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Note

Abnormal forms of *Myxobolus bizerti* and *Myxobolus mülleri* (Myxosporea: Bivalvulida) spores with caudal appendages

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Abstract

Abnormal forms of spores were observed in fresh preparations of *Myxobolus bizerti and Myxobolus mülleri*. These spores present caudal appendages making them appearing as *Henneguya* spores. The abnormal spores of *M. bizerti* were 28.5-30.5 μm in length; body width 14 μm; caudal appendages 12-14 μm in total length and polar capsules measuring 6.5-7 in length by 4.5-5 μm in width. However, abnormal spores of *M. mülleri* were rounded oval in front view with total length 20-22 μm; body width 9 μm; caudal appendages 9-11 μm; polar capsules L (4.5-5) x W (2-3) μm.

Although myxozoans have been studied for a long time, many questions about their biology, life cycle and taxonomy have not been answered till recently. Nevertheless, taxonomic studies have not been abandoned and the phylogenic status of myxosporeans has undergone several changes.

Nowadays, molecular systematics has become a widely applied approach in taxonomic and phylogenetic studies of the Myxozoa, mainly through the analysis of small subunit ribosomal DNA sequences.

The genera *Myxobolus* and *Henneguya* (suborder Platysporina) have been considered separate groups with regard to their morphology (Lom & Dykova, 1992). Here we report the presence of abnormal forms of *Myxobolus bizerti and Myxobolus mülleri* spores with caudal appendages suggesting the existence of a much closer relationship between the two genera.

Myxobolus bizerti and *M. mülleri* (Bahri & Marques, 1996; Bahri, 1997) are known to infect respectively gills of flathead grey mullet *Mugil cephalus* and mesenteric vessels of thin-lipped grey mullet *Liza ramada* from the Mediterranean coastal waters of Tunisia. *M. bizerti* developed numerous plasmodia in the primary gill filaments, inducing occasionally obstruction of their vessels. However, *M. mülleri* formed plasmodia in the wall of mesenteric vessels (up to 3 mm) inflicting damage to the infected tissue.

Mugil cephalus and *Liza ramada* fish were caught in Lake Ichkeul in north Tunisia. Fish were brought alive to the laboratory and organs were examined for the presence of myxozoans. Plasmodia found in infected

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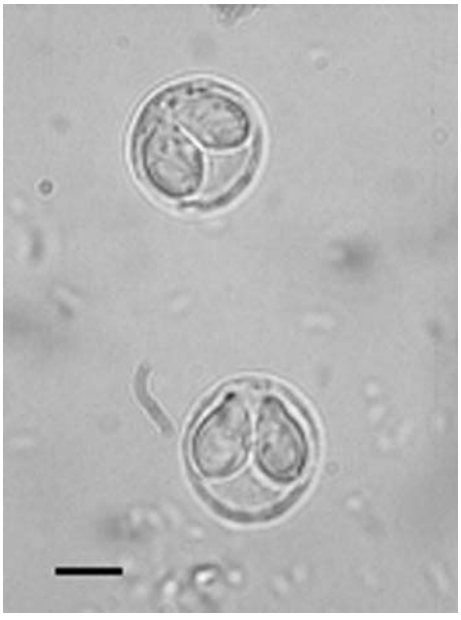

Figure 1. Fresh spore of *Myxobolus bizerti* from gills of *Mugil cephalus* (Bar: 7μm).

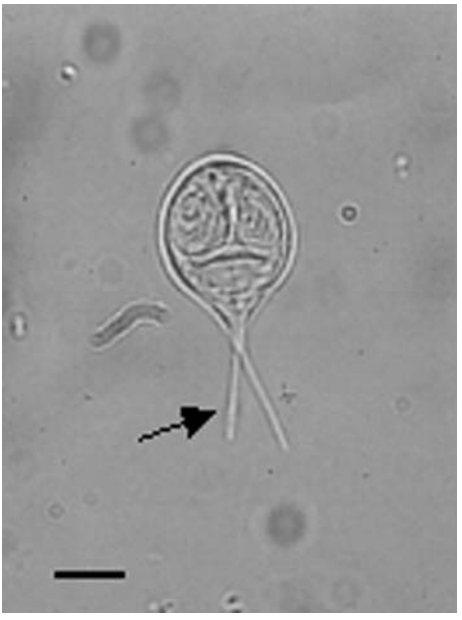

Figure 2. Spore of *Myxobolus bizerti* with caudal appendages (arrow) from gills of *Mugil cephalus* (Bar: 7μm).

tissue were ruptured and the contents were examined by light microscopy. The spores were identified according to the criteria established by Lom & Arthur (1989).

The observation of *Myxobolus bizerti* fresh smears showed the presence of an abnormal form of spore with caudal appendages making this *Myxobolus* species appearing as a spore of the genus *Henneguya* (Figure 2). The spore was rounded oval in front view with two valves, each one continued as a caudal projection. The total length of spore was 28.5-30.5 μm; body width 14 μm; tail length 12-14 μm; valvular cells width 0.7 μm; polar capsules L (6.5-7) x W (4.5-5) μm.

According to prior description (Bahri & Marques, 1996) *Myxobolus bizerti* spores were 14-14.5 μm in diameter with polar capsules L (6-7) x W (5.5-6) μm; the abnormal spore has approximatively the same dimensions.

In comparison with *Myxobolus mülleri* spores dimensions L (10-12) x W (9-11) μm and polar capsules sizes L (4-5) x W (2-3) μm), the abnormal spore (Figure 3) was very close by its shape and size. In fact, the abnormal spore was rounded oval in front view with total length 20-22 μm; body width 9 μm; caudal appendages 9-11 μm; polar capsules L (4.5-5) x W (2-3) μm.

This is the first record of *Myxobolus* spores with caudal appendages. Though this conflicts with morphology-based taxonomy, this finding supports the phylogenetic relationships among the two major genera *Myxobolus* and *Henneguya.*

In recent years, many papers have reported on the molecular phylogenetic study of Myxozoa, and Platysporina in particular. The discrepancies within the platysporina were

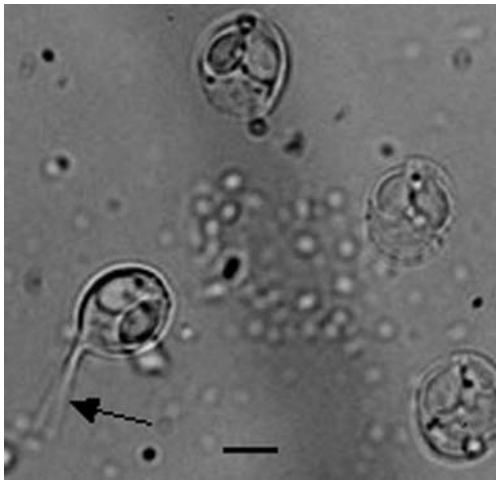

Figure 3. Spores smear of *Myxobolus mülleri* from mesenteric vessels of *Liza ramada* with spore showing caudal appendages (arrow) (Bar: 5µm).

reported first by Smothers et al. (1994) and later by Andree et al. (1999), Kent et al. (2001), Bahri et al. (2003) and Yokoyama et al. (2005). The 18S rDNA sequence data in these studies do not support a phylogenetic separation of the two genera *Henneguya* and *Myxobolus*. For example, *Henneguya salminicola*, which was used as an outgroup in the phylogenetic analysis with *Kudoa thyrsites*, and *Ceratomyxa shasta*, grouped within the clade formed by the *Myxobolus* freshwater species (Andree et al., 1999). Moreover, Bahri et al. (2003) used as outgroup several species selected from platysporinid genera that included *Henneguya salminicola*, *Henneguya zschokkei, Henneguya ictaluri, Henneguya exilis,* with *Myxidium lieberkeuhni, Kudoa thyrsites, Ceratomyxa shasta* and *Tetracapsuloides bryosalmonae*. Once again, *Henneguya* marine species grouped within the clade formed by marine *Myxobolus* species. The phylogenetic data supports the hypothesis that caudal appendages on spore valves, which distinguishes *Henneguya* from *Myxobolus*, is a pleomorphic feature that may have arisen on multiple occasions during evolution and is not a valid character to separate these two speciose groups of platisporinids into separate genera.

Consequently, caudal appendages provide less insight into relationships among the two genera and suggestions to elucidate *Henneguya* classification in future work are expected.

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