

Comments on the host, organ and tissue specificity of fish myxosporeans and on the types of their intrapiscine development

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Abstract: Different fish-parasitic myxosporeans are characterized by a varying degree of host specificity. While certain species have very strict specificity and can colonize only a single fish species, most species of Myxosporea share several closely related fish species as hosts. Myxosporeans are tissue-specific parasites and always develop in a specific host tissue. The author assumes that the development of all myxosporean species includes an intracellular stage. Organ specificity depends on the tissue types that occur in the given organ. The author distinguishes three main types of development: *Myxobolus*-type, *Hoferellus*-type and *Sphaerospora*-type development. *Myxobolus*-type myxosporeans develop in large plasmodia (or, according to an incorrect but generally used term: cysts). Some species of them showing muscle or nervous tissue specificity usually complete their development intracellularly and form spores within the cell. Host cells of small size, however, are destroyed during the growth of the parasite: the developmental stages released from them usually become surrounded by cells of the same type, and the parasite continues its development within the capsule formed by these cells. From plasmodia developing on the surface or in organs having efferent ducts the spores are usually excreted directly into the outworld; while the spores of species developing in the inner organs are transported by the blood to organs suitable for spore dejection. Coelozoic (*Hoferellus*-type) development means that the early development of myxosporeans takes place in the cells lining the efferent ducts while the second stage occurs in the lumen of the said ducts. During *Sphaerospora*-type development a short intracellular stage, one or two blood stages characterized by a series of internal cleavage, and a coelozoic or intercellular sporogonic stage can be distinguished.

Key words: Myxosporea, host specificity, tissue specificity, organ specificity, types of intrapiscine development

INTRODUCTION

Fish-parasitic myxosporeans comprise an extraordinarily large number of species. The genus *Myxobolus* alone, which is the best studied genus of Myxosporidia, was reported to contain 444 species (Landsberg and Lom 1991). Accurate determination of the number of species is rendered difficult by the fact that taxonomic classification is based on the morphology of spores showing only slight structural differences, and that the development and the species, organ and tissue specificity of the parasites are little studied.

Reliable information on the extrapiscine development of myxosporeans has existed only since the studies of Markiw and Wolf (1983) who demonstrated the involvement of Oligochaeta alternative hosts in the development of *Myxobolus cerebralis*. The stages formerly called Actinosporidia develop in these oligochaetes. The studies of Markiw (1989) revealed that infection by myxosporeans can take place also via pathways other than the alimentary route, and that *Myxobolus cerebralis* infection may occur also in the manner observed by Daniels et al. (1976), i.e. through the percutaneous entry of sporoplasms released from triactinomyxons. El-Matbouli et al. (accepted for publication) demonstrated that after some divisions the sporoplasms that have entered the epithelial cells of the skin, gills and fins actively travel along the nerve tracts to the final site of colonization specific of the given species. However, there still are only few species whose life cycle is known in every detail. Precisely the inadequate knowledge and poor reproducibility of the life cycle of myxosporeans account for the scarcity of data available on the species, tissue and organ specificity of these parasites.

DISCUSSION

Relying on my own studies spanning a period of 25 years and on data of the literature, in this work I will attempt to determine the species-specificity of different myxosporeans, to demonstrate their strict tissue specificity and their occasional organ specificity arising from the former. The same studies enable me to describe the three basic models of the intrapiscine development of myxosporeans. The task undertaken is very difficult, as numerous excellent books have been published on the subject, which contain a detailed description of the complex intrapiscine developmental processes of these parasites. At the same time, these sources still contain some erroneous statements while failing to mention some general characteristics of myxosporeans. Of the latter, here I would like to point out the following:

1. The host specificity of different myxosporean species is different; however, it is always restricted to a well-definable circle of related hosts.
2. Myxosporeans are characterized by a very pronounced tissue specificity.
3. The organ specificity of myxosporeans depends primarily on whether the cell type necessary for the development of the given myxosporean species is available in the organ concerned.

4. Myxosporeans equally include intracellular, intercellular and coelozoic parasites; however, the development of all species starts in intracellular location.
5. Internal cleavage is a process highly typical of myxosporean development. The formation of pansporoblasts and the emergence of the "enveloped" condition also take place by such internal cleavage, as opposed to the view that the latter condition develops by the fusion of two cells.
6. The "blind alleys" observed during the development of certain species of Myxosporea are based on an erroneous assumption.
7. The relationship of breeders and fingerlings seems to have decisive importance in the development of myxosporean infections, and the myxosporean infection of fry are ensured primarily by spores that get into the outworld during spawning.

The host specificity of myxosporeans

Myxosporeans equally include species with a relatively broad host range and those showing strict specificity. *Myxobolus cerebralis* can colonize numerous salmonid species (Hoffman and Putz 1969), while *Myxobolus pavlovskii* can infect only the two closely related *Hypophthalmichthys* species (Molnár 1979). Some *Thelohanellus* species possess even stricter specificity. Achmerow (1955, 1960) described 4 *Thelohanellus* species which occur exclusively in common carp. The uncertainty existing in connection with host specificity is mainly due to the fact that some specialists less than perfectly versed in this subject tend to identify spores found in different hosts with spores of the morphologically most similar species. At the same time, in the absence of holotypes and based upon inaccurate original drawings other specialists often describe as new species parasites of an already known species but derived from closely related fish hosts. This is how it could occur that some of the species recorded by Shulman (1966, 1984) have been reported from more than 40 fish species, while others have been described in a single host only. The actual situation is obviously between these two extremes: this means that the majority of these species parasitize a few closely related fish hosts, and that the currently recorded species include numerous synonyms and many new species not yet distinguished. Species like *Myxobolus exiguus*, whose hosts reportedly include numerous cyprinids as well as *Mugil* and *Silurus* spp., are obviously collective species that comprise several morphologically similar myxosporeans. Although theoretically feasible, cross-infections suitable for the exact determination of host specificity yet seem to be a remote possibility. The advances made in the PCR technique, a method suitable for detecting a specific DNA sequence, are more likely to bring a simple and rapid solution. Until that is accomplished, the identification of typical hosts serving as a subject of description and the accurate determination of location within the host remain to be tasks of fundamental importance.

