Description of *Myxobolus bulbocordis* sp. nov.  
(Myxospora: Myxobolidae) from the heart of *Barbus sharpeyi* (Günther) and histopathological changes produced by the parasite

M Masoumian¹, F Baska² and K Molnár²

¹Iranian Fisheries Research and Training Organization, Department of Fish Diseases, Tehran, Iran, and.
²Veterinary Medical Research Institute, Hungarian Academy of Sciences, Budapest, Hungary

Abstract

A new myxosporean, *Myxobolus bulbocordis* sp. nov., has been found in the heart of a Mesopotamian fish, *Barbus sharpeyi* (Günther), in rivers in Southwest Iran. Cysts containing matured spores were located on the serosa of the atrium cordis, bulbus arteriosus, larger gill arteries and inside the wall of the bulbus. The species showed an affinity to connective tissue cells and was never associated with the muscles. Mature cysts were surrounded by a connective tissue capsule composed of two to three layers. Spores in disrupted cysts were infiltrated by epithelioid cells and macrophages. The spores found in *Barbus sharpeyi* differed in size and morphology from species known from other barbels.

Introduction

In a recent paper, Molnár (1994) has pointed out that myxosporains are host-, tissue- and organ-specific parasites. Most of them have a relatively strict host specificity and show affinity to a certain tissue of the host fish. Because of this specificity, most myxosporains only develop in a given organ, and they are ubiquitous in location only if they start their development in a tissue which occurs in different parts of the fish body (loose connective tissue, endothelium or muscle cells). The majority of the known *Myxobolus* spp. have a well-defined site of development, and there are species specific to the gills, skin, kidney, intestine and so on. Unfortunately, data on vegetative development is only available for a few of the known *Myxobolus* spp., and the majority of species have been described by the morphology of spores disseminated in the host after the disruption of cysts. In these cases, the site of infection cannot be designated properly, which makes it difficult to evaluate organ specificity.

Occurrence in the heart is commonly recorded for *Myxobolus* spp., but only a few species like *M. cordis* and *M. dogielii* develop plasmodia and cause pathological changes in this organ (Keyselitz 1908; Bauer, Voronin & Yunchis 1991). In Iran, the occurrence of a *Myxobolus* sp. in the heart of *Barbus sharpeyi* had already been reported by Moghainemi & Abasi (1992); however, these latter authors failed to give detailed information on the species found.

This paper reports the occurrence of a new *Myxobolus* species in *Barbus sharpeyi*, a fish endemic in Mesopotamian rivers and in Southwest Iran. The new species is described under the name *Myxobolus bulbocordis* and the pathological changes caused by it are presented.

Materials and methods

The fish surveyed in this study were composed of 83 specimens of *B. sharpeyi* (Günther), 14–31 cm in length. They were collected in the period between June and October 1993 as well as May and October 1994 from Hoor-Elazim, Shadgan Marsh and six different stations of the Karun River in Khuzestan Province in Southwest Iran.

Immediately after collection, the fish were transported alive to the laboratory where they were
observed on the surface of the serosa (Fig. 8).

The tissues containing cells with fusiform, elongated nuclei and which surrounded the cysts were easily discernible by Farkas-Mallory's method, in which the connective tissue elements stained blue, the muscle red, while the spores assumed a conspicuous yellow colour.

**Discussion**

The number of known *Myxobolus* species is extremely large. In a synopsis of the genus *Myxobolus*, Landsberg & Lom (1991) listed 444 valid species, indicating their type hosts. The majority of species known to date have been described on the basis of spore morphology. Although some of the species can be well characterized by the shape and size of spores, morphological variance is still limited. The similarity of spores has resulted in the misidentification of numerous species, and even species occurring in systematically distinct hosts and in dissimilar locations have been identified with some already-known species. Thus, Donec & Shulman (1984) recorded as many as 40 hosts for
some species; these are obviously conspecifics. To enable a more accurate identification of parasites, Lom & Arthur (1989) suggested morphological characteristics which should be taken into consideration besides spore size and shape, while Molnár (1994) has called attention to the fact that host, organ and tissue specificity represent a feature which must not be neglected when describing new species of Myxosporea.

Thus far, six Myxobolus species (Myxobolus dogielii, M. muelleri, M. bramae, M. musculi, M. cordis and M. ellipsoideus) have been recorded from the heart of cyprinid fishes (Donec & Shulman 1984). Myxobolus muelleri, M. bramae, M. musculi and M. ellipsoideus differ from M. bulbocordis by the size and morphology of spores. The size of M. bulbocordis spores is much larger than that of M. muelleri, M. bramae and M. musculi. The spores of M. ellipsoideus are about the same size, but they distinctly differ from the spores of M. bulbocordis by having an elongated ellipsoidal shape. In addition to morphological differences, M. bramae differs from M. bulbocordis by being a specific gill parasite of the bream, while M. musculi is known to occur only in striated muscle cells.

Myxobolus cordis, a well-known parasite of the European Barbus spp., morphologically resembles M. bulbocordis, but its spores are significantly smaller than those of the new species.

The spores of M. dogielii are also similar to M. bulbocordis but somewhat smaller, varying between 9 and 16 μm in spore length. Bykhovskaya & Bykhovsky (1940), who first described this species, designated six different cyprinid fish as hosts for M. dogielii. The wide range of spore measurements characterizing infections of different cyprinids suggests that M. dogielii is a conspecific comprising several undifferentiated species. Bauer et al. (1991) also remarked that only the species infecting the common carp should be regarded as M. dogielii.

Two other Myxobolus species, M. karuni and M. persicus have been described from Barbus sharpeyi (Masoumian, Baska & Molnár 1994), but these species are specific parasites of the gills and they also differ from M. bulbocordis in spore morphology. Myxobolus karuni differs from M. bulbocordis by its large, elongated ellipsoidal polar capsules in which the polar filaments turn at least ten times, and by its prominent intercapsular appendix. The spores
M. persicus are significantly smaller than those of M. bulbocordis and have only a small intercapsular appendix.

In M. bulbocordis infection of B. sharpeyi, the location of the cysts was always restricted to the heart, but in more severe cases, cysts attached to the senosa of efferent arteries of the heart were also recorded. Although M. dogielii also has a predilection for the heart, Bauer et al. (1991) remarked that, in severe cases, the ‘muscles of the gill vessels’ also harboured cysts. While studying M. tucanarenisis infection of a South American fish, Molnár & Bekési (1993) found that the heart was consistently infected but other organs were also involved.

Myxobolus bulbocordis typically has a connective tissue affinity and never affects the musculature of the ventricle. Striated muscles of the fish body are often infected by several species of Myxobolus. Molnár & Kovács-Gayer (1985) and Baske (1987) described that location for M. cyprini and M. pseudodispar, respectively, and it is also known that the barbel parasites M. pfeifferi and M. musculi occur exclusively in that intracellular location. However, there is no evidence to show that any of the species designated as heart parasites would develop in or among the heart muscle cells.

The histological findings of this study show severe changes in the infected heart tissues, but no functional disorders were recorded in Barbus sharpeyi living in natural waters. In M. dogielii infection, Bykhovskaya & Bykhovskiy (1940) observed mortality among infected fish with the development of pericarditis and endocarditis. Bauer et al. (1991) also recorded deaths in stocks of carp infected by M. dogielii and severe pathological changes caused by the sausage-like cysts of M. dogielii penetrating into the muscle of the heart’s pericardium. This latter statement seems to be incorrect as the precardium does not contain muscular elements. In the present study, cysts were only occasionally found in the precardium, but a relatively heavy infection of the bulbus arteriosus was established. The cysts had a rounded shape, even inside the connective tissue of the bulbus, and distinctly differed from the sausage-like cysts of M. dogielii.

From histological examinations, no data...
could be collected on the stage of plasmodium development. However, the local pathological changes caused by mature and disrupted cysts were well visible. The most elementary form of host reaction was the formation of a connective tissue capsule around the cyst. Disrupted cysts consistently became penetrated by granulation tissue containing epithelioid cells and macrophages; however, direct spore phagocytosis was not seen. At the same time, gradual necrosis of the spores and the cells surrounding them gave rise to a tissue debris which became absorbed by the granulation tissue. The mechanism of granulation, the penetration of the tissue containing epithelioid cells, the appearance of melanomacrophages and the accumulation of yellowish pigment occurred in a manner analogous to that described by Kovács-Gayer & Molnár (1983) for the gill parasite of the common carp, *Myxobolus basilamellaris*.

The differentiation of spore-containing mature plasmodia surrounded by connective tissue from encapsulated spore masses remaining from earlier infections often poses a problem in histopathological examinations. In such cases, the type of capsule may provide guidance, as the wall of the cyst is usually thin while encapsulated spores are surrounded by a thick connective tissue capsule consisting of split fibres.

The pathological importance of *M. bulbocordis* cannot be assessed properly as only natural infections have been recorded. From the intensity of infection, however, it may be concluded that in the future during intensive pond culture of the host species similar pathological problems to those seen in *M. digieli* infection of the common carp might appear. The host fish, *Barbus sharpeyi*, is one of the most important fishes selected for artificial propagation in Iran, and successful efforts have already been made to culture this species in ponds (Yazdipour, Marashi & Moazed 1991; Jamili, Oryan & Seifabadi 1993).

**Acknowledgments**

The authors thank Dr S. R. Moghainemi for his help in collecting material in Iran. The studies of the senior author were funded by the Iranian Fisheries Research and Training Organization. The work of the Hungarian authors was supported by the US-Hungarian Joint Fund, J. F. No. 326.
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