Conference Paper

Trematode Parthenitae Infection Rate and Distribution of Kola Bay Actic Molluscs of the Genus Littorina

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Abstract

The study was carried out in 2018 in the littoral zone of Kola Bay during the autumn period in the areas of Abram Mys Settlement, Mishukovo Settlement and Retinskaya Bay. Molluscs of the genus Littorina were collected from various substrates: stones, algae, metal construction and soil. In addition, samples were taken not from a particular substrate, but along the borders of the littoral zone to study species composition of molluscs and common level of infection rate in study areas. Our data showed that *L. saxatilis* infested by mature trematode parthenitae prefer being on the surface of algae, metal structure, stones at low tide instead of hiding under the stones, in the thickness of algae and in other possible shelters. The study of age distribution among infested Littorina molluscs living on different substrates showed that the ratio of age groups is different and varies from 1+ to 13+. Distribution data are established and considered for infested molluscs by trematode parthenitae of the group "pygmaeus": *Microphallus pygmaeus*, *M. piriformes*, which are characterized by the absence of free-living cercariae. Trematode parthenitae of other species which have a stage of free-living cercaria in their life cycle are absent in molluscs during the autumn period.

Keywords: periwinkle, distribution of periwinkles, molluscs of the genus Littorina, infection rate of periwinkles, Microphallidae

1. Introduction

Parasites affect their host's mortality, fertility, growth, nutritional status, energy needs and population behavior [1, 2]. Thus the impact of parasites affects various spheres of the organism's vital activity.

Of the listed negative consequences, the behaviour of infected hosts is of particular interest, and gastropod molluscs of the genus Littorina are one of the convenient objects for studying this phenomenon. Periwinkles are widely distributed in the littoral zone and form clusters with high density and are readily available for research. The life cycles of various trematode species are carried out through the periwinkles as the first intermediate host [3, 4]. The final host in the life cycle is coastal birds or fish [5, 6].

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The behaviour of infested hosts is one of peculiar interest among the other negative effects. One of the most convenient objects for studying this phenomenon is gastropod molluscs of the genus Littorina.

Distribution of the genus Littorina species through the intertidal zone has been successfully described by many authors. [7--9] However due to infestation of these molluscs, their distribution changes [10, 11]. This study considers the distribution features of infested periwinkles on different types of substrate and various age categories in Autumn in the littoral zone of Kola Bay.

2. Material and Methods

The study was carried out in the intertidal zone of Kola Bay (Barents Sea) in autumn period of 2018 in the areas of Abram Mys Settlement, Mishukovo Settlement and Retinskaya Bay. The map of study areas is shown in Figure 1.

![Map of study areas.](image)

Molluscs were collected by means of a frame 50x50 cm. in triple frequency from the top, average and lower horizons of intertidal zone from the surface of various substrates: stones, algae, metal (metal constructions in vertical position) and soil. This technique was also previously used by Galaktionov K.V., 1992 [12]. Samples were also additionally collected using the same method, but not from a specific substrate, but along the borders of the littoral zone to study species composition of molluscs and common level of infection rate in the study areas.

Molluscs were fixed in a 70% ethyl alcohol solution. During laboratory examination the age of one-year growth rings on the shell was previously set to 1 year accuracy. Then sexually mature periwinkles were dissected with pliers and the body was removed to determine species.
The species of molluscs was determined by the peculiarities of the sexual system structure according to the Reed monograph [9]. The body was also examined for trematode and in the event of infestation the species identity of parasites was determined.

3. Results and Discussion

The study identified 5 species of periwinkles: *Littorina littorea* (Linnaeus 1758), *L. saxatilis* (Olivi 1792), *L. arcana* (Hannafoord Ellis 1978), *L. obtusata* (Linnaeus 1758), *L. fabalis* (W. Turton 1825). Among the molluscs of *L. arcana* and *L. fabalis*, single healthy individuals have been found and thus they are absent in further parasitological analysis.

While investigating molluscs for infestation with trematode parthenitae it should be noted that trematodes of the Microphallidae family of «pygmaeus» group have been detected for all studied areas, namely: mature parthenitae of *Microphallus pygmaeus* and *Microphallus piriformes*. Embryonal stages of these parthenitae are found in molluscs from areas of Abram Mys Settlement and Retinskaya Bay. Two molluscs *L. saxatilis* and one mollusc *L. littorea* are infested with *Notocotylus sp.* in Retinskaya Bay, but in further analysis these individuals will be absent due to insufficient quantity to study the distribution of infested molluscs.

Mollusks infection rate (extensity of invasion) in studied areas in Table 2 shows that extensity of invasion for molluscs *L. saxatilis* and *L. obtusata* increases from south to north and in Retinskaya Bay it reaches high values – 72% and 60% respectively. Among molluscs *L. littorea*, infested individuals are found in Retinskaya Bay, where the extensity of invasion is low at 7%.

Such high values of extensity of invasion for molluscs *L. saxatilis* and *L. obtusata* in Retinskaya Bay are likely due to the fact that during this period of study (autumn) the level of infestation is inherent in a specific point of the littoral zone, despite annual fluctuations, where trematodes from the whole community interact actively and exclusively with its small part [13, 14].

Our data on extensity of invasion by mature and embryonal stages of trematode parthenitae show that infection rate of periwinkles with embryonal stages is significantly lower in comparison with that by mature stages of *Microphallus spp.* This is probably due to the fact that the peak of trematode infection rate in molluscs occurs during the spring-summer period. These studies are reflected in Tables 3, 4.

It should be noted that the present study was carried out in the autumn period and therefore trematodes of "pygmaeus" group are found in molluscs and characterized by
TABLE 1: The extensity of invasion (EI,%) and the number of dissected mollusc (DM, specimen) of the genus Littorina infested with trematode parthenitae of Microphallus pygmaeus and Microphallus piriformes in study areas.

| Study area          | L. saxatilis | L. obtusata | L. littorea |
|---------------------|--------------|-------------|-------------|
| Abram Mys Settlement| EI, % | DM, spc. | EI, % | DM, spc. | EI, % | DM, spc. |
| Mishukovo Settlement| 10  | 373      | 0   | 16      | 0   | 4       |
| Retinskaya Bay      | 26  | 227      | 17  | 6       | -   | -       |
|                     | 72  | 363      | 60  | 141     | 7   | 29      |

Note to the table: "-" - missing value.

TABLE 2: The extensity of invasion (EI,%) and the number of dissected mollusc (DM, specimen) of the genus Littorina infested with mature stages of trematode parthenitae of Microphallus pygmaeus and Microphallus piriformes on various substrates of the littoral zone within the study areas.

| Study area          | Microphallus pygmaeus + M. piriformes (mature stages) |
|---------------------|------------------------------------------------------|
| Abram Mys Settlement| L. saxatilis | L. obtusata | L. littorea |
| Stone surface       | EI, % | DM, spc. | EI, % | DM, spc. | EI, % | DM, spc. |
| Mishukovo Settlement| 14  | 221      | -   | -       | -   | -       |
| Stone surface       | 83  | 6        | -   | -       | -   | -       |
| Retinskaya Bay      | 47  | 111      | *   | 1       | -   | -       |
| Stone surface       | 74  | 255      | 60  | 140     | 20  | 10      |
| Soil surface        | 63  | 8        | -   | -       | -   | -       |
| Metal construction  | 75  | 35       | 1   | -       | -   | -       |
| surface             | 61  | 64       | -   | -       | -   | -       |

Note to the table: * - calculating the extensity of invasion is impossible due to having only 1 animal in this group (EI = 100%).

TABLE 3: The extensity of invasion (EI,%) and the number of dissected mollusc (DM, specimen) of the genus Littorina infested with embryonal stages of trematode parthenitae of Microphallus sp. on various substrates of the littoral zone in study areas.

| Study area          | Microphallus sp. (embryonal stages) |
|---------------------|-------------------------------------|
| Abram Mys Settlement| L. saxatilis                        |
| Stone surface       | EI, % | DM, spc. |
| Retinskaya Bay      | Metal construction surface | 13 | 46 |
the absence of free-living cercaria and characterized by life cycle, where the final stage
is eating infested mollusc by the final host -- birds [15].

Trematode parthenitae of other species, which have a stage of free-living cercaria in
their life cycle are absent in molluscs of the genus Littorina during the autumn period,
which is probably due to the migration of birds carrying such species of trematodes
during this period.

The dominance of the "pygmaeus" group over trematode parthenitae with a free-
living stage is generally characteristic of the Barents Sea region as this group is better
adapted to constantly changing northern environmental conditions [16].

With reference to distribution of periwinkles infested with mature stages of Microphal-
lus spp. on different substrates, Table 3 shows a curious picture:

1. In the areas of Abram Mys and Mishukovo a significant part of molluscs L. saxatilis
is concentrated on the stone surfaces, periwinkles were not found on the algae surface
in the area of Abram Mys Settlement. In Mishukovo Settlement only 6 molluscs were
found, of which 5 were infested (EI - 83%). L. obtusata found in Mishukovo Settlement
-- a single infested specimen, infested molluscs L. littorea are not found in Abram Mys
Settlement and no common periwinkles L. littorea were found in Mishukovo Settlement.

2. The greatest extensity of invasion depending on substrate is observed for molluscs
L. saxatilis in Retinskaya Bay from the algae, metal construction, stone and soil surfaces.
Compared to other surfaces a relatively small number of L. obtusata had been found on
the surface of algae and characterized by high infection rate -- 60%, there is 1 infected
mollusc on the soil surface, on the surface of metal and stones this species was absent.
Molluscs L. littorea were observed only on the surface of algae in amount of 10 specimen
with EI -- 10%.

Normally, during low tide, periwinkles take refuge from a negative factors of the littoral
zone --drying and overheating -- by placing themselves in the thickness of algae, where
relatively constant temperature and humidity are maintained. This ability is suppressed
in infested molluscs and for the period of drying, they remain where they were found
by the high tide [17]. This is clearly observed in Retinskaya Bay, where most of infested
molluscs from the community at low tide were found on the algae and metal construction
surfaces.

The analysis of the age structure of infested molluscs of the genus Littorina in autumn
period showed that:

1. Infection rate with embryonal stages of Microphallus sp. is low in comparison with
infection rate with mature trematode parthenitae and is typical for molluscs L. saxatilis
of older age categories: from 3+ to 12+ found on the surface of stones in the area of Abram Mys and on the metal surface in Retinskaya Bay. No pronounced features of distribution of molluscs infested with embryonic stages have been established.

2. As shown in Figures 2-4 for the area of Abram Mys and Retinskaya Bay, infection rate with mature trematode parthenitae of molluscs *L. saxatilis* found on the surface of stones is lower (taking into account the number of dissected molluscs) than in Mishukovo. Infection rate is typical for molluscs of different ages in studied areas: from 1+ to 11+ for *L. saxatilis* and from 2+ to 13+ for *L. obtusata*. Infested molluscs *L. littorea* are found with the age of 7+ and 9+.

3. In general, coming from Figures 4-6 the highest rates of infection with mature trematode parthenitae (taking into account the number of dissected molluscs) are observed for the younger and older age groups of *L. saxatilis* on the algae and metal construction surfaces in Retinskaya Bay. Periwinkles *L. obtusata* and *L. littorea* are found on the surface of algae in Retinskaya Bay. The first of them are characterized by a high infection rate of age 7+ and 8+, 85% and 83% respectively for the second EI, taking into account that the number of dissected molluscs is low.

Molluscs which are found in a single specimen per age group on a certain substrate and being infested in a single specimen are not presented as graphic data and are not reflected in Figures 2-6.

Most likely the peak of infection rate with trematode parthenitae occurs during the spring-summer period as mentioned earlier and as a result the level of infection rate with *Microphallus sp.* of embryonal stages is low and infection rate with mature parthenitae is typical for both younger and older age groups of molluscs.

![Figure 2: Age structure of molluscs *L. saxatilis* infested with mature trematode parthenitae *Microphallus pygmaeus* and *Microphallus piriformes* on various substrates in Abram Mys Settlement.](image)

*Note:* This figure and the subsequent table show the number of dissected molluscs (in specimen) with corresponding age and on corresponding substrate.
Figure 3: Age structure of molluscs *L. saxatilis* infested with mature trematode parthenitae *Microphallus pygmaeus* and *Microphallus piriformes* on various substrates in Mishukovo Settlement.

Figure 4: Age structure of molluscs *L. saxatilis* infested with mature trematode parthenitae *Microphallus pygmaeus* and *Microphallus piriformes* on various substrates in Retinskaya Bay.

Figure 5: Age structure of molluscs *L. obtusata* infested with mature trematode parthenitae *Microphallus pygmaeus* and *Microphallus piriformes* on various substrates in Retinskaya Bay.
Figure 6: Age structure of molluscs *L. littorea* infested with mature trematode parthenitae *Microphallus pygmaeus* and *Microphallus piriformes* on various substrates in Retinskaya Bay.

4. Conclusion

Our data about the distribution of molluscs of the genus Littorina infested with mature trematode parthenitae on various substrates in the littoral zone represent an analysis of the consequence of behavioural disturbances. Indeed, present study shows that those infested *L. saxatilis* (the number of which was higher than other periwinkles) with mature parthenitae *Microphallus spp.* prefer being on algae, metal constructions and stone surfaces instead of hiding under the stones, in the thickness of algae and in other possible shelters at low tide. The former behavioural patterns, therefore, can show the presence of violations associated with motor ability and activity.

Conflict of Interest

The authors have no conflict of interest to declare.

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