HYPERPARASITISM AS A MODIFYING FACTOR IN HOST–PARASITE RELATIONSHIPS: THEORETICAL AND PRACTICAL ASPECTS

According to dictionaries, a parasite is defined as an organism which lives on, within or aside of another organism using it as a food or shelter. Such broad definition allows to include into the group of parasites such sub-organisms or organisms as viruses, bacteria, fungi, protozoans, nematodes, insects, vertebrates and even plants, if they live at the expense of plants or animals.

Out of numerous possible forms of parasitism I will treat here these cases, which concern biological control of plants and animals. Biological control may or must be considered as applied parasitology, because it is based on intentional use of parasitic/pathogenic organisms to control plants and animals which, due to interference with human activities, are considered as pests.

In classical cases of biological control we have only simple cases of parasite–host or predator–prey relationships. However, there are known cases when such a relationship is complicated by the fact that „parasite" or „predator" has its own parasite or predator. Such situation is defined as hyperparasitism and the organisms involved are named as hyperparasites or secondary parasites. Hyperparasitism is especially frequent phenomenon among insects but such cases also known in other groups of zoological or botanical taxa. A well-known entomological case is that braconid *Apanteles glomeratus* parasitizing in a lepidopteran *Pieris brassicae* is in turn parasitized by hyperparasitic Chalcididae. As an example from the area of medical/veterinary parasitology may serve hyperparasitic protozoan *Nosema eurythreme* developing in a trematode *Fasciola hepatica*, parasite of humans or sheep.

Phenomena of parasitism and hyperparasitism are very important for the theory and practice of biological control and knowledge of them is a critical issue in order to avoid failure and secure the success. It is almost a rule that phytophagous insect, e.g. Colorado potato beetle (*Leptinotarsa decemlineata*), in its homeland is a minor pest or no pest at all, as its population density is regulated and controlled by local parasites and predators. However, when accidentally introduced to Europe (as well as many other insects or weeds), without associated natural enemies, its population density is exploding what leads to great economic losses in potato crops and makes control treatments necessary. In case of an accidentally introduced plant pest the classical biological control attempts base on a survey for effective natural enemies (parasites or predators) in its homeland and then their transport and release in new areas of the selected biological control agents. In all such attempts special attention must be paid to avoiding phenomena of hyperparasitism and the quarantine procedure must be observed. This quarantine procedure eliminates the danger that, together with a parasite, its hyperparasite will be introduced and will interfere or ruin the hopes for a successful biological control program.

Hyperparasitism may be deleterious or beneficial from the human activities point of view. It is believed, and in some cases it was proved, that the mass outbreaks of forest insect pests were due to the mass development of hyperparasitic insects. Such hyperparasites decreased the number of primary parasites and therefore the pest insects were able to reproduce without parasites' pressure and realize their full biological potential. The beneficial hyperparasitism may be illustrated by the above-mentioned microsporidian *Nosema eurythreme* which, by hyperparasitizing in a parasitic trematode *Fasciola hepatica*, is decreasing its abundance.

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