Short Communication

Effect of different feed regime on the survival and larvae development of mantis shrimp larvae (*Miyakella nepa*)

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Introduction

Miyakella nepa (Latreille, 1828) (Crustacea: Stomatopoda), also known as the small-eyed squillid mantis shrimp can be found throughout the Indo-West Pacific regions (Ahyong, 2001). To date, most mantis shrimps fisheries resource in Asia was collected from the wild (Lui *et al.*, 2007). *M. nepa* and a few other mantis shrimps species are important commercial fisheries in certain parts of Asia and has been overly exploited since the 1980s (Hamano and Matsuura, 1986; Musa and Lee, 2008; Ngoc *et al.*, 2018). High demand on local and import/export markets can be seen to be increasing throughout the years in countries like Indonesia (Wardiatno and Mashar, 2011), Vietnam (Ngoc *et al.*, 2018), China (Xing, 2015) and even in Malaysia (Chern, 2020). Thus, the pressure for sustainable aquaculture efforts has been on the rise in many countries.

One of the main challenges in aquaculture for any species is understands the optimal nutritional requirement of its larvae. The biology of mantis shrimps larvae life cycle are still in its initial phase (Ngoc *et al.*, 2018). The full development of *M. nepa* larval stages has not been fully explored. The only available *M. nepa* larval study was based on a monthly wild zooplankton sampling in the wild (Ng, 2013). It has been reported that mantis shrimp (*Oratosquilla oratoria*) larvae go through a total of 11 development stages. The larval form of mantis shrimps are predators equipped with two raptorial claws for hunting their food. In order to satisfy their natural predatory behaviour, live prey with high nutritive value and optimal size is deduced to be suitable as feed throughout the mantis shrimp larval development (Hamano and Matsuura, 1987).

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For high success rate of mantis shrimp aquaculture, an understanding of suitable sized larval feed is essential. A short preliminary evaluation of different feeding regimes consisting of rotifer and artemia was conducted to determine suitable live feed for mantis shrimp *M. nepa* larvae. Larval survival and duration of stage development were determined to identify the best feeding regime for larvae in captivity.

Materials and methods

Broodstock and larvae procurement

Total of 100 mantis shrimps (>100mm total length) was obtained from fishermen in Bayan Lepas, Penang Island, Malaysia. The mantis shrimps were kept in individual tanks for acclimatization. They were fed to satiation daily on a prepared ration of shrimp, clam and fish. The animals were exposed to natural environmental lighting during the rearing period. Water quality parameters such as temperature, salinity, pH, ammonia concentration, alkalinity and dissolved oxygen concentration were monitored three times a week.

After the acclimatization period, female and male mantis shrimps were paired in a tank. The female mantis shrimp were observed weekly for the development of ovaries on the ventral side of telson. The females spawned within 1-2 weeks once an isosceles triangle of ovary development was visible on the telson. The female was removed and kept in a large volume tank (1 tonne litres). The tank was covered and kept in dark, while the eggs hatched approximately after ten days of maternal care.

Experimental feed regime

Larvae were subjected to three diet regimes; rotifer (*Brachionus plicatilis*) only, artemia only (Aquafauna Bio-Marine Inc., USA), and a mixed diet consisting of rotifer and artemia. There were approximately 50 ind/mL of rotifers for rotifer only diet; 25 ind/mL of artemia for artemia only diet; and approximately 25 and 12.5 ind/mL for rotifer and artemia respectively for mixed rotifer and artemia diet. Triplicates of each feed regime at a density of 50 mantis shrimp larvae per liter were set up in a two litres capacity container. Water change was done once daily in the morning, before feed was added. The diet regime study was started when the mantis shrimp larvae have reached development stage 3.

Survival and larvae development

Survival and larvae development were observed daily. Mortality was estimated by calculating the difference between the initial and the final numbers of surviving individuals every seven days. Larvae development was observed under a dissecting microscope (20x) daily by picking six larvae randomly from all three replicates of the respective feed diet regime. The experiment was ended when the larvae moulted into juveniles or when there were no surviving larvae left. The development of larvae was based on the description by Hamano and Matsuura (1987). Gentle aeration and artificial lighting (12h

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light:12h dark) were provided during the study. When larvae developed into stage 4, artemia only diet regime and mixed rotifer and artemia diet regime was replaced with Red AlgaMac enriched artemia (Aquafauna Bio-Marine Inc., USA) The artemia used for the enrichment procedure was one day old (complete gut development).

Results and discussion

Diet regime trial was started when mantis shrimp larvae attained stage 3, as stages 1 and 2 larvae do not require external feed. They still contain yolk in their anterior part of the carapace as energy reserves. Active feeding and swimming will usually take place when the larvae have reached stage 3 (Hamano and Matsuura, 1987). *M. nepa* larvae that were fed on rotifer only regime declined rapidly upon commencement of the study (≤ 10 larvae on day 7), without any larvae development observed. On day 14, no more surviving larvae were observed for the rotifer only feeding regime. Survival and larvae development were similar for both artemia only and mixed feed (Fig. 1). However survival started to decline (<50%) after four weeks of the trial for both types of feed and the maximum larval development was only till stage 5. Only a limited number of individuals made it to stage 6, but they only survived for three to four days and were unable to be recorded on the stipulated sampling day (Fig. 1).

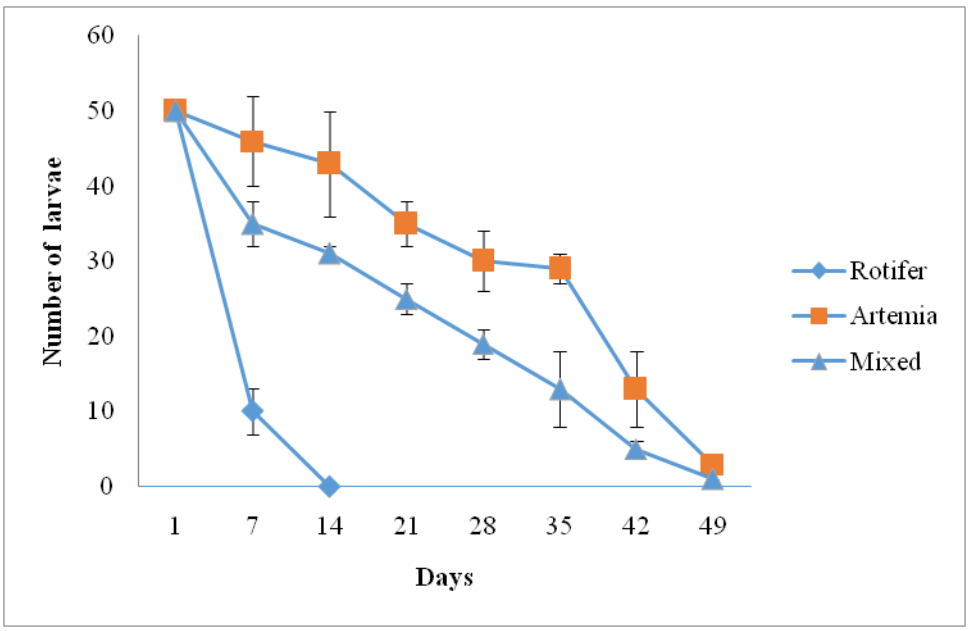

Figure 1: Average survival rate of mantis shrimp (*Miyakella nepa)* larvae fed different live feeds. Error bars indicate standard error of mean (n=3).

Based on survival rates, rotifers are not an ideal feed for mantis shrimps larvae, probably due to its small size (130 µm). Similar to its adult form, mantis shrimp larvae has been observed to use its raptorial claw to lock and capture prey

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during feeding (Dingle and Caldwell, 1978; Atkinson *et al.*, 1997). Prey size is one of the factors affecting the live feed preference for many larvae species; such as crab larvae (Ikhwanuddin *et al.*, 2015) and fish larvae (Pryor and Epifanio, 1993). Larval rearing in laboratory conditions was more favourable when they were provided with live feed compared to non-live feeds (Pyne, 1972). In terms of behaviour, mantis shrimp larvae are planktonic and predatory, preying on other planktonic organisms (Haug *et al.*, 2018). Therefore, the most suitable live feed for *M. nepa* should be explored to determine feeds that contribute towards high survival rates and optimal growth. Hamano and Matsuura (1987) noted in their study, that newly hatched artemia nauplius was only able suitable to sustain the growth of *O. oratoria* larvae till stage 5. Stage 5 and beyond will require larger and more nutritionally enriched artemia. This could be a possible reason for the poor survival beyond stage 5 of *M. nepa* larvae in this study. Newly hatched artemia nauplius was used for stage 3 *M. nepa* larvae, while Red AlgaMac enriched artemia was used for stage 4 onwards *M. nepa* larvae throughout the study. Larger sized artemia and different enrichment method could be a solution for improving the survival of *M. nepa* larvae beyond stage 5.

Days of larvae metamorphosis (Table 1) were longer for stage 3 onwards, compared to the larvae development described in Hamano and Matsuura (1987). Other similar studies mentioned that larvae survivability depended on food availability and environment (Hamano and Matsuura, 1987; Morgan and Goy, 1987; Yan *et al*., 2015).

Table 1: General description of larval stages of mantis shrimp *Miyakella nepa* in laboratory observation during feeding regime trials.

Stage	Days of Metamorphosis	Description
1	1 – 2	Yolk at anterior part of carapace, carapace oval shaped
2	2 – 4	Decreased yolk at anterior of carapace, carapace elongated
3	3 – 20	Yolk absent, carapace angular, pleotelson round
4	10 – 40	Pleotelson broad, pleopod V uniramous bud
5	15 – 50	Pleopod V biramous bud

Delayed metamorphosis in this study could be caused by inappropriate live feed size, thus *M. nepa* took longer time for their growth. Therefore, future recommendation for this study will be to consider larger sized live feed to complement the use of artemia. The raptorial claw reach and swimming speed of mantis shrimp larvae has to be considered when live feed are selected. Artemia are suitable live feed up to a certain life stage for mantis shrimp larvae, however they cannot be the sole source of feed. Figures 2 and 3 (A and B) show the different morphology of stage 1 and stage 5 larvae, respectively.

Prey size plays an important role in stimulating *M.nepa* larvae to feed.

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Rotifers do not seem to be an ideal first feed for mantis shrimp larvae possibly to their small size. The raptorial claw of *M. nepa* larvae is not able to capture the rotifer efficiently, which is smaller in size as compared to artemia. Enriched artemia of various sizes and possibly some larger live prey such as copepod are recommended to be used for future studies.

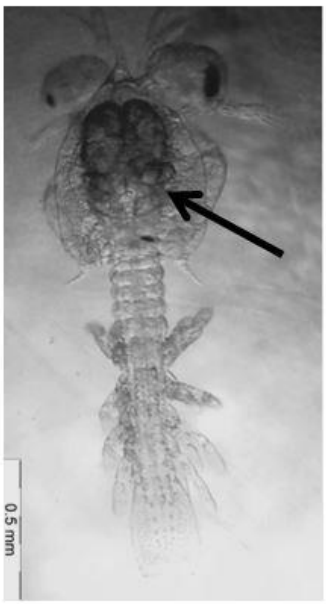

Figure 2: Dorsal view of mantis shrimp *Miyakella nepa* stage 1 larvae, the arrow shown is the yolk reserve at anterior part of the carapace.

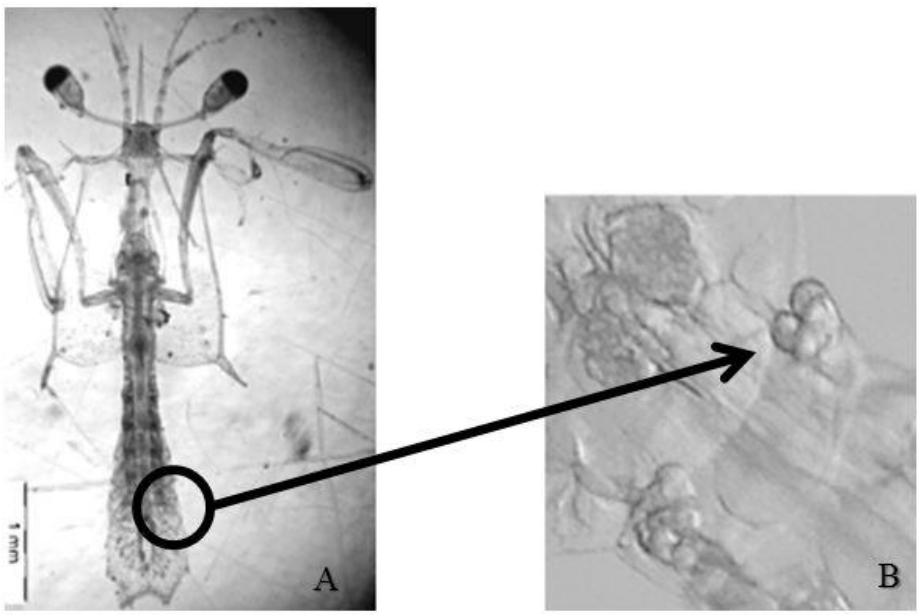

Figure 3: A: Dorsal view of mantis shrimp *Miyakella nepa* stage 5 larvae; B: the biramous bud of the fifth pleopod (ventral view zoomed in).

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