

Larvivoros Fish in Mosquito Control

Use of fish in mosquito control has been well-known for more than 100 years. In India, as far back in 1904 larvivoros fishes were used in Mumbai City for the control of malaria vector *An. stephensi*. Larvivoros fishes *Poecilia reticulata* (Guppy), a native of South America and *Gambusia affinis* (Gambusia), a native of Texas were imported in India in 1908 and 1928, respectively for the control of malaria vectors. Soon after that use of larvivoros fish became a common practice in India, e.g. in Bengaluru and Kolkata cities and during the construction of Sharda Canal in Uttarakhand. During mid-1980s National Institute of Malaria Research demonstrated the use of larvivoros fish as part of an integrated vector control strategy. Though use of larvivoros fish is an important component of vector control in the urban malaria schemes in India, use of larvivoros fish in control of rural malaria was shown for the first time in India.

Fish fauna surveys have been undertaken at different NIMR field units which revealed that there are several indigenous fish like *Danio rerio*, *Esomus danricus*, *Badis badis*, *Chanda nama*, *Puntius ticto*, *Rasbora daniconius*, *Colisa fasciata*, etc. which are commonly found in Indian fresh waters. These fish

were found to have significant larvivoros potential in various conditions. However, they either can not be mass produced or are not hard enough to withstand transportation, variation of water quality, turbidity and temperature. Also these fish produce smaller broods than the exotic fish.

During laboratory trials at Rourkela, Orissa, *Danio rerio* and *Oryzias melastigma* showed a high predatory efficacy against the mosquito larvae. A single tiny *Danio* fish (2.7–3.0 cm) consumed on an average 52 IV instar anopheline larvae per day, whereas *Oryzias* sp (2.5 cm) consumed 98 larvae per day. The results obtained during the trials in rice-field quadrates showed that both the fish are highly effective in reducing the density of mosquito immatures in the rice-fields. The reduction in density of III and IV instars and pupae became evident right from the beginning. On Day 6 *Danio* and *Oryzias* lowered the densities by 86.8 and 76.2% respectively.

Recently, in north Gujarat (Kutchh district) an indigenous fish *Aphanius dispar* was found in many water bodies such as in the rivulets, seepage waters of dams/check dams and ponds. As no previous study was done in India to evaluate its effectiveness in vector/malaria control, a randomised controlled trial



Danio rerio



Rasbora daniconius



Esomus danricus



Puntius sp.



Colisa fasciata



Poecilia reticulata (guppy)



Gambusia affinis



Mass production of Fish

was undertaken in Rapar taluka during 2005–07 with the objectives to assess the impact of *A. dispar* on malaria vector population, malaria prevalence, operational feasibility, social acceptance and sustainability of *A. dispar* under the vector-borne disease control programme. Results of the trial indicate that the fish is highly effective in malaria vector control and propagates very well in brackish water as well freshwater in the earthen and concrete irrigation tanks, wells where malaria vector *An. culicifacies* and *An. stephensi* breed profusely. Monitoring of the incidence of malaria by routine surveillance system and cross-sectional surveys indicated that the fish use was as effective as IRS. The SPR in the fish area was 1.4% compared to 1.6% in the IRS area (Fig. 62). The acceptance of fish by the native farming community was high.

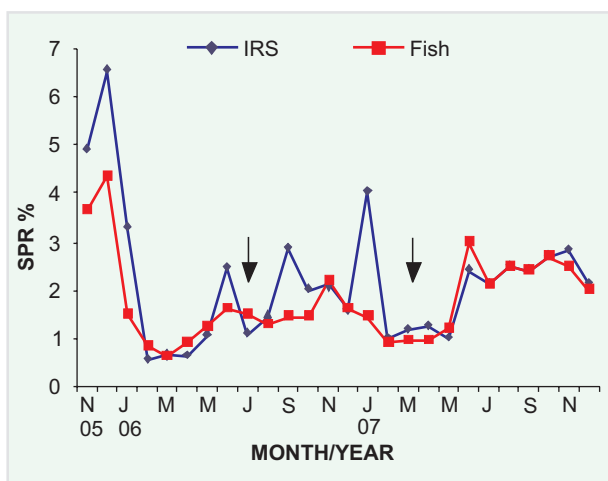


Fig. 62: Slide positive rate in *A. dispar* used and IRS villages in Rapar Taluka, Gujarat. Arrows indicate malathion spray in the control areas

Mass Production of Larvivorous Fish

Mass production of *P. reticulata* and *G. affinis* was undertaken for mosquito control programme as part of the bioenvironmental control of malaria at many places in India. Some innovative methods have been developed to reduce the cost of mass production and distribution of fish. A number of hatcheries for mass production were established and fish were transported to the villages where they were stocked and introduced in the mosquito breeding places from time-to-time.

Mass production of *G. affinis* was undertaken in

District Nainital in Uttarakhand and Districts Shahjahanpur and Allahabad in Uttar Pradesh. Big ponds were converted into fish hatcheries as well as new hatcheries were made. *G. affinis* were introduced into these ponds for multiplication. *G. affinis* breeds thrice in a year and within a year all the field units had good stocks. Similarly, large stocks of *P. reticulata* (Guppy) were established at Nadiad, Gujarat and BHEL, Hardwar. The fish from these stocks were used for mosquito control in various breeding sites like drains and underground tanks. Regular introduction and monitoring was undertaken.

Composite Fish Culture

Improvement of village economy by promoting local raw materials and natural resources was an important component of the programme. Carps are grown by the farmers all over and the adjoining areas of Haldwani, District Nainital, Uttarakhand. As a result of health education and personal discussions with fish farmers, it was possible to culture *Gambusia* along with carps. The tendency of *Gambusia* to remain near margins convinced farmers that this fish does not compete with edible fish for space and food. It was amply clear to the farmers that it eats mosquito larvae at the margins while carp fish is mainly herbivorous. Experiments on composite culture of the larvivorous fish along with food fish were carried out, which showed that guppies and *Gambusia* can be cultured without causing an adverse effect on the edible fish production, as well as generate income to the rural communities. Culture of *G. affinis* with food fish and *P. reticulata* was carried out at Nadiad and Shahjahanpur field units involving local fish farmers and village Panchayats.

In Nadiad, >50% village ponds were infested with water hyacinth. Water hyacinth was manually removed from these ponds and these important resources were used for fish production. *P. reticulata* (Guppy) along with the major carps was used in mixed cultures in four experimental ponds in Kheda district. An average annual yield of 847 kg/ha of carps in such ponds was comparable with 839 kg/ha of four other experimental ponds without guppies and there was no adverse effect on the population of food fish due to rearing of guppies with carps.

Culture of *Gambusia* along with carps in fish culture ponds in Shahjahanpur district showed very little change in the fish productivity—1539 kg/ha in

ponds with *Gambusia* and 1572 kg/ha in ponds without them. The growth and survival of *Gambusia* were found normal in most of the composite fish culture ponds. Using this technique, large-scale production of larvivorous fish for vector control could be achieved which helped the community to generate resources for the developmental activities in experimental villages. These studies showed that composite fish culture can yield double benefits of food fish production as well as the suppression of mosquitoes. Culture of larvivorous fish *G. affinis* and *P. reticulata* at village-level is very vital for the successful implementation of bioenvironmental control of vector borne diseases. This may be done with the active community participation under the technical guidance of malaria control agencies.

Operational Use of Larvivorous Fish

Suitable fish species and rate of application in different breeding habitats for the control of different mosquito vector species are shown in Table 2. Use of larvivorous fish for vector control is a simple, inexpensive, effective and local measure. Larvivorous fish has been accepted as a selective vector control method in the Enhanced Malaria Control Projects launched with World Bank financing in eight states of India since 1997. An independent assessment of the performance of the larvivorous fish programme as an integrated control measure was carried out in Ahmedabad City and in rural areas of Nagpur (Maharashtra) and Chhindwara (Madhya Pradesh) districts during 2003–04. The assessment included the status of development of fish resources, introduction of larvivorous fish and maintenance of hatcheries, methodologies adopted for producing fish



Larvivorous fish hatchery

stocks, transportation and distribution/release, available infrastructure and manpower, training needs, social acceptance and community perception. The impact of the larvivorous fish on the mosquito borne diseases and the sustainability of the larvivorous fish programme was also assessed. It was observed that the use of larvivorous fish in malaria



Training on collection of fish

Table 2. Suitable fish species and rate of application in different mosquito breeding habitats

Aquatic habitats	Main vector mosquito	Fish species	Number of fish to be released
Ponds/rain water pools	<i>An. culicifacies</i>	<i>Gambusia</i> and <i>Guppy</i>	10–20 fish/m ²
Water storage tanks, ornamental tanks, fountains, swimming pool and cisterns	<i>An. stephensi</i> , <i>Aedes</i> sp.	<i>Guppy</i> and <i>Gambusia</i>	5–10 fish/m ²
Wells	<i>An. stephensi</i>	<i>Guppy</i> and <i>Gambusia</i>	50–250 (For rapid control)
Paddy-fields	<i>An. culicifacies</i>	<i>Gambusia</i> , <i>Danio</i> , <i>Aplocheilus</i> , <i>Oryzias</i> and <i>Aphanius</i>	5000/acre
Farm ponds and check dams	<i>An. culicifacies</i>	<i>Gambusia</i> , <i>Aphanius</i> and <i>Aplocheilus</i>	25–50/m ²
Mine pits	<i>An. culicifacies</i>	<i>Gambusia</i> and <i>Guppy</i>	2500/acre (For immediate control)
Swamps	<i>Cx. quinquefasciatus</i>	<i>Guppy</i> , <i>Aplocheilus</i> , <i>Colisa</i> ,	10,000/acre
Drains	<i>Cx. quinquefasciatus</i>	<i>Guppy</i> and <i>Colisa</i>	

control programme has been taken up on operational scale with variable performance levels.

Currently, the use of larvivorous fish is in full swing to cover the entire states of Gujarat, Maharashtra and Karnataka. In Maharashtra, the bioenvironmental methods have been spread to cover the entire state through the primary health care system. In Gujarat, hundreds of fish hatcheries have been established for use in the entire state and training programmes are being organised in association with the National Institute of Malaria Research.

Cost-effectiveness

Although no specific studies have been conducted to evaluate comparative per capita cost of fish and insecticides under programmatic conditions. Some of the examples of integrated vector control using larvivorous fish were found very effective in controlling the breeding of malaria and dengue vectors in a variety of habitats (Fig. 63) in an urban setting. The per capita annual operational cost of the integrated strategy was Rs. 8.1 (US\$ 0.19; 2000 prices) compared as Rs. 9.3 (US\$ 0.21) with chemical control. The strategy was found feasible, appropriate, cost-effective and resulted in a major reduction in antimalarials and insecticide consumption in industrial complexes.

Future Plan

At present in India or elsewhere large-scale operational use of larvivorous fish for vector control

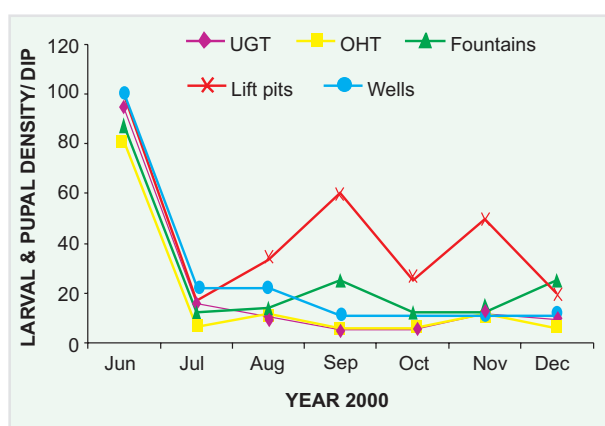


Fig. 63: Impact of the use of fish on mosquito breeding in selected larval habitats of an urban setting. UGT–Underground tanks; OHT–Overhead tanks

remains under exploited in situations where there is technical feasibility of use of fish as part of an integrated vector management approach. There is an urgent need to strengthen facility to impart operational training on operational aspects on larvivorous fish. Keeping in view of the increasing role of fish in vector borne disease control and training requirements of the personnel involved in antimalaria programme, NIMR has been in the process of supporting capacity strengthening of the National Vector Borne Disease Control Programme such as in Gujarat state to scale-up use of larvivorous fish including indigenous fish *A. dispar* in suitable ecosystems.

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