

Influence of Environmental Factors on Growth and Egg-Laying Behavior of the Freshwater Snail *Indoplanorbis exustus*

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Abstract

The present study investigates the effect of environmental factors such as temperature, photoperiod, pH, starvation, and water quality on the growth and oviposition of the freshwater pulmonate snail *Indoplanorbis exustus*. Results indicate that optimum growth and reproduction occur at temperatures between 25–30 °C under a 12:12 h light–dark photoperiod and neutral to slightly alkaline pH (7.0–8.0). Prolonged starvation significantly reduces growth rate, delays maturity, and suppresses egg-laying activity. Poor water quality and low dissolved oxygen levels also adversely affect fecundity and hatchability, while clean, well-aerated water enhances reproductive performance. Temperature and photoperiod jointly influence the duration of egg development and clutch frequency. The findings demonstrate that *I. exustus* is highly sensitive to environmental fluctuations, and its population dynamics largely depend on the stability of physicochemical and nutritional conditions in its aquatic habitat.

Keywords: *Indoplanorbis exustus*, growth, fecundity, temperature, water chemistry, density, egg laying

Introduction

Freshwater pulmonate snails play a significant role in the aquatic ecosystem in sustaining healthy environments and is an essential species for conserving biodiversity by acting as a biofilter (Hwang S. *et al.*, 2021^[1] and Gheoca V. *et al.*, 2021)^[2]. Understanding how environmental factors shape growth, age/size at maturity and egg-laying (fecundity, clutch characteristics) is critical for predicting population booms and for control measures in aquaculture and public-health settings.

Gastropod molluscs, especially those living in temperate regions, generally exhibit a well-defined seasonal reproductive activity which is controlled by environmental parameters, such as photoperiod, temperature and availability of food (Joosse and Geraerts 1983^[12], Geraerts and Joosse 1984)^[9]. The effects of photoperiod, temperature and population density on adult fecundity and juvenile growth in *Marisa cornuarietis* was described by Aufderheide *et al* (2005)^[3].

Photoperiod provides the most reliable external signal in nature indicating the time of the year (Gwinner 1986), and with its stability and predictability, photoperiod acts as a proximal cue that signals cyclic changes before they occur (Brett 1979)^[4]. It is widely acknowledged that for most seasonal breeders living in temperate climates, photoperiod is the primary environmental signal that regulates the timing of reproduction (Goldman 2001)^[10].

pH of water is also important factor for the survival and reproduction of the snails. Freshwater pulmonates commonly live in slightly alkaline waters to a maximum of pH 8.5. The alkalinity is due to the presence of calcium carbonate, (Boycott 1936)^[5] which is essential for the well-being of fresh water snails.

Many researchers have conducted studies to investigate the effect of starvation on energy reserves in marine gastropods and bivalves. Starvation has also been shown to affect egg size and composition in a number of species (Bayne *et al* 1978, Thompson 1982, Townshend & Wootten 1984)^[19, 20].

Starvation period affected growth of reproductive organs (Moriarty 1978)^[7] in *Planorbis corneus*.

Water quality and temperature were found to affect egg output in two species of *Planorbis* (Timmermans 1959). The distribution of freshwater snails depends on water qualities, e. g., pH, dissolved O₂, calcium, etc. and temperature (Okland 1969, Williams 1970, McKillop and Harrison 1972)^[17, 21].

Material and Methods

The snails *Indoplanorbis exustus* ranged between 5-15 mm shell lengths were collected from local pond near Aurangabad, Maharashtra, India. The snails were maintained in tap water in laboratory for acclimatization. To study the effect of environmental factors (temperature, photoperiod, pH, starvation and dirty water) on growth and oviposition, 6 groups including the control were made. In each group, 30 matured animals with shell length 10-12mm were taken.

- To observe the effect of temperature on egg-laying, different temperatures were maintained (10-12°C, 25-28°C, 32-35°C & 42-45°C).
- Keeping three groups of animals at different photoperiod schedule carried out the effect of photoperiod on egg-laying. LD16:8, Medium day length LD12:12, and short-day length LD8:16.
- Similarly, effect of hydrogen ions on survival and egg laying of snail was studied by immersing the snails in different medium. Acidic medium pH 6.5-6, distilled water was used as neutral (pH 7) pH of tap water 7.8-8.2 and for basic medium pH 8.5-9 was taken. The pH of water was lowered by adding 0.1N HCl or raised by adding 0.1N NaOH.
- For starvation, 30 animals kept in plastic troughs without food.
- The effect of dirty water on egg laying was observed by the sexually mature 30 snails. The snails kept for several days in dirty water. During this period of dirty water treatment, water of trough was not changed to

minimize air or oxygen exchange. The snails were transferred to fresh and aerated water with fresh vegetative food after 15 days.

- For the control experiment 30 snails with water temperature 25-27°C having tap water pH 7.8-8 with daily fresh food and natural light, were run simultaneously. Daily water change was carried for all groups, except dirty water experiment for 15 days.

Results and Discussion

In the present investigation the effect of environmental parameters like temperature, photoperiod, pH, starvation and dirty water treatment on growth and oviposition were studied.

Effect of temperature on growth and oviposition

Environmental temperature has a great influence on the survival of the snail. The present laboratory studies on the influence of temperature on egg-laying of *I. exustus* showed the egg laying activity is greatly affected by temperature. In June to October the temperature of water in laboratory varied between 25-28°C. Snails *I. exustus* are seasonal breeders; they show their reproductive activity between the months of July-October. Relatively changes in water temperature have dramatic influence on the frequency of egg laying events. *I. exustus* maintained in laboratory at 10-12°C temperature completely stopped egg laying. Their survival rate was decreased. Within 4-5 days all snails died. At 40-45°C temperatures, they did not show egg laying and survival rate was also decreased. At 32°C temperature they showed egg-laying for 2-3 days. In control group, with water temperature 25-28°C, showed egg-laying.

The development of eggs with different temperature was also observed. At 10°C no development was observed and the eggs disintegrated within 24 hours of exposure. At 20°C all eggs underwent development up to the formation of eyes. The time taken for various developmental stages was longer than at other higher temperatures although much shorter than at 15°C. At 30°C and 35°C most of the eggs developed into young-ones. Amongst these three temperatures the time taken for development was longest at 35°C and gradually shortened at 30°C. At 40°C the eggs did not show development and the eggs disintegrated within 4-5 hours.

Complete embryonic development followed by the hatching of juveniles occurred between 25°C and 30°C for *I. exustus*. Temperature was strongly affects the embryonic development duration which decreases when temperature increases. The present study revealed that the optimum temperature for egg laying in *I. exustus* is 25-28°C, which is also optimum temperature for survival of snails.

Effect of photoperiod

From figure, it was observed that, long day lengths (LD16:8) have stimulatory effects on sexual maturation, advancing the onset of spontaneous egg laying by 30 days compared with animals raised on either short day (LD8:16) or medium days (LD12:12). Snails maintained on long days were slightly more sensitive to hormonal induction of egg laying than those animals kept on medium days. The most prominent effect of photoperiod is on the number of eggs laid. *I. exustus* reared in the laboratory under artificial photoperiodic conditions laid significantly greater number

of eggs and laid eggs more frequently under long days than under medium or short days.

Exposure of snails of *I. exustus* to differing photoperiods for their life had no significant effect on somatic growth but it effects on oviposition. In long day photoperiod, snails lay a greater number of egg masses and number of eggs per egg masses also more in number as compare to short-day and medium-day photoperiod. These findings compare with those observed by Hunter & Stone (1986) [11] during a study of *Cepaea nemoralis* in which they concluded that gametogenesis and functional development of the reproductive system were neither prevented nor retarded by exposing the animals to short-day photoperiods.

Effect of pH

Animals kept in acidic pH (6.5-6) and basic pH (8.5-8.8) did not show egg-laying. Their survival rate also decreased. In acidic pH more than 6.5, all snails died within 8-10 days. In pH more than 8.5-8.8, 15 snails were live for 15 days, but do not show egg-laying. In control group pH was 7.8-8, animals survived for longer period and showed egg-laying. At neutral pH where snails kept in distilled water survive but do not show egg-laying.

The distribution of molluscs is directly related with the pH of the medium, but more strong evidence is found with calcium content or total alkalinity of the medium (Boycott 1936, Macan 1950) [14]. Laboratory experiments revealed that, *I. exustus* survive in basic pH of about 7.8-8 and also show natural growth and egg-laying. At pH 8.5 to 9 the snails were survived for 2-3 days but in acidic pH 6.5-6 resulted in death of the snail. At neutral pH where snails kept in distilled water survive but do not show egg-laying.

Effect of starvation

Starvation is another factor which decreases growth rate and maturation. In *I. exustus* effect of starvation indicated that there was a striking decrease in oxygen up take during starvation period. Starvation completely abolished egg-laying in *Indoplanorbis exustus*, without food, for 15 days. When they are fed again, they reach sexual maturity, and then lay progressively more and more clutches and eggs up to a certain level after which the quantity remains constant. Spontaneous oviposition of snails was noted after 15 days. After starvation, *I. exustus* had higher consumption rates than snails that were fed continuously. Starvation has no effect on survival of snails. Near about 90-95% snails survived up to the 15 days.

Berg and Ockelmann (1959) [6] observed distinct decrease in oxygen consumption of *L. palustris* and *Bithynia leachii*, during starvation.

Fasting or starvation completely stops body growth. Reproduction is also heavily influenced by starvation. Starvation only delays reproduction of snails. The undeniable deficiency of growth does not induce a reduction of sexual activity when snails are fed, so fasting has no permanent action.

Effect of dirty water

The effect of dirty water treatment on egg mass output was examined. Sexually matured snails when kept for 15 days in dirty water, the egg-laying ceased or were few. The matured snails treated with dirty-water have significant effects on egg mass as well as number of eggs per egg mass as compare to control snails. When snails transferred to fresh water and provided with fresh food, showed immediate

resumption of egg-laying. Egg masses were more in number and number of eggs per egg mass also more. Further studies showed that both cleanliness and oxygen content of water had positive effect on burst of reproductive activity. From the data it was concluded that dirty-water treatment abolishes the burst of reproductive activity of snails. *I. exustus* tolerates neutral to slightly alkaline waters; pH near 7–8 and moderate conductivity favor growth and egg laying. Polluted, turbid or heavily organic-loaded waters often reduce egg-laying behavior and hatchability. Under the experimental conditions described, *I. exustus* oviposition was found to be highly dependent upon water change. One can imagine that the responses to dirty water described in this study are very similar to the reduced survivorship and fecundity observed when snails are raised at high densities, the so called ‘crowding effect’ (Chaudhary 1987, Loreau & Baluku 1987).

Conclusions

The growth and oviposition behaviour of the freshwater pulmonate snail *Indoplanorbis exustus* are strongly influenced by environmental factors such as temperature, photoperiod, pH, water quality and food availability. Optimal growth and reproductive performance occur under moderate conditions — particularly at temperatures between 25–30 °C and neutral to slightly alkaline pH (7.0–8.0). Within this range, the snails exhibit faster maturation, larger clutch sizes, and higher egg-laying frequency. Overall, *Indoplanorbis exustus* demonstrates high ecological plasticity, yet its reproductive output remains closely tied to the stability and quality of its aquatic habitat. Understanding these environmental influences is crucial for predicting population fluctuations and managing the ecological and epidemiological implications of this species, particularly in regions where it serves as an intermediate host for parasitic diseases.

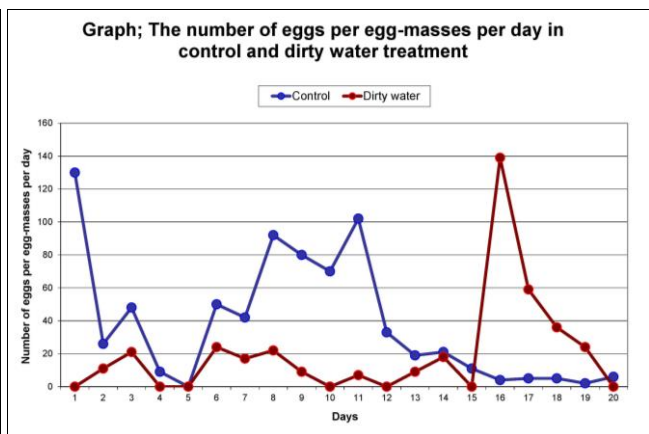
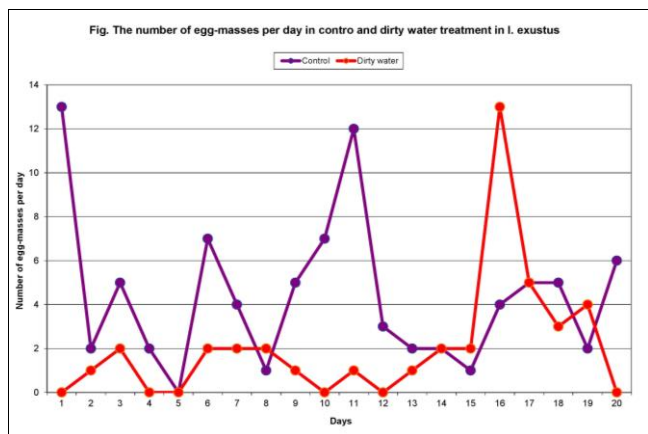
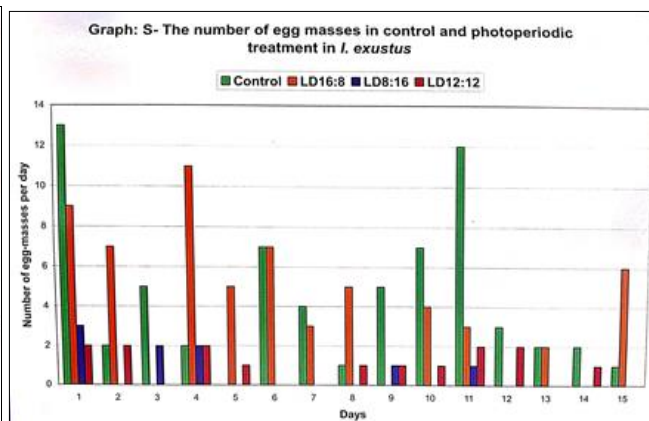
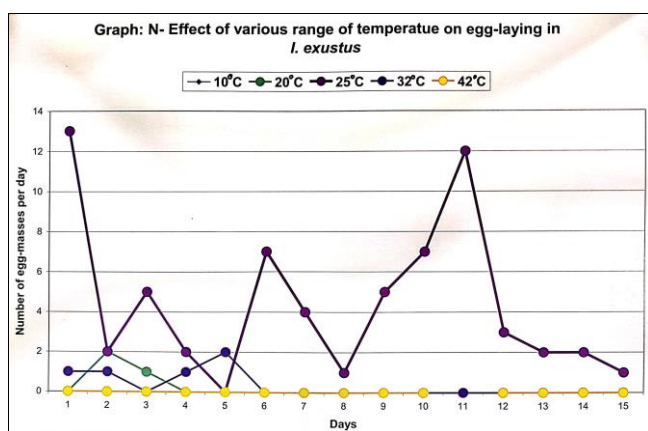


Fig. Showing effect of environmental factors on oviposition of freshwater pulmonate snail *Indoplanorbis exustus*

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