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# INTERSPECIFIC AND INTRASPECIFIC RELATIONSHIPS OF GREAT CORMORANT'S NEMATODE *CONTRACAECUM RUDOLPHII* IN PAVLODAR REGION

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***Summary***

*The size of helminths is substantially influenced by interspecific interactions. There are around 90 copies present. The presence of Contracecums in the intestine of a single cormorant individual resulted in a significant reduction in the overall size of the nematodes. When cestodes are present, Contracecums undergo brachymorphic changes, which can be seen as an adaptation to maintain fertility while minimising energy expenditure. The ratio of parasite abundance in the host to parasite size might vary based on the specific parameters of the host-parasite interaction. The size of the parasite can be regulated by multiple factors associated with the parasite population within the host.*

***Keywords***: *parasite, host,* Contracaecum rudolphii, *great cormorant, interspecific interactions of helminths.*

**Introduction.** The investigation of the relationships between parasites and their hosts is gaining significance in the present period, particularly in the realms of biodiversity conservation and safeguarding the well-being of both wildlife and humans. Interactions between different species, particularly parasites and their hosts, are a significant focus of study in the fields of biology and medicine. The worm *Contracaecum rudolphii Hartwich, 1964*, which is a parasite of the great cormorant, serves as a valuable model for investigating these interactions in this particular environment.

Despite recent research on the morphology and ecology of the nematode *Contracaecum rudolphii* [1-3] and its interactions with the host [4], there is still a significant need for a more comprehensive understanding of the interspecific relationships between this parasite and its host in specific regions. Studies conducted on other kinds of parasites and their hosts have demonstrated the adaptations that parasites evolve to ensure their effective survival within their hosts, as well as the changes that occur in the hosts' bodies as a result of the parasites' presence. Specimens of *Contracaecum osculatum* were measured, revealing a decline in the average length of worms in correlation with high worm densities in cod, as indicated by the number of nematodes per liver [5]. A series of laboratory experiments investigated the impact of intraspecific competition on the growth and reproductive abilities of the parasitic nematode *Phasmarhabditis hermaphrodita*. The findings revealed that intraspecific competition has a detrimental effect on the fertility and overall quality of *P. hermaphrodita*. Additionally, the nematode is capable of partially avoiding overcrowding by actively avoiding areas that are already occupied [6].Studying the interspecific relationships of parasites helps to understand the evolutionary mechanisms underlying the formation of biodiversity.

This study aims to investigate the interspecific connections of the nematode *Contracaecum rudolphii* found in the great cormorant in the Pavlodar region. The study specifically aims to estimate the parasite's size based on the number of individuals it has within a single host. Furthermore, the research aims to ascertain the precise biological characteristics of the nematode, its ability to adapt to life within the host, and its associations with other parasite species. This will provide a more comprehensive comprehension of the mechanisms governing interactions within the natural parasite-host system.

The nematode *Contracaecum rudolphii* is a prevalent parasite commonly found in birds, particularly great cormorants. The interactions between this nematode and its host constitute a fascinating subject of study in the disciplines of parasitic disease epidemiology and bird ecology. These investigations will not only enhance the current data on the links between the nematode *Contracaecum rudolphii* and the great cormorant, but will also improve our understanding of the ecoepidemiology of parasitic disorders in birds in this area. Furthermore, they can be valuable in formulating strategies to manage and mitigate parasitic infestations, not only in natural habitats but also in agricultural environments where cormorants can serve as a reservoir for infestations affecting other avian and aquatic species.

**Material and methods.** Using the method of complete helminthological dissection, 200 individuals of the great cormorant were studied, shot in August-September in the Pavlodar region (Kazakhstan) near the lakes Auelikol, Shiganak, Karasor, Kirpichnoe.

Lake Auliekol covers an area of 910 hectares and is situated in the Ekibastuz district of the Pavlodar region in North-Eastern Kazakhstan. Its coordinates are 52° 11'03.4"N 74°46'04.9"E. The lake has a width of 3.1 km and a length of 3.81 km.

Lake Shiganak is situated in the Aktogay district of the Pavlodar region in North-Eastern Kazakhstan. It covers an area of 1280 hectares and has a length of 4.6 kilometres and a width of 5.1 kilometres.

Lake Karasor is situated in the Maysky district of the Pavlodar region in North-Eastern Kazakhstan. It has coordinates of 51°04'48.8"N 77°29'33.3"E and covers an area of 4430 hectares. The lake is 11 km wide and 6.27 km long.

Lake Kirpichnoe is situated in the Ertis district of the Pavlodar region in North-Eastern Kazakhstan. Its coordinates are 53° 46'15.0"N 74°58'18.0"E. The lake has an area of approximately 1.5 hectares, with a width of 255 metres and a length of 104 metres.

Collection, fixation and office processing of parasitological material were carried out according to standard methods [7-8]. Identification of helminths was carried out on the basis of keys and original descriptions [9-12] in accordance with WoRMS data [13].

When identifying parasites, we used the equipment of the Scientific Center for Biocenology and Environmental Research of Pavlodar Pedagogical University. A.Margulan using two types of microscopes: the MBS-100 Biolab, which is a trinocular stereoscopic microscope, and the MX-100T, which is a trinocular microscope made by West Medica.

To study the interspecific and intraspecific relationships of helminths using the method of morphometric analysis and sex ratio in nematodes, measurements were taken of all individuals of Contracaecum rudolphii in material from 6 birds. Hemipopulations of nematodes were selected so that they differed in the number of simultaneously parasitizing contracecums, as well as the presence or absence of ligulid cestodes.

Statistical processing of quantitative data was carried out using standard methods [14-18].

**Results and discussion.** A study was conducted on the interspecific relationships of helminths in cormorants. This study involved analysing the morphology of six different hemipopulations. Three of these hemipopulations consisted only of nematodes, while the other three comprised adult cestodes. *Ligula interrupta* is a species of parasite first described by Rudolphi in 1810. (Table 1).

When discussing the factors that affect the size of helminths (*Contracecums*) in cormorants, it is important to acknowledge that the interactions between different species of helminths have a notable and meaningful impact. The presence of a significant number of roundworms in Lake Auliekol leads to an observable phenomenon where the nematodes hinder each other's growth. This is evident in the size of the nematodes found in cormorant No. 2, which had the highest number of helminths (89 specimens).

Table 1. Quantitative ratio of helminths in model hemipopulations

| **The specimen number (according to the observation journal)** | **Helminths, number of specimens** | |
|---|---|---|
| | ***Contracaecum rudolphii*** | ***Ligula interrupta*** |
| 1 (1) | Total - 70 | |
| | Mature males – 29 | |
| | Mature females – 41 | |
| 2 (2) | Total – 89 copies. | |
| | Mature males – 27 | |
| | Mature females – 51 | |
| | Immature males – 1 | |
| | Immature females – 10 | |
| 3 (3) | Total – 48 copies. | |
| | Mature males – 22 | |
| | Mature females – 23 | |
| | Immature males - 0 | |
| | Immature females – 3 | |
| 4 (51) | Total – 87 copies. | 1 |
| | Mature males –11 | |
| | Mature females – 22 | |
| | Immature males – 19 | |
| | Immature females – 35 | |
| 5 (53) | Total – 33 copies. | 2 |
| | Mature males – 9 | |
| | Mature females – 22 | |
| | Immature males – 0 | |
| | Immature females – 2 | |
| 6 (52) | Total – 34 copies. | 2 |
| | Mature males – 9 | |
| | Mature females – 19 | |
| | Immature males – 1 | |
| | Immature females – 5 | |

cormorant No. 2, which had the highest number of helminths (89 specimens). Among these, the majority (78 specimens) were sexually mature. In this particular subset of the population, there are observed reductions in both the minimum sizes of males and females, as well as decreases in both length and width. The other characteristics vary in direct proportion to the reduction in the overall body size of the worms. The size limits (minimum and maximum) of the male and female *Contracecum* in cormorant No. 2 decrease, showing a considerable range of variance.

At the same time, the presence of 70 copies. sexually mature nematodes (in bird No. 1) are provided by several larger helminths of both sexes. The parameters increase even moresignificantly in bird No. 3, in the intestines of which 48 specimens were noted nematodes, of which 45 were sexually mature (Tables 2, 3).

In certain subpopulations of cormorant contraceums from Lake Kirpichnoe, helminths exhibit an increase in their width (either absolute or relative) in proportion to their relatively modest body length. Simultaneously, the largest measurements of length and width in female birds were seen in bird No. 4 (51), which had a total of 87 helminth specimens, although only 33 of them were fully developed. The nematodes collected from bird No. 6 (52) exhibited notable dimensions, with 28 out of 34 contracecums being fully developed. In cormorant No. 5 (53), the male and female have minimal length, while the male has maximum width and the female has large width (nearly comparable to No. 51). The nematodes collected from Lake Kirpichnoe exhibited notable variations in the length of females' tails, both in absolute terms and relative to their body length. Additionally, the position of the vulva similarly varies among these nematodes. In Lake Auliekol, the distance from the head end of the body to the vulva in female contracecums was less than one-third of the body length, specifically ranging from 30 to 32%. However, in Lake Kirpichnoe, this distance ranged from 33 to almost 40%.

The mean helminth abundance in cormorants from Lake Kirpichnoe did not result in significant interspecific competition. Furthermore, the existence of a substantial quantity of minuscule undeveloped larvae did not impact the size of fully grown adults. Presumably, the separation of parasites in various locations played a significant impact, as each location developed its own distinct morphological kind of contracecums. Although cormorants have the ability to migrate between different reservoirs, the contracecums, which are a type of biohelminth, remain linked to the reservoir. This is because they require intermediate hosts for their growth and accumulate in reservoir hosts.

It is important to note that no tapeworms were found in the intestines of cormorants in Lake Auliekol, however in Lake Kirpichnoe, tapeworms were detected in the intestines of cormorants, with a range of 1 to 4 specimens. The ligulids Ligula interrupta were of considerable size, measuring up to 20-25 cm in length. The introduction of interspecific antagonism may have contributed to a reduction in length without a corresponding fall in breadth. It is worth noting that the width of the body is crucial for the proper functioning of internal organs, particularly female fertility.

Helminths from Lake Kirpichnoe may have a brachymorphic shape and do not undergo a reduction in body width as they decrease in length. These body proportions are likely the most advantageous in challenging circumstances, such as competition between different species and within the same species due to parasites. Firstly, it is important to maintain a substantial width in order to guarantee that the nematode's body cavity has enough capacity to accommodate all the essential organs and reproductive products. Furthermore, in people with a brachymorphic structure, there is a decrease in the body surface area per unit volume. This results in a reduction of the detrimental effects caused by external factors such as the host's immune system and compounds generated by competing individuals of their own and alien species.

It should be noted that researchers - however, previously expressed a similar opinion about the higher adaptive capabilities of brachymorphic individuals in relation to cestodes (individuals with brachymorphic segments won, in which the length decreased without changing the width).

Several researchers have observed and studied the presence of varied body proportions in morphological forms of helminths, either by chance or with intent. The monograph authored by K.I. Skryabin and A.M. Petrov, titled "Fundamentals of Veterinary Nematodology" [20], presents visual representations of the long-tailed and short-tailed females, as well as the larvae, of the horse oxyurid species known as Oxyuris equi. Some authors have described the intraspecific variability in the cestodes Proteocephalus osculatus found in catfish and Proteocephalus percae found in perch. They observed that the proglottids, which are segments of the cestodes, can be categorised into two types: short and wide segments with a width much greater than their length, and elongated segments that are almost square in shape. Simultaneously, the evolutionary benefits of cestodes with a greater number of brachymorphic segments were highlighted. These benefits include the ability to adapt to a wide range of temperatures, resilience to unfavourable conditions, larger overall size (which corresponds to the huge size of the complete strobila), and increased fertility [21-22]. In their study, N.E. Tarasovskaya and G.K. Syzdykova classified the sifacies from mouse-like rodents into three morphological types: dolichomorphic, medium, mesomorphic, and brachymorphic. They specifically highlighted the greater fertility of brachymorphic nematodes [23].

Thus, it is likely that the presence of large cestodes in the intestines of cormorants created unfavourable conditions, leading to nematodes adopting a more stable brachymorphic form. This transformation did not affect their fertility or vital functions. When cestodes are present, it is crucial to have adaptations for interspecific competition. This is because cestodes actively absorb monomers from the host's intestine and also adsorb intestinal enzymes on the surface of the strobili. As a result, they consume a significant amount of food and create intense competition for other parasites [24]. Cestodes excrete substances from their entire body surface that create an inhospitable environment in the intestine, preventing the presence of other parasites, such as nematodes.

Compact body proportions are crucial for adapting to space, particularly when competing with both similar and larger alien species. This enables for efficient utilisation of available habitats, occupying any vacant and acceptable niche while minimising space requirements.

It is important to note that there is a large variation in the linear diameters of contracecums in both males and females, observed in both Lake Auliekol and Kirpichnoe. Evidently, the impacts of interspecific and intraspecific factors differ in their effects on helminths, resulting in the development of sizable and somewhat stunted individuals. This phenomenon is particularly evident during various stages of infection, where the initial nematodes that invade the bird's intestines grow to significant sizes due to ample food resources. Subsequently, other parasites that enter the intestines at a later time will be hindered by the inhibitory effects of the pioneering individuals. A.V. Krivopalov and V.D. Gulyaev observed this occurrence while examining the interactions of cestodes in the intestines of voles [25]. Oppression can manifest in two ways: direct oppression, which involves physical displacement or the impact of metabolic products on each other, and indirect oppression, which occurs through the immune system and physiological reactions of the host body.

The distance from the vulva to the anterior end of the body as well as the breadth and length of the oesophagus, show relatively limited variation.

Table 2. Dimensions of female contracecums depending on the number of helminths in one host

| Size and nature of the sample | Parameter | Average value | Dispersion | Limits | |
|---|---|---|---|---|---|
| | | | | minimum | maximum |
| No. 1, n = 41, total 70 specimens, all mature | Length | 32.883±0.9553 | 36.50745 | 23.8 | 47.2 |
| | Width | 1.2585±0.0367 | 0.053988 | 0.8 | 1.8 |
| | Esophagus length | 2.302±0.1695 | 0.14887 | 1.6 | 3.2 |
| | Ventricle length | 0.208±0.0085 | 0.0028761 | 0.1 | 0.3 |
| | Length of the gastric process | 4.687±0.1304 | 0.68013 | 3.2 | 6.7 |
| | Length of intestinal outgrowth | 1.602±0.0537 | 011524 | 0.9 | 2.6 |
| | Tail length | 0.498±0.02015 | 0.016244 | 0.3 | 0.9 |
| | Distance to vulva | 11.0±0.3987 | 6,359 | 8.2 | 20.0 |
| | Egg length | 0.0751±0.00145 | 0.00008581 | 0.056 | 0.098 |
| | Egg width | 0.031415±0.00063 | 0.000019899 | 0.021 | 0.042 |
| No. 2, n = 51, total 89 specimens, mature 78 specimens. | Length | 29.445±0.9026 | 40.738525 | 18.7 | 42.2 |
| | Width | 1.0578±0.0343 | 0.05873725 | 0.7 | 1.6 |
| | Esophagus length | 2.4255±0.06298 | 0.19834 | 1.7 | 3.4 |
| | Ventricle length | 0.2531±0.0076 | 0.002914 | 0.14 | 0.35 |
| | Length of the gastric process | 5.176±0.1406 | 0.989035 | 3.5 | 7.4 |
| | Length of intestinal outgrowth | 1.696±0.04899 | 0.119984 | 1.2 | 2.6 |
| | Tail length | 0.402±0.0173 | 0.014996 | 0.2 | 0.7 |
| | Distance to vulva | 9.4±0.3123 | 4,878 | 5.4 | 14.1 |
| | Egg length | 0.06922±0.00148 | 0.0001106 | 0.056 | 0.084 |
| | Egg width | 0.02827±0.00257 | 0.000033243 | 0.021 | 0.035 |
| No. 3, n = 23, total 48, mature 45 | Length | 35.4217±1.5718 | 54.355415 | 23.0 | 50.5 |
| | Width | 1.1791±0.0575 | 0.0727447 | 0.7 | 1.5 |
| | Esophagus length | 2.8826±0.0966 | 0.205138 | 1.9 | 3.6 |
| | Ventricle length | 0.3087±0.0118 | 0.0030664 | 0.2 | 0.4 |
| | Length of the gastric process | 6.2435±0.2092 | 0.962569 | 4.4 | 8.2 |
| | Length of intestinal outgrowth | 1.9391±0.0773 | 0.131581 | 1.3 | 2.4 |
| | Tail length | 0.4261±0.0187 | 0.007698 | 0.25 | 0.55 |
| | Distance to vulva | 10.6826±0.4264 | 4.005929 | 7.0 | 13.2 |
| | Egg length | 0.07609±0.00197 | 0.000085992 | 0.056 | 0.084 |
| | Egg width | 0.03104±0.00095 | 0.000021498 | 0.021 | 0.035 |

Table 2 continued

| | | | | | |
|---|---|---|---|---|---|
| No. 4 (51), n = 22, total 87, mature 33 | Length | 32.6273±1.1939 | 29.93255411 | 21.4 | 40.7 |
| | Width | 1.29545±0.0529 | 0.05878788 | 0.65 | 1.6 |
| | Esophagus length | 2.8136±0.1072 | 0.24123377 | 1.8 | 3.5 |
| | Ventricle length | 0.2982±0.0128 | 0.003425108 | 0.2 | 0.37 |
| | Length of the gastric process | 6.09545±0.2351 | 1.1604545 | 3.8 | 7.6 |
| | Length of intestinal outgrowth | 1.9773±0.0923 | 0.178982684 | 1.1 | 2.7 |
| | Tail length | 0.44318±0.0219 | 0.01007 | 0.2 | 0.6 |
| | Distance to vulva | 10.4364±0.4359 | 3.99004329 | 7.4 | 13.4 |
| | Egg length | 0.07064±0.00205 | 0.0000882424 | 0.056 | 0.084 |
| | Egg width | 0.028±0.00105 | 0.000023333 | 0.021 | 0.035 |
| No. 5 (53), n = 22, total 33, mature 31 | Length | 26.8273±1.043045 | 22.84683983 | 19.8 | 38.6 |
| | Width | 1.2091±0.0483 | 0.04896104 | 0.7 | 1.55 |
| | Esophagus length | 2.44545±0.0652 | 0.08926407 | 1.8 | 3.0 |
| | Ventricle length | 0.2523±0.00799 | 0.001342208 | 0.19 | 0.32 |
| | Length of the gastric process | 5.2±0.1438 | 0.434285714 | 3.8 | 6.4 |
| | Length of intestinal outgrowth | 1.6318±0.0615 | 0.079415584 | 1.0 | 2.4 |
| | Tail length | 0.3523±0.02005 | 0.008447 | 0.2 | 0.5 |
| | Distance to vulva | 10.5727±0.4675 | 4.59064935 | 6.1 | 14.0 |
| | Egg length | 0.072545±0.00217 | 0.000100545 | 0.056 | 0.091 |
| | Egg width | 0.02991±0.00114 | 0.0000288485 | 0.021 | 0.042 |
| No. 6 (52), n = 19, total 34, mature 28 | Length | 30.4684±1.3707 | 33.82116959 | 16.8 | 40.4 |
| | Width | 1.1053±0.0414 | 0.03080409 | 0.75 | 1.4 |
| | Esophagus length | 2.67105±0.0736 | 0.09758772 | 2.0 | 3.2 |
| | Ventricle length | 0.2737±0.0088 | 0.001402339 | 0.2 | 0.35 |
| | Length of the gastric process | 5.5053±0.1467 | 0.387192982 | 4.2 | 6.5 |
| | Length of intestinal outgrowth | 1.7632±0.0639 | 0.073567251 | 1.4 | 2.4 |
| | Tail length | 0.3921±0.0201 | 0.007295 | 0.2 | 0.5 |
| | Distance to vulva | 10.1105±0.5687 | 5.82099415 | 5.1 | 14.2 |
| | Egg length | 0.07295±0.00234 | 0.0000997193 | 0.056 | 0.091 |
| | Egg width | 0.02984±0.00118 | 0.0000263626 | 0.021 | 0.042 |

Table 3. Sizes of male contracecums depending on the number of helminths in one host

| Size and nature of the sample | Parameter | Average value | Dispersion | Limits | |
|---|---|---|---|---|---|
| | | | | minimum | maximum |
| No. 1, n = 29, total 70 specimens, all mature | Length | 27.28965±0.7282 | 14.847389 | 17.7 | 38.4 |
| | Width | 0.97759±0.03699 | 0.038319 | 0.6 | 1.4 |
| | Esophagus length | 2.0448±0.0521 | 0.076133 | 1.6 | 2.6 |
| | Ventricle length | 0.1879±0.00905 | 0.00229557 | 0.12 | 0.3 |
| | Length of the gastric process | 4.18965±0.10599 | 0.314532 | 3.4 | 5.7 |
| | Length of intestinal outgrowth | 1.4228±0.0434 | 0.0527278 | 1.0 | 2.2 |
| No. 2, n = 27, total 89 specimens, mature 78 specimens. | Length | 25.7074±0.8245 | 17.674558 | 17.2 | 32.7 |
| | Width | 0.8703±0.0332 | 0.0287037 | 0.6 | 1.2 |
| | Esophagus length | 2.0667±0.0533 | 0.0738462 | 1.7 | 2.6 |
| | Ventricle length | 0.2244±0.0072 | 0.00134103 | 0.16 | 0.3 |
| | Length of the gastric process | 4.3926±0.1049 | 0.2860969 | 3.5 | 5.4 |
| | Length of intestinal outgrowth | 1.4722±0.0288 | 0.021603 | 1.2 | 1.8 |
| No. 3, n = 22, total 48, mature 45 | Length | 32.6682±1.33201 | 37.259416 | 18.3 | 42.2 |
| | Width | 0.9636±0.0417 | 0.0364719 | 0.5 | 1.3 |
| | Esophagus length | 2.6545±0.08185 | 0.140683 | 1.7 | 3.2 |
| | Ventricle length | 0.3086±0.0099 | 0.00206948 | 0.2 | 0.37 |
| | Length of the gastric process | 5.6295±0.2374 | 1.18349026 | 2.35 | 7.0 |
| | Length of intestinal outgrowth | 1.7295±0.0662 | 0.092062 | 1.25 | 2.3 |
| No. 4-5 (51), n = 11, total 87 specimens, mature 33 | Length | 27.14545±2.0346 | 41.394727 | 17.3 | 37.7 |
| | Width | 0.8864±0.0625 | 0.0390455 | 0.55 | 1.15 |
| | Esophagus length | 2.4045±0.1167 | 0.1362273 | 1.7 | 2.9 |
| | Ventricle length | 0.2573±0.0189 | 0.00358182 | 0.17 | 0.34 |
| | Length of the gastric process | 5.4±0.2135 | 0.456 | 3.8 | 6.3 |
| | Length of intestinal outgrowth | 1.4909±0.10045 | 0.10090909 | 0.9 | 2.1 |
| No. 6 (53), n = 9, total 33 specimens, mature 31 | Length | 24.9967±1.7245 | 23.7925 | 17.7 | 32.8 |
| | Width | 1.0111±0.08605 | 0.0592361 | 0.65 | 0.4 |
| | Esophagus length | 2.1111±0.1041 | 0.0867361 | 1.8 | 2.7 |
| | Ventricle length | 0.2133±0.01199 | 0.00115 | 0.18 | 0.28 |
| | Length of the gastric process | 4.4889±0.2361 | 0.44611111 | 3.7 | 5.7 |
| | Length of intestinal outgrowth | 1.3667±0.0619 | 0.030625 | 1.1 | 1.6 |

Table 3 continued

| | | | | | |
|---|---|---|---|---|---|
| No. 7 (52), n = 9, total 34 specimens, 28 mature | Length | 27.7889±1.01603 | 8.2586111 | 21.0 | 30.4 |
| | Width | 0.9367±0.0545 | 0.023725 | 0.65 | 1.1 |
| | Esophagus length | 2.4611±0.0967 | 0.0748611 | 1.8 | 2.7 |
| | Ventricle length | 0.2478±0.0121 | 0.00116944 | 0.17 | 0.28 |
| | Length of the gastric process | 5.1555±0.1937 | 0.3002778 | 3.8 | 5.5 |
| | Length of intestinal outgrowth | 1.5222±0.0656 | 0.34444 | 1.1 | 1.7 |

**Conclusion.** The size of helminths is substantially influenced by interspecific interactions. There are around 90 copies present. The presence of contracecums in the intestine of a single cormorant individual resulted in a significant reduction in the overall size of the nematodes. When cestodes are present, contracecums undergo brachymorphic changes, which can be seen as an adaptation to maintain fertility while minimising energy expenditure.

The ratio of parasite abundance to parasite size might vary based on the specific parameters of the host-parasite interaction. The size of the parasite can be regulated by multiple factors that are associated with the abundance of parasites within the host. Here are few potential situations:

1. Resource competition. In cases where there is a high number of parasites in a host, they may engage in competition for scarce resources, such as nutrients or space. This competition may lead to a reduction in the size of individual parasites, as they must distribute available nutrients across a greater number of people.

2. Effects that vary in intensity according on the density of a population. Occasionally, the abundance of parasites within a host can exert a density-dependent influence on the growth and reproductive capabilities of individual parasites. Elevated levels of parasites can lead to impaired growth or diminished reproductive rates, leading to the development of smaller parasites.

3. The immunological reaction of the host. An abundance of parasites within the host might elicit a heightened immune response, hence impacting the growth and maturation of each individual parasite. When parasites multiply, the host's immune system can become more efficient in controlling their growth. This can result in smaller worms and a delay in reaching puberty.

4. Process of genetic change throughout time that allows organisms to better survive and reproduce in their environment. Parasites might exhibit strategic modifications in accordance with the parasite load within the host. For instance, certain parasites may exhibit a predilection for generating a greater number of smaller offspring when the host is extensively infested. This strategy aims to maximise the chances of transmitting inheritable characteristics.

Overall, the relationship between the number of parasites in the host and the size of the parasite is complex and may depend on many interacting factors. Researchers continue to study these dynamics in different host-parasite systems to better understand host-parasite relationships and the mechanisms that control parasite size.

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### *Павлодар облысындағы ірі қарақат нематодының* **Contracaecum rudolphii** *түраралық және түрішілік байланыстары*

***Аңдатпа***

*Гельминттердің мөлшеріне түраралық өзара әрекеттесу айтарлықтай әсер етеді. 90-ға жуық данасы бар. Жалғыз қарақаттың ішегінде Contracecums болуы нематодтардың жалпы мөлшерінің айтарлықтай төмендеуіне әкелді. Цестодтар болған кезде контрацепумдар брахиморфтық өзгерістерге ұшырайды, бұл энергия шығынын азайту кезінде құнарлылықты сақтауға бейімделу ретінде қарастырылуы мүмкін. Иедегі паразиттердің көптігінің паразит мөлшеріне қатынасы иеисі мен паразиттердің өзара әрекеттесуінің нақты параметрлеріне байланысты өзгеруі мүмкін. Паразиттің мөлшерін ие ішіндегі паразиттік популяциямен байланысты көптеген факторлармен реттеуге болады. Иедегі паразиттердің саны мен паразит мөлшерінің арақатынасы иесі мен паразиттің өзара әрекеттесу ерекшеліктеріне байланысты өзгеруі мүмкін болады. Көптеген жағдайларда паразиттің мөлшеріне иесінде болатын паразиттердің санына байланысты әртүрлі факторлар әсер етуі мүмкін.*

***Түйінді сөздер**: паразит, иесі, Contracaecum rudolphii, ірі қарақат, гельминттердің түр аралық әрекеттесуі.*

***Материал баспаға 15.02.24 түсті***

### *Межвидовые и внутридовые связи нематод большого баклана* **Contracaecum rudolphii** *в Павлодарской области*

***Аннотация***

*Межвидовые взаимодействия гельминтов существенно влияют на их размеры. Присутствие почти 90 экз. контрацекумов в кишечнике одной особи баклана приводило к заметному уменьшению абсолютных размеров нематод. В присутствии цестод контрацекумы приобретали брахиморфные пропорции, что можно расценивать как адаптацию, направленную на сохранение плодовитости при снижении энергзатрат. Соотношение количества паразитов в хозяине и размеров паразита может меняться в зависимости от особенностей взаимодействия хозяина с паразитом. Во многих случаях на размер паразита могут влиять различные факторы, связанные с количеством паразитов, присутствующих в хозяине.*

***Ключевые слова:** паразит, хозяин,* Contracaecum rudolphii*, большой баклан, межвидовые взаимодействия гельминтов.*

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study, monitoring the conduct of research activities, compliance with ethical standards of the publication process, formation of the design concept; **Klimenko M.Yu.** – Corresponding author. Compliance with all required publication deadlines, correct completion of documentation, filling out information about all authors of the work, preparation of research.

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