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Dispersal Experiment of *Aedes togoi*

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ABSTRACT: The dispersal experiment of the adults of *Aedes togoi* was carried out on Uku Island, Nagasaki Prefecture, South Japan in July, 1970, to know how long they can fly to feed on man from their breeding sites at the sea coast in relation to the transmission of malayan and bancroftian filariasis. In total, 6,230 females and 7,540 males differently marked with four dyes were released from 2 sites on the sea coast, and recovery catches were made for 5 days after release at the sea coast and the grassland by the human-bait trap and at two villages by the aspirator and the net. By these catches, 70 females (1.12%) and 9 males (0.12%) were recovered. Based on the number of recovered mosquitoes at each recovery site, it was concluded that females can fly a long distance, perhaps several km, and males have a lesser ability of flight.

Aedes togoi is known as the primary vector of malayan filariasis in China (Gun, 1960), in Korea (Chun, 1968 ; Kim and Seo, 1968 ; Lee, 1969 ; Wada *et al.*, 1974), and in Hachijo-Koshima Island, Japan (Sasa *et al.*, 1952), and also as the secondary vector of bancroftian filariasis in Japan (Omori, 1962). Because the larva of this aedine mospuito breeds mainly in rock pools on the sea coast, villages are frequently situated far from the breeding place of *A. togoi*. Therefore, it is important in understanding the epidemiology of filariasis how long the female of *A. togoi* can fly from the site breeding. For this reason, the dispersal experiment of this mosquito was conducted in 1970 in an area, in which two villages endemic for bancroftian filariasis were located, Uku Island, Nagasaki prefecture, Kyushu, Japan.

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Place and Method

The area where the dispersal experiment was carried out is illustrated in Fig. 1. There were two farming villages, Okubo and Koba, both of which had been highly endemic for bancroftian filariasis (see Omori *et al.*, 1967), though the microfilarial carriers were few at the time of the present experiment owing to drug treatment and anti-vector measures. The primary vector was *Culex pipiens pallens* and the secondary one *A. togoi*.

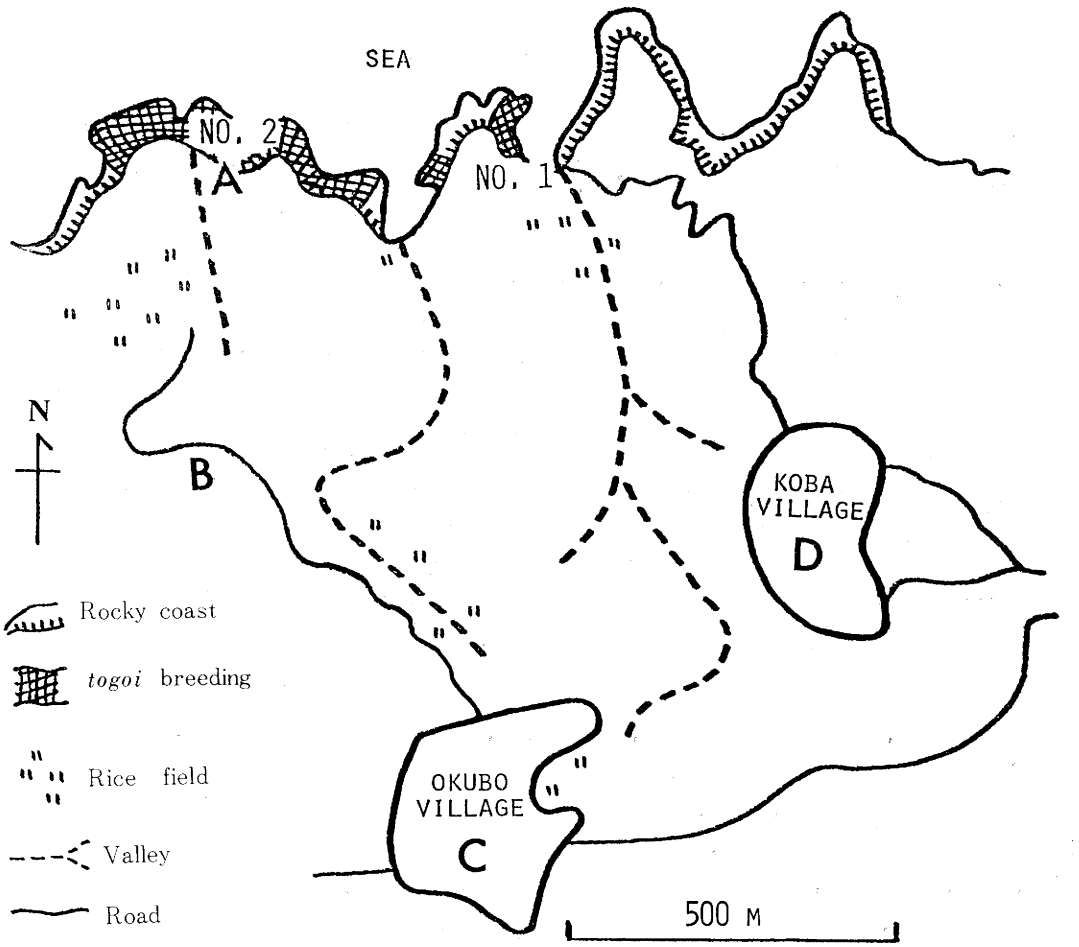

Fig. 1. A map showing the area for the dispersal experiment of *Aedes togoi*. No. 1 and No. 2 indicate the sites of release, and A, B, C and D the sites of recovery catch.

As given in Table 1, the released females and males of *A. togoi* were derived from the two origins. One was the adults which had been reared from the laboratory colony at the Department of Medical Zoology, Nagasaki University School of Medicine, and brought to the area for the experiment; the age at the release was 5–10 days after emergence. The adults of the other origin were obtained from pupae collected from rock pools at the sea coast in the area; the age at the release was 2–3 days after emergence.

Table 1. Females and males of *Aedes togoi* released around 4: 30 AM, July 26, 1970

Origin	Days after emergence	Mark	No. released		Site of release*
			Females	Males	
From laboratory colony	5−10	Crystal violet	900	100	No. 1
		Rhodamine 6G	530	340	No. 1
		Yellow 8G	1,100	1,200	No. 2
From field-collected pupae	2− 3	Kaycoll BZ	3,700	5,900	No. 2
		Total	6,230	7,540	

* See Fig. 1.

In total, 6,230 females and 7,540 males were released after marking them by spraying either of four kinds of dyes in water solution. 0.5% crystal violet, 0.1% Rhodamine 6G, 1.0% Yellow 8G, and 1.0% Kaycoll BZ (the latter three are fluorescent dyes), which had all been confirmed beforehand in the laboratory to have no significant effects on the survival or behavior of *A. togoi* adults. The marked mosquitoes were released from site No. 1 and No. 2 on the sea coast (see Fig. 1) around 4 : 30 AM (just before the daybreak), July 26, 1970, when it was fine and nearly calm.

After the release of the marked mosquitoes on July 26, recovery catches were made until the night of July 30, as shown in Table 2. Mosquitoes were collected by the human-bait trap throughout the night at site A on the sea coast, which was the same place as the release site No. 2, and at site B on the grassland between the sea coast and Okubo Village. Within Okubo Village (site C) and Koba Village (site D), mosquito catches were made by an aspirator and a net at dwelling houses and cowsheds in the nighttime, and at dwelling houses in the daytime. At each dwelling or cowshed, one person spent about 20 minutes, which was usually enough time to catch almost all mosquitoes feeding or resting there.

Collected mosquitoes were brought to the Department of Medical Zoology in Nagasaki City and sorted for species and sex, and mosquitoes identified as *A. togoi* were examined for the dyes with the aid of the fluorescence detection light.

Table 2. Recovery catches for released *Aedes togoi*

Site of recovery catch*	Method	Time	Period
A, on sea coast	By human-bait trap	All night	July 27−30
B, on grassland between sea coast and Okubo Village	By human-bait trap	All night	July 27−30
C, Okubo Village	At 8 dwellings & 6 cowsheds	Nighttime	July 26−30
	At 37 dwellings	Daytime	July 27−30
D, Koba Village	At 10 dwellings & 7 cowsheds	Nighttime	July 26−30
	At 30 dwellings	Daytime	July 27−30

* See Fig. 1 for A, B, C and D.

RESULTS

By the recovery catches given in Table 2, 13 species of mosquitoes were collected. Table 3 shows the numbers of mosquitoes collected at 4 sites for recovery, A,B,C and D. It can generally be said that mosquitoes were abundant near the larval breeding site. For example, *C. pipiene pallens* and *Armigeres subalbatus*, which breed mainly at drains and artificial containers with dirty water around houses, were abundant at dwellings and cowsheds in the villages. Rice field breeders, *Anopheles sinensis*, *C. tritaeniorhynchus summorosus* and *C. bitaeniorhynchus*, were abundant at the grassland and the sea coast near the rice field as shown in the catches by the human-bait trap, and a fairly large number of *C. tritaeniorhynchus summorosus* were collected in the nighttime at dwellings in Okubo Village facing the rice field (see Fig. 1). However, it is interesting that *A. togoi* was numerous inside as well as outside the villages, which situated ca. 1 km south of the sea coast where the larvae were breeding. The possibility of the breeding of *A. togoi* within the villages at the time of the present experiment could be excluded after the extensive and careful examinations of potential breeding sites.

Table 3. Numbers of females (and males) of mosquitoes collected by the recovery catches given in Table 2

Mosquito species	Human-bait trap		Okubo Village (C)			Koba Village (D)			Total
			Dwelling		Cowshed	Dwelling		Cowshed	
	(A)[1]	(B)[1]	night[2]	day[3]	night[4]	night[5]	day[6]	night[7]	
Anopheles sinensis	276 (1)	111	60 (1)	19	15	3	5	2	491 (2)
An. sineroides		4	4	2	3		1		14
Aedes togoi	212 (17)	202 (4)	77 (14)	230 (22)	10 (1)	24 (2)	72 (20)	5	832 (80)
Ae. nipponicus							1		1
Ae. albopictus			3	18 (1)		2	22 (3)		45 (4)
Ae. vexans nipponii	3	3	4		1	1			12
Armigeres subalbatus	2 (1)	7	13 (4)	52 (22)	3	11 (16)	88 (27)	32 (6)	208 (76)
Culex vorax							1		1
C. bitaeniorhynchus	36	183	10 (1)	3		1	1		234 (1)
C. whitmorei	1								1
C. pseudovishnui	11	20	5	1	4	2	1	6	50
C. tritaeniorhynchus summorosus	64	89	101	10	12	1	6	34	317
C. pipiens pallens	19	11	64 (12)	232 (47)	2	243 (135)	388 (341)	22 (5)	981 (540)

1) in 4 all nights ; 2) at 8 dwellings at 5 nights; 3) at 37 dwellings in 4 days; 4) at 6 cowsheds in 5 nights; 5) at 10 dwellings in 5 nights; 6) at 30 dwellings in 4 days; 7) at 7 cowsheds in 5 nights.

Among 6,230 females and 7,540 males released from the two sites, 70 females and 9 males were recovered as given in Table 4. It is shown that the percentage recovery rates were very similar in the females released at the same site; the percentages of the females

marked with Crystal violet and Rhodamine 6G which had been released from site No.1 were 0.56 and 0.57, and those with Yellow 8G and Kaycoll BZ from site No. 2 were 1.55 and 1.22. This indicates that there was no difference in the dispersal of females marked with different dyes. Also, such a high recovery rate of females as 1.12 % suggests that the mosquito catches were adequately done to recover the marked *A. togoi*.

Table 4. Numbers of recovered females of *Aedes togoi*

Site of release	Mark	Females			Males		
		Number released	Number recovered	%	Number released	Number recovered	%
No. 1	Crystal violet	900	5	0.56	100	0	0.00
	Rhodamine 6G	530	3	0.57	340	0	0.00
No. 2	Yellow 8G	1,100	17	1.55	1,200	8	0.67
	Kaycoll BZ	3,700	45	1.22	5,900	1	0.02
Total		6,230	70	1.12	7,540	9	0.12

Table 5 gives the number of marked *A. togoi* found in the catches shown in Table 2 at each recovery site. In total, 834 females were collected in which 70 (8.39%) were marked ones, and 80 males in which 9 (11.25%) were marked. The fact that 16 females released from site No. 2 on the sea coast (see Fig. 1) were collected at C (Okubo Village) and 1 male released from No. 2 was collected at D (Koba Village) strongly suggests that *A. togoi* feeding on man in the villages come from the breeding places on the sea coast, since no mosquitoes breed within the villages.

Table 5. Number of marked *Aedes togoi* found in catches at each recovery site

Site of recovery**	Females				Males			
	Number collected	Number (%)* marked			Number collected	Number(%)* marked		
		No.1***	No.2***	Total		No.1***	No.2***	Total
A	212	5(2.36)	25(11.79)	30(14.15)	17	0	8(47.06)	8(47.06)
B	202	3(1.49)	21(10.40)	24(11.88)	4	0	0	0(0.00)
C	317	0	16(5.05)	16(5.05)	37	0	0	0(0.00)
D	101	0	0	0(0.00)	22	0	1(4.55)	1(4.55)
Total	834	8(0.96)	62(7.43)	70(8.39)	80	0(0.00)	9(11.25)	9(11.25)

* % to Number collected.
** See Fig. 1.
*** Site of release.

This suggestion is supported by the distribution of *A. togoi* within the villages Fig. 2 and 3 show the mean numbers of females and males by daytime catches (see Table 2) in each house in Okubo Village. In Fig. 2, the number of marked females recovered is given too. In these two figures, the data by nighttime catches are not included, since the houses and the

cowsheds for the nighttime catches were rather small im number and not evenly distributed within the village. It is apparent that more *A. togoi* were found, and more marked females were recovered, in the northern part of the village which is nearer to the sea coast.

From these facts, it seems certain that released *A. togoi* invaded Okubo Village from the north. In Fig. 4 is shown the supposed main route of the dispersal of *A. togoi* females, based on the results of recovery catches. The dispersal appears to occur mostly along the sea coast and along the valley with gentle slope. The reason why few released mosquitoes were recovered at site D (Koba Village) is not very clear at present, however the precipice at the valley between the release site No. 1 on the sea coast and Koba Village may have been the obstacle for the dispersal of *A. togoi*.

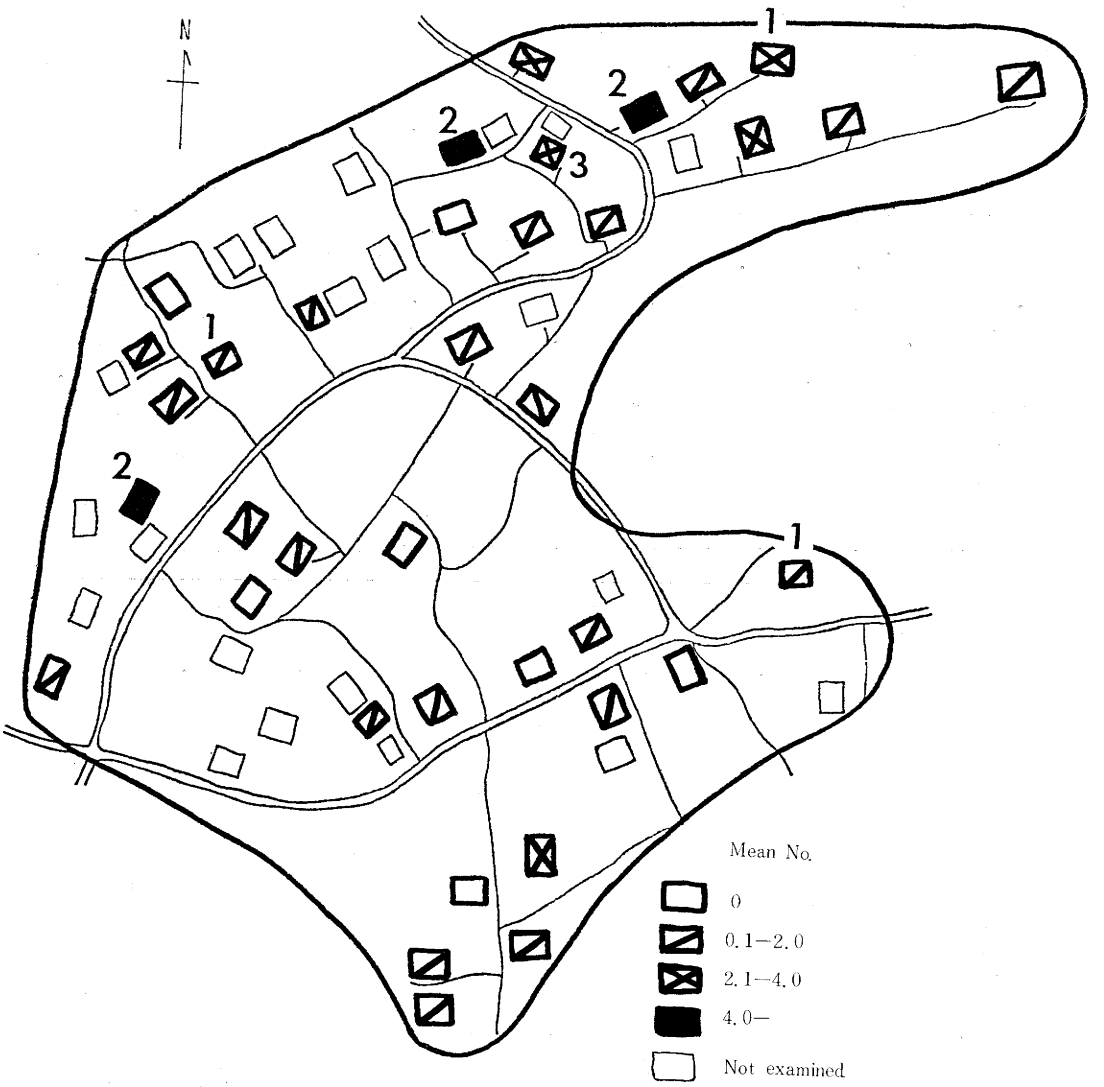

Fig. 2. Distribution of dwelling houses in Okubo Village, showing the mean number per house per day of *Aedes togoi* females by daytime catches, and the number of marked females recovered in each house (Arabic numeral).

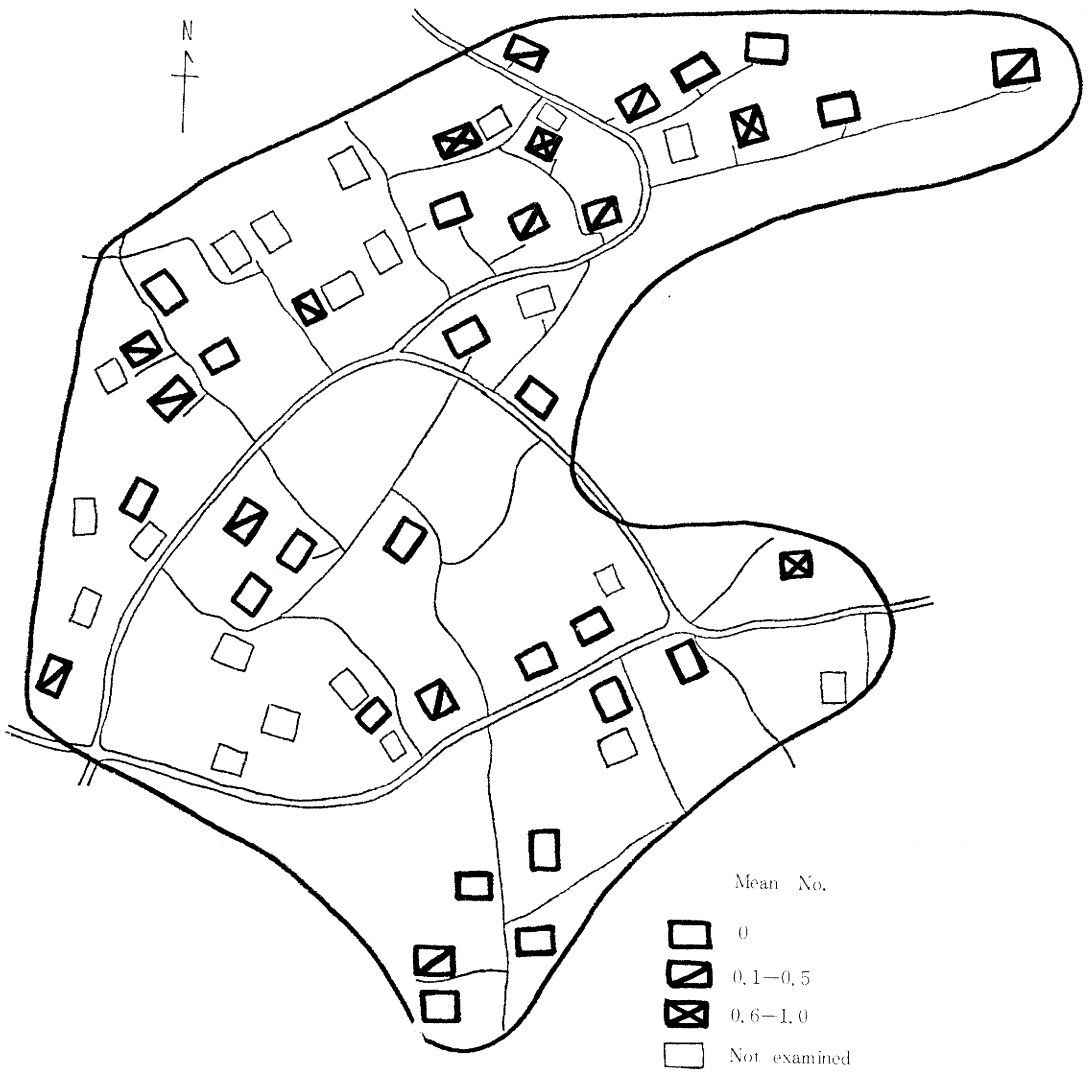

Fig. 3. Distribution of dwelling houses in Okubo Village, showing the mean number per house per day of *Aedes togoi* males by daytime catches.

As illustrated in Fig. 4, among 4,800 females released from site No. 2, 25, 21 and 16 were recovered at the sea coast (A), the grassland (B), and Okubo Village (C), respectively. It is indicated that the decrease in the number of recovered females with the distance from the release site was only slight (recovery site A was the same as release site No. 2), even if we consider the different methods of mosquito catches at site A and B and at site C (see Table 2). This fact is considered to show that released females have the ability to disperse far beyond Okubo Village (C). Since the distance between the release site and Okubo Village was about 1 km, it is said that the females can fly a long distance, perhaps several km. On the other hand, marked males were recovered only at site A on the sea coast, except for

one male at Koba Village (see Table 5). This seems to indicate the lower dispersal ability of males than females.

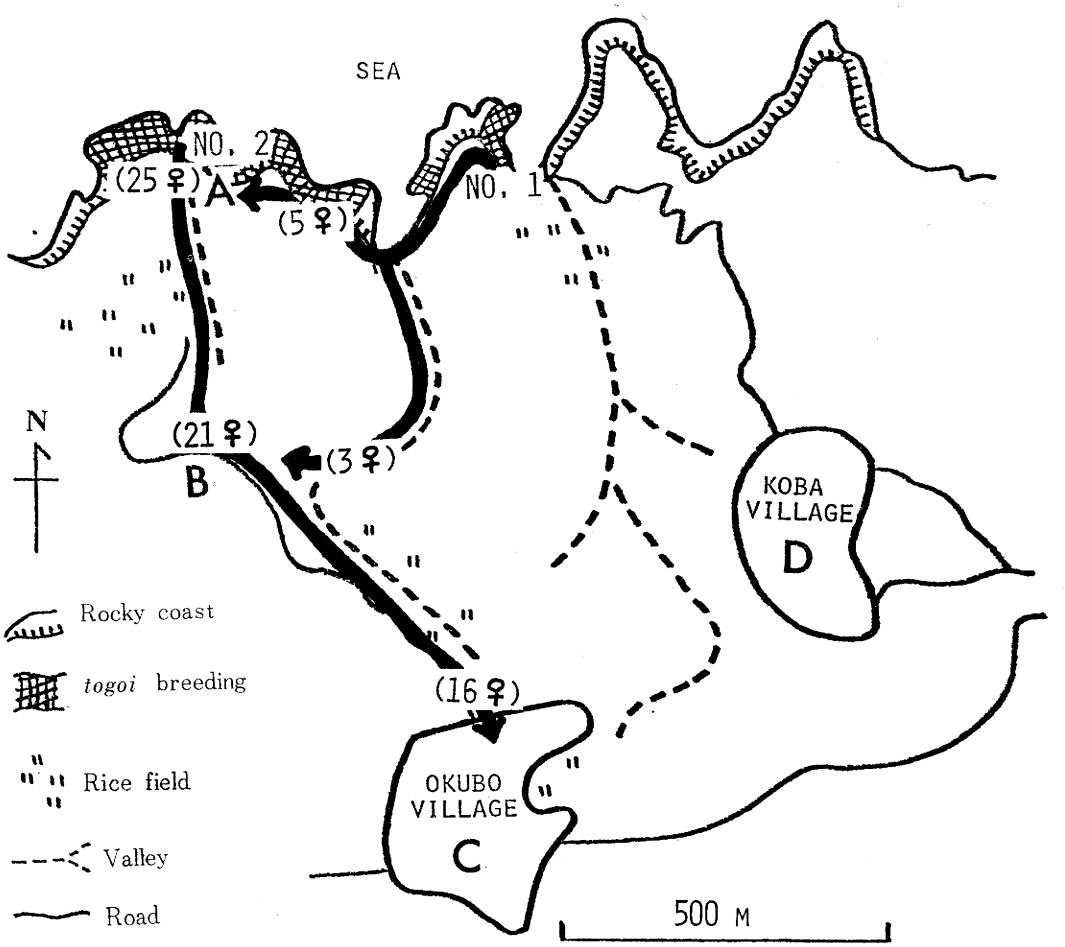

Fig. 4. A map showing the supposed route of the dispersal of released *Aedes togoi* females. Among 1,430 females released from site No. 1, 5 and 3 were recovered at site A and B, and among 4,800 females from No. 2, 25, 21 and 16 were recovered at A, B and C, respectively.

As shown in Table 4 and 5, 70 females and 9 males of released *A. togoi* were recovered at the 4 sites. These recovered mosquitoes were arranged by the time after release in Table 6. In the night of July 27, as many as 15 and 13 females were recovered at site A on the sea coast and at site B on the grassland, respectively, and the number decreased afterwards. This is considered to be due to the natural mortality, and also to the blood feeding from which to the following oviposition the females are not attracted to animals. On July 30, the last day of the recovery catch, a relatively large number of females were recovered only at site A on the sea coast where there were many rock pools suitable for the breeding of this mosquito. This fact may be explained by considering that besides nulliparous females some parous ones

were attracted to the human-bait trap after they oviposited at the rock pools near recovery site A. The decrase of the number of recovered females with the progress of time after release was less remarkable at Okubo Village than that by the human-bait trap. This is probably related to the gradual invasion into the village. In the case of the males, the decrease with time of the number is considered to be due to the natural mortality.

Table 6. Changes of the numbers of recovered females (and males) of *Aedes togoi* with the progress of time after release on July 26

	Human-bait trap (A)*	Human-bait trap (B)*	Okubo (C)*	Koba (D)*
July 26, night	**	**	1	0
27, day	**	**	5	0
night	15(6)	18	2	0
28, day	**	**	0	0
night	5(1)	7	1	0
29, day	**	**	3	0
night	4(1)	3	0	0
30, day	**	**	4	(1)
night	6	1	0	0
Total	30(8)	24	16	(1)

* See Fig. 1.

** Recovery catches were not made (see Table 2).

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トウゴウヤブカの分散実験

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トウゴウヤブカは韓国や中国大陸などでのマレイ糸状虫の主要伝搬蚊であり，またわが国でのバンクロフト糸状虫の二次的伝搬蚊でもある．幼虫は海岸の岩の水たまりに主として発生するので，幼虫の発生場所が人の住んでいる部落から離れている場合が少なくなく，従って，トウゴウヤブカの成虫がどれ位の距離を飛翔分散し得るかが重要な問題となる．そこで，長崎県宇久島において1970年７月に，４種類の色素でマークした雌成虫6,230個体と雄成虫7,540個体を海岸の２地点から放逐し，その後５日間にわたって，海岸と草地では人をおとりとした二重蚊帳を用い，また２つの部落では人家内と牛舎内で，蚊を採集した．その結果，放逐したトウゴウヤブカの中で，70雌（1.12%）と９雄（0.12%）が回収された．放逐地点と採集地点の間の距離と各採集地点での回収個体数とから，雌成虫はかなり大きな飛翔能力を持ち，おそらく数kmは自由に飛びまわるであろうことがわかった．なお，雄は雌よりも飛翔能力は小さいようである．

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