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Utility of Food Fishes for the Control of Mosquito Vectors of Malayan Filariasis in Shertallai, Kerala

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ABSTRACT

Composite fish culture involving fast growing edible varieties of Carps such as *Catla catla, Cyprinus carpio, Labeo rohita, Labeo fimbriatus, Cirrhina mrigala* and *Ctenopharyngodon idella* was demonstrated in the domestic ponds of Shertallai Taluk in Kerala, as a part of integrated approach in the control of *Mansonia* mosquitoes, the vector of *Brugia malayi.* Fish fingerlings were introduced at the rate of 50/100 m^2 after the initial removal of weeds such as *Pistia stratiotes, Salvinia molesta* and *Eichhornia crassipes* which are the major host plants of vector mosquitoes. The effect of polyculture with or without grass carp (*C. idella*) on weed reinfestation and vector breeding was compared with monoculture involving weedivorous fishes *viz., C. idella* and *Osphronemous gorami.* The proportion of fish culture ponds with weed reinfestation was significantly lower than that of the ponds without fish culture. Vector breeding was significantly brought down from the pre-release level of 80.6% to 28.2% in ponds under polyculture including grass carp. *C. idella* recorded the highest growth rate of 1087± 503 grams, while *L. rohita* recorded a maximum survival of 36.9% at the end of one year. The utility of fish culture in vector control and economic gains accruing to the society through this programme are discussed.

Key Words : Food fishes, hydrophytes, *Mansonioides,* breeding, *Brugia malayi* control

The use of fishes in the control of vector mosquitoes is well documented and highly regarded as an adjunct to chemical pesticides. However, most of the recommended larvivorous fishes are tiny and do not have any food value. In view of making vector control programmes more acceptable to the community, this concept was changed by involving food fishes (Panicker *et al.,* 1985, Petr, 1987).

Filariasis due to *Brugia malayi* still persists along the west coast of Kerala, where over 3 million people are at risk from this disease (Rajagopalan *et al.,* 1988). *Mansonia annulifera, M. uniformis* and *M. indiana,* belonging to the subgenus *Mansonioides* are the natural vectors of this disease in this area and these mosquitoes can survive and proliferate only in association with hydrophytes such as *Pistia stratiotes, Salvinia molesta* and *Eichhornia crassipes,* as their immatures take oxygen from the rootlets of these plants. Hence, the control of vectors is feasible through the elimination of aquatic weeds. Herbicidal control is not practical as majority of the habitats are domestic ponds and hence the only avenue open is either through manual removal or by deployment of weedivorous fishes. To make the programme more acceptable, a strategy of 'composite fish culture for vector control' by employing fast growing edible fishes was developed and evaluated at Shertallai. The results of this programme are presented here.

MATERIALS AND METHODS

The present study was conducted in Shertallai taluk (09° 42'N and 76° 20'E) in Alleppey District of Kerala which lies on a peninsula between Arabian sea and Vembanad lake. The area is highly waterlogged with about 75,000 ponds and a vast stretch of canals and channels. All these water bodies are chocked with aquatic weeds which support profuse breeding of *Mansonioides* mosquitoes, the vectors of *B. malayi.* Ponds used for domestic purposes were selected in three villages *viz.*, Kadakarapalli, Shertallai South Panchayat and Pattanakad for the present study. These ponds ranged from 10 to 20 m in diameter and 2.0 to 4.5 m in depth. The average surface area of these ponds at full capacity was 120 m^2. These ponds are uniformly distributed throughout this area where rural population is scattered without any agglomeration.

Composite fish culture (polyculture) involving fast growing edible carps such as *Catla catla, Cyprinus carpio, Labeo rohita, Labeo fimbriatus* and *Cirrhina mrigala* were introduced in ponds which were initially deweeded by the community. The fingerlings were procured from the State Government fish farms and stocked in 13,600 ponds at the rate of 50/100 m^2 in the ratio of 2:2:1:1:4 respectively of the above mentioned fish species. Simultaneously, the efficacy of weedivorous fishes such as *Osphronemus goramy* (giant gourami) and *Ctenopharyngodon idella* (Chinese grass carp) in weed control was also assessed through monoculture with a stocking rate of 10/100 m^2 and 50/100 m^2 in 128 and 763 ponds respectively. Grass carp was also introduced in 1000 ponds at the ratio of 2:3 along with other varieties of carps the number of each variety of which was based on the proportion followed for polyculture without grass carp. Thirty ponds were maintained without fishes as control to compare the reinfestation of weeds as well as vector breeding.

The growth rate and survival rate of fishes, and their efficacy in weed and vector control were assessed for one year through monthly observations. Vector breeding was monitored by taking three samples of aquatic weeds from each pond using a specially designed "cloth dipper" covering a surface area of 0.1 m^2. The plants were vigorously shaken in a clean enamel tray with water so as to dislodge the immatures of *Mansonioides* from the roots. The number of larvae per dip per sample was recorded. Details of fish harvest were also recorded at household level. The pH of the water in the ponds ranged from 6 to 7.5 and the salinity from 162.488 to 794.23 ppm. Temperature fluctuated between 26°C and 30.5°C, and dissolved oxygen between 2.2 ppm and 9.4 ppm.

While vector breeding was monitored in ponds for one year both prior to and after fish release in individual categories of fish culture, the vector biting density was not measured, since the immigration of mosquitoes from outside the experimental area could not be ruled out. The data were analysed using Chi-square test for proportion significance and Log odds ratio test (Kahn and Sempos, 1989) for comparing the effect between different types of fish cultures.

RESULTS AND DISCUSSION

A total of 789 ponds was examined of which 697 (87.3%) were found to be naturally infested with floating weeds *viz., P. stratiotes, S. molesta* and *E. crassipes,* the natural host plants of *Mansonioides*. As many as 670 ponds selected at random were monitored at the end of 10 months following the introduction of polyculture with *C. catla, C. carpio, L. rohita, L. fimbriatus* and *C. mrigala* including *C. idella* (grass carp). The number of ponds maintained completely free from weeds (prevented from weed reinfestation and establishment) was found to be as high as 470 (70.2%). However, out of 630 randomly selected ponds under polyculture without grass carp, only 190 (30.2%) were found free from weeds. Out of 128 and 763 randomly selected ponds under monoculture using giant gourami and grass carp respectively, 104 (81.3%) and 612 (80.2%) were free of weeds. Out of thirty ponds which were initially deweeded and maintained without fish, 24 (80.0%) ponds were found to be reinfested with weeds.

Table 1. ***Mansonioides*** **breeding in ponds prior to and after introduction of fish culture**

Type	Prior to introduction			After introduction			Percentage reduction in vector breeding	Proportion significance	
	No. ponds exami-ned	+ve for vector breeding		No. ponds exami ned	+ve for vector breeding				
		No.	%		No.	%			P value
Polyculture with grass carp	697	562	80.6	670	189	28.2	65.0	377.10	<0.05*
Polyculture without grass carp	697	562	80.6	630	183	29.1	64.0	355.10	<0.05*
Monoculture with grass carp	612	494	80.7	612	63	10.3	87.2	568.1	<0.05*
Monoculture with giant gourami	128	105	82.0	128	12	9.4	88.6	133.23	<0.05*
Control	697	562	80.6	30	23	76.7	4.9	0.091	0.763

* Significantly different

The proportion of ponds maintained free from weeds was significantly higher in monoculture ponds with grass carp ($\chi^2 = 57.39$; $p < 0.05$) as well as giant gourami ($\chi^2 = 40.26$; $p < 0.05$) than in the control. However, there was no significant difference ($\chi^2 = 0.023$; $P=0.88$) between ponds with grass carp and giant gourami. The proportion of ponds without weed reinfestation was significantly higher in polyculture ponds both with ($\chi^2 = 38.92$; $p < 0.05$) or without ($\chi^2 = 18.25$; $p < 0.05$) grass carp when compared to that of control. When comparison was made between polyculture ponds with grass carp and without grass carp, the proportion of ponds maintained free from weeds was significantly ($x^2 = 713.9$; $p < 0.05$) higher in the former. Monoculture was found superior to polyculture as the proportion of ponds maintained free from weed reinfestation was significantly higher in the former either with grass carp ($\chi^2 = 18.98$; $p < 0.05$) or giant gourami ($\chi^2 = 6.02$; $p = 0.014$). Further analysis of weed reinfestation in different months showed that the difference in proportion of ponds with weed reinfestation between control and fish culture ponds was significant only from the third month onwards. This is due to the fact that it takes 2-3 months for the reinfestation and establishment of weeds in the deweeded ponds.

The number of ponds supporting vector breeding was brought down from 494 to 63 after introduction of monoculture with grass carp, with a reduction of 87.3% and it was from 105 to 12 in monoculture ponds with giant gourami, with a reduction of 88.6%. The percentage of ponds supporting vector breeding was 80.6% prior to the introduction of polyculture. The number of ponds found positive for vector breeding in polyculture ponds with grass carp was 189 (28.2%) and without grass carp was 183 (29.1%) with a reduction of 65.0% and 63.9% respectively. The proportion of ponds supporting vector breeding was significantly brought down in all the three types of fish culture after stocking with fishes (Table 1). Over 75% of the control ponds were found to support vector breeding and the proportion of positive ponds did not differ significantly in the corresponding pre and post introduction periods of fish culture. The larvivorous behaviour of common carp (*C. carpio*), major carp (*C. catla*) and grass carp (*C. idella*) has already been reported under laboratory conditions (Panicker *et al.*, 1985). The present observations in natural habitats support these findings.

When the effect of fish culture on vector breeding was compared using Log Odds ratio test, there was no significant ($z=10.22$; $p > 0.05$) difference between polyculture with and without grass carp. Similarly, the impact of monoculture on vector breeding did not show any significant ($z=10.04$; $p > 0.05$) difference between grass carp and giant gourami. However, the proportion of ponds supporting vector breeding was significantly lower in monoculture ponds either with grass carp ($z=122.94$; $p < 0.05$) or giant gourami ($z=-39.61$; $p < 0.05$) when compared to polyculture with grass carp. Food fishes such as *C. carpio* in combination with other larvivorous fishes have been shown to reduce the breeding of malaria vectors in rice fields (Ruddle, 1982; Nalim *et al.,* 1988).

The maximum growth rate at the end of one year was observed with *C. idella,* followed by *C. catla, C. mrigala, L. rohita, C. carpio, O. goramy* and *L. fimbriatus* (Table 2). The survival rate was maximum in *L. rohita* (36.9%) and least in *C. carpio* (13.0%). The weight gained per year and survival rate for *C. idella* were 1087± 503 and 24.72% respectively when used under monoculture and the corresponding values were 1004±324 g and 28.75% when used along with other carps under polyculture.

Polyculture with grass carp was found to be effective in preventing reinfestation of weeds as well as reducing vector breeding in weed reinfested ponds. Herbivorous potential of grass carp and its use for the biological control of weeds have been well documented (Alikunhi and Sukumaran, 1964; Avault *et al.,* 1968; Dow, 1975) and the present field trial showed its role in reducing vector breeding also. Based on large scale evaluation, this fish has been recommended for mosquito control in rice growing areas (Shumkov *et al.,* 1981). Though monoculture either with grass carp or giant gourami has shown to be more effective in reducing weed reinfestation and vector breeding, polyculture with grass carp is recommended for the maximum utilization of pond ecosystem so as to get maximum fish yield, in addition to weed and vector control as by-products. This is evident from the present observation that ponds with polyculture including

Table 2. Growth rate and survival rate of different fish species at the end of one year

Fish species	Growth rate (g) ± S.D	Survival rate (%)
Catla catla	937 ± 460	15.6
Cirrhina mrigala	699 ± 364	16.6
Labeo rohita	656 ± 320	36.8
Cyprinus carpio	300 ± 364	13.0
L. fimbriatus	430 ± 206	26.4
Ctenopharyngodon idella	1087 ± 503	24.7
Osphronemus goramy	498 ± 153	60.0

grass carp, the average yield per pond of 100 m^2 was 13529±1797 g per year which is slightly higher than that of grass carp under monoculture (13435±3360 g). Similar observations of relatively higher yield from ponds with Indian and exotic carps when compared with fish culture using exotic varieties alone have been reported earlier. Further, local people prefer *C. catla* and *L. rohita* to grass carp. Attractive economic return from polyculture has made this programme well acceptable to the community of Shertallai region where there are about 75,000 domestic ponds, of them about 70% are suitable for fish culture.

Convinced by the multifarious gains (economic, nutritional and disease control) of composite fish culture, the National Bank for Agriculture and Rural Development (NABARD), has brought this programme under the purview of their activities. Through their bankable scheme, loans are made available to farmers for fish culture at the rate of Rs. 1,420/- per pond measuring about 100 m^2 surface area. The expected annual return from each pond is about Rs. 1,800/ (VCRC unpublished report).

Thus, it has been well demonstrated that the food fishes can play a very vital role in controlling vector mosquitoes of Malayan filariasis. Culture of food fishes in ponds was linked with bioenvironmental control of vectors of malaria undertaken in Gujarat (Gupta *et al.,* 1989). This programme has been reported to provide financial support to undertake various developmental activities which resulted in large scale elimination of breeding sites of malaria vectors. Since the benefits accruing to the society are multiple, the programme will be sustained in the community on a long term basis, making a major contribution towards total elimination of this disease which has gripped this endemic tract for centuries.

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REFERENCES

ALIKUNHI,K.H. and SUKUMARAN,K.K. 1964. Preliminary observations on Chinese carp in India. *Proc. Indian Acad. Sci.*, **60**, (B), 171.

AVAULT,J.M., SMITHERMAN,R.O. and SHELL, E.W. 1968. Evaluation of eight species of fish for aquatic weed control. *FAO Fish Rep.*, **44**, 109-122.

DOW,A.J. 1975. The use of fish for the biological control of aquatic vegetation. *Proc. of forty three Annual Conf. of California Mosquito Control Ass.*, 55-58.

GERBERICH, J.B. 1985 Update of annotated bibliography of papers relating to the control of mosquitoes by the use of fish for the year 1965-1981. *WHO/VBC*, **85**, 917

GUPTA,D.K., SHARMA,R.C. and SHARMA,V.P. 1989. Bio-environmental control of malaria linked with edible fish production in Gujarat. *Indian J. Malariol.*, **26**, 55-59.

KAHN,H.A. and SEMPOS,C.T. 1989. Statistical methods in Epidemiology. Oxford University Press, New York, p. 292.

LAKSHMANAN, M.V.A., SUKUMARAN, K.K., MURTY, D.S., CHAKRABORTY, D.P. and PHILIPOSE, M.T. 1971 Preliminary observations on intensive fish farming in fresh water ponds by the composite culture of Indian and exotic spices. *J.Inland Fish. Soc. India*, **2**, 1-21.

NALIM,S., TRIBOEWONO,D., HELIMAN,A. and WINOTO,E. 1988. Control demonstrations of the rice field breeding mosquito, *Anopheles aconitus* Donitz in Central Java using *Poecilia reticulata* through community participation. 3. Field trial and evaluation. *Bull. Penelit. Kesehat.*, **16**, 6-11.

PANICKER,K.N., SRINIVASAN,R., VISWAM,K. and RAJAGOPALAN,P.K. 1985. Larvivorous potential of some Cypriniformis fishes. *Indian J. Med. Res.*, **82**, 517-520.

PETR,T. 1987. Food fish as vector control strategy for their use. 7th annual meeting. *PEEM/7/WP/87*, 1-15.

RAJAGOPALAN,P.K., PANICKER,K.N., SABESAN, S., KRISHNAMOORTHY,K. and RAO,A.S. 1988. Control of *Brugia filariasis* in Shertallai, South India. Pre-control epidemiological observation. *Misc. Publ. Vector Control Res. Centre*, **7**, 1-18.

RUDDLE,K. 1982. Traditional integrated farming systems and rural development: the example of rice field fisheries in Southeast Asia 1982, *Agric. Administration*, **10**, 1-11.

SHUMKOV,M.A., MOTENKOV,YU., M., STARCHI KOV,A.V. and SHILENKO,YU.V. 1981. Large scale evaluation of the use of White Armur fry in biological control of mosquitoes in rice growing areas. *Meditsinskaya Parazitologiya Parazitarnye Bolenzi*, **52**, 34-38.

WORLD HEALTH ORGANIZATION. 1981 Informal consulttion on the use of fish for mosquito control *WHO/VBC*, **82**, 838, Geneva.