International Journal of Zoology Studies
www.zoologyjournals.com
E-ISSN: 2455-7269
Received: 17-10-2023, Accepted: 03-11-2023, Published: 18-11-2023
Volume 8, Issue 4, 2023, Page No. 88-91

Infection affecting fecundity in freshwater snail *Lymnaea acuminata*

Krushna Raju Nagare*
Department of Zoology, Indraraj Arts, Commerce and Science College Sillod, Aurangabad, Maharashtra, India
DOI: https://doi.org/10.66856/ijzs.2026.11.4.11085

Abstract
The freshwater pulmonate snail *Lymnaea acuminata* is hermaphroditic snail found abundantly in various kinds of water bodies. It acts as a vector snail for various larval trematode pathogens. Laboratory observations were carried out to quantify the impact of infection on fecundity. It was aim to study the effect of cercarial infection on fecundity of host snail. Observation made on Size dependent egg-laying activity of the infected snail, during period of patency. Different sized animals shell lengths ranging from 5±1mm, 10±1mm, 15±1mm and 20±1mm were sorted out and maintained separately in the dechlorinated tap water under laboratory conditions. It was observed that cercarial larvae affect the host's reproductive capacity and minimizing its fecundity. These finding are important and throws light in the field of reproductive physiology of the intermediate host snail *L. acuminata*. These experimental data can be used to confirm that snail populations are regulated by host parasitic system.

Keywords: Impact, Infection, fecundity, freshwater snail, *Lymnaea acuminata*

Introduction
Snails are believed to be among the oldest living organisms on Earth. Since most snails are hermaphrodites, they have reproductive organs of both male and female in same individual. As they are slow moving creature, may have problem to find proper mate from distance. Hence nature may provide them hermaphroditism to tackle with mating problem. Mollusc are serving good study materials for pollution and environmental effect on aquatic biota. Molluscs are ecologically crucial organisms, which are essential to the biosphere and to the human economy. *Lymnaea acuminata* snail are freshwater snails having hermaphrodite nature. After cross fertilization, each individual produce enormous numbers of eggs during reproductive cycle. Egg-laying activity starts in *Lymnaea* at an age of about 2 months. Up to an age of about 250 days it increases, and in older snails it decreases with age. (Janse C, et al. 1989) [8]. But this snail acts as secondary host for many cercarial trematode parasite. The developmental stages of parasite which carried out inside the snail body utilise snail's biochemical contents for self -development and from this point all the problems in the physiology of snail get started. It is well known fact that after emerging from final host, parasite depends only upon natural chance to meet with secondary host or miracidium emerging from that egg must find-out a proper snail for its further development. After reaching inside the snail's body miracidium cast off as sporocyst from that sporocyst redia get produces and from redia cercaria are produces. This development from egg to cercaria requires energy and secure atmosphere. Host snail unknowingly provide both to the invaded parasite.
Many times, the cost is in terms of temporary damage to the reproductive system of host snail which on the other hand impact on snail's own population. Many relationships are compatible in the sense that, both the host snail and the larval trematode successfully perpetuate their species, but an individual infected snail may suffer marked pathological effects (Wright, 1966c and Cheng, 1967) [3, 32]. These effects may not directly cause death and indeed infected snail may live longer and grows faster than uninfected ones in laboratory but under natural conditions it is possible that infected snails have a lowered tolerance of adverse environmental conditions. Even though infected snails can survive extensive damage to their tissue, their reproductive capacity is often completely or partly destroyed. For example, 2 or 3 weeks after infection with *F. hepatica* egg production by *L. truncatula* ceased entirely and was not resumed (Hodasi, 1972) [6]. The total egg production of snails infected at two weeks was depressed to a more 3% of that achieved by uninfected snails during their life time. Hodasi (1972) [6] found that the ovotestis of infected snails degenerated and atrophied even though this organ was rarely invaded by the parasite. Hence with the help of *Lymnaea acuminata*'s reproductive system as a model trying to find-out damage to the reproductive system by parasitic cercaria.

Material and Method
Collections of snails, *L. acuminata* was done during infection period i.e. from September to November of the study period from in and around Aurangabad region. After getting the snails to the laboratory, were washed with tap water in order to remove mud particles and algal threads grown on the shell if any. Food material consisting of aquatic vegetation, *Spirogyra, Hydrilla* and other aquatic plants was provided.
Different sized animals shell lengths ranging from 5±1mm, 10±1mm, 15±1mm and 20±1mm were sorted out and maintained separately in the dechlorinated tap water under laboratory conditions. Observations were made after 24 hrs. of laboratory acclimation. Naturally infected snails were identified while observing under binocular microscope, from the point of cercarial release. Infected snails show release of cercaria, which is evident under binocular microscope.

Size dependent egg-laying activity of the infected snail *L. acuminata* during patency period

After getting identified naturally infected snails of different size, each size group were maintained individually in 250 ml capacity beakers in order to study egg-laying activity of the different sized animals during period of patency. Egg capsule in the form of gelatinous strip or sting are laid on the leaves of aquatic plant which serves as food of snail. Every 24 hrs. interval egg strip were collected and their length was measured with the help of scale in all sized group animals. An average length in triplicate of three specimens of each size group was calculated. A batch of all different sized group of non-infected snails were maintain simultaneously. Also, simultaneously number of egg capsules present in each egg string or strip was counted and an average number of egg-capsule per sting was calculated for each size group of infected and non-infected snails.

Effect of parasitic infection on egg-laying activity in percent during period of patency in *L. acuminata*

In order to study the egg laying behavior in infected and non-infected snail of *L. acuminata*, 25 infected snails of irrespective size were selected and maintained individually in 250 ml capacity separate beakers with sufficient dechlorinated tap water. Simultaneously non-infected were sorted out and maintained in separate beakers as control, in order to compare egg laying behavior. Food material was provided *Ad libitum* consisting of hydrophytes collected from snail's habitat. Egg capsule in the form of gelatinous strip or sting are laid on the leaves of aquatic plant which serves as food of snail.

After 24 hrs. of patency period interval, snail water was observed individually in both infected and non-infected snail beakers in order to know egg laying activity. Number of snails showing egg laying activity was calculated in both infected and non-infected groups. Knowing this number percentage of snails showing egg laying was calculated for both parasitized and non-parasitized host snails for total patency period of 7 days.

Observations and Results

Size dependent parasitic infection on egg-laying behaviour of the snail, *L. acuminata* during period of patency

Egg strip laid by infected and non-infected snails with number of egg capsule present in each strip is shown in the table 1. From the table it is clear that the size of the egg-strip laid by small snail sized (5±1mm shell length) normal snail is smaller than the egg strip of large sized animal. Also, the number of egg capsules present is directly proportional to the size of egg string laid by non-parasitized snail. The egg strips of infected snail are small in size compared with non-infected one. The number of egg capsules present per sting is most significantly less; even some times egg strips are without egg capsules in them. Egg strips are abnormal in their structures in infected snail. Normal sized (20±1mm shell length) healthy snails lay the gelatinous egg-strips of size 15±0.15 mm length, having 45±5 egg-capsules in each strip.

Impact of parasitic infection on egg-laying activity of the snail *L. acuminata* during patency period

Number of snails showing egg-laying activity in percent during patency is depicted in the table 2 and 3. Normal egg laying activity during 7 days of patency period ranges from 55 to 70% snails shows egg capsules in the form of egg strings. But in infected snails, the egg laying capacity is decreased due to larval trematode parasitic infection. During early phase of patency only 20 % shown egg-laying activity but at the end of patency period again egg laying capacity of the snails significantly reduced to 2 %compared with 55 % egg laying was present in non-parasitized snail. (See table 2)

Table 1: Size dependent egg-laying activity of the trematode infected snail, *L. acuminata* during patency period.

Size of the snail in mm	Snail category	Length of egg strip in mm	No. of egg present per strip
5±1	Non-infected	6±00.2	8±1
	Infected	4±0.42	Nil
10±1	Non-infected	8±0.013	17±3
	Infected	6±0.21	2
15±1	Non-infected	11±0.07	53±3
	Infected	9±0.038	5±1
20±1	Non-infected	15±0.15	45±5
	Infected	13±0.74	8±2

Table 2: showing number of snails showing egg-laying in % during period of patency.

Patency period in days	Egg laying % in non-infected snail	Egg laying % in infected snail
1	70	20
2	68	10
3	67	8
4	65	8
5	62	7
6	57	5
7	55	2

Table 3: Showing numbers of egg-capsule per string by the non-infected and infected snail *Lymnaea acuminata* ± S.D.

Egg laying in Days	non-infected snail	infected snail
1day	70±5	3±1
2 day	54±3	Nil
3 day	49± 4	02
4 day	40±2	Nil
5 day	36±2	Nil
6 day	27±2	Nil
7 day	15±2	Nil

Discussion

Lymnaea acuminata abundantly present in and around study area and studies with its associate flora and founa by Nagare & Dummalod (2012) [14]. In field populations of Lymnaeid snails, *Lymnaea acuminata* the prevalence and intensity of patent of larval trematode infections in particular of *Fasciola* and avain schistisome *Trichobilharzia* species was noticed during infection period. Infected snails were showing shedding of cercaria indicating polyembryony i.e. simultaneous development of cercaria and their release during period of patency. Snails infected in nature, when collected at random irrespective of their body size, trematode infection prevalence was high in large sized *L. acuminata* compared with small sized snails. Prevalence increased with host size in laboratory studies made by Rothschild (1941) [25] suggestive of a pattern of gigantism in the snail *Peringia ulvae*.

Naturally parasitized snails of *L. acuminata*, when compared with non-infected ones are having slightly large sized shell lengths indicative of parasitic induced shell

growth in the snail. Similar type of enhanced growth of parasitized snails (gigantism) was reported in the prosobranch snails *Hydrobia ulvae* both field (Gorbuschin 1997) [5] and laboratory investigations (Rothschild and Rothschild, 1939 and Mouritsen and Jensen, 1994) [13, 24]. Alteration in lipid, glycogen and respiratory response in infected snail *Lymnaea acuminata* was investigated by Nagare and Dummalod (2013), Nagare and Rane (2015) Nagare and Dhole (2021) [15, 16, 17] respectively.

Normally, in *L. acuminata* egg laying is observed throughout the year. During October normal eggs are laid by non-infected snails. But due to larval trematode infection had tremendous effects on reproductive behavior of the snails. The parasitic castration of molluscan host by digenetic trematodes is known since 1873, and was first described by McCrady. In the present investigation it has been observed that fully matured rediae found invading in the hepatopancreas resulting in complete damage to the tissue ovotestis of the snail *L. acuminata*. More recently, many investigators have reported the phenomenon of castration (Sullivan *et al*., 1985; Pearson and Cheng, 1985) [20, 27] and reviewed by many investigators (Souza, 1983 and Minchella 1985) [12, 26]. All the known reports on parasitic castration are related to larval stages of digenetic trematodes, but not by the action of an adult trematode. The present castration effect to the gastropod snail *L. acuminata* is only due to the normal stages of trematode parasites in particular at redial stages of infection to the gonad and hepatopancreas of the snail.

The effect of trematode infections on fertility and egg-laying has been reported previously. Najarian, (1961) [18] observed a significant reduction in the average number of eggs laid per snail per day by *Bulinus truncatus* infected with *Schistosoma haematobium*. The present snail *L. acuminata* infected by *Fasciola hepatica* in nature shows changes in egg laying behavior during period of patency. There is a significant decrease in number of egg laying snails in percent during infection season (2%) compared with the non-infected shown (70%) snails egg laying activity under laboratory conditions. Again Sturrock (1966) [2] reports that infection in *Biomphalaria pfrifferi* with *S. mansoni* results in complete sterility, but that some eggs were laid throughout life, if infection is established before maturity. In the adult Lymnaeid intermediate host snail, naturally infected with trematode larvae at field also show egg-laying in the laboratory during period of patency (2-10% snails). The size of egg-strip laid by infected snail is similar than the egg strip laid by normal non-parasitized snails. Also, the number of egg capsules present within the egg strips laid by infected snails, are few in number compared to the normal one. The normal structure of egg strip is not maintained by parasitized snail's egg-strip. The egg-laying capacity which is already decreasing due to parasitic infection comes to lowest level at the end of the patency period of the snail, *Lymnaea*. Infections with mother sporocysts of *Plagiorchis elegans* had a significant impact on reproductive output of *B. glabrata* exposed as juveniles or adults. The total number of eggs produced was reduced to approximately 7 and 13% of them of their respective control levels (Zakikhani and Rau 1998) [10]. Among immature *B. glabrara* infected with *Schistosoma mansoni* such effects on host reproduction are associated with the beginning of cercarial production (Thornhill *et al*., 1986) [30], whereas immediate, prepatent effects have been reported from adult snails by Crews and Yoshino (1989) [1].

Naturally infected snail shows totally disturbed process of gametogenesis and egg-laying process is suggestive of parasitic castration in the trematode infected host snail, *L. acuminata*. Inhibition of oocytes production and germinophagy are just few causes of the parasitic castration known to occur in snails and leading to reduction of the host population and reproductive potential. Many authors contend that reduced fecundity of the infected snails is primarily a result of the direct parasitic infected damage to the gonad (Robson and Williams, 1971; Yoshino, 1975; Huffman and Fried, 1985; and Crews and Esch, 1987). Lapeta (2003) [4, 7, 9, 23, 33] while studying effects of larvae of *F. hepatica* on activity of an enzyme lactate dehydrogenase in the reproductive gland (albumen) was due to toxic effects of the developing larvae. Less attention has been paid on impact of larval trematode on accessory sexual organs of the parasitized host snail. Pelseneer was pioneer to report that the penis of the *Littorina littorea* infected with progenitor stages of *Cercaria emasculaus* was greatly reduced in size with that of uninfected snails. Similar type of conditions was noticed in the present study on *L. acuminata*. Accessory sexual organs (ASO including glands) were reduced in size during patency period of the snail.

Rees (1936) [22] reported that same phenomenon in the snail *L. littorea* when infected by rediae of *Cercaria himasthala secunda* or by rediae of *Cercaria lophocerca*. Rees revealed that these trematode larvae actually damaged mollusc gonad and attributed the reduction in size of external genitalia to this destruction, since it is known that the degree of genitalia development is directly correlated with gonadal function. May be due to gonadal atropy in the snail, *L. acuminata*, resulted reduction in the size of penial complex compared to normal non-infected snails. Woodard (1934) [31] also reported a reduction in size of the external genitalia of parasitized *G. laqueta*. Theron and Gerard (1994) [29] while investigating development of accessory sexual organs in *B. glabrata* during different growth period of the snail reported that the ASO in snails infected when immature remains at a juvenile developmental stage. When infections of snails occur after sexual maturity, growth of the ASO is inhibited after 3rd week of parasitic infection, which corresponds to the decrease in egg-laying for the host (Pan 1965) [19] and beginning of intrasporocystic cercarial production for the parasite (Theron 1981) [28]. The present findings on the impact of parasitism on reproduction is based on the snails infected in the nature, needs further experimentation in the laboratory to have more elaborated conclusions on the intermediate snail host, *L. acuminata*, which has a wide distribution in various water bodies in and around the city, Aurangabad (M.S.)

References

1. Crews AE, Yoshino TP. *Schistosoma mansoni*, Effect of infection on reproduction and gonadal growth in *Biomphalaria glabrata*. Experimental Parasitology,1989:68(3):326–334.
2. Sturrock BM. The influence of infection with *Schistosoma mansoni* on the growth rate and reproduction of *Biomphalaria pfeifferi*. Annals of Tropical Medicine and Parasitology,1966:60(2):187–197.

3. Cheng TC. Marine molluscs as hosts for symbiosis. With a review of known parasites of commercially important species. Advances in Marine Biology,1967:5:424 p.
4. Crews AY, Esch G. Histopathology of larval trematode infections in the freshwater snail, *Helisoma anceps*. Journal of Invertebrate Pathology,1987:49:76–82.
5. Gorbushin AM. Field evidence of trematode-induced gigantism in *Hydrobia* spp. (Gastropoda, Prosobranchia). Journal of the Marine Biological Association of the United Kingdom,1997:77:785–800.
6. Hodasi JKM. The effects of *Fasciola hepatica* on *Lymnaea truncatula*. Parasitology,1972:65:359–369.
7. Huffman JE, Freid B. Histopathological and histochemical effects of larval trematodes in *Goniobasis virginica* (Gastropoda, Pleuroceridae). The Veliger,1985:27(3):272–281.
8. Janse C, Wildering WC, Popelier CM. Age-related changes in female reproductive activity and growth in the mollusc *Lymnaea stagnalis*. Journal of Gerontology,1989:44(6):B148–B155. doi: 10.1093/geronj/44.6.b148. PMID: 2809101
9. Lapeta A. Activity of lactate dehydrogenase in *L. (G) truncatula*. Zoologica Poloniae,2003:48(1-4):43–69.
10. Zakikhani M, Rau ME. Effects of *Plagiorchis elegans* (Digenea, Plagiorchiidae) infection on the reproduction of *Biomphalaria glabrata* (Pulmonata, Planorbidae). The Journal of Parasitology,1998:84(5):927–930.
11. McCrady J. Observations on the food and the reproductive organs of *Ostrea virginica*, with some account of *Bucephalus cuculus* nov. spec. Proceedings of the Boston Society of Natural History,1873:16:170–192.
12. Minchella DJ, Leather BK, Brown KM, McNair JN. Host and parasite counter adaptations, An example from a freshwater snail. American Naturalist,1985:126:843–854.
13. Mouritsen KN, Jensen KT. The enigma of gigantism, Effect of larval trematodes on growth, fecundity, egestion and locomotion in *Hydrobia ulvae* (Pennant) (Gastropoda, Prosobranchia). Journal of Experimental Marine Biology and Ecology,1994:181:53–66.
14. Nagare KR, Dummalod CB. Aquatic flora and fauna associated with the freshwater snail *Lymnaea acuminata* in Kham river at Aurangabad (M.S.). International Multidisciplinary Research Journal,2012:2(5):05–08.
15. Nagare KR, Dhole JS. Effect of parasitic infection on rate of respiration of the freshwater pulmonate vector snail *Lymnaea acuminata* during patency period from Aurangabad city, Maharashtra, India. International Journal of Research and Analytical Reviews,2021:8(4):280–284.
16. Nagare KR, Dummalod CB. Alterations in lipid contents of infected and non-infected snail *Lymnaea acuminata* during patency period from Aurangabad (M.S.). Indian Journal of Applied Research,2013:3(4):14–15.
17. Nagare KR, Rane MS. Effect of parasitic infection on alteration in glycogen content in the vector snail *Lymnaea acuminata* during patency period from Aurangabad (M.S), India. Global Journal for Research Analysis,2015:4(4).
18. Najarian HH. Egg-laying capacity of the snail *Bulinus truncatus* in relation to infection with *Schistosoma haematobium*. Texas Reports on Biology and Medicine,1961:19:327–331.
19. Pan TC. Studies on the host-parasite relationships between *Schistosoma mansoni* and *Australorbis glabratus*. American Journal of Tropical Medicine and Hygiene,1965:14:931–976.
20. Pearson EJ, Cheng TC. Studies on parasitic castration, Occurrence of a gametogenesis inhibiting factor in extract of *Zoogonus lassius* (Trematoda). Journal of Invertebrate Pathology,1985:46:239–246.
21. Pelseneer P. Trematodes parasites de mollusques marins. Bulletin Scientifique de la France et de la Belgique,1906:40:161–186.
22. Rees WJ. The effect of parasitism by larval trematodes on the tissues of *Littorina littorea* (Linné). Proceedings of the Zoological Society of London,1936:1936:357–372.
23. Robson EM, Williams IC. Relationship of some species of Digenea with the marine prosobranch *Littorina littorea* (L.). II. The effect of larval Digenea on the reproductive biology of *L. littorea*. Journal of Helminthology,1971:45:145–159.
24. Rothschild A, Rothschild M. Some observations on the growth of *Peringia ulvae* (Pennant, 1777) in the laboratory. Novitates Zoologicae,1939:41:240–247.
25. Rothschild M. Observations on the growth and trematode infections of *Peringia ulvae* (Pennant 1777) in a pool in the Tamar Saltings, Plymouth. Parasitology,1941:33:406–415.
26. Souza W. Host life history and the effect of parasitic castration on growth, A field study of *Cerithidea californica* Haldeman (Gastropoda, Prosobranchia) and its trematode parasites. Journal of Experimental Marine Biology and Ecology,1983:73:273–296.
27. Sullivan JT, Cheng TC, Howland KH. Studies on parasitic castration, Castration of *Ilyanassa obsoleta* (Mollusca, Gastropoda) by several marine trematodes. Transactions of the American Microscopical Society,1985:104(2):154–171.
28. Theron A. Dynamics of larval population of *Schistosoma mansoni* in *Biomphalaria glabrata*. II. Chronobiology of the intramolluscal larval development during the shedding period. Annals of Tropical Medicine and Parasitology,1981:75:547–554.
29. Theron A, Gerard C. Development of accessory sexual organs in *Biomphalaria glabrata* as related to infection timing by *Schistosoma mansoni*, Consequences on the energy utilisation patterns by the parasite. Journal of Molluscan Studies,1994:60:23–31.
30. Thornhill JA, Jones JT, Kusel JR. Increased oviposition and growth in immature *Biomphalaria* after exposure to *Schistosoma mansoni*. Parasitology,1986:93:443–450.
31. Woodard TM. Anatomy of the reproductive system of *Goniobasis laqueata* (Say). Journal of the Tennessee Academy of Science,1934:9:243–254.
32. Wright CA. The pathogenesis of helminthes of Mollusca. Helminthological Abstracts,1966:35:207–224.
33. Yoshino TP. A seasonal and histological study of Digenea infecting *Cerithidea californica* (Gastropoda, Prosobranchia) from Goleta Slough, Santa Barbara County, California. The Veliger,1975:16:156–161.