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## Research Note

The first record of the invasive Asian fish tapeworm (*Schyzocotyle acheilognathi*)  
from an endemic cichlid fish in MadagascarT. SCHOLZ<sup>1,\*</sup>, A. ŠIMKOVÁ<sup>2</sup>, J. RASAMY RAZANABOLANA<sup>3</sup>, R. KUČHTA<sup>1</sup>

<sup>1</sup>Institute of Parasitology, Biology Centre of the Czech Academy of Sciences, Branišovská 31, 370 05 České Budějovice, Czech Republic, E-mail: \*[tscholz@paru.cas.cz](mailto:tscholz@paru.cas.cz); [krtek@paru.cas.cz](mailto:krtek@paru.cas.cz); <sup>2</sup>Department of Botany and Zoology, Faculty of Science, Masaryk University, Kottlářská 2, 611 37 Brno, Czech Republic, E-mail: [simkova@sci.muni.cz](mailto:simkova@sci.muni.cz); <sup>3</sup>Department of Animal Biology, Faculty of Science, University of Antananarivo, BP 906 Antananarivo 101, Madagascar, E-mail: [jeanne.rasamy@gmail.com](mailto:jeanne.rasamy@gmail.com)

## Article info

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## Summary

The Asian fish tapeworm, *Schyzocotyle acheilognathi* (Yamaguti, 1934) (Cestoda: Bothriocephalidea), is an invasive parasite of freshwater fishes that have been reported from more than 200 freshwater fish worldwide. It was originally described from a small cyprinid, *Acheilognathus rombeus*, in Japan but then has spread, usually with carp, minnows or guppies, to all continents including isolated islands such as Hawaii, Puerto Rico, Cuba or Sri Lanka. In the present account, we report the first case of the infection of a native cichlid fish, *Ptychochromis cf. inornatus* (Perciformes: Cichlidae), endemic to Madagascar, with *S. acheilognathi*. The way of introduction of this parasite to the island, which is one of the world's biodiversity hotspots, is briefly discussed.

**Keywords:** Invasive parasite; new geographical record; Cestoda; Cichlidae; Madagascar

## Introduction

Madagascar is a biodiversity hotspot with over 90 % of its fauna represented by endemic species (Hobbes & Dolan, 2008). Even though the island is situated near the African continent, it originally belonged to the Indian Peninsula, from which it split around 88 million years ago (Rosemary & Clague, 2009). The island's diverse ecosystems and unique wildlife are threatened by the encroachment of the rapidly growing human population and other environmental threats, including water pollution (Benstead *et al.*, 2003). As much as 41 % (71 from 172) species of freshwater fish from Madagascar are endemic, including two endemic families (Froese & Pauly, 2017). Native fish are also endangered by the introduction of non-native fish species and their parasites, which may have a detrimental effect on local fish communities, especially of native hosts, which are not adapted to these newly introduced parasites (Lévêque, 1997).

One of the most widely distributed fish parasites, and probably the most successful invasive parasite at all, is the so called Asian

fish tapeworm, *Schyzocotyle acheilognathi* (Yamaguti, 1934) (syn. *Bothriocephalus acheilognathi*) (Cestoda: Bothriocephalidea). This tapeworm of the supposedly East Asian origin has been reported from more than 200 species of freshwater fish throughout the world, including isolated islands such as the Hawaii, Puerto Rico, Cuba or Sri Lanka (Font, 2003; Choudhury *et al.*, 2006; Scholz *et al.*, 2012).

The parasite has been disseminated worldwide mainly due to the import of veterinary uninspected common carp, grass carp, guppies and minnows (Scholz *et al.*, 2012). It may reduce the growth of fish fry or even cause mortality, as reported in the 1960' – 1980's in the former USSR and central Europe (Bauer *et al.*, 1973; Scholz, 1999). However, it also represents a threat for populations of native fish (Williams & Jones, 1994; Dove *et al.*, 1997).

## Material and Methods

In April 2016, freshwater fishes of six species from Antsohihy (Anjingo River), Madagascar (14°53' S, 47°54' E) were examined

\* – corresponding author



Fig. 1. **A** – *Ptychochromis* cf. *inornatus* from Madagascar, definitive host of *Schyzocotyle acheilognathi* (Yamaguti, 1934) **B** – Anterior part of *S. acheilognathi* with scolex.

for the presence of metazoan parasites. Among them, originally unidentified species of the endemic cichlid genus *Ptychochromis* Steindachner, 1880, designated as *Ptychochromis* sp. 1 (Perciformes: Cichlidae; field nos. 18/1; 19/2; 21/4; 22/5; 30/11; 32/13), was infected with 43 specimens of *S. acheilognathi* (prevalence 40 %; intensity of infection 1 – 18; mean intensity  $\pm$  SD  $7.5 \pm 8.2$ ; mean abundance  $\pm$  SD  $3.0 \pm 6.2$ ).

Tapeworms were fixed in 70 % ethanol under pressure (for morphological evaluation<sup>1</sup>) and in 96 % molecular-grade ethanol (for DNA sequencing). The specimens fixed with 70 % ethanol were stained with Mayer's carmine, dehydrated in an ethanol series, cleared with clove oil and mounted in Canada balsam; they were deposited as vouchers at the Helminthological Collection of the Institute of Parasitology, Biology Centre of the Czech Academy of Sciences, České Budějovice, Czech Republic (IPCAS C-15/35).

Partial *cox1* gene of one of the specimens was sequenced by J. Brabec using the method described by Brabec *et al.* (2016). We analyzed a segment (580 bp) of DNA from the mitochondrial large ribosomal subunit (16S) of RNA gene for our *Ptychochromis* sp. 1 using the same primers as applied for Malagasy and South African cichlids by Sparks and Smith (2004). The obtained DNA sequence was identical with the sequence of *Ptychochromis inornatus* from GenBank (accession number AY263876). Therefore, the host is designated as *Ptychochromis* cf. *inornatus*. The PCR conditions and methods followed Mendlová *et al.* (2012).

## Results and Discussion

Tapeworms found in *Ptychochromis* cf. *inornatus* (Fig. 1A) belong to the family Bothriocephalidae because they possess median gonopores (a dorsally situated common cirro-vaginal pore and a ventral uterine pore) (Kuchta *et al.*, 2008; Brabec *et al.*, 2015). They were identified as *S. acheilognathi* based on the typical heart-

shaped scolex bearing deep and narrow bothria with slit-like orifices (Fig. 1B; Pool & Chubb, 1985). Most tapeworms were not fully developed and only a few specimens contained gravid proglottids with the eggs in the uterus. Species identification was confirmed by the *cox1* gene sequence, which corresponds to that of *S. acheilognathi* (J. Brabec – unpubl. data; see also Brabec *et al.*, 2015, 2016).

None of the five other fish species examined including one native and endemic species, *Paretroplus lamenebe* Sparks, 2008 (Cichlidae), three native species, namely *Pachypanchax omalonotus* (Duméril, 1861) (Aplocheilidae), *Valamugil robustus* (Günther, 1861) (Mugilidae) and *Glossogobius giuris* (Hamilton, 1822) (Gobiidae), and one introduced species, *Oreochromis niloticus* (Linnaeus, 1758) (Cichlidae), were infected by this parasite.

*Schyzocotyle acheilognathi* has been reported from 9 countries of Africa including Morocco (new geographical and host records from *Carasobarbus fritchii* (Günther, 1874), *Luciobarbus massaensis* (Pellegri, 1922), *L. rifensis* Doadrio, Casal-Lopez & Yahyaoui, 2015, *L. yahyaouii* Doadrio, Casal-López & Perea, 2016 and *L. rabatensis* Doadrio, Perea & Yahyaoui, 2015 – unpublished data of the present authors). However, no data on its occurrence in Madagascar are available (Gibson *et al.*, 2005; Kuchta *et al.*, 2012).

The origin and the way of the introduction of *S. acheilognathi* to this island remains unclear, even though a number of alien fish species have been introduced to Madagascar (Kiener, 1963). Many fish were introduced for aquaculture and others to improve fish production in natural water bodies. However, breeding fish often escaped from fishponds and succeeded well in wild habitats. The first two fish species, *Osphronemus gouramy* Lacépède and *Carassius auratus* (Linnaeus), were introduced to Madagascar from East Asia and Europe (France) in 1857 and 1861, respectively (Kiener, 1963). Common carp (*Cyprinus carpio* Linnaeus), which is one of the most susceptible definitive hosts of *S. acheilognathi*, was imported from France to Madagascar in 1916. From 1966

<sup>1</sup> – This fixation method, i.e. flattening of tapeworms and their fixation in 70 %, is not recommended; instead, heat-fixation, best with 4 % hot formaldehyde solution, should be used – see, e.g., Oros *et al.* (2010).

to 1972, juveniles of common carp were reintroduced into Lake Alaotra. In the 1950's and 1960's, several species of tilapias were also introduced (Kiener, 1963), but *S. acheilognathi* has never been reported from any of the introduced or native fish (Khalil & Polling, 1997; Gibson *et al.*, 2005; R. Kuchta – unpubl. data).

Cichlids and perciform fishes in general are not the most common definitive hosts of *S. acheilognathi*. A total of 12 species of perciform fish (out of more than 200 fish species) were previously reported as hosts of *S. acheilognathi*, mostly from Mexico, with two records from *Oreochromis niloticus* (Linnaeus) in South Africa and Nigeria (Paperna, 1996; Ogbulie *et al.*, 2011).

## Conclusion

The present report of *S. acheilognathi* from Madagascar, which is a new geographical and host record of this invasive parasite, is considered to be of concern from the veterinary and conservation point of view, especially because this parasite was found in an endemic fish and with a high prevalence and intensity of infection. Even though the pathological effect of *S. acheilognathi* on cichlid fishes has not been studied, the observed infection rate indicates that this tapeworm has successfully colonized a new region, an isolated island in the Indian Ocean, most probably as a result of human activities. Therefore, inspection of cichlids and other fishes from the locality and surrounding water bodies is strongly recommended to detect possible spreading of this invasive and potentially dangerous fish parasite.

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