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Larvivorous Fish in Mosquito Control: Efficacy, Ecological Risks, and Sustainable Alternatives

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Abstract

Mosquito-borne diseases such as malaria, dengue, chikungunya, and filariasis remain significant public health challenges in tropical countries, including India. Biological control using larvivorous fishes has been implemented worldwide for over a century as an alternative to chemical insecticides. Among these, the mosquito-fish (*Gambusia affinis*) and guppy (*Poecilia reticulata*) are the most widely introduced species. This review examines their effectiveness in mosquito larval control, ecological consequences, and implications for biodiversity and public health. Evidence demonstrates that while these species significantly reduce mosquito larvae in controlled and semi-natural environments, their invasive nature has led to severe ecological disruption, including predation on native fish and amphibians, alteration of aquatic food webs, and transmission of parasites. The World Health Organization discontinued its recommendation for *Gambusia* in 1982 due to ecological risks. Alternative strategies, including the use of indigenous larvivorous fishes and invertebrate predators, may offer safer and more sustainable solutions. This review highlights the urgent need for stricter policies to prevent further introduction of invasive fish species and to promote indigenous alternatives for integrated vector management.

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Introduction

Mosquitoes are spreading diseases at an accelerating rate due to climate change. Rising temperatures and increased humidity have created ideal conditions for mosquito breeding and survival. According to the World Health Organization (WHO, 2024), more than 500 million people are affected by mosquito-borne diseases each year globally. In India, mosquito bites lead to illness in approximately 40 million people annually (Golechha, 2015).

In response to this growing public health concern, biological methods of mosquito control have gained attention. One such method involves the use of larvivorous fish species, including *Gambusia affinis* (mosquito fish) and *Poecilia reticulata* (guppy fish). *Gambusia affinis*, native to the southeastern United

States, was first introduced to India by the British in 1928 as a component of malaria control strategies. Similarly, *P. reticulata*, native to regions in South America and the Caribbean, has been widely used for mosquito control around the world for over a century, including in India through initiatives like the Urban Malaria Scheme (WHO, 2009).

These fish are deployed primarily in stagnant water bodies—such as drains, ponds, and rice fields—where they feed on mosquito larvae. Several Indian states, including Karnataka, Assam, Arunachal Pradesh, Gujarat, Maharashtra, Rajasthan, Tamil Nadu, Uttar Pradesh, Andhra Pradesh, Odisha, and Punjab, have adopted this method as part of vector control programs. However, while the use of *Gambusia* and *Poecilia* was initially well-intentioned, their introduction has raised serious ecological concerns. According to Pritchard Cairns *et al*. (2024), these species have caused significant disruptions to aquatic ecosystems. *Gambusia* is now listed by the International Union for Conservation of Nature (IUCN) as one of the world's 100 worst invasive alien species (Lowe *et al*., 2000).

Larvivorous Fish in Malaria Control

The use of larvivorous fish has been an integral part of mosquito and malaria control programs in many countries since the early 20th century (Gratz and Pal, 1988). Research has confirmed the efficacy of *Gambusia* in significantly reducing mosquito larvae populations in rice fields and stagnant water (Menon and Rajagopalan, 1978; Chandra *et al*., 2008; Haq and Yadav, 2003). Prasad *et al*. (1993) reported over 87% reduction in mosquito larvae following the introduction of *Gambusia* in paddy fields.

Globally, the introduction of *Gambusia* began in 1905 in Camden, England (Singh and Gupta, 2016), and spread across Europe by 1921. In India, there are varying accounts of its introduction—some report its arrival in 1914 from Italy and again in 1930 from Siam, while others cite a 1928 introduction by B. A. Rao under the Urban Malaria Scheme (Ghosh *et al*., 2012; Singh and Gupta, 2016).

In Karnataka, Ghosh *et al*. (2012) observed a notable reduction in malaria cases where *Gambusia* and *Poecilia* were introduced. However, studies have also shown that running water and agricultural runoff reduce the efficacy of *Gambusia* as a mosquito predator (Reddy and Pandian, 1974). Insecticides like profenofos and chlorpyrifos further compromise their survival (Rao *et al*., 2005; 2006), while dense aquatic vegetation limits their access to larvae.

Ecological Impacts of Invasive Species

Both *Gambusia affinis* and *Poecilia reticulata* are considered invasive species in India. Their introduction has resulted in significant ecological imbalances, primarily due to their aggressive feeding and reproductive behavior (Deacon *et al*., 2011). These species disrupt native food webs and outcompete indigenous aquatic fauna.

In Australia, mosquito fish contributed to the extinction of native species such as the red-finned blue-eye (Kerezsy *et al*., 2013). Similar ecological impacts have been reported in New Zealand. In India, native amphibians like *Microhyla* tadpoles have declined in habitats where *Gambusia* was introduced (Raja and Ravikanth, 2020). Several experimental studies have documented reductions in rotifers, crustaceans, odonate larvae, and native fish in the presence of *Gambusia* (White and Pyke, 2011; Rowe *et al*., 2008).

In some cases, *Gambusia* have injured native fish through fin-nipping, increasing their susceptibility to infections and eventual death (Raghavan *et al*., 2008). They also feed on zooplankton, causing phytoplankton blooms by disrupting ecological balance (Pyke, 2008). Their presence in Nainital Lake was found to significantly alter planktonic communities, leading researchers to recommend their removal (Singh, 2013).

Human Health Concerns

If consumed, mosquito fish contaminated by environmental pollutants can pose a risk to human health. *Gambusia* can bioaccumulate toxins such as heavy metals, pesticides, and microplastics in their tissues, which may then enter the human food chain (Jakšić *et al*., 2008; Annabi *et al*., 2011). These pollutants are known to cause serious health issues, highlighting the potential unintended consequences of using such species for biological control.

Vector-Borne Diseases and Biological Control

Vector-borne diseases like malaria, dengue, chikungunya, Japanese encephalitis, kala-azar, and filariasis continue to pose major public health threats in India. Climate change is expected to increase the incidence of these diseases. Biological methods, especially those involving mosquito larvae predators, are being promoted to reduce mosquito populations and interrupt disease transmission cycles.

Effectiveness of Guppy Fish

Poecilia reticulata, also known as guppy fish, is widely recognized for its adaptability and resilience. Originating from Central and South America, guppies are now common in Indian water bodies. They thrive in various environments, reproduce rapidly, and are easy to transport and release. Female guppies can store sperm and produce offspring without repeated mating, making them effective colonizers.

Although guppies consume up to 100 mosquito larvae per day, their overall mosquito control efficacy is lower than that of *Gambusia*. Guppies prefer the water surface and may require vegetation for juvenile survival due to their cannibalistic tendencies. Laboratory studies show promise (Seng *et al*., 2008), but field results vary. Their effectiveness can be influenced by alternative prey availability and environmental conditions (Saha *et al*., 2020).

The study conducted by Rajnikant *et al.* (2019) through a series of experiments, showed that the *G. affinis* was the best predator of the larvae of *Anopheles stephensi* breeding in overhead tanks. Control of mosquito breeding in rice fields through fish seemed to be promising. According to Tabibzadeh *et. al.,* (1970), when rice fields had been stocked with 250 to 750 *G. affinis* per hectare, there was a 95% and a 40% reduction in the immature density of *An. freeborni* and *An. pulcherrimus* respectively. In similar experimental conditions, Das & Prasad (1991) evaluated the mosquito control potential of *G. affinis* in the rice fields in Shahjahanpur district of Uttar Pradesh, India with the stocking rate of 5 fish/sq.m. In a study performed by Prasad *et. al*., (2003) reported that the *G. affinis* survived well in submerged rice fields and provided 87.8% mosquito larval control in Shahajahanpur district, Uttar Pradesh.

Using biological control agents is preferable to chemical insecticides for mosquito reduction in wetlands, temporary pools and rice fields, as it minimizes harm to aquatic life and biodiversity. Several aquatic insects including dytiscid beetles (like *Colymbetes* and *Rhantus* species) (Lundkvist *et. al.,* 2003; Von Kögel, 1987; Aditya *et. al*., 2006; Aditya and Saha, 2006), odonate naiads (Chatterjee *et. al*., 2007; Mandal *et. al*., 2008), and hemipteran bugs (Aditya *et. al.,* 2004, Saha *et. al.*, 2007a, Saha *et. al*., 2007b), show promise as biological mosquito control agents (Kumar and Hwang, 2006; Mogi, 2007; Voyadjoglou *et. al.,* 2007). While larvivorous fish like *Gambusia affinis* (mosquito fish) and *Poecilia reticulata* (guppy) are also effective, their invasive nature can negatively impact native fish populations and even affect the abundance of other mosquito predators and food sources (Rehage *et. al*., 2005; Manna *et. al*., 2008). This potential for ecological disruption necessitates careful consideration when introducing these fish (Hurlbert *et. al*., 1972; Hurlbert and Mulla, 1981; Bence, 1988; Blaustein and Karban, 1990; Blaustein, 1992).

However, many studies have challenged the effectiveness of using guppies to control mosquitoes (El-Sabaawi *et. al.,* 2016). While laboratory studies show their effectiveness in controlling mosquito larvae, these are done under controlled conditions and may not reflect the reality about the efficiency of guppies in controlling mosquito larvae in actual conditions. Laboratory studies are undertaken under certain preconditions that include starving the animals before any feeding experiment which can lead to an artificial increase in their mosquito control efficiency.

In a multi prey system, guppies do not show preference for mosquito larvae, sometimes preferring other prey items over the larvae. Hence their introduction would become conditional on where they are released. Indian researchers have also shown that the rate of consuming the larvae can alter based on its body size besides alternative prey items (Saha *et. al.,* 2020).

Despite their benefits, guppies pose ecological risks. They are aggressive, invasive, and feed on various native species, leading to biodiversity loss (Sasanami *et. al.*, 2021). Some unpublished observations from Maharashtra suggest a decline in microcrustacean diversity in water bodies where guppies are present. Their ability to survive in polluted waters and reproduce rapidly makes them a high-risk species for freshwater ecosystems (Deacon and Magurran, 2016).

Comparative Analysis of Larvivorous Fish

The advantages and disadvantages of exotic (*Gambusia*, *Poecilia*) and indigenous larvivorous fish are summarized in Table 1.

Table.1 Comparison of Larvivorous Fish Species Used in Mosquito Control

Feature	***Gambusia affinis* (Mosquito fish)**	***Poecilia reticulata* (Guppy fish)**	**Indigenous species (e.g., *Aplocheilus spp.*, *Puntius spp.*, *Colisa spp.*, *Anabas testudineus*, *Clarias batrachus*)**
Origin	Southeastern USA	South America & Caribbean	Native to India
Larval consumption	100–300 larvae/day (field-dependent)	~100 larvae/day (lab); lower in field	Variable; effective in local habitats
Habitat preference	Stagnant/slow-moving waters	Surface waters; tolerate varied environments	Wetlands, rice fields, irrigation canals, ponds
Reproduction	Live-bearer; prolific breeder	Live-bearer; females store sperm, rapid colonization	Seasonal, moderate reproduction
Advantages	Highly effective larval predator; hardy	Adaptable; easy to breed and transport	Ecologically compatible; maintain food web balance
Limitations	Poor efficacy in running water; sensitive to insecticides; cannibalistic	Variable field success; cannibalistic; prefers surface	Some species seasonal; need habitat-specific selection
Ecological impact	Highly invasive; outcompetes natives; fin-nipping; alters plankton communities	Invasive; reduces microcrustaceans; biodiversity loss	Low risk; sustain ecosystem integrity
Conservation concern	Listed as one of world's 100 worst invasive species (IUCN)	Considered invasive in India	Support biodiversity; safer for ecosystems

Alternative Approaches

Given the ecological risks associated with *Gambusia* and *Poecilia*, scientists recommend using indigenous larvivorous fish such as *Aplocheilus* spp., *Puntius* spp., and *Colisa* spp., which naturally inhabit Indian wetlands, rice fields, and irrigation canals (Chandra *et al*., 2008). Other natural mosquito predators—such as aquatic bugs, beetles, odonate nymphs, and crustaceans like *Triops*—also show promise (Mogi, 2007). These native species pose less ecological threat and maintain the balance of freshwater ecosystems.

Indigenous fish species have been employed for mosquito control in various parts of the world (Morton *et. al*., 1988; Neng *et. al*., 1987; Wu *et. al*., 1991; Yu, 1986; Yu and Kim, 1993; Kim *et. al*., 1994; Martinez-Ibarra *et. al*., 2002; Hurst *et. al*., 2006; Marti *et. al*., 2006). These fish often offer the dual benefit of reducing mosquito populations while simultaneously contributing to aquaculture (Menon, 1991; Sharma and Ghosh, 1994; Walton, 2007; Chandra *et. al*., 2008). Genera like *Puntius*, *Ambylopharyngodon*, and *Colisa* commonly found in irrigation canals and rice fields (Bambaradeniya *et. al*., 2004; Chandra *et. al*., 2008), naturally feed on mosquito larvae, making them ideal candidates for mosquito control and rice paddy fish culture. Furthermore, these indigenous fish often exhibit superior predatory capabilities compared to insect predators in larger larval habitats (Aditya *et. al*., 2004; Aditya and Saha, 2006; Chandra *et. al*., 2008).

Experimental studies have also explored the mosquito control potential of indigenous air-breathing fish such as *Anabas testudineus* (climbing perch), *Clarias batrachus* (walking catfish), and *Heteropneustes fossilis* (stinging catfish). These species are hardy, tolerate low oxygen levels, and are suitable for use in rice paddies and temporary pools (Talwar and Jhingran, 1991; Daniels, 2000). Their use could offer a sustainable and ecologically safer approach to mosquito control.

Conclusion and Recommendations

Despite being officially listed as invasive by the National Biodiversity Authority (Sadilyan, 2018), *Gambusia* continues to be introduced into Indian water bodies without sufficient ecological risk assessment. Its widespread presence and unregulated use have raised concerns about long-term ecological damage. Immediate action is needed to stop further introductions, monitor affected ecosystems, and develop national policies for ecological restoration.

Promoting the use of native larvivorous species could offer a balanced solution—combining mosquito control with biodiversity conservation. Comprehensive studies and coordinated policy implementation are essential to ensure sustainable, effective, and ecologically responsible mosquito management strategies in India.

References

Aditya, G., Ash, A., Saha, G.K., 2006. Predatory activity of *Rhantus sikkimensis* and larvae of *Toxorhynchites splendens* on mosquito larvae in Darjeeling. *Indian Journal of Vector Borne Diseases* 43, 66–72.

Aditya, G., Bhattacharyya, S., Kundu, N., Kar, P.K., Saha, G.K., 2007. Predatory efficiency of the sewage drain inhabiting larvae of *Toxorhynchites splendens* Wiedemann on *Culex quinquefasciatus* Say and *Armigeres subalbatus* (Coquillet) larvae. *Southeast Asian Journal of Tropical Medicine and Public Health* 38, 799-807.

Aditya, G., Bhattacharyya, S., Kundu, N., Saha, G.K., Raut, S.K., 2004. Predatory efficiency of the water bug *Sphaerodema annulatum* on mosquito larvae (*Culex quinquefasciatus*) and its effect on adult emergence. *Bioresource Technology* 95, 169–172.

Aditya, G., Saha, G.K., 2006. Predation of the beetle *Rhantus sikkimensis* (Coleoptera: Dytiscidae) on the larvae of *Chironomus Meigen* (Diptera: Chironomidae) of the Darjeeling Himalayas of India. *Limnologica* 36, 251–257.

Annabi, A., Messaoudi, I., Kerkeni, A. and Said, K., 2011. Cadmium accumulation and histological lesion in Mosquito fish (*Gambusia affinis*) tissues following acute and chronic exposure. *International Journal of Environmental Research*, *5*(3), pp.745-756.

Bence, J.R., 1988. Indirect effects and biological control of mosquitoes by mosquito fish. *Journal of Applied Ecology* 25, 505–521.

Blackburn, T.M., Pyšek, P., Bacher, S., Carlton, J.T., Duncan, R.P., Jarošík, V., Wilson, J.R. and Richardson, D.M., 2011. A proposed unified framework for biological invasions. *Trends in ecology & evolution*, *26*(7), pp.333-339.

Blaustein, L., Karban, R., 1990. Indirect effects of the mosquito fish *Gambusia affinis* on the mosquito *Culex tarsalis*. *Limnology and Oceonography* 35, 767–771.

Chandra G, Bhattacharjee I, Chatterjee SN and Ghosh A. 2008. Mosquito control by larvivorous fish. *Indian. J Med Res*; 127:13–27

Chatterjee, S.N., Ghosh, A., Chandra, G., 2007. Eco-friendly control of mosquito larvae by *Brachytron pratense* nymph. *Journal of Environmental Health* 69, 44-48.

Das MK, Prasad RN. 1991. Evaluation of mosquito fish *Gambusia affinis* in the control of mosquito breeding in rice fields. *Indian J Malariol*; 28: 171–177

Deacon AE, Ramnarine IW, Magurran AE. 2011 How reproductive ecology contributes to the spread of a globally invasive fish. PLoS ONE 6, e24416. http://dx.doi.org/10.1371/journal.pone.0024416

El-Sabaawi RW, Frauendorf TC, Marques PS, Mackenzie RA, Manna LR, Mazzoni R, Phillip DAT, Warbanski ML, Zandona` E. 2016 Biodiversity and ecosystem risks arising from using guppies to control mosquitoes. *Biol. Lett.* 12: 20160590. http://dx.doi.org/10.1098/rsbl.2016.0590

Ghate, H. V. and Padhye, A. D. 1988. Predation of Microhyla tadpoles by Gambusia. *J. Bombay Nat. Hist. Soc.* 85, pp. 200–201.

Ghosh, S. K., Tiwari, S. and Ojha, V. P. 2012. A renewed way of malaria control in Karnataka, South India. *Front. Physiol.* 3, 194.

Gillespie, G. and Hero, J. M. 1999. Potential impacts of introduced fish and fish translocations on Australian amphibians – declines and disappearances of Australian frogs. *Environment Australia*, Canberra, Australia. pp. 131–144.

Golechha, M., 2015. Healthcare agenda for the Indian government. *Indian Journal of Medical Research*, *141*(2), pp.151-153.

Gratz NG, Pal R. 1988. Malaria vector control: larviciding. In: Wernsdorfer WH, McGregor I, editors. Malaria: Principles and practice of malariology. Edinburgh, UK: Churchill Livingstone; 1213–26.

Güner, U., 2010. Bioaccumulation of cobalt in mosquito fish (*Gambusia affinis* baird & girars, 1853) at different flow rates and concentrations. *Journal of Fisheries Sciences. com*, *4*(1), p.20.

Hamed Mousavi-Sabet, Hoda Azimi, Soheil Eagderi, Sepideh Bozorgi, Bagher Mahallatipour, 2014. Growth and morphological development of guppy *Poecilia reticulata* (Cyprinodontiformes, Poeciliidae) larvae. *Poeciliid Research* (4:1)

Haq S, Yadav RS. 2003. Developing larvivorous fish network for mosquito control in urban areas: A case study. ICMR Bull; 33: 69–73.

Hurlbert, S.H., Mulla, M.S., 1981. Impacts of mosquito fish (*Gambusia affinis*) predation on plankton communities. *Hydrobiologia* 83, 125–151.

Hurlbert, S.H., Zedler, J., Fairbanks, D., 1972. Ecosystem alteration by mosquito fish (*Gambusia affinis*) predation. *Science* 175, 639–641.

Ingale, D.S. and Charjan, A.P., 2010. Impact of artificial and natural food on the length, weight and fecundity of *Poecillia reticulata*. *Biosci. Biotech. Res. Comm*, *3*(2), pp.195-199.

Jakšić, Ž., Hamer, B., Landeka, N. and Batel, R., 2008. Western mosquitofish as a bioindicator of exposure to organochlorine compounds. *Ecotoxicology and environmental safety*, *71*(2), pp.426-435.

Kerezsy, A. and Fensham, R., 2013. Conservation of the endangered red-finned blue-eye, Scaturiginichthys vermeilipinnis, and control of alien eastern gambusia, *Gambusia holbrooki,* in a spring wetland complex. *Marine and Freshwater Research*, *64*(9), pp.851-863.

Kharat, S., Dahanukar, N., Raut, R. and Mahabaleshwarkar, M. 2003. Long-term changes in freshwater fish species composition in north Western Ghats, Pune district. *Curr. Sci*. 84, 816–820.

Kim,H.C., Kim, M.S.,Yu,H.S., 1994. Biological control of vector mosquitoes by the use of fish predators, *Morocooxy cephalus* and *Misgurnusanguilli caudatus* in the laboratory and semifield rice paddy. *Korean Journal of Entomology* 24,269–284

Knight, J. D. M. 2010. Invasive ornamental fish: a potential threat to aquatic biodiversity in peninsular India. *J. Threat. Taxa*. 2, 700–704.

Kumar, R., Hwang, J.-S., 2006. Larvicidal efficiency of aquatic predators: a perspective for mosquito biocontrol. *Zoological Studies* 45, 447–466.

Kumar, R., Rao, R., 2003. Predation on mosquito larvae by *Mesocyclops thermocyclopoides* (Copepoda: Cyclopoida) in presence of alternate prey. *International Review of Hydrobiology* 88, 570–581.

Lawal, M.O., Edokpayi, C.A. and Osibona, A.O., 2012. Food and feeding habits of the guppy, *Poecilia reticulata*, from drainage canal systems in Lagos, Southwestern Nigeria. *West African Journal of Applied Ecology*, *20*(2), pp.1-9.

Lowe, S., Browne, M., Boudjelas, S. and De Poorter, M., 2000. 100 of the world's worst invasive alien species: a selection from the global invasive species database (Vol. 12, p. 12). Auckland: Invasive Species Specialist Group.

Lundkvist, E., Landin, J., Jackson, M., Svensson, C., 2003. Diving beetles (Dytiscidae) as predators of mosquito larvae (Culicidae) in field experiments and in laboratory tests of prey preference. *Bulletin Entomological Research* 93, 219–226.

Mandal, S.K., Ghosh, A., Bhattacharjee, I., Chandra, G., 2008. Biocontrol efficiency of odonate nymphs against larvae of the mosquito, *Culex quinquefasciatus* Say, 1823. *Acta Tropica* 106, 109–114.

Manna, B., Aditya, G., Banerjee, S., 2008. Vulnerability of the mosquito larvae to the guppies (*Poecilia reticulata*) in the presence of alternative preys. *Journal of Vector Borne Diseases* 45, 200–206.

Marti, G.A., Azpelicueta, M.M., Tranchida, M.C., Pelizza, S.A., Garcia, J.J., 2006. Predation efficiency of indigenous larvivorous fish species on *Culex pipiens L.* larvae (Diptera: Culicidae) in drainage ditches in Argentina. *Journal Vector Ecology* 31, 102–106.

Martinez-Ibarra, J.A., Guillen, Y.G., Arredondo-Jimenez, J.I., Rodrigu-Lopez, M.H., 2002. Indigenous fish species for the control of *Aedes aegypti* in water storage tanks in Southern Mexico. *BioControl* 47, 481–486.

Menon PKB, Rajagopalan PK. 1978. Control of mosquito breeding in wells by using *Gambusia affinis* and *Aplocheilus blochii* in Pondicherry town. *Indian J Med Res;* 68: 927–33.

Menon, A.G.K., 1991. Indigenous Larvivorous Fishes of India. NIMR, New Delhi, India.

Mogi, M., 2007. Insect and other invertebrate predators. *Journal of the American Mosquito Control Association* 23 (Suppl. 2), 93–109.

Morton, R.M., Beumer, J.P., Pollock, B.R., 1988. Fishes of a subtropical Australian salt marsh and their predation upon mosquitoes. *Environmental Biology of Fishes* 21, 185–194.

NCVBDC.2025. report on Guidelines on the use of larvivorous fish for vector control. https://ncvbdc.mohfw.gov.in/WriteReadData/l892s/Guidelines%20for%20use%20of%20larvivorus%20fish.pdf accessed 25.02.2025

Neng, W., Shusen, W., Guangxin, H., Rongman, X., Guangkun, T., Chen, Q., 1987. Control of *Aedes aegypti* larvae in household containers by Chinese cat fish. Bulletin of the World Health Organization 65, 503–506.

Pethiyagoda, P.D.R.S., De Alwis, S.M.D.A.U. and De Silva, B.G.D.N.K., 2021. Food and feeding habits of wild guppy (*Poecilia reticulata*), in natural water bodies of Sri Jayewardenepura canal system, Sri Lanka.

Prakash P, Gnanaprakasam P, Emmanuel R, Arokiyarajb S, Saravanan M. 2013. Green synthesis of silver nanoparticles from leaf extract of *Mimusops elengi*, Linn. for enhanced antibacterial activity against multi drug resistant clinical isolates. *Coll Surf B Biointerfaces*; 108: 255–259.

Prasad H, Prasad RN, Haq S. 1993. Role of biological agents for the control of mosquito breeding through *Gambusia affinis* in rice fields. *Indian J Malario*. 30: 57–65.

Praveenraj, J., Praveena, P. E., Bhuvaneswari, T., Krishnan, A. N. and Jithendran, K. P., 2018. Experimental infection of Betanoda virus in freshwater fish *Gambusia affinis* (Baird and Girard, 1853) – a potential infection model for viral encephalopathy and retinopathy. *Aquacult. Int.*, 26, 617–627

Pritchard Cairns, J., de Bragança, P.H.N. and South, J., 2024. A systematic review of poeciliid fish invasions in Africa. *BMC Ecology and Evolution*, *24*(1), p.136.

Pyke, G. H., 2008. Plague minnow or mosquito fish? A review of the biology and impacts of introduced Gambusia species. *Annu. Rev. Ecol. Evol. Syst.* 39, 171–191.

Raghavan, R., Prasad, G., Anvar-Ali, P. H. and Pereira, B. 2008. Exotic fish species in a global biodiversity hotspot: observations from River Chalakudy, part of Western Ghats, Kerala, *India. Biol. Invasions.* 10, 37–40.

Raja, M.N. and Ravikanth, G., 2020. The enemy of my enemy is still my enemy. *Current Science*, *119*(11), pp.1752-1759.

Rajnikant, Pandey SD, Sharma SK. 1996. Role of biological agents for the control of mosquito breeding in rice fields. *Indian J Malariol*; 33: 209–15.

Rao, J. V., Begum, G., Jakka, N. M., Srikanth, K. and Nageswara Rao, R. 2006. Sublethal effects of profenofos on locomotor behavior and gill architecture of the mosquito fish, *Gambusia affinis*. *Drug Chem. Toxicol.* 29, 255–267.

Rao, J. V., Begum, G., Pallela, R., Usman, P. and Rao, R. 2005. Changes in behavior and brain acetylcholinesterase activity in mosquito fish, *Gambusia affinis* in response to the sub-lethal exposure to chlorpyrifos. *Int. J. Environ. Res. Public Health*. 2, 478–483.

Reddy, S. R. and Pandian, T. J. 1974. Effect of running water on the predatory efficiency of the larvivorous fish *Gambusia affinis*. *Oecologia*, , 16, 253–256.

Reynolds, S. J. 2009. Impact of the introduced poeciliid *Gambusia holbrooki* on amphibians in southwestern Australia. *Copeia*. 296–302.

Rowe, D. K., Moore, A., Giorgetti, A., Maclean, C., Grace, P., Wadhwa, S. and Cooke, J. 2008. Review of the impacts of Gambusia, redfin perch, tench, roach, yellowfin goby and streaked goby in Australia. Draft report prepared for the Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra, Australia.

Saha, N., Aditya, G., Bal, A., Saha, G.K., 2007a. A comparative study of predation of three aquatic Heteropteran bugs on *Culex quinquefasciatus* larvae. *Limnology* 8, 73–80.

Saha, N., Aditya, G., Bal, A., Saha, G.K., 2007b. Comparative studies on functional response of common heteropteran bugs of East Calcutta Wetlands, Kolkata, India. *International Review Hydrobiology* 92, 242–257.

Saha, N., Kundu, M., Saha, G.K. and Aditya, G., 2020. Alternative prey influence the predation of mosquito larvae by three water bug species (Heteroptera: Nepidae). *Limnological Review*, *20*(4), pp.173-184.

Sandilyan, S., Meenakumari, B., Biju Kumar, A. and Rupam Mandal. 2018. A review on Impacts of invasive alien species on Indian inland aquatic ecosystems. National Biodiversity Authority, Chennai.

Sasanami, M., Hustedt, J., Alexander, N., Horstick, O., Bowman, L., Hii, J., Echaubard, P., Braack, L. and Overgaard, H.J., 2021. Does anthropogenic introduction of guppy fish (*Poecilia reticulata*) impact faunal species diversity and abundance in natural aquatic habitats? A systematic review protocol. *Environmental Evidence*, *10*, pp.1-11.

Seng, C.M., Setha, T., Nealon, J., Socheat, D., Chantha, N. and Nathan, M.B., 2008. Community-based use of the larvivorous fish *Poecilia reticulata* to control the dengue vector *Aedes aegypti* in domestic water storage containers in rural Cambodia. *Journal of Vector Ecology*, *33*(1), pp.139-144.

Singh, N. and Gupta, P. K. 2016. *Gambusia holbrooki:* a case study in India with special reference to Lake Nainital. *Int. J. Fish. Aquacult.,* , 6, 33–48.

Singh, N., 2013. In vivo studies on the effect of *Gambusia holbrooki* on planktonic community. *Int. J. Fish. Aquacult. Sci.*, 3, 99– 111.

Smith, G. R., Boyd, A., Dayer, C. B. and Winter, K. E. 2008. Behavioral responses of American toad and bullfrog tadpoles to the presence of cues from the invasive fish, *Gambusia affinis. Biol. Invasions.* 10, 743–748.

Tabibzadeh I, Behbehani G, Nakhai R. 1970. Use of gambusia fish in the malaria eradication programme of Iran. Bull WHO; 43: 623–628.

Von Kögel, F., 1987. Zur biologie und ökologie von *Rhantusconsputus* STRM. Entomologische Arbeitenausdem Museum 35 (36), 5–19.

Voyadjoglou, A.S., Roussis, V., Petrakis, P.V., 2007. Biological control of mosquito populations: an applied aspect of pest control by means of natural enemies. In: Elewa, A.M.T. (Ed.), Predation in Organisms: A Distinct Phenomenon. Springer, Berlin, pp. 123–149.

Wagh, G. K. and Ghate, H. V. 2003. Freshwater fish fauna of the rivers Mula and Mutha, Pune, Maharashtra. *Zoos Print J.* 18, 977–981.

White, A. and Pyke, G., 2011. World War II and the rise of the plague minnow *Gambusia holbrooki* (Girard, 1859) in Australia. *Aust. Zool.* 35, 1024–1032.

World Health Organization. 2009 Dengue: guidelines for diagnosis, treatment, prevention and control. Geneva, Switzerland: World Health Organization.

World Health Organization. 2024 Dengue and Severe Dengue, Geneva, Switzerland: World Health Organization.

Wu, N., Liao, G., Li, D., Luo, Y., Zhong, G., 1991. The advantages of mosquito biocontrol by stocking edible fish in rice paddies. *Southeast Asian Journal of Tropical Medicine and Public Health* 22, 436–442

Yu, H.S., 1986. Biological control of malaria vector, *Anopheles sinensis* Wiedemann by the release of larvivorous fish, *Aplocheilus latipes* in simulated rice paddies in Korea. *Korean Journal of Entomology* 16, 93–99.

Yu, H.S., Kim, H.C., 1993. Integrated control of encephalitis vector (*Culex tritaeniorhynchus*) with native fishes (*Aplocheilus latipes and Aphyocypris chinensis*) and *Bacillus thuringiensis* (H-14) in marshes in Jindo Island of Korea. *Korean Journal of Entomology* 23, 221–230.

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