GUIDELINES ON THE USE OF LARVIVOROUS FISH FOR VECTOR CONTROL

INTRODUCTION

Fish have been widely used in public health, since as early as 1903. One of the most successful and widely used biological control agent against mosquito larvae is the top water minnow or mosquito fish *Gambusia affinis*. Fish other than *Gambusia* which has received the most attention as a mosquito control agent is *Poecilia reticulata*, the common guppy.

All the states have been advised to upscale the use of fish as biological control method in rural areas. The following guidelines have been prepared to guide the states in the use of fish for vector control.

ADVANTAGES OF USE OF FISH

- These fishes are self-perpetuating after its establishment and continuous to reduce mosquitoes larvi for long time.
- The cost of introducing larvivorous fish is relatively lower than that of chemical control.
- Use of fish is an environment friendly method of control.
- Larvivorous fish such as *Gambusia* and *Poecilia* prefer shallow water where mosquito larvae also breed.

CHARACTERISTICS OF LARVIVOROUS FISH

- Should be small in size to survive in shallow water.
- Should be surface feeders and carnivorous.
- Should be able to survive in the absence of mosquito larvae.
- Should be easy to rear.??
- Should be able to withstand a wide range of temperature and light intensity.
- Should be hardy and able to withstand transport and handling.
- Should be insignificant/useless as food for other predators.
- Should have preference for mosquito larvae over other types of food available at the water surface.

SPECIES OF FISH

1. Gambusia affinis

Gambusia affinis has been in use in India since 1928. It is an exotic species and has been distributed throughout the warmer and some temperate parts of the world.

Habitat

It is a very hardy fish and can adapt to wide variations in temperature as well as to chemical and organic content of the water but does not tolerate very high organic pollution. The optimum temperature for reproduction ranges from 24^0C to 34^0C but the fish can survive at freezing temperatures. The most suitable pH of water is between 6.5 and 9.9. *Gambusia* frequents areas especially suitable for the mosquito larvae. It lives and multiplies in ponds stocked with larger fish provided pond is shallow and has protective vegetation for refuge.

Gambusia - Male

Gambusia - Female

Size and Longevity

The maximum size attained by a male is 4.5 cm. and by a female 5.2 cm to 6.8 cm. Its life span is approximately 4+1 years.

Breeding Habit

The female matures in about 3 to 6 months. Each ovary contains approximately 120 eggs. Young ones are released in broods of 25.30 at a time. The young females have two gestations per season while the older females may have upto six generations per season. A season lasts about 30 days.

A single female may produce between 900 and 1200 off springs during its life span.

Breeding Season

Gambusia breeds throughout the year after maturity, especially in tropical conditions. In relatively colder climate such as is found in north and north-west India breeding period lasts from May to September and in warmer climate of southern India from April to November.

Larvivorous Efficiency

The larvivorous efficiency of *Gambusia* is due to following characters:

- A single full grown fish eats about 100 to 300 mosquito larvae per day.
- *Gambusia* is a surface feeder, hence it is suitable for feeding on both anophelines and culicines.
- It frequents the margins of the water container, pond or other ground water collections, except where there is dense vegetation at the margins of the water body.
- It is small and inedible.
- It can tolerate salinity.

- ✍ It can withstand transportation and does not require any specialized equipment or containers.
- ✍ It survives in new places (water bodies) and multiplies easily. After release when it becomes well established in a water body, the fish can survive in good numbers for years and does not require constant care.

2. Poecilia reticulata (GUPPY)

Like *Gambusia*, Guppy is also an exotic fish introduced in India in 1910. It is easy to care for, and it reproduces quickly and prolifically. It is now widely distributed in India and is an important larvivorous fish.

Habitat

It is a very hardy fish and survives in all types of water bodies. It tolerates high degree of pollution with organic matter. The temperature range suitable for breeding is from 24^0C to 34^0C. It can survive in water with pH ranging from 6.5 to 9.0 However, it can not survive in cold water (often below 10^0C) and stock may need replenishment if the temperature fall below 10^0C.

Guppy - Male

Guppy - Female

Size and Longevity

The male is 3 cm long, whereas the female is upto 6 cm in length. The Guppy lives for 4 + 1 years.

Breeding Habitat

The guppy takes about 90 days to mature. Each ovary contains 100 to 160 eggs. The female gives birth to young ones in broods of 5 to 7 at a time. About 50 to 200 young ones are released by the female every four weeks.

Breeding Season

Reported to breed throughout the year at about four weeks interval after maturity. However breeding season will depend on climatic conditions. In warmer climate it may breed from April to November.

LARVIVOROUS EFFICIENCY

The larvivorous efficiency of *Poecilia* is due to following characters:

- A single fish eats about 80 to 100 mosquito larvae in 24 hours. Therefore it is comparatively less efficient than Gambusia affinis.
- It is a surface feeder.
- Negotiates margins of ponds more easily.
- It is highly carnivorous and parents or older brood may eat up their own young ones. Therefore, a fair amount of weeds is required in the water so that young ones can hide and survive.
- Tolerates handling and transportation very well.
- Does not require specialized equipment for transportation.
- Survives and reproduces when introduced into new water bodies. Once well established, it can be found in the habitat even after many years.

FISH HATCHERIES

The Hatchery for larvivorous fish can be established in:

- A Natural water body
- A special hatchery

The Natural water body

Criteria for selecting a water body for a fish hatchery are:

- It should be a permanent water body.
- Depth of water should be at least 1.5 metre or more.
- Water should be confined and without big natural outlet.
- The minimum size of water body should be at least 5 m X 4 m. The water body of 10 m X 5 m can support 50000 fish.
- It should be free from other carnivorous fish.
- Water should not be contaminated by chemical or other harmful substances.
- Easily accessible for daily or periodic inspection and for collection of fish.
- De-weeding in ponds and shallow water bodies and cleaning of margins should be carried out periodically.

Special Hatchery

Following points may be kept in view, while constructing the special hatcheries for the rapid reproduction of the fish:

- Fish hatcheries should be established at state, district headquarters, CHC/PHC and subcentre levels and other places so that adequate quantities of the fish are available for supply.

- There should be a constant supply of fresh water so that the required level of water in the tank does not drop.
- Submerged vegetation such as hydrilla, vallisneria should be available in the tanks.
- Salinity of water should not exceed 20 grams per litre. These fish may survive salinity up to 52 gms. per litre. But it cannot reproduce at this salinity level.
- Hatchery should not be subjected to strong water current and should be protected from heavy rains and floods.
- Entire tanks should be brick made, lined with good quality of cement plaster, thikness of wall about 0.5 m.
- The tank should be divided into two portions of equal size of 5 m X 4 m with central separator of 0.5 m thick.
- Area . sufficiently big for construction of 2 tanks of 5 m X 4 m (one for laying young ones and other for holding mature full grown fish).
- Depth of water in the hatchery should be 1.5 m.
- Proper outlet at the bottom of tank should be provided.
- Overflow outlet about 5 cm below inlet protected with proper wire mesh to prevent escape of fish.
- Floor of tank 0.5 m thick with slope from the partition towards sides.
- Proper inlet at 1.25 m height.
- Bottom of tank covered with uniform thickness of sand for about 10 cm.
- The bottom should be seeded with organic matter about 2 kg/m^2.
- The tank should be allowed to mature for 10.15 days.
- Minimum 25% of water should be replaced once a week.
- The fishes should be tranfered from the tank to avoid over population.
- In case of scarcity of natural food, artificial food such as waste flour (atta) may be given. Chlorination of water beyond the tolerance levels, or presence of insecticides can be lethal to the fish.

TRANSPORTATION OF FISH

- The fish are best transported in small containers of up to 40 litres, such as plastic buckets and jerry cans, or in strong plastic bags, half filled with water from the rearing pond.
- Fish should be transported in water at ambient temperatures and should not be exposed to direct sunlight. The containers should have sufficient openings to allow flow of air.
- Take polythene bag of 3 -5 litre capacity.
- Fill it with 1.5 lit. of water.
- Introduce the fish in the bag till the total volume of water + fish is two litres.
- Bubble the oxygen in bag from O2 cylinder or from air pump.
- Close the mouth of bag with a string leaving sufficient space at the top.
- Put the bag in a thermocol container and close the mouth of container.
- The container can be transported for a period of 24 hours without further filling oxygen. If the period of transport is more than 24 hours then arrange for change of water and oxygenate.

Collection of fishes

- Fishes are collected with help of netting, which is fitted on a circular iron ring of 60 to
- 90 cm diameter with a wooden handle.
- Sufficient quantity is collected by repeated dips.
- Collection in bucket or drum till they are packed for transportation.

Precaution during Transportation

- Fish do not tolerate sudden temperature changes.
- Preferably the fishes should not be given any food for 10.12 hours period prior to packing for transportation.

RELEASE OF FISH

- To release the fish in a water body, measure the perimeter of water body.
- Release the fishes at the rate of 5.10 fish per linear meter.
- If the larval density is high more fish up to 20 can be released.

Precautions during release of fish:

- Fishes should be released in the morning hours or in the evening.
- Before releasing ensure that the temperature of water both in container and in the larval habitat is more or less same.
- Clean out dense vegetation from the water body.
- Ensure that water body is free from predators of larvivorous fishes.

WHERE TO USE FISH

- Fish should be preferably introduced in all unused wells in the rural and peri-urban areas before the high mosquito breeding season to maximize impact. However, the fish may be used in such wells even if the seeding has been delayed.
- Fresh water bodies in rural areas such as stagnant ponds, slow moving streams quarry pits, large borrow pits, margins of ponds should be targetted apart from wells. Such places should be surveyed and numbered to facilitate subsequent monitoring of impact.
- In open mosquito breeding sites or rice fields, the fishes need to be protected from pesticides applied to crops, when used in rice fields.

MONITORING

- Supervisors should check the fish hatcheries at least once a month during the high transmission season.
- At least 10% of the sites where fish have been introduced should be checked for:
  - Whether fish have been introduced or not
  - Whether the fish are surviving or not
  - Identification of possible reasons, in case the introduced fish are not surviving.

REPORTING

- Monthly report to state programme officer and to NAMP containing following information:
  - Number of fish hatcheries established
  - Name of urban and rural areas using larvivorous fish
  - Number of unused wells marked for the introduction of the fish
  - Number of sites in the urban areas marked for the introduction of the fish.
  - Field reports of supervision of 10% of the sites
- Community participation and response

Maintenance and rearing of larvivorous fish for mosquito control

Gambusia affinis and *Poecilia reticulata* are the two most important larvivorous fish which have been used extensively in the country for the control of mosquito breeding in urban area. Both these fish though exotic but have acclimatized very well in different types of climatic conditions prevailing in the country. These fish possess requisite qualities of good larvivorous fish viz. small size, hardy, extremely prolific breeders of shallow and deep waters, worthless as food, adaptable to various climatic conditions and able to tolerate considerable degree of organic pollution and salinity, able to withstand handling, transportation and capable of flourishing in confined water collections.

Gambusia affinis

An American top feeding minnow, has been introduced into almost all the countries of the world where malaria is endemic. The fish was introduced in India during 1928 when a consignment was brought from Italy by Dr.B.A.Rao then at the Mysore State Health Department. Since then the fish has been used extensively in different parts of the country for the control of *Anopheles stephensi* breeding particularly in urban areas.

The fish is ovoviparous. The female is about 6.0 – 6.5 cms long and olive green in colour whereas the male is much smaller and its size varied from 2.0 – 3.5 cms. Besides the size difference in the adults, males may be distinguished from females due to the modification of the normal round anal fin in male into a long thin intromitten organ; the gonopodium for the transfer of sperms.

The breeding season varies in different localities according to the climatic conditions. In Northern India it lasts from March till October. Eggs are retained within the female oviduct where they develop and are released as young ones at approximately four months interval at a temp of about 25^0C. A single internal fertilization of a female can produce about 5-6 broods with an average of 40 eggs in each brood.

Youngs grow rapidly and attain sexual maturity at the age of about 6 weeks. *Gambusia* is omnivovous, feeding virtually on all the organisms of convenient size. However, the dorsally oriented mouth and habit of swimming near the surface makes the species a voracious feeder of anopheline larvae.

Poecilia reticulata

It is commonly known is guppy or Barbados Millions or mosquito fish – a native of Barbados Island in South America. The fish was introduced in India by Major Shelleby from London in 1910 for the control of malaria vectors. Initial attempts made to establish this fish in Indian Museum Compound, Calcutta failed. However, in 1967, a prolific breeding of this fish was detected in the sullage water of Nagnadi in Nagpur. The fish was brought to Delhi and since then the healthy colony of fish is being maintained at the NICD, Delhi (presently NCDC) and under field conditions. Since then the fish has been introduced in different parts of the country for the control of culicine breeding. Female fish resembles *Gambusia affinis* in colour whereas the males are vividly coloured. The fish is more tolerant to organic pollution than *Gambusia* but can not withstand a temperature below 10-11^0C.

Stock culture of *G.affinis* and *P.reliculata* is being maintained at the NICD, 22-Sham Nath Marg and can be obtained on request on any working day between 9.30 am to 4.30 p.m. with prior appointment. The fish can be collected and transported in a wide mouthed plastic/tin container. The transportation of fish should be undertaken preferably in morning hours or after the sun set when the temperature is comparatively low during summers. Under no circumstances tap water should be added to the container having fish otherwise fish would die due to presence of chlorine in tap water. Initially the fish may be kept in an indoor situation having temp. of about 27^0C in an aquarium or some open container provided

with 3-4 days old water free of chlorine gas. Food material comprising of mosquito larvae, crustaceans, protozoans etc. can be given twice a day. The fish can subsequently be transferred in tank/pond maintained for rearing the fish.

Maintenance of rearing of fish culture and upscaling

In order to have continuous supply of fish, it is necessary to establish a hatchery where the fish may survive and multiply before contemplating their use in the local waters for the control of mosquito breeding. Any small pond is devoid of larger fish, otherwise they may prey upon the *Gambusia* or *Poecilia*.

A convenient form of hatchery is a cement concrete tank measuring 3 x 3 x 1 meters (length x breadth x depth). The bottom of the tank should be provided with silt and fine sand granules covering about 0.3 meters of the bottom. Manure in the form of decaying organic matters viz. cowdung manure etc. should be added to the water to facilitate and accelerate the growth of micro-organisms which would eventually serve as a food material for the fish. In tank, reeds should be planted which afford shelter for the young fish, many of which otherwise may be eaten by their parents. The size of the hatchery will depend on the extent of the fish which have to be stocked. At Delhi, where large number of fish are required both for local use and for supplying to workers in other parts of India, the hatcheries vary in size from 3 x 3 x 1 meters to 5 x 6 x 1 meters. For regular supply of fresh water the tanks should be provided with small fountains.

It is not necessary to provide food for the fish once they are established, but when a large body of water is being stocked they probably multiply quicker if an additional food supply is made available. The fish may be maintained on chooped-up blood-clot obtained from the slaughter house, this can placed in wire gauze receptacles supported just below the water surface on tripods. The fish can also be fed on wheat-flour balls thrown into the water. It is necessary to keep free of leeches which may attack on fish.

It occasionally happens that fish disappear from a breeding place soon after being introduced, for some un-explained reason. In such cases it is always worthwhile to restock with another batch of fish.

For the control of mosquito breeding in wells and allied habitats, the fish can be introduced @ of 10 fish (equal female male ratio) per square meter area. However, it is necessary to keep a vigil on the activity of fish and as soon as the fish density decreases, it should the replenished by fresh stock. The decline in fish density in confined water collections is due to restricted food supply and lack of shelter for young fish, which are often devoured by parent fish at the time of scarcity of other food materials. At times when the food is completely exhausted in such habitats, the adult fish may also die of starvation.

The stocking of wells, ornamental tanks and other such habitats with larvivorous fish should be undertaken at least one month before the commencement of malaria season and a periodic check on the activity of fish vis a vis mosquito larvae density should be monitored.

Gambusia affinis

Poecilia reticulata (GUPPY)