GROWTH, MOLT AND SURVIVAL OF *PALAEMONETES ARGENTINUS* (DECAPODA, CARIDEA) UNDER DIFFERENT LIGHT-DARK CONDITIONS

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ABSTRACT

Growth, survival and molting rate in *Palaemonetes argentinus* Nobili, 1901 were compared under different light-dark conditions. During 80 days, 150 immatures of both sexes (initial mean weight 0.09±0.002g), from Los Padres lagoon, Mar del Plata, Argentina, were maintained in aquaria at 19±0.4°C under three light conditions: 0:24, 10:14 and 13:11 (L-D). They were fed daily on an artificial diet (45% proteins, 17.2% lipids, 7% water, 7% ash). Good weight increment was obtained with the three treatments, finding a positive linear correlation between mean weight and time (0:24, r=0.97; 10:14, r=0.99; 13:11, r=0.98). There were no significant differences in the percentage increment in mean weight among the treatments (0:24, 19.3%; 10:14, 29.3% and 13:11, 26.5%) ($p<0.05$). Molting rate was significantly higher at a long-day photoperiod (MR=1.7) than at a short-day (MR=0.6) or continuous dark condition (MR=0.3) ($p<0.05$). The lowest survival was found in animals maintained under 13:11 L-D conditions (77%), being statistically different of the other two treatments (92% and 89% at 10:14 and 0:24, respectively) ($p<0.05$). These results suggest that the best growth and survival in *P. argentinus* result with a 10:14 L-D cycle, and that the growth is less affected by photoperiod than molting rate and survival.

KEYWORDS. Growth, molt, photoperiod, Crustacea, Palaemonidae.

INTRODUCTION

The animal physiology comprises many rhythmic functions where the circadian cycles influence is essential to maintain appropriate timing relationships between these functions and the environment. In many species, seasonal changes in day length (photoperiod) act as an external temporal clue to initiate a series of physiological processes. As result, certain events (molting, reproduction, hatching) are restricted to specific periods of the year. These photoperiodically controlled responses imply a capacity of the organisms to distinguish between short and long days and therefore

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measure geophysical time; this measurement seems to be based, at least in some species, on endogenous rhythms (SAUNDERS, 1975; HOFFMAN, 1981; CASTAÑÓN-CERVANTES *et al*., 1995).

Survival and growth of decapods can be affected by a variety of environmental factors including temperature, oxygen concentration, salinity and light (MASON, 1978; AIKEN *et al*., 1983; TIDWELL *et al*., 1996). Intensity variations, spectral composition, light polarization and photophase duration affect the growth and reproduction in crustaceans. Some studies have compared the effect of constant conditions with the daily light-dark cycles, with variable results (DALLEY, 1980). Artificial light is used as a tool, in species adapted to diverse environments and at different latitudes, to investigate the physiological dynamics which could be involved in determining distribution and adaptation patterns of these animals (FANJUL-MOLES *et al*., 1998). The daily cycle of light and dark, and the seasonal changes in the proportions of light-dark are most likely to be of significance in the crustacean life (DALLEY, 1980). Seasonal effects on growth, molting, metabolic rate, induction of anecdysis, maturation of gonads and sex determination may be under photoperiodic control in some species (PASSANO, 1960; AIKEN, 1969; SEAGAL, 1970; AIKEN *et al*., 1983).

Palaemonetes argentinus Nobili, 1901 is a species of ecological interest due to its abundance in ponds and lagoons of Argentina and south of Brazil (BOND-BUCKUP & BUCKUP, 1989) and because it is part of the diet of several species of fish and birds (DESTEFANIS & FREYRE, 1972).

The objective was to compare growth, survival and molting rate in individuals of *P. argentinus* maintained at different light-dark conditions.

MATERIAL AND METHODS

Immature individuals of both sexes (initial mean weight 0.092±0.0026g), collected from Los Padres lagoon, Mar del Plata, Argentina (37°57´S, 57°44´W) were maintained during 80 days (March-May) in nine 30 litres aquaria with a sand and shell filter and gently aerated freshwater. Freshwater fit for human consumption (pH=7.6) was used in the experiment. Mean total water hardness (as $CaCO_3$) was 110 $mg.l^{-1}$; TDS, 955$mg.l^{-1}$; nitrite, 0.01 $mg.l^{-1}$; nitrate, 0.01 $mg.l^{-1}$ and unionised ammonia, 0.01 $mg.l^{-1}$. Twenty five animals were held communally in each aquarium under three light conditions: 0:24, 10:14 and 13:11 (L-D). The first photoperiod was used as an extreme condition and the latter ones correspond to the average light hours in autumn and spring, respectively, at this latitude. Each treatment was carried out in triplicate and using natural light in the light treatments, covering the aquaria with black boxes after the required photophase. The complete darkness was kept using black glass aquaria covered with black boxes. The temperature was maintained at 19±0.4°C, which was found to be the optimal for growth and survival of *P. argentinus* (DÍAZ *et al*., 1998).

The individuals were fed daily on a pelletized diet prepared in the laboratory (45% proteins, 17.2% lipids, 7% water, 7% ash), providing about 10% of body weight (DÍAZ *et al*., 2001). Prior to feeding, exuviae were collected; presence of any dead prawn was recorded and any excess of food removed to preserve water quality. Samples were deposited in Departamento de Ciências Marinas, Universidad Nacional de Mar del Plata, Argentina. Molting rate was determined according to GUARY *et al*. (1974): MR=number of molts/initial number of individuals. The animals were weighed at the beginning of the experiment and every 20 days (0.001g). The results were analyzed using linear regression models and the following statistical tests were performed: ANOVA, ANCOVA, Bartlett, Cochran and x^2 (SOKAL & ROHLF, 1995).

RESULTS

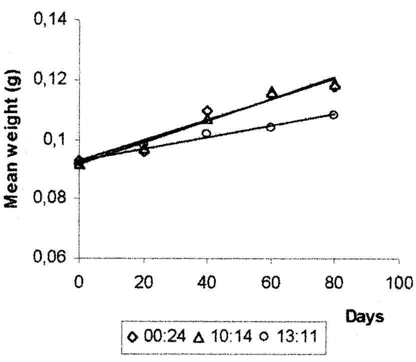
A significant weight increment was obtained with the three treatments (tab. I), and the mean weight was plotted against time determining a linear adjustment (fig. 1). The

Table I. Growth, survival and molting rate of *Palaemonetes argentinus* maintained under different photophases (%Δw, percentage increment in mean weight; comb, combined values of three aquaria; MR, molting rate; ni, initial number of individuals; s, standard error; S, survival; xi and xf, initial and final mean weight).

Light-dark condition	Aquarium	ni	xi (g) ± s	xf (g) ± s	S (%)	MR	%Δw
	1	25	0.096 ± 0.0150	0.116 ± 0.0226	88.0	0.60	20.80
0:24	2	25	0.091 ± 0.0136	0.116 ± 0.0285	96.0	0.16	27.15
	3	25	0.092 ± 0.0155	0.121 ± 0.0298	84.0	0.20	31.52
	Combined	75	0.093 ± 0.0026	0.118 ± 0.0028	89.3	0.32	26.49
10:14	1	25	0.091 ± 0.0173	0.122 ± 0.0204	88.0	0.96	34.06
	2	25	0.094 ± 0.0179	0.116 ± 0.0242	92.0	0.32	23.40
	3	25	0.092 ± 0.0159	0.120 ± 0.0305	96.0	0.44	30.43
	Combined	75	0.092 ± 0.0015	0.119 ± 0.0030	92.0	0.57	29.30
13:11	1	25	0.092 ± 0.0168	0.117 ± 0.0123	84.0	2.20	27.17
	2	25	0.087 ± 0.0186	0.110 ± 0.0326	60.0	1.80	26.43
	3	25	0.095 ± 0.0119	0.099 ± 0.0195	88.0	1.04	04.21
	Combined	75	0.091 ± 0.0040	0.108 ± 0.0091	77.3	1.68	19.27

regression equations are: 00:24 (L-D), mean weight (g) = 0.0926 + 0.0003 time (days), r=0.97; 10:14, mean weight (g) = 0.0916 + 0.0004 time (days), r=0.99; 13:11, mean weight (g) = 0.0926 + 0.0002 time (days), r=0.98. ANCOVA showed that all slopes and intercepts are not significantly different ($p<0.05$).

No significant differences in the mean weight increment were found among the treatments (0:24, 19.30%; 10:14, 29.3%; 13:11, 26.5%) ($p<0.05$). The daily mean weight increment, in the different treatments, was: 0.24% (13:11), 0.33% (0:24) and 0.36% (10:14). Significant differences were found among the molt rates obtained with the three



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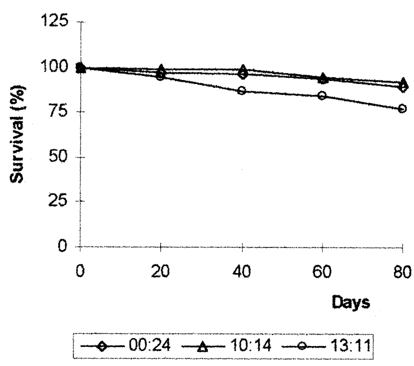

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Figs. 1, 2. Growth and survival of *Palaemonetes argentinus* Nobili, 1901 under different photophases, respectively.

treatments. Molt rate was significantly higher during the longest photophase (MR=1.68) than during the shortest one (MR=0.57) and than under continuous dark condition (MR=0.32) ($p<0.05$). The lowest survival (fig. 2) was found in animals maintained under 13:11 L-D conditions (77%), being statistically different of the other two treatments (92% and 89% at 10:14 and 0:24, respectively) ($p<0.05$).

DISCUSSION

Most of the studies on the effect of light on crustaceans indicate variable results. Larger increments in size were noted in larvae of *Homarus americanus* Milne-Edwards, 1837 (Aiken *et al.*, 1983) when kept in continuous darkness, but this effect has not been observed in other species. Generally, neither the duration nor the intensity of light has been found to affect the molt increment. This aspect was recorded in *Panulirus longipes* (Milne-Edwards, 1868), *Pachygrapsus marmoratus* (Fabricius, 1787), larvae of *Palaemonetes vulgaris* (Say, 1818) and in various other species (Hartnoll, 1982). In *P. argentinus* was observed a good weight increment with the three treatments. Mason (1978), working on *Pacifastacus leniusculus* (Dana, 1852), found that growth was more affected by temperature than by photoperiod.

In the present study, a high survival was recorded at complete darkness and at 10:14 L-D conditions, the last one corresponding to the normal day-length of the locality in autumn. The maximum mortality was observed at the maximum light conditions (13-hour light), which correspond to the normal day-length in spring months. The highest mortality was coincident with the highest molting rate (MR=1.7), which was very high compared to that obtained with the other two treatments. Survival in *P. argentinus* was more affected by photoperiod than growth; this aspect was also observed in *Pacifastacus leniusculus* (Mason, 1978). In contrast, Gardner & Maguire (1998), in *Pseudocarcinus gigas* (Lamarck, 1818) larvae, found that survival was not significantly affected by photoperiod.

A long-day photoperiod increases molting rate but causes a greater mortality. Long days shorten the time between molts, which produce lower biomass incorporation due to the high cost of energy that the molt implies. An increase of photoperiod length produces an increase in haemolymph of lactate similar to that produced by exercise and other factors considered as stressors in decapod crustaceans (Fanjul-Moles *et al.*, 1998). *Palaemonetes argentinus* is not very aggressive and the density in the aquaria was quite low to avoid cannibalism on individuals which had recently moulted. This argument allows thinking that the main cause of death was the stress produced by the high molting rate at 13:11 L-D.

In *P. argentinus* the lowest molting rate occurred in complete darkness. Coincidentally, in *Procambarus clarkii* (Girard, 1852) submitted to constant darkness, molting inhibition was notorious; probably darkness alters the relationship between the X-organ sinus gland molting-inhibiting hormone (MIH) and the Y-organ molting hormone (MH) (Castañón-Cervantes *et al.*, 1995). Aiken (1969) suggested a stimulating effect of light on the Y-organ of *Orconectes virilis* (Hagen, 1870), which implies the possibility of a photoperiodic control of the Y-organ which would be missing in absence of light. Kurup (1970) observed in *Hemigrapsus nudus* (Dana, 1851) that the animals are more resistant to dark environs, though prolonged darkness blocks molting altogether. BISHOP & HERRNKIND (1976) found in *Farfantepenaeus duorarum* (Burkenroad, 1939) the highest number of exuviae in complete darkness, indicating that this species might have an endogenous molt rhythm in the absence of light.

The best growth and survival in *P. argentinus* was observed in a 10:14 L-D cycle, recording an intermediate molting rate, and that the growth was less affected by photoperiod than molting rate and survival. Molting in *P. argentinus* does not require a particular photoperiod but photoperiod, drives the annual molt cycle. This control of molting is clearly evident in responses of prawns maintained under normal photoperiods, the short-day period (10:14 L-D) of the yearly cycle reduces the frequency of molting and the long-day period (13:11 L-D) increases molting. Under the experimental conditions, survival was clearly affected by an increase of the photophase length.

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