



Biodiversity of marine scuticociliates (Protozoa, Ciliophora) from China: Description of seven morphotypes including a new species, *Philaster sinensis* spec. nov.

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Abstract

Seven marine scuticociliates, *Philaster sinensis* spec. nov., *Pseudocohnilembus hargisi* Evans and Thompson, 1964. J. Protozool. 11, 344, *Parauronema virginianum* Thompson, 1967. J. Protozool. 14, 731, *Uronemella filificum* (Kahl, 1931. Tierwelt. Dtl. 21, 181) Song and Wilbert, 2002. Zool. Anz. 241, 317, *Cohnilembus verminus* Kahl, 1931, *Parauronema longum* Song, 1995. J. Ocean Univ. China. 25, 461 and *Glauconema trihymene* Thompson, 1966. J. Protozool. 13, 393, collected from Chinese coastal waters, were investigated using live observations, silver impregnation methods, and, in the case of the new species, SSU rDNA sequencing. *Philaster sinensis* spec. nov. can be recognized by the combination of the following characters: body cylindrical, approximately 130–150 × 35–55 μm in vivo; apical end slightly to distinctly pointed, posterior generally rounded; 19–22 somatic kineties; M1 triangular, consisting of 13 or 14 transverse rows of kinetosomes; M2 comprising 10–12 longitudinal rows; CVP positioned at end of SK1; marine habitat. We also provide improved diagnoses for *Pseudocohnilembus hargisi*, *Parauronema virginianum*, *Uronemella filificum* and *Parauronema longum* based on their original descriptions as well as the present work. Phylogenetic analyses support the monophyly of the genus *Philaster*.

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Keywords: Marine habitat; *Philaster sinensis* spec. nov.; Phylogeny; Scuticociliates

Introduction

Ciliates in the subclass Scuticociliatia Small, 1967 are commonly found in ecosystems worldwide and exhibit both a great biological and morphologic diversity (Foissner and Wilbert 1981; Fan et al. 2011a,b; Foissner et al., 1994, 2013; Pan et al. 2011; 2013c; Seo et al. 2013; Song and Wilbert 2002; Thompson and Kaneshiro, 1968; Whang et al. 2013).

Abbreviations: AIC, Akaike information criterion; BI, Bayesian inference; CV, contractile vacuole; CVP, contractile vacuole pore; MCMC, Markov chain Monte Carlo; ML, maximum-likelihood; M1, membranelle 1; M2, membranelle 2; M3, membranelle 3; PM, paroral membrane; SK1, first somatic kinety; SK2, second somatic kinety.

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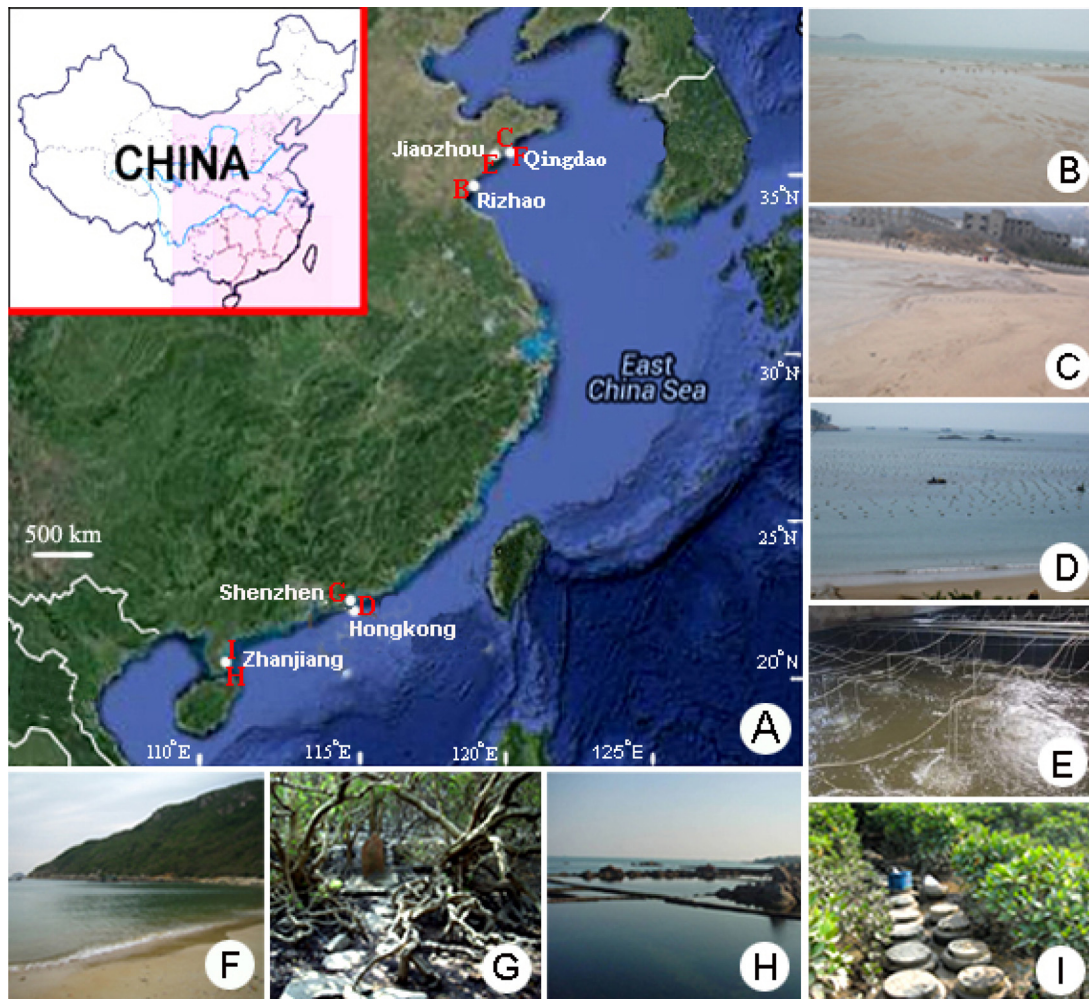


Fig. 1. Map (A) and photographs of biotopes (B–I) in which the samples were collected. (A) Map showing collecting sites. (B) Ganhaiyuan beach in Rizhao, Shandong province. (C) Yangkou beach, Qingdao. (D) Daya Bay, Guangdong province. (E) Mariculture pond in Jiaozhou, Shandong province. (F) Beach of Nanyao, Qingdao. (G) Mangrove wetland in Shenzhen. (H) Mariculture pond at Techengdao in Zhanjiang, Guangdong province. (I) Mangrove wetland in Gaoqiao.

About 20 genera and 40 species of scuticociliates have been reported in Chinese coastal waters (Fan et al., 2011a, 2011b; Pan et al. 2010, 2011, 2013c; Song et al. 2009). Because of their small size and the high degree of similarity in infraciliature, many scuticociliates are identified based upon a combination of characteristics observed in vivo and silver impregnation (Ma and Song 2003; Pan et al. 2010; Song and Wilbert 2000; Song et al. 2001; Thompson 1964). Recent investigations have revealed a high diversity of scuticociliates in Chinese coastal waters, and the discovery of new species highlights the need to conduct further studies on this group (Fan et al., 2011a,b; Hu et al. 2008; Pan et al. 2011; Song et al. 2009; Wang et al., 2008a,b, 2009). In recent years, molecular phylogenetic analyses based on SSU rDNA sequences have been increasingly used to investigate the evolutionary relationships among Scuticociliatia. The relationships among this species-rich assemblage remain unresolved as molecular and morphological interpretations often conflict (Fan et al. 2009;

Gao and Katz 2014; Gao et al., 2010, 2012a,b, 2013, 2014; Miao et al. 2008; Yi et al. 2009).

As part of an on-going faunistic study of marine ciliates in China, the morphology and infraciliature of seven scuticociliates were studied, including the molecular phylogenetic assignment of *Philaster sinensis* spec. nov.

Material and methods

Geographic distribution and ecological features

Environmental samples were collected between July 2010 and December 2012 from mariculture ponds, mangrove wetlands or coastal waters along the coastal line of eastern China (Fig. 1A–I). Investigations were conducted mainly in six cities distributed in Shandong and Leizhou peninsulas (Qingdao, Rizhao, Jiaozhou, Zhanjiang, Hong Kong and

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