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Morphology, Biology and Predatory Efficiency of *Poecilia reticulata* for Mosquito Larvae

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ABSTRACT. *Wild variety of Poecilia reticulata is a fish used widely as a mosquito larvivore in many geographical locations of the world. However, its efficacy as a mosquito larvivore mainly depends on its capability to establish in the introduced location. Its overall efficiency as a mosquito larvivore is still questionable in local situations. Morphological and biological characters of this species is an effective tool in predicting its potentiality to establish in different locations. This experiment was carried out to determine the morphological and biological characters of P. reticulata and the predatory efficiency on mosquito larvae.*

Morphological characters indicate that the genetically improved P. reticulata (sari guppy) has higher number of fin rays in caudal fin, dorsal fin and in pectoral fin (D 7–8, C 21–26, P 8–12) than that of wild guppy (C 20–22, D 7, P 7–10). Condition factor of laboratory reared wild males was found to be significantly higher ($p<0.05$) than that of the wild caught males. Males of wild guppy became sexually mature within 34–50 days after birth, while first spawning of females started 90 days after birth. The male to female ratio of the offspring was 1:3. The spawning interval was 19 –45 days. Regression analysis indicated that the standard length (SL) and the number of offspring produced by a female (NOF) is highly correlated (NOF = - 48.35 + 25.57 SL, $r = 0.76$). Predatory capacity of fish for mosquito larvae depends on the body size of the fish. The presence of other feed materials in a given location significantly ($p<0.05$) reduces the predatory capacity of fish for mosquito larvae.

INTRODUCTION

Control of mosquitoes through insecticide application has been the common practice in Sri Lanka for many decades. However, due to many reasons such as the increased number of spraying cycles, build up of resistance to insecticides by mosquitoes (WHO, 1980), killing of non target species, non biodegradability and accumulation of insecticides in the environment, and higher cost for stronger and safer insecticides have proven that this control method is ineffective. Today, the mosquito control programmes are geared as integrated approaches where environmental management and biological control methods being the key components. Biological control of mosquitoes with predatory organisms in most instances is the most acceptable from environmental standpoint, and has been applied in many situations with reasonable success (WHO, 1995).

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There is a wide range of animal phyla among the natural enemies of mosquitoes, which predate on the eggs, larvae and adults of mosquitoes. Among them, larvivorus fish that are particularly suitable for control of aquatic stages of mosquitoes have shown some success. Most commonly used predatory fish for mosquito control are *Gambusia affinis* and *Poecilia reticulata*. These have been used in experiments in many geographical areas of the world (Garcia *et al.*, 1991; Homski *et al.*, 1994; Mohsen *et al.*, 1995; Prasad *et al.*, 1993; Rawlins *et al.*, 1993; Singaravelu *et al.*, 1997).

Poecilia reticulata, a fish native to the West Indies and parts of Central America had been introduced to Sri Lanka's inland waters since 1928 to 1945 as a mosquito larvivore by Antimalaria Campaign (Pethiyagoda, 1991). However, its overall efficacy as a larvivore is still questionable in local situations (Costa, 1985; Jayasekara, 1986). No controlled use of this fish has been made and disappearance of mosquito larvae when fish is added has been observed mostly on *ad hoc* basis. Most of the studies, which have been carried out, were with respect to the *P. reticulata* (sari guppy), which is reared as an ornamental fish. The wild type has received less attention. Present study is a part of a detailed study on *P. reticulata* as a mosquito larvivore.

The efficiency of *Poecilia reticulata* as a mosquito larvivore mainly depends on its ability to establish in the introduced location. Information on morphological, biological characters and feeding behaviour of *P. reticulata* can be used as an effective tool in deciding minimum stocking density and its establishment in the introduced location and thereby can reduce the unnecessary stocking densities and transportation costs.

Determination of morphological characteristics, condition factor under different environments, reproductive biology and its predatory efficiency for mosquito larvae were the objectives of this study.

MATERIALS AND METHODS

Poecilia reticulata (Wild guppy) for the experiment was collected from the fishpond at the Department of Animal Science, Faculty of Agriculture, University of Peradeniya. They were conditioned to the laboratory and were fed with prepared feeds. The sari guppy were obtained from the aquarium of the Department Animal Science.

Morphometrics

The total body length, standard length, head length, depth, eye length and number of fin rays were recorded as morphometric characters for wild and sari guppy adults using 16 fish from each category (Deraniyagala, 1938).

Condition factor

The standard length and live weight of males caught from the wild and the laboratory reared wild stock were measured using a millimeter scale and an electronic

balance, respectively. Condition Factor was calculated for males caught from the wild and for laboratory reared wild stock using 8 fish from each group. Females were not used in the determination of Condition Factor to increase the accuracy. Means of the Condition Factor were compared using the SAS Package.

Reproductive biology

The offspring of laboratory reared wild females (n=16) were reared separately, and recorded the time taken for the development of gonopodium in males which is an indication of the attainment of sexual maturity. The number of males and females in each generation were counted and sex ratio was calculated. The males and females were stocked into separate tanks in 1 : 2 ratio (n=16, respectively. The standard lengths, date of first spawning, the number of offspring produced by each female and the time taken for next spawning were recorded. Regression analysis was carried out to determine the relationship between standard length (SL) of female and the number of offspring (NOF) produced at a time.

Predatory capacity of wild guppy for mosquito larvae

Treatment 1: Wild *Poecilia reticulata* of different length (range from 1.5 cm to 3.5 cm) were starved for 48 h and introduced separately into 29×29×15 cm^3 glass tanks. After 15 min of acclimatization period, each fish was provided with 100 mosquito larvae (n=12). The number of mosquito larvae remained in each tank after 45 min was counted to calculate the number of mosquito larvae eaten by each fish. The standard length of the fish was also recorded.

Treatment 2: For another group of fish kept separately as in the above experiment, 100 mosquito larvae and one teaspoonful of microworms was introduced to each fish and calculated the number of mosquito larvae eaten by each fish, 45 min after the introduction (n=10).

Results of the two treatments were compared using the SAS statistical package by Covariance Analysis.

RESULTS AND DISCUSSION

Morphological characters of wild guppy and sari guppy

Total length and standard length of sari guppy males were significantly higher than that of the wild males. The other morphometric characters such as depth, head length and eye length were also higher for sari guppy than those of wild guppy males (Table 1).

The relatively larger body size of sari guppy than the wild guppy males is mainly due to the elongation of caudal fin of the sari guppy which is a favourable character in ornamental fish trade which has been resulted from selective breeding for better characters.

Table 1. A comparison of some morphometric characters of male and female wild guppy and sari guppy.

Character	Male		Female	
	Wild guppy (cm)	Sari guppy (cm)	Wild guppy (cm)	Sari guppy (cm)
Total length	2.30 ± 0.3	3.34 ± 0.2	2.60 ± 0.3	3.45 ± 0.40
Standard length	1.80 ± 0.2	2.10 ± 0.1	2.00 ± 0.3	3.28 ± 0.10
Depth	0.38 ± 0.0	0.44 ± 0.1	0.55 ± 0.1	0.78 ± 0.04
Head length	0.36 ± 0.0	0.47 ± 0.1	0.40 ± 0.1	0.60 ± 0.00
Eye length	0.12 ± 0.0	0.18 ± 0.0	0.12 ± 0.0	0.20 ± 0.00

A comparison of the total length and standard length of females exhibited the similar trend (Table 1). The difference in the morphological characters between wild and sary guppies expresses the genetical changes, which have taken place over time. Provision of better environment and gene pool acquired through selection by sari guppy would explain these results .

The number of caudal fin rays, dorsal fin rays and pectoral fin rays were always higher in sari guppy (C 21–26, D 7–8, P 8–12) than those of wild guppy (C20–22, D 7, P 7–10). The increased number of fin rays in sari guppy, would have developed to support their relatively enlarged caudal, dorsal and pectoral fins. Pelvic and anal fin ray numbers remained unchanged in both groups (Table 2). In males anal fin rays are fused to form a structure called gonopodium.

Table 2. Number of fin rays found in wild guppy and sari guppy.

Fish type	Caudal fin rays	Dorsal fin rays	Pelvic fin rays	Pectoral fin rays	Anal fin rays
Wild guppy	20–22	7	6–7	7–10	8–10
Sari guppy	21–26	7–8	6–7	8–12	8–10

Condition factor

Mean condition factor for wild caught male was 1.76 and for laboratory reared wild males was 2.11. The condition factor for laboratory reared wild males was found to be significantly higher than that of the males caught from the wild ($p<0.05$). The increase in condition factor of laboratory reared wild guppy infers that they can get adjusted to

laboratory condition easily and that the artificial feed given had been more productive than the natural feeds available in the wild. This further explains the differences in morphological characters discussed earlier.

Reproductive biology

Males became sexually mature between 34–45 days after the birth. In females, first spawning was recorded 3 months after birth and the spawning interval was 19–45 days. For sari guppy, gestation period varies from 4–8 weeks (De Silva and Anderson, 1995). This indicates that wild guppy has a relatively frequent spawning cycle than that of the sari guppy. The male to female ratio of offspring of wild guppy was 1:3 respectively.

The relationship between standard length (SL) of the females and the number of offspring produced (NOF) was positively correlated (NOF = - 48.35 + 25.57 SL, r = 0.76) (Fig. 1).

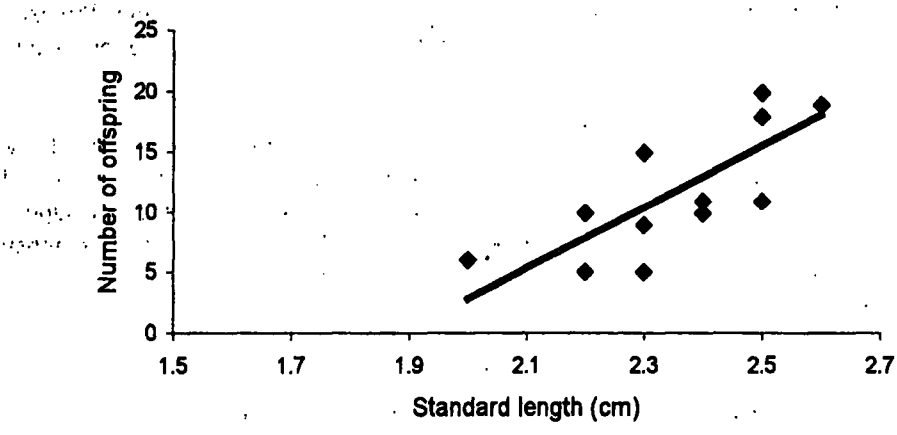

Fig. 1. Standard length Vs number of offspring produced by *P. reticulata*.

Feeding

There was a positive correlation between standard length of the fish and the number of mosquito larvae eaten by *P. reticulata*. Fish having a standard length of more than 2 cm have predated on higher number of mosquito larvae (Fig. 2 and Fig. 3). There was a significant difference between the number of mosquito larvae taken as feed in the presence or in the absence of microworms ($p<0.05$) in the experimental tanks.

Addition of microworms (represent zooplankton) led to the reduction of mosquito larval predation by fish. It can be inferred from these results, that the availability of other feeds in the natural system has an effect on the predatory capacity of fish for mosquito larvae.

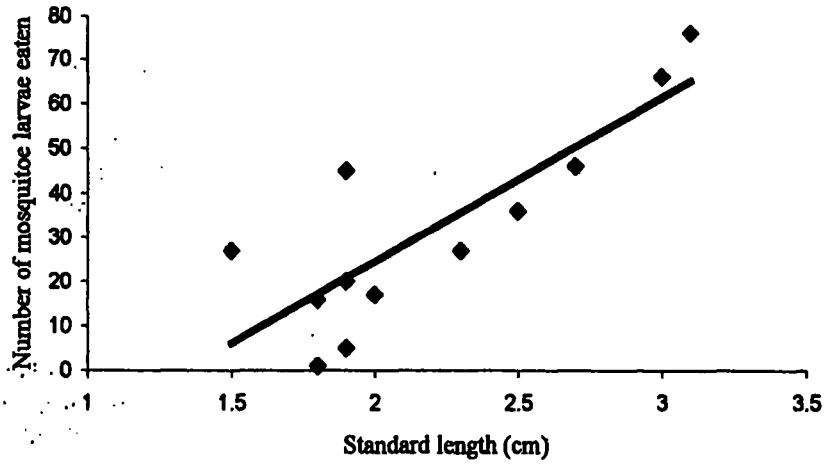

Fig. 2. The standard length Vs predatory efficiency of *P. reticulata* for mosquito larvae.

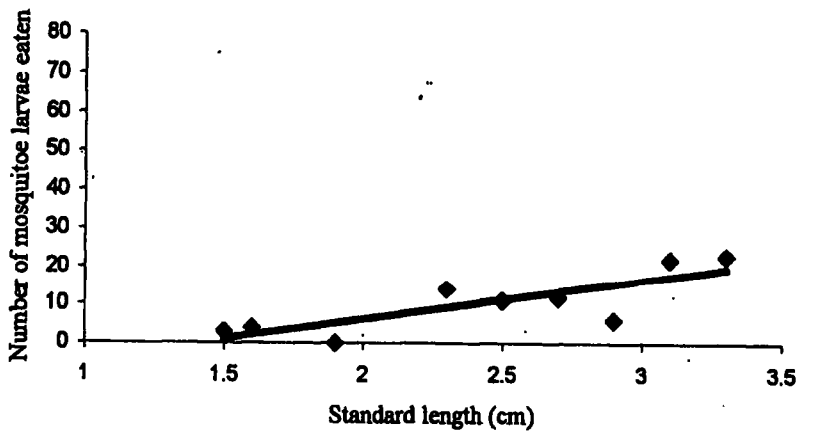

Fig. 3. Feeding preference of *P. reticulata* when microworms were added.

CONCLUSIONS

Morphological characteristics indicate that there is a difference in the number of fin rays in sari guppy (C 21–26, D 7–8, P 8–12) and in wild guppy (C 20–22, D 7, P 7–10). The condition factor for laboratory reared wild males was significantly higher ($p<0.05$) than males caught from the wild indicating that the artificial conditions are more suitable

even for wild guppy. Males of wild guppy attain sexual maturity between 34–45 days. Females spawn 3 months after birth. The spawning interval ranged between 19–45 days. The average male to female sex ratio in the litter was 1:3. The relationship between standard length (SL) and the number of offspring (NOF) of wild laboratory reared stock is positively correlated. Mosquito larval predatory efficiency of *P. reticulata* mainly depends on the size of the fish. Abundance of other feeds of fish in a given habitat has a significant effect on the predatory efficiency of fish for mosquito larvae. Therefore, it can be concluded that the number of larger fish in the stock and the availability of natural feeds for fish in a given location have an effect on overall predatory capacity of *P. reticulata.*

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REFERENCES

Costa, H.H. (1985). Control of *Culex quinquefasciatus* larvae by larvivorus fish *Poecilia reticulata* in drains and ditches of Colombo. J. Nat. Aq. Res. Ag. S.L. 32: 24-3.

Deraniyagala, P.E.P. (1938). A coloured atlas of some vertebrates from Ceylon. National Museum Publication, Sri Lanka.

De Silva, S.S. and Anderson, A.T. (1995). Fish nutrition in Aquaculture. Chapman and Hall Press, London.

Garcia Avila, I., Koldenkova, I., Santamarina Mijares, A., Gonzales, ... (1991). Introduction of larvivorous fish *Poecilia reticulata* (Peters, 1895) (Cyprinodontiformes; Poeciliidae), a biological control agent of mosquitoes in oxidation ponds and polluted ditches on the Isla de la Juventud. Revista-Lubana-de-Medicina-Tropical. 43(1): 45-49.

Homski, D., Goren, M., Gasith, A. (1994). Comparative evaluation of the larvivorous fish *Gambusia affinis* and *Aphanius disapear* as mosquito control agents. Hydrobiologia. 284(2): 137-146.

Jayasekera, A.M. (1986). Potential role of inland fisheries in biological control of malaria. J. Inland Fish S.L. 3: 24-30.

Mohsen, Z.H., Ouda, N.A., Hashim, A.K., Zayra, H.H. (1995). Combined Larvicidal efficiency of labda-cyhalothrin and larvivorous fish (*Gambusia affinis*) against *Culex quinquefasciatus* mosquitoes. J. Vector Ecology. 20: 164-167.

Pethiyagoda, R. (1991). Fresh water fishes of Sri Lanka. Wildlife Heritage Trust, Colombo, Sri Lanka.

Prasad, H., Prasad, R.N., Haq, S. (1993). Control of mosquito breeding through *Gambusia affinis* in rice fields. Ind. J. Malariology. 30(2): 57-65.

Rawlins, S.C., Martines, R., Nimblett, A. (1993). Consumption of *Aedese aegypti* larvae by *Poecilia reticulata* (guppy) and factors which affect production of larvivorous fish in drum environments. J. Florida-Mosquito Assoc. 64: 125-128.

Singaravelu, G., Mahalingam, S., Yaya Bharathi, K.J. (1997). Predatory efficiency of larvivorous fish, *Gambusi affinis* on the mosquito larvae of *Aedes aegypti* and *Anopheles stephens*. Current Sc. 72: 514-612.

World Health Organization. (1980). Fifth report of WHO expert committee on vector biology and control Technical report series No. 655, Pp. 82. *In:* Wickremasinghe, M.B. and Costa, H.H. (Eds) (1986). Mosquito Control with Larvivorous Fish. J. Parasitology Today. 8(2).

World Health Organization. (1995). Vector control of malaria and other mosquito born diseases: WHO. Technical Report Series 857.