

Control of *Aedes aegypti* larvae in household water containers by Chinese cat fish

WU NENG,¹ WANG SHUSEN,² HAN GUANGXIN,³ XU RONGMAN,⁴ TANG GUANGKUN,⁵ & QIAN CHEN⁶

In 1980-81 an outbreak of dengue fever occurred in Guangdong province and in Guangxi-Zhuang autonomous region in the central-southern part of China. Subsequently, a nationwide survey indicated that the vector of the disease, Aedes aegypti, was confined to the coastal strip of Guangdong and Guangxi-Zhuang. Since the first case in the outbreak occurred in Guangxi-Zhuang, a community-based programme to control A. aegypti was set up in eight fishing villages of this region where the mosquito was breeding in household water containers. The principal method of control was use of the indigenous edible fish Clarias fuscus (Chinese cat fish), which is highly larvivorous and tolerant of harsh environmental conditions. Each container was stocked with a young fish, which could survive there for periods of up to a year. A team of primary medical personnel (barefoot doctors) made sure that the programme was correctly implemented. The programme was monitored from 1981 to 1985 in three of the villages, and the results indicated that the Breteau index remained at a low level throughout this period.

Although more than 40 different biological agents for the control of mosquito larvae have been reported, only fish have shown promise for deployment in operational control programmes. Previously, attention has been directed mainly to fish of the genus *Gambusia* for the control of the larvae of *Anopheles* and *Culex* species that breed in large stretches of water such as rice fields, ponds, and canals. Here we report the results of a dengue fever prevention programme carried out between 1981 and 1985 in eight fishing villages in the coastal area of Guangxi-Zhuang autonomous region, China. The approach involved use of the indigenous edible fish *Clarias fuscus*

(Chinese cat fish) to control *Anopheles aegypti* larvae breeding in household water containers.

MATERIALS AND METHODS

In 1980-81 there was an outbreak of dengue fever in Guangxi-Zhuang autonomous region and Guangdong province in central-southern China. Since the first case was confirmed in the coastal region of Guangxi-Zhuang, a surveillance group was set up there to survey the distribution of *A. aegypti*, the principal vector of the disease in the epidemic area, and to devise methods of controlling the mosquitos. The results of the survey indicated that indoor household water containers were the most frequent breeding sites for the mosquitos, and a pilot study was set up to investigate the suitability of using Chinese cat fish to control the number of larvae in the containers (1).

Voracity of *Clarias fuscus*

In a separate laboratory study, it was determined that, on average, specimens of *C. fuscus* of 4-6 g body weight ate 227 *A. aegypti* 4th instar larvae per

¹ Professor and Head, Department of Medical Entomology, Guangxi Institute of Parasitic Diseases Control, 80 Tao Yuan Road, Nanning, Guangxi-Zhuang, China. Requests for reprints should be sent to this address.

² Associate Professor, Department of Medical Entomology, Guangxi Institute of Parasitic Diseases Control, Guangxi-Zhuang, China.

³ Director, Baihai City Anti-epidemic Station, Guangxi-Zhuang, China.

⁴ Associate Researcher, Institute of Microbiology and Epidemiology, Academy of Military Medical Sciences, China.

⁵ Physician, Fangcheng County Anti-epidemic Station, Guangxi-Zhuang, China.

⁶ Director, Hepu County Anti-epidemic Station, Guangxi-Zhuang, China.

day, while those of body weight 14 g ate 1000 larvae per day (2). Still larger fish of 40–50 g body weight ate 1500 larvae per day. Small fish, although they were less voracious, were nevertheless more suitable for keeping in the household water containers in the study villages, were less likely to escape, and could be bought more readily and cheaply at local markets.

Tolerance of Clarias fuscus to the environment

C. fuscus is widely distributed in the tropical and subtropical regions of the world; the Chinese strain of the fish is relatively small, adults weighing 50–100 g. Chinese cat fish are able to tolerate inhospitable environmental conditions, and, for example, can survive in polluted water having a free chlorine concentration of 4 mg/l as well as in water that has a low free oxygen content. These characteristics make *C. fuscus* well suited to withstand the harsh conditions that can prevail in the water containers in the study villages. Fish were provided with a few grains of boiled rice as a food supplement, and could live for up to a year in the containers.

Impact on population density of Aedes aegypti

The efficacy of using *C. fuscus* as a method of controlling *A. aegypti* larvae was investigated in one of the villages. The population index of larvae in the containers was first determined, and each container was then stocked with a cat fish. Containers were subsequently surveyed 1 month after the fish had been released. As shown in Table 1, the fish significantly reduced the house and container indices, although it should be noted that some containers still contained larvae; further analysis revealed, however, that the fish had escaped from these containers.

In a subsequent study in another village, carried out between January and July 1982, no *A. aegypti* larvae

Table 1. Efficacy of control of *Aedes aegypti* larvae by *Clarias fuscus* in water containers

	Before fish were introduced	One month after the fish were introduced
No. of houses inspected	260	192
No. of houses with larvae in containers	108	21
House index	41.5	10.9 ^a
No. of containers inspected	358	271
No. of containers with larvae	123	21
Container index	34.4	7.8 ^a
Breteau index	47.3	10.9 ^a

^aVery significant, $P < 0.001$.

were found in 1324 water containers that were each stocked with one cat fish, while larvae were breeding in 43 out of 1408 unstocked containers in the same village (Table 2).

Effectiveness of various methods of controlling mosquitos

The following methods of controlling *A. aegypti* were compared in different study villages in Guangxi-Zhuang: spraying of the interiors of houses with dichlorvos or fenitrothion; "artificial" approaches, such as eliminating the mosquito breeding sites, changing the water and cleaning the containers once a week, as well as covering the containers; and stocking the containers each with one Chinese cat fish.

Table 2. Effect of *Clarias fuscus* on *Aedes aegypti* larvae in water containers in one of the study villages

Date (1982)	Containers with fish			Containers with no fish		
	No. of containers inspected	No. of containers with larvae	Container index	No. of containers inspected	No. of containers with larvae	Container index
13 January	175	0	0	239	7	2.93
2 March	67	0	0	130	8	6.15
28 June	505	0	0	648	19	2.93
28 July	577	0	0	391	9	2.30
Total	1324	0	0	1408	43	3.05

Table 3. Effectiveness of various methods of controlling mosquitos in fishing villages in Guangxi-Zhuang, China

Method	No. of families	No. of water containers	Before control measure		15 days after control measure		Cost (yuan) ^a
			Breteau index	Adult mosquito density	Breteau index	Adult mosquito density	
Indoor aerial spraying	50	118	64	7	48	2	15
Artificial method	50	112	44	6	12	1	—
Fish	50	97	50	7	0	0	1
No action	50	87	60	4	64	5	—

^a Data are costs for 7 months' control; 1 yuan = US\$ 0.31.

Spraying with insecticide immediately killed mosquitos that were at rest indoors, but, as the results in Table 3 show, 15 days after spraying the Breteau index was 48, whereas prior to spraying it was 64. In principle, "artificial" methods of control are straightforward to carry out, and, in addition to their low cost, should be effective. Nevertheless, in practice they were difficult to implement and 15 days later, the Breteau index was still 12. Stocking each container with a Chinese cat fish, however, proved a highly effective means of controlling the mosquitos, and 15 days after initiation the Breteau index was zero. In addition, the cost of keeping the fish for 7 months from April to October was fifteen times less than that of spraying houses with insecticide.

RESULTS AND DISCUSSION

A dengue fever control programme has been carried out since 1980 in eight fishing villages in the coastal region of Guangxi-Zhuang where *A. aegypti* breeding sites were identified in a preliminary survey. Altogether, 10 849 families live in the villages. A provisional working team consisting of three local primary health care personnel was set up, and a community-based integrated vector control programme was inaugurated. Members of the working team were trained on general aspects of dengue fever, with particular emphasis on control of *A. aegypti*.

The team was charged with carrying out the following tasks:

- organizing the Patriotic Hygiene Movement of village inhabitants (a community-based sanitary programme) and educating them about dengue fever and its prevention, in particular on how to reduce the number of breeding sites of the mosquito vectors;
- setting up in each village a coordinating and data-collecting centre;

—periodically making surveys of larvae in household water containers in order to determine the Breteau index; and

—obtaining the equipment to undertake the operational control project.

The principal method of reducing the population density of vector larvae in the villages was the use of *C. fuscus*. During the initial phases of the programme, the interior of each house in the villages was sprayed with dichlorvos or fenitrothion to eradicate any adult *A. aegypti* that might be resting indoors. Each domestic water container was then stocked with a Chinese cat fish, and the working team checked on a weekly basis whether the containers still had their fish, as well as surveyed the density of *A. aegypti* larvae. If a fish could not be found in a container, the householder concerned was required to replace it within a specified time or pay a fine. On the other hand, householders whose container had a fish, and was consequently free of mosquito larvae, were

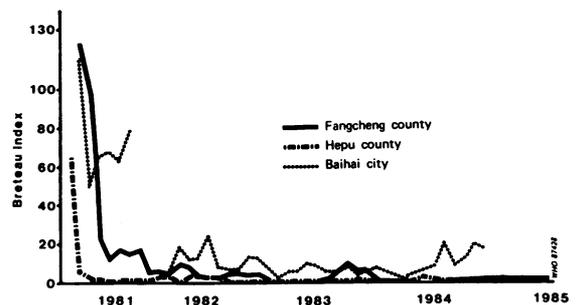


Fig. 1. Breteau index for *Aedes aegypti* larvae from 1981 to 1985 in three villages in Fangcheng county, Hepu county, and Baihai city, Guangxi-Zhuang autonomous region, China.

rewarded with a prize. During the period from April to October, when the weather conditions were most favourable for *A. aegypti* breeding, the working teams were strengthened in order to enforce the control measures.

Three of the villages, located in Fangchen and Hepu counties and Baihai city (consisting of a total of 3022 families and a total population of 14 655), were surveyed from 1981 to 1985 to evaluate the efficacy of the control programme. The results (Fig. 1)

indicate that in these villages the Breteau index for *A. aegypti* larvae decreased sharply soon after the household water containers were stocked with young *C. fuscus* and that the population of *A. aegypti* vectors remained low throughout the 5-year study period.

In the remaining five fishing villages where the vector control programme was conducted, no case of dengue fever has been reported since 1981, although in the neighbouring province of Guangdong there was an outbreak of the disease in 1985.

ACKNOWLEDGEMENTS

The valuable guidance of Professor Lu Baolin in the initial phases of the study is acknowledged. We thank Mr Huang Jianren and Mr Wei Zhouong for their assistance in part of this work. The study was supported financially by the Chinese Committee for Patriotic Hygiene Campaigns.

RÉSUMÉ

LUTTE CONTRE LES LARVES D'*Aedes aegypti* DANS LES RÉCIPIENTS D'EAU À USAGE DOMESTIQUE, GRÂCE AU POISSON-CHAT CHINOIS

En 1980-1981, une poussée de dengue est apparue dans la province de Guangdong et dans la région autonome de Guangxi-Zhuang, situées dans le centre-sud de la Chine. Une enquête menée à l'échelon national à la suite de cette poussée a indiqué que le vecteur de la maladie, *Aedes aegypti*, était confiné le long de la bande côtière de la province de Guangdong et de la région de Guangxi-Zhuang. Comme le premier cas était apparu dans la région de Guangxi-Zhuang, un programme à base communautaire fut mis en place dans huit villages de pêcheurs de la région afin de lutter contre *A. aegypti*; dans ces villages, les moustiques se reproduisaient dans les récipients d'eau à usage

domestique. La principale méthode de lutte a été l'emploi d'un poisson indigène comestible, *Clarias fuscus* (poisson-chat chinois), qui est très larvivore et qui supporte des conditions de vie difficiles. On introduisit dans chaque réservoir un alevin, capable de survivre jusqu'à un an dans ces conditions. Une équipe de personnel médical de base (les "médecins aux pieds nus") vérifiait que le programme était correctement appliqué. Ce programme a été surveillé de 1981 à 1985 dans trois de ces villages, et les résultats ont indiqué que l'indice de Breteau était resté à une valeur faible pendant toute cette période.

REFERENCES

1. NENG, W. & SHUSEN, W. Using fish against mosquito-borne diseases: dengue. *World health forum*, 6: 321 (1985).
2. NENG, W. & SHUSEN, W. Vector control for the prevention of dengue fever in Guangxi, People's Republic of China. *Dengue newsletter*, 11: 77-80 (1985).