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Food, feeding and growth of Golden Apple Snail *Pomacea canaliculata*, Lamarck (Gastropoda: Ampullariidae)

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Abstract: The freshwater Apple snail *Pomacea canaliculata* is a prominent paddy field pest in Southeast Asia. Due to highly voracious macrophytophagous feeding habit it has also been utilized as a possible control agent against macrophytes. Recently it has invaded Haleji Lake in Pakistan.

The laboratory experiments revealed that water temperature has great influence over feeding and growth of these animals. Among various physico-chemical variables such as DO, TDS, EC, salinity, temperature and pH recorded during present study, the growth and feeding rates were found to be mainly effected by temperature.

The average initial length of male *P. canaliculata* was 10.1 mm whereas female was 12.1 mm. The snails attained to a body length of 45.4 mm (male) and 56.0 mm (female) after six months of feeding with a mixed diet of three plants namely *Launaea nudicaulis*, *Oxalis corniculata* and *Dipteracanthus patulus*. The rapid growth was observed in female *P. canaliculata* rather than male. Food conversion ratio (FCR) was highest (75.1) in March and lowest in August and September (2.1 and 2.4, respectively). The favorable temperature range for the growth of *P.* canaliculata was found to be 28˚C - 31˚C.

Keywords: *Pomacea canaliculata*, food and feeding, (FCR), growth.

INTRODUCTION

The Apple snail *Pomacea canaliculata* is native to South America. It was introduced from Argentina to Taiwan in 1980 for commercial production and was distributed widely in Asia as a dietary protein. It has recently invaded the Haleji Lake Pakistan in (personal communication).

Most of the Apple snails are voracious herbivores. *P. canaliculata* is less selective in food and feed upon all types of vegetation. They are considered extremely polyphagous. They are primarily macrophytophagous, preferring floating or submerged plants over emerged ones (Bonetto and Tassara, 1987). Ontogenetic shifts in diet have been reported, young snails feeding on detritus and algae; they begin to attack higher plants when reaching 15 mm (Halwart, 1994; Schnorbach, 1995). However, laboratory trials showed that even hatchlings 2.5 mm long are capable of continuous feeding on lettuce and submerged macrophytes when other food sources are absent and that food preference does not change with the age (Estebenet, 1995; Estebenet and Cazzaniga, 1992, 1998). *P. canaliculata* snails actively locate and select those freshwater macrophytes that promote faster growth when the snails are reared on monospecific diets, growth rates depending partially on the ingested macrophyte biomass (Estebenet, 1995, Estebenet and Martin, 2002).

The growth is also affected by photoperiod under constant light, from hatching to maturity, notably higher than that of natural photoperiod.

MATERIALS AND METHODS

An experiment was set to assess the feeding and growth in *P. canaliculata*, in the laboratory. Three aquaria of 10L water were used. Length of all animals

was recorded before introducing in aquaria. Three animals at a ratio of two males and one female (2:1) were introduced in each aquarium. The food was a mixed diet of three plants commonly available in the area, these included *Launaea nudicaulis*, *Oxalis corniculata* and *Dipteracanthus patulus*. Every month increase in body size was calculated. Weight was taken by electric balance (Ohaus precision GT400) and length was measured by digital vernier caliper. The aquaria were cleaned after two to three weeks. The Experiments lasted up to the first copulation of the snails, virtually up to the maturity. The water quality parameters including DO, TDS, EC, salinity, temperature and pH were measured weekly.

RESULTS

Water Chemistry

The average temperature of aquaria in March 2009 was 28˚C. It gradually increased to the highest during May-July (31˚C). While a slight decrease was seen in August-September (30˚C). The Salinity of the tap water was comparatively higher from March to June **(Table 1)**. It ranged from 0.2-0.3 ppt. This was because of no flood in the Indus River. From July onward (during flood season) the water salinity was found zero ppt. The pH ranged from 7.14 to 7.95, being lowest (7.14) in March while highest (7.95) in April. Dissolved Oxygen was maintained and it ranged between 6.5 to 7.2 mg/l. Higher TDS was noted from March to July, when it ranged from 398 to 561 mg/l. It was lowest in September 184.3 mg/l. The conductivity followed the same pattern as that of TDS; its range was from 421 to 1245µS/cm.

Table 1. Physico-chemical parameters (average) of aquaria.

Month	Temp (°C)	Salinity (ppt)	D.O (mg/l)	pH	TDS (mg/l)	Cond. (µs/cm)
March 2009	28.2	0.2	6.5	7.1	446.7	973.7
April	29.7	0.3	6.2	7.1	561.3	1245.0
May	31.4	0.2	6.2	7.7	525.3	1228.0
June	31.5	0.2	6.1	7.6	496.7	2838.7
July	31.2	0.1	6.3	7.7	398.0	929.3
August	30	0	7.0	7.4	195.0	440.0
September	30.4	0	7.0	7.5	184.3	420.7

Snail Behavior

Apple snails are not selective and eat almost everything available (plant origin) in their environment. The snails generally preferred *Launaea nudicaulis*, having soft, large and flat leaves. During present study we observed that apple snails showed rapid attraction to food whenever it was added to aquaria. Mostly at night time they took more food. The snails inhaled air with siphon when grazing on the surface (surface film feeding).

Growth in Snail

The young snails were very voracious and their feeding intensity was very high, however, growth was slow. They consumed more food with very slow growth. Initially we gave 80g/aquarium food in March; it was increased to 105g in April, 144g in May, 165g in June, 208g in July, 240g in August and 270g in September.

The initial average shell length and average body weight of the male snails in March was 10.1mm and 0.3g, respectively. It increased to 15. 7mm and 1.9g in March, 15.7 and 1.9g in April, 20.3mm and 3.9g in May, 25.5mm and 6.2g in June, 32.1mm and 13.2g in July, 38.3mm and 19.5g in August and 45.4mm and 29.1g in September **(Fig. 1)**.

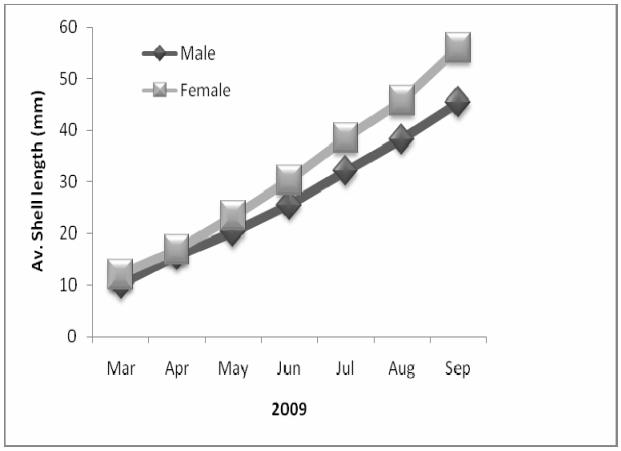

Fig. 1. Increase in length (average) of *Pomacea canaliculata* reared in aquaria from March to September 2009.

In females initial average shell length and average body weight (in March) was 12.1mm and 0.5g, respectively. It increased to 16.8mm and 2.3g in April, 23.4mm, 5.5g in May, 30.3mm and 7.9g in June, 38.5mm and 17.6g in July, 45.8mm, 27.0g in August and 56.0mm and 44.7g in September. The FCR was highest in Mach (75.1) indicating highest food intake with slow growth. It gradually decreased in April, May, June, July, August and September (17.4, 11.6, 8.6, 4.7, 2.1, 2.5) respectively.

DISCUSSION

In the present study we found similar growth in males and females initially, however, a faster growth in females was evident afterwards. According to Estebenet, and Cazzaniga (1998) the snail growth tended to be similar between males and females before sexual maturity however, growth was continuous in female while growth tended to be slower in males. **(Table-2)**. It was also found that females were heavier than males of the same total length (Estebenet, 1998).

Table 2. Effect of physical factors on growth of apple snail *P. canaliculata*.

Present study					**Previous study (Estebenet and Martin, 2002)**				
Photoperiod	Average Temperature	Duration	Shell length (mm)		Photoperiod	Temperature	Duration	Shell length (mm)	
hours/day	°C	days	Male	Female	hours/day	°C	days	Male	Female
8	30.4	160	45.4	56.0	24	25	107	40	40

Some other scientist also found sexual dimorphic Growth patterns, female grew in variably to be larger than male and female growth rates were slightly higher. (Estebenet and Cazzaniga, 1998; Tanaka *et al.*, 1999; Martin and Estebenet, 2002). We exposed *P. canaliculata* 8h/day for a period of 160 days. The average mature animal's size was 45.4mm and 56mm for male and female, respectively.

Effect of Photoperiod

Constant light is believed to have higher growth rates than that of natural photoperiod (Estebenet and Martin, 2000; Martin and Estebenet, 2002). The prolonged photoperiod increases the grazing period and hence increase in growth. We kept the snails under natural photoperiod.

Effect of Temperature

The apple snails are more active at higher temperature. At higher temperature, they eat faster, creep faster and they grow faster. The growth pattern of *P.canaliculata* was found related with temperature. Estebenet and Cazzaniga (1992) kept *P.canaliculata* at constant temperature of 25˚C and reported successful reproductive activity at 10 months. Lach*at el al*., (2000) on the other hand, exposed *P.canaliculata* at an average temperature of 23 ˚C. They also matured in 10 months. Our laboratory growth experiment showed that at an average temperature of about 30˚C, the animals matured in 6 months.

Food Preference

Laboratory studies of *P. canaliculata* in its native range show that it exhibits preferences among different food plants (Cazzaniga and Estebenet 1984; Estebenet 1995). We used three species of plants for the food choice experiments and found a clear preference to the larger and soft leaves.

In Hawaii *P. canaliculata* reaches reproductive maturity in 10 months or more, less time than in its native temperate and seasonal Argentina, where it takes 2 years, but longer than in parts of southeast Asia, where it may take as little as 2 months (Estebenet and Martin 2002).

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