

# Records of Adult Caligiform Copepods (Crustacea: Copepoda: Siphonostomatoidea) in Marine Plankton from East Asia, Including Descriptions of Two New Species of *Caligus* (Caligidae)

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Adults of caligiform copepods are often found in plankton samples, in addition to the naupliar and copepodid stages. Here, we report on adult parasitic copepods of the families Caligidae and Pandaridae from plankton samples collected in Japanese and Chinese coastal waters. The following previously described species were found in 2008: *Caligus calotomi* Shiino, 1954; *C. orientalis* Gusev, 1951; *C. undulatus* Shen and Li, 1959; *Lepeophtheirus semicossoyphi* Yamaguti, 1939; *Metacaligus uruguayensis* Thomsen, 1949, and *Pandarus satyrus* Dana, 1852 in Japanese waters; and *C. orientalis* and *C. rotundigenitalis* Yü, 1933 in Chinese waters. The findings of adults of *Lepeophtheirus* and *Metacaligus* in plankton samples represent the first such a record for each genus. Two new species of *Caligus* are also described from plankton taken in Japanese waters in 2008 and 2010. An ovigerous female collected from off Iheya Island, Ryukyu Islands, Okinawa Prefecture is described as *Caligus quadrigenitalis* sp. nov., and two adult females and a male collected from the Seto Inland Sea and off Hirado Island, Kyushu, western Japan is described as *Caligus ogawai* sp. nov.

**Key Words:** Caligidae, caligiform, copepod, Pandaridae, plankton, sea lice, coastal plankton, life cycle, ectoparasites, Japan, China.

## Introduction

Caligiform copepods (the Caligidae Burmeister, 1835 and their allies) are commonly known as sea lice, and some species have caused serious impacts on cultured fishes (Ho and Lin 2004a; Rosenberg 2008). The presence of adult caligiform copepods in plankton, previously considered as accidental occurrences has recently been highlighted and re-evaluated (Venmathi Maran and Ohtsuka 2008; Venmathi Maran *et al.* 2012a). Also Hayward *et al.* (2008) noted the occurrence of only adults of *Caligus chiastos* Lin and Ho, 2003 on cultured tuna with earlier developmental stages totally absent and later concluded that the adults are likely to swim in the water column to search of their final host (Hayward *et al.* 2011; Venmathi Maran *et al.* 2012b). Pelagic adults are thus likely to be common in the life cycle of caligiform copepods and the adaptive benefits of free-living adults detached from their hosts were considered by Venmathi Maran and Ohtsuka (2008).

In the present study, three genera of Caligidae (*Caligus* Müller, 1785, *Lepeophtheirus* von Nordmann, 1832, and *Metacaligus* Thomson, 1949) and a single genus of

Pandaridae Milne Edwards, 1840 (*Pandarus* Leach, 1816) are reported from plankton samples taken in Japanese and Chinese waters. Adults of *Caligus* have been reported repeatedly from plankton samples (Heegaard 1972; Pillai 1985; Todd *et al.* 1996; Suárez Morales *et al.* 1998, 2003, 2012; Ho and Lin 2004b; Venmathi Maran and Ohtsuka 2008; Venmathi Maran *et al.* 2012a), but in contrast, adults of *Lepeophtheirus* and *Metacaligus* have never been reported from the plankton until now. Hull *et al.* (1998) did however, report that *Lepeophtheirus* is known to switch host individuals in aquaculture facilities, in addition to which the developmental stages of *Lepeophtheirus salmonis* (Krøyer, 1837) have been reported in plankton samples around aquaculture facilities (Costello *et al.* 1998; Penston *et al.* 2004) but not from open oceanic waters. Pandarid males are routinely found in the plankton (Cressey 1967; Kabata 1979; Venmathi Maran and Ohtsuka 2008), and a young male of *Pandarus satyrus* Dana, 1852 was collected from Japan during the present study.

In this paper, we report on the occurrence of altogether eight caligids and a pandarid newly discovered from plankton samples in East Asia, including two new species. Full descriptions are given for the new species; supplemental