Changes in the Incidence Rates of Bites by the Habu (*Trimeresurus flavoviridis*) in the Okinawa Islands from 1964 to 1996

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沖縄諸島における1964年から1996年の間のハブ咬症率の変化

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Abstract : I describe changes in the incidence rate of bites by the habu (*Trimeresurus flavoviridis*) in the Okinawa Islands from 1964 to 1996. The incidence rate, defined as the number of bite cases per one million of residents per year, was rather constant during each of the following three periods - 1964-1973 (x = 422), 1982-1991 (x = 164), and 1992-1996 (x = 89). Throughout these three periods, the rate reduced in 24 districts (cities, towns and villages), while they did not in 15 districts. Of the latter, three districts exhibited an increase in the incident rate. The reduction was greater in the following elements that are not necessarily mutually exclusive: in most spring and summer months, from evening to midnight, at dawn, on roads, in woods, in most rooms inside the house, during sleep, and when relieving oneself. On the other hand, the reduction was smaller in autumn and winter months, in the daytime exclusive of 12:00-14:00, in gardens and in weeds, when weeding, and during indoor activities exclusive of sleeping and relieving oneself. These results suggest that the frequency of bite cases caused by habus in an active state greatly decreased. A large part of the decrease in the number of bite cases on farm land and when farming was attributable to the reduction in the farming area, although the incidence rate on farm land (yearly number of bite cases / farming area) also reduced from the period of 1982-1991 to the period of 1992-1996.

Key words : Snake bite, Incidence rate change, Habu, *Trimeresurus flavoviridis*, Okinawa

I Introduction

The viperid snake, habu (*Trimeresurus flavoviridis*), is the most dangerous snake species to human inhabitants of the Ryukyu Archipelago, Japan. A number of works have summarized epidemiological data for the habu bite in the Okinawa and Amami Islands[1)-16)]. However, only a few works have described the long term changes in the number of bite cases with statistical examinations[17)18)]. This is probably due to the fact that the aggregated data for the habu bites have been published in a number of different media, and that it was difficult to access the original data sheet of case records of the bite. I have surveyed pertinent literature and unpublished sources for case records of habu bites and estimated the numbers of bite cases in the Okinawa Islands for more than 30 recent years[19)].

Habu bites occur during an encounter between habu and man after the movement of at least one of them, and the probability of a bite in each situation depends on the density and activity of both the snake and man. For the analyses of the risk of habu bite, we should quantify several of these factors, for example, by utilizing human population size in a particular area as an index of human density. In the present work I describe the changes in the incidence rate of the habu bites in the Okinawa Islands from 1964 to 1996, discriminating each of several circumstantial variables of the bite, e.g. the locality, season, and habitat, and utilizing human population size or the farming area as a denominator of the incidence rate.

Ⅱ Methods

The present analysis is based on the numbers of bite cases estimated in other paper[19]. The outline of the estimation process is as follows. The yearly number of bite cases in each element was taken from yearly reports (see other paper[19] for sources) or by recounting the number of the case records[14] in the case that the information in a report was insufficient. When the number for the same year differed among the sources, the largest number was chosen for the analyses. Numbers of cases without data were prorated to each element as the proportion among the cases with data. The number of bite cases in1972 was extraordinarily small and the published data of habitat and of human activity at bites between 1974 and 1976 were not enough to be categorized. Except for these data, the number of bite cases in each element was estimated for each year between 1964 and1996.

Among the circumstantial information of the bite, data on the locality, season, time of day, habitat and

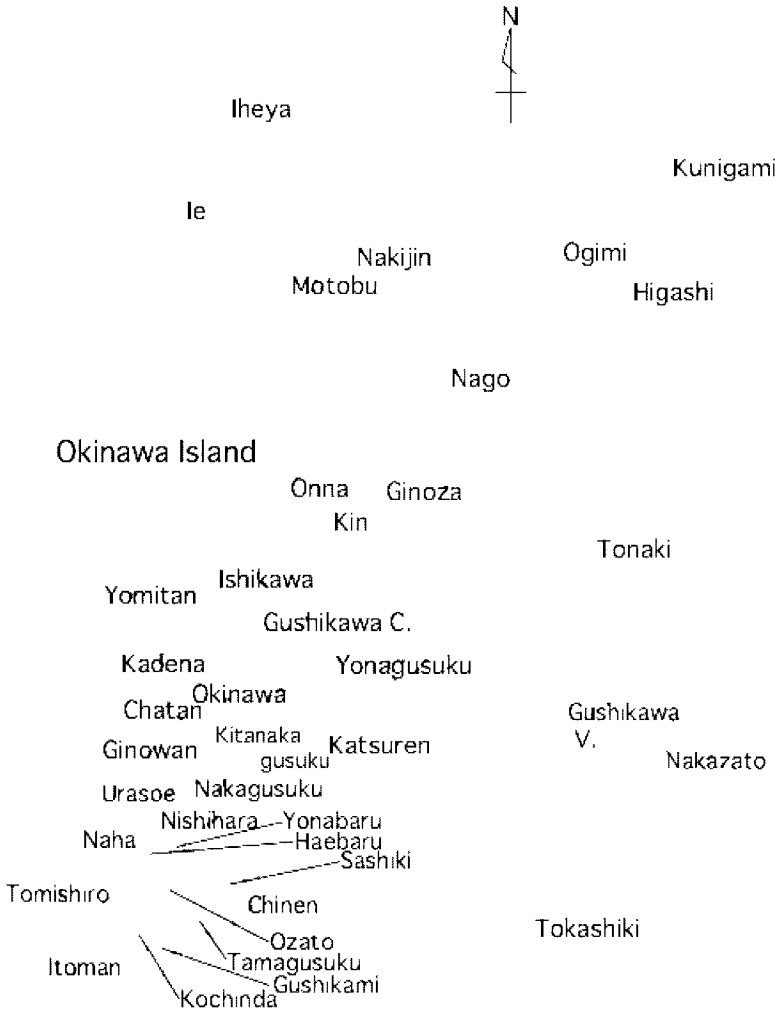

Fig. 1. Map of the Okinawa Islands showing locations of the 39 districts (cities, towns and villages) where the habu is distributed.

図１．沖縄諸島においてハブが分布する 39 市町村の地図.

human activity were sufficiently recorded, and were selected as the variables to be analyzed. Each variable was composed of several elements. The elements of the locality were 39 districts of local government (cities, towns and villages) where the habu is distributed in Okinawa Prefecture (Fig. 1). The elements of season and time of the day were each month and each period of two hours of the day, respectively. The variables of the habitat and the human activity were composed of several major elements and the other two elements (see Fig. 6 and Fig. 7 for all elements). One of the latter two elements, named "other indoor", was an element composed of indoor habitats or of indoor activities other than the major indoor ones, and the other element, named "other outdoor", was an element composed of outdoor habitats or of outdoor activities other than the major outdoor ones.

I adopted the incidence rate of habu bites as the risk of bite in each element. For most elements I defined the incidence rate as the yearly number of bite cases divided by the human population size of the year (Fig. 2). The incidence rates on farm land and when farming were analyzed separately from other habitats and other human activities, respectively, and were calculated by dividing the numbers of bite cases by the

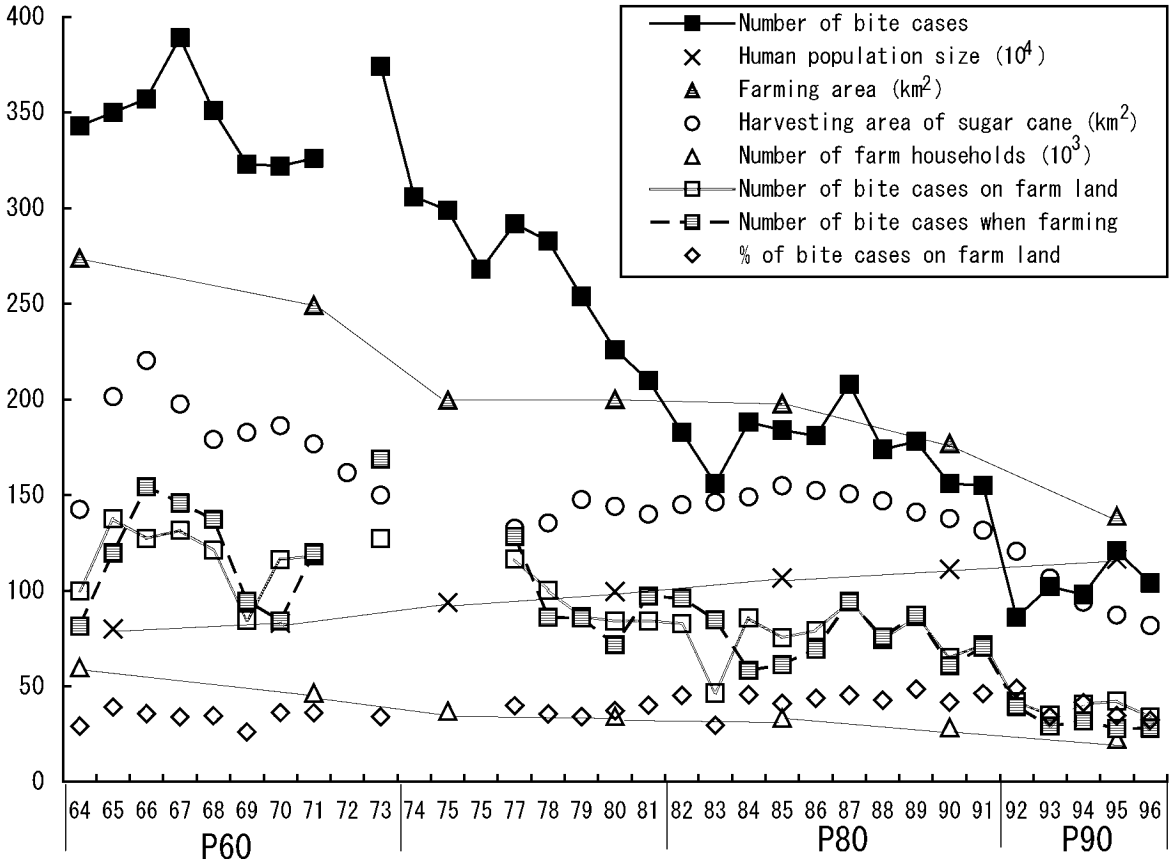

Fig. 2. Changes in the number of bite cases of habu (*Trimeresurus flavoviridis*), human population size, farming area, and the number of farm households in the 39 districts in the Okinawa Islands from 1964 to 1996. See other paper[19] for data sources.

図２．沖縄諸島の 39 市町村における，1964 年から 1996 年の間のハブ咬症件数，人口，農地面積，農家数の変化．資料の原典は，既報[19]を参照.

farming area (km^2) under operation. The number of bite cases on farm roads was not large, and, because of the neutral attribution of the habitat (roads on farm land), was included in other outdoor habitats. The incidence rates in the sugar cane field and when harvesting sugar cane were calculated by dividing the numbers of bite cases by the harvesting area (km^2) of sugar cane. In the analyses other than on the districts, the data on human population size and the farming and harvesting area were the totals of those in the 39 districts (see other paper[19] for the data sources).

In each of the following three periods, 1964-1973 (named P60), 1982-1991 (P80) and 1992-1996 (P90), the number of bite cases in whole districts (Fig. 2) were rather constant. I compared the incidence rates in each element among these three periods, mainly between P60 and P80 because of the small sample size of P90 (n = 5). In these comparisons I used the Kruskal-Wallis test and nonparametric multiple comparisons test of Dunn's procedure at alpha level (double-sided) of 0.1. To describe the trends in a whole period of 1964-1996 in some graphs, I subdivided the period, including a period between 1974-1981, into six groups of 4-7 years, i.e., 1964-1967, 1968-1973, 1974-1981, 1982-1986, 1987-1991, and 1992-1996.

I compared the change pattern of incidence rate through the three periods between each element and the other elements by Fisher's exact test at alpha level (double-sided) of 0.1. In order to avoid over-estimating the number of bite cases in these tests, the total number of bite cases in a period was revised to the same or smaller number, under the assumption that both the length of the period and human population size were the same between the two periods of comparison.

Ⅲ Results

1. General trend

From P60 to P90 the yearly number of bite cases decreased from 348 to 102 and the human population grew by about 1.4 times (Table 1, Fig. 2), meaning that the whole incidence rate reduced to 1/5. From P60 to P90 the farming area and the number of farm households decreased (Table 1, Fig. 2). The decrease in the period from P60 to P80 was greater in the number of farm households than in the farming area. The sugar cane field consisted of more than 2/3 of the farming area throughout the three periods (Table 1).

2. Local incidence rate

From P60 to P90 the human population grew more than twice in six districts near Naha (Chatan, Ginowan, Nishihara, Urasoe, Tomishiro and Haebaru), whereas in 13 districts it diminished. Therefore, there were great regional changes in the denominator of the incidence rate.

Three patterns were recognized in the change of incidence rate among the three periods: reducing from P60 to P80 (and/or from P60 to P90), no significant changes, and increasing from P60 to P80 (Fig. 3). All districts in Fig. 3a, 3b and 3c showed the first pattern. The mean incidence rates (per human population of one million per year) were higher than 1000 in ten districts in the first period (1964-1967), but only in Higashi in the last period (1992-1996) (Fig. 3). Other districts with high incidence rates of more than 500 in the last period were Kunigami, Ogimi and Gushikawa Village. The incidence rates were lower than 100 only in Onna and Tonaki in the first period, but in many districts in the last period.

From P60 to P80 the reduction in incidence rate was greater than the others in Ie, Naha, Gushikawa Village, Nago and Itoman, and smaller or none mainly in the districts in the middle of Okinawa Island and in some districts of southern Okinawa Island (Table 2, Fig. 1). Among the latter districts the increase in the incidence rate was observed in Ginoza, Onna and Kochinda (Fig. 3).

Table 1. Changes in the numbers, incidence rates, and proportions of the bite cases of the habu (*Trimeresurus flavoviridis*) and the human population size and the agricultural indices during the three periods (P60, P80, P90) in the 39 districts where the habu is distributed in the Okinawa Islands.

	P60 (1964-73)		P80 (1982-91)			P90 (1992-96)			
	Mean	S.D.	Mean	S.D.	%/P60	Mean	S.D.	%/P60	%/P80
Human population size [P]	825706	—	1077704	—	131	1154425	—	140	107
No. of bite cases [Bt]	348.3	21.8	176.3	16.0	51	102.2	11.3	29	58
Bt x 10^6 / P	422.3	29.3	163.8	16.6	39	88.5	9.1	21	54
Bt - Bfl	221.7	16.0	99.3	8.4	45	63.6	12.0	29	64
(Bt - Bfl) x 10^6 / P	268.8	21.6	92.4	9.3	34	55.0	9.9	20	60
Farming area [Af] (km^2)	257.5	—	188.9	—	73	146.6	—	57	78
Harvesting area of sugar cane [As] (km^2)	181.9	23.0	145.6	6.7	80	98.1	14.1	54	67
No. of farm households	51870	—	31362	—	60	23538	—	45	75
No. of bite cases on farm land [Bfl]	126.7	14.7	77.0	12.0	61	38.6	3.7	30	50
Bfl / Bt (%)	36.3	3.3	43.5	4.3	120	38.3	6.1	105	88
Bfl / Af	0.494	0.066	0.408	0.063	83	0.264	0.026	54	65
No. of bite cases when farming [Bf]	125.5	26.9	75.6	12.5	60	31.3	4.3	25	41
Bf / Bt (%)	35.8	6.1	43.0	6.8	120	31.4	7.9	88	73
Bf / Af	0.491	0.123	0.401	0.066	82	0.213	0.018	43	53
No. of bite cases in the sugar cane field [Bsf]	56.9	10.6	54.9	14.5	96	19.6	3.3	34	36
Bsf / As	0.315	0.056	0.377	0.098	119	0.203	0.041	64	54
No. of bite cases when harvesting sugar cane [Bhs]	24.3	9.3	16.9	8.0	70	6.8	2.2	28	41
Bhs / As	0.135	0.057	0.117	0.057	87	0.071	0.025	53	61

3. Seasonal incidence rate

The incidence rates (per human population) were close to or lower than 10 only in winter months (December-February) in the first period (1964-1967), but in and after P80 the rates of July and August reduced close to the rates of winter months (Fig. 4). The rates in October were always highest and most (11 out of 12) incidence rates in autumn months were higher than those of the other months in and after the third period (1974-1981).

Compared to the incidence rate in P60, the rate reduced in the months between April and December in P80, and between March and December in P90 (Fig. 4). The rates in January and February did not change significantly. The reduction in the incidence rate was greater in April, May, July and August than in the other months, and smaller between October and March from P60 to P80 or P90 (Table 2, Fig. 4). In September the reduction was smaller from P60 to P80 and greater from P80 to P90.

4. Daily incidence rate

The rank of incidence rate (per human population) in each two hours of a day was similar through the periods, which fact indicated that the daily pattern of habu bites was fixed. Throughout the six periods the incidence rates between 22:00 and 8:00 were low (Fig. 5). The incidence rates at lunch time (a period from12:00-14:00) were always lower than the rates at other daytime.

The incidence rate in each two hours of a day reduced from P60 to P80 and also from P80 to P90 (Fig. 5). The reduction from P60 to P80 (or to P90) was greater in 4:00-6:00 and in 18:00-0:00, and smaller in the daytime between 8:00-18:00, exclusive of a period from 12:00-14:00 (Table 2, Fig. 5).

5. Incidence rate in the habitat exclusive of farm land

Throughout the six periods in Fig. 6, the incidence rates in gardens were highest distinctly, and especially, it was more than three times higher than the rate of any other habitat in the last period (1992-1996). The

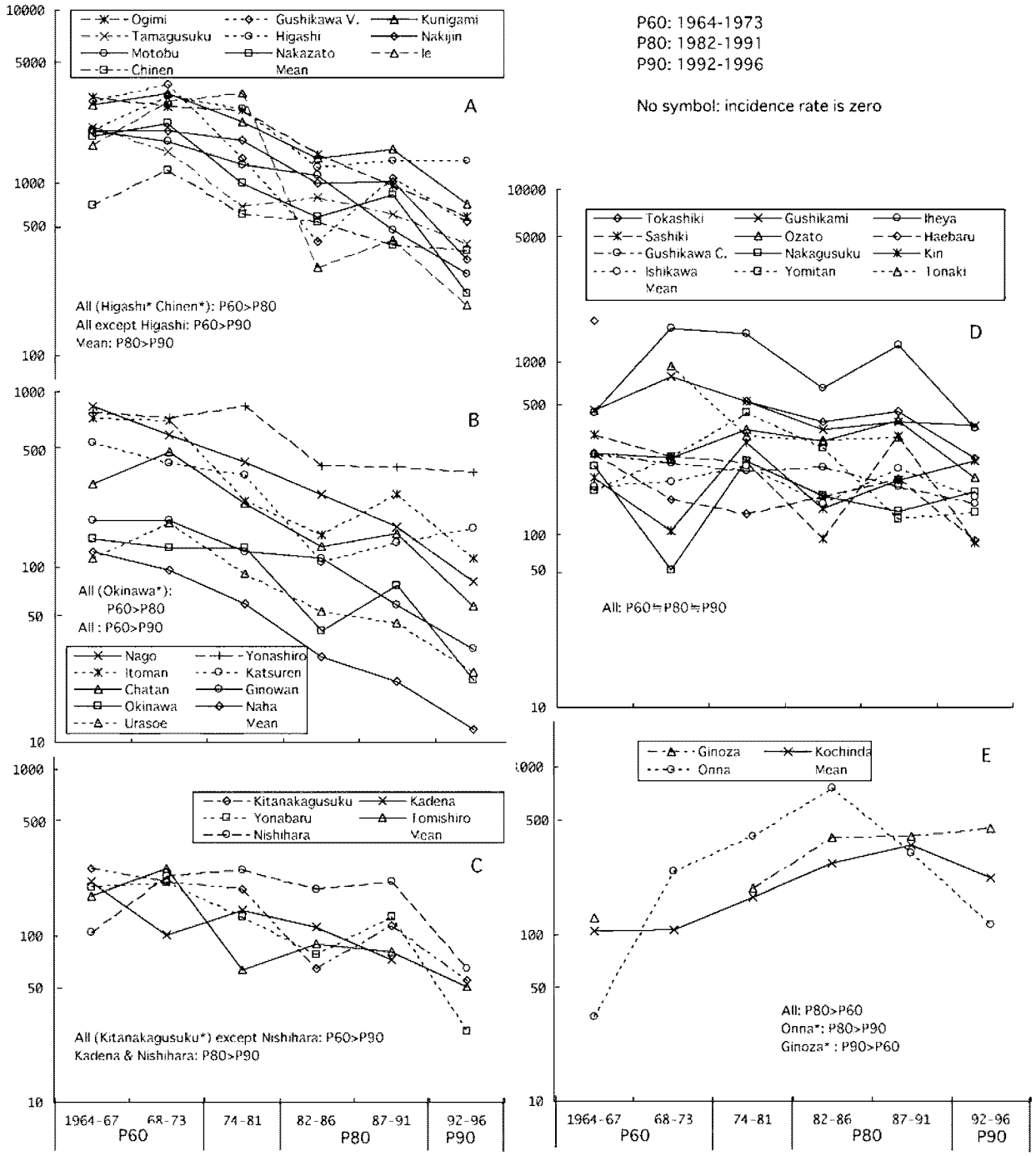

Fig. 3.　Change in the mean incidence rate of bites by the habu (*Trimeresurus flavoviridis*) in each district.　Each graph (A-E) shows districts with similar patterns of changes in the incidence rate among the three periods, P60 (1964-1973), P80 (1982-1991) and P90 (1992-1996).　A: reducing from high incidence rates of P60; B: reducing from middle or low incidence rates of P60; C: reducing from P80 to P90; D: no-change; E: increasing.　Absence of symbols indicates that the value equaled zero.　*: 0.05 < P < 0.1 in nonparametric multiple comparisons test of Dunn's procedure (the other Ps < 0.05).

図３．各市町村におけるハブ咬症率の平均値の変化．A-E のそれぞれは，P60（1964-1973），P80（1982-1991），P90（1992-1996）の３期間の間において，咬症率が似た変化をした市町村を集めた．咬症率が，A：P60 の高い値から減少；B：P60 の中程度か低い値から減少；C：P80 から P90 の間に減少；D：増減なし；E：増加．記号無しは，咬症率が零．*：Dunn のノンパラメトリック多重比較検定の結果，0.05 < P < 0.1 のもの（それ以外では，P < 0.05）．

Table 2. Change patterns of the incidence rate through the three periods. The total number of bite cases of each element was compared to those of the others between the couple of periods, after adjusting the number to the shorter period and to smaller size of human population of the two periods (Fisher's exact test, $P < 0.05$ except * as $0.05 < P < 0.1$).

	Decrease in proportion			Increase in proportion		
	P60 > P80	P60 > P90	P80 > P90	P60 < P80	P60 < P90	P80 < P90
District	Ie	Ie	Motobu*	Iheya	Higashi	Kin
	Naha	Nago	Kadena*	Onna	Ginoza	Higashi*
	Gushikawa V.	Naha		Ginoza	Kin	Yonashiro*
	Nago*			Kin	Ishikawa	Katsuren*
	Itoman*			Ishikawa	Gushikawa C.	
				Yomitan	Yonashiro	
				Gushikawa C.	Yomitan	
				Nakagusuku	Nakagusuku	
				Nishihara	Kochinda	
				Haebaru	Gushikami	
				Kochinda	Ozato	
				Ozato	Onna*	
				Nakijin*	Chinen*	
				Sashiki*		
				Gushikami*		
Month	April	April	September	January	January	October
	May	May		February	February	
	July	July		September	October	
	August			October	November	
				November	December*	
				December		
				March*		
Time of day	4-6			8-10	10-12*	14-16*
	20-22			14-16		
	22-0			16-18*		
	18-20*					
Habitat	Lavatory & bath	Roads*		Gardens	Gardens	
	Roads			Weeds		
	Woods					
	Other indoor*					
Human activity	Sleep	Sleep		Weeding	Weeding	
	Releaving oneself	Releaving oneself		Other indoor*		

incidence rates in the kitchen, and lavatory and bath were low.

The total incidence rates (per human population) of all habitats exclusive of farm land in P60 reduced to 1/3 in P80 and to 1/5 in P90 (Table 1, Fig. 6). Incidence rate in each habitat exclusive of farm land reduced from P60 to P80 and from P60 to P90 (Fig. 6). The reduction in the incidence rate from P60 to P80 (and P60 to P90) was greater on roads, in woods, in lavatory and bath and in other indoor habitats, and

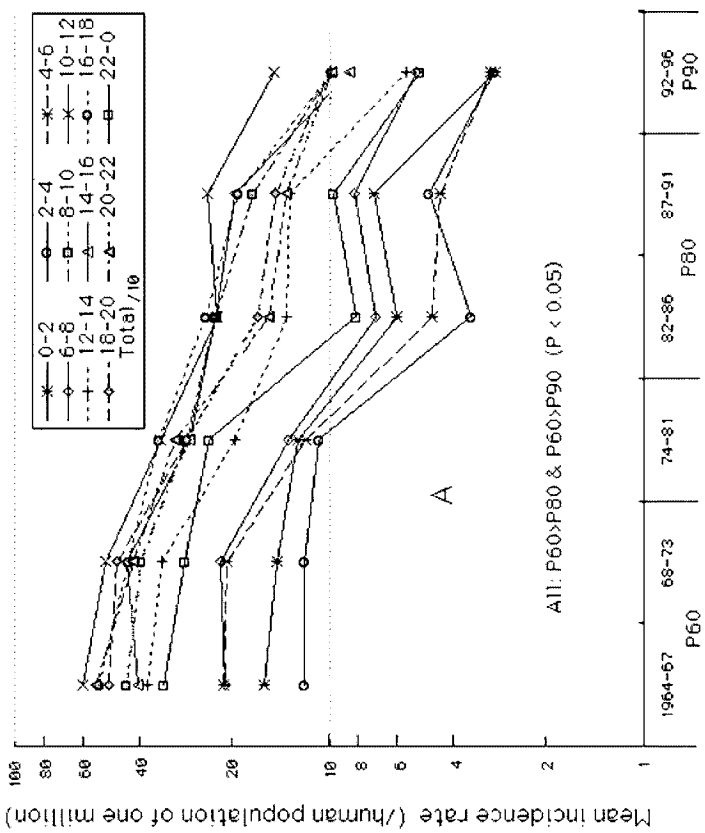

Fig. 4. A. Changes in the mean monthly incidence rate of bites by the habu (*Trimeresurus flavoviridis*). B. The total proportions of the incidence rates in months with greater (open triangle) and smaller (closed circle) reduction (see Table 2). Data for September, showing highly variable pattern, were excluded.

図 4．A．月ごとのハブ咬症率の平均値の変化．B．咬症率の割合を，咬症率の減少が大きい月（白抜き 3 角形）と小さい月（黒丸）の別に（表 2）合計した値の変化．いずれにも属さない 9 月は除く．

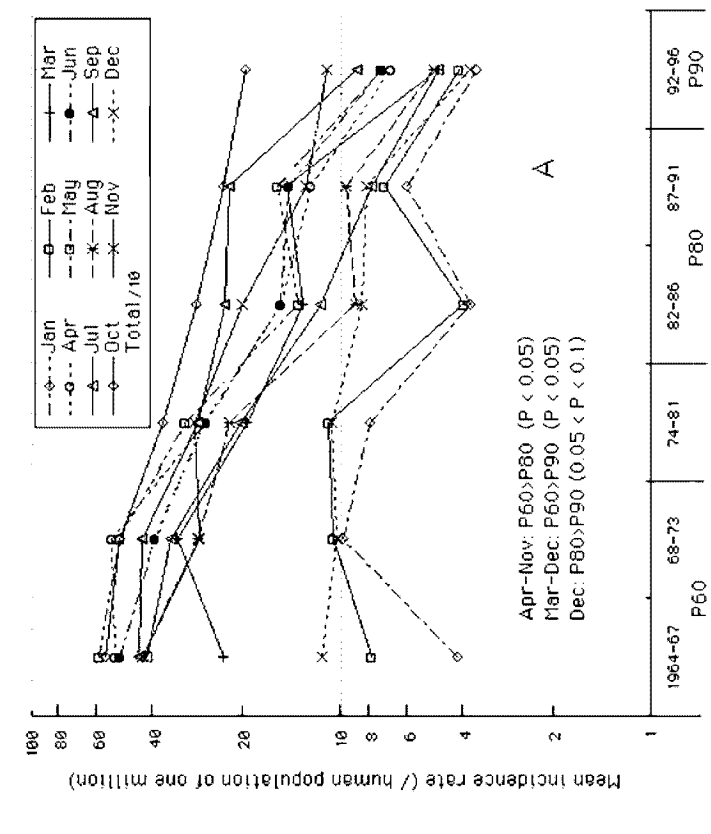

Fig. 5. A. Changes in the mean incidence rate of bites by the habu (*Trimeresurus flavoviridis*) in each time of the day. B. The total proportion of the icidence rates with greater (open triangle) and smaller (closed circle) reduction (Table 2).

図 5．A．時刻ごとのハブ咬症率の平均値の変化．B．咬症率の割合を，咬症率の減少が大きい時刻（白抜き 3 角形）と小さい時刻（黒丸）の別に（表 2）合計した値の変化．

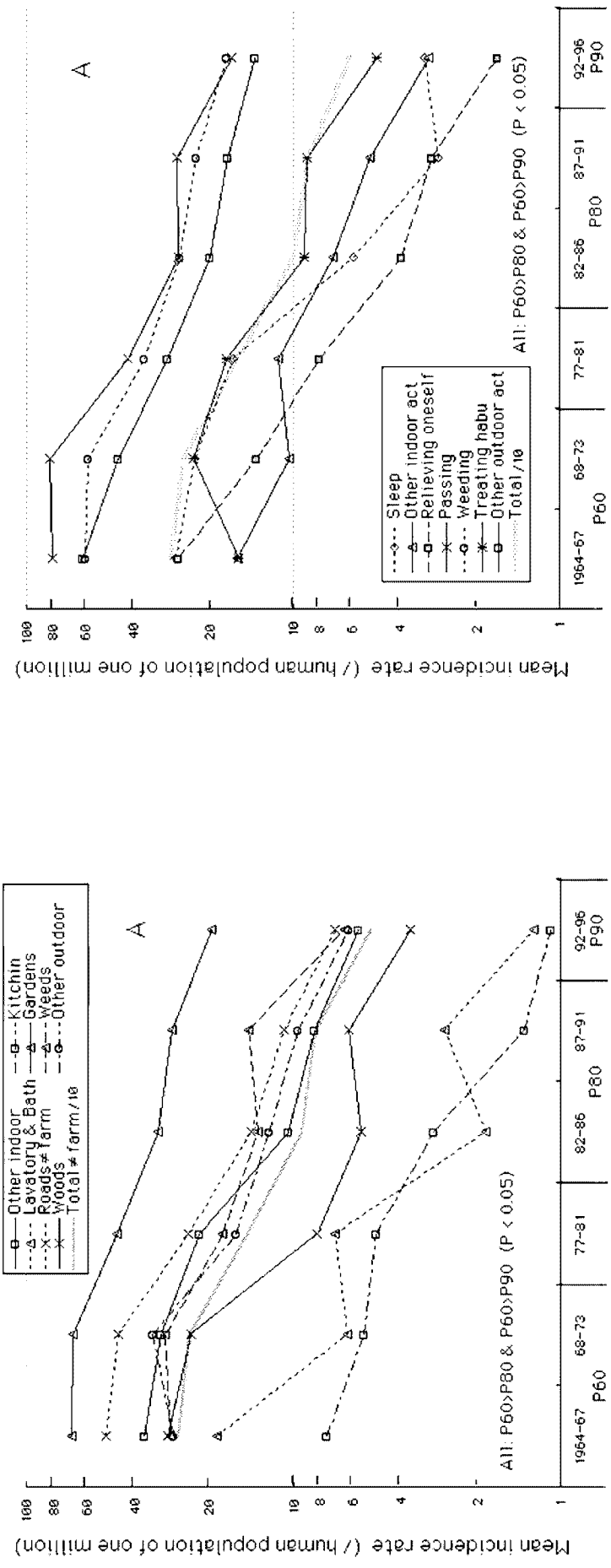

Fig. 6. A. Changes in the mean incidence rate of bites by the habu (*Trimeresurus flavoviridis*) in each habitat (exclusive of on farm land). B. The total proportion of the incidence rates with greater (open triangle) and smaller (closed circle) reduction (Table 2).

図 6．A．農地をのぞく場所ごとのハブ咬症率の平均値の変化．B．咬症率の割合を，咬症率の減少が大きい場所（白抜き 3 角形）と小さい場所（黒丸）の別に（表 2）合計した値の変化．

Fig. 7. A. Changes in the mean incidence rate of bites by the habu (*Trimeresurus flavoviridis*) during each type of human activity (exclusive of when farming). B. The total proportion of the incidence rates with greater (open triangle) and smaller (closed circle) reduction (Table 2).

図 7．A．農作業をのぞく人の活動ごとのハブ咬症率の平均値の変化．B．咬症率の割合を，咬症率の減少が大きい活動（白抜き 3 角形）と小さい活動（黒丸）の別に（表 2）合計した値の変化．

was smaller in gardens and in weeds (Table 2, Fig. 6).

6. Incidence rate during each type of human activity exclusive of farming

Among the types of human activities exclusive of farming, passing, weeding and other outdoor activities were associated with the top, second and third in incidence rates (per human population), respectively, in most of the six periods (Fig. 7). The incidence rate during each type of human activity exclusive of farming reduced from P60 to P80 and from P60 to P90 (Fig. 7). The incidence rates during sleep and when relieving oneself reduced more greatly than the others and became the lowest two in and after the fourth period (Table 2, Fig. 7). The reduction in the incidence rate when weeding and during other indoor activities was smaller from P60 to P80 and from P60 to P90 (exclusive of other indoor activities). The incidence rate when weeding was close to that at passing in and after the fourth period (1982-1986).

7. Incidence rates on farm land and when farming

The mean number of bite cases on farm land was 36% of the total number of bite cases in P60. The proportional number of bite cases on farm land in the decreased number of bite cases in P80 accounted for 29% (Fig. 8). Therefore, the decrease in the number of bite cases from P60 to P80 was smaller on farm land

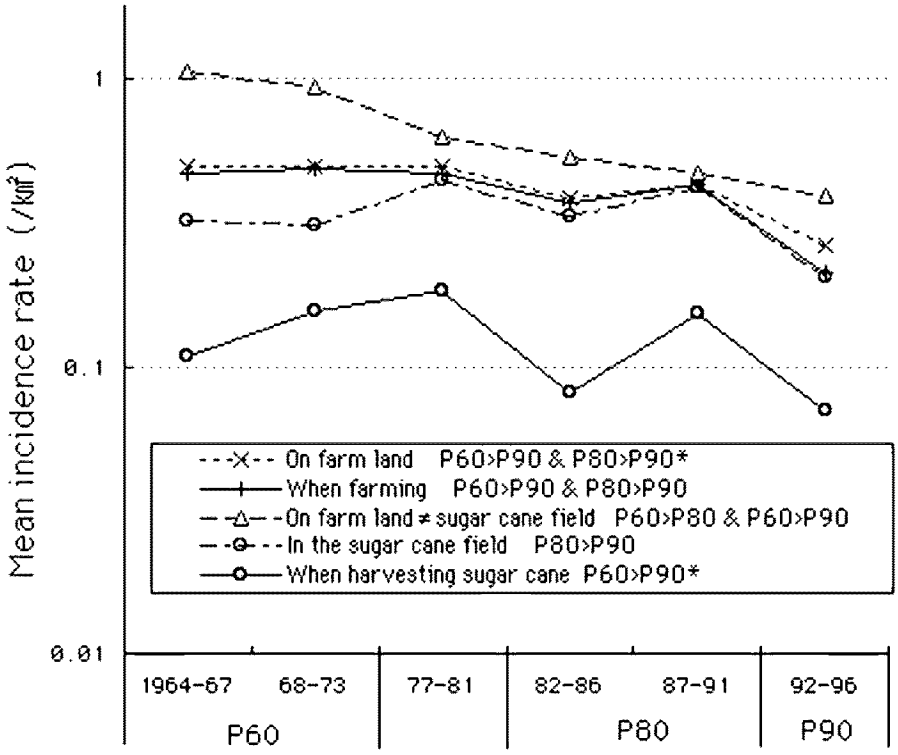

Fig. 8. Changes in the mean number of bite cases of *Trimeresurus flavoviridis* among the three periods (P60, P80 and P90) and the means of the number and proportion of bite cases on farm land. The decreased numbers of bite cases on farm land were divided to those attributed to the decreases in the farming area (a product of the number of bite cases in the farming area in the previous period and proportional area of decrease) and to the reduction in incidence rate per area (the residual number in the decrease).

図８．３期間（P60，P80，P90）の間におけるハブ咬症件数の平均値の変化を，農地における件数と割合の平均値とともに示す．農地における咬症件数の減少は，農地の減少に帰す部分（前の期間の農地における咬症件数×減少した農地面積の割合，表１）と面積あたりの咬症率の減少（減少件数中の残り）に帰す部分との，２つに分けて示した．

than in the other habitats, in spite of the opposite trends in the background variables, i.e., decreases in both the farming area and the number of farm households and the increase in human population size. The decreased number of bite cases on farm land can be attributable to the decrease of both the farming area and the incidence rate (per area) on farm land (Fig. 8). Incidence rates on farm land and when farming (per area) reduced from P60 to P90 (both $P < 0.01$) only about 20%, less than the rates in the other habitats, < whereas they reduced from P80 to P90 (on farm land $P < 0.1$; at farming: $P < 0.05$) similarly to the rates in the other habitats (Table 1, Fig. 9).

The incidence rates in the sugar cane field (per harvesting area of sugar cane) reduced from P80 to P90 ($P < 0.01$), and the rate when harvesting sugar cane reduced from P60 to P90 ($P < 0.1$) (Fig. 9). The incidence rates on farm land exclusive of the sugar cane field reduced from P60 to P90 ($P < 0.01$) and from P60 to P80 ($P < 0.05$) (Fig. 9). Therefore, the reduction in

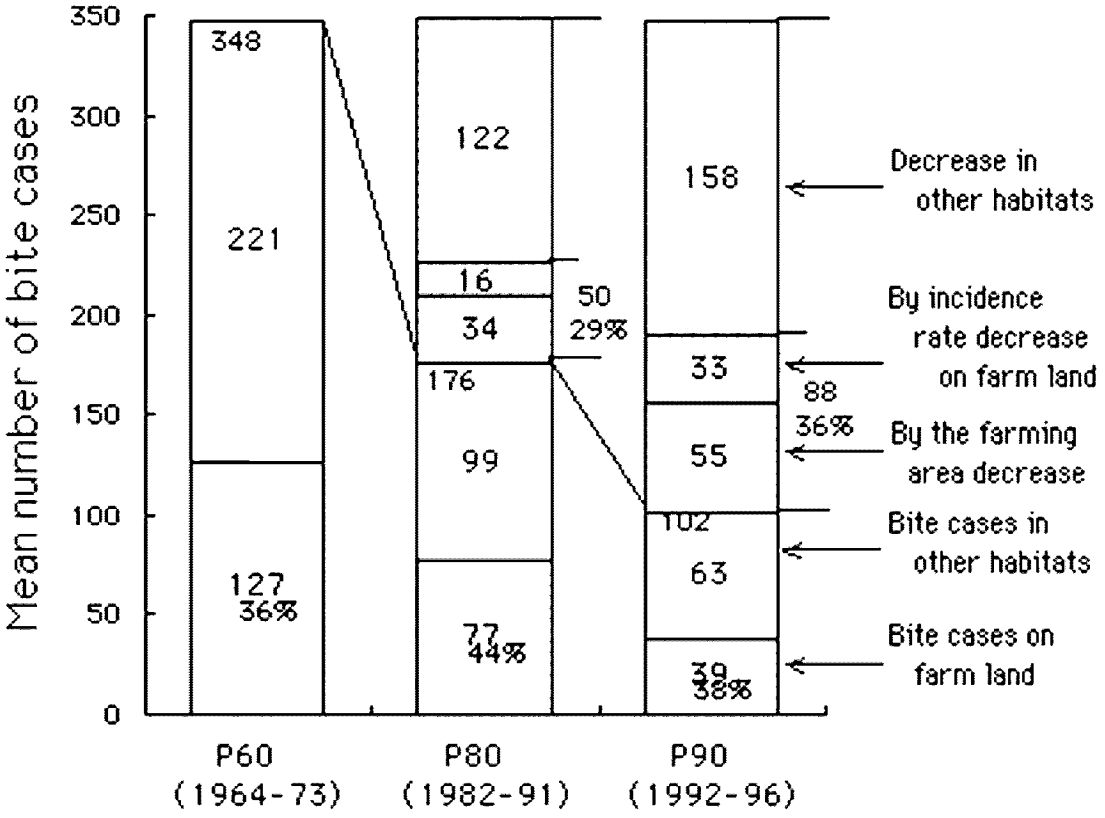

Fig. 9. Changes in the mean incidence rate (per farming area) of *Trimeresurus flavoviridis* on farm land and when farming. The incidence rates on farm land and when farming were calculated by dividing the number of bite cases by the farming area under operation (Af). Those in the sugar cane field and when harvesting sugar cane were calculated by dividing the number of bite cases by the harvesting area of sugar cane (As). The number of bite cases on farm land except for the sugar cane field was divided by Af - As. The significant changes in the incidence rates among the three periods (P60, P80 and P90) are also presented ($P < 0.05$, except for * as $0.05 < P < 0.1$).

図９．農地または農作業中におけるハブ咬症率（農地面積あたり）の平均値の変化．農地または農作業中におけるハブ咬症率は，咬症件数を経営耕地面積（Af）で除した値．キビ畑またはキビ刈り中におけるハブ咬症率は，咬症件数をキビ収穫面積(As)で除した値．キビ畑以外の農地におけるハブ咬症件数は，咬症件数をAf - Asで除した．３期間(P60, P80, P90)の間における咬症率の有意な変化も記した（$P < 0.05$，ただし *：$0.05 < P < 0.1$）．

the incidence rate on farm land and when farming from P80 to P90 is mainly attributable to the reduction in the incidence rate in the sugar cane field.

IV Discussion

The incidence rate reduced in Naha, and its suburbs (Urasoe, Chatan and Ginowan). In these suburbs the rapid growth of human population may be one of the reasons for the reduction in the incidence rate. In Haebaru and Nishihara, however, the incidence rates did not reduce at least from P60 to P80, although human population also grew greatly. For further analyses, we should examine more factors for these districts with rapid growth in human population. We should also analyze the data of other districts showing differential patterns of changes in incidence rate: reducing, Ie, Gushikawa Village, Ogimi, Motobu, etc.; almost stable, Kin, Gushikami, Ozato, etc.; increasing, Onna, Ginoza, and Kochinda. These three groups seem to have no connection to the four district groups distinguished by two parameters: the degree of incidence rate (1972-1975) and the proportional population of farmers[6]. I cannot suspect any reasons for the increase in the incidence rate in several districts. Some of the districts without reduction in the incidence rate were concentrated around Ishikawa and Ozato, and some common factors might have prevented the reduction of the incidence rate in each of the two localities.

The incidence rates reduced greatly in the following elements, in spring and summer, in early morning and at night, in indoor habitats and on roads, and during most types of indoor activities. In these elements, the bites occurred in active seasons and at active times of the day for the habu[20], or were supposed to be caused by an active habu after leaving the resting spot. On the other hand, the bite cases in a less active time of the habu (daytime and winter), in weeds (when weeding), and in gardens (supposed to have been caused mainly by a resting habu) showed smaller decreases. I suppose that one of the reasons for the reduction in the incidence rate was the improvements of human environments, e.g., decreases of old wooden houses, limb stone fences, and unpaved roads. These improvements might reduce the number of active habus intruding into human houses and allow the local inhabitants to see habus before any contact.

The decrease in the number of bite cases on farm land and when farming from P60 to P80 can be attributable mainly to the decrease in the farming area, because the incidence rates (per farming area) of the two periods were similar. These similar incidence rates suggest that the density of the habu on farm land did not change greatly from P60 to P80. Bite cases on farm land were supposed to have been caused by habus resting in the daytime. The number of bite cases on farm land reduced less than the number in the other habitats from P60 to P80, which fact coincided with the slower decrease of the numbers of bite cases caused by resting habus in the other habitats.

The incidence rates (per area) on farm land and when farming reduced from P80 to P90. This reduction was attributable to the reduction of incidence rates in the sugar cane field, the dominant farming field throughout the three periods. There might be some changes in the farming environments or the density decrease of the habu from P80 to P90. Improvements of farm land (including the sugar cane field), mainly by the arrangements of the farming blocks and farm roads, have been proceeded in a large scale after Okinawa was returned to Japan from U.S.A. in 1972. The total improved area (km^2) (percent in farming area) in the 39 districts of the present study were nearly 0 (0.0), 37.6 (18.8), 73.8 (40.8) and 88.3 (63.5) in 1971, 1981, 1989 and 1995, respectively (Farmland Water Supply Division of Okinawa Prefecture, unpublished data). Though the period of the great increase of the improved area (1971-1989)

does not exactly coincide with the period of reduction in the incidence rate on farm land (i.e., from P80 to P90), the changes in the quality of the farm land resulting from such improvements may have caused the reduction in the incidence rate on farm land. For further studies on the changes in the incidence rate, cross factor analyses should be adopted as were tried by other studies[15)16)18)].

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VI 要約

沖縄諸島における1964年から1996年の間のハブ咬症率の変化を記述した．1964-1973 年，1982-1991 年，1992-1996年のそれぞれの期間における，百万人あたりの年間咬症率はほぼ一定で，それぞれ，422，164，89であった．これら３期間の間の比較において，咬症率は24の市町村では経時的に減少したが，15 の市町村では減少せず，３市町村で増加した．また，咬症率の減少は，春夏のほとんどの月，夕方から深夜と夜明けの時刻，道路，林，便所・風呂，その他の室内，就寝中と排泄中の人における咬症で大きく，いっぽう，秋冬のほとんどの月，12:00-14:00以外の日中，庭と草地，草刈り中と他の室内の活動中の人における咬症で小さかった．これらの傾向は，活動中のハブによる咬症数が，顕著に減少したことを示唆する．農地における咬症数の減少の多くは，農地面積の縮小によると推測されたが，1992-1996年には農地面積あたりの咬症率の低下も顕著であった．