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STUDY THE BREEDING BIOLOGY OF ORNAMENTAL FISH

POECILIA RETICULATA (*GUPPY*)

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ABSTRACT

The breeding biology guppy fish, *Poecilia reticulata* was studied during December 2014 to March 2015 in laboratory, Government College for Women (A) Kumbakonam, Bharathidasan University. Guppy bred all over year, when in compared to December to January with a pick period in March. They were viviparous and multiple breeders (i.e) give birth to fry several times in the breeding season. The gestation period ranged from 20 to 35 days. In the present study, successive stages of fry development of *Poecilia reticulata* were observed. The number of fry per brood ranged from 10 to 70. New born fries were observed with transparent or blackish color having slender body with jaws developed on month and were fully capable of swimming, eating and avoiding danger. In general guppy grew rapidly, attained sexual maturity 7-9 weeks and reached full size in 4 months.

KEY WORDS

Guppy fish, *Poecilia reticulata*, breeding biology.

INTRODUCTION:

The annual value of the world's wholesale trade in ornamental fish (including commodities) was estimated 1 billion dollars in 2001 (Olivier, 2001). The Free- On-Board export value of freshwater and saltwater fish was estimated 264 million US dollars in 2005, an increase of 50% with respect to 2001 (FAO, 2007). Ornamental fish farming is a relatively new branch of the agricultural industry. Popular aquarium fish, *Poecilia reticulata* commonly known as 'guppy' was introduced in various countries for mosquito control and often loosely

called ‘mosquito fish’. It has been found to establish itself in both fresh and polluted waters (Ahmed *et al.* 1985). It introduced in India as early as 1910 to control mosquito (Kaira *et al*. 1967). Guppies are small poeciliid fishes of northeastern South America (*Endler, J. A.*, 1987). This species is widely studied as a model species ecology and evolutionary biology, and has had a long and popular history as an ornamental fish. A wide variety of strains differing in color and fin shape have been developed by aquarists (Axelrod et al. 1985; Sakurai et al. 1993; Wischnath 1993).Males are brightly colored and vary greatly in their colour patterns within and populations, where as females do not have conspicuous colour patterns. Their biology, ecology, behaviour and genetics have been reviewed previously (Endler 1978, 1983). Briefly, guppies live in tropical forests, in clear streams with clean gravel or sand bottoms, and occasional patches of leaf litter. The larvivorous fish, *Poecilia reticulata* is an effective biological control agent of mosquitoes in different habitats in Iran. This specie regulates the populations of different species of pest and vector mosquitoes. *P. reticulata* can consume a good number of mosquito larvae, with the consumption rate varying with the body size (Manna *et al*., 2008). Hora & Mukherjee classified the gender *Poecilia* in surface feeder which is less efficient owing to their mode of life (Chakraborty *et al*., 2008).

Animals often find themselves in a dilemma: By increasing the energy devoted to reproductive processes, they decrease the resources available for growth and maintenance, which can in turn constrain their future reproductive attempts (Hirshfield and Tinkle 1975). From the physiological costs of gamete production to the effort allocated into parental care, females are traditionally considered the sex that pays higher energetic costs to reproduce (Andersson 1994). However, recently, more emphasis has been placed on recognising the energetic constraints suffered by males in order to reproduce (Bonduriansky 2001). Females with enlarged bellies, presence of gravid spots, eggs, or embryos seen with the naked eye were classified as gravid according to Winemiller (1989). We adapted the methods of Shahjahan *et al*. (2013) to determine under the binocular stereomicroscope the developmental stages of reproductive females. Males increase their reproductive success when they have access to a large number of females (Bateman 1948) The guppy was one of the first vertebrates in which sex-linked inheritance of color loci was demonstrated (Winge, 1927). More recently, the guppy has become a model organism for studying behavioral traits such as courtship and mate choice (Evans *et al*., 2003; Magurran and Henderson, 2003), as well as for understanding ecogeographic adaptation (Endler, 1991, 1995; Reznick, 1997). The nature of the guppy mating system makes guppies especially am enable to studies of sexual selection and mate choice, and previous work on guppy sexual behavior has already provided much

needed information on how sexual selection may operate in natural populations (Houde, 1997).This larvivorous fish are quite tolerant of a variety of water conditions thus can be used as predators of mosquito larvae and they can be moved to water areas where they are needed (Travis 1957). Larvivorous fish have been used in mosquito control on and off for many years in different parts of the world (Ahmed *et al.* 1985).An understanding of the breeding biology of *P. reticulata* is a basic requirement for the successful proliferation of the fish, hence successful mosquito control. It is a viviparous fish and is capable of increasing its population in shallow or polluted water (Menon and Rajagopalan 1977). In Bangladesh no published information on the breeding of *P. reticulata* is available. Researches have been carried out on the bio-control of mosquito larvae by guppies (Ahmed *et al.* 1985, Khanum *et al.* 2002). Therefore, the present investigation was carried out on the breeding biology of *P. reticulata* in a controlled aquarium condition.

METERIAL AND METHODS

Procurement and rearing of experimental fishes

A common fresh water aquarium fish, guppies are known for their extraordinary colors and patterns sure pleasing to have in any aquarium. *Poecilia reticulata* was collected from the Star Aquarium Centre in Kumbakonam. The collected fishes without least disturbance were transported in polythene bags filled half with water. About ten fishes were put in a bag and water was well aerated tap water using pressurized air from a cylinder. This mode of transit proved successful, since there was no mortality in all consignments throughout the course of this study. The fish were acclimated to laboratory conditions 30 days. Ground water used for maintaining the fish in the fish tank had a PH7.2± 0.1, dissolved oxygen 8.0 ± 0.3mg/l and bicarbonates 95.0±5.0mg/l. The fish tanks kept free were fungal infection by washing with potassium permanganate solution. The fish were disinfected with 0.1% potassium permanganate solution and were maintained for 4 weeks in well aerated tap water. The test fishes were critically screened for the signs of disease, stress, physical damage and mortality. The injured, severely diseased abnormal and dead individuals were discarded. Males should be selected with the fins and body with the desired color, shape, and size. Females are selected for good body shape, desired tail color, and good tail shape. Both sexes should have thick peduncles to hold the large tails well. In this experiment the breeding set up is 2 males to 3 females to reduce stress on specific females from the male.

Males were clearly distinguished by having modified and taking the form of gonopodium and in females, body color was less bright and had swollen abdomen. Each of the aquatic contained 5 liters of water. Water was changed manually every day in the afternoon when the temperature of the aquarium water was close to that of the tap water. The guppy prefers hard water and can with salinity up to one ppt. An active fish, guppies use an enormous amount of energy and need to be fed at least 3 times a day, with a variety of foods including dry, fresh, frozen or live foods. Guppies are top feeders and will readily take most prepared foods. However, they should be given a diet with high vegetable content and a dry food such as TETRA's Spirulina Tropical Flakes should be used occasionally. The broods were provided with paper food and commercial pellet feed as their food and given twice a day in the morning and afternoon. The fishes were observed young one that from moment of birth the newly born baby fish (fry) were observed in ten occasions viz (1 hour 1,5,10,15,20&50 days) of age till up to 7 weeks. The month wise reproduction of *Poecilia reticulata* was also observed in 3 months (December, January, February, and March).

RESULT AND DISCUSSION

The month wise reproduction of *Poecilia reticulata* was observed throughout the year in December, January, February, and March (Fig.1). Guppy began fry birth in December and ended in March with a peak in March. Hidebrand (1921) reported that the breeding season of guppy in the Southeastern U. S. begins in May and ends in September and October. Davis (1978) reported that in South-central Texas, the breeding season of *Gambusia affinis*, a closely related fish of guppy ranges from March to October with a peak in April. In the present study, it was observed that the gestation period of guppy was 25-35 days with an average of 28 days. Guppy was reported to bring out broods at approximately four-week intervals (Ahmed *et al.* 1985). Krumholz (1948) reported that the average gestation period of *G. affinis*, a closely related fish of guppy (*P. reticulata*), was 23-24 days. In guppy, fertilization is internal and takes place through mating of couples showing specific mating behavior. Male transfer's sperms into female body by a modified anal fin called gonopodium. Male perform an S-shaped posture known as 'sigmoid display' and orientates himself in front of the females at the beginning of courtship. Collier (1936) and Paden (1975), obsereved courtship behaviour in mosquito fish, that was similar to the present study. Houde and Endler (1995) observed that females exhibit sexual preferences for males with larger color spots,

which is displayed during elaborate "sigmoid" courtship displays. Larger females produce large number of offspring than smaller fish. Shikano and Fujio (1997) reported that the female guppy gave birth 2 to100 fry, but the typical range is between 5 and 30. Nutritional balance, water condition or differences in rearing procedure might be the cause of the variation. The neonate fry was knocked by the mother with her head to learn swimming and they floated and moved around the aquarium. The fries took birth with jaws developed on mouth. So, they could easily take food immediately after birth. It was observed that from the moment of birth, each fry was fully capable of swimming, eating and avoiding danger. Shikano and Fujio (1997) also made similar observation. It was observed that females typically mate with more than one male. Evans and Magurran (2000) noted the similar facts in guppies during their sexually receptive phase. Females have the ability to store sperm, so that they can give birth many times, after mating with a male only once. Three to five times hatching was observed after a single mating in several couples during this study. Constantz (1989) also observed that female guppies store sperm for several months. It was observed that *P. reticulata* hatch its first brood at the age of 3-4 months. Menon and Rajagopalan (1977) also reported that this fish can reproduce at the age of 90 days. After giving birth, the female became ready for conception again within only a few hours.

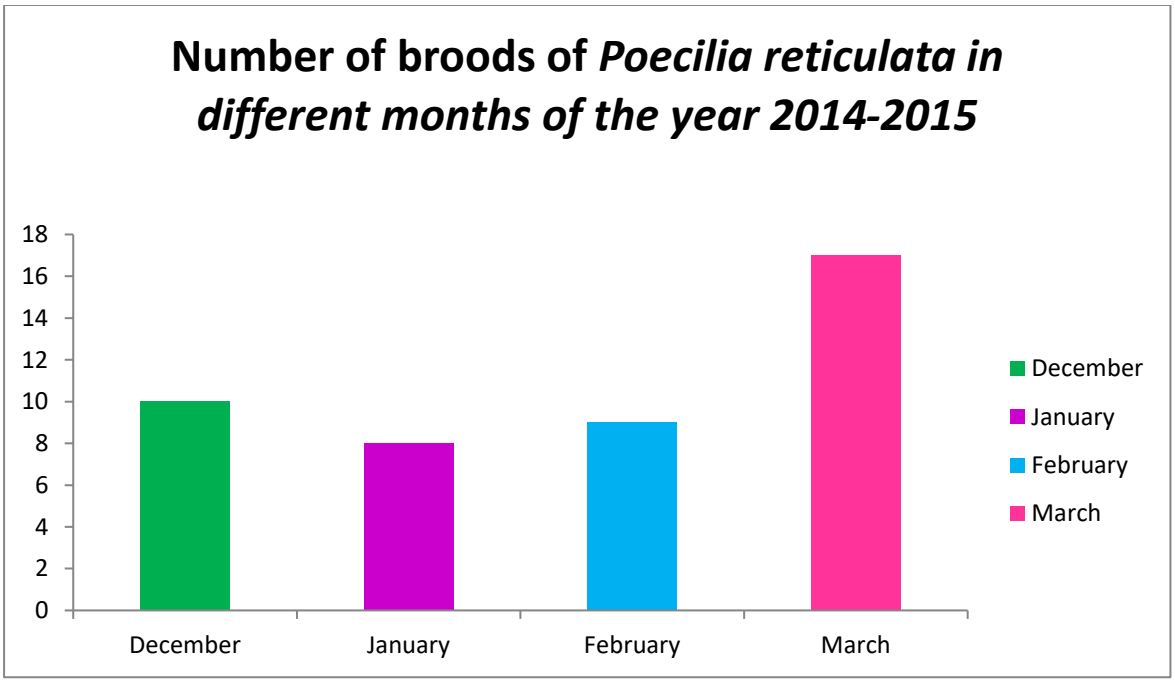

Fig. 1. Number of broods of *Poecilia reticulata* in different months of the year 2014-2015.

Development after birth:

Newly hatched fries were blackish or transparent and slender with chromatophore on head measuring from 6.5 to 7.5 mm in length. They settled down at the bottom of the aquarium and searched food in the stones within 1-2 hours. Characteristics of the different stages of fry development are briefly pointed below-

Fry, just after birth:

Transparent, some are blackish or grayish in color. Body slender, about 0.8-1cm long. Pectoral fins were larger than caudal.

One day old fry:

Fins clearly observed, pelvic fin is smaller than pectoral. Caudal fin with dark spot. Length of the body was 6.6-7.5mm.

5-day old fry:

Caudal fin somewhat flat clearly appeared as a tail. A longitudinal thread like structure, the alimentary canal was observed in the transparent body. Body length was 6.8-8.0mm.

10-day old fry:

Caudal and pectoral fin was clearly appeared in body. Body length was 7.2-8.5mm.

15-day old fry:

A primary concept might be achieved of sex differences. Female abdomen was somewhat wider than male. Body measured 7.8-9.0mm in length. Anal fins of both sexes were similar.

20-day old fry:

The anal fin of male becomes elongated and tube shaped while in the female it becomes small and rounded. Fin rays observed in male but not in female. Body measured 8.0-9.0mm in length.

25-day old fry:

Anal fin of both sex shapes was clearly. Body length was 8.0-9.5mm.

30-day old fry:

Caudal fin of the male becomes colored, especially appeared as brownish. Female caudal fin was blackish in color. Size of female became larger compared to that of the male. The range of the body length was 8.2-9.5mm.

35-day old fry:

Male and female were clearly distinguished according to their size, tail and anal fin. The abdomen of female became larger and flatter compared to that of the male. Body measured 8.2-10mm
in length.

40-day old fry:

Blacked tail clearly appeared in female. Body length was 9.2-10.5mm.

45-day old fry:

Fish was clearly appeared in tail and fin. Body length was 9.2-11mm.

50-day old fry:

Male initiate their sexual traits and moved behind female. In some cases, a dark spot surrounding the anus and urinogenital area known as 'gravid spot' present in females while that was absent in males. Approximate body length was 10.8-12mm.

The full size of male ranged 3-5 cm and female ranged 4-7 cm and reached full size at about 4-6 months.

Plate 1. Successive stages of fry development of *Poecilia reticulata.*

REFERENCE

1. Ahmed, T.U., M.K.R. Rabbani and Meher-e-Khuda. 1985. Observation of the larvivorous efficiency of *Poecilia reticulata* (Cyprinodontiformes: cyprinodontidae). *Bangladesh J. Zool.* 13: 7-12.

2. Andersson M (1994) Sexual selection. Princeton University Press,Princeton

Axelrod, H.R., W.E. Burgess, N. Pronek, and J.G. Walls. 1985. Dr. Axelrod's atlas of freshwater aquarium fishes. Tropical Fish Hobbyist Publications, Inc., Neptune City, NJ.

3. Bateman AJ (1948) Intrasexual selection in *Drosophila*. Heredity2:349 – 368

4. Bay, E.C. 1967. Mosquito control by fish. *Chronicle, WHO.* 21: 415.

5. Bonduriansky R (2001) The evolution of male mate choice in insects:a synthesis of ideas and evidence. Biol Rev 76:305– 339

6. Chakraborty S, Bhattacharya SW, Bhattacharya SA. 2008. Control of mosquitoes by the use of fish in Asia with special reference to India: Retrospects anr prospects. *J. Manusia Dan Lingkungan* 15:147-156.

7. Davis, J.R. 1978. Reproductive season in *Gambusia affinis and Gambusia geiseri* (Osteichthyes:

8. Endler JA. 1978. A predator's view of animal color patterns. *Evol Biol*., 11:319-364.

9. Endler JA. 1983. Natural and sexual selection on color patterns in poeciliid fishes. *Environ. Biol. Fishes* 9:173-190.

10. Endler JA. 1987. Predation, light intensity and courtship behaviour in *Poecilia reticulata* (Pisces : Poeciliidae). *Anita. Behav*., 35:1376-1385.

11. Endler JA. 1991. Variation in the appearance of guppy color patterns to guppies and their predators under different visual conditions. Vision Res 31:587–608.

12. Endler JA. 1995. Multiple-trait coevolution and environmental gradients in guppies. Trends Ecol Evol 10:22–29.

13. Evans JP, Zane L, Francescato S, Pilastro A. 2003. Directional postcopulatory sexual selection revealed by artificial insemination. Nature 421:360–363.

14. Food and Agriculture Organization (FAO). 2007. http://www.fao.org;

15. Gupta D K, Bhatt RM, Sharma RC, Gautam AS, Kant R (1992) Intradomestic mosquito breeding sources and their management. *Indian J. Malariol*. 29, 41–46.

16. Hidebrand, S.F. 1921. Use of top minnows in malaria control. *U. S. Public health Bull.* **114**:

34.
17. Hirshfield MF, Tinkle DW (1975) Natural selection and evolution of reproductive effort. Proc Natl Acad Sci USA 72:2227 – 2231
18. Houde, A. (1997). Sex, color, and mate choice in guppies. Princeton, NJ: Princeton University Press.
19. Kaira, N.L., B.L. Wattal and N.G.S. Raghavan. 1967. Occurance of larvivorous fish *Lebister reticulatus* (Peters) breeding in sullage water at Nagpur-India. *Bull. Ind. Soc. Mal. Com. Dis.* **4**: 253-254.
20. Khanum, S.I., H.R. Khan and A. Begum. 2002. Larvivorous potential of the guppy *Poecilia reticulata* on *Culex quinquefasciatus* larvae. *Bangladesh. J. Zool.* **30**: 41-46.
21. Krumholz, L.A. 1948. Reproduction in the Western mosquito fish, *Gambusia affinis*, and its use in
22. Magurran AE, Henderson PA. 2003. Explaining the excess of rare species in natural species abundance distributions. Nature 422:714–716.
23. Manna B, Aditya G, Banerjee S. 2008. Vulnerability of the mosquito larvae to the guppies (*Poecilia reticulata*) in the presence of alternative preys. *J Vector Borne*. 4:200–206.
24. Menon PKB, Rajagopalan PR (1978) Control of mosquito breeding in wells by using *Gambusia affinis* and *Aplocheilus blochii* in Pondicherry town. *Ind. J. Med. Res.* 68, 927–933.
25. Menon, P.K.B. and P.K. Rajagopalan. 1977. Mosquito control potential of some species of Indigenous fishes in Pondicherry. *Ind. J. Med. Res.* **66**: 765
mosquito control. *Ecol. Monorg*. **18**: 1-43.
26. Olivier K. 2001. The Ornamental Fish Market. FAO/Globefish Research Programme, 67, FAO, Rome. 99.
Poeciliidae) from Southcentral Texas. *Texas J. Sci.* **30**: 97-99.
27. Reznick DN. 1997. Life history evolution in guppies (*Poecilia reticulata*): guppies as a model for studying the evolutionary biology of aging. Exp Gerontol 32:245–258.
28. Sakurai, A., Y. Sakamoto, and F. Mori. 1993. Aquarium fish of the world: the comprehensive guide to 650 species. Chronicle Books, San Francisco, CA.
29. Shahjahan, R. M., Ahmed, M. J., Begun, R. A. & 30 T. D. OLIVEIRA *ET AL*. *Pan-American Journal of Aquatic Sciences* (2014), 9(1):21-30 Rashid, M. A. 2013. Breeding biology of guppy fish, *Poecilia reticulata* (Peters, 1859) in the laboratory. Journal of the Asiatic Society of Bangladesh, Science. 39(2): 259-267.
30. Travis, B.V. 1957. Prent status and future possibilities of biologcal control of mosquitoes.

Mosquito News. **17**: 143-147.

31. WHO (1995) Vector control for malaria and other mosquito-borne diseases. World Health Organization, WHO Technical Report Series 857, Geneva, p. 97. U.S. Dept. of Health and Human Services (1977) Mosquitoes of public health importance and their control. HHS Publication No. (CDC) 87-8396, p. 21.

32. Winemiller, K. O. 1989. Patterns of variation in life history among South American fishes in seasonal environments. **Oecologia**, 81(2): 225-241

33. Winge O¨ . 1927. The location of eighteen genes in *Lebistes reticulatus*. J Genet 18:1–43.

34. Wischnath, L. 1993. Atlas of livebearers of the world. Tropical Fish Hobbyist Publications, Inc., Neptune City, NJ.

35. Collier, A. 1936. The mechanism of internal fertilization in *Gambusia. Copeia.* 45- 53pp

36. Constantz G.D. 1989. Reproductive biology of Poeciliid fishes. In: Meffe GK, Snelson F. F,editors. *Ecology and evolution of Livebearing fishes (Poeciliidae)*. New Jersey: Prentice Hall. p 33–50

37. Houde, A.E. and J.A. Endler. 1995. Geographic variation in female preferences for male traits in *Poecilia reticulata*. *Evolution.* **49**: 456-468.

38. Shikano, T. and Y. Fujio. 1997. Successful propagation in seawater of the guppy *Poecilia reticulata* with reference to high salinity tolerance at birth. *Fish. Science.* **63**: 573-575.

39. Evans, J.P. and A. E. Magurran. 2000. Multiple benefits of multiple mating in guppies. *PNAS.* **97**(18):10074-10076

40. Peden, A.E. 1975. Differences in copulatory behaviour as partial isolating mechanisms in the Poecillid fish *Gambusia. Can. J. Zool*. **53**: 1290-1296.