ソロモン島における昆虫成長制御剤ピリプロキシフェンの Anopheles farauti に対する野外効力評価

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Field evaluation of a new insect growth regulator, pyriproxyfen, against *Anopheles farauti*, the main vector of malaria in the Solomon Islands[1)]

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Abstract: A field study to control the malarian vector, *Anopheles farauti*, with an insect growth regulator, pyriproxyfen (S-31183), was carried out in northern Guadalcanal in the Solomon Islands. An emulsifiable concentrate of 1% pyriproxyfen was applied to two breeding sites: one with fresh water and another with brackish water. Pyriproxyfen at a dosage of 0.1 ppm inhibited emergence of *An. farauti* completely, at both test sites, for at least 5 weeks after treatment and the efficacy (more than 70% inhibition) lasted for *ca.* 2 months. The body color of the larvae and pupae in the test sites whitened noticeably after the application of the compound.

INTRODUCTION

Larvae of *Anopheles farauti*, the most important vector of malaria in the Solomon Islands, are found in a large variety of water accumulations including brackish water. This species prefers man as a blood source and is an efficient vector of malaria. Because of the exophagy and exophily of adult females, DDT residual sprays are not effective in preventing malaria transmission. Other control measures will have to be established. Larviciding is an effective and practical measure. It is, however, hazardous to non-target organisms and requires extensive manpower, large amounts of chemicals, and frequent treatment of breeding places. Recently some insect growth regulators (IGRs) have been synthesized and used for mosquito control (Axtell *et al.*, 1980; Mulla *et al.*, 1985, 1986; Kawada *et al.*, 1988). IGRs generally have

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a good margin of safety to dominant macroinvertebrates and fish in mosquito breeding sources, and low mammalian toxicity (Miura and Takahashi, 1973, 1974; Mulla *et al.*, 1986). In the present paper we report on the residual efficacy of a new insect growth regulator, pyriproxyfen (S-31183, 4-phenoxyphenyl (*RS*)-2-(2-pyridyloxy) propyl ether), against *An. farauti*, in the field.

Materials and Methods

The experiment was conducted in northern Guadalcanal in the Solomon Islands. Four ground water accumulations were chosen for our trials. Three of the four, Mamara I, Mamara II and Tamboko are located to the northwest of Honiara, and the fourth, Gilutae, to the east (Fig. 1). In Tamboko, the water course expanded and the fresh water was stagnant at the test site (Fig. 2A). The water volume was calculated as 170 m^3 (area: 591.5 cm^2; depth: 0.1 to 0.5 m). Mamara I is a river with fresh water running throughout the year (Fig. 2B). Width of the river was *ca.* 20 m and the depth reached more than 1 m at the deepest. The larvae were found among waterweeds which grew at the edge of the river where it was moderately shallow (*ca.* 0.5 m). Mamara II is a water accumulation closed by a sand bar at the sea shore (Fig. 2C). The water was always brackish (salinity: *ca.* 1%) and the volume was calculated as 70 m^3 (area: 253 m^2; depth: 0.2 to 0.3 m). Gilutae is a large creek formed by a sand bar at the sea shore with a large amount of stagnant brackish water (salinity: *ca.* 1%, Fig. 2D).

An emulsifiable concentrate (EC) of 1% pyriproxyfen provided by Sumitomo Chemical Co., Ltd., Osaka, Japan, was used in this study. Tamboko and Mamara II were treated on September 17, 1987, with 1% pyriproxyfen EC diluted with ten times the amount of water. Using a Hudson's X-pert sprayer, the chemical was evenly sprayed over the water surface of the test areas. The treatment dosage was 0.1 ppm for the water volume.

During a period of *ca.* 4 and a half months after treatment (September 16, 1987 to February 1, 1988) sampling for 4th instar larvae and pupae was conducted ten times including one pre-treatment sample. At each sampling, larvae and pupae with the water from the test sites were collected into a plastic cup and brought back to the laboratory. Larvae were reared in this water for 3 days until pupation. Each pupa was transferred separately to a small plastic container (30 ml) and adult emergence was recorded. In addition, the changes in the larval or pupal body

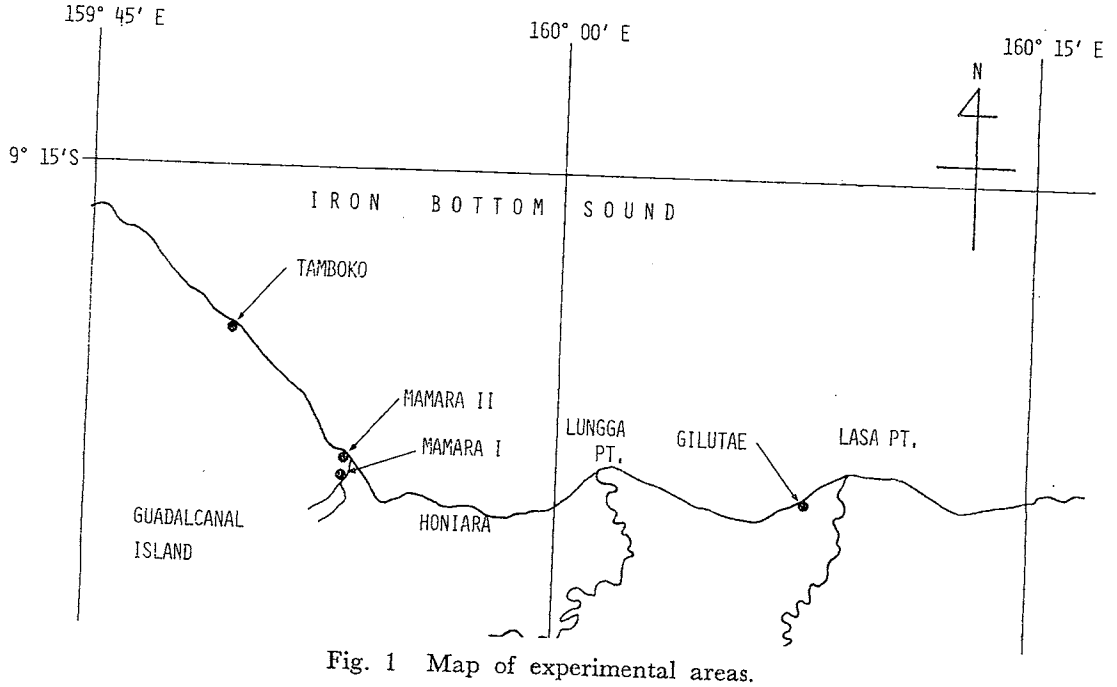
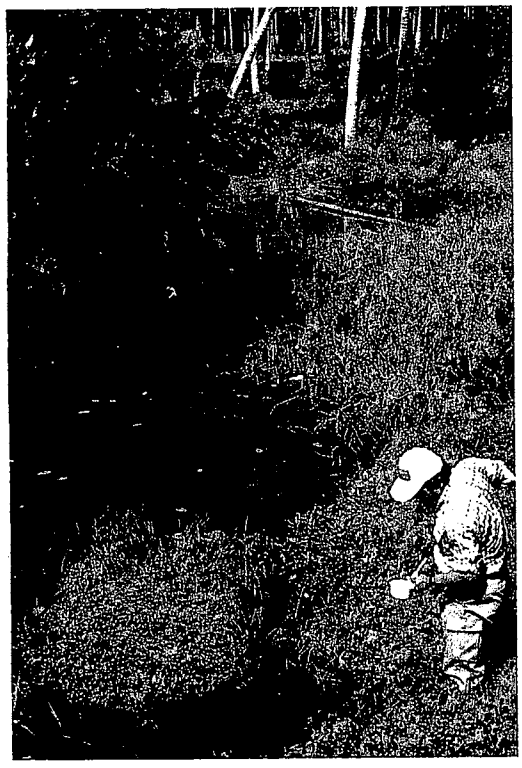
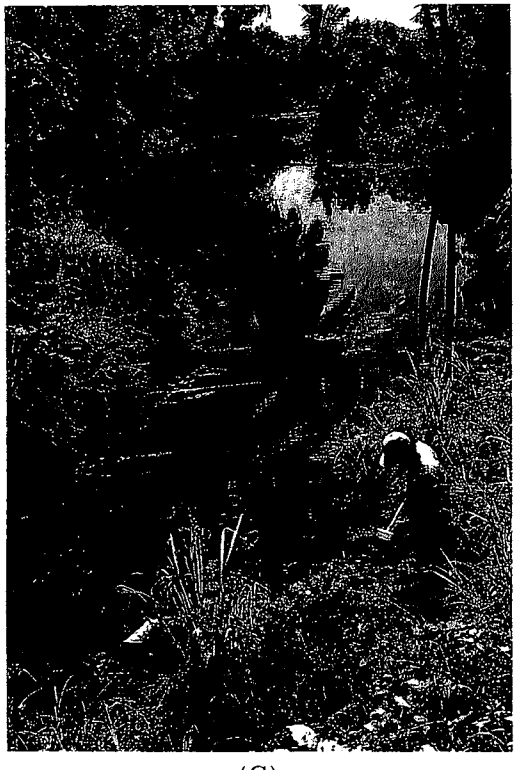


Fig. 1 Map of experimental areas.



(A)

(B)



(C)

(D)

Fig. 2 Landscape at test sites.
A: Tamboko. Pyriproxyfen EC 0.1 ppm treatment (19 km northwest from Honiara, fresh water). B: Mamara I. As control (7 km northwest from Honiara, fresh water). C: Mamara II. Pyriproxyfen EC 0.1 ppm treatment (7 km northwest from Honiara, brackish water). D: Gilutae. As control (24 km east from Honiara, brackish water).

color were macroscopically compared with those of insects in untreated areas. The air temperature in the laboratory was 29±2°C. Precipitation at the test sites could not be recorded because of lack of apparatus.

Results and Discussion

The insect growth regulator, pyriproxyfen, inhibited emergence of *An. farauti* complete-

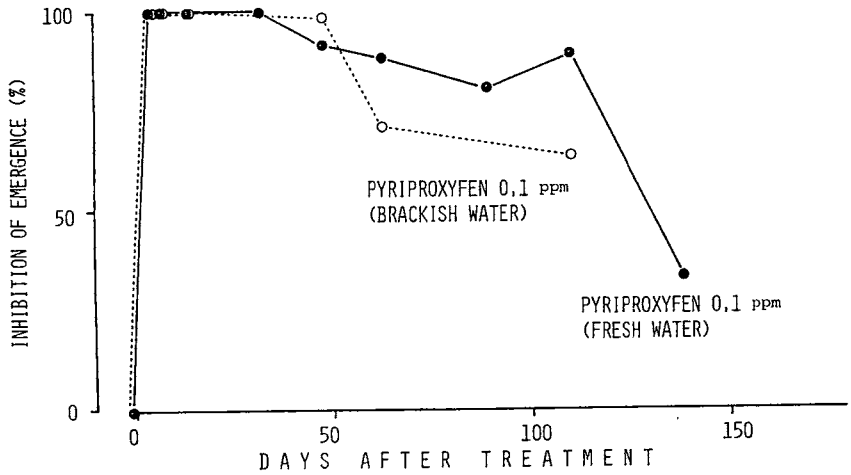


Fig. 3 Residual activity of pyriproxyfen against *Anopheles farauti* under field conditions.

Table 1 Evaluation of efficacy of pyriproxyfen against *Anopheles farauti* in the field.

Days after treatment		Fresh water						Brackish water					
		Test Tamboko			Control Mamara I			Test Mamara II			Control Gilutae		
		♂	♀	%IE	♂	♀	%IE	♂	♀	%IE	♂	♀	%IE
Pre	−1	1/27	0/51	1.3	1/41	0/32	1.4	1/32	0/33	1.5	0/21	0/22	0.0
Post	4	36/36	46/46	100	1/25	1/38	3.2	38/38	36/36	100	1/25	1/27	3.8
	7	37/37	34/34	100	1/41	0/39	1.3	25/25	40/40	100	0/29	2/35	3.1
	14	21/21	20/20	100	0/36	1/50	1.2	32/32	52/52	100	0/55	0/35	0.0
	32	(3/3)	(3/3)	(100)	0/19	0/34	0.0	22/22	38/38	100	0/32	0/26	0.0
	48	25/25	44/45	98.6	1/28	0/32	1.7	25/28	40/43	91.5	1/43	0/39	1.2
	63	12/19	26/35	70.4	0/33	0/41	0.0	29/33	23/26	88.1	—/—	—/—	—
	89	(1/3)	(1/2)	(40.0)	0/28	2/36	3.1	29/39	43/50	80.9	1/29	0/37	1.5
	110	16/21	12/23	63.6	0/34	1/40	1.4	34/42	49/51	89.2	1/21	0/37	1.7
	131	—/—	—/—	—	1/40	0/46	1.2	(0/3)	(0/5)	(0.0)	0/32	1/38	1.4
	138	—/—	—/—	—	0/32	0/26	0.0	12/36	11/33	33.3	—/—	—/—	—

A 0.1 ppm of pyriproxyfen was treated. ♂, ♀, No. of pupal deaths (♂, male; ♀, female); %IE, percent of inhibition of emergence.

ly, for at least 5 weeks after treatment, at both test sites regardless of whether the water was fresh or brackish (Fig. 3 and Table 1). More than 60% of inhibition of emergence resulted even after 110 days. By contrast, the emergence rate in the pre-treatment sample and in the control was always very high, more than 95%. There was no difference between the inhibition rate for males and that for females.

The body color of all the larvae and pupae in the two test sites whitened noticeably after the application of pyriproxyfen. The larvae remained white for *ca.* 8 weeks after treatment and then gradually returned to their original color with the decrease of the inhibition rate. Natural color was always retained in the larvae at the control sites. While juvenile hormone (JH) and JH mimics are known to inhibit melanization of insects such as in Orthoptera and Lepidoptera (Raabe, 1982; Morita *et al.*, 1988), this is probably the first report on inhibition of melanization in mosquito larvae. To investigate this phenomenon, 4th instar larvae collected from control sites were exposed to 1.0–0.125 ppm

pyriproxyfen solution for 4 days in the laboratory. No color change was observed. The result suggests that longer contact with the compound from the younger larval stage or contact with compounds of higher concentration is needed for their color to change. More detailed investigation will be needed.

In conclusion, inhibition of adult emergence of *An. farauti* by the use of the insect growth regulator, pyriproxyfen, was satisfactory. The efficacy (more than 70% inhibition) lasted for *ca.* 2 months in stagnant water at 0.1 ppm treatment. The long-lasting efficacy at low dosages proved that the use of this compound should be a safe and effective larviciding method for malaria vector control. Further study is necessary for large scale field trials, and this is now being planned.

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REFERENCES

Axtell, R. C., D. A. Rutz and T. D. Edwards (1980): Field tests of insecticides and insect growth regulators for the control of *Culex quinquefasciatus* in anaerobic animal waste lagoons. *Mosq. News,* **40**: 36–42.

Kawada, H., K. Dohara and G. Shinjo (1988): Laboratory and field evaluation of an insect growth regulator, 4-phenoxyphenyl(*RS*)-2-(2-pyridyloxy)propyl ether, as a mosquito larvicide. *Jpn. J. Sanit. Zool.,* **39**: 339–346.

Miura, T. and R. M. Takahashi (1973): Insect developmental inhibitors. 3. Effects on nontarget aquatic organisms. *J. Econ. Entomol.,* **60**: 917–922.

Miura, T. and R. M. Takahashi (1974): Insect developmental inhibitors. Effects of candidate mosquito control agents on nontarget aquatic organisms. *Environ. Entomol.,* **3**: 631–636.

Morita, M., M. Hatakoshi and S. Tojo (1988): Hormonal control of cuticular melanization in the common cutworm, *Spodoptera litura*. *J. Insect Physiol.,* **34**: 751–758.

Mulla, M. S., H. A. Darwazeh, L. Ede and B. Kennedy (1985): Laboratory and field evaluation of the IGR fenoxycarb against mosquitoes. *J. Am. Mosq. Control Assoc.,* **1**: 442–448.

Mulla, M. S., H. A. Darwazeh, B. Kennedy and D. M. Dawson (1986): Evaluation of new insect growth regulators against mosquitoes with notes on nontarget organisms. *J. Am. Mosq. Control Assoc.,* **2**: 314–320.

Raabe, M. (1982): Morphological and physiological color change. *In*: *Insect Neurohormones,* pp. 141–162, Plenum Press, New York.

摘　要

ソロモン島における昆虫成長制御剤ピリプロキシフェンの *Anopheles farauti* に対する野外効力評価

昆虫に対して高い幼若ホルモン様活性を示すピリプロキシフェン (S-31183) の *Anopheles farauti* に対する野外効力試験を，ソロモン諸島国，ガダルカナル島北部の淡水および半塩水の発生源で行った．その結果，ピリプロキシフェン乳剤の 0.1 ppm 施用により，淡水，半塩水のいずれの発生源においても約 2 カ月以上にわたって70%以上の防除効果が得られた．ピリプロキシフェンの散布後に採集された幼虫および蛹が白色化しているのが観察され，羽化阻害効果が持続する期間，この現象が続いた．