

ABSTRACT (streszczenie w języku angielskim)

The parasitism and interactions between organisms in the parasite-host system have been the subject of many studies, both observational and experimental. Importantly, animals are often simultaneously infected with parasites from different taxa, and this phenomenon is known as co-parasitism. Parasites representing different taxa may influence the host organism and each other. The host and the parasite community form a microenvironment within which various processes occur, affecting both infection by parasites from different taxa and host fitness. Up until now, the type of interactions between co-existing parasites was mostly determined by data from a single time point. This made it difficult to reliably determine how parasites from different taxa interact as well as the mechanisms behind the outcome of infection with new parasites invading an already parasitized host. On the other hand, the influence of parasitism on host fitness has often been studied in systems where infection by parasites from only one taxon was considered, despite the common presence of co-parasitism in nature. Particularly interesting and important may be the impact of co-parasitism during the crucial stage of the host's life – the breeding period – due to the high energetic costs of reproduction. Co-existing parasites may affect the reproductive success of infected hosts. However, the currently available information mostly relates to the impact of single parasitic infections. At the same time, there is little data on the occurrence of infection at the early stages of the host's life, and therefore, data on co-parasitism in this period is also scarce.

The aim of this study was to examine the type of interactions between endoparasites commonly found in the blood of hole-nesting birds – the blue tit *Cyanistes caeruleus* and the great tit *Parus major* – as well as to determine the impact of these parasites on the parameters of breeding biology of the host beginning from the early stages of the nesting period, as well as patterns of infection during the first weeks post-fledging. The research was carried out on two populations of tits: the blue tit population in Gotland, Sweden, and the great tit population in the Sękocin Forest, Poland.

The blue tit population was subjected to an experimental treatment aimed at diversifying the condition of females during the breeding season. This treatment aimed to highlight the relationship between co-existing parasites and enhance differences in the parameters of breeding biology between females infected with parasites representing

several taxa and females uninfected or infected with parasites representing a single taxon. To accomplish this, the infection status with blood parasites was determined at two time points – during incubation and 14 days after hatching.

The great tit population was monitored to collect data on parameters of breeding biology and to mark nestlings for identification during the post-fledging period. Juveniles were captured a few weeks after fledging to determine their blood parasite infection status, factors associated with the occurrence of infection, and to identify the type of interactions between co-existing parasites during this phase of the host's life.

The results of presented studies show that blood parasites from four different taxa may interact with each other either synergistically, antagonistically, or neutrally. The type of the interaction is primarily driven by the genus of infecting parasites. No effect of the experimentally manipulated host condition on the probability of parasite infection or on the type of interactions between the co-existing parasites was found. However, experimental manipulation of nest infestation by fleas did not significantly affect the condition of females. Co-infecting parasites did not significantly affect the parameters of breeding biology, except for hatching success, which was significantly lower in the case of co-infection with parasites representing three taxa. Females carrying a single infection differed from uninfected females only in two cases: infection with *Trypanosoma* resulted in a delayed onset of egg-laying and infection with *Haemoproteus* led to the laying of fewer eggs. The study on blood parasite infection in juvenile great tits showed that in the case of parasites from the genera *Plasmodium*, *Leucocytozoon* and *Trypanosoma*, individuals become infected after they leave the nest, as the probability of infection increased in individuals caught later in the breeding season. The types of interactions between parasites from different taxa infecting great tit juveniles were the same as those identified in adult great tits and blue tits.

The presented research determines the type of interactions between some of the most common endoparasites of adult and juvenile hole-nesting birds. Additionally, it examines the effect of co-parasitism on the parameters of the host's reproductive biology, beginning from the early stages of the nesting period, and identifies the factors associated with the probability of parasitic infection in the early stage of the host's life.