

# *Salsuginus seculus* (Monogenea: Ancyrocephalidae) Newly Recorded from Japan, Infecting the Introduced Mosquitofish *Gambusia affinis*

Masato Nitta<sup>1,2</sup> and Kazuya Nagasawa<sup>1</sup>

<sup>1</sup>Graduate School of Biosphere Science, Hiroshima University, 1-4-4 Kagamiyama, Higashi-Hiroshima, Hiroshima, 739-8528 Japan  
E-mail: licht.bsn.mono@gmail.com (MN)

<sup>2</sup>Corresponding author

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The ancyrocephalid monogenean *Salsuginus seculus* (Mizelle and Arcadi, 1945) was found infecting the gills of mosquitofish, *Gambusia affinis* (Baird and Girard, 1853), from Okinawa, Aichi, Tokushima, and Kyōto prefectures in Japan. These are the first records of *S. seculus* from Japan. This parasite was most likely introduced along with mosquitofish from Texas (USA) through Hawaii and Taiwan into Japan in the late 1910s. It appears to have low salinity tolerance.

**Key Words:** *Salsuginus seculus*, Monogenea, fish parasite, *Gambusia affinis*, new country record, introduced species, Japan.

## Introduction

Mosquitofish *Gambusia affinis* (Baird and Girard, 1853) are native to North America, ranging from New Jersey to southern Mexico (Rosen 1973). Since the 1900s, this species has been transplanted to various countries and regions to control mosquitos, which has resulted in its pan-global spread, and now it is one of the most widely introduced freshwater fishes in the world (Welcomme 1988).

Mosquitofish were introduced from Taiwan into Japan in the late 1910s for control of mosquitos and malaria: they were brought to Nara, Tōkyō, and Okinawa prefectures in 1916, 1917, and 1919, respectively (Ida 1918; Matsui 1917; Kuroiwa 1927). Subsequently, mosquitofish were released at many locations in Japan and by 1979 they had become established in 25 prefectures (Wada 1979). In particular, mosquitofish were transplanted in 1968 from Tōkyō to Tokushima City, Tokushima Prefecture, where they were reproduced in tanks by the city government (Tashiro *et al.* 2007). In 1969 and afterwards, mosquitofish produced there were released into water bodies at various locations in Japan for the extermination of mosquitos and water clarification (Tashiro *et al.* 2007). They have thus become established in a wide area of Japan, ranging from Nagano Prefecture in central Honshū in north through Shikoku and Kyūshū to Iriomote Island, Okinawa Prefecture, in the south (Anonymous 2010). The release program, however, was ended in 2005, when the species was designated by the national government as one of the most serious invasive alien species in Japan (Tashiro *et al.* 2007). Recently, we found the ancyrocephalid monogenean *Salsuginus seculus* (Mizelle and Arcadi, 1945) on the gills of mosquitofish collected at five sites in Japan, which is herein reported as a new country record for the parasite.

## Materials and Methods

A total of 164 mosquitofish (11.9–35.1 mm in standard length) were collected by hand-net from six sites in Japan (Table 1): an irrigation canal (24°23'46"N, 123°46'17"E) flowing into Urauchi Bay, Iriomote Island (the Ryūkyū Islands), Okinawa Prefecture, on 13 October 2013 (designated as site 1); an irrigation canal (33°14'12"N, 130°11'35"E) connected to the Ushitsu River in Ashikari, Ogi City, Saga Prefecture, on 20 October 2013 (site 2); the middle reaches of the Umeda River (34°42'55"N, 137°24'23"E) in Hamamichi, Toyohashi City, Aichi Prefecture, on 7 November 2013 (site 3); two irrigation canals (34°05'18"N, 134°35'58"E [site 4]; 34°06'37"N, 134°35'22"E [site 5]) connected to the Yoshino River system in Kawauchi, Tokushima City, Tokushima Prefecture, on 6 December 2013; and the Dōno River (34°55'42"N, 135°47'32"E) in Momoyama, Fushimi District, Kyōto City, Kyōto Prefecture, on 31 May 2014 (site 6). The fish were brought on ice to the laboratory, where their gills were removed and examined under a dissecting microscope. Monogeneans were collected from the gills using small needles. Some were flattened and fixed in ammonium picrate glycerin (Lim 1991), while others were fixed in 70% ethanol or acetic acid-formalin-alcohol (AFA) under coverslip pressure and then stained in Heidenhain's iron hematoxylin or Gomori's trichrome. All specimens were dehydrated through a graded ethanol series, cleared in xylene, and mounted in Canada balsam. Drawings were made with the aid of a drawing tube fitted on an Olympus BX51 compound microscope. The basic measurements and terminology follow Murith and Beverley-Burton (1985). Penis arc lengths were measured on images taken by an Olympus DP20 microscope digital camera at a magnification of ×1,000 using ImageJ software (version