Proceedings of the 11th International Coral Reef Symposium, Ft. Lauderdale, Florida, 7-11 July 2008
Session number 11

Lunar periodicity of larval release and larval development of *Pocillopora damicornis* in Thailand

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Abstract. In this study, the lunar periodicity of larval release and development of larvae of *Pocillopora damicornis* in the Gulf of Thailand were investigated. Ten colonies of *P. damicornis*, approximately 15 cm in diameter, were tagged and collected for observation every month. To observe the releasing period of larvae, each colony was placed in a separate tank in a rearing system until the planula larvae were released. The results showed that *P. damicornis* released planulae during the day and night between 1-14 days after the new moon. However, the highest numbers of planula larvae were released 5-6 days after the new moon. The releasing rates were 0.19±0.05 larvae per polyp. Moreover, some colonies released larvae for up to 3 months consecutively. The newly released larvae were approximately 1 mm in length. The larvae started settling on a substrate within 0.5 hours after released, and depressed their body shape in 1.5 hours. The polyp, tentacle, and exoskeleton were observed after 40 hours. After 4 days, a juvenile coral (primary polyp) started budding and expanding its size. At the 6th month, the colony shape started uplifting.

Key words: *Pocillopora damicornis*, coral, lunar periodicity, larval release, larval development

Introduction

Pocillopora damicornis is typically a hermaphroditic brooder releasing the planula larvae with symbiotic zooxanthellae (Szmant 1986). However, in some areas such as Eastern Pacific, this species is a broadcast spawner (Glynn et al. 1991). Releasing periods are related to lunar cycle, which can vary in different areas (Harriott 1983; Richmond and Jokiel 1984; Chou and Quek 1993; Fan et al. 2002). For example, in Singapore, larvae of *P. damicornis* were released from a few days before the new moon to almost the first quarter (Chou and Quek 1993). In Southern Taiwan, larvae were released from lunar days 2-9 (Fan et al. 2002). After released, planula larvae of other pocilloporids settle rapidly on substrates (Baird and Morse 2004). They change their body shape, generate hard structures as a basal plate, and start budding after settling 3-7 days (Sato 1985; Babcock et al. 2003).

Although there are many papers on lunar periodicity and development of *P. damicornis*, some are contradictory in releasing periods, and none of them are from Thailand (Harriott 1983; Richmond and Jokiel 1984; Sato 1985; Chou and Quek 1993; Fan et al. 2002; Babcock et al. 2003; Baird and Morse 2004). The purpose of this study is to investigate the larval releasing period and development of *P. damicornis* in Thailand. The releasing rate and settlement behavior of larvae are also observed.

Materials and Methods

To observe the releasing period of larvae of *P. damicornis*, 10 colonies (each colony 15 cm in diameter) were randomly collected at Khao Maa Cho, Ko Pla Muk and Ko Samae San in Sattahip area, Chonburi Province (Fig. 1). Then, they were tagged and brought back to the laboratory to observe during the full moon and new moon of each month from March 2006 to December 2007. In the laboratory, each colony was placed in a separate tank in a rearing system until the planula larvae were released. To determine numbers of releasing larvae, the larvae were collected from each tank using a Pasteur pipette, and counted every day from the beginning to the end of the releasing periods.

In addition, the releasing larval rates were investigated. Three fragments of corals approximately 3-4 cm in length were randomly cut from each of 5 colonies. Then, the numbers of releasing larvae were counted in each fragment. Each fragment was further decalcified using formic acid solution and sodium citrate to determine the numbers of polyps. Then, numbers of released larvae were compared on a polyp basis.

After the larvae settled, their development stages were observed under the stereo-light microscope. The behavior during the settlement and metamorphosis were also observed.

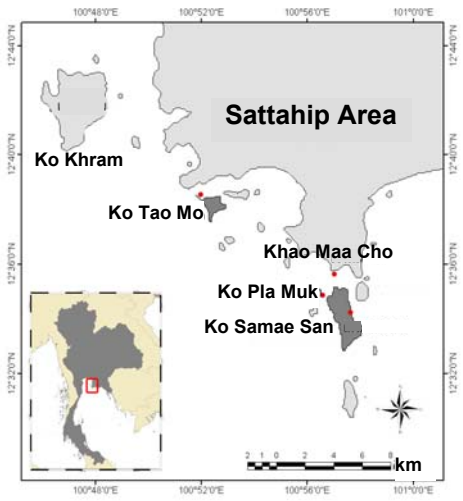

Figure 1: Study sites at Khao Maa Cho, Ko Pla Muk and Ko Samae San, Chonburi Province, where *P. damicornis* was collected

Results

Planulae size of *P. damicornis* was approximately 1 mm. Planulae were released almost every month during 1-14 days after the new moon (Fig. 2). However, the peak of larval release occurred 5-6 days after the new moon. The average numbers of larvae released ranged between 107.2-457.2 individuals per colony per day (Fig. 3). Larvae of *P. damicornis* were found every month. The average numbers of larvae released was high in September 2006 and May 2007. However, when using statistical analyses, there was no significant difference in the numbers of larvae released between months (p>0.05). In addition, the results showed that some colonies could release planulae for up to 3 months consecutively. However, other colonies released planulae every other month. From the observation and calculation, the rate of releasing *P. damicornis* larvae was 0.19±0.05 individuals per polyp.

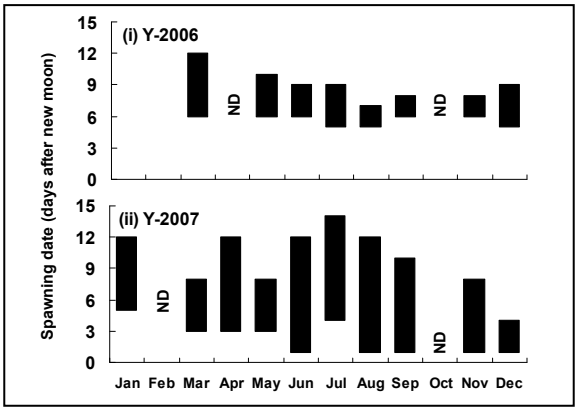

Figure 2: Releasing periods of *P. damicornis* larvae related to lunar cycle during March 2006 to December 2007 (ND: no observation)

After released, the larvae started settling within 0.5 hours. They compressed their body within 1.5 hours, and changed their shape to barrel shape (Fig. 4). During the experiments, larval behaviors were observed. Those behaviors included 1) touching substrates and then swimming (termed touch down), 2) creeping on surfaces of substrates, and 3) spinning while touching substrates. The metamorphosis of *P. damicornis* larvae was shown in Fig. 4. Within 20 hours, their exoskeletons fused to the substratum. The polyp, tentacle, and exoskeleton were observed after 40 hours. A primary polyp started budding to several new polyps 4 days after settling.

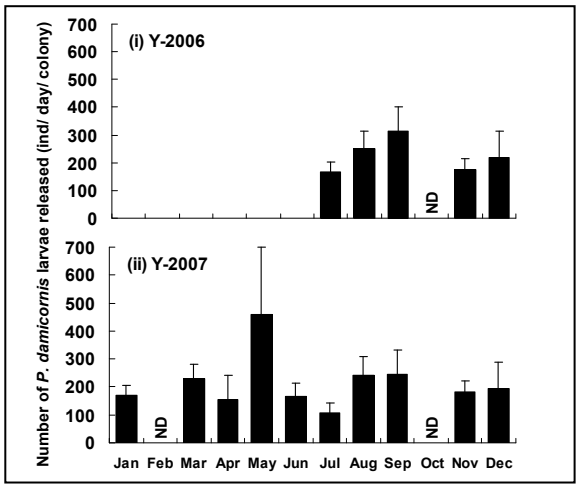

Figure 3: Average number (± SE; n=10) of *P. damicornis* larvae released daily during July 2006 to December 2007 (colony size: 15 cm in diameter) (ND: no observation)

Discussion

In this study, *P. damicornis* in Thailand was found to release planulae during the day and night between 1-14 days after the new moon. In Taiwan and Australia, the releasing periods of *P. damicornis* larvae were between 2-9 and 1-15 days after the new moon respectively (Richmond and Hunter 1990; Fan et al. 2002), while in Singapore, it was between a few days before the new moon to almost the first quarter (Chou and Quek 1993). In agreement with other study (Hodgson 1985), *P. damicornis* in Thailand also released both during the day and at night. From the observation, there was no difference in the numbers of larvae released between months (p>0.05). The results also showed that planulae were present every month. In Heron Island, Australia, Tanner (1996) reported that *P. damicornis* larvae were observed during summer months (between September to April), but were rarely present during the winter. Harriott (1983) showed that the reproduction of *P. damicornis* was not synchronized within a colony due to different stages of gonad maturation in different polyps. Thus, every polyp in a colony may not release larvae during

a certain reproductive cycle (Harriott 1983). In addition, Fadlallah (1983) suggested that in *P. damicornis,* testes matured before ovaries to avoid self-fertilization, which led to asynchronization in a colony.

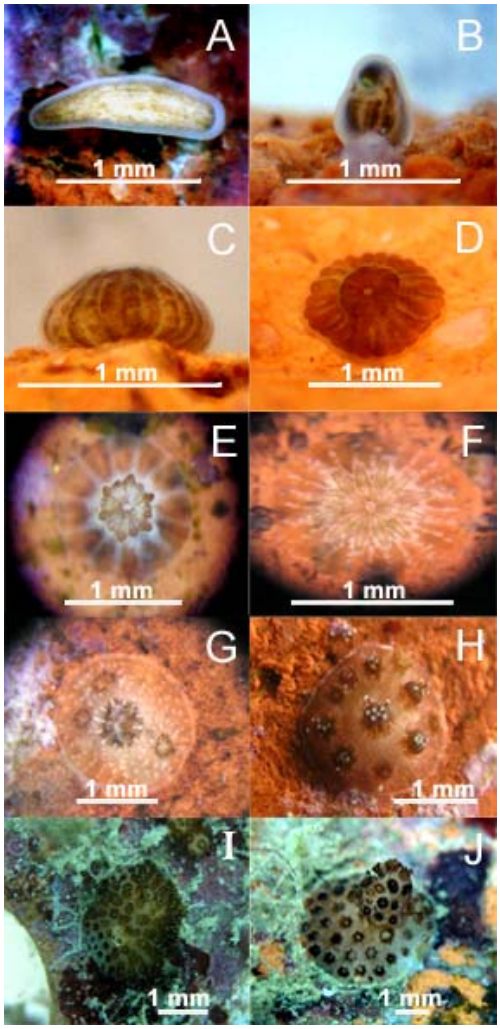

Figure 4: Metamorphosis of *P. damicornis*. A) searching for suitable plate; B) started attaching, 0.5 hrs; C) depressed its shape, 1.5 hrs; D) polyp formation, 5 hrs; E) tentacles and exoskeleton formation, 20 hrs; F) tentacles and exoskeleton observed, 40 hrs; G) started budding, 4 days; H) 1 month old; I) size expanding, 3 months old; J) started uplifting, 6 months old.

The rate of larval release can vary depending on colony sizes (Tioho et al. 2001). In this study, rate of releasing *P. damicornis* larvae was 0.19±0.05 individuals per polyp per month. Tanner (1996) showed that *P. damicornis* in Heron Island, Australia released 1-3 larvae per polyp, and in each month, only 1/3-1/2 of all polyps in a colony released planulae.

The settlement behaviors and development of larvae observed in this study were similar to other previous studies (Sato 1985; Babcock et al. 2003; Baird and Morse, 2004). Once larvae settled, metamorphosis was started and basal plate was formed. *P. damicornis* started budding 3-7 days after the settlement (Sato 1985).

In conclusion, lunar periodicity of larval release by *P. damicornis* in Thailand was consistent with those reported in other areas. However, the releasing period in Thailand was longer than that of other areas. More studies are needed to determine what environmental factors can influence the gonad maturation of *P. damicornis* in Thailand.

Acknowledgments

We would like to thank the Plant Genetic Conservation Project under the Royal Initiative of Her Royal Highness Princess Maha Chakri Sirindhorn and the Naval Special Warfare Group, Royal Thai Navy for field support and assistance. We also would like to thank all students in the Reef Biology Research Group, Chulalongkorn University for field and laboratory assistance. This work was funded by the 90th Anniversary of Chulalongkorn University Fund (Ratchadaphiseksomphot Endowment Fund), Office of Commission for Higher Education - CU Graduate Thesis Grant, Asia Research Center at Chulalongkorn University, and TRF/BIOTEC Special Program for Biodiversity Research and Training Grant T_348009.

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