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Growth and survival of *Metamysidopsis elongata* (Crustacea: Mysidae) from Mazatlán Bay, Sinaloa, Mexico

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Short Communication

Abstract

Mysids are important as food in aquaculture. In the present study, growth of embryos, juveniles, and survival of *Metamysidopsis elongata* was analysed. The average length (mm) of wild adult females was 5.67 ± 0.54, F1 was 5.41 ± 0.60 and 5.36 ± 0.32 for F2 and for the adult males it was 4.49 ± 0.21, 4.44 ± 0.14 for F1 first generation and 4.54 = 0.16 for F2 second generation. The length of the embryos (stage I) in wild females, F1 and F2 were found in the range of 0.28 to 0.41 (0.34 ± 0.03) mm. The increase in size of embryos from stage I to IV for wild mysids was 1.02 mm, 0.96 mm for F1 and 1.0 mm for F2. The average growth rates by von Bertalanffy model for juvenile mysids males and females were 0.304 mm day^{-1}, 0.149 mm day^{-1} and 0.208 mm day^{-1} respectively. The average daily growth over 30 days for all mysid was 0.201 mm day^{-1}. Females grow larger than males and survival also was greater. Culture of mysids showed a survival between 77 and 78%.

Keywords: *Culture, growth, Metamysidopsis elongata, survival, Mexico.*

Introduction

Studies of *M. elongata* have concerned the micro distribution and social behavior (Clutter, 1969), the ecological efficiency, growth, energy budget and mortality (Clutter and Theilacker, 1971), the post marsupial life cycle and growth under laboratory conditions, the molt cycles and growth rates, and the influence of temperature and salinity on behaviour (Gama *et al*., 2002, 2006).

M. elongata Holmes, 1900 has two subspecies: the nominal subspecies *M. elongata elongata* in the Pacific Ocean and *M. elongata atlantica* in the Atlantic Ocean (Bacescu, 1968). Growth and development of embryos in *M. elongata atlantica* have been studied in Brazil (Gama *et al*., 2002). However, the reproduction and growth of mysids are influenced by latitude (Calil and Borzone, 2008). Mysids are abundant, have accelerated growth and survival, so the present study analysed the growth and survival of embryos and juveniles of a population of *M. elongata* from northern Mexico is taken for the present study.

Material and methods

Monthly samplings at 0.5 and 1.0 m depth were made with a plankton net having a mesh size of 1000 μm from September

2010 to October 2011. Once mysids were collected they were placed in a box container and in the next morning, when new mysids were born, laboratory experiments in semi-controlled conditions began and to avoid cannibalism, juveniles were separated in a different 20 l aquarium tank.

To estimate the daily growth for 30 days, they were placed in four 100 l aquariums each, containing 1000 new born juveniles (10 ind· l^{-1}). The aquariums were maintained with continuous aeration, temperature of 22±1°C and salinity of 32±1‰. They were fed *adlibitum* with *Artemia* having age 18-48 h and average size of 480 μm. The tanks were cleaned daily by siphoning and replenishing seawater with the same characteristics. This procedure was repeated with F1 and F2 juveniles.

Embryo stages I to V correspond to: Embryonic stage (Stage I) with 0.28-0.41 (0.35±0.04) mm length, Nauplioid early phase (Stage II) 0.53-0.71 (0.62±0.03) mm length, Nauplioid late stage (Stage III) with 0.70-0.95 (0.73±0.04) mm length, post nauplioid early stage (Stage IV) with 0.92-1.24 (1.10±0.08) mm length and post nauplioid late stage (Stage V) with 1.14-1.30 (1.24±0.03) mm length were identified as described by Núnez (2013).

Mysids of the F1 and F2 generations were installed in three separate 20 l aquarium with 100 newly released juveniles at a density of 5 ind l^{-1}.The release of juveniles from adult females began at 26 days in F1 and at 28 days in F2. The growth was calculated based on the total length (TL) of ten samples of taken on daily basis juveniles from F1 and F2 parents. Rates and growth curves of mysids were obtained for juveniles, males and females of F1 and F2 generations. The average length of wild adult females was 5.67 ± 0.54 mm for F1, 5.41 ± 0.60, for F2 5.36 ± 0.32 mm and for the males was 4.49 ± 0.21 mm, for F1 4.44 ± 0.14 and for F2 4.54 ± 0.16.

The daily growth rate is calculated using the equation of von Bertalanffy growth model (1951) $L_t = L\infty\ (1 - e^{-k(t-to)})$ where: L_t=length (mm) of the individual at time t, t=age, L_∞=asymptotic length, namely the average maximum length of an organism elderly, K=an estimate of the growth rate of the individual target value, t_0 =time at which the length is zero. The same was calculated for males and females of both generations.

At the end of the experiments, the remaining adult mysids were used to determine survival, and identify stages of embryonic development.

Results

The length of Stage I embryos ranged between 0.28 and 0.41 mm (0.34 ± 0.03 mm), with no significant differences (F = 2.98; P> 0.05) between wild, F1 and F2 embryos. Average increase in embryo length (Stage I to Stage V) was similar in all cultures: 1.02 mm for wild, 0.96 mm for F1 and1.0 mm for F2 (Fig. 1 and 2).

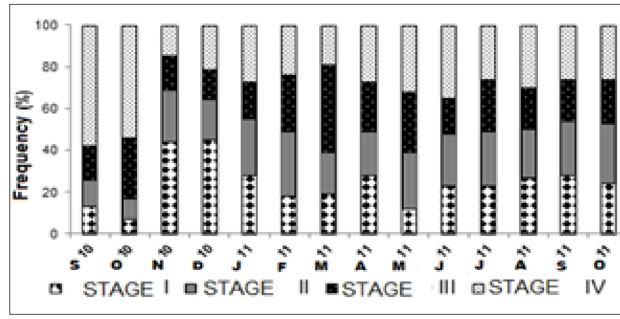

Fig. 1. Monthly frequency of stages along the sampling cycle

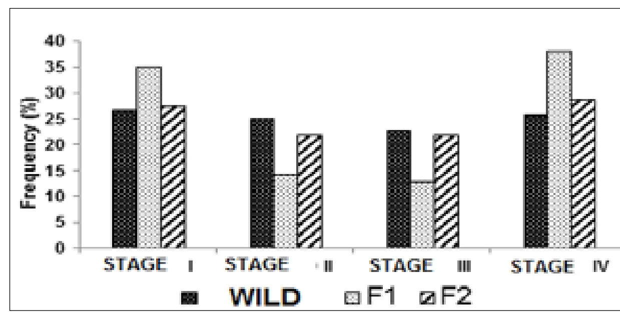

Fig. 2. Frequency of stages in wild mysids F1 and F2 generations

In both generations growth rates (mm/day) for juveniles (0.304), males (0.149) and females (0.208) did not differ significantly (P> 0.05). Average daily growth over 30 days for

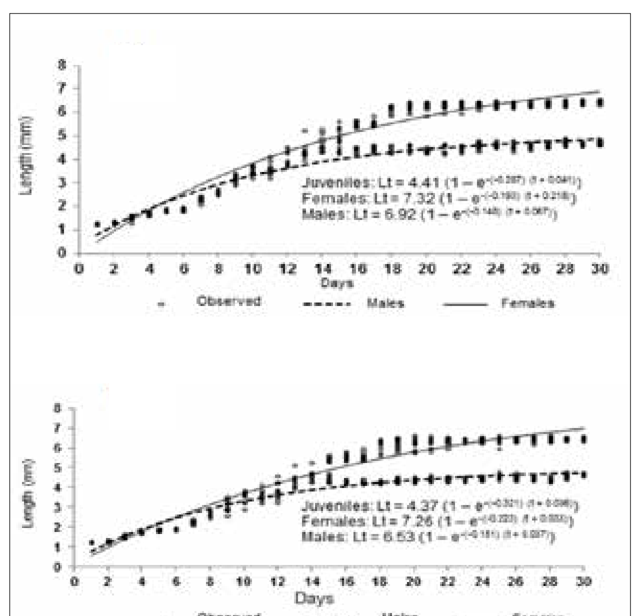

Fig. 3. Curves and von Bertalanffy growth equations for juvenile mysids, males and females in F1 and F2 generations

all organisms was 0.201mm/ day. Growth rates were higher in females than in males before sexual maturity and then decreased in both (Fig. 3).

Males and females develop recognizable morphological characteristics during the period of rapid growth before maturity and after maturity, growth becomes progressively slower. In males, the swimmerets reach the trailing edge of the last abdominal segment, and the male lobe is fully developed and setose. In females elongated osteguites (the marsupium growing) were developed. Survival was 78% for the F1 and 77% for the F2 generations.

Discussion

Growth

Growth in crustaceans is a batch process; the succession of molts (ecdysis) is separated by intermolt periods (Fockedey *et al.*, 2005). The von Bertalanffy model was originally used to describe the growth of fish, but has been applied to crustaceans and more specifically to mysids (Schnute and Fournier, 1980; Cuzin-Roudy *et al.*, 1981; Mees *et al.*, 1994). It assumes an asymptotic growth, and the sigmoid pattern of growth has been confirmed in other studies with mysids (Astthorsson and Ralph, 1984; Winkler and Greve, 2002).

However, although it was not possible to compare numerically the growth rates between *M. elongata atlantica* (whose authors used carapace length) and *M. elongata* in this study, due to the different measurement methods, both showed an accelerated growth during 0-15 days of the juvenile phase. Growth intervals (marked by shedding of the exoskeleton) became progressively longer until mysids reached maturity compared to the rates obtained in mature mysids. Females had higher average daily growth (mm day $^{-1}$) than males in the 30 days of culture.

The growth rate (0.201 mm day^{-1}, reaching a maximum TL of 6.4 mm after a month) during the present study was higher than that recorded by Allen (1982) for *Heteromys formosa* (0.03 mm day^{-1}, reaching a maximum of 9.2 mm after ~6 weeks).

While studying of *Mysidium columbiae*, Stage I embryos Mauchline, 1988, recorded the length range as 0.018-0.026 mm for early embryos, while Prieto *et al.*, (2009) recorded 0.04 and 1.1 mm in the more developed female, thus difference in the length of early embryos (Stage 1) were observed among species. The early embryos of *Acanthomysis thailandica, Mesopodopsis slabberi, Mesopodopsis zeylanica* and *Mesopodopsis orientalis* have lengths of 0.26 ± 0.03, 0.35 ± 0.60, 0.39 ± 0.06 and 0.38 to 0.43 mm respectively (Delgado *et al.*, 1997, Biju and Panampunnayil, 2011; Ramarn *et al.*, 2012; Biju and Panampunnayil, 2010) were almost similar to those observed for *Metasysidopsis elongata* during the present study (0.34 ± 0.03 mm).

Although the length of the embryos (Stage I) between wild mysids, F1and F2 of *M. elongata* is found in the range from 0.28 to 0.41, there was no significant difference between the diameter of the embryo and the length of the female body in the three groups, so that the transmitted energy remained constant in wild and farmed mysids. The length of the embryos are found to be independent of the length of the wild females, as in *Mesopodopsis orientalis* (Hanamura *et al.*, 2008), *M. zeylanica* (Biju and Panampunnayil, 2010) and in *A. thailandica* (Ramarn *et al.*, 2012).

It was noted that the female progenitors of *A. robusta* (10.25-16.32 mm) and *M. californica* (6.10-7.74 mm) (Sudo, 2003; Ortega-Salas *et al.*, 2008) were longer than those of the *M. elongata* species of Mazatlan, Sinaloa (4.43-6.53 mm).

Survival

Survival of adult *M. elongata* at the end of the experiments was 78% (F1) and 77% (F2) at a temperature of 21-23°C while *M. californica* adults had a survival of 88% at a temperature of 20.5-21.2°C (F1) and 21.6-23.3° C (F2) (Ortega-Salas *et al.*, 2008). Domíngues *et al.* (1999) and Wortham-Neal and Price (2002) reported that temperature has an inverse effect on the survival of *Mysidopsis almyra* and *Americamysis bahia*. They recorded a survival of 69% at 26°C, 82% at 22°C and 80% at 18°C. Gama *et al.* (2006) mentioned that at lower temperatures *M. elongata atlantica* had life spans of up to 86 days and beyond 25 ± 1°C, its longevity was 40 days.

The temperature used in this study (22 ± 1°C) was constant throughout the experimental cycle. It was adequate for assessing fertility and determination of some biological parameters (age at sexual maturity, release of juveniles and survival).

Adults and juveniles have optimum temperature for reproduction, growth and survival (Domíngues *et al.*, 1999). They also mention that the cultivation of the mysids *M. almyra* maintained at low temperatures (22°C) gave adequate production with reduced production costs (less food for the mysid) resulted in improved water quality and reduced mortality. But it is necessary to cultivate mysids at high temperatures (about 26°C) for rapid growth along with excellent survival especially during the first week of development. With respect to food, Domíngues *et al.* (2001) reported that survival of mysids increased significantly with enriched *Artemia* nauplii.

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