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The first record of *Centrocestus formosanus* (Nishigori, 1924) (Digenea: Heterophyidae) in Egypt

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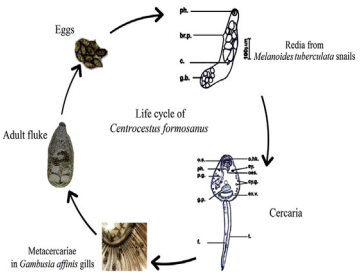
HIGHLIGHTS

- *Centrocestus formosanus* is first recorded in Egypt and its life cycle completed.
- The cercariae pleurolophocercous were obtained from *Melanoides tuberculata* snails.
- The cercariae encyst in the gills of *Gambusia affinis* fish to form metacercariae.
- The metacercariae were fed to *Rattus norvegicus* to obtain adult worms after 7 days.
- The morphological characteristics of all stages of this parasite were given.

GRAPHICAL ABSTRACT



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ABSTRACT

The life cycle of *Centrocestus formosanus* (Digenea: Heterophyidae) was to be successfully completed in the laboratory in the present study. Hundreds of the thiarid snail, *Melanoides tuberculata,* were collected from the main water course Mansouriya Canal, Giza Governorate, Egypt. The snails were individually exposed to artificial light to determine possible infection with trematode larvae. Fifteen snails were found infected with opthalmopleurolophocercous cercariae (infection index of 1.97). These opthalmopleurolophocercous cercariae shedded from snails were collected and placed in an aquarium with fish intermediate host, *Gambusia affinis*, to obtain metacercariae encysted in the gills. The gills with metacercariae were fed to albino rats, *Rattus norvegicus*, to obtain the adult worms. Adult worms were recovered in the small intestine of rats at 7 days after infection and they were identified as *Centrocestus formosanus* based on the morphological characteristics and the comparison with the previous descriptions in the literature. They were small, 518 × 324 μm in average size and had characteristic 32 circumoral spines around the oral sucker. The morphological characteristics of the developmental stages, from cercariae to adults, of this heterophyid fluke were given here. Therefore, the presence of this fluke is to be confirmed for the first time in Egypt by the present study.

1. Introduction

Centrocestus formosanus (Digenea: Heterophyidae) is a small-sized heterophyid trematode widely distributed in many Asian and American countries, i.e., China (Chen, 1942); Taiwan (Nishigori, 1924); Japan (Yanohara et al., 1987); Lao PDR (Han et al., 2008);

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India (Madhavi, 1986); Turkey (Yıldız, 2005); Iran (Farahnak et al., 2005); Saudi Arabia (Arfin, 1999); Mexico (Salgado-Maldonado et al., 2005); Brazil (Pinto and Melo, 2010); Venezuela (Hernandez et al., 2003); Colombia (Velásquez et al., 2006) and USA (Mitchell et al., 2005). This trematode is known to provoke certain economic loss in the aquaculture industry being the etiologic agent of the fish gills destruction (Mitchell et al., 2005) and has a medical importance being an intestinal fluke in humans (Chai et al., 2013).

This parasite is known to utilize *Melanoides tuberculata* as first intermediate host which is the only snail host for it worldwide. The cercariae released from these snails encyst in fish gills (the second intermediate host) to form metacercariae. Therefore they are eaten by mammals or birds and recovered to adult worms in the small intestine.

Centrocestus genus is classified to species by Waikagul et al. (1997) into 3 main groups depending on the number of spines on the oral sucker: One group is composed of those with 26–36 spines: *Centrocestus yokogawai* (Kobayasi, 1942); *Centrocestus caninus* (Lieper, 1913); *Centrocestus formosanus* (Nishigori, 1924); *Centrocestus cuspidatus* (Leiper, 1913) and *Centrocestus asadai* (Mishima, 1959), the other is formed of those carrying 38–48 spines: *Centrocestus armatus* (Tanabe, 1922) and the third group is formed of those carrying 50–60 spines: *Centrocestus polyspinosus* (Kobayashi, 1942).

In Yousif et al. (2010), eleven different types of cercariae were detected in *Melanoides tuberculata* (Müller, 1774) snails from Mansouriya, Giza Governorate, Egypt. They were divided into four main type groups, namely pleurolophocercous cercariae (4 types), xiphidiocercariae (2 types), gymnocephalus cercariae (3 types) and furcocercous cercariae (2) types. Among them, a type of pleurolophocercous cercarie were used in this study to complete the life cycle of *C. formosanus*.

A review of the literature shows also that *Melanoides tuberculata* snail is the intermediate host of many other trematodes in other countries such as *Paragonimus westermani* (Kerbert, 1878) in Taiwan (Nakagawa, 1917); *Haplorchis pumilio*, in China (Shen, 1959); *Echinochasmus japonicus* in China (Cheng and Fang, 1989); *Mesostephanus haliasturis* in Australia (Barker and Cribb, 1993); *Philophthalmus nocturnus* (Madhavi et al., 1997); *Acanthostomum burminis* in India (Roopa and Janardanan, 1998); *Philophthalmus distomatosa* in Israel (Radev et al., 2000) and *Echinochasmus milvi* in Iran (Farahnak et al., 2005).

In Egypt, *M. tuberculata* snail was reported to be intermediate host for many trematodes such as: *Haplorchis pleurolophocerca* (Khalil, 1932); *Paralecithodendrium pyramidium* (Azim, 1936); *Gigantobilharzia* sp. (Fahmy et al., 1976); *Paramonostomum aegyptiacus* (Khalifa and El-Naffar, 1978); *Haplorchoides cahirinus* (El-Naffar, 1980); *Eumegacetes spinosus* (Sakla and Khalifa, 1983); *Pygidiopsis genata* (Youssef et al., 1987); *Centrocestus unequiorchalis* (Saad, 1994); *Haplorchis pumilio* (Khalil, 1932; Khalifa et al., 1977; Saad and Abed, 1995); *Stictodora* sp. (Khalifa et al., 1997). Besides there is a record of some cercarian groups of unidentified species from the same snail: brevifurcate ocellate cercaria, two different parapleurolophocercous cercariae and a xiphidiocercaria (El-Gindy and Yousif, 1963). Two other different xiphidiocercariae were recorded from the same snail by Wanas et al. (1993).

The main objective of the present work was completion of the life cycle of a pleurolophocercous cercaria procured from *M. tuberculata* for proper identification of the trematode. This led to confirmation of the presence of *C. formosanus* for the first time in Egypt. This trematode is known to have economic and medical importance since it causes damage of the fish gills (Mitchell et al., 2005) as well as being an intestinal fluke of man (Chai et al., 2013).

2. Material and methods

Hundreds of the prosobranchial snails, *Melanoides tuberculata* (Fig. 1) and a total of 150 freshwater fish *Gambusia affinis*, were collected from Mansouriya main canal, in Giza Governorate, Egypt, (30°00 N, 31°10 E) using a hand net in October. Four albino rats,-*Rattus norvegicus*, 4–6 weeks old (180–200 g) were obtained from the Animal House at Theodor Bilharz Research Institute (TBRI). The snails were collected from black muddy places rich in vegetation, *Lemna gibba* and algae where oxygen content of the water was 5.7 mg/l and pH was 7.7. The temperature was 26 °C, at water depth 1.5 m. The snails and fish were carried to the laboratory where they were maintained in several separate aquaria containing dechlorinated tap water. The snails were fed on blue green algae while the aquaria containing fish were aerated and provided with fish food "tetramin". The snails were examined for cercariae shedding by placing them individually in wells containing 3 ml water each and

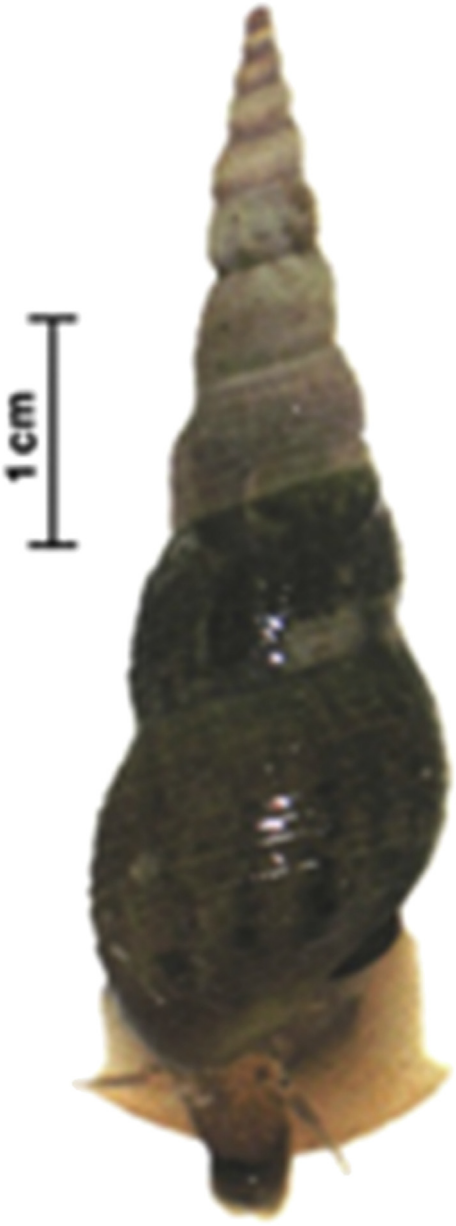

Fig. 1. Photo of *Melanoides tuberculata* snail.