

***Myxobolus episquamalis* (Myxosporea: Myxobolidae) on the scales of wild mullet, *Mugil cephalus* L, in Korea.**

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Numerous large whitish cysts were found on the scale of wild mullet, *Mugil cephalus* captured in Jin-Hae bay of southern coastal sea of Korea. The cyst consisted of many trophozoites, mature spores and interstitial tissues of host origin. Spores were 8.25 μm (7.26-9.35) in length, 6.3 μm (5.63-6.78) in width, 4.34 μm (3.96-5.04) in thickness. Polar capsules were 4.45 μm (3.8-5.4) in length and 2.35 μm (1.62-2.86) in width, and the length of polar filament was about 39.57 μm (26.3-56.33). Based on the spore morphology and the host & tissue specificity, the present specimens were identified as *Myxobolus episquamalis* Egusa, Maeno & Sorimachi, 1990. Deformation of bony plate of the scales and infiltration of inflammatory cells were observed in the histological sections.

Key Words: Myxobolus episquamalis, Mugil cephalus, Scale

Introduction

The Family mugilidae in Korea was classified into 3 separate species belonging to two genera: *Mugil cephalus*, *Liza haematocheilus*, *L. carinatus* (Lee and Joo, 1994). Particularly *Mugil cephalus* L. is commercially valuable fish species, successfully cultured in Korea.

Recently Kim *et al.* (2003) found the systemic infection of *Myxobolus* sp. of wild mullet caught in a Kwang-Yang bay, Korea. The genus *Myxobolus* is a member of the class Myxosporea in the phylum Myxozoa, which could localized on/in various organs including brain, gill, skin, intestine, spleen, kidney of the fish. They have been described above 450 species from the wild and cultured populations (Kudo, 1920; Landsberg and Lom, 1991; Lom and Dykova, 1992; Shulman, 1988).

In this study, we found white cysts on the scale of wild caught mullet in Korea, and this appearance was corresponded to previous reports of myxosporean cysts on the surface of mugilid fish in the costal waters of different countries. Thus we compared the spore morphology with other myxobolids parasitizing *M. cephalus* and also investigate its histopathology.

Materials and Methods

Wild mullets *Mugil cephalus* L. were captured by fishing at Jin-Hae Bay in southern coastal sea of Korea. Among 20 captured fish, 3 individuals showed whitish cyst on their surface. Cysts on the infected scales were carefully removed and squashed for the fresh observations or fixed with Bouin's fixative for histology. Smear preparations

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were also made by Diff-Quik staining (International Co. Ltd. Japan). Fresh spores obtained from cysts were photographed and measured according to guideline for species description of myxosporeans by Lom and Authur (1989), and by using differential inference contrast (DIC) light microscope equipped with ocular micrometer and image analysis system (ImageTool ver. 3.0, UTHSCSA). Spore dimensions were obtained from fresh 50 spores (mean \pm standard deviation).

Results

Morphology of *Myxobolus episquamalis* Egusa, Maeno & Sorimachi, 1990

M. episquamalis formed a large flat, white cyst on the outer surface of the apical region of the scale (Fig. 1A, B, C, D). Ovoid spore (Fig. 2A, B, D), in

frontal view, contained two pyriform polar capsules. Capsules were somewhat unequal and occupied the anterior half of the spore. The apex of the polar capsule directed to the apical end of the spore. In lateral view, spores were lenticular (Fig. 2C). The length of spore was $8.25 \mu\text{m}$ (7.26-9.35) and width $6.3 \mu\text{m}$ (5.63-6.78) and thickness $4.34 \mu\text{m}$ (3.96-5.04). The polar capsule measured $4.45 \mu\text{m}$ (3.8-5.4) in length and $2.35 \mu\text{m}$ (1.62-2.86) in width. The length of polar filament was about $39.57 \mu\text{m}$ (26.3-56.33) (Fig. 2D). Spore dimensions were summarized in Table 1 and compared with the previous descriptions of *M. episquamalis*.

Host: *Mugil cephalus*

Locality: Jin-Hae Bay, Korea.

Site of infection: Scale and muscle

Prevalence: 3 of 20 specimens examined

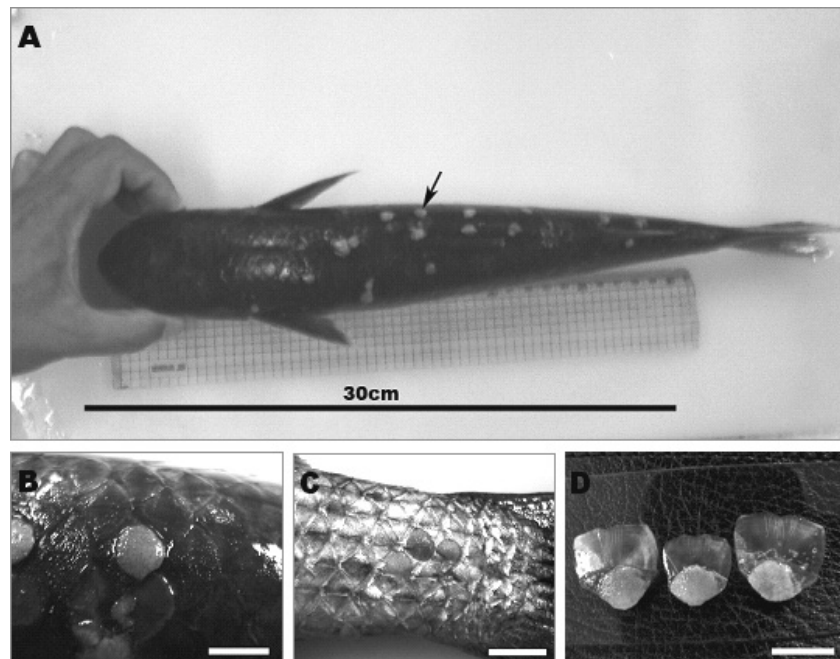


Fig. 1. *Mugil cephalus* with dermatitis caused by *M. episquamalis*. (A, B) white spotted appearance of infected mullet. Note whitish cyst (arrowed) on the dorsal regions of the fish. Scale bar (figure B = 5 cm). (C) Caudal region of the affected fish. Some cyst was red-fringed. Scale bar = 10 cm. (D) The large cyst of *Myxobolus episquamalis* on the apical area of the scale. Cysts were raised as it growths. Scale bar = 5 cm.

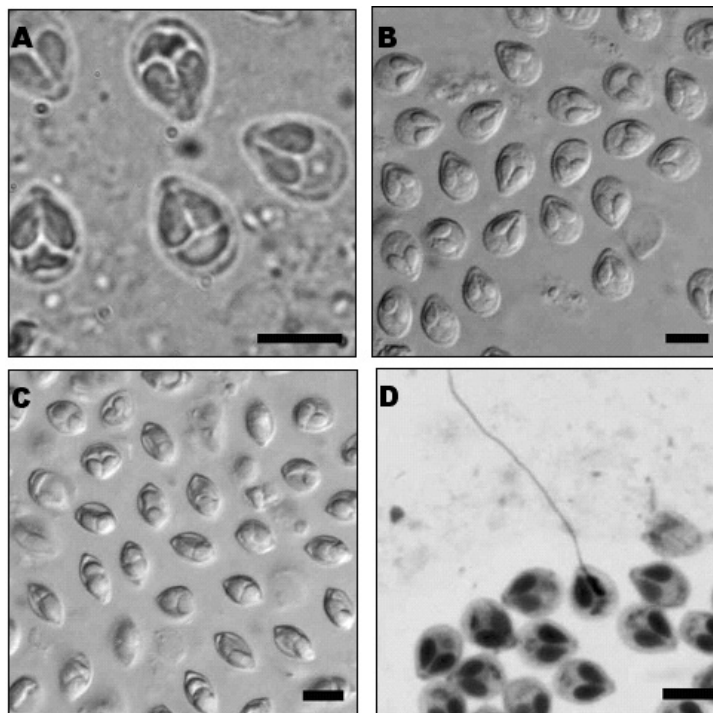


Fig. 2. Mature spores of *M. episquamalis*. (A) Fresh spores observed under light microscope. (B, C) Fresh spores observed under DIC microscope. figure B is frontal view of spores and figure C is lateral view of ones. (D) Diff-Quik stained spores. Two polar capsules were observed in the spores. All scale bars = 6 μ m.

Table 1. Summary of spore characteristics of *Myxobolus episquamalis* reported from other regions and present results

Authors		Bahri & Marques	Egusa <i>et al.</i>	Rothwell <i>et al.</i>	Lin & Ho	Present
Spore	length (μ m)	8.5 (8-9)	8.6 (7.5-9.5)	9.2 (8.8-10)	9.02 (8.69-10.27)	8.25 (7.26-9.35)
	width (μ m)	6.5 (6-7)	6.8 (6-7.5)	6.4 (6.2-6.8)	6.32 (5.53-7.11)	6.3 (5.63-6.78)
	thickness (μ m)	-	5.1 (4.5-5.5)	4.9 (4.7-5.0)	5.20 (4.74-5.53)	4.34 (3.96-5.04)
PC	length (μ m)	4 (3.5-4.5)	4.4 (3.8-5.0)	4.1	3.95 (2.39-4.74)	4.45 (3.8-5.4)
	width (μ m)	2 2.2 (1.5-2.5)	2.1-2.6 (2.0-3.0)	1.78	2.35 (1.58-2.37)	(1.62-2.86)
PF	coling	5-6		7	-	
	length	-	31.2 (25-44)	48-58	30.02 (20.54-37.92)	39.57 (26.3-56.33)
Host		<i>Mugil cepahlus</i>	<i>M. cepahlus</i>	<i>M. cepahlus</i>	<i>Liza macrolepis</i>	<i>M. cepahlus</i>
Location		Tunisia	Japan	Australia	Taiwan	Korea
Site		Scale	Scale	Scale	Scale	Scale

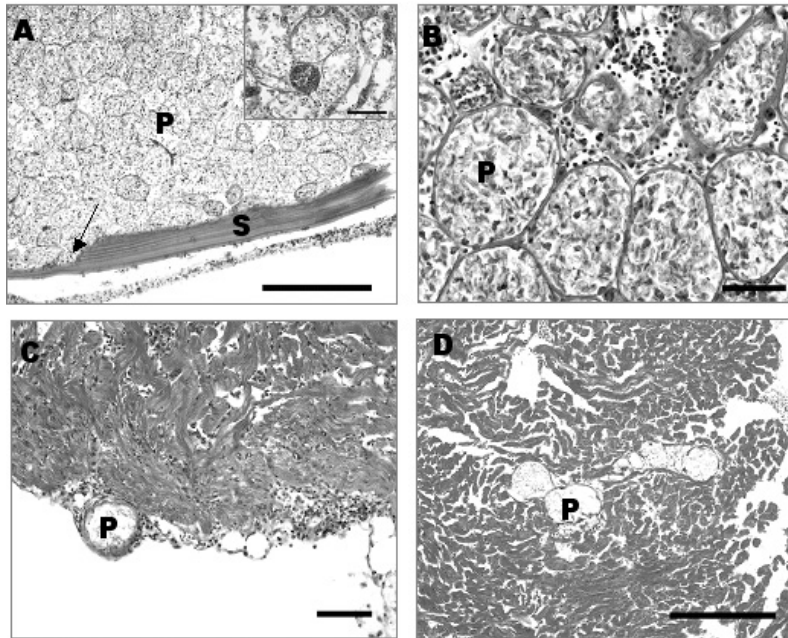


Fig. 3. Histological sections. (A) Cyst filled with numerous plasmodium (P). Bony plate of the scale (S) was disappeared (arrowed in figure A). Inlet showed blood vessels among trophozoites. Scale bar (figure A = 400 μm ; inlet = 200 μm). (B) Fibrous interstitial materials and leucocytes between dense-thin walled plasmodium. Plasmodium contained developing sporoblasts and spores. Scale bar = 100 μm . (C, D) Plasmodia invasions in muscle tissues under the skin. Scale bars = 200 μm .

Histopathology

Cysts consisted of many trophozoites and interstitial mass which contained leucocytes (Fig. 3A, B) and sporadic growth of blood vessels (See inset in figure 3A). The bony layer of the scale was deformed by invasion of trophozoites (Fig. 3A, B). Besides scale, plasmodia sometimes invaded into muscle tissues (Fig. 3C, D). Plasmodia (trophozoite) were varied in shape and size about 200 μm in diameter. The wall of plasmodium was thin, dense and eosinophilic, and most trophozoites were polysporous with many spores and sporoblasts (Fig 3B).

Discussion

According to our knowledge, 11 species of genus *Myxobolus* have been described in *Mugil cephalus* L. (Kudo, 1920; Shulman 1966; Iversen *et al.*, 1971; Egusa *et al.*, 1990; Maeno *et al.*, 1990;

Landsberg and Lom, 1991; Lom and Dykova, 1992, 1994). Among them, only *M. episquamalis* infected the scales of *Mugil cephalus* (Bahri and Maques, 1996; Egusa *et al.*, 1990; Menezes, 1984; Overstreet and Howse, 1977; Rothwell *et al.*, 1997). Fish-parasitic myxosporeans generally reveals strong host and tissue specificity in well-definable life cycle (Molnar, 1994). This tendency as well as the morphology of spore stage was also provide valuable information for the taxonomic classification of the myxosporean parasites. In addition, spore dimensions of the present specimen were quite resembled those in previous descriptions of *Myxobolus episquamalis* - Australia (Rothwell *et al.*, 1997), Israel (Overstreet and Howse, 1977), Japan (Egusa *et al.*, 1989, 1990), Portugal (Menezes, 1984), Taiwan (Lin and Ho, 1997), Tunisia (Bahri and Maques, 1996; Bahri *et al.*, 1995, 2003). Thus, we identified the present speci-

men as *M. episquamalis* based on the spore morphology, host species and target tissue.

The lesions seen in the scale of Korean sea mullet were also similar to those described in *M. episquamalis* infected mugilid fish from other countries (Egusa *et al.*, 1989, 1990; Rothwell *et al.*, 1997). *M. episquamalis* has affinity for connective tissues associated with dermal scales like other scale dwelling myxosporeans such as *Myxobolus notemigoni* (Lewis and Summerfelt, 1964), *M. squamophilus* (Molnar, 1997), *Unicaudata clavicauda* (Cone and Melendy, 2000). *Myxobolus episquamalis* formed large, flat white cyst on the outer surface of apical region of the scales of *Mugil cephalus* with plasmodia penetrated the bony plate of the scales and often caused surface erosion of the scales. However, we were unable to find epithelium attenuation reported by Rothwell *et al.* (1997). Interestingly the plasmodia invaded into muscle tissues under skin and elicit leukocyte infiltration. This observation has never been reported in other previous reports of *M. episquamalis* infected mullet.

Since first report of *M. episquamalis* in Japanese seawater (Egusa, 1989), it was considered that pathogenic effects of this myxosporean parasite on host *Mugil cephalus* were minimal. However, Bahri and Marques (1996) reported that this parasite invades the whole body of the mullet and could decrease the commercial values because the fish were unsaleable. The epidemiological study in farmed mullet should be necessary in further study, because the occurrence of *M. episquamalis* infections in cultured stock near sampling site of this study were not still determined.

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References

- Bahri, S., Andree K. B. and Hedrick R. P.: Morphological and phylogenetic studies of marine *Myxobolus* spp. from mullet in Ichkeul Lake, Tunisia. *J. Eukaryot. Microbiol.*, 50: 463-70, 2003.
- Bahri, S. and Marques, A.: Myxosporean parasites of the genus *Myxobolus* from *Mugil cephalus* in Ichkeul lagoon, Tunisia: description of two new species. *Dis. Aquat. Org.*, 27: 115-122, 1996.
- Bahri, S., Marques, A., Coste, F., Bouix, G. and Ben-Hassine, O. K.: Presence of cutaneous myxosporidian in Tunisian *Mugil cephalus* (Linnaeus, 1758). *Bull. Eur. Ass. Fish Pathol.*, 15: 54-57, 1995.
- Cone, D. K. and Melendy J. S.: Infections of *Unicaudata clavicauda* (Kudo, 1934) (Myxozoa) in the skin of *Notropis hudsonius* (Cyprinidae) from Montana, with a synopsis of the genus *Unicaudata* Davis, 1944. *Folia Parasitol.*, 47: 273-278, 2000.
- Egusa, S., Jyo, Y., Oka, H. and Ikata, K.: Skin disease of *Mugil cephalus* due to *Myxobolus* sp. (Myxozoa: Myxobolidae). *Fish Pathol.*, 24: 59-60, 1989.
- Egusa, S., Maeno, Y. and Sorimachi, M.: A new species of Myxozoa, *Myxobolus episquamalis* sp. n. infecting the scales of the mullet, *Mugil cephalus* L. *Fish Pathol.*, 25: 87-91, 1990.
- Iversen, E. S., Chitty, N. and Van Meter, N.: Some Myxosporidia from marine fishes in south Florida. *J. Protozool.*, 18: 82-86, 1971.
- Kim, W. S., Lee, M. K., Park, K. H., Jung, S. J. and Oh, M. J.: The infection of *Myxobolus* sp. in

- wild mullet, *Mugil cephalus*. J. Fish Pathol., 16: 31-38, 2003.
- Kudo, R. R.: Studies on Myxosporidia. A synopsis of genera and species of Myxosporidia. III. Biol. Monog., 5: 1-265, 1920.
- Landsberg, J. and Lom, J.: Taxonomy of the genera of the *Myxobolus/Myxosoma* group (Myxobolidae:Myxosporidia) current listing of species and revision of synonyms. Syst. Parasitol., 18: 165-186, 1991.
- Lee, C. L. and Joo, D. S.: Synopsis of family Mugilidae (Perciformes) from Korea. Bull. Korean Fish. Soc. 27: 814-824, 1994.
- Lewis, W. M. and Summerfelt, R. C.: A myxosporidian, *Myxobolus notemigoni* sp. n., parasite of the golden shiner. J. Parasitol. 50: 386-389, 1964.
- Lin, C. L. and Ho, J. S.: *Myxobolus episquamalis* (Myxosporidia) occurring on the scales of the mullet, *Liza macrolepis*, cultured in Taiwan. J. of the Fisheries Society of Taiwan. 24(3): 193-200, 1997.
- Lom, J. and Dykova, I.: Protozoan parasites of fishes. Amsterdam, Elsevier Science Publishers B.V., 315pp, 1992.
- Lom, J. and Dykova, I.: Studies on protozoan parasites of Australian fishes III. species of genus *Myxobolus* Butschli, 1882. Eur. J. Protistol., 30: 431-439, 1994.
- Maeno, Y., Sorimachi, M., Ogawa, K. and Egusa, S.: *Myxobolus spinacurvatura* sp. n. (Myxosporidia: Bivalvulida) parasitic in deformed mullet, *Mugil cephalus*. Fish Pathol., 25: 37-41, 1990.
- Menezes, J.: A case of massive cutaneous myxobolosis in wild mullet. Biol. Inst. Nac. Invest. Pesca., 12: 71-73, 1984.
- Molnar, K.: Comment on the host, organ and tissue specificity of fish myxosporidia and on the types of their intraspine development. Parasit. Hung., 27: 5-20, 1994.
- Molnar, K.: *Myxobolus squamophilus* sp. n. (Myxosporidia: Myxosporidia), a common parasite of scales of bream (*Abramis brama* L.). Acata Protozool., 36: 221-226, 1997.
- Overstreet, R. M., Howse, H. D.: Some parasites and diseases of estuarine fishes in polluted habitats of Mississippi. Ann. N. Y. Acad. Sc., 298: 427-462, 1977.
- Rothwell, J. T., Virgona, J. L., Callinan, R. B., Nicholls, P. J. and Langdon, J. S.: Occurrence of cutaneous infections of *Myxobolus episquamalis* (Myxosporidia: Myxobolidae) in sea mullet, *Mugil cephalus* L., in Australia. Aust. Vet. J., 75: 349-352, 1997.
- Shulman, S. S.: Myxosporidians in the fauna of the USSR. Nauka Publ, Moscow (in Russian), 1966.
- Shulman, S. S.: Myxosporidia of the USSR. Nauka Publ, Moscow, 504pp (Translated by the Amerind Publishing Co Pvt Ltd, New Delhi), 1988.

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