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Journal of Fish Diseases

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Journal:	*Journal of Fish Diseases*
Manuscript ID	JFD-2020-8
Manuscript Type:	Short Communication
Date Submitted by the Author:	14-Jan-2020
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SHORT COMMUNICATION

Dermocystidium sp. (Mesomycetozoea: Dermocystidiaceae) primary ocular infection in a koi carp (*Cyprinus carpio* var. *koi*)

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Running head: *Dermocystidium* sp. ocular infection in a koi

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Keywords: *Dermocystidium* sp., Mesomycetozoea, koi carp, eye

Dermocystidium spp. (Mesomycetozoea: Dermocystidiaceae) comprises several species able to infect a wide range of marine and freshwater fish (Gozlan et al., 2014; Rowley et al., 2013). The taxonomic position of *Dermocystidium* is still under debate, even though Dyková and Lom (1992) observed hyphae associated to *Dermocystidium koi* infection, suggesting its fungal nature. Currently, the genus is classified in the superclass Mesomycetozoea which includes protists "fungus-like" in the supergroup Opisthokonta (Gozlan et al., 2014).

The lesions caused by *Dermocystidium* spp. in fish are chronic and characterized by visible cysts or nodules on skin and fins (Feist et al., 2004; Wildgoose, 1995; Zhang & Wang, 2005), but severe gills and systemic infections causing mortality have been described in several species (Höglund et al., 1997; Olson & Holt, 1995; Athanassopoulou, 1998; Landsberg & Paperna, 1992; Kirkbright et al., 2016; Fujimoto et al., 2018).

The present study described a primary ocular infection by *Dermocystidium* sp. in a koi carp (*Cyprinus carpio* var. *koi*). The koi carp was found dead by the owner of a private pond and sent refrigerated to the laboratory. The fish presented an evident subconjunctival whitish exophytic tissue, surrounded by reddish edges, that protruded over both ocular bulbs (Fig. 1a). The fish was necropsied and tissues fixed in 10% buffered formalin. The ocular globes were then dissected under stereomicroscope and smears of the exophytic tissue placed on slides, clarified with lactophenol or stained with China ink, and examined under light microscope. For histopathology, tissues were routinely processed, sections were cut at 4 µm and stained with Haematoxylin and Eosin (H&E), Periodic Acid Shiff (PAS) and Gomori.

At the stereomicroscope, the peribulbar tissue and anterior chamber presented numerous filiform 3-mm-length white hyphal-like cysts (Fig. 1b). At the light microscope, the cysts were filled with round variably sized (5.53-12.90 µm in diameter; mean=9.71; sd=1.99; n=80) mature spores referable to *Dermocystidium* sp. admixed with developmental stages (>5 µm). The spores showed a large refractile body or central vacuole and a peripheral cytoplasm with a nucleus and three or more vacuoles (Fig. 1c).

At histology, the peribulbar soft tissues until muscle and the choroid space of the posterior chamber, adjacent to the retina, were infiltrated by numerous elongated cysts (Fig. 2f-h). The cysts had a thick eosinophilic wall and contained numerous spores (Fig. 2h,i). Around the cysts, a granulomatous inflammatory reaction was visible (Fig. 2h). The iris and the ciliary body were also replete by numerous free mature spores. An intense mixed inflammatory infiltrate with multinucleated giant cells, vascular congestion and abundant granulation tissue were observed (Fig. 2g). Haemorrhagic and necrotic areas were observed. Some basophilic granular aggregates referable to bacteria were also found. Neither developmental stages of *Dermocystidium* sp. nor inflammatory reaction were seen in internal organs. PAS and Gomori stains helped to visualize the developmental stages (Fig. 1d,e) and exclude the presence of spores in other organs.

In literature, only three descriptions of ocular infection by *Dermocystidium* sp. are reported in fish (Elkan, 1962; Molnar et al., 2008; Fujimoto et al., 2018). The present case is the first report of a primary ocular infection in a koi carp. The spore size and morphology are consistent with literature reports of *Dermocystidium koi* (Gjurcevic et al., 2008; Hoshina & Sahara, 1950). The life cycle of *Dermocystidium* spp. is partly unknown. The parasite produces motile zoospores which encyst in the host tissues, form sporonts by division of the plasmodia until subsequent maturation of spores (Lotman et al., 2000; Mahboub & Shaheen, 2020). In experimental trials, it has been demonstrated that fish can acquire the infection through intra-gastric and immersion routes. The pathogen cycle begins from the ingestion of spores through feeding on infected fish or contaminated feed or via penetration of spores into the gills (Mahboub & Shaheen, 2020).

Considering the economic value of koi carps and the possible direct transmission of the infection in optimal temperatures condition, *Dermocystidium* spp. infection should be considered as an important disease also in ornamental species.

Conflicts of interests

The authors declare to have no conflict of interests.

Data availability

The data that support the findings of this study are available from the corresponding author upon request.

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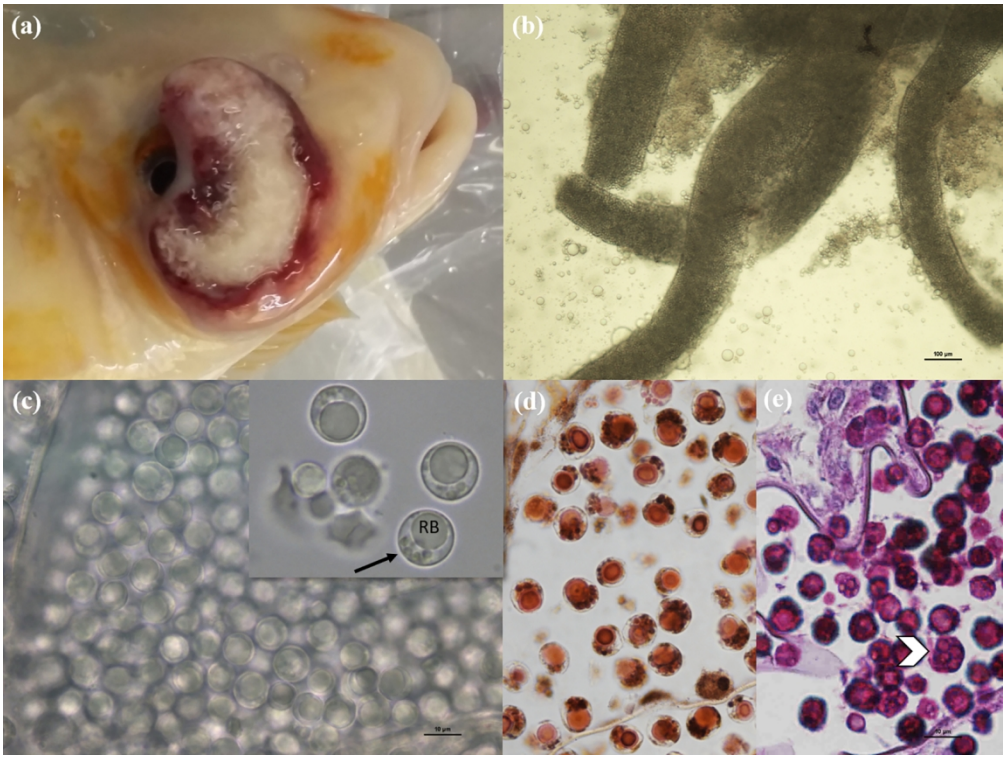
Figure legends

Figure 1. (a) Koi carp showing an ocular exophytic whitish tissue. (b) Numerous filiform hyphal-like cysts visible at the stereomicroscope (bar=100 µm). (c) The cysts are filled with round mature spores morphologically referable to *Dermocystidium* sp. (bar=10 µm). The spores show a large refractile body (RB) and a peripheral cytoplasm with a nucleus and vacuoles (inset, arrow). (d) Gomori stain shows cytological details of the spores (bar=10 µm). (e) PAS stain evidences the developmental stages of the parasite. Four zoospores are visible inside a spore (arrowhead) (bar=10 µm).

Figure 2. (f) The choroid space near the retina is infiltrated by numerous cysts (asterisk) (H&E, bar=500 µm). (g) The iris and the ciliary body are replete by numerous free mature spores (arrowhead). A severe inflammatory reaction and granulation tissue are evident. Note the multinucleated giant cells (inset) (H&E, bar=50 µm). (h) Around the cysts, a granulomatous inflammatory reaction characterized by a wall of epithelioid cells is visible (inset) (H&E, bar=100 µm). (i) The cysts show a thick eosinophilic wall and contain spores at different developmental stages (H&E, bar=50 µm).



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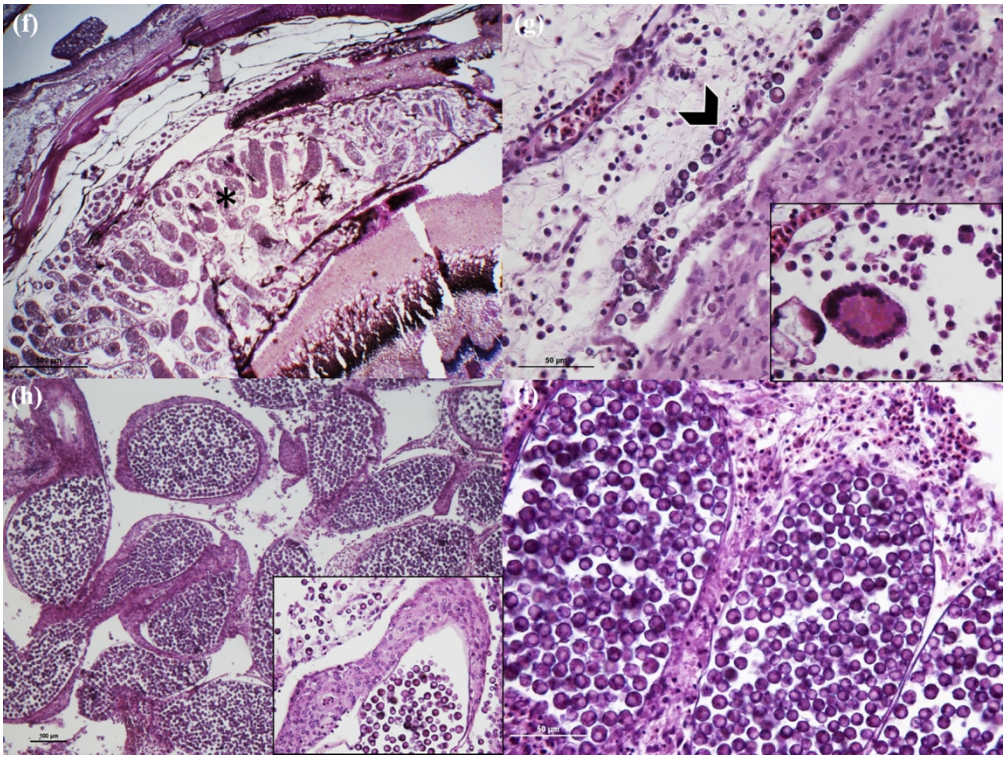

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