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PECULIARITIES OF ECOLOGY AND AEROBONE RESPIRING OF NEMATODES OF THE SPECIES DICTYOCAULUS FILARIA PARASITES OF RUMINANTS

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Summary

Nematodes of the species Dictyocaulus filaria parasitize in the lungs of ungulates, negatively affect the host organism, affecting the metabolism. The cycle of development of the considered nematodes occurs in a direct way, i.e. without the intervention of an intermediate host. The contact of invasive elements with the final host occurs through trophic channels within the "parasite-host" system. The age composition of the population of the genus Dictyocaulus consists of free-living and parasitic groups. Each group occupies a certain ecological niche in biocenoses. A high aerobic respiration of the nematode D. filaria was established in comparison with warm-blooded rats. The inhibitory analysis of nematode respiration allows us to note that the respiratory system of these organisms is largely focused on the consumption of amino acids and their dicarboxylic products. This circumstance is important for assessing the metabolic factor in the host-parasite relationship and the nature of the parasitism of the studied nematodes, one of the consequences of which may be the depletion of vital proteins and amino acids, as well as a decrease in the access of oxygen to the host organism.

Key words: *nematodes, ecology, aerobone, dicarboxylic, inhibitory analysis, respiratory system, biocenoses.*

Introduction. Nematode of the species *Dictyocaulus filaria* (Strongylida; Dictyocaulidae) parasitize in the respiratory tract of the lungs of ruminants, negatively affect the host organism, affecting the metabolism and leads to disruption of lipid-protein interactions in membrane cells [1-3]. The studied nematodes live mainly in the organs of the respiratory system of the final hosts - ungulates. They have adapted to parasitizing in oxygen-rich organs. The cycle of development of the considered nematodes occurs in a direct way, i.e. without the intervention of an intermediate host.

Helminths live in the host organism under different conditions of the oxygen regime - in anaerobic and aerobic conditions, which leads to different ways of energy production of parasites to ensure vital activity. Anaerobic helminths, which do not have a developed respiratory chain, use the enzymes phosphoenolpyruvate carboxykinase , fumarate reductase in energy metabolism . In this case, pyruvate is converted through oxaloacetate to fumarate, which is reduced to succinate with the help of fumarate reductase and provides ATP synthesis. The end product of the process is either succinate or propionate and volatile fatty acids. Other final pathways of anaerobic metabolism in

helminths are also possible [4]. There are also facultative helminths that can live in different oxygen regimes and have aerobic and anaerobic ATP synthesis pathways [5].

The study of helminths capable of life under aerobic conditions showed the presence in their tissues of mitochondrial structures and enzymes of the Krebs cycle [6-8]. Helminths are characterized by the metabolism of not only carbohydrate substrates [6-8] but also amino acids [9]. Considering this information, we studied the respiration of helminths using inhibitors of aminotransferases and inhibitors of mitochondrial transport of anionic substrates, previously described in the literature [10].

In this context, studies were carried out on the features of the ecology and aerobic respiration of the nematodes *Dictyocaulus filaria,* the results of which deserve special attention.

Materials and methods. Sexually mature and larval specimens of the nematode *Dictyocaulus filaria*, which are parasites of sheep, goats and cattle, served as the object of the study. At the same time, during 2018-2022 years, 58 sheep and 32 cattle were examined with well-known methods of helminthology, belonging to farms in the Namangan and Kashkadarya regions of Uzbekistan, as well as cattle slaughterers in the city of Tashkent.

When studying the ecology of parasites, we were guided by the work [11, 12].

To determine the aerobic respiration of the nematode *Dictyocaulus filaria* used the polarography method. The equipment used was based on a generally accepted scheme and included a KSP.4 recorder and a power supply. A closed Clark electrode was used as the polarography electrode.

In the experiments, freshly extracted from the lungs of sheep nematodes *D.filaria* were used, which were immediately placed in Eagle's medium. Then, several specimens, with a total weight of up to 30 mg, were transferred to a polarographic cell with Eagle's medium. The cell was hermetically sealed with a Clark electrode and incubated at 25º C, the intensity of oxygen consumption by intact nematodes was recorded according to the Chance and Williams method [13]. The needle medium used contained blood serum of small ruminants as an oxidation substrate.

After determining the intensity of respiration on the serum substrate of the control group of organisms (nematodes) without the use of blockers, one of the following blockers of enzyme-metabolic processes was added to the Eagle's medium: aminooxyacetate (aminotransferase inhibitor) - (1 mM); α - cyano-4-hydrosicinnamate (an inhibitor of pyruvate transport into mitochondria) - 1mM; butylmalonate (an inhibitor of dicarboxylates in mitochondria) - 1mM; 1,2,3-benzyl tricarboxylate (tricarboxylate inhibitor) - 1 mM. When using the indicated concentrations of blockers, we proceeded from the literature [14].The results obtained were processed by the calculation criterion of Chance, Williams [13] and the method of vibrational statistics according to Student -Fisher.

Results. The results of the conducted studies allow us to state that the age structure of the population of the species *Dictyocaulus filaria* consists of sexually mature forms: males and females and larval forms - larvae of stages I, II and III. The habitat of sexually mature individuals is the lungs of animals and larvae of the first, second and third stages - the external environment. The age structure of the population of dictyocaul species consists of free-living and parasitic groups (Table 1). Each group occupies a specific ecological niche in biogcenoses.

The considered nematodes have a pronounced sexual dimorphism. They are clearly separated into males and females. Sexual maturation and the onset of maturity

of males and females of dictyocaul take 29-44 days [15]. Females lay eggs in the lumen of the bronchi, from which larvae of the 1st stage hatch, emerging with the excrement of the definitive host into the external environment, where they molt twice and become invasive after 5 or more days. They develop without an intermediate host. Infection of animals occurs by ingestion of invasive larvae with water and grass. This ensures multiple inseminations of females and the birth of a large number of offspring. When examining the lungs of experimentally infected sheep, the presence of males and females of dictyocaul in the host's body varied between 1:5 and 1:7 (Table 1). At the peak of invasion, the number of nematodes in one host reaches 300 or more specimens.

Table 1. Population structure of the nematode *Dictyocaulus filaria*

Form of existence	Population status	Location	
		Hosts	In the external environment
Imago	parasitic	+	-
I stage larvae	free-living	+	+
Larvae II stage	free-living	-	+
III stage larvae	free-living	-	+

The population size of parasitic and free-living generations is regulated by endogenous and exogenous factors. The growth of free-living populations of the considered system is suppressed by abiotic environmental factors. The number of parasitic populations depends on endogenous factors. However, the response of the parasite to survive in extreme environmental conditions should also be taken into account. The functioning of the "parasite-host" system becomes possible as a result of the stabilization of relationships between partners. The implementation of parasite-host relationships is carried out by populations of species, as well as components of aquatic and terrestrial ecosystems.

Discussion. The obtained results showed that *D. filaria* have high aerobic respiration. When recalculated for 1 g the mass of nematodes, the intensity of their respiration reached 3.32 ml O2/hour, which exceeds the intensity of oxygen consumption by warm-blooded animals (rats). This feature is primarily associated with the habitation of this object in oxygen-enriched conditions (in the lungs).

It has been established that the pyruvate transport blocker (α-cyano-4-hydroxycinamate, CHST) has little effect on the respiratory activity of the studied nematodes, and the blocker of tricarboxylic acids (1,2,3 - benzyl tricarboxylate, BTK) reduces it to 8% (table 2, fig. 1). A more pronounced decrease in the intensity of respiration of nematodes was found with the use of butylmalonate (BM) and aminooxyacetate (AOA), the action of which had a similar effectiveness in suppressing respiration (up to 35%).

The inhibitory analysis of nematode respiration, taking into account the literature [16], allows us to note that the respiratory system of these organisms is largely focused on the consumption of amino acids and their dicarboxylic products. This circumstance is important for assessing the metabolic factor in the "parasite-host" relationship and the nature of parasitization of the studied nematodes, one of the consequences of which may be the depletion of vital proteins and amino acids, as well as a decrease in the access of oxygen to the host organism.

Table 2. The effect of energy system blockers on the respiratory activity of *Dictyocaulus filaria*

Variants of experiments with blockers	Number of experiments	Respiratory activity ng,at.min/mg raw tissue	Respiratory activity, O_2 ml.h	% of residual breath
Control	6	99.57 ± 08.14	3.327±0.26	-
Aminooxyacetate	10	65.47 ± 05.31	2.187 ± 00.18	65.7
Alpha - cyano - 4-hydroxycin-namate	8	97.27 ± 09.7	3.247±0.32	97.6
Butylmalonate	6	68.087 ± 05.2	2.277±0.17	68.4
1,2,3-benzylcar-boxylate	6	92.047 ± 08.0	3.077±0.27	92.5

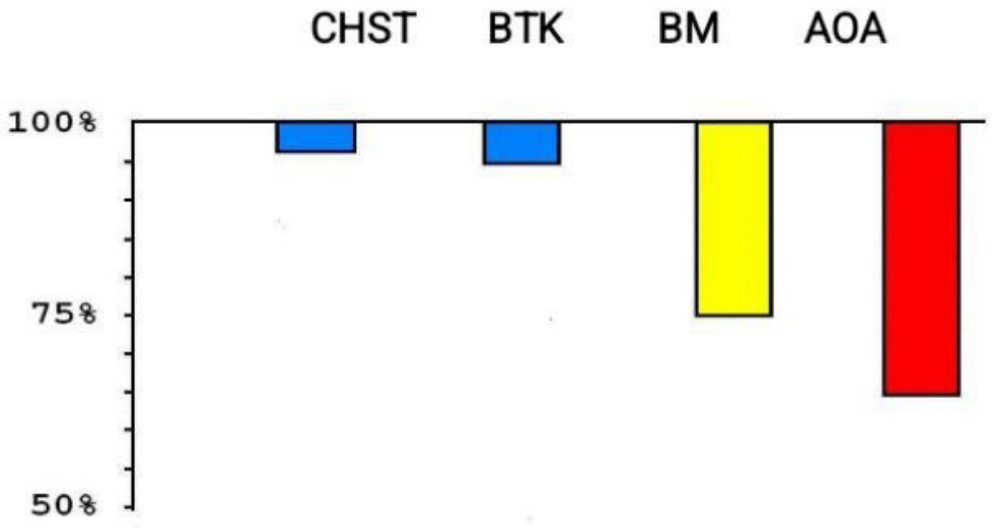

Figure 1. *The degree of decrease in the respiratory activity of nematodes under the influence of blockers of the energy system. Designations: CNST - a- cyano-4-hydrosicinnamate; BTK -1,2,3 - benzyl tricarboxylate; BM - butylmalanate; AOA - aminooxyacetate. 100% accepted control data (without inhibitors).*

Conclusion. Thus, populations of dictyocaulas enter into relationships with the components of a particular biocenosis. These relationships developed in the course of the evolution of the parasite-host system to ensure the vital requirements of the parasite and functional-energy connections with population systems of various levels: host organism (definitive) - nematode population - biocenosis - biogeocenosis. The most important characteristics of a dictyocaulid population are the life cycles and metabolic processes of the species in food chains, as well as the adaptive potential that contributes to the maintenance of population homeostasis. When these processes are implemented, the dynamic reproduction of the species under specific conditions and its participation in the cycle of substances in the ecosystem is carried out.

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Dictyocaulus filaria түрінің нематодтарының, күйіс қайыратын жануарлардың паразиттерінің экологиясы мен аэротермиялық тыныс алуының ерекшеліктері

Аңдатпа

Dictyocaulus filaria түрінің нематодтары тұяқты жануарлардың өкпесінде паразиттік тіршілік етеді, метаболизмге әсер ететін иесінің денесіне теріс

әсер етеді. Қарастырылып отырған нематодтардың даму циклі тікелей жолмен жүреді, яғни аралық иесінің қатысуынсыз. Инвазиялық элементтердің соңғы иесімен байланысы "паразит - иесі" жүйесіндегі трофикалық арналар арқылы жүреді. Dictyocaulus тұқымдасының популяциясының жас құрамы еркін тіршілік ететін және паразиттік топтардан тұрады. Әр топ биоценоздарда белгілі бір экологиялық тауашаны алады. Жылы қанды егеуқұйрықтармен салыстырғанда D. filaria нематодтарының жоғары аэробты тыныс алуы анықталды. Нематодтардың тыныс алуын ингибиторлық талдау бұл организмдердің тыныс алу жүйесі аминқышқылдары мен олардың дикарбон өнімдерін тұтынуға көп көңіл бөлетінін атап өтуге мүмкіндік береді. Бұл жағдай "паразит-иесі" қатынастарындағы метаболикалық факторды және зерттелетін нематодтардың паразиттену сипатын бағалау үшін маңызды, оның салдары өмірлік маңызды ақуыздар мен аминқышқылдарының сарқылуы, сондай-ақ иесінің ағзасына оттегінің азаюы болуы мүмкін.

Түйінді сөздер: *нематодтар, экология, аэробты тыныс алу, дикарбон қышқылы, ингибиторлық талдау, тыныс алу жүйесі, биоценоз.*

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Особенности экологии и аэротермального дыхания нематод вида Dictyocaulus filaria, паразитов жвачных животных

Аннотация

Нематоды вида Dictyocaulus filaria, паразитируют в легких копытных животных, негативно воздействуют на организм хозяина, влияя на обмен веществ. Цикл развития рассматриваемых нематод происходит прямым путем, т.е. без участия промежуточного хозяина. Контакт инвазионных элементов с окончательным хозяином происходит через трофические каналы в рамках системы «паразит - хозяин». Возрастной состав популяции рода Dictyocaulus состоит из свободноживущих и паразитических групп. Каждая группа занимает в биоценозах определенную экологическую нишу. Установлено высокое аэробное дыхание нематоды D.filaria по сравнению с теплокровными крысами. Проведенный ингибиторный анализ дыхания нематод позволяет отметить, что дыхательная система этих организмов в большей степени ориентирована на потребление аминокислот и их дикарбоновых продуктов. Это обстоятельство важно для оценки метаболического фактора во взаимоотношениях "паразит-хозяин" и характера паразитирования исследуемых нематод, одним из следствий которого может явиться истощение жизненно важных белков и аминокислот, а также снижение доступа кислорода в организм хозяина.

Ключевые слова: *нематоды, экология, аэробное дыхание, дикарбоновая кислота, ингибиторный анализ, дыхательная система, биоценоз.*

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