

Seasonality of pathogens and other symbionts of *Gammarus pulex* in the tributary of Słupia River

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Gammarus pulex is a keystone species of amphipod crustacean found in fresh water across much of Europe. Presence of pathogens is a key factor that can alter population size, behavior, survival and physiology of these amphipod hosts. Seasonal changes are important to the extent that the parasites or pathogens under study act as agents of selection. Our study was carried out on original material, collected from a stream that flows into a Słupia River (54°28'30,79"N 17°02'37,20"E). The research hypothesis contained the assumption of the role of the inflow of a small coastal river as a refugium of native species and their parasites. For the study, 600 individuals of gammarids were dissected in 2016–2017. Using aggregate data from 12 date-by-site comparisons, we found that both prevalence and intensity of Apicomplexa and Ciliophora were seasonally unimodal. Parasitism first increased and then declined seasonally after peaking midseason. In the case of infections caused by Microsporidia, the highest increase in the rate of infection falls in the early autumn period, reaching the value from 48 to 56%. The minimum share of infected hosts was recorded in March 2016 and January 2017. In the early spring period, there was a slight decrease in microsporidian infection with subsequent minor fluctuations in the summer.

Pathogens and other symbionts was observed in 538 individuals, which accounted for nearly 90% of the total sample. The detected parasites and other symbionts belong to seven different phyla: Apicomplexa, Microsporidia, Rotifera, Acanthocephala, Cestoda, Nematoda, Ciliophora. The studies carried out showed that the most common *G. pulex* parasites belong to gregarines (*Cephaloidophora gammari*, *Cephaloidophora* sp., *Uradiophora longissima*, *Uradiophora* sp.), microsporidians (*Dictyocoela* spp.), commensal and parasitic rotifers (*Embata parasitica*, *Embata* sp.). Gregarines were identified from the gut lumen and hepatopancreas of their amphipod host. Little is known about their effect on the host. The pathogenicity of *Dictyocoela* spp. is associated with their localization and transmission mode. Heavily infected specimens have been documented as whitish in color due to the occurrence of numerous spores filling the infested tissue of the host, and it was also noted that infection was not present in the gut wall. Sporogonial stages and spores occurred within the cytoplasm of host cells, and specifically the sporogonial stages could also be found floating in the haemolymph or adhering to the haemocytes. *Embata parasitica* occupies a large surface area of the gills, reducing the respiratory capacity and heat tolerance of the host, causing death under unfavorable conditions. Epibiotic ciliated protists (*Branchioecetes gammari*, *Epistilis* sp., *Zoothamnium* sp. *Vorticella* sp. have been observed from the carapace, gills and extremities of amphipods. Throughout the entire study period, the cystakants of acanthocephalans *Polymorphus magnus* was found three times. During the study, a single occurrence of

cysticercoids of tapeworms was recorded which, on the basis of morphological features, were temporarily referred to representatives of the Cyclophilidea family. Tapeworm cysticercoid (Cyclophilidea gen sp.), microphallid metacercaria and nematodes were sporadically recorded. The prevalence of rotifers varies from 36 to 86% throughout the year. The maximum infection rate was recorded in June. Acanthocephalans were detected in October and December. Ciliophora was recorded in May, July and October. In February and in May, individuals infected with flukes appeared, while in September and December individuals infected with Cestoda. Representatives of Nematoda were observed in July.