Generation Time of Some Marine Harpacticoid Species in Laboratory Condition

K. Zaleha, B. Ibrahim, B. Akbar John and B. Y. Kamaruzzaman
Department of Fisheries, Faculty of Fisheries and Aqua-Industry,
Universiti Malaysia Terengganu, 21030 Kuala Terengganu, Terengganu, Malaysia
Department of Biotechnology, Kulliyyah of Science,
Institute of Oceanography and Maritime Studies (INOCERM), International Islamic University Malaysia,
Jalan Sultan Ahmad Shah, Bandar Indira Mahkota, 25200 Kuantan, Pahang, Malaysia

Abstract: Recent investigations on harpacticoid copepods have demonstrated their higher nutritional values compared to Artemia and rotifer. Nevertheless, studies on the potential use of tropical harpacticoid copepods as live feed in aquaculture are still limited. The present study was carried out to compare the generation time between selected harpacticoid species cultured in laboratory condition as an early step to choose a potential live feed for aquaculture practices. Some estuarine species of harpacticoid were isolated from Merchang river mouth, an estuary of the South China Sea in Terengganu and undergone trial culture procedure. Three species (Paradactylospodia oculata, Schizopera knabeni and Robertsonia knaxi) were successfully adapted to the laboratory condition thus their generation time were recorded. Copepod samples were cultured under controlled laboratory condition at temperature 25±1°C and salinity 27±1 ppt for 40 days and fed with 0.1 mL of baker’s yeast (0.02 g/L/day). The mean generation time (day) was different for each species where P. oculata showed the long generation time (17.19±4.74 days) followed by S. knabeni (10.19±3.51 days) and R. knaxi (8.93±1.00 days). The species with short generation times could be a better choice for fish larval rearing and hatchery activity due to the early time of nauplii production and hence we suggest the R. knaxi could be used as a potential live feed (on the basis of their generation time) in aquaculture practices.

Key words: Estuarine harpacticoid, generation time, laboratory condition, south China sea

INTRODUCTION

Fish larvae directly depends on the live feed organism for their survival both in the wild and hatchery system. At present, various live feed organisms are used in aquaculture practices as a larval feed to enhance the production and reducing feed cost. Studies have shown that for a number of marine fish species larvae fed with copepod nauplii as a diet resulted in faster growth, enhanced nutritional content and better survival rate of first feeding larvae compared to diets consisting solely of rotifers and Artemia (Watanabe et al., 1983; Stottrup et al., 1986; Kraul et al., 1992; Stottrup and Norsker, 1997; Schipp et al., 1999; Shields et al., 1999; Stottrup, 2000; Payne and Rippingale, 2000). Interestingly, high natural omega-3 profile in copepods compared to other commercially available live feed organism together with better preference of copepod nauplii by the fish larvae has driven researchers to show greater attention on copepod culture in recent years (Bjørgen et al., 2003). Copepods are among the most abundant and important components of aquatic invertebrates in many marine and freshwater ecosystem. They become the major biomass in zooplankton community in the water column and at many occasions they form significant entity of benthic community structure on bottom sediment. They are a major food source for organisms in higher trophic level such as juvenile fishes and shrimps (Vinye, 1996; Penechak, 2004). They constitutes large percentage of larval diet and proven to be the best alternative source to rotifer and Artemia nauplii containing high level of DHA and other PUFA that are necessary for the growing marine fish larvae (McKinnon et al., 2003; Stottrup, 2000). They also contain high level of exogenous digestive enzymes that are believed to be playing notable role in fish larval digestion.

Among the copepods, harpacticoids becomes an important live feed source for aquaculture industry since they have combination of an appropriate size for larval fish, adaptability to culture condition and high nutritional values. Copepod diets were proved to increase the growth of fish and crustacean larvae compared to Artemia or
rotifer *Brachionus plicatilis* (Kuhlmann et al., 1981; Watanabe and Kiron, 1994) because of the low in HUFA’s content in the later group (Barclay and Zeller, 1996; Rainuzzo et al., 1997; Shields et al., 1999).

Harpaacticoid copepods have been found to be a good candidate in aquaculture industry since they have a high reproductive potential, short generation time, high population growth, flexible in diet and tolerate a wide range of environmental factors such as temperature and salinity (Sun and Fleeger, 1995; Stottrup and Norsker, 1997). There are reports that indicate the availability of enzyme in harpaacticoid copepods which enable the organisms to convert any type of their organic food into lipids stored in their body (Nanton and Castell, 1998). They have direct benthic development and pass through six nauplius stages followed by six copepodite stages, then copepodite VI being the adult (Nybakken, 2001). Sun and Fleeger (1995) indicated that the average turn-over time (generation time from egg to egg) of *Amphiascoides atopus* was between 21 and 26 days at 30 ppt and 24°C. A study by McKinnon et al. (2003) showed nauplii development will be completed by 2.46 days in *Parvocalanus crassirostris* and *Acartia sinjiensis* and by 3.2 days in *Bestiola similis*. Due to high commercial values of copepod, present study was aimed to compare the generation time of three harpaacticoid species (*Paradacyclops oculata, Schizopera knabeni* and *Robertsonia knoxi*) collected from estuarine habitat and cultured in a laboratory condition as to evaluate their potential as a live feed source for fish larval rearing practice.

**MATERIALS AND METHODS**

**Sample collection:** Stocks of harpaacticoid copepods used in this study were collected from the sea grass patch at estuaries of Merchang, Terengganu (5°2.260’N, 103°17.821’E) in the South China Sea on 16 January 2007. Metobenthic samples were collected using the 62 μm plankton net (Somerfield et al., 2005), where the net was towed on the surface of sediment at seagrass patch. The samples were then placed in aquarium containing aerated seawater and immediately transported to the Biodiversity Laboratory, Universiti Malaysia Terengganu (UMT), Malaysia.

**Culture of harpaacticoid copepod:** Harpaacticoid copepods were reared in static (batch) cultures in 20 mL culture medium since 2007 (Rippingale and Payne, 2001). For the present study, seawater was filtered with GF/C membrane filter and then autoclaved for 15 min. Culture was initiated by the single gravid female of harpaacticoid copepod. The copepods were fed with 1 mL of baker’s yeast (0.02 g L\(^{-1}\)) daily (Nanton and Castell, 1998). Temperature was maintained at 25±1°C and salinity was at 27±1 ppt. Once the copepods produced the eggs, the hatched nauplii were counted. Then the female copepod was transferred into a new culture medium. Total number of copepods were counted under dissection microscope. The observations were carried out each day for 40 days.

**Data analysis:** Accidentally two culture vessels were found to support the same species of *R. knoxi* after identification. Thus data for both cultures were included in this report. Life table parameters were calculated using standard life table methods following Ricklefs (1990). Fertility at age x (m\(_x\)) was the average number of births per female of age x, during the time interval x to x+1. Net reproductive rate, Ro, represented the total expected number of offspring produced by a female during her lifetime. The calculation for Ro as follows:

\[
\text{Ro} = \sum \text{m}_x
\]

Mean generation time (T) is the time required for a population to increase by the factor Ro. It is derived from the equation:

\[
T = \frac{\sum \text{m}_x}{\text{Ro}}
\]

**RESULTS**

The life-history parameters including generation time, T (days) for three species of harpaacticoids cultured under laboratory condition (temperature 25±1°C and salinity 27±1 ppt) for 40 days are given in Table 1. *P. oculata* showed the longer mean generation time (17.19±4.74 days) compared to other two species. The mean generation time of *S. knabeni* and *R. knoxi* were 10.19±3.51 days and 8.93±1.00 days respectively. The net reproductive rate (Ro) was higher in *P. oculata* (100.00±28.28) followed by *R. knoxi* (22.50±20.51) and *S. knabeni* (13.00±9.90). The Intrinsic growth rate (r) was higher in *R. knoxi* (0.58±0.18) followed by *S. knabeni* (0.50±0.22) and *P. oculata* (0.45±0.13).

Naupliar stages for all three species were completed within two days in the second generation though it took

<table>
<thead>
<tr>
<th>Table 1: Life-history parameters of <em>P. oculata, S. knabeni</em> and <em>R. knoxi</em> under laboratory condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameters</td>
</tr>
<tr>
<td>Net reproductive rate (Ro)</td>
</tr>
<tr>
<td>Generation time (T) (day)</td>
</tr>
<tr>
<td>Intrinsic growth rate (r) (day)</td>
</tr>
</tbody>
</table>

Values are Mean±SD, Ro: \(\sum \text{m}_x\), T: \(\sum \text{m}_x/\text{Ro}\), r: InRo/T
generation time and the population growth seemed to be quickly adapted to laboratory culture in the second generation. Recent studies on the effect of food, environmental stability and temperature suggested that they could play an important role in affecting the generation time of copepod (Zaleha and Busra, 2012). Generation time of R. knaxi was considered short compared to the other two species in this study and others species in previous study. Similar results were noted by Rhodes (2004) who observed a generation time of 10-12 days for Nitokra lacustris. On the other hand Amphiascus teniremis has a generation time of 16 to 17 days (Chandler et al., 2004) when cultured under laboratory condition. Harpacticoids with short generation time proved their suitability for mass culture. This was found in Tisbe biminiensis and Tigriopus japonicus (Pinto et al., 2001). The longer generation time in most of the life stage period in the first generation might be caused by the physiological adjustment to the culture condition. The fast moving water and tidal change from the South China Sea influenced the harpacticoids in the area (Zaleha et al., 2006) and naturally they need to adjust their physiology in response to the calm environment in the culture bottle. Some species collected from the same vegetative area including Paralaophonte octavia and Longipedia sp. (Nurla Huda and Zaleha, 2005) failed to survive the same laboratory condition.

Nauplii stage is an important first day feed for some fish larvae (Stottrup and Norsker, 1997). Larval stages of shrimp such as Litopenaeus vannamei was also reported to prefer the naupliar over the copepodite stage of harpacticoid (De Lima and Souza-Santos, 2007). The short life stage for the species found in this study (2 days) needs an efficient collecting or harvesting technique if they are planned to be used as live feed in aquaculture. Culture technique by Sun and Pfeffer (1995) for negative phototaxis species might be a good example. Nevertheless, further study of phototaxis of the present species need to be carried out to facilitate the culture technique design.

**CONCLUSION**

Of the three cultured species, R. knaxi showed its potential as a good candidate for mass culture due to their short generation time (8.95±1.100 days). On the other hand, P. oculata showed more stable and high population starting from the first generation thus also indicates its commercial potential. The Naupliar and copepodite stage took longer time during the first generation in all studied species. The finding on the longer time taken by the harpacticoids to stay in their juvenile stages as shown in
this study could be further investigated as to be manipulated for hatchery industry. Further research is also important to design a technique to sample the different life stage of the population.

ACKNOWLEDGMENT

The authors are indebted to ABI-MOSTI, Malaysia for the e-science research grant (07-05-ABI-AB005) on ‘Mass Fry Production Technology of Grouper (Epinephelus sp.): Production of Live Feeds’.

REFERENCES


