurs at 6 years of age [12].

Kabardino-Balkaria also demonstrates high prevalence of fascioliasis among food-producing animals. Helminthoscopic analysis revealed a cattle infection rate of 48.2% and a mean fecal egg count of 47.7 fasciola eggs per gram. Post-mortem helminthological examination revealed an infection prevalence of 52.3% and a mean intensity of infection (II) of 99.8 fasciola individuals per animal. Infection of adult cattle is observed year-round, with the rates ranging from 52.5% in August to 76.6% in February. Studies demonstrate that the II with fascioles in farm animals in Kabardino-Balkaria varies significantly depending on the time of year. In particular, there are different infection rates with adult trematodes and young fascioles [13, 14, 15].

The predominant species of fascioles affecting livestock in the region is *F. hepatica* (78.3%). However, the prevalence of infection with *F. gigantica* is higher in irrigated areas (from 6.4 up to 30.3%). In juvenile cattle, the first fasciola eggs are detected in fecal samples in July, after which the extensity of infection (EI) increases. Overall prevalence of fasciola infection among young animals is 22.7%. According to S. B. Cherkesov and A. K. Oshkhunova, the development of *F. hepatica* and *F. gigantica* eggs occurs in Kabardino-Balkaria from mid-March to mid-November. During winter, fasciola eggs exposed to freezing air temperatures desiccate and die, while up to 38.1% of fasciola eggs submerged in water can remain viable [16].

Studies in Kabardino-Balkaria demonstrate that the summer-autumn season provides the most favorable conditions for the reproduction of *Lymnaea auricularia* and *Lymnaea truncatula* snails, the intermediate hosts of fasciola. At this time, the infection rate of mollusks with parasite larvae reaches 3.8–9.5%. The distribution of mollusks depends on the landscape: *L. truncatula* prefers mountainous and foothill areas, *L. auricularia* prefers irrigated lands. It is important to note that the metacercarial cysts of fasciola are highly resistant to adverse conditions, remaining viable on hay during winter and on pasture vegetation. However, intense sunlight (insolation) quickly desiccates and destroys metacercarial cysts on exposed vegetation. Parasites at all developmental stages can be found in animal hosts throughout the year. The parasite population exhibits clear seasonal dynamics: adult forms dominate in the liver and gallbladder during the winter-spring period, while preimaginal stages predominate during the summer-autumn period [17, 18].

A comparable pattern of fascioliasis epidemiology is observed in cattle populations across the North and Central Caucasus. The highest prevalence of fasciola infection (70.7%) was recorded in January among the adult cattle. The first cases of fascioliasis in young cattle were detected at the end of July. The high reproductive capacity of fasciola, particularly during the summer months, is a key driver of widespread invasion in the host population [19].

Studies in the Chechen Republic have revealed varying prevalence rates of fasciola infection among domestic livestock and wild animals. Prevalence in sheep was 33.2% (II – 8–59 individuals/animal), 8.1% in goats (II – 3–11 individuals/animal), 19.2% in cattle (II – 12–108 individuals/animal), 13.4% in buffaloes (II – 5–42 individuals/animal), 4.8% in horses (II – 3–7 individuals/animal), 5.7% in hares (II – 2–3 individuals/animal) and 0.9% in roe deer (II – 3 individuals/animal). Along with *F. gigantica, F. hepatica* was reported in these animals. *F. gigantica* dominates in the lowland Chechen regions, while *F. hepatica* is predominant in the mountainous regions. The researchers also established the following infection rates in farm animals: 28% for cattle (II – 14–117 individuals/animal), 34.8% for sheep (II – 9–243 individuals/animal), 26.6% for goats (II – 5–24 individuals/animal) and 23.3% for buffaloes (II – 21–84 individuals/animal) [7, 20].

Fascioliasis in buffaloes in the North Caucasus region is understudied. The liver fluke disease caused by *F. hepatica*, is widespread in ruminant populations worldwide, occurring sporadically and locally. The parasite has established persistent, localized reservoirs of infection in specific natural habitats. Inadequate herd management practices, particularly the absence of structured pasture rotation, exacerbate the environmental contamination and transmission of *F. hepatica* in ruminant populations. Analysis of epidemiological data reveals that *F. hepatica* infection is most prevalent in adult cattle and small ruminants within regions of high humidity [21].

Susceptibility to *F. hepatica* increases significantly with host age, a pattern primarily attributed to the cumulative effect of repeated exposure and reinfection over time. In adult ruminants with prolonged pasture exposure, the liver can harbor both mature adult flukes and juvenile stages simultaneously [22, 23, 24].

Epidemiological data on infection seasonality are essential for determining the most effective timing of strategic deworming to control liver fluke burdens in ruminants.

In central Russia, periods of high humidity – particularly in spring and autumn – elevate the risk of fascioliasis outbreaks in grazing ruminants. The larval stages develop most successfully during the warmer months when water temperatures remain within a permissive 12–30 °C range. Any divergence from this thermal threshold directly disrupts development within the intermediate mollusk, effectively breaking the transmission cycle. Beyond temperature, the life cycle of *F. hepatica* is critically regulated by ambient humidity and solar radiation [25, 26, 27, 28, 29].

The prevalence of fascioliasis in buffalo populations exhibits clear age dependence, with infection rates consistently higher in adult animals than in juveniles. Sexually mature *F. hepatica* can survive within the definitive ruminant host for up to 4 years. Persistent grazing on infective floodplain meadows is the primary driver for the elevated intensity of invasion most frequently recorded in adult livestock [30].

The intensity of the trematode life cycle is influenced by host population metrics – such as abundance, density, and distribution – as well as by the extensity of infection and abiotic factors like the hydrothermal regime (including precipitation, humidity, and temperature) during the vegetation season. This situation is a complex environmental problem that has a negative impact on the food security of the local population [31, 32, 33].

The freshwater biotopes of the North Caucasus include 10 species of mollusks: *Lymnaea truncatula, Lymnaea auricularia, Galba oblonga, Lymnaea peregra, Physa fontinalis, Lymnaea stagnalis, Physa acuta, Succinea putris, Planorbis planorbis* and *Lymnaea ovata*. Among these, *L. truncatula* serves as the obligate intermediate host for the trematode *F. hepatica*. The distribution of *L. truncatula* covers a wide range of natural and artificial water reservoirs. The intensity of invasion of *L. truncatula* with by *F. hepatica* larvae ranges from 3.05 to 27.14% (13.10% in average) depending on the biotope. A parallel variation in the morphological features of *L. truncatula* was observed, which correlated with the type of water body. The greatest susceptibility to invasion is observed in mollusks of the third stage of development [34, 35].

Analysis of the literature indicates a correlation between mollusk population density and their level of parasitic infection. Higher mollusk density is associated with a greater prevalence of parasitic infections. As common parasites of mollusks, trematodes act as key agents of natural population control, significantly influencing host numbers. They also alter fundamental ecosystem processes by reshaping trophic networks and modifying system-wide structure and function. The complex, multi-host life cycle of trematodes is a key driver of endemic mollusk infection, creating significant and persistent risks to regional and national food security [36].

MATERIALS AND METHODS

From March 2023 to March 2024, a cross-sectional study was conducted in the lowland zone of the Republic of Dagestan to investigate the prevalence of fascioliasis in buffalo across different age groups. Fecal samples were subsequently collected from the buffaloes and analyzed for fasciola infection using established laboratory techniques.

Fecal samples were collected from 240 buffaloes categorized into four age groups ($n = 60$ per group): calves (< 1 year), young stock (1–2 years), adults (2–5 years), and mature animals (> 5 years). All samples were analyzed for fasciola eggs using a standardized flotation coproscopy technique.

All study animals were maintained on pastures known to be environmentally contaminated with parasite stages and situated near populated areas.

The age-related dynamics of *F. hepatica* infection in buffalo were studied using both intravital and postmortem diagnostic techniques. Intravital detection was based on coproscopic examination, while postmortem assessment involved helminthological autopsy of the liver and gallbladder, performed according to the method of K. I. Scriabin.

The intensity of fasciola invasion was assessed in autumn via helminthological post-mortem examination. Livers and gallbladders from 20 buffaloes, with five animals sampled from each of the four age groups, were analyzed for parasite burden.

Seasonal dynamics of *F. hepatica* development was studied by coproscopic examination according to the method of N. V. Demidov.

The distribution of biotopes inhabited by intermediate snail hosts of fasciola was surveyed monthly across the study pastures (5–7 hectare area). Three biotopes (5 to 10 m^2) were examined. A total of 1,428 mollusks belonging to the family *Lymnaeidae* were collected from 34 water reservoirs. The collected specimens comprised the following species: *L. palustris*, *L. stagnalis*, *L. auricularia* and *L. truncatula*. The mollusks were identified using the N. D. Kruglov guide[1].

During the grazing season, mollusk populations were monitored monthly for infection with larval stages of *Fasciola* spp. Parasites were initially identified using the compression slide technique under a light microscope. Subsequently, the intensity of infestation was quantified.

At the onset of the grazing season, field visits were conducted to buffalo pastures to sample and examine lymnaeid snails. This preliminary work aimed to establish the species composition and population density of these mollusks. Concurrently, natural biotopes serving as habitats for the intermediate host of *F. hepatica* were identified. Pond snails were collected using tweezers and placed in plastic containers.

Following collection, the mollusks were dissected. The soft body tissue was carefully extracted from the shell using fine-pointed scissors. In cases where the shell was exceptionally robust – particularly in larger specimens – it was first cracked open with a hammer to facilitate access. During this procedure, hemolymph – which may contain helminthic larval stages such as cercariae and rediae – was released.

To prevent workplace contamination and facilitate parasite examination under the microscope, all mollusk dissections were performed within a contained vessel – either a Petri dish, a watch glass, or a dissection cuvette. Following dissection, the mollusk's body was separated into discrete anatomical sections or organs. Each of these tissues was then mounted between a microscope slide and a coverslip (compression slide technique) for detailed microscopic examination.

For very small mollusks, the entire specimen was often examined *in situ*–directly within the intact shell. In this preparation, live cercariae – if present – would actively emerge from the mollusk's tissue into the surrounding liquid medium. Their intrinsic motility significantly facilitated detection and identification under the microscope.

Statistical data were processed using variation statistics (according to N. A. Plokhinsky) and the Biometrics software.

RESULTS AND DISCUSSION

Parasitological surveys in the Babayurt Raion indicated a high prevalence of fascioliasis in adult buffalo, with many herds showing a heavy parasite burden (infection intensity).

Our data suggest that in the shallow, hydrologically stable reservoirs of the lowlands, temperature serves as the key driver of biological activity for *F. hepatica*, maintaining the continuity of its epizootic chain from egg to miracidium. Liver fluke life cycle is shown in Figure 1.

The parasite's life cycle begins with the sexual reproduction of the adult stage, known as the marita, which resides in the bile ducts of the definitive host (humans or cattle). Eggs produced by the marita are excreted into the environment via the host's feces.

For development to proceed, these eggs must reach a freshwater habitat. In water, a ciliated larva called a miracidium hatches from the egg.

The next stage involves the free-swimming miracidium locating and penetrating a suitable intermediate host – a dwarf pond snail. Inside the snail, a phase of complex asexual multiplication begins. The miracidium transforms into a primary sporocyst, which then produces numerous rediae.

Studies confirmed the widespread fascioliasis prevalence among buffaloes inhabiting the lowlands of the region.

A direct relationship was established between the age of animals and the level of their infection (extensity and intensity) with liver fluke. The results are given in Table 1.

Prevalence of infection with fascioles in different age groups was: calves (< 1 year old) – 18.3%, in young animals (< 2 years old) – 23.3%, in buffaloes (2–5 years old) – 36.7%, and in > 5 years old animals – 48.3%.

The intensity of the infection, determined by counting the number of helminth eggs per gram of faeces, also increased with age: in calves, it was (58.6 ± 9.9), in young animals – (88.5 ± 9.2), in 2 to 5 years old buffaloes – (127.6 ± 8.7), in > 5 years old

[1] Kruglov N. D. Molluscs of family *Lymnaeidae* (*Gastropoda, Pulmonata*) of Europe and Northern Asia. Smolensk: SGPU Publishing; 2005. 507 p. https://djvu.online/file/tffRyg0rOq4jg (in Russ.)

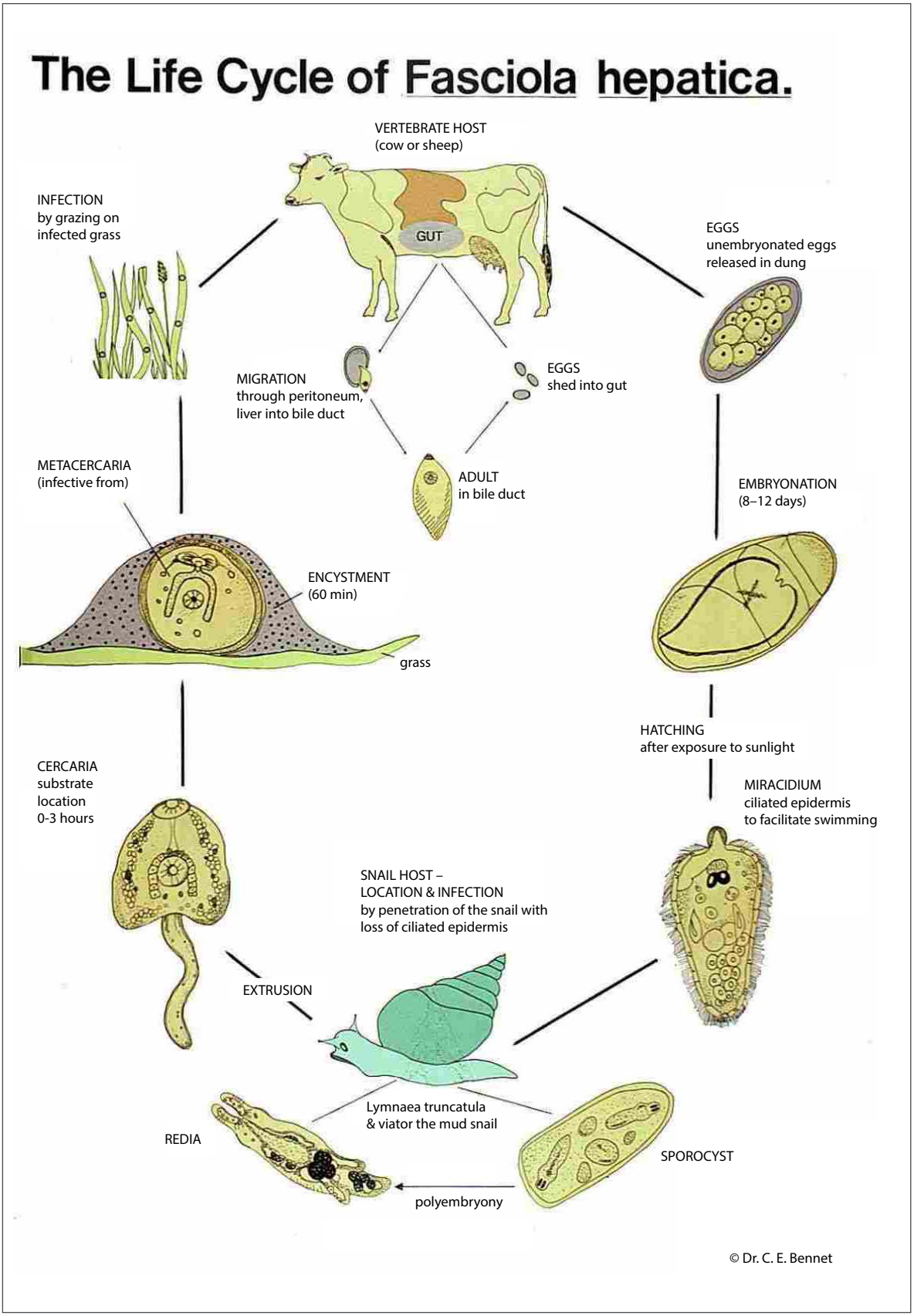

Fig. 1. Common liver fluke life cycle

animals – (166.4 ± 9.3) eggs per animal. The overall prevalence of fasciola infection in the buffalo population was 31.7%. The mean intensity of infection, measured as the number of eggs per animal, was (112.3 ± 9.2).

A direct positive correlation was confirmed between buffalo age and infection prevalence, with the highest prevalence (48.3%) observed in adult animals. The intensity of invasion in adult buffaloes is almost three times (2.8 times) higher than in calves.

Table 1
Prevalence of fasciola infection in buffaloes by age group, determined by coproscopy

Parameters	Buffalo age				
	< 1 year	< 2 years	2–5 years	> 5 years	Total
Tested, in total	60	60	60	60	240
Infected, in total	11	14	22	29	76
EI, %	18.3	23.3	36.7	48.3	31.7
Number of *F. hepatica* eggs per animal	58.6 ± 9.9	88.5 ± 9.2	127.6 ± 8.7	166.4 ± 9.3	112.3 ± 9.2

Table 2
Prevalence of fasciola infection in buffaloes by age group, determined by postmortem helminthological autopsy of the liver

Parameters	Buffalo age				
	< 1 year	< 2 years	2–5 years	> 5 years	Total
Tested, in total	5	5	5	5	20
Infected, in total	1	2	3	3	9
EI, %	20.0	40.0	60.0	60.0	45.0
Number of *F. hepatica* per animal	14.6 ± 2.3	46.7 ± 8.5	92.7 ± 9.9	132.4 ± 9.8	71.6 ± 7.6

Post-mortem examination revealed the lowest prevalence of fasciola infection in the youngest cohort (buffaloes < 1 year of age): the EI – 20.0% and the II – (14.6 ± 2.3) individuals per animal, and the highest in the oldest cohort (> 5 years old): the EI – 60.0% and the II – (132.4 ± 9.8) individuals per animal (Table 2).

Analysis of seasonal dynamics revealed an absence of *F. hepatica* infection in the examined livestock during March and April. In June and August, the average parasitic burden per animal was (19.7 ± 2.1) and (21.8 ± 2.4). In October, the number of detected fasciola increased to (49.6 ± 3.5). In December, the maximum number was recorded – (67.1 ± 6.4), Figure 2.

Field surveys in the Babayurtovsky Raion showed that pastures within the Terek River floodplain are characterized by a specific hydrology, featuring numerous small, lentic (stagnant or slow-flowing) water bodies formed by distributary streams. These water bodies are inhabited by *L. palustris* (marsh pond snail), *L. stagnalis* (great pond snail), *L. auricularia* (European ear snail) and *L. truncatula* (dwarf pond snail).

During the pasture survey, persistent wet hollows – small, groundwater-fed pools that do not dry out, were identified. These basins exhibited variable

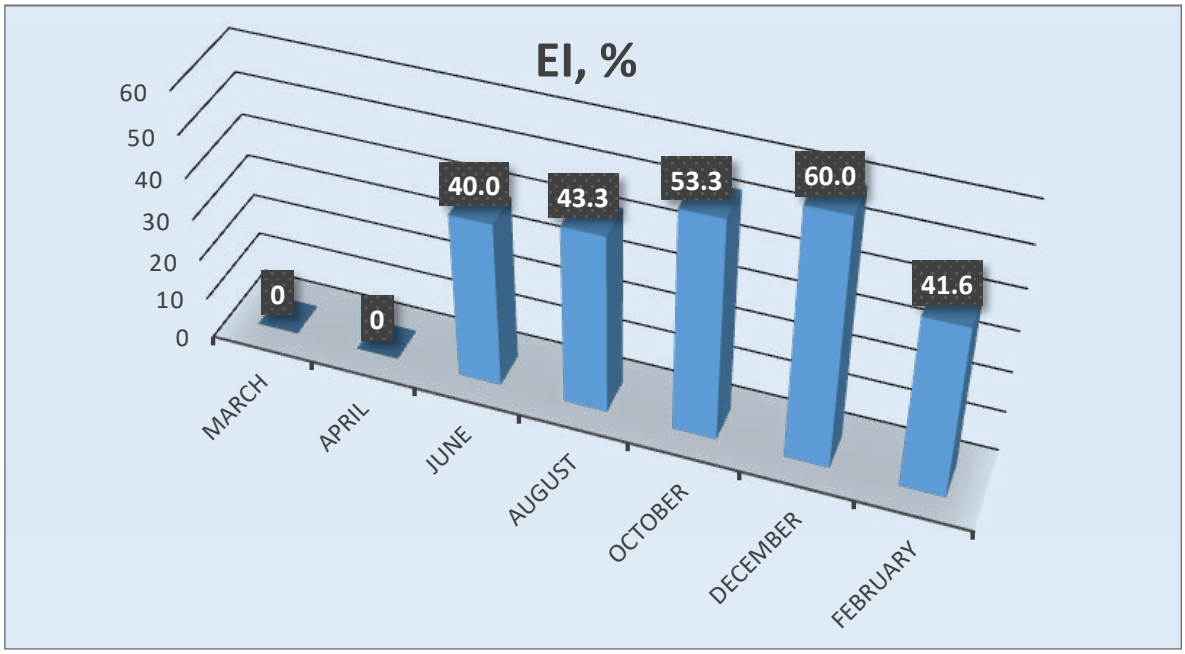

Fig. 2. Seasonal prevalence of fascioliasis in buffaloes of the Dagestan lowlands (coproscopy results)

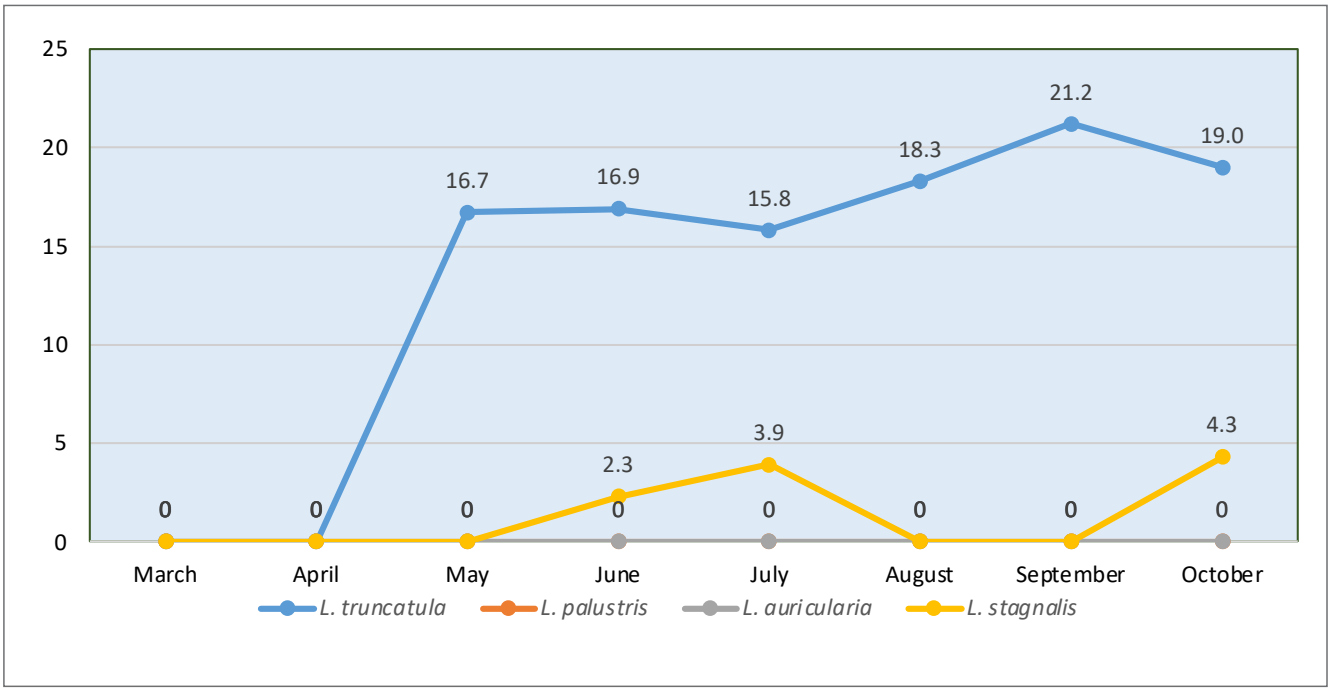

Fig. 3. Prevalence of F. hepatica infection in lymnaeid snails, March – October 2023 (%)

morphometry: surface areas started from 4 m², the substrate consisted of silty sediments, and the water column depth ranged from 3 to 25 cm. Various species of aquatic invertebrates and other freshwater inhabitants were found in these hollows. The dwarf pond snail was a predominant species among them. Its population density ranged from 50 to 70 mollusks per 1 m². The vegetation of these wet hollows was dominated by *Elytrigia repens*, *Plantago lanceolata*, and several sedge species of the genus *Carex*.

The presence of grazing livestock in the area was confirmed by direct observation of fresh hoofprints and feces. The proximity to saturated soils and streams caused animal hoofprints to fill with water, forming persistent puddles. In these microhabitats, the population density of the dwarf pond snail reached or exceeded 60 individuals per 1 m². Other mollusk species were also present within the same puddles.

In areas of peak mollusk concentration, measured parameters showed neutral to slightly alkaline conditions (pH 7.0–7.7 in water and soil, via litmus paper), with water temperature (17–22 °C) closely tracking air temperature due to the shallow nature of the water bodies.

The investigation of the malacofauna in pasture-associated aquatic habitats confirmed the presence of snail intermediate hosts of fasciola. Among all lymnaeid snails examined, only *L. truncatula* and *L. stagnalis* were found harboring larval stages of *F. hepatica*. Other lymnaeid species were not infected by these trematodes. The results are shown in Figure 3.

In rare instances, echinostomatid larvae were detected. These were distinguished from fasciola larvae by their greater motility and larger size.

From May to October, we recorded infection of dwarf pond snails with rediae and cercariae of *Fasciola* spp. This finding indicates that larval stages can partially overwinter within the mollusk host. The highest intensity of infection of the dwarf pond snail was observed in September.

Our data established that the population density of the dwarf pond snail in floodplain biotopes peaks during August and September. This period of peak snail density coincides with the highest prevalence of *F. hepatica* larval infection in the snails, creating optimal conditions for the environmental persistence and transmission of fascioliasis.

CONCLUSION

A direct positive correlation was confirmed between buffalo age and fasciola infection prevalence. In adult animals, the EI is 48.3%, and the II is 2.8 times higher than in young animals.

The studies demonstrated a clear age-dependent trend, with infection prevalence increasing significantly in older animal cohorts. In < 1 year old calves the EI was 18.3%, the II was (58.6 ± 9.9) individuals per animal; in < 2 years old animals the EI was 23.3%, the II was (88.5 ± 9.2) individuals per animal; in < 5 years old buffaloes the EI was 36.7%, the II was (127.6 ± 8.7) individuals per animal; in > 5 years showed 48.3% EI, the II was (166.4 ± 9.3) individuals per animals.

Post-mortem examination of livers from 20 buffaloes revealed fasciola infection in 9 animals, corresponding to a prevalence of 45.0%. However, in young animals < 1 year of age, the infection rate was only 20.0%, while in buffaloes over 5 years of age, this figure reached 60.0%. Moreover, the II increased with age, reaching maximum values in adult animals (on average (132.4 ± 9.8) individuals per animal). Adult buffaloes grazing in lowland areas demonstrated a consistently high intensity of infection by *F. hepatica* larvae throughout the year. This trend is primarily driven by a cumulative effect – fasciola parasites accumulate within the host over time, leading to higher prevalence and intensity in older animals.

Seasonal monitoring revealed a complete absence of fasciola parasites in buffalo during the early spring months of March and April. In June and August, the average parasitic burden per animal was (19.7 ± 2.1) and (21.8 ± 2.4). Infection intensity with the liver fluke increased significantly from August to October, peaking at (49.6 ± 3.5) parasites per animal. This seasonal peak likely corresponds to the period of highest abundance of the intermediate snail hosts in the pastures. The peak of infection intensity in buffalo was recorded in December, with a mean burden of (67.1 ± 6.4) parasites per animal.

The highest densities of lymnaeid snails were associated with specific lentic habitats: stagnant or slow-flowing reservoirs, abandoned irrigation channels, seasonal puddles, and small ponds prone to summer drying. These areas are inhabited by many species of mollusks, including the dwarf pond snail (*L. truncatula*), whose population density reached 70 individuals per 1 m^2.

Monitoring of larval trematode infections in four lymnaeid species – *L. palustris*, *L. stagnalis*, *L. auricularia* and *L. truncatula* revealed that only the dwarf and great pond snail harbored fasciola larvae. The other three species showed no evidence of infection with this parasite. In some instances, echinostomatid larvae were detected. These were distinguished from fasciola larvae by their greater motility and elongated shape.

REFERENCES

1. Ksenofontov M. Yu., Poskachei M. A., Sapova N. N., Kozin D. E. Scenario forecasting as an agricultural strategy development instrument. *Studies on Russian Economic Development*. 2008; 19 (5): 439–451. https://elibrary.ru/ylospj (in Russ.)

2. Maslova V., Schastlivtseva L., Tyapkin N. Regulating the market of animal farming produce. *AIC: economics, management*. 2007; (8): 46–50. https://elibrary.ru/iaucnl (in Russ.)

3. Kononova T. A., Naumov M. M., Stasenkova Y. V., Leonidova Y. P. Epizootological characteristics of the development of fascioliasis of ruminants. *Molodezhnaya nauka – razvitiyu agropromyshlennogo kompleksa: materialy IV Mezhdunarodnoi nauchno-prakticheskoi konferentsii studentov, aspirantov i molodykh uchenykh (Kursk, 15 noyabrya 2023 g.)* = *Science for early-carrier researchers to develop agro industrial sector: Proceedings of IV International Scientific and Practical Conference of students, post-graduate students and young-career researchers (Kursk, November 15, 2023)*. Kursk: Kursk SAU; 2024; 398–402. https://elibrary.ru/vfdawu (in Russ.)

4. Bespalova N. S., Grigoryeva N. A., Vosgorkova E. O. Pastbishchnye gel'mintozy krupnogo rogatogo skota v Tsentral'nom Chernozem'e Rossii = Pasture-acquired helminth infections in cattle from the Central Chernozem Region of Russia. *Tavricheskii nauchnyi obozrevatel'*. 2016; (5): 271–273. https://elibrary.ru/wckxyn (in Russ.)

5. Lopatina O. M. Fascioliasis of cattle: a dangerous zoonosis. *Vestnik of Voronezh State Agrarian University*. 2009; (2): 53–56. https://elibrary.ru/levoxl (in Russ.)

6. Gorokhov V. V., Klenova I. F., Puzanova E. V. Prevalence of *Fasciola* infection among cattle at the territory of Russia according to statistics in 2012–2016. *Theory and Practice of Parasitic Disease Control*. 2018; 19: 142–145. https://elibrary.ru/ytegcd (in Russ.)

7. Huklaeva M. G. Epizootology of fasciolosis of ruminant in Chechen Republic. *Russian Journal of Parasitology*. 2009; (4): 63–66. https://elibrary.ru/ladvez (in Russ.)

8. Kabardiev S. Sh., Bittirov A. M., Aliev A. Yu., Aigubova S. A. Fasciolous invasion as a sanitary and hygienic threat to the population and animal husbandry in the subjects of the Caspian Region of Russia. *Hygiene and Sanitation*. 2023; 102 (2): 121–125. https://doi.org/10.47470/0016-9900-2023-102-2-121-125 (in Russ.)

9. Fiapsheva A. B., Malkandueva M. I., Chilayev S. Sh. Biogeografiya i ekologiya trematod roda fasciola u krupnogo rogatogo skota v gornoi zone Kabardino-Balkarskoi Respubliki = Biogeography and ecology of fasciola nematodes in cattle of Kabardino-Balkaria mountainous zone. *Bulletin of KrasSAU*. 2008; (5): 254–256. https://elibrary.ru/jwuwzb (in Russ.)

10. Datchenko O. O., Titov N. S., Ermakov V. V. Vliyanie fastsioleza na veterinarno-sanitarnye kachestva produktov uboya krupnogo rogatogo skota = Effects of bovine fascioliasis on veterinary-sanitary quality of slaughter by-products. *Bulletin Samara State Agricultural Academy*. 2018; 3 (2): 32–35. https://elibrary.ru/xpborv (in Russ.)

11. Musaev M. B., Khalikov M. S. Method for application of triclabendazole complex "Triclafascid" for treatment and prevention of fascioliasis in farm animals. *Theory and Practice of Parasitic Disease Control*. 2023; 24: 331–336. https://doi.org/10.31016/978-5-6048555-6-0.2023.24.331-336 (in Russ.)

12. Durdusov S. D., Lazarev G. M. The epidemiology of parasitic diseases in ruminants from the arid zones of southern Russia. Elista: Dzhangar; 1999. 320 p. (in Russ.)

13. Bittirov A. M., Shemyakova S. A., Laipanov B. K., Bolatchiev K. Kh., Arkelova M. R., Bittirov I. A. Fasciolesis in the subjects of the North Caucasus as a probable biological, epidemiological and epizootic threat to the population and animal husbandry. *Veterinary, animal science, and biotechnology*. 2021; (7): 63–71. https://elibrary.ru/yvrrco (in Russ.)

14. Bittirov A. M., Kagermazov Ts. B., Kalabekov A. A., Bittirova A. A., El'darova L. Kh., Musaev Z. G. Commonality and the number of species of helminths of humans and animals in the North Caucasus. *Agrarian Russia*. 2015; (12): 40–41. https://doi.org/10.30906/1999-5636-2015-12-40-41 (in Russ.)

15. Bittirov A. M. Parasitic zoonoses as a global and local problem of sanitation and hygiene over the world and in the Russian Federation. *Hygiene and Sanitation*. 2018; 97 (3): 208–212. https://elibrary.ru/urpuyv (in Russ.)

16. Cherkesov S. B., Oshchunov A. K. Seasonal and age dynamics of *Dicrocoelium lanceatum* and *Fasciola* spp. infection of yaks in the Kabardino-Balkarian Republic. *Theory and Practice of Parasitic Disease Control*. 2009; 10: 416–418. https://vniigis.ru/1_dlya_failov/TPB/Vniigis_2009_konferenciya.pdf (in Russ.)

17. Shikhaliyeva M. A., Atabieva J. A., Kolodiy I. V., Bittirov A. M., Sarbasheva M. M., Bichieva M. M.,

Bittirov A. M. Structure of the plains of belt parasitocenosis North Caucasus Region. *Russian Journal of Veterinary Pathology*. 2012; (2): 109–113. https://elibrary.ru/pbgbul (in Russ.)

18. Atabieva J. A., Bichieva M. M., Kolodij I. V., Bittirov A. M., Shikhaliyeva M. A., Sarbasheva M. M., Zhekamuhova M. Z. Prediction epizootic and epidemic situation zoonotic invasion in Southern Russia. *Russian Journal of Veterinary Pathology*. 2012; (1): 119–122. https://elibrary.ru/oyrsbz (in Russ.)

19. Rekhviashvili E. I. Reproductive capacity of *Fasciola* spp. in the ruminant host. *In: Ecological parasitology*. Ivanovo; 1998; 23–24. (in Russ.)

20. Huklaeva M. G., Ataev A. M., Akhmedrabadanov Kh. A. Zarazhennost' domashnikh i dikikh zhivotnykh fastsiolami v Chechenskoi Respublike = *Fasciola* spp. prevalence in domestic and wild animals in the Chechen Republic. *Theory and Practice of Parasitic Disease Control*. 2007; 8: 378–379. (in Russ.)

21. Sarbasheva M. M., Bittirov A. M., Ardavova Zh. M., Aripsheva B. M., Bittirov A. M. Improvement of sanitary-parasitologic conditions of objects of environment in Kabardino-Balkarian Republic. *Russian Journal of Parasitology*. 2010; (4): 98–100. https://elibrary.ru/neetlx (in Russ.)

22. Atabieva Zh. A., Bittirova A. A., Sarbasheva M. M., Shikhaliyeva M. A., Bittirov A. M., Zhekamukhova M. Z., et al. Ecological and species composition of the fauna endoparasites and epidemiological characteristics zoonoses in Kabardino-Balkaria. *Belgorod State University Scientific Bulletin. Medicine. Pharmacy series*. 2012; 10: 142–146. https://elibrary.ru/pjmkxv (in Russ.)

23. Kabardiev S. Sh., Bittirov A. M., Karpushchenko K. A., Shapiev B. I. Ecological and epizootic analysis of ruminant fasciolosis in the conditions of trans-humance grazing in the subalpine belt of the Kabardino-Balkarian Republic. *Perm Agrarian Journal*. 2024; (3): 98–103. https://elibrary.ru/xkwdwk (in Russ.)

24. Uyanaeva F. B., Bittirov A. M. Epizootic process of fasciolesis of the Caucasian buffalo population during different seasons under the conditions of the plain zone of Kabardino-Balkarian Republic. *Izvestiya of the Kabardino-Balkarian State Agrarian University named after V. M. Kokov*. 2018; (4): 106–109. https://elibrary.ru/zdsjxn (in Russ.)

25. Gorochov V. V., Skira V. N., Klenova I. F., Volichev A. N., Pechkov R. A., Samoilovskaya N. A., et al. Modern epizootic situation on the main helminthoses of agricultural animals in Russia. *Theory and Practice of Parasitic Disease Control*. 2013; 14: 121–127. https://elibrary.ru/zqpjsb (in Russ.)

26. Ustinov A. M., Safiullin R. T., Safiullin R. R. Methodical guidelines on the control of fasciolosis in cattle in the Kaluga region. *Russian Journal of Parasitology*. 2018; 12 (2): 108–116. https://doi.org/10.31016/1998-8435-2018-12-2-108-116 (in Russ.)

27. Lopatina O. M., Bespalova N. S. The distribution of fascioliasis of cattle in the Voronezh Region. *Russian Journal of Veterinary Pathology*. 2009; (1): 53–54. https://elibrary.ru/oczdgt (in Russ.)

28. Arisov M. V. Contamination of cattle fasciolosis and paramphistomosis on territories of the Nizhniy Novgorod area, economic damage and therapy. *Russian Journal of Veterinary Pathology*. 2007; (2): 168–175. https://elibrary.ru/oezjst (in Russ.)

29. Vasilevich F. I., Shemyakova S. A. Distribution of fascioliasis of cattle depending on climatic conditions in Moscow Region. *Russian Veterinary Journal. Productive animals*. 2016; (4): 17–19. https://elibrary.ru/xeahsh (in Russ.)

30. Bichieva M. M., Dzhabayeva M. D., Sarbasheva M. M., Bittirov A. M. Dynamics age-qualification and seasonal infection buffalos trematodis *Fasciola hepatica* L., 1758 the planar zone Kabardian-Balkarian. *Theory and Practice of Parasitic Disease Control*. 2009; 10: 452–457. https://vniigis.ru/1_dlya_failov/TPB/Vniigis_2009_konferenciya.pdf (in Russ.)

31. Kryukova N. A., Yurlova N. I., Rastyagenko N. M., Antonova E. V., Glupov V. V. The influence of *Plagiorchis mutationis* larval infection on the cellular immune response of the snail host *Lymnaea stagnalis*. *Journal of Parasitology*. 2014; 100 (3): 284–287. https://doi.org/10.1645/13-214.1

32. Rastyazhenko N. M., Vodyanitskaya S. N., Yurlova N. I. The emission of plagiorchis multiglandularis cercariae from naturally infected snails lymnaea stagnalis in Chany lake, south of West Siberia. *Parazitologiya*. 2015; 49 (3): 190–199. https://elibrary.ru/twfhbz (in Russ.)

33. Vorontsova Y. L., Slepneva I. A., Yurlova N. I., Ponomareva N. M., Glupov V. V. The effect of trematode infection on the markers of oxidative stress in the offspring of the freshwater snail *Lymnaea stagnalis*. *Parasitology Research*. 2019; 118 (12): 3561–3564. https://doi.org/10.1007/s00436-019-06494-5

34. Romashov B. V., Romashova N. B. First intermediate host *Alaria alata* (*Trematoda*, *Strigeidida*) in the natural conditions of the Central Black Earth Region. *Theory and Practice of Parasitic Disease Control*. 2020; 21: 337–340. https://doi.org/10.31016/978-5-9902341-5-4.2020.21.337-340 (in Russ.)

35. Golubyov A. A., Mazikhova A. M., Kazanchev M. Kh., Tolgurov M. A., Bittirov A. M. Ecology of the fresh-water mollusks the Kabardian-Balkarian Republic. *Theory and Practice of Parasitic Disease Control*. 2009; 10: 457–462. https://vniigis.ru/1_dlya_failov/TPB/Vniigis_2009_konferenciya.pdf (in Russ.)

36. Israpov I. M., Abdulmedzhidov A. A., Gapisova U. A. Freshwater mollusks in Dagestan. Makhachkala: Dagestan State Pedagogical University; 2008. 154 p. (in Russ.)

Received 30.06.2025
Revised 19.08.2025
Accepted 13.11.2025

INFORMATION ABOUT THE AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

Sadrutdin Sh. Kabardiev, Dr. Sci. (Veterinary Medicine), Chief Researcher, Head of the Laboratory for the Study of Invasive

Кабардиев Садрутдин Шамшитович, д-р вет. наук, главный научный сотрудник, заведующий лабораторией

Diseases of Farm Animals and Poultry, Caspian Regional Research Veterinary Institute – Branch of Dagestan Agriculture Science Center, Makhachkala, Republic of Dagestan, Russia; *https://orcid.org/0000-0001-6129-8371, pznivi05@mail.ru*

Karine A. Karpushchenko, Cand. Sci. (Veterinary Medicine), Leading Researcher, Laboratory for the Study of Invasive Diseases of Farm Animals and Poultry, Caspian Regional Research Veterinary Institute – Branch of Dagestan Agriculture Science Center, Makhachkala, Republic of Dagestan, Russia; *https://orcid.org/0000-0003-4639-241X, pznivi@mail.ru*

по изучению инвазионных болезней сельскохозяйственных животных и птиц Прикаспийского зонального НИВИ – филиала ФГБНУ «ФАНЦ РД», г. Махачкала, Республика Дагестан, Россия; *https://orcid.org/0000-0001-6129-8371, pznivi05@mail.ru*

Карпущенко Карине Альбертовна, канд. вет. наук, ведущий научный сотрудник лаборатории по изучению инвазионных болезней сельскохозяйственных животных и птиц Прикаспийского зонального НИВИ – филиала ФГБНУ «ФАНЦ РД», г. Махачкала, Республика Дагестан, Россия; *https://orcid.org/0000-0003-4639-241X, pznivi@mail.ru*

Contribution of the authors: Kabardiev S. Sh. – investigation, formal analysis, original drafting; Karpushchenko K. A. – visualization, review and editing.

Вклад авторов: Кабардиев С. Ш. – сбор и анализ информации и результатов эксперимента, написание статьи; Карпущенко К. А. – составление таблиц и графического материала, написание и редактирование текста статьи.