J. Nat. Aq. Res. Ag. Sri Lan. 32 (1985) 24 - 33

# CONTROL OF *CULEX QUINQUEFASCIATUS* LARVAE BY THE LARVIVOROUS FISH *POECILIA RETICULATA* IN DRAINS AND DITCHES OF COLOMBO.

*by*

H. H. COSTA

**Department of Zoology, University of Kelaniya, Kelaniya, Sri Lanka.**

*Poecilia reticulata* Rosen & Baily 1963, formerly known as *Lebistes reticulatus* Peters was originally brought to Sri Lanka as an aquarium fish. Its escape into certain drainage systems in the South East of Colombo is not documented but in the late 1970s a few of them were detected by the author in a few clear water and slightly polluted ditches in one locality in a suburb of Colombo. In a survey made in late 1970s they were still absent in the drains and ditches of the greater part of Colombo except in the Nugegoda area and a few other areas where localized small dispersed populations were located.

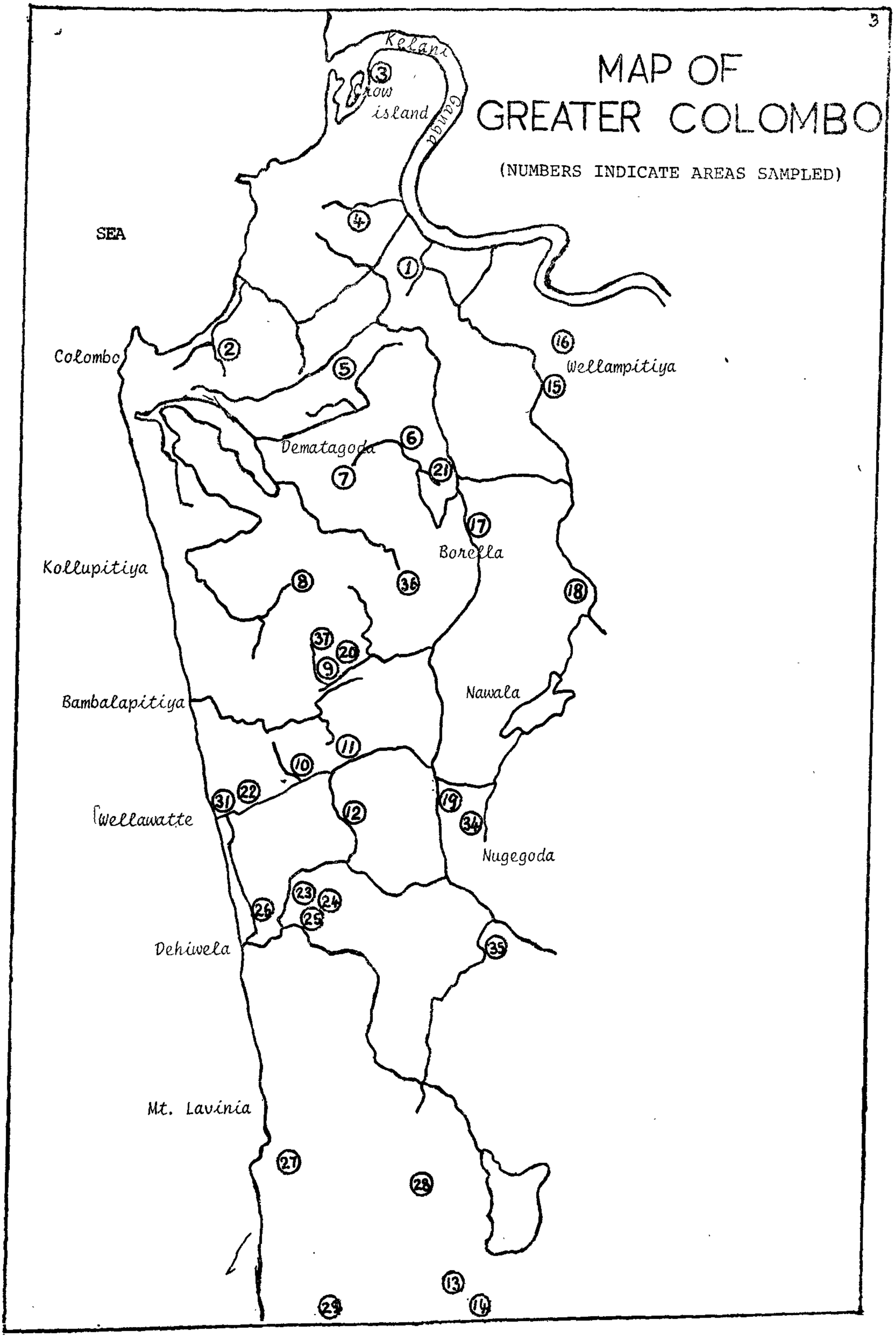
The drains and ditches of Colombo normally contain slightly to highly organically polluted waters; the degree of pollution varying seasonally with the amount of rainfall received. Heavy downpours in the city flush the drains temporarily. During the dry season accumulation of wastes mostly of organic origin makes the waters to produce undesirable stenches and odours. These drains and ditches produce ideal habitats for the breeding of *Culex quinquefasciatus* and other species of nuisance mosquitoes causing a serious pest problem to the City dwellers.

Already a number of workers, in Thailand, Burma, Taiwan, India etc. (Bay & Self, 1972; Sasa *et al.*, 1965; Prakong Pran Urai, 1975; Sitharaman *et al.*, 1976) have reported the utilization of the guppy *Poecilia reticulata* in the control of mosquitoes and specially *Culex* spp. Various degrees of success have been achieved by these workers depending on the various conditions existing in the experimental habitats.

The present study is an assessment of the efficacy of the guppy *Poecilia reticulata* in the control of mosquito larvae in the drains and ditches under the conditions existing in the City of Colombo.

## MATERIALS AND METHODS

During the period of 1978/80 batches of the fish *Poecilia reticulata* were stocked in a few selected areas of ditches and canals in the City of Colombo. Observations were made regularly on the spread of the fish in the drains and the ditches. A detailed survey was conducted in 1982 and 1983 to ascertain the present distribution pattern and the success of colonization of the drains by guppy populations in the City and Greater Colombo and also to ascertain the potential of *Poecilia reticulata* in the control of mosquito larvae.


3
MAP OF
GREATER COLOMBO
(NUMBERS INDICATE AREAS SAMPLED)
Kelani
Ganga
Crow island
SEA
Colombo
Wellampitiya
Demataguda
Borella
Kollupitiya
Nawala
Bambalapitiya
Wellawatte
Nugegoda
Dehiwela
Mt. Lavinia

A few drains and ditches were selected in all localities in Colombo for sampling (Fig. 1) The approximate number of guppies per sampling area was determined by using a square frame of 100 $cm^2$. When the populations were very low the number per unit area was recorded visually.

The larval and pupal mosquito population densities in the ditches were monitored simultaneously using a ladle having a diameter of 9.5 mm. They were collected by making five dips mainly along the edges of the drains and ditches. For each sampling area, the appearance of the water, odour of the water and whether the water was stagnant or flowing were noted. Important chemical factors such as BOD, COD and the dissolved oxygen content were determined from the watet samples taken from each sampling area at the time of sampling.

A few isolated drains and ditches where fish were absent due to complete isolation served as controls.

## RESULTS

Surveys carried out during the rainy months showed that the guppy populations have spread throughout the city of Colombo and also to certain areas of Greater Colombo since the time of initial stocking (Fig. 1) The canals which were highly polluted with chemical detergents and toxic materials were devoid of fish.

Table 1 gives the appearance turbidity and the odours noted for the waters of the drains examined. Table II gives the value for BOD, COD and DO. From these values it could be deduced that the ditches, drains and smaller canals examined are slightly to highly polluted. The high BOD values indicate that the waters are polluted mostly with organic matter. In some drains during certain times of the day the waters were almost devoid of dissolved oxygen. (Table II).

**TABLE 1**

**SOME PHYSICAL PARAMETERS OF THE WATERS OF THE DRAINS AND DITCHES SAMPLED IN GREATER COLOMBO**

| *No. of sampling station* | *Name of canal/ drain* | *date of collection* | *Whether water is flowing or stagnant* | *Appearance* | *Odour* |
|---|---|---|---|---|---|
| 1. | Orugodawatte canal | 11.01.83 | Slow moving | Turbid with a faint black colour. Black sediment present | Faint odour of discharged engine oil |
| 2. | Main drain flowing down Bloemendhal Rd. | 01.03.83 | Slow moving | Marked turbidity with a blackish tint. | Odour of $H_2S$ |
| 3. | Crow Island | 01.03.83 | Stagnant | Turbid water of a pale brown colour. Patches of *Eichhornia* | Earthy odour |
| 4. | Main drain near Victoria Bridge | 11.03.83 | Slow flowing | Turbid with a faint black colour | Odour of $H_2S$ |
| 5. | Maligawatte North drain | 11.03.83 | Slow moving | Marked turbidity with a faint black colour. Black sediment present. | Odour of $H_2S$ |

Table 1 (Cont. 1)

| *No. of sampling station* | *Name of canal/ drain* | *date of collection* | *Whether water is flowing or stagnant* | *Appearance* | *Odour* |
|---|---|---|---|---|---|
| 6. | Dematagoda South canal | 01.03.83 | Stagnant | Turbid with a pale brown colour | Odour of engine oil |
| 7. | Maligakanda drain close to Kuppiawatte temple. | 01.03.83 | Flowing | Turbid with a light brown colour. Appreciable amounts of sediment present | Earthy odour |
| 8. | Norris canal road near hospital | 07.12.82 | Stagnant | Marked turbidity. Water with a blackish tint | Peaty odour |
| 9. | Green Path canal near museum | 07.12.82 | Flowing | Turbid with clear water | |
| 10. | Kirullapone canal near Polhengoda bridge | 07.12.82 | Flowing | Turbid with a brownish tint | Musty odour |
| 11. | Kalubowila canal | 07.12.82 | Flowing | Turbid with a pale brown colour. Sediment present | Earthy odour |
| 12. | Dehiwela Nedimala canal | 14.12.82 | Slow flowing | Faint black colour | Odour of $H_2S$ |
| 13. | Bellanwila marsh | 14.12.82 | Stagnant | Turbid with a pale yellow colour covered with *Eichhornia* | Earthy odour |
| 14. | Aththidiya canal | 14.12.82 | Stagnant | Turbid with a pale yellow colour | Earthy odour |
| 15. | Kuruniyawatte canal, Wellampitiya | 11.01.83 | Stagnant | Turbid with a pale yellow colour. Patches of *Salvinia* | Earthy odour |
| 16. | Sedawatte canal Wellampitiya | 11.01.83 | Flowing | Turbid with a yellow colour. Large patches of *Eichhornia* and *Salvinia*. | Earthy odour |
| 17. | Diyawanna oya near Rajagiriya | 11.01.83 | Flowing | Turbid with a pale brown colour | Fishy odour |
| 18. | Diyawanna oya main canal near Parliament | 11.01.83 | Slow flowing | Turbid with a pale brown colour | Earthy odour |

Table 1 (Cont. 2)

| *No. of sampling station* | *Name of canal/ drain* | *date of collection* | *Whether water is flowing or stagnant* | *Appearance* | *Odour* |
|---|---|---|---|---|---|
| 19. | Nawala canal near the Open University | 11.01.83 | Slow flowing | Turbid with a pale yellow colour | Fishy odour |
| 20. | Narahenpita canal Manning town | 11.01.83 | Flowing | Marked turbidity with a blackish tint | Peaty odour |
| 21. | Wanathamulla canal | 25.01.83 | Slow flowing | Marked turbidity with a blackish tint | Peaty odour |
| 22. | Upper Wella-watte canal | 25.01.83 | Slow flowing | Turbid with a pale yellow colour. Patches of *Salvinia* | odour of $H_2S$ |
| 23. | Canal close to Zoological Gardens, Dehiwela | 25.01.83 | Flowing | Turbid with a blackish colour | Odour of $H_2S$ |
| 24. | Pond in the Zoological Gardens | 08.02.83 | Stagnant | Turbid with a green colour | Musty odour |
| 25. | Dehiwela main canal (lower part) | 08.02.83 | Slow flowing | Turbid with a pale brown colour | Odour of $H_2S$ |
| 26. | Waidya Road canal, Dehiwela | 25.01.83 | Slow moving | Turbid with a blackish colour | Odour of $H_2S$ |
| 27. | Mount Lavinia canal (near the beach) | 25.01.83 | Stagnant | Highly turbid with a blackish colour | Peaty odour |
| 28. | Kotalawalapura canal (Ratmalana) | 25.01.83 | Stagnant | Marked turbidity with a brown colour | Earthy odour |
| 29. | Kandawala drain (Ratmalana) | 08.02.83 | Stagnant | Turbid with a pale yellow colour | Earthy odour |
| 30. | Soysapura drain (Katubedde) | 25.01.83 | Stagnant | Turbid with a blackish colour | Peaty odour |
| 31. | Wellawatte canal (lower part) | 08.02.83 | Flowing | Faint black colour. Highly turbid with black matter | Odour of $H_2S$ |
| 32. | Lakshapathiya canal (Moratuwa) | 25.01.83 | Stagnant | Marked turbidity with a blackish tint. Patches of *Eichhornia* | Odour of engine oil |
| 33. | Katubedde canal near Moratuwa University | 25.01.83 | Slow flowing | Clear water | — |

Table 1 (Cont. 3)

| *No. of sampling station* | *Name of canal/ drain* | *date of collection* | *Whether water is flowing or stagnant* | *Appearance* | *Odour* |
|---|---|---|---|---|---|
| 34. | Nugegoda main canal | 08.02.83 | Slow flowing | Faint brown colour. Highly turbid with black flocculent matter | Peaty odour |
| 35. | Delkande-handiya canal, Nugegoda | 18.01.83 | Flowing | Turbid with a brown tint | Faint odour of $H_2S$ |
| 36. | Bullers Road drain,Colombo 8 | 18.01.83 | Flowing | Turbid with a faint black colour | Musty odour |
| 37. | Jawatte Road drain, Colombo 8 | 08.02.83 | Slow flowing | Faint black colour. Highly turbid with flocculent matter | Musty odour |

**TABLE II**

**SOME CHEMICAL PARAMETERS OF THE WATERS OF THE DRAINS AND DITCHES SAMPLED IN GREATER COLOMBO**

| *No. of sampling station* | *Time of sampling* | *D.O. (mg/1)* | *B.O.D. (5 days at 28°C)* | *C.O.D.* |
|---|---|---|---|---|
| 1 | 1.55 p.m. | 0.0 | 15.0 | 50.0 |
| 2 | 12.30 p.m. | 1.0 | 125.0 | 67.0 |
| 3 | 11.15 a.m. | 1.0 | 140.0 | 65.0 |
| 4 | 12.50 p.m. | 0.0 | 275.0 | 109.0 |
| 5 | 10.20 a.m. | 0.4 | 130.0 | 55.0 |
| 6 | 10.45 a.m. | 0.3 | 95.0 | 76.0 |
| 7 | 10.30 a.m. | 1.2 | 45.0 | 80.0 |
| 8 | 10.25 a.m. | 0.3 | — | 58.0 |
| 9 | 10.50 a.m. | 6.0 | 5.5 | 26.0 |
| 10 | 11.55 a.m. | 6.2 | 8.5 | 19.0 |
| 11 | 12.05 p.m. | 6.1 | 15.1 | 23.0 |
| 12 | 11.00 a.m. | 2.0 | — | 54.0 |
| 13 | 11.10 a.m. | 1.1 | — | 24.0 |
| 14 | 11.55 a.m. | — | — | 40.0 |
| 15 | 10.35 a.m. | 6.2 | 16.0 | 62.0 |
| 16 | 10.50 a.m. | 10.6 | 8.75 | 25.0 |
| 17 | 11.20 a.m. | 5.5 | 9.0 | 76.0 |
| 18 | 12.10 a.m. | 8.4 | 4.75 | 0.4 |
| 19 | 12.25 p.m. | 4.8 | — | 34.0 |
| 20 | 1.55 p.m. | 0.2 | 100.0 | 97.0 |
| 21 | 10.55 a.m. | 1.8 | 395.0 | 61.0 |
| 22 | 11.30 a.m. | 1.5 | 140.0 | — |
| 23 | 11.50 a.m. | 0.5 | 210.0 | 71.0 |
| 24 | 12.25 p.m. | 13.6 | 23.5 | 66.0 |
| 25 | 12.15 p.m. | 6.3 | 160.0 | 66.0 |
| 26 | 1.55 p.m. | 1.1 | 175.0 | 36.0 |
| 27 | 11.25 a.m. | 3.1 | 420.0 | 32.0 |
| 28 | 11.10 a.m. | 2.8 | 180.0 | 66.0 |
| 29 | 11.30 a.m. | 2.4 | 30.0 | 68.0 |
| 30 | 11.45 a.m. | 1.0 | 190.0 | 55.0 |
| 31 | 12.45 p.m. | 1.8 | 40.0 | 58.0 |
| 32 | 11.25 a.m. | 0.5 | 310.0 | 128.0 |
| 33 | 11.10 a.m. | 6.0 | 6.75 | 30.0 |
| 34 | 10 40 a.m. | 1.0 | 210.0 | 56.0 |
| 35 | 11.20 a.m. | 4.4 | 20.0 | 24.0 |
| 36 | 12.25 p.m. | 0.3 | 175.0 | 108.0 |
| 37 | 11.10 a.m. | 1.8 | 13.0 | 74.0 |

The density of fish, their intensity of colonization and density of mosquito larvae in relation to the presence or absence of fish is given in Table III. In most drains the population densities were suprisingly high and in certain sections of these drains the guppy population exceeded 8000/$m^2$ Specimens of *Poecilia reticulata* examined for their condition of guts showed that they were always fully satiated as there is, in addition to faunal elements which are tolerant of polluted conditions, an abundance of organic waste material which is always present for use as food.

**TABLE III**

**THE PRESENCE OR ABSENCE OF MOSQUITO LARVAE IN RELATION TO DENSITY OF FISH IN THE DRAINS AND DITCHES SAMPLED IN GREATER COLOMBO.**

| *Number of sampling station* | *Density of mosquito larvae per 5 dips* | *Density of Poecilia reticulata per $m^2$* |
|---|---|---|
| 1 | Absent | Absent |
| 2 | Absent | 70-75 |
| 3 | 1st & 2nd stages | 5-7 |
| 4 | Absent | Absent |
| 5 | Absent | 400-500 |
| 6 | Absent | 40-50 |
| 7 | Absent | 9-10 |
| 8 | 800-1000 | Absent |
| 9 | Absent | 10-12 |
| 10 | Absent | 10-17 |
| 11 | Absent | 30-33 |
| 12 | Absent | 8-12 |
| 13 | 5 | Absent |
| 14 | 5 | Absent |
| 15 | 10 | Absent |
| 16 | 9 | Absent |
| 17 | Absent | 8-12 |
| 18 | Absent | 35-45 |
| 19 | 3 (among vegetation) | 8-12 (in clear water) |
| 20 | Absent | 40-45 |
| 21 | Absent | 150-175 |
| 22 | 15 | Absent |
| 23 | Absent | 50-60 |
| 24 | 3 | Absent |
| 25 | 15 | Absent |
| 26 | 20 | Absent |
| 27 | 75 | Absent |
| 28 | 3 | Absent |
| 29 | Absent | 10-15 |
| 30 | Absent | 150-200 |
| 31 | 8 | Absent |
| 32 | 4 | Absent |
| 33 | Absent | 22-25 |
| 34 | 500-750 | 5-7 |
| 35 | Absent | 20-23 |
| 36 | Absent | 300-400 |
| 37 | Absent | 800-1000 |

A noticeable feature in this survey was the registration of extremely variable counts for fish even in adjoining sections of the same canal. The survey also revealed that there were no other fish in these drains and ditches except in the larger canals and marshy swamps where the air breathing fishes *Ophiocephalus punctatus* and *Ophiocephalus striatus* were present.

## DISCUSSION

The results of this study indicate that *Poecilia reticulata* could be effectively used in an integrated control program as a biological agent for use against *Culex quinquefasciatus* breeding in the drains and ditches in the City of Colombo.

It is also seen that the strain of this guppy in Colombo drains is well adapted to live in moderate to highly polluted waters.

Guppies usually occur in open water but the mosquito larvae usually occur among vegetation and debris. This could at most times lead to unsuccessful predation by fish (Nelson *et al.*, 1976). However, in most drains and ditches in Colombo there is little debris accumulating although in small canals there are occasional and sometimes heavy vegetation patches. In these areas mosquito larvae could survive although fish may be present in the adjoining clear water as in station No. 19.

**TABLE IV**

**CATEGORIZATION OF DRAINS AND DITCHES ACCORDING TO PRESENCE OR ABSENCE OF MOSQUITO LARVAE AND FISH.**

| *No.* | *Category of drains & ditches* | *Remarks* | *Categorization of sampled drains (Sampling station No.)* |
|---|---|---|---|
| 1. | Drains and ditches without fish and mosquito larvae. | Polluted with highly toxic industrial effluents. | 1 |
| 2. | Drains and ditches with fish and mosquito larvae. | Where the fish population did not exceed 7-10/$m^2$. | 3, 34 |
| 3. | Drains and ditches with fish and no mosquito larvae (without vegetation) | Where the fish population exceeded 10/$m^2$. | 2, 5, 6, 7, 9 10, 11, 12, 17, 18 20, 21, 23, 29, 30 33, 35, 36, 37 |
| 4. | Drains and ditches with mosquito larvae but no fish. | Where the fish have not yet colonized the ditches. | 4, 8, 13, 14, 15 16, 19, 22 24, 25, 26, 27, 28, 31, 32 |

It is apparent from this survey that the dissemination of *Poecilia reticulata* have had significant effects upon the density of *Culex quinquefasciatus* populations in the drains and ditches of Colombo. As indicated in Table IV, mosquito larvae were absent when the fish population exceeded 7-10/m². In some habitats reproduction is apparently insufficient to keep pace with mortality, emmigration or getting washed off with heavy rains.

Significant relationship at 5% level was found between the abundance or absence of fish with absence or presence of mosquito larvae.

The spread of *P. reticulata* to all quarters of the City has not become well known even to the urchins in shanty dwellings in the municipal areas of Colombo although the author has has obrerved a few instances where children were trying to catch them with various improvised gears. This may be one of the important teasons for its survival and rapid spread in the City of Colombo and even beyond in small numbers to Dehiwela and Mount Lavinia.

*P. reticulata* was never found in streams or in open marshy places probably due to the presencenatural enemies such as *Ophiocephalus* spp. Therefore, it is unlikely that this guppy will pose a danger to the indigenous fishes.

The Colombo Municipality periodically carries out programs of insecticide spraying into drains, ditches and canals. Although the guppies are known to be resistant to low concentrations of insecticides such as Sumithion at 0.1 ppm (Sasa *et al.*, 1964) the fish could get eliminated at higher concentrations (about 4.0 ppm). Other factors that could eliminate the fish would include detergents garbage etc. These may prevent the build up of fish populations to attain their maximum potential.

In an intensive integrated program, it may be necessary for the Municipal authorities to continuously monitor the populations of fish as these populations may decrease due to drying of water or for other reasons. It is also necessary that instructions should be given to spraying teams to avoid insecticide spraying into canals already colonized by *P. reticulata*. By doing this the Municipality could save large sums of money now spent on insecticides which could then be more profitably used for the purchase of insecticides for spraying into mosquito breeding habitats where fish cannot be effectively used for their control.

## ACKNOWLEDGEMENTS

I am thankful to Messrs T. B. Wanninayake, T. Gunawardene and Misses S. Kao, Y. Lokuwithana and R. Abeyratne for help with the field studies.

## REFERENCES

BAY, E. C. & SELF, L. S., 1972

Observations on the guppy *Poecilia reticulata* Peters in *Culex pipiens fatigans* breeding sites in Bangkok, Rangoon and Taipei. Bull Wld. Health, Org. 46 407-416.

G. C. JOSHI, B. L. WATTAL and V. N. BHATNAGAR, 1978,

Efficacy of larvivorous fish *Poecilia reticulatus* (Peters) for the contol of *Culex pipiens fatigans* Wied in a rural area of Delhi. J. Com. Dis. 10, 238-243.

MATHIS, H. L., NELSON, M. J. & G. P. PANT, 1976,

*Culex fatigans* and the larvivorous guppy *Poecilia reticulata* in Bangkok, Thailand II Mosquito control by fish. WHO/VBC/76.641.

PRAKONG, U., M. J. NELSON and B. PANTHUMACHINDA, 1975,

Control of *Culex pipiens fatigans* (W) by the larvivorous fish *Poccilia reticulata* and by removal of debris from the breeding habitat. WHO/VBC/75.572.

SASA, S., KURIHARA T., DHAMVANIJ O. and HARINASUTA C., 1965,

Studies on mosquitoes and their natural enemies in Bankgok Part III Obsrevations on a mosquito eating fish guppy *Lebistes reticulatus* breeding in polluted waters.
Jap. J. Exp. Med., 35. 63-80.

SITTARAMAN, N. L., MAHADEVAN, S. and SWARNIDAS, S. 1976,

Biological control of *A. stephensi* larvae in wells by *Poecilia reticulata* in Greater Hyderabad City, India. J. Com., Dis. 8, 315-319.