

# Past and present infestation of the stalked ciliate *Zoothamnium* sp. on copepods in the Klang Strait

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**ABSTRACT:** Ciliate–copepod epibiosis is a common but poorly understood phenomenon in the aquatic environment. This study investigated the prevalence of ciliate infestation on copepods in the Klang Strait, Straits of Malacca. We hypothesized that anthropogenic impacts in the strait have increased ciliate epibiont infestation. Zooplankton samples were collected in 2013–2014 and compared to samples collected from the same 5 stations in 1985–1986, prior to the establishment of the Kapar Power Station (KPS). The 5 sampling sites, including 1 impact (I) and 4 control (C1–C4) stations, were located along an 18 km transect ranging from near the KPS (I) to progressively further offshore (C4). Ciliate epibionts on the copepods belonged to an unidentified *Zoothamnium* species; 14 copepod species were infested by this ciliate. The highest infestation prevalence occurred in 5 key calanoid species: *Paracalanus aculeatus*, *Acrocalanus gibber*, *Labidocera euchaeta*, *Parvocalanus crassirostris* and *Subeucalanus subcrassus*. Before–after–control–impact–pairs (BACI) analysis showed that infestations were more prevalent at all stations in 2013–2014 compared to 1985–1986 and were lowest at or nearest the impact site. The prosome of the copepod was the body part most susceptible to attachment by the ciliate. Generally, the density of infested copepods and their epibiont loads were positively correlated with copepod abundance. Only the density of infested *A. gibber* showed a significant positive relationship with water temperature, while in *P. aculeatus* the infested copepod density was significantly correlated with phytoplankton abundance after a lag of 2 mo. We suggest that sea warming and eutrophication in recent years have increased ciliate–copepod epibiosis in the Klang Strait.

**KEY WORDS:** Epibiosis · Prevalence · Anthropogenic impacts · Asymmetrical BACI · Straits of Malacca

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## 1. INTRODUCTION

As stated by Wahl (1989), epibiosis is a facultative association between a basibiont and epibionts. The basibiont is the substrate organism that serves as a host to the epibionts, whereas the epibionts are organisms that grow and attach on a living or non-living substrate. Epibiotic infestation of ciliates on zooplankton is prevalent in the aquatic environment

(Fernandez-Leborans 2001, 2009). The relationship between the ciliates (epibiont) and copepods (basibiont) has been previously known as commensalism, but more recent studies have shown deleterious effects, with copepods infested by ciliates having higher mortality rates than the uninfested copepods (Visse 2007, Lynn 2008, Souissi et al. 2013). Souissi et al. (2013) reported that ciliate epibionts from the genus *Zoothamnium* Bory de St. Vincent, 1824 re-

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