Myxobolus sp. cf. *angustus* Kudo, 1934 (Cnidaria: Myxosporea: Myxobolidae) on the Gills of *Dionda* sp. cf. *flavipinnis* (Cope) (Cypriniformes: Cyprinidae) from the South Concho River, Texas

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Abstract: An undescribed species of roundnose minnow, *Dionda* sp. cf. *flavipinnis* (Cope), is a small endemic cyprinid that inhabits northern tributaries (San Saba and upper Concho rivers) of the Colorado River drainage in southcentral Texas. Nothing is known of the protistan or metazoan parasites of this fish. Therefore, we examined a small sample of this minnow from the South Concho River for parasites. One species of myxozoan, morphometrically very similar to *Myxobolus angustus* Kudo, 1934, was found on the gills of one of four (25%) *D.* sp. cf. *flavipinnis*; no other parasites were found. As such, this is the first time any parasite has been reported from this fish and represents a new host and geographic record for a myxozoan from this endemic species.

Introduction

Myxozoans are a group of microscopic, oligocellular, obligate parasites that belong to the Phylum Cnidaria. They are parasites of aquatic poikilothermic invertebrates (annelids and oligochaetes) and vertebrates but are most commonly encountered in wild and cultured freshwater teleost and marine fishes of the world (Lom and Dyková 2006). Those cnidarian species belonging to the genus *Myxobolus* Bütschli, 1882, are known from a wide variety of fish, including many minnows and shiners of the family Cyprinidae (Eiras et al. 2005, 2014). These parasites are found on the fins, gills and skin of these hosts, as well as internally, generally infecting the gall bladder and various organs. However, many cyprinids have yet to be surveyed for these parasites, including some in the genus *Dionda* (Thomas et al. 2007; Page and Burr 2011). One example is an undescribed species of roundnose minnow, *Dionda* sp. cf. *flavipinnis* (Cope) = (*Dionda* sp. 3) of Schönhuth et al. (2012). It is a small minnow endemic to the headsprings and upper reaches of the northern tributaries of the upper Colorado River (the Concho and San Saba river drainages) in Texas (Schönhuth et al. 2012). This minnow is locally common in pools and runs of headwaters, creeks, rocky pools, and small rivers where it is usually found associated with filamentous algae. It was formerly synonymized with the Roundnose Minnow, *D. episcopa* Girard (Gilbert 1988; Mayden et al. 1992; Nelson et al. 2004), but is now considered a distinct undescribed species (Schönhuth et al. 2012). There are no published reports concerning any parasite of this species. This paper reports the presence of a myxozoan parasite on the gills of *D.* sp. cf. *flavipinnis*.

Methods

On 22 June 2018, 4 adult (67–75 mm total length [TL]) *D.* sp. cf. *flavipinnis* were collected by backpack electrofisher from the South Concho River at Christoval, Tom Green

County, Texas (31.187341°N, 100.501214°W). Fish were placed in aerated habitat water and killed by immersion in a concentrated tricaine methanesulfonate solution following accepted guidelines (Use of Fishes 2014). A mid–ventral incision was made to expose the gastrointestinal (GI) tract and internal viscera. The GI tract was split longitudinally from esophagus to anus and all internal organs were placed in Petri dishes containing 0.9% saline and examined under a stereomicroscope at 20–30×. The gills were also removed and examined for parasites similarly. Myxozoan plasmodia were picked directly from the gills with small forceps or needles and placed in a drop of tap water on microscopic slides. They were photographed from these wet smears. Plasmodia were measured (to the nearest μm) and then ruptured to release spores for observation as wet mounts. Spores were measured to the nearest 0.1 μm with a calibrated ocular micrometer and identified by comparing its morphometrics with other North American freshwater myxozoans (Landsberg and Lom 1991; Cone and Raesly 1995; Eiras et al. 2005, 2014).

Prevalence and intensity of infection were calculated according to Bush et al. (1997). A photovoucher of parasites were deposited in the Harold W. Manter Laboratory of Parasitology (HWML), University of Nebraska, Lincoln, Nebraska. Photovouchers of fish were deposited in the Henderson State University Collection, Arkadelphia, Arkansas.

Results

One species of myxozoan, morphometrically very similar to *Myxobolus angustus* Kudo, 1934, was found on a 75-mm TL *D.* sp. cf. *flavipinnis* and is described below. No other parasites were found.

Cnidaria: Myxosporea: Myxobolidae
***Myxobolus* sp. cf. *angustus* Kudo, 1934 (Figs. 1A–C)**

***Site of infection*:** Gill lamellae.

Prevalence: 1/4 (25%).

***Intensity*:** 2 plasmodia, spores too numerous to count.

***Specimens deposited*:** Photovoucher (HWML 216064).

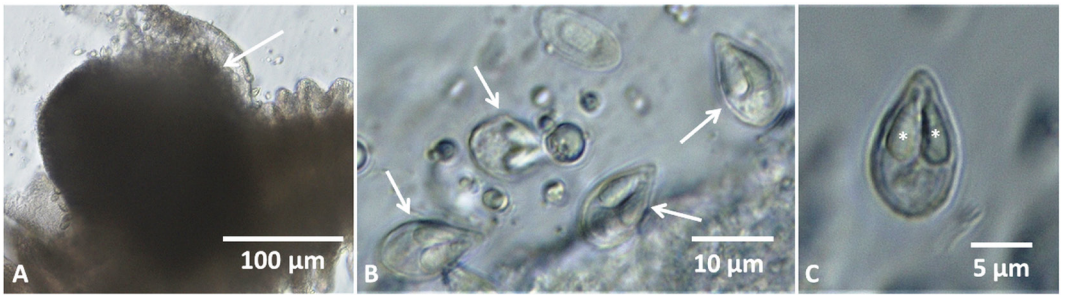
***Description*:** Plasmodia (cyst) spheroidal, diameter 213–234 (n = 2). Myxospores (n = 20): pyriform, widest in region near tips of polar capsules, length 12.9 (12.3–14.4), width 7.5 (6.7–8.2). Two polar capsules, equal or one usually slightly longer than the other; length of longer polar capsule 7.9 (7.2–9.0), width 3.2 (2.8–3.5); length of shorter polar capsule 7.6 (7.2–8.5), width 3.1 (2.8–3.6). Sutural ridge distinct.

Remarks: The pyriform spores of *Myxobolus* sp. cf. *angustus* are very similar to those of *M. angustus*, but are slightly smaller (12.9, range = 12.3–14.4 *vs.* 14.0–15.0) (Kudo 1934). The polar capsules of both species are pyriform and extend approximately halfway through the spores, but those of *M*. sp. cf. *angustus* (width 3.2, range = 2.8–3.6) are more robust than those of *M. angustus* (width 2.5–3.0) (Kudo 1934). The cysts of the two species differ in shape, spheroidal in *M*. sp. cf. *angustus vs.* ellipsoidal in *M. angustus* (Kudo 1934).

Myxobolus sp. cf. *angustus* is also very similar to *M. spalli* (Spall, 1974) Landsberg and Lom, 1991 (Syn: *Myxosoma cyprini* Spall, 1974, a junior homonym of *Myxobolus cyprini* Doflein, 1898 (Landsberg and Lom 1991). The spores and polar capsules of *M. spalli* are pyriform as in *M*. sp. cf. *angustus*, but are larger (length of fixed specimens 14.5, range = 13.5–15.5) (Spall 1974).

Discussion

The majority of species of *Myxobolus* display strict site and host specificity, as they are often found on or in only one organ/tissue and a single host species (Landsberg and Lom 1991; Cone and Raesly 1995; Eiras 1995, 2014; Hoffman 1999). Contrary to this trend, *M. angustus* had been previously reported from the gills of several cyprinids, including Bullhead Minnow,



Figures 1A–C. ***Myxobolus* sp. cf. *angustus* from the gills of *Dionda* sp. cf. *flavipinnis*. A. Plasmodium showing myxospores along the edge of cyst (arrow). B. Frontal view of four myxospores (arrows). C. Single myxospore showing polar capsules (*).**

Pimephales vigilax (Baird and Girard) from Illinois (Kudo 1934); Common Shiner, *Luxilus cornutus* (Mitchill) from Ontario, Canada (Desser and Paterson 1978, as *Myxobolus* sp.; Hoffman 1999, probably *M. angustus*); and Golden Shiner, *Notemigonus crysoleucas* (Mitchill) and Fathead Minnow, *Pimephales promelas* Rafinesque, both from North Carolina (Hoffman 1999). *Myxobolus spalli* has been reported from gills of Red Shiner, *Cyprinella lutrensis* (Baird and Girard) and *N. crysoleucas* from Oklahoma (Spall 1974). The very close similarity between *M. angustus* and *M. spalli* was revealed when Hoffman (1999) stated that *M. cyprini* is probably *M. angustus* or *M. spalli*, perhaps hinting that they may be synonyms.

Whether our *M.* sp. cf. *angustus* is synonymous with a variable wide-ranging *M. angustus* that may include *M. spalli*, or a separate undescribed species, remains to be resolved. The most definitive approach to identifying species of myxozoans is utilization of small-subunit ribosomal DNA (SSU rDNA) gene sequences. Such sequences are needed to help resolve the identification of *M.* sp. cf. *angustus* and the taxonomic status of *M. angustus* and *M. spalli* on a variety of hosts.

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