Journal of Experimental Marine Biology and Ecology 586 (2025) 152093

Contents lists available at ScienceDirect

Journal of Experimental Marine Biology and Ecology

journal homepage: www.elsevier.com/locate/jembe

Screening of predatory fish species for larvae of *Acanthaster solaris* and quantitative analysis techniques of environmental DNA

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ARTICLE INFO

Keywords:
Acanthaster solaris
Predator fish
eDNA
Quantitative detection
Coral reefs

ABSTRACT

In the context of ongoing outbreaks of the crown-of-thorns starfish, the outbreak of the South China Sea's crown-of-thorns starfish (*Acanthaster solaris*) has severely threatened coral reef ecosystems, highlighting the urgent need for research on related control and eradication technologies. Biological control offers environmental friendliness and long-term effectiveness, making research on predator fish species crucial for managing the crown-of-thorns starfish outbreaks. This study investigates the feeding effects of seven common coral reef fish species in the South China Sea on crown-of-thorns starfish larvae, aiming to identify suitable predator fish species for South China Sea reefs. Additionally, the study develops and validates eDNA quantitative detection technology for the most effective predator, providing technical support and data for subsequent stock enhancement, release effectiveness evaluation, and fishery management. The results indicate that *Pomacentrus coelestis* significantly outperforms other species in terms of both feeding amount and feeding rate on brachiolaria, making it the most optimal predator identified in this study with a consumption rate of 403 larvae/day. There is a significant positive correlation between the density of the *P. coelestis* and eDNA concentration, with eDNA concentration stabilizing after 96 h of cultivation. The linear function (eDNA concentration = 267,120,000 density − 234,320,000) shows a good fit ($R^2 = 0.985$), making it generally effective for assessing the resource levels of *P. coelestis* in stable water environments.

1. Introduction

The crown-of-thorns starfish (*Acanthaster* spp., CoTS) is a coral-eating carnivorous species, with its earliest outbreak recorded in the Ryukyu Islands in 1957 (Endean and Chesher, 1973). Since then, outbreaks of crown-of-thorns starfish have been observed across the Indian Ocean and Pacific regions. During these periodic outbreaks, their density can fluctuate dramatically, increasing from fewer than 1 ind./ha to over 1000 ind./ha, causing severe damage to coral reef ecosystems. For instance, the coral cover on the Great Barrier Reef decreased from 28.0 % to 13.8 % between 1985 and 2012., with predation by crown-of-thorns starfish accounting for an estimated 42 % of this coral loss (De'ath et al., 2012; Pratchett et al., 2017). In the South China Sea, the predominant species is the Pacific crown-of-thorns starfish, *Acanthaster solaris* (hereafter referred to as CoTS) (Li et al., 2024). Outbreaks are mainly concentrated around the South China Sea islands. From 2006 to 2010, outbreaks in the Xisha Islands reached an average density of 423 ind./ha, leading to a more than 50 % decline in coral cover in surrounding waters since 2006, with a new outbreak has just ended (2018–2023) (Li et al., 2019). The predation by crown-of-thorns starfish not only alters the composition and diversity of coral reef ecosystems but, more critically, large-scale outbreaks can result in massive coral mortality. Thus, periodic outbreaks of crown-of-thorns starfish are a major factor in the severe degradation of coral reefs in the Indo-Pacific region (De'ath et al., 2012). Coral reef degradation and loss first lead to reduced marine biodiversity and resource abundance, which in turn may lead to increased coastal erosion and a series of ecological problems.

Early scholars posited that a reduction in predator numbers was the direct cause of CoTS outbreaks, leading to the development of the Reduced larvae predation hypothesis (Pratchett et al., 2017). Although

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https://doi.org/10.1016/j.jembe.2025.152093
Received 6 October 2024; Received in revised form 13 January 2025; Accepted 21 February 2025
Available online 20 March 2025