

UNIQUENESS OF LARVAL RELEASING OF *Littoraria Scabra* L. (GASTROPODA: LITTORINIDAE), IN TOMBARIRI MANGROVE, NORTH SULAWESI, INDONESIA

(Keunikan Pelepasan Larva *Littoraria Scabra* L. Gastropoda : Littorinidae, Di Mangrove Tombariri Sulawesi Utara, Indonesia)

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ABSTRACT

This research was found novelty of reproduction strategy uniqueness of *L. scabra* that very rare in nature, reverse male function fertilized eggs are sucked for brooding in mantle of male up to hatching as veligers, and thus, the males are capable of releasing the larvae in full and new moon at spring tide during the research. The second finding in reproduction strategy uniqueness of *L. scabra* that mating individuals, both males and females, released their larvae during research period.

Key Words : *Littoraria scabra*, uniqueness, releasing, veliger, male and female

ABSTRAK

Penelitian yang amat langka di alam ini menemukan kebaruan keunikan strategi reproduksi *Littoraria. scabra*, di waktu kopulasi jantan berperan seks terbalik menyedot sebagian telur yang dibuahi dan dierami telur-telur yang dibuahi dalam tubuhnya sampai menetas menjadi larva-larva serta melepaskan larva-larva tersebut di bulan penuh dan baru yang mengikuti siklus pasang selama penelitian. Temuan amat langka kedua keunikan strategi reproduksi *L. scabra*, yang amat langka di alam dengan pasangan jantan-betina lagi kawin melepaskan larva-larva baik jantan maupun betina pada siklus bi-lunar bersamaan dengan siklus pasang selama penelitian.

Kata Kunci : *Littoraria scabra*, keunikan, pelepasan, veliger, jantan dan betina

INTRODUCTION

Nocturnal larval release is common in marine invertebrate because it minimizes predation (Morgan and Christy, 1995) and reduces the effects such as temperature stress and photodamage (Forward, 1987). Irregularities of larval release before the high tide occurs when light/dark cues entrain stronger rhythms than tidal cues.

In mangrove habitats, invertebrates perceive the tidal amplitude cycle by water pressure or even the tidal force (Hovel and Morgan, 1997).

The synchronised release of larvae has been argued to minimise the risks of predation and unfavourable environmental factors (Forward, 1987; Morgan, 1995). An error in timing of larval release could have fatal results for

progeny and significant implications for local population. Timing errors of larval release could occur if adults did not have an adaptation of endogenous release rhythms, or if entrainment to a cycle, on rare occurrences, increased the risk of mortality (Ricardo, 2011).

Littorinids living high on the shore are only reached by new or full moon spring tides, and hence most release their eggs or larvae during these periods (Berry 1986). Both *Littoraria ardouiniana* and *L. melanostoma* live in the upper zone of the mangrove trees (Yipp 1985; Lee and Williams 2002b; Reid 1986), and their bi-lunar periodicities of egg or larval release, associated with spring tides, matches those of many other rocky shore and mangrove littorinids (Gallagher and Reid 1974; Aliflerakis and Berry 1980; Berry 1986). In Malaysia, however, *Littoraria melanostoma* mainly spawns during full moon spring tides, as tidal heights during this phase of the moon are higher than during the new moon phase (Berry and Chew 1973). Releasing large numbers of veligers in a single event could, therefore, be an effective strategy to compensate for this limitation. This behaviour can, however, also be a strategy to reduce predation risk. Shell crushing scars are frequently observed on individuals of both species, which may indicate severe predation risk from crabs in Hong Kong, as recorded in Australia (Reid 1992). By releasing more larvae at each larval release event within a shorter reproductive season, females of *L. ardouiniana* may spend less time immersed in seawater, and hence reduce their exposure time to predators.

Reid (1989) suggested that short-term brooding of embryos to the planktotrophic veliger stage in ovoviparous *Littoraria* species may increase larval survival, whilst energetic costs may even be reduced as

compared to producing eggs, due to the absence of a capsule gland in ovoviparous females.

Females of *L. ardouiniana* release their entire brood of larvae faster and over a much shorter duration in a single event, as compared to the longer, slower and repeated release of eggs in *L. melanostoma*. Such differences in egg- and larva-releasing behaviour have also been observed between members of another sympatric pair of oviparous and ovoviparous *Littoraria* species in Florida, *L. irrorata* and *L. scabra angulifera* (Gallagher and Reid 1974). It seems reasonable to assume that rapid release of larvae in ovoviparous species may reduce exposure to marine predators; thus, predation may be a selective force driving the development of ovoviviparity in *Littoraria* species (Reid 1989; Reid *et al.* 2010).

In the mangrove habitat studied at Cockle Bay, Crabs were the major predators of the larger postlarval stages of *Littoraria* species (Reid, 1984). The most common crab on the *Rhizophora* trees was *Metopograpsus latifrons*, a small, agile grapsid with relatively weak and unspecialized chelae. To avoid predation, invertebrates are expected to release larvae at times that minimise the risk of predation (Morgan and Christy, 1995). Larvae are assisted by receding tidal currents and disperse outward into the estuary or the coast (Hovel and Morgan, 1997).

Methods

Research map of Tombariri mangrove can be seen in (Appendice 1). Ten individuals of each males and females collected were mature. The collection was done 4 days before new moon and full moon to avoid missing larval release period from February to December 2014. Male and female

spawners were separated in different plastic containers. Males and females released larvae in the plastic bottle, and they were counted using a dissecting microscope / binocular. Also, 10 mating pairs were collected. The males and females were put in different plastic containers. They released larvae as well, and the larvae were counted.

Larval release rate is number of larvae released per second (Ng, 2013). Number of larvae released was counted using a hand tally counter. Ten individuals of each males and females releasing the larvae were randomly selected. The larvae were released by withdrawing their snout and tentacle inside mantle cavity. Difference in larval release between male and female was estimated using t-test. The same test was also used for difference in the larvae released by mating male and females.

Results and discussion

Larval Periodicity of mating *Littoraria scabra*

Summary of research can be seen in (Appendice 2). Mean larval periodicity of *L.scabra* on *Sonneratio ovata* during the study in Tombariri Mangrove, North Sulawesi, Indonesia. The present findings in station Mokupa

demonstrated that *L. scabra* spawned along the year with the highest in the full moon of February 2014, 10 mating pairs of total 30 individuals encountered and the lowest in the full moon of October 2014, 10 mating pairs of total 98 individuals. In new moon, the highest mating pairs occurred in June 2014, 10 mating pairs of total 96 individuals the lowest, can be seen in Figure 1 and 2.

The highest larval release of mating male *L. scabra* was found in station Mokupa in April 2014, 259.4 individuals in full moon and 267.1 individuals in new moon. The lowest was recorded in June 2014, 182.1 individuals in full moon and 148.4 individuals in new moon of December 2014. In Station Elu, males released the highest number of larvae in new moon, 229.2 individuals, in April 2014, and in new moon, 290.5 individuals, in February 2014. The lowest number of larvae was recorded in full moon of August 2014, 100.6 individuals, and in new moon of the same month, 155.8 individual. Station Tambala has the highest number in full moon of April 2014, 256.4 individuals, and in new moon of October 2014, 268.4 individuals. The lowest number occurred in full moon of June 2014, 108.7 individuals and in new moon of August 2014, 189.2 individuals (Figure 1 and 2).

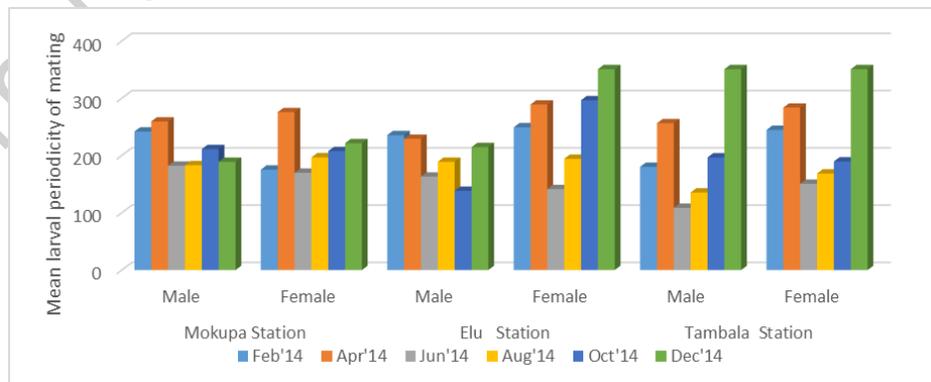


Figure 1. Mean larval periodicity of mating individuals of *L.scabra* on *Sonneratio ovata* in full moon during the study in Tombariri mangrove

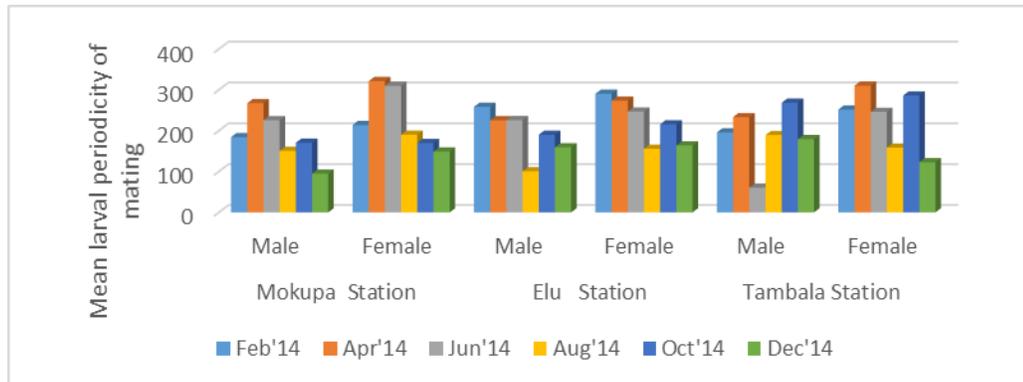


Figure 2. Mean larval periodicity of mating individuals of *L. scabra* on *Sonneratio ovata* in new moon during the study in Tombariri mangrove

One-year observations, February 2014 to December 2014, at two-month intervals in station Tambala showed that the highest mating occurred in the full moon of February 2014, with 10 mating pairs of total 51 individuals, while the lowest occurred in the full moon of October, with 10 mating pairs of total 125 individuals.

Larval Periodicity of non-mating *Littoratia scabra*

This study found that both males and females released their larvae the

sea margin and it was achieved in the full moon of December, 2014, 257.4 individuals. The lowest larval periodicity occurred in August 2014, 174.9 individuals in April 2014 and the lowest occurred in June 2014, 126 individuals (Figure 3,4,5 and 6).

Larval periodicity occurred along the year for either females or males. Rare finding was male *L. scabra* released their larvae along the year with the highest mean periodicity in Tombariri mangrove

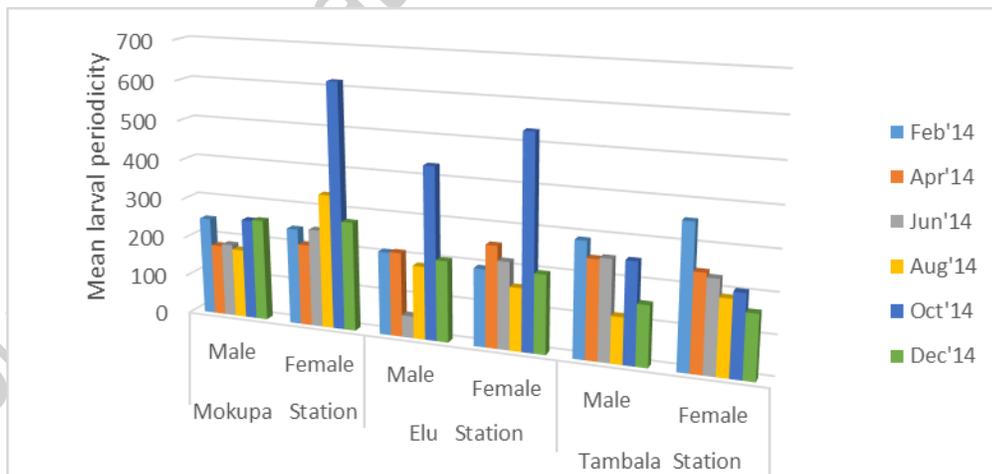


Figure 3. Mean larval periodicity of *L. scabra* on *Sonneratio ovata* in full moon at the sea margin during the study in Tombariri mangrove

In new moon, the highest mean number of larvae released by males

was 291.7 individuals. Elu station of sea margin and inner mangrove, the

highest mean number of larvae released occurred in full moon, 433 individuals in October 2014 and new moon, 249.2 individuals in February, 2014. The lowest larval release occurred in full moon, 184.1 individuals, in August 2014 and in new moon, 159.3 individuals, in June 2014. In Elu station of inner mangrove, the highest mean number of larvae released by males occurred in full moon, 310 individuals, in February 2014 and in new moon, 285.2 individuals, in April 2014. The lowest larval release, 181.4 per individuals, occurred in full moon of April 2014 and in new moon, 149.6 individuals, in December 2014 (Figure 4).

In new moon, the highest mean number of larvae released by males was 291.7 individuals. Elu station of

sea margin and inner mangrove, the highest mean number of larvae released occurred in full moon, 433 individuals in October 2014 and new moon, 249.2 individuals in February, 2014. The lowest larval release occurred in full moon, 184.1 individuals, in August 2014 and in new moon, 159.3 individuals, in June 2014. In Elu station of inner mangrove, the highest mean number of larvae released by males occurred in full moon, 310 individuals, in February 2014 and in new moon, 285.2 individuals, in April 2014. The lowest larval release, 181.4 per individuals, occurred in full moon of April 2014 and in new moon, 149.6 individuals, in December 2014 (Figure 3 and 4).

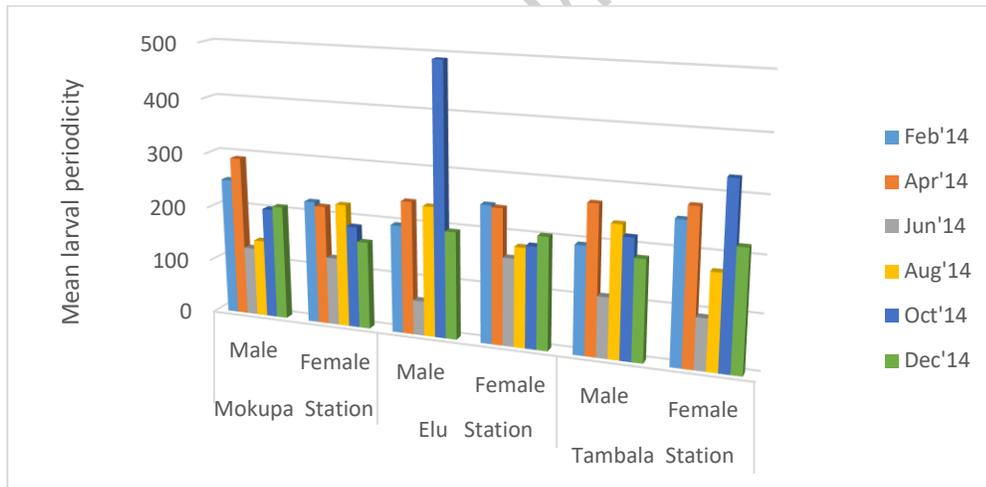


Figure 4. Mean larval periodicity of *L. scabra* on *Sonneratio ovata* in new moon at the sea margin during the study in Tombariri mangrove

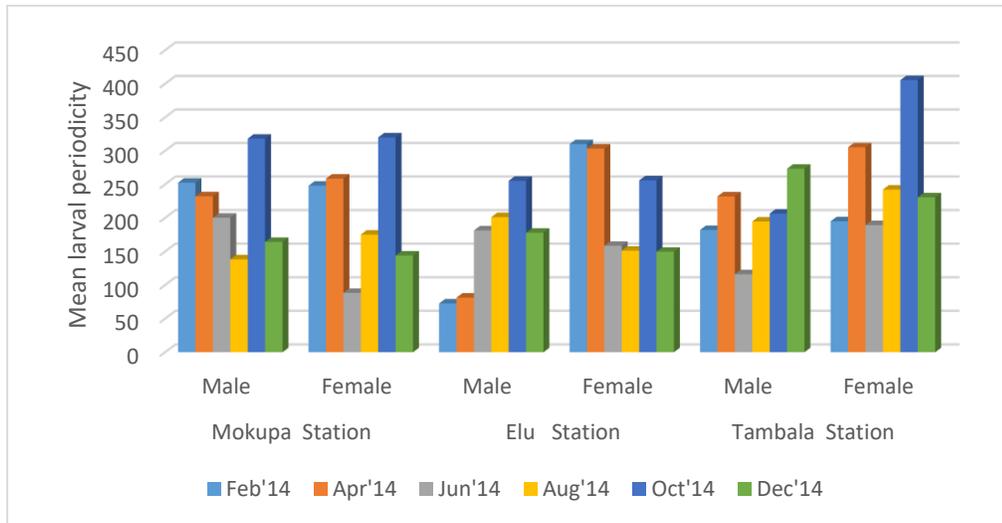


Figure 5. Mean larval periodicity of *L. scabra* on *Sonneratio ovata* in full moon at the inner mangrove during the study in Tombariri mangrove

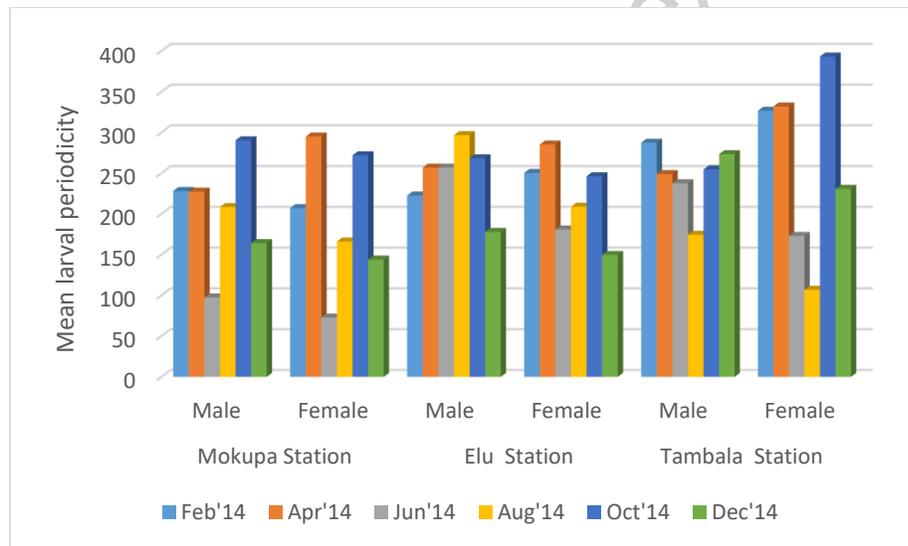


Figure 6. Mean larval periodicity of *L. scabra* on *Sonneratio ovata* in new moon at the inner mangrove during the study in Tombariri mangrove

In Tambala station of sea margin mangrove, males released the highest number of larvae in full moon, 289.1 individuals in February 2014 and in new moon, 268.9 individuals, in April 2014. The lowest was found in full moon, 109.4 individuals, in June 2014 and in new moon, 92.7 individuals, in June 2014 (Figure 3 and 4).

Most tropical species *Littoraria* release planktotrophic veligers but a few species brood embryos (Reid, 1984, 1986). According to (Sanpanich *et al.*, 2008), *Littoraria strigata* spawned regularly on the spring tides with 89 % of eggs appearing between one and five days after the new and full moon. However, full moon spawnings (when spring tides are highest) yielded an average of seven times more eggs than the weaker new moon tides (Berry, 1986). Burgett *et al.* (1987) reported *Littoraria angulifera* spawned through at least 10 months of the year, peaking in the spring and autumn between June and December and being minimal in December and March. Berry and Chew (1973) reported that egg capsules of *Littoraria melanostoma*

Larval release is defined as the deliverance of eggs or larvae from an adult into the water column, usually from the saltmarsh-mangrove to deeper waters (Ricardo, 2011). Littorinids including *L. scabra* living on high shore only reached by new or full moon spring tides, mostly release their larvae (eggs) during these periods. Both *Littoraria ardouiniana* and *Littoraria melanostoma* live in the upper zone of the mangrove trees (Lee and Williams, 2002), and their bi-lunar periodicities of egg or larval release, associated with spring tides, match those of many other rocky shore and mangrove littorinids (Gallagher and Reid, 1974). In Malaysia, however, *L. melanostoma* mainly spawns during full moon spring tides, as the tide height during this phase of the moon is higher than during the new moon phase (Berry and Chew, 1973).

Larval Release Rate

Mean larval rate released by male *L. scabra* was 172.5 ± 33.15 per sec., while females averagely released 195.4 larvae $\pm 27,8$ per sec. Based on the t-test, mean rate of the larval release was significantly different between males and females. Total duration of larval release was 2.2 – 5.0 min or 132 -300 sec. *This study found very rare and unique phenomenon in the nature where mating males and females release their larvae along the year in full and new moon following the tidal cycle.* They had mean larval release rate of 88.65 ± 11.25 per sec. (95 % confidence level), $n = 20$, for males, and 138 ± 14.18 per sec., $n = 20$, for females. The t-test on mating individuals shows also significantly higher number of larvae released by females than males. Gallagher and Reid (1974) showed that the ovoviviparous *Littoraria angulifera* could release up to 246,000 veligers in 30 minutes, while the oviparous *Littoraria irrorata* of similar size released a maximum of 32,000 egg capsules in 2.5 hours. According to Ng (2013), in each event of larval release, total duration of *Littoraria ardouiniana* releasing larvae (2.4 – 7 min) was also much shorter than *Littoraria melanostoma* releasing eggs (31.3 – 94.1 min). Releasing large numbers of veligers in a single event could, therefore, be an effective strategy to compensate this limitation. This behaviour can, however, also be a strategy to reduce predation risk (Ng, 2013). It seems reasonable to assume that rapid release of larvae in ovoviviparous species may reduce the exposure to marine predators; thus, predation may be a selective force driving the development of ovoviviparity in *Littoraria species* (Reid *et al.*, 2010).

Larval release occurs more in reproductive season along the year, in which male and female *L. scabra* probably spend less time submerging in the seawater, and therefore, reduce time exposed to the predators. The larval release of *L. scabra* occurs along

the year indicated with (1) Male and female *L. scabra* mature all the year; (2) the continuous presence of mature oocytes in the ovary and the gonadal oviduct; (3) no evidence of gonad decrease period (gonadal regression), as supported in the littorinid in spawning season (Borkowski, 1971; Muggeridge, 1979); (4) Spawning peak occurrence due to effect of tide (Borowski, 1971; Lalita, *pers.obs*), water temperature (Muggeridge, 1979; Lalita, *pers.obs*), and phytoplankton abundance (Underwood, 1979), and (5) prolonged spawning period of *L. scabra* as response to high predation for small and newly settled individuals (*pers.obs*). Releasing large numbers of veligers in a single event could, therefore, be an effective strategy to compensate for this limitation. This behaviour can, however, also be a strategy to reduce predation risk. By releasing each larval release event within all the year, males and females of *L. scabra* may spend less time immersed in seawater, and hence reduce their exposure time to predators. Risks of predation and lodgement from wave action are likely to differ between species living at high and low levels between rocky shores and mangrove habitats (Raffaelli and Hawkins 1996; Little *et al.* 2009).

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