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Short Research Communications

Efficacy of *Aphanius dispar* (Rüppell) an indigenous larvivorous fish for vector control in domestic tanks under the Sardar Sarovar Narmada project command area in District Kheda, Gujarat

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Vector-borne diseases associated with construction of dams and network of irrigation canals have received considerable attention in the past and health impact assessments of such projects have also been conducted[1, 2]. Large-scale construction activities often bring about considerable ecological changes and create new mosquito breeding habitats. Moreover, increased supply of water may bring about an overall behavioural change in the community leading to enhanced water use and storage practices. This may result in enhanced risk of mosquito-borne diseases in the area[3, 4]. Sardar Sarovar project (SSP) on Narmada river in Gujarat is multipurpose water resources development project, the network of the canal aims to irrigate nearly 1.9 million ha of agricultural land and provide drinking water to nearly 110 cities and towns mainly located in the semi-arid areas of Gujarat and Rajasthan states in western India.

As a part of health impact assessment study and need of feasible and sustainable mosquito control measures in this area, feasibility of use of an indigenous larvivorous fish was undertaken in the command area of Kheda district during 2010–11. The efficacy of the common larvivorous fish species, viz. *Gambusia affinis* and *Poecilia reticulata* (Guppy) and some local fishes in different mosquito breeding habitats has been well-demonstrated[5–8]. In Kolar district, Karnataka, a study on the use of larvivorous fishes and its impact on malaria carried out during 1993–99 revealed a sharp reduction in malaria cases and annual parasite index (cases per 1000 population) came down to a very low level in 1999 as compared to the base year 1993 (reduction 99.8%, $p < 0.001$)[9]. It is well-recognized that the use of larvivorous fish for vector control is a simple, inexpensive and reasonably effective measure and it has been incorporated as a component in the National Vector Borne Disease Control Programme (NVBDCP) and used at large-scale in urban malaria control schemes (UMS) throughout the Gujarat state. It has also been advocated that the use of native fish should be given preference to avoid possible undesirable implications of introduction of exotic fish species. Therefore, an indigenous fish *A. dispar* found in natural saline water habitats on the coastal area of Gujarat[10] and can also survive in fresh waters was assessed for its efficacy in controlling mosquito breeding in domestic tanks. In July 2010, 15 villages in Kathlal taluka of Kheda district under SSP command area were surveyed to select suitable villages for the trial. Two villages, viz. Pithai and Anara, were selected owing to the similar conditions in respect of type of domestic tanks, water supply and water storage practices. The State Programme Officer (SPO), Chief District Health Officer (CDHO) and District Malaria Officer (DMO), Gujarat were informed about the need and significance of the trial and a written permission was obtained from the competent health authorities before initiating the trial. A meeting with the village head and other responsible persons was also conducted to brief them about the trial and seek their consent for releasing fishes in domestic tanks and further monitoring.

A baseline larval survey was carried out in both the villages in July 2010 and >100 houses in each village were checked. The domestic tanks were mainly cemented tanks constructed underground or above the ground for storage of clean tap water for washing clothes, utensils and bathing, etc. The size of the tanks ranged 1×1 to 2 × 3 m with an average depth of 1.5 m. All available water containers were listed and checked for mosquito breeding and recorded. The containers survey revealed very high larval indices in both the villages (Table 1). Overall, 80% houses were found positive for mosquito breeding.

Larval samples collected from each habitat were brought to the laboratory and adult emergence from each

Table 1. Details of domestic containers survey showing larval indices in the selected villages

Village	House		Containers		Habitat			Positive				Indices		
	Checked	Positive	Checked	Positive	Name	Nos.	Positive	*An.*	*Ae.*	*Cx.*	Mix	BI	HI	CI
Pithai	100	89	186	89	Tank	67	22	16	4	1	1			
					UGT	21	9	5	3	0	1			
					Kothi	92	56	4	52	0	0			
					Barrel	6	2	1	1	0	0			
					Total	186	89	26	60	1	2	60	89	47.84
Anara	103	88	131	109	Tank	41	39	31	6	0	2			
					UGT	7	6	4	2	0	0			
					Kothi	75	58	1	57	0	0			
					Barrel	8	6	0	6	0	0			
					Total	131	109	36	71	0	2	68.93	85.43	83.2

Kothi (big mud pot); UGT–Underground tank; *An.*– *Anopheles*; *Ae.* – *Aedes*; *Cx.*– *Culex*; BI– Breteau index; HI– House index; CI– Container index.

sample was recorded. *Anopheles stephensi*, *An. subpictus*, *Aedes aegypti* and *Ae. vittatus* were mainly found breeding in tanks in both the villages. In Pithai village *An. stephensi* (35.6%), *An. subpictus* (15.9%), *Ae. aegypti* (38%) and *Ae. vittatus* (10.3%) were found breeding in the tanks, whereas in Village Anara the percent composition of these mosquito species was 31.1, 14.4, 18.1 and 36.2 respectively. In both the areas mosquito breeding and species were comparable. The trial was initiated in December 2010 and monitoring was done for 12 months, i.e. up to November 2011. Randomly, one of the Village Pithai was selected for introduction of *Aphanius* fish in all the tanks and water containers, while Village Anara was chosen as control with routine intervention.

Fishes were collected from a natural habitat in a salt factory in Cambay (Khambhat). The fish introduction was carried out in Village Pithai in the months of November–December 2010. In a total of 295 water storage containers such as cement tanks including underground tanks (127), kothi (big mud pots) and barrels (167) *Aphanius* fishes were released @ 10–25 fishes/tank or per container, depending on the size of the container. These fishes were released only once during one year of study period. The cooperation and acceptance of fish release was amazing among the villagers except one instance where a house hold refused to accept the fish introduction probably due to religious reasons. The children were overwhelmed and showed special interest in fish release activity as some of them volunteered their participation and also took the fishes to put in their house tanks as their pets.

Larval density was measured with the help of standard dipper before the fish introduction. Further, immature density of I & II instar larvae, and III & IV instar larvae and pupae was recorded at weekly interval for four weeks followed by fortnightly taking the average of three dips. The survival of the fish and mosquito breeding was monitored in 30 containers in the experimental village and 25 in the control village. Reduction in III & IV instar larvae and pupae was calculated as per the formula given below[11].

$$\text{Percent reduction} = 100 - [(C_1 \times T_2)/C_2 \times T_1)] \times 100$$

Where, C_1 = Pre-release larval density in control tanks; C_2 = Post-release larval density in control tanks; T_1 = Pre-release larval density in fish tanks; and T_2 = Post-release larval density in fish tanks.

Data on reduction in III & IV instar larvae and pupae in experimental and control tanks post-fish introduction were subjected to statistical analyses applying the paired *t*-test. The survival of the fishes was recorded by monitoring presence of the fishes in the cement tanks and other containers. The presence of fishes was monitored with the help of a bright light torch. Fishes were easily visible even in the underground tanks with the help of the torch. In small containers such as kothi (big mud pots) and plastic barrels the presence of fishes sharply declined and within a fortnight >50% containers were found without fishes because of the frequent use and replenishment of the water in containers by the householders almost on daily basis. Therefore, only the cement tanks were included in the longitudinal monitoring to assess the efficacy of the fishes. The survival of fishes in cement tanks was >90% up to 120 days; >70% up to 225 days; and >50% up to 360 days. No fish food was provided to the fishes during the trial. The fishes might have survived for such a long period by feeding on mosquito larvae and the algal mass deposited on the inner walls of the cement tanks.

The reduction in the density of III–IV instar larvae and pupae of *An. stephensi* and *Ae. aegypti* in tanks dur-

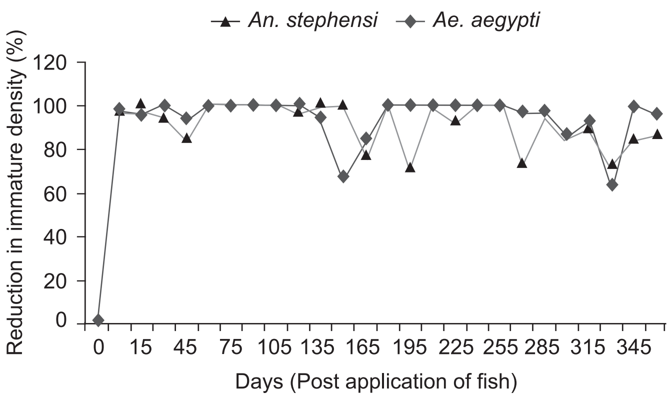

Fig. 1: Percent reduction in III–IV instar larvae and pupae of *An. stephensi* and *Ae. aegypti* in domestic water storage containers post-application of *A. dispar*.

ing the study period is shown in Fig. 1. The impact of *Aphanius* fish on the larval density in experimental tanks was highly significant (p <0.001) relatively to the control tanks for both the vector species, viz. *An. stephensi* and *Ae. aegypti*. Fishes successfully devoured all the larval stages and pupae of *Anopheles* and *Aedes*. Earlier, *Aphanius* fish has been reported suitable for different natural and man-made mosquito breeding habitats. Natural occurrence and capability of *A. dispar* to control the mosquito breeding in shallow channels had also been reported near Riyadh, Saudi Arabia[12]. In an urban area in Djibouti *A. dispar* has been found capable of effectively suppressing the breeding of *An. arabiensis* and *An. gambiae* up to 97% in wells, cisterns, barrels and containers[13]. In another report *A. dispar* has been reported to suppress the breeding of *An. culicifacies adenensis* in wells and containers in Ethiopia[14]. Five indigenous fish species tested for the control of *Ae. aegypti* in water storage tanks were found highly effective in bringing down the experimental container index to zero as compared to control tanks with a mean value of 89 ± 9.6 in southern Mexico[15]. In a comparative study in the villages of Karnataka with outbreak of chikungunya on the efficacy of two exotic fish species, viz. *P. reticulata* and *G. affinis* in indoor cement tanks against *Ae. aegypti* and *P. reticulata* exhibited greater survival rate than *Gambusia* and found most effective in conjugation with the information, education and communication (IEC) campaigns in controlling the outbreak of the disease[16].

In the present study the reduction in larval and pupal density varied between 84 and 100% in the case of *An. stephensi* and 94 and 100% in *Ae. aegypti* up to 120 days. Thereafter, range of the reduction was recorded 71 to 100% in the case of *An. stephensi* and 63 to 100% in *Ae. aegypti* during the rest of the period of investigation. It was also observed that even a survival of 2–5 fishes per tank was enough to reduce 100% mosquito breeding in the cement tanks. In an earlier study on the efficacy of *A. dispar* in industrial tanks mainly breeding for *An. stephensi* revealed that there was 93% reduction in larval density in the experimental fish tanks on Day 3 and 98% on Day 21 (p <0.001) as compared with control tanks[10]. Under the laboratory conditions *A. dispar* was more successful than *Gambusia* in preying upon the III & IV instar larval and pupal stages of mosquitoes, and *G. affinis* and *A. dispar* can complement each other as mosquito control agents in different habitat conditions[17]. In accordance with the above mentioned studies, our findings also conform that *A. dispar* is capable of controlling vector mosquito propagation in confined water bodies.

The conventional larvicides are used under the National Vector Borne Disease Control Programme—an application of Temephos 1 ppm per litre is being done for larval control of the vector mosquitoes on weekly basis in domestic containers and potable waters. Different formulations of biolarvicides for larval control have also been found effective in clean and polluted waters for 10–15 days. The use of exotic larvivorous fishes (*G. affinis* and *P. reticulata*) and a few other locally available fish species (*Aphanius, Oreochromis, Fundulus* and other Killi fishes) had been successfully field-tested and utilized against vector mosquito in a variety of situations and have been found self-sustainable for longer periods. Thus, to avoid repeated application of conventional larvicides, use of *A. dispar* can provide a local solution for the management of vector control in confined waters for a longer period. Our experience showed that this fish can easily be mass-reared in cement as well as mud tanks/pits with some aquatic vegetation.

In conclusion, the findings of the present study indicate that *Aphanius* fish has the potential to contain the breeding of vector mosquitoes, viz. *An. stephensi* and *Ae. aegypti* in domestic tanks without re-application during a calendar year. However, fishes were not found sustainable in kothi (big mud pots) and plastic barrels for longer duration. These containers should be kept properly covered to avoid mosquito breeding. The *Aphanius* fish is available in abundance in the coastal area of Gujarat and can be used as efficient tool to control mosquito breeding in domestic tanks and to meet the challenge of enhanced water use and storage practices especially in command area of the Sardar Sarovar Narmada project and coastal districts of Gujarat.

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