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MYXOBOLUS INFECTIONS OF COMMON CARP (*CYPRINUS CARPIO*) IN SYRIAN FISH FARMS

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During a survey on *Myxobolus* infection of pond-cultured common carp in Syria three *Myxobolus* spp. were found. *Myxobolus dispar* infected the gill arteries, forming large elongated plasmodia in the gill filaments. The plasmodia of *M. basilamellaris* were located in the gill arches at the base of the filaments. Elongated filiform plasmodia of *M. encephalicus* were found in the blood vessels of the brain. Despite the common occurrence of the above parasites, no disease symptoms were observed in the infected fish specimens. This is the first report on myxosporean infection of fish from Syrian waters.

Key words: *Myxobolus*, Myxosporea, common carp, first occurrence, Syria, histology

Studies on parasitic infections of fish in Syria were started only in recent years. Up to that time, mostly monogenean infections of freshwater fishes (Samman, 1989; Dayoub et al., 2002, 2003; Al-Samman et al., 2006) had been studied. The only general survey on the helminth parasite fauna of pond-cultured carp in Syria has been performed by Dayoub (2003). Recently, for the first time in Syria, a survey has been conducted on actinosporean infection of the alternate oligochaete hosts for myxozoans (Dayoub et al., 2007*a*, 2007*b*; Székely et al., 2007).

Of the countries neighbouring Syria, some myxosporeans were studied in Iraq, where Herzog (1969) described the occurrence of *Myxobolus muelleri* and *M. oviformis,* while Ali et al. (1987) reported on finding *M. pfeifferi* in several freshwater fishes. In addition to these *Myxobolus* spp., even a new species was

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described by Rahemo (1976) from *Barbus grypus* by the name of *Unicauda lumae*. More data are available on myxosporean infections in the neighbouring Israel, where several papers have been published on fish diseases caused by myxosporeans (Paperna, 1982; Landsberg, 1983, 1985, 1986; Diamant and Paperna, 1992; Diamant et al., 1994; Diamant et al., 2005).

Histological studies on myxosporean infection of the gills of common carp falling within the subject-matter of the present paper have mostly been performed in Europe (Kovács-Gayer and Molnár, 1983; Lom and Molnár, 1983; Dyková et al., 1986; Dyková and Lom, 1988; Antychowicz and Reichert, 2005).

This paper reports the occurrence and histopathological features of three *Myxobolus* spp. infecting the gills and brain of pond-cultured common carp in Syria.

Materials and methods

Monthly samples of common carp 4 to 40 cm in length were collected from Al-Sinn Farm located in the coastal area of Syria and from Ain-Altaka and Shatha fish farms located in the inland region of Syria, Al Ghab Region (Table 1). Altogether 458 specimens of fish were obtained from the three farms between 13 March 2005 and 6 November 2006.

Table 1

Common carp surveyed for *Myxobolus* infection

Name of fish farms	No. of collected fish	Age	Number of infected fish			Prevalence of infection (%)		
			M. dispar	*M. basilamellaris*	*M. encephalicus*	*M. dispar*	*M. basilamellaris*	*M. encephalicus*
Shatha Farm	176	4 months – 3 years	22	5	9	12.5	2.84	5.11
Ain-Altaka Farm	120	2 months – 1.5 years	–	1	17	–	0.83	14.17
Al-Sinn Farm	162	3 months – 2 years	–	–	17	–	–	10.49

Details of the general parasitological survey have been presented by Dayoub (2003), Dayoub et al. (2002, 2003) and Dayoub and Salman (2004). In this paper we only report on the data concerning the myxosporean infections.

The fish were carried to the laboratory alive in oxygenated plastic bags, kept in aerated aquaria and subjected to complete parasitological dissection within three days. Hemibranchia of the gills were first surveyed under a preparation microscope *in toto*, then the dissected filaments were examined under a compound microscope. Pieces of inner organs were compressed between two

glass plates and examined under a compound microscope. Plasmodia with matured spores from infected organs were carefully picked off and opened with a needle. Part of the spores were placed into glycerol-gelatine on a slide under a coverslip, while another part was examined, drawn and measured in live state. Infected organs were fixed in 10% buffered formalin, embedded in paraffin wax, cut to 4–5 μm sections, and stained with haematoxylin and eosin. The vitality of spores was checked by placing spores into a 0.4% solution of urea. Spores of a given plasmodium were regarded as matured when at least 90% of the spores extruded polar filaments in this solution. Unfixed spores were studied by Nomarski's differential interference contrast using an Olympus BH2 microscope. The spores were photographed with an Olympus DP10 digital camera or recorded on videotapes, digitised images were obtained and measurements were taken with the IMAGO® software.

Results

During the survey, three *Myxobolus* spp. – *Myxobolus dispar* Thelohan, 1895, *M. basilamellaris* Lom et Molnár, 1983 and *M. encephalicus* Mulsow, 1911 – were found in Syrian common carp. The large, elongated plasmodia of *Myxobolus dispar* infected the apical tip of the gill filaments, plasmodia of *M. basilamellaris* were found in the cavity of the gill arches under the base of filaments, while the elongated cysts of *M. encephalicus* were detected in the brain. The shapes and measurements of the spores of the three species (Fig. 1a, b, c) corresponded to the figures and data given by Lom and Dyková (1992).

Histology

The large, elongated oval cysts of *M. dispar* were always located at the tip of the infected gill filaments (Fig. 2). No secondary lamellae were observed in that region. At the basal end of the plasmodium a part of the afferent artery and the cartilaginous gill ray could be observed. More basally in the filament unaffected lamellae were present.

Plasmodia of *M. basilamellaris* were found in the typical location (Fig. 3). They were located in the lumen of the gill arch just under the base of the cartilaginous gill rays. Some of the plasmodia slightly intruded into the connective tissue between the two filaments.

The elongated filiform plasmodia of *M. encephalicus* were found in the blood vessels of the brain. The central bulk of the plasmodium was found in the enlarged parts of blood vessels (Fig. 4), its ends, however, intruded into the narrow blood vessels and capillaries (Fig. 5). Despite the large size of plasmodia no obstruction of blood flow was recorded, and red blood cells observed around plasmodia both at their enlarged central part and narrowed end parts indicated that the infected area of the blood vessels was passable for the blood.

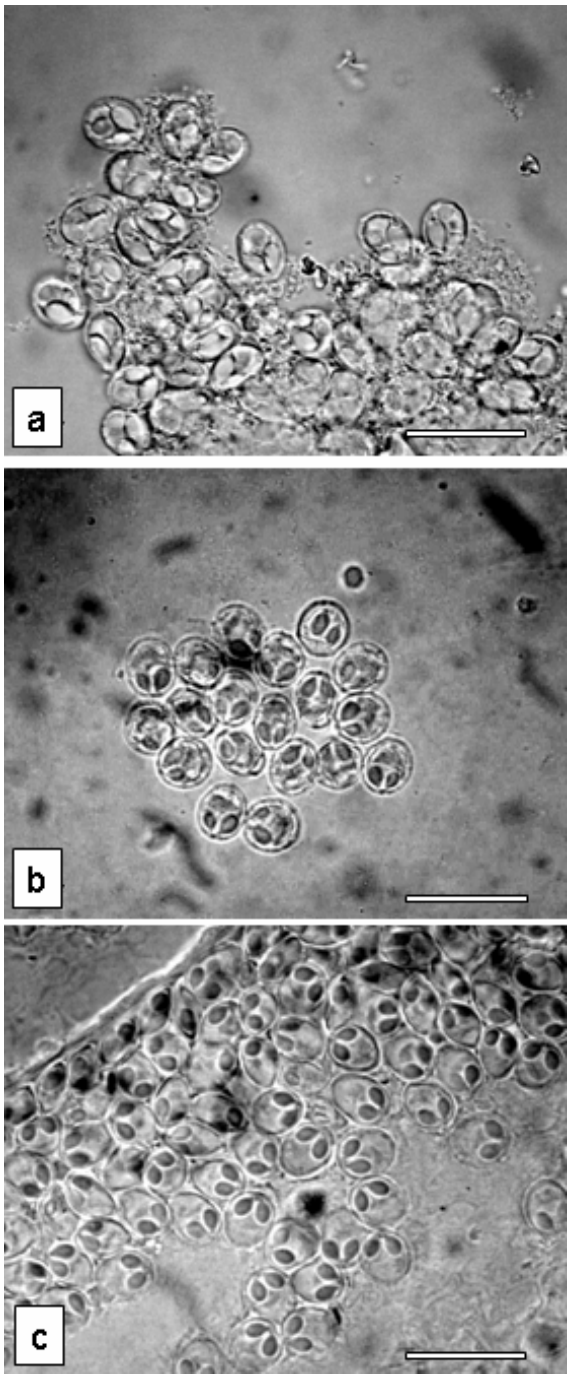

Fig. 1. Spores of *Myxobolus* spp. infecting the common carp. (a) *M. dispar*, (b) *M. basilamellaris*, (c) *M. encephalicus.* Photos taken of glycerol-gelatine preparation. Bar = 20 µm

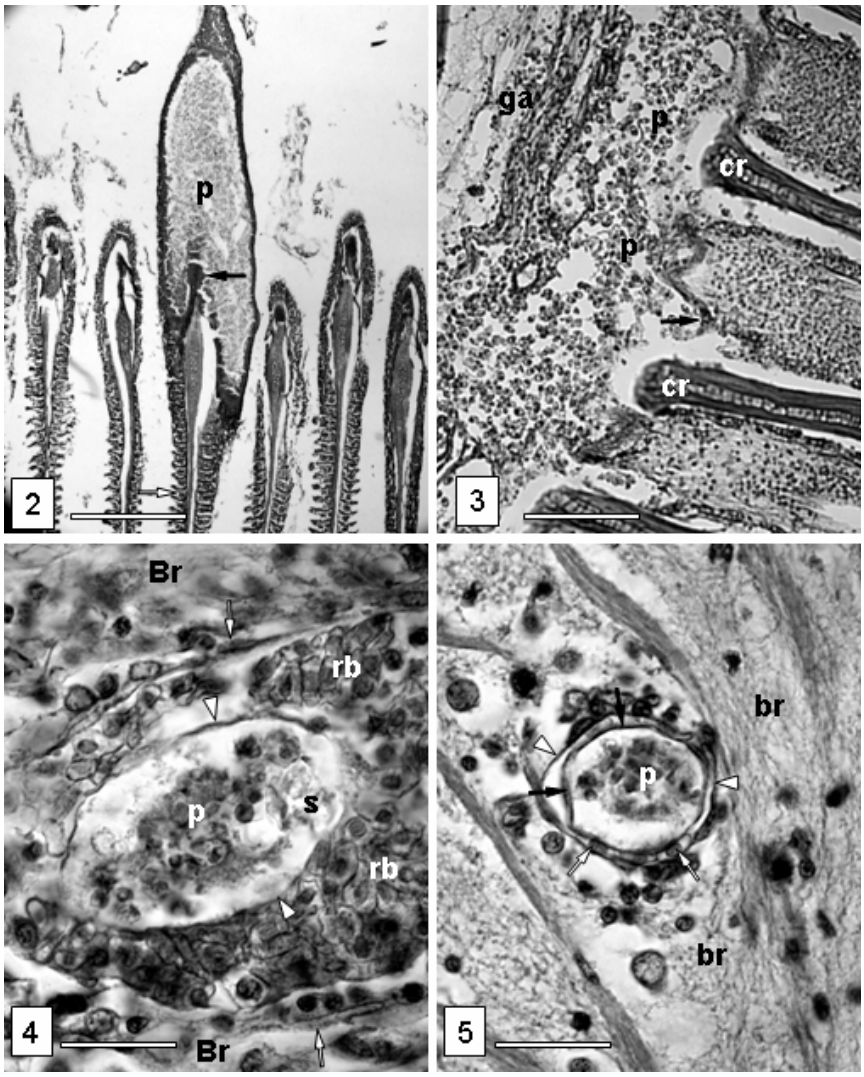

Fig. 2. A large *Myxobolus dispar* plasmodium (p) is located at the tip of a gill filament among uninfected filaments. The plasmodium developed in the afferent artery (arrow). At the basal part of the filament unaffected gill lamellae (open arrow) are seen. Histological section, haematoxylin and eosin (H.-E.) staining. Bar = 100 µm; *Fig. 3. Myxobolus basilamellaris* infection in the gill of common carp. A large matured plasmodium (p) with some spores is located in the gill arch (ga) under the base of the filaments. Parts of the plasmodium bulge into the filament tissue (arrow) between the cartilaginous gill rays (cr). Histological section, H.-E. staining. Bar = 50 µm; *Fig. 4.* Histological section of a thin-walled vein (arrow) in the brain tissue (br). A *M. encephalicus* plasmodium (p) is located free among red blood cells (rb) inside the vein. The plasmodium, bordered only by a thin ectoplasm (open arrow), contains developmental stages and some spores (s). H.-E. staining. Bar = 20 µm; *Fig. 5.* Cross-sectioned end of a *M. encephalicus* plasmodium (p) occupying a large part of a small vein in the brain (br). Between the ectoplasm of the plasmodium (small arrow) and the wall of the vein (open arrow) red blood cells (large arrow) can be seen. Histological section, H.-E. staining. Bar = 20 µm

Table 2

Myxobolus spp. described from common carp

Name of species	Authors of description	Infected organs	Country of original description	Distribution of the parasite
M. acinosus	Nie et Li, 1973	Gills	China	China
M. basilamellaris	Lom et Molnár, 1983	Gills	Hungary	Hungary
M. circulus	(Akhmerov, 1960)	Gills	Russia	Russia
M. cuttacki	Haldar, Samal et Mukhopadhyay, 1996	Gills	India	India
M. cyprini	Doflein, 1898	Muscles	Germany	Europe
M. cyprinicola	Reuss, 1906	Intestine	Russia	Europe
M. dogieli	Bikhovskaya et Bikhovski, 1940	Heart	Russia	Europe
M. ectopicus	Nie et Li, 1992	Urinary bladder	China	China
M. encephalicus	(Mulsow, 1911)	Brain	Germany	Europe
M. gracilis	Nie et Li, 1992	Urinary bladder	China	China
M. hanchuanensis	Chen, 1998	Gills	China	China
M. heteromorpha	Ma, 1993	Heart, kidney	China	China
M. hoshinai	Landsberg et Lom, 1991	Integument	Japan	Japan
M. intrachondrealis	Molnár, 2000	Gill arches	Hungary	Hungary
M. junchisi	Yukhimenko, 1986	Gills	Russia	Far East
M. koi	Kudo, 1919	Gills	Japan	Japan
M. longisporus	Nie et Li, 1992	–	China	China
M. microlatus	Li et Nie, 1973	All organs	China	China
M. miyunensis	Chen, 1998	Kidney	China	China
M. musseliusae	Yakovchuk, 1979	Gills	Russia	Russia
M. obovoides	Li et Nie, 1973	Gills	China	China
M. ovoidalis	Fantham, 1930	Subcutaneous tissue	South Africa	South Africa
M. paratoyamai	Nie et Li, 1992	Nose cavity	China	China
M. rotundatus	Akhmerov, 1956	Gut	Russia	Far East
M. sinocyclochilusi	Ma, 1998	Gills	China	China
M. toyamai	Kudo, 1917	Gills	USA	USA
M. wuchangensis	Chen, 1998	Caudal fins	China	China
M. wucheni	Landsberg et Lom, 1991	Kidney, gills	China	China
M. yibinensis	Zhao et Ma, 1994	Muscles	China	China

Discussion

Up to now about 30 *Myxobolus* species (Table 2) have been described from common carp (Landsberg and Lom, 1991; Eiras et al., 2005), but some other species described from other cyprinids also seem to be capable of infecting the common carp. Of the latter, *M. artus* Achmerow, 1960 originally described from *Carassius gibelio* is the most important due to its high pathogenicity (Ogawa et al., 1992). Some *Myxobolus* species infecting common carp in the European region (e.g. *M. cyprini*, *M. cyprinicola*, *M. basilamellaris*, *M. dispar*, *M. dogieli*, *M. encephalicus* and *M. intrachondrealis*) are well studied and, besides their spores, abundant data are available on the location, development and histopathology of their plasmodial stages as well (Kovács-Gayer and Molnár, 1983; Molnár and Kovács-Gayer, 1985; Dyková and Lom, 1988; Bauer et al., 1991; Molnár, 2000, 2002; Antychowicz and Reichert, 2005). Similarly, *Myxobolus koi* and *Myxobolus artus* have been studied thoroughly in Japan (Ogawa et al., 1992; Yokoyama et al., 1997). A large number of *Myxobolus* spp. infecting the common carp have been described from China; however, due to the inadequate descriptions based upon individual spores and the lack of data on the plasmodial stages, their validity might be questioned in some cases.

During the survey of Syrian pond-farm fishes three *Myxobolus* species (*M. basilamellaris*, *M. dispar* and *M. encephalicus*) were found in carp in their typical location. *M. dispar* formed large 'cysts' at the tip of the gill filaments, while the plasmodia of *M. basilamellaris* were located under the base of filaments inside the gill arch as it had been reported by Kovács-Gayer and Molnár (1983). The heaviest infection was recorded for *M. encephalicus*, where most of the one- and two-year-old carp examined were infected by elongated plasmodia inside the brain, giving a histopathological picture similar to that described by Antychowicz and Reichert (2005). Although Lom and Dyková (1995) described that in heavy infections with *M. encephalicus* granulomatous inflammation might develop in the brain tissue and infected fish may show locomotor disorders, in our cases such symptoms were not observed.

Myxobolus infections of the common carp found in Syrian pond farms seem to be relatively mild cases, and pathogenic effects manifesting themselves in apparent signs were not recorded for any of the three species. On the other hand, local alterations affecting restricted parts of the gills and brain suggest the chance that a more severe parasitosis might develop in intensive common carp culture.

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