

# Two New Species of *Halicyclops* (Crustacea: Copepoda: Cyclopidae) from Honshu with a Key to the Species of the Genus in Japan

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Two new species of cyclopoid copepod, *Halicyclops setiformis* and *H. itohi*, are described based on female specimens from the Tama River estuary in Tokyo Bay, central Japan. One of the defining characteristics of *H. setiformis* is the presence of a setiform lateral element on the third exopodal segment of legs 3 and 4. Among its congeners, only *H. blachei* Lindberg, 1952 has similar elements; *H. setiformis* differs from it in the shape of the third endopodal segment of leg 4. This new species is considered carnivorous based on the occurrence of a specimen biting a nematode and the presence of stout, claw-like spines on the oral appendages. The second new species, *Halicyclops itohi*, is distinguishable from most of its congeners in the absence of lateral protuberances on the genital double-somite, the absence of a terminal accessory seta on the caudal ramus, and a 3.4.4.3 spine formula on the third exopodal segment of legs 1–4. Congeners sharing these three morphological characteristics differ variously from *H. itohi* in their caudal ramus shape, urosomal frills, antennal setal number, medial elements of the third endopodal segment of leg 4, and/or the shape of leg 5. The hitherto known *Halicyclops* species from Japan are briefly reviewed, and a key to the Japanese species is presented to resolve previous questionable identifications.

**Key Words:** Copepoda, Cyclopoida, *Halicyclops*, new species, identification key, Tama River, Japan.

## Introduction

*Halicyclops* Norman, 1903, a cyclopoid copepod genus of the subfamily Halicyclopinæ of the family Cyclopidae, is characterized by females having a six-segmented antennule, three-segmented antenna, two- or three-segmented and slender maxilliped, three-segmented rami on legs 1–4, and a two-segmented leg 5 with three spines and a seta on the distal segment (Dussart and Defaye 2001). The genus is planktonic, predominantly inhabiting brackish waters. Some exceptional species are stygophilic, inhabiting anchialine caves and interstitial media (Pesce *et al.* 1996), and symbionts of benthic invertebrates such as with polychaetes (Herbst 1962) and within the gill chambers of lobsters (Humes 1947). In total, 93 species are currently known from around the world (Boxshall 2011). The following 10 nominal species have been recorded from Japan: *H. propinquus* Sars, 1905 by Motoda and Ishida (1948); *H. japonicus* Ito, 1956 by Ito (1956) and Ishida (2002); *H. higoensis* Ito, 1957 by Ito (1957); *H. ryukyuensis* Ito, 1962 by Ito (1962); *H. sinensis* Kiefer, 1928 by Ishida (1993, 2002); *H. fosteri* Wilson, 1958 by Ishida (2002); *H. cf. rotundipes* Kiefer, 1935 by Ishida (2002); *H. ariakensis* Ueda and Nagai, 2009, *H. continentalis* Ueda and Nagai, 2009, and *H. uncus* Ueda and Nagai, 2009 by Ueda and Nagai (2009).

Tadasugi and Itoh (1999) recorded *Halicyclops sinensis* and *Halicyclops* sp. 1 from the Tama-gawa River estuary, Tokyo, Japan. Ishida (2002) identified these specimens as *H.*

*sinensis* and *H. cf. rotundipes*, respectively, but our examination of this material revealed that it consists of three species, *H. uncus* and two undescribed species. Herein we describe the latter two species as new. The identification of some of the hitherto known species from Japan is questionable. To remedy this, we briefly review the *Halicyclops* species of Japan and provide an identification key based on easily observable morphological characteristics.

## Materials and Methods

The specimens provided to us by Dr Hiroshi Itoh were taken from burrows of the Japanese mud crab *Macrophthalmus japonicus* (De Haan, 1835) on the tidal flat of the Tama River mouth (35°32.3'N, 139°45.2'E) on 16 May 1998. Specimens were collected by removing water from crab burrows using a bellows pipette, and subsequently filtering the water through a 0.1-mm mesh sieve. Retained specimens were preserved in a 5% formalin solution. Temperature and salinity of the burrow water were 24.7°C and 7.6, respectively (H. Itoh, pers. comm.). Microscopic examination and dissection of specimens were done in lactophenol. Length measurements and drawings were made with the aid of an optical micrometer and a camera lucida attached to a differential interference compound microscope. The type specimens have been deposited in the National Museum of Nature and Science, Tokyo (formerly National Science Museum, Tokyo, NSMT). Morphological terminology generally follows that