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# Growth rate studies of marine ornamental fish *Pomacentrus caeruleus* in artificial conditions

**Author Details**

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|---|---|
| **R.G. Prashanth** | Department of Zoology, Bangalore University, Bangalore-560056, India |
| **C.H. Debala Devi** | Department of Zoology, Bangalore University, Bangalore-560056, India |
| **D. Usha Anandhi** *(Corresponding author)* | Department of Zoology, Bangalore University, Bangalore-560056, India usaanandhi@rediffmail.com |

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**Abstract**

Aquaculture industry depends on development and testing of protocols for rearing and breeding of new aquaculture species as these techniques vary with species. In the present study attempts have been made to study the effect of temperature and salinity on the rate of growth of the marine ornamental fish, *Pomacentrus caeruleus* under artificial conditions. Results reveal the length and weight of the fish to increase gradually at an average rate of 0.10 cm and 0.23 g with decreasing salinity (25ppt to 5ppt) at 25ºC and 6.54 condition factor (K). Statistical output indicates a significant positive relationship between K at 25ºC and K at 30ºC ($R=0.557$, $P<0.05$). Correlation indicated growth rate to be higher between 25ºC and 30ºC. This is in contrast to the hypothesis which states the weight of the fish to be different at different temperatures, $F(2,54)=5.713$, $P<0.05$. Tukey's test results indicate a significant difference in the weight of the fishes acclimatized at different temperatures. Mortality rate was highest in 20ºC followed by 30ºC while least in 25ºC. The incidence of diseases was highest in 20ºC and the acclimatization period highest in 30ºC. In conclusion it appears that *Pomacentrus caeruleus* exhibits allometric growth at lower salinities and at a controlled temperature of 25ºC.

**Key words**

Aquaculture, *Pomacentrus caeruleus,* Allometric growth, Ornamental fish

## Introduction

Intensive exploitation of wild ornamental tropical marine organisms, especially reef fishes, mollusks, hermatypic and soft corals, has resulted in reduction in number and size of many wild populations so much so that many have reached a point of no return and the whole ecosystem is destroyed in many areas (Pet Soede *et al*., 1999). It is in this context that development of sustainable aquaculture techniques for marine ornamental fishes is gaining significance.

Length-weight relationship is of great importance in fishery assessments (Garcia et al., 1998; Haimovici and Velasco, 2000). Length and weight measurements in conjunction with age data can provide information about stock composition, age at maturity, life span, mortality, growth and production (Diaz *et.al*., 2000). Water temperature and salinity are important abiotic components that determine productivity in aquaculture. As water temperature influences the biology of fishes (Dunham *et al*., 2003), the relationship between water temperature and animal physiology has been widely studied (Crockett and Londraville, 2006). In fish, the degree of tolerance to lethal temperatures is dependent upon environmental effects, history of the fish and genetic effects (Cnaani *et al*., 2000) as well as fish health and nutritional status. Many ectotherms can extend their thermal tolerance range through acclimatization and acclimation (Harrison *et al.,* 2005). Fish growth increases with water temperature up to a species-specific maximum after which it rapidly decreases (Jobling 1996). One method to estimate the optimal temperature for a species is through temperature preference studies.

Salinity being an important ecological factor influences not only the oxygen holding capacity of water but also affects development and growth of marine fish (Boeuf and Payan 2001 and Resley *et al*., 2006) through its effect on metabolic rate, food intake and food conversion ratio (FCR). Some species are known for their ability to acclimate to different salinity media (Jordan *et al*., 1993 and Suresh and Lin, 1992), including extreme environments (100 psu). In fact, many fish species have been tested and almost always the level of salinity has been observed to influence growth. In cod, an increase in food conversion efficiency results in a higher growth rate at lower salinity. The objective of the present study was to evaluate the rearing of *Pomacentrus caeruleus* at lower salinities and further determine the condition factor (K) and growth rate under artificial conditions.

## Materials and Methods

Fish belonging to the species *Pomacentrus caeruleus* were procured from Rameshwaram and Chennai, through ornamental fish traders. They were placed in polythene bags filled with sufficient air and transported to Bangalore. Fishes, 120 in number were quarantined and transferred to glass aquaria (2x1x2 ft) with a 60 l water holding capacity. The aquaria were fitted with under water biological filters and thermostat for maintaining water temperature. Artificial sea water was made by dissolving 25 g of commercial sea salt in 975 ml of water (25ppt), mixed thoroughly, allowed to settle and then aerated for 48 hrs before use.

**Acclimatization at different temperatures to lower salinities :** Fish were divided into three groups of 24 each. Group 1 was used for acclimatization at 20ºC, group 2 at 25ºC and group 3 at 30ÚC. Initial salinity was maintained at 25 ppt. Fish belonging to each group were divided further into four groups of 6 each based on their length. Initial length (Total length) and weight was recorded before the start of acclimatization process. Fish were then subjected to the process of acclimatization to lower salinities by gradual decrease in salt concentration. The length, weight and the body width was recorded at 20, 15, 10 and 5ppt of salt concentration. The temperature of water was maintained constant throughout the experiment (48 days) and once in 2 days 30% water was changed. Fishes were fed with boiled beef (minced heart meat) twice a day i.e. morning and evening. Water salinity was measured using a refractometer. pH and dissolved oxygen (DO) was maintained at 7.8-8.2 and 4.5-5.0 respectively.

**Length-Weight relationship :** The total length of the fish was measured from the anterior part of the mouth to the caudal fin using a meter scale and expressed to the nearest centimeter. Fish weight was measured on a tabletop weighing balance, to the nearest gram. The relationship between the length and weight was expressed using the formula given by Pauly's (1983): Analysis of variance (ANOVA) and multiple comparisons were made using the average values for length and weight from each aquarium over temperature.

## Results and Discussion

At 20ºC, the average increase in length was 0.15cm and weight 0.11g. At 25ºC, the average difference in length was 0.10cm and weight gain 0.23g and at 30ºC the average increase in length was 0.07 cm and weight gain 0.14g. The condition factor K was maximal at 25ºC (6.54) followed by 20ºC (6.27) and least in 30ºC (6.21)(Table 1). Statistical output confirms the presence of a significant positive relationship between K at 25ºC and K at 30ºC ($R=0.557, P<0.05$). Co-relation indicated higher growth rate between 25ºC and 30ºC. This is in contrast to the hypothesis that states the weight of the fish to be different at different temperatures, $F(2,54)=5.713, P<0.05$. Tukey's test (Table 2) indicates a significant difference in the weight of the fishes acclimatized at different temperatures. The mortality rate was found to be highest in the temperature 20ºC, followed by 30ºC and least in 25ºC. The length-weight relationship showed allometric pattern of growth during the process of acclimatization (Table 3). The incidence of diseases was highest in 20ºC (Fig. 1) and the acclimatization period highest in 30ºC (Fig. 2).

The fish metabolism decreases with diminishing water temperature and increases with increasing temperature(Wootton, 1990). In the present study, at 20ºC, the average increase in length was

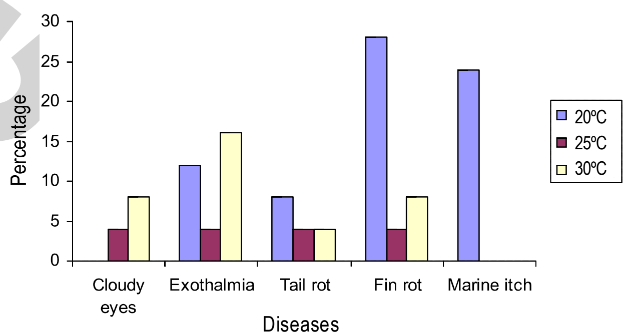


**Fig. 1:** Incidence (%) of disease observed in *P. caeruleus* under different temperature

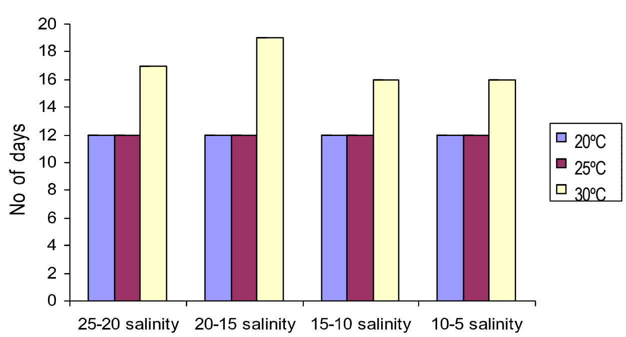


**Fig. 2:** Values of acclimatization period (days) of *P. caeruleus* under different temperature

**Table- 1:** Values of length and weight of *P. caeruleus* along with condition factor (K)

| Temperature (ºC) | Length (cm) | | Weight (g) | | Fulton |
|---|---|---|---|---|---|
| | Initial | Final (48 days) | Initial | Final (48 days) | condition factor (K) |
| 20 | 3.95±0.55 | 4.10±0.54 | 3.08±0.59 | 3.19±0.58 | 6.27±1.33 |
| 25 | 4.01±0.36 | 4.11±0.36 | 2.85±0.38 | 3.08±0.37 | 6.54±0.99 |
| 30 | 4.15±0.36 | 4.22±0.35 | 3.15±0.41 | 3.29±0.40 | 6.21±1.02 |

Values are mean of 6 replicates ± SE or SD

**Table- 2:** Multiple comparison of condition factor (K) using Tukey's method in *P. caeruleus*

| Temperature (ºC) | | Mean Difference | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound |
| 20 | 25 | -0.27 | 0.98 | -4.61 | 4.07 |
| | 30 | 0.06 | 0.99 | -4.31 | 4.43 |
| 25 | 20 | 0.27 | 0.98 | -4.07 | 4.61 |
| | 30 | 0.33 | 0.96 | -3.03 | 3.70 |
| 30 | 20 | -0.06 | 0.99 | -4.43 | 4.31 |
| | 25 | -0.33 | 0.96 | -3.70 | 3.03 |

**Table- 3:** Length-weight relationship (W) of *P. caeruleus* at different temperatures

| Temperature(ºC) | logW= log a+blog$^L$ | W = aL$^b$ |
|---|---|---|
| 20 | logW = -0.36+0.73log$^L$ | W = 0.37$^{0.73}$ |
| 25 | logW = -1.25+1.86log$^L$ | W =0.51$^{1.86}$ |
| 30 | logW = -1.26+1.95log$^L$ | W = 0.69$^{1.95}$ |

0.15cm and weight 0.11g. At 25ºC, the increase in length was 0.10cm and weight gain 0.23g, and at 30ºC increase in length was 0.07 cm and weight gain 0.14g. The survival rate of fishes was highest in 25ºC, followed by 30ºC and least in 20ºC. The occurrence of diseases was maximum in 20ºC, followed by 30ºC and the least in 25ºC.

Acclimatization involves a series of physiological changes genetically regulated for each species. The response of marine fish towards changes in salinity has not been consistent amongst species (Morgan and Iwama, 1996), the importance of salinity should be determined for each aquaculture species. For example, Woo and Kelly (1999) and Boeuf and Payan (2001) suggested that an iso-osmotic salinity of 15, growth is enhanced in stenohaline fish species. However, these effects are species-specific and need to be evaluated for each species or for fish from different origins. Euryhaline species can be reared at salinities below 35 due to their ability to move across salinity gradients (Ferreira, 2010). Reduced salinity decreases energy demand for osmoregulation in some species and plays an important directing role for the growth of fish by improving their ability to digest and utilize food more efficiently (Resley *et al*., 2006). Turbot, *Scophthalmus maximus*, is reported to grow faster and the food conversion ratio was observed to improve when reared at salinities of 12–19 when compared to 35 ppt salinity of seawater (Boeuf and Payan 2001 and Imsland *et al*. 2003). Similarly, *Sciaenops ocellatus* commercially produced under iso-osmotic conditions, grew better at a salinity of 11 than in seawater (Craig *et al*., 1995). The effect of salinity on length and weight gain could be detected at the end of the acclimatization period. The average growth and survival rate was highest in temperature 25ºC followed by 30ºC and least in 20ºC. The present study suggests that *Pomcentrus caerulus* can be reared at salinity 5 and temperature 25ºC without negative effects on growth.

Length-weight relationships gives information on the condition and growth patterns of fish and is an important fishery management tool used in assessing the relative well being of a fish population (Fafioye and Oluajo, 2005). Fish are said to exhibit isometric growth when length increases in equal proportions with body weight for constant specific gravity. The regression co-efficient for isometric growth is 3 (Abowei, 2009) and values greater or lesser than 3 indicate allometric growth (Gayando and Pauly,1997). In the present study, fish acclimatized at different temperature showed allometric growth.

In fish, the factor of condition (K) reflects, through its variations, information on the physiological state of the fish in relation to its welfare. Abowei *et al.* (2009) showed that values of the condition factor vary according to seasons and are influenced by environmental conditions. The condition factor K is maximal at 25ºC followed by 20ºC and 30ºC. Since there were no significant differences in condition factor of fish that had been subjected to different salinity treatments, it is hypothesized that fish from all treatments consumed and utilized food equally well at all salinities. Gayando and Pauly (1997) reported certain factors to affect the well being of a fish. These include: Data pooling, sorting into classes, sex, stages of maturity and state of the stomach.

From the above work it is evident that fish growth is influenced by water temperature and salinity and further, there exists a complex interaction between them. It appears that *Pomacentrus caeruleus* exhibits allometric growth at lower salinities and at controlled temperature.

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