Journal of Experimental Marine Biology and Ecology 503 (2018) 100–108

Contents lists available at ScienceDirect

Journal of Experimental Marine Biology and Ecology

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

Corallivory plays a limited role in the mortality of new coral recruits in Hong Kong marginal coral communities

Ryan Ho Leung Tsang, Apple Pui Yi Chui, Kwan Ting Wong, Put Ang Jr*

Marine Science Laboratory, Chinese University of Hong Kong, Shatin, NT, Hong Kong Special Administrative Region

ARTICLE INFO

Keywords:
Acropora pruinosa
Coral recruits
Corallivory
Drupella rugosa
Herbivory
Platygyra acuta

ABSTRACT

Coral recruitment plays a vital role in mediating adult coral population structure as well as in promoting coral reef recovery after disturbances. As one of the most delicate life stages of coral, coral recruits were reported to be sensitive to several environmental, physical and biological stresses. This study aimed to examine the effects of *Drupella* corallivory on coral recruits of the massive *Platygyra acuta* and branching *Acropora pruinosa* in Hong Kong. Coral recruits were induced to settle on settlement tiles (R tiles). These tiles, alongside with tiles without coral recruits (NR tiles) and brand new tiles (NE tiles), were used in the prey-choice experiment to test the attractiveness of coral recruits to *Drupella*. The overall attractiveness of different types of tiles to the snails was low, and more *Drupella* snails were found on NR tiles instead of the R tiles. Effect of *Drupella* corallivory was also evaluated by counting the number of recruits lost after a movement experiment. The results revealed that only < 10% of coral recruits were removed by *Drupella*, and similar outcomes were also obtained when herbivorous gastropods *Tectus pyramis* and *Euplica scripta* were used. This suggested that the loss of coral recruits due to corallivorous gastropods was not any greater than that due to the herbivores. All these results indicate that coral recruits were not attractive to *Drupella*, and the effect posed by this corallivore gastropod on the survival of coral recruits was limited.

1. Introduction

Coral recruitment is vital to the population maintenance and recovery of coral reef communities (Connell et al., 1997; Doropoulos et al., 2014). The addition of new individuals to the population is critical in mediating adult population structures and in helping to restore coral reefs after disturbances (Caley et al., 1996; Connell et al., 1997). The decline in coral recruitment rates was one of the reasons suggested to be responsible for the slow recovery of Caribbean reefs (Hughes and Tanner, 2000).

Similar to other marine organisms, recruits of coral are delicate and sensitive to a wide range of environmental, biological and anthropogenic factors. Global environmental changes, such as ocean acidification, have been shown to affect multiple early life stages of coral, including the post-settlement growth and the calcification rate of coral recruits (Albright et al., 2010; Doropoulos et al., 2012). The post-settlement mortality of coral recruits was also reported to increase under reduced salinity or elevated temperature (Vermeij et al., 2006; Nozawa and Harrison, 2007). Tropical cyclones (hurricanes or typhoons) could also act as a stressor to coral recruits. Apart from directly breaking coral recruits, sediment scouring induced by strong waves, even in small magnitude, could cause negative impacts on coral recruits (Mumby, 1999; Babcock and Smith, 2000; Carpenters and Edmunds, 2006).

Besides environmental disturbances, coral recruits also encounter a large variety of biological stresses such as competition and predation. In Hong Kong, Chui and Ang (2010) documented a poritid recruit being outcompeted by barnacles in less than a month. Similar incident was also reported in the Caribbean in which the macroalgae *Lobophora variegata* and *Dictyota pulchella* reduced the survivorship of juvenile corals through shading and abrasion (Box and Mumby, 2007). To alleviate the impact of macroalgal competition, grazing herbivores were commonly introduced to coral larval culture to inhibit macroalgal proliferation (Omori et al., 2007; Villanueva et al., 2013). However, these grazing herbivores could in turn become another cause of recruit mortality, as they may accidentally graze on or dislodge the recruits from the substratum (Christiansen et al., 2009; Penin et al., 2010).

Apart from the grazers, the corallivorous amphinomid fireworm *Hermodice carunculata* was reported to feed on the coral settlers. Wolf and Nugues (2013) demonstrated that small- and mid-sized fireworms fed on coral spat upon encounter, leaving remnants of coral tissue behind. The incidents of coral recruits being attacked by corallivores like parrotfish were also noted (Box and Mumby, 2007). Surprisingly,

* Corresponding author.
E-mail addresses: thlryan.411@gmail.com (R.H.L. Tsang), applepychui@cuhk.edu.hk (A.P.Y. Chui), zoew929@hotmail.com (K.T. Wong), put-ang@cuhk.edu.hk (P. Ang).

https://doi.org/10.1016/j.jembe.2018.03.003
Received 13 June 2017; Received in revised form 26 February 2018; Accepted 12 March 2018
Available online 20 March 2018

however, literatures documenting the predatory effects on coral recruits by other well-known corallivores like the crown-of-thorns starfishes (COTs) and the muricid *Drupella* spp. are scarce, compared with the intensive studies of their effects on the adult corals.

Being one of the most notorious coral predators, *Drupella* snails were capable of inducing damages equivalent to that of the crown-of-thorns starfishes (COTS). Cumming (2009a) suggested that 6.40 *Drupella* per m^2 can consume coral tissue at the same rate of 68 COTS per hectare. Their periodic population outbreaks were reported throughout the reef areas in the Indo-Pacific and the Red Sea, devastating local coral communities (Ayling and Ayling, 1987; Antonius and Riegl, 1998; Baird, 1999; Schoepf et al., 2010; Hsieh et al., 2011). With the absence of COTS and with the density of other fish corallivores like parrot fish being very low, *Drupella* is also the major corallivore in marginal reef environment like Hong Kong, preying on no < 16 out of the 28 coral genera found (Cumming and McCorry, 1998; Morton and Blackmore, 2009; Tsang, 2017) and causing severe bioerosion on corals in north-eastern Hong Kong (Lam et al., 2007; Personal observation).

Located near the Tropic of Cancer, the marine environment of Hong Kong is considered as marginal for coral growth, yet it houses at least 84 species of scleractinian corals in 28 genera (Ang et al., 2005). Previous studies on coral reproduction in Hong Kong recorded a high fertilization success in the massive coral *Platygyra acuta* (Chui et al., 2014; Chui and Ang, 2015) and other species of branching acroporids (Chui and Ang, 2017a). Coral recruitment rate, however, remained very low despite the high fertilization success (Chui and Ang, 2015, 2017b; Chui et al., 2016). Interestingly, when the same batch of coral recruits were reared under a controlled laboratory environment, the larvae showed high settlement rate and could survive for at least 56 days (Chui and Ang, 2017a). The recruitment failure and the high post-settlement mortality of coral recruits in Hong Kong were suggested to be affected by high sedimentation and intense competition with other organisms (Chui and Ang, 2017b). However, the effects of incidental grazing by herbivores and/or corallivores also cannot be overlooked. The objective of the present study was therefore to investigate the possible interactions between *Drupella* and the coral recruits, and the importance of this corallivore in regulating the success of coral recruitment in Hong Kong.

2. Materials and methods

This study was divided into two parts. The first part addressed the question of prey choices of *Drupella* snails (prey-choice experiment) and the second part, on possible impact of snail physical movement on recruit mortality (movement experiment). Layout of the designs of these experiments is given in Fig. 1 and the details described below.

2.1. Gastropods collection

Drupella rugosa (Born, 1778) was selected as the corallivore in the present study as it is the main corallivore in Hong Kong. *Drupella* snails were reported as generalist corallivores, but preferred mainly the acroporid corals (Morton et al., 2002). Herbivorous gastropods were used in the present study as a control against any effects of the corallivores on coral recruits that may be due to their physical movement alone. The herbivorous gastropods chosen included the topshell *Tectus pyramis* (Born, 1778) and the dotted dove shell *Euplica scripta* (Lamarck, 1822). Both gastropods were commonly used as grazers to remove fouling macroalgae and to improve the health of juvenile corals in mariculture and aquarium (D'Angelo and Wiedenmann, 2012; Omori et al., 2007; Toh et al., 2013).

All gastropods were collected from Wong Wan Chau, New Territories, Hong Kong (22°31′N, 114°19′E). A total of 75, 190 and 180 *D. rugosa* snails were collected in May 2012, 2013 and 2014 respectively, while 40 individuals of the herbivores *T. pyramis* and *E. scripta* were each collected respectively in May 2013 and May 2014. The low number of *T. pyramis* snails in 2014 precluded them from being used as a control in the second part of the experiment in 2014.

2.2. Coral gamete collection, rearing, and induced settlement

The coral communities in Hong Kong are dominated mainly by massive and encrusting corals, rather than by the fast-growing branching corals (Ang et al., 2005). Therefore, recruits of *Platygyra acuta* Veron, 2000, the main building block of the local coral community, were used in the present study. On the other hand, recruits of *Acropora pruinosa* (Brook, 1893) were also used in a comparative experiment as acroporid corals were reported as the preferred prey of *Drupella* (Turner, 1994; Morton et al., 2002).

Coral gametes were collected during coral spawning seasons (May to June) in A Ye Wan, Tung Ping Chau Marine Park (TPCMP) (22°55′N 114°43′E). In 2012 and 2013, coral gametes were respectively collected from ten *P. acuta* colonies, while the gametes from three *A. pruinosa* colonies were used in 2014. The gamete collection and culturing procedures followed those described in Chui et al. (2014). Gametes of different tagged colonies were captured using underwater collection traps. The collected bundles were then mixed in a culture tank for fertilization followed by sperm wash. Fertilized eggs were reared in culture tanks filled with freshly prepared 40 μm filtered seawater. Seawater was changed every day until the zygotes reached the planula stage and became competent to settle.

Induced settlement was conducted in the same culturing tank. Ceramic tiles 10 × 10 cm (100 cm^2) were used as the artificial substrata. These tiles were pre-conditioned in TPCMP for 1.5 months before the coral spawning season to allow development of biofilm and crustose coralline algae (Chui and Ang, 2015). Induced settlement lasted for three days and the tiles with coral recruits were examined thereafter. The number of recruits in each tile was counted under the stereomicroscope (Kyowa, Model SZM). In 2013 and 2014, the spatial location (on surface or depression), as well as the position of the recruits were also mapped prior to further experimentations. As settlement pattern of coral larvae was a natural process that cannot be experimentally controlled, tiles with coral recruits used between treatments were carefully selected to be as similar as possible in their recruit number and pattern to minimize experimental artefacts.

2.3. Prey-choice experiment

The prey-choice experiments were conducted to examine the prey preference of *Drupella*, with "prey" being the ceramic settlement tiles with different treatments.

2.3.1. Experimental design

The experimental design followed that described in Tsang and Ang (2015) (Fig. 1A). An aquarium (24 × 44 × 26 cm) filled with 14 L well-aerated filtered seawater constituted one experimental unit (replicate). Six tiles (representing three types of prey as detailed in the next section) were placed on the bottom of each aquarium arranged in a semicircle at random order, with 25 *D. rugosa* (predators) placed in the center of the semicircle to ensure that the distance between the predators and each of the prey was equal. As suggested by Kita et al. (2005), *Drupella* may be attracted by chemicals secreted by corals as feeding cues. In order to avoid any disruption of the chemicals (if any), aeration in the experimental aquarium was stopped immediately after the start of the experiment. This experiment ran for 6 h from 2200 h to 0400 h of the following day as *Drupella* snails were known to be nocturnal in their feeding behavior (Cumming, 2009b). Observations were made at every 15 min in the first 4 h, and every 30 min for the remaining 2 h, making a total of 20 observations per experiment. As the parameter being compared in this experiment was the number of snails found present on different tiles at different time points, difference in the time interval of observation between the first 4 h and later 2 h of the experiment was not a concern. In each observation, the number of snails that crawled on