

琉球大学学術リポジトリ

台湾および琉球諸島における恙虫病媒介ツツガムシの疫学的調査

メタデータ	言語: 出版者: The Japan Society of Medical Entomology and Zoology 公開日: 2020-05-29 キーワード (Ja): キーワード (En): Tsutsugamushi disease, trombiculid mites, epidemiology, Taiwan 作成者: Hasegawa, Hideo, Otsuru, Masamitsu, Fujii, Tamotsu, Toma, Hiromu, Sato, Yoshiya メールアドレス: 所属:
URL	http://hdl.handle.net/20.500.12000/45949

Surveys on vector mites of Tsutsugamushi disease in Taiwan and the Ryukyu Islands¹⁾

Hideo HASEGAWA,^{2,3)} Masamitsu OTSURU,^{2,3)} Tamotsu FUJII,^{2,4)}
Hiromu TOMA²⁾ and Yoshiya SATO^{2,3)}

²⁾ Department of Parasitology, and ³⁾ Research Center of Comprehensive Medicine,
School of Medicine, University of the Ryukyus, Nishihara, Okinawa 903-01, Japan

(Received: February 3, 1990)

Key words: Tsutsugamushi disease, trombiculid mites, epidemiology, Taiwan.

Abstract: An epidemiological survey on the vector mites of Tsutsugamushi disease was conducted in Taiwan and the Ryukyu Islands. On the Penghu Islands and Taitung of Taiwan, the only trombiculid mite belonging to the subgenus *Leptotrombidium* collected from rodents and insectivores was *L. (L.) deliense*, the potential vector of *Rickettsia tsutsugamushi* in the Asia-Pacific region south of Japan. On the other hand, on Mt. Alishan three species of the subgenus *Leptotrombidium* including *L. (L.) kawamurai* were collected from rodents, suggesting that the reservoirs of *R. tsutsugamushi* may be in this highland. On Okinawa Island, Japan, the trombiculid mite was not collected from rodents and insectivores in the present survey.

INTRODUCTION

In the Japanese mainland, the number

¹⁾ This study was supported by a Grant-in-Aid for Overseas Scientific Survey, No. 63041108: "Epidemiological surveys on the Tsutsugamushi disease in Taiwan, in connection with its high prevalence in recent Japan" and by a Grant-in-Aid for Scientific Research, No. 60304051: "Epidemiological studies on new-type Tsutsugamushi disease" from the Ministry of Education, Science and Culture of Japan.

⁴⁾ Present address: Laboratory of Immunobiology, Hiroshima Women's University, Hiroshima 734, Japan.

^{2),3)} 長谷川英男, 大鶴正満, 佐藤良也: 琉球大学医学部寄生虫学教室, 琉球大学医学部地域医療研究センター (〒903-01 沖縄県西原町上原 207)

²⁾ 藤井 保, 當真 弘: 琉球大学医学部寄生虫学教室 (〒903-01 沖縄県西原町上原 207)

⁴⁾ 現住所: 広島女子大学免疫生物学研究室 (〒734 広島市南区宇品東 1-1-71)

of cases of new-type Tsutsugamushi disease has increased rapidly yearly since 1976, reaching about 1,000/year (*cf.* Kawamura and Tanaka, 1988; Otsuru, 1988a, b). The new type has several characteristics distinguishing it from classical-type Tsutsugamushi disease in Japan. In the classical type the infection occurs in river sides of North Japan; the agent is highly virulent and is transmitted mainly by *Leptotrombidium (L.) akamushi*. On the other hand, the new type is rarely fatal; its infection occurs in the scrub, forests and mountains, and its vectors are *L. (L.) pallidum* and *L. (L.) scutellare* mainly (*cf.* Otsuru, 1986, 1988b; Kawamura and Tanaka, 1988).

The recent increase of new-type Tsutsugamushi disease might be attributed to several factors, namely, changes of the natural environment, which made favorable conditions for rodents, mites and *Rickettsia*; changes in pathogenicity of *Rickettsia*; prohibition of

usage of some insecticides; increased opportunity of people to enjoy outdoor activities, misapplication of antibiotics, *etc.* (*cf.* Suto, 1983; Otsuru, 1986, 1988b; Kawamura and Tanaka, 1988). However, it is mostly likely that such a remarkable increase of new-type Tsutsugamushi disease is related to a proliferation of vector mites themselves, although there is no good explanation as to how those foci of vector developed.

Interestingly, some of the characteristics of new-type Tsutsugamushi disease resemble those of scrub typhus, the Southeast Asian type of Tsutsugamushi disease (*cf.* Philip, 1964; Traub and Wisserman, 1974). Taiwan is the closest country south of Japan, and a study on this disease in Taiwan is expected to contribute to the elucidation of factors of the recent increase in new-type Tsutsugamushi disease in the Japanese mainland and to devise control measures against it.

Surveys were carried out to clarify the epidemiological and etiological characteristics of Tsutsugamushi disease in Taiwan and the Ryukyu Islands which is situated between Taiwan and the Japanese mainland. In this paper, the results of surveys on reservoir hosts and trombiculid mites are reported.

MATERIALS AND METHODS

Rodents and insectivores were captured using live traps with baits (raw peanut, fried squid or fried sweet potato) in various parts in Taiwan and the Ryukyu Islands (Fig. 1). They were killed by pressure on the thorax. After the liver and spleen were dissected to be stored in a dry ice pot for isolation of *Rickettsia*, the external ears were resected and put into a small, tightly stoppered plastic container in order to collect the trombiculids parasitic in the ear. Three days later, 70% ethanol was poured into this plastic container to fix the mites. The remnant part of the host animal was hung with a string, and a Petri dish containing water was put under the animal. Mites dropped from the hosts were collected from the water surface with a fine hair pencil and fixed in 70% ethanol. The mites were then mounted on slides with gum chloral solution in the usual procedure and observed under Nikon Optiphoto microscope equipped with Nomarski interference-

contrast prism. Classification of host mammals is based on Corbet and Hill (1986).

RESULTS

1. Environment of the surveyed areas and mammals captured

1) *Taiwan*. Surveys were carried out in July and August, 1986 and August, 1988. Most of the surveyed areas are in level lands and low hills, while one mountainous locality, Mt. Alishan, was also surveyed. One species of insectivore and 7 species of rodents were captured (Table 1).

(1) Tanshui and other localities in Taipei Prefecture (Fig. 1A): *Suncus murinus* was collected around residential sites. *Rattus losea* and *Bandicota indica* were captured in miscanthus fields near residential sites. *Rattus losea* was also trapped at levees of paddy fields.

(2) Taitung Prefecture (Fig. 1C): In Changpin, *Rattus losea* and *Bandicota indica* were captured in papaya fields distant from residential areas. In Chengkung, *Suncus murinus* and *Bandicota indica* were collected in cultivated papaya fields and deer pastures near residential areas, and *Rattus losea* and *Mus caroli* in miscanthus fields.

(3) Mt. Alishan (Chiai Prefecture) (Fig. 1C): This is situated in the middle of a mountainous area. *Apodemus draco* (= *A. semotus*) and *Niviventer confucianus* were collected in coniferous forests and cultivated "Wasabi" (a kind of horseradish) fields at altitude *ca.* 2,200 m.

(4) Kaohsiung Prefecture (Fig. 1C): *Rattus rattus*, *R. losea* and *Bandicota indica* were captured in grass bushes around residential sites or fruit orchards.

(5) Pingtung Prefecture (Fig. 1C): This area is located in the southernmost part of Taiwan. *Suncus murinus* and *Bandicota indica* were collected in papaya fields and miscanthus fields distant from residential sites.

(6) Penghu Islands (Pescadores Islands; Penghu Prefecture) (Fig. 1B): Penghu is composed of small flat islands with the highest point of 52 m. *Suncus murinus* and *Mus musculus* were captured in sugar cane, peanut and koaliang fields, which were close to residential sites.

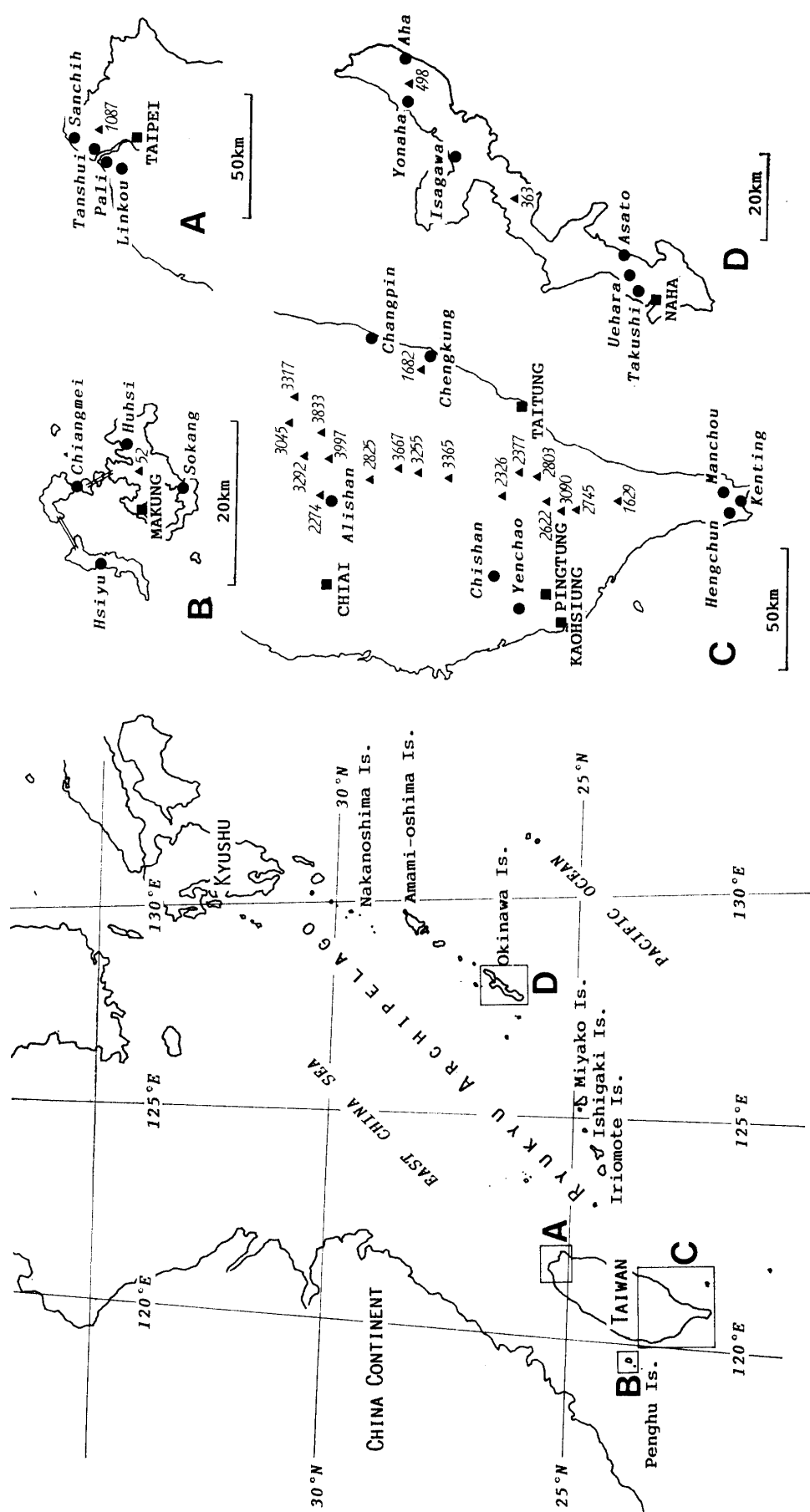


Fig. 1 Map of localities surveyed.

Table 1 Mammals examined and trombiculid

Locality and date of collection	No. host examined	<i>Leptotrombidium</i>				
		(<i>L.</i>) <i>del.</i>	(<i>L.</i>) sp. 1	(<i>L.</i>) <i>asa.</i>	(<i>L.</i>) <i>kaw.</i>	(<i>L.</i>) sp. 2
<i>Suncus murinus</i> * ¹						
Tanshui, Taipei P.* ² 8/19 '88	2					
Chengkung, Taitung P. 8/7-9 '86	16	15* ³ (2-369)* ⁴				
Hengchun, Pingtung P. 8/12 '86	2	1 (1)				
Huhsi, Penghu P. 7/30 '86	6	6 (1-46)				
Hsiyu, Penghu P. 7/31 '86	1	1 (20)				
Chiangmei, Penghu P. 8/1 '86	2	2 (16-34)				
Sokang, Penghu P. 8/2 '86	3	1 (1-110)				
<i>Mus musculus</i>						
Huhsi, Penghu P. 7/30 '86	3	1 (8)				
Hsiyu, Penghu P. 7/31 '86	2	2 (2-176)				
Sokang, Penghu P. 8/2 '86	1	1 (1)				
<i>Mus caroli</i>						
Chengkung, Taitung P. 8/8 '86	2	1 (3)				
<i>Apodemus draco</i>						
Alishan, Chiai P. 8/23-26 '88	17			2 (1-3)	7 (1-6)	
<i>Rattus rattus</i>						
Chishan, Kaohsiung P. 8/28 '88	1					
<i>Rattus losea</i>						
Sanchih, Taipei P. 8/18 '88	1					
Linkou, Taipei P. 8/19 '88	2					
Pali, Taipei P. 8/19 '88	1					
Changpin, Taitung P. 8/6 '86	1	1 (316)				
Chengkung, Taitung P. 8/9 '86	3	3 (115-772)				
Yenchao, Kaohsiung P. 8/28 '88	1					
<i>Niviventer confucianus</i>						
Alishan, Chiai P. 8/25-26 '88	2			1 (1)		2 (1)
<i>Bandicota indica</i>						
Linkou, Taipei P. 8/19 '88	2					1 (1)

mites collected from them in Taiwan.

(T.) sp.	<i>Garliepia</i>			<i>Schoengastia</i> sp.	<i>Doloisia</i> sp.	<i>Walchiella</i> sp.	Total
	(G.) spp.	(W.) spp.	(S.) sp.				
							0
	1 (1)						15 (2-369)
							1 (1)
				1 (1)	2 (1)		6 (1-47)
							1 (20)
					1 (1)		2 (16-35)
							1 (1-110)
							1 (8)
					1 (1)		2 (2-177)
							1 (1)
	1 (1)	2 (2-11)					2 (3-14)
1 (1)	1 (1)						7 (1-7)
							0
							0
	2 (1)	1 (43)		1 (12)			2 (1-56)
		1 (1)					1 (1)
		1 (3)			1 (1)		1 (320)
		3 (1-50)					3 (116-882)
							0
2 (2-8)	2 (31-49)	2 (5-14)	1 (4)				2 (57-59)
		1 (36)		1 (5)			1 (42)

Table 1

Locality and date of collection	No. host examined	<i>Leptotrombidium</i>				
		(<i>L.</i>) <i>del.</i>	(<i>L.</i>) sp. 1	(<i>L.</i>) <i>asa.</i>	(<i>L.</i>) <i>kaw.</i>	(<i>L.</i>) sp. 2
Sanchih, Taipei P. 8/20 '88	1	1				
		(3)				
Changpin, Taitung P. 8/6 '86	3	3				
		(76-1, 576)				
Chengkung, Taitung P. 8/7-8 '89	8	8				
		(91-529)				
Hengchun, Pingtung P. 8/12 '86	1					
Kenting, Pingtung P. 8/13 '86	1	1				
		(514)				
Manchou, Pingtung P. 8/14 '86	2					
Chishan, Kaohsiung P. 8/28 '88	1					
Yenchao, Kaohsiung P. 8/28 '88	1					

*¹ Mammalian species. *² Prefecture. *³ No. hosts infected. *⁴ Range of intensity. Abbreviations: (W), (*Walchia*). Species *asa.*, *asanumai*; *del.*, *deliense*; *kaw.*, *kawamurai*.

2) *The Ryukyu Islands.* On Okinawa Island, surveys were carried out at various times in the period between 1984 and 1988. Two species of insectivores, *Suncus murinus* and *Crocidula horsfieldi watasei*, and three species of rodents, *Mus caroli*, *Rattus rattus* and *R. norvegicus*, were trapped in sugar cane fields near residential sites and at the feet of mountains (Fig. 1D, Table 2). On Iriomote Island no rodent was collected in this survey.

2. Trombiculid mites from mammals

1) *Taiwan.* Species and number of the trombiculid mites collected from the rodents and insectivores are presented in Table 1.

In the level lands and low hills of Taiwan, 7 species of trombiculids were collected from small mammals, and 2 of the species belong to the subgenus *Leptotrombidium*. *Leptotrombidium* (*L.*) *deliense* is the predominant species occupying over 90% of the total number of trombiculids obtained. This species was found mainly in the inner side of auricle of the rodents and on the thigh and around anus in *Suncus murinus*. The prevalence of infection with this mite was higher among small mammals on the Penghu Islands and Taitung Prefecture than those of other localities; the intensity in *Rattus losea* and *Bandicota indica* was much higher in Tai-

tung Prefecture.

On Mt. Alishan, 8 species of trombiculids were collected and among them, 3 species belong to the subgenus *Leptotrombidium*. They were mostly found on the inner side of auricle. *Leptotrombidium* (*L.*) *deliense* was not detected.

2) *The Ryukyu Islands.* On Okinawa Island, trombiculid mite was not collected from the rodents and insectivores in the present survey.

3. Morphology and remarks on the trombiculid mites of the subgenus *Leptotrombidium* collected

1) *Leptotrombidium* (*Leptotrombidium*) *deliense* (Walch, 1923)

Numerous individuals were collected from the insectivores and rodents trapped in the level lands of Taiwan.

Morphological features (Fig. 2A): Light orange in color, approximately 0.18-0.40 mm in length. Palpal setal formula N/N/BNN/7BN. Galeala feathered. Scutum square with slightly convexed posterior margin. Sensillae bases slightly anterior to bases of posterolateral setae. Sensillae nude in basal 1/3 and with about 10 barbs in distal 2/3. AW 54-67, PW 66-72, SB 25-30, ASB 20-24, PSB 12-16, AP 24-29, am 42-56, al 36-44, pl 48-70, s 46-61. Dorsal setae 2-8-6-6-4-2=

Continued

(T.) sp.	<i>Garliepia</i>			<i>Schoengastia</i> sp.	<i>Doloisia</i> sp.	<i>Walchiella</i> sp.	Total
	(G.) spp.	(W.) spp.	(S.) sp.				
		1					1
		(20)					(23)
	3	2					3
	(1-10)	(5-15)					(82-1,586)
1	5	7					8
(3)	(1-160)	(2-61)					(118-540)
							0
1						1	19
(3)						(2)	(519)
							0
							0
							0

subgenera (G.), (*Garliepia*); (L.), (*Leptotrombidium*); (S.), (*Schoengastiella*); (T.), (*Trombiculindus*);

Table 2 Mammals examined for trombiculid mites on Okinawa Island, Japan.

Mammalian species and locality	Date of collection	No. host examined	No. host parasitized
<i>Suncus murinus</i>			
Isagawa, Nago	12/12 '84-1/7 '85	8	0
Asato, Nakagusuku	4/15 '84	2	0
Uehara, Nishihara	6/25 '85	4	0
<i>Crocidula horsfieldi watasei</i>			
Isagawa, Nago	1/7 '85-2/27 '89	9	0
Tanabaru, Nishihara	1/5 '83; 5/12 '83	3	0
Takushi, Urasoe	7/23 '87	2	0
<i>Mus caroli</i>			
Aha, Kunigami	8/14 '84	2	0
Yonaha, Kunigami	2/27 '85	2	0
Isagawa, Nago	12/12 '84-2/27 '85	3	0
Asato, Nakagusuku	4/15 '88	1	0
Uehara, Nishihara	3/7-19 '86	9	0
Takushi, Urasoe	7/23 '87	1	0
<i>Rattus rattus</i>			
Uehara, Nishihara	6/25 '84	1	0
<i>Rattus norvegicus</i>			
Isagawa, Nago	1/7 '85	1	0

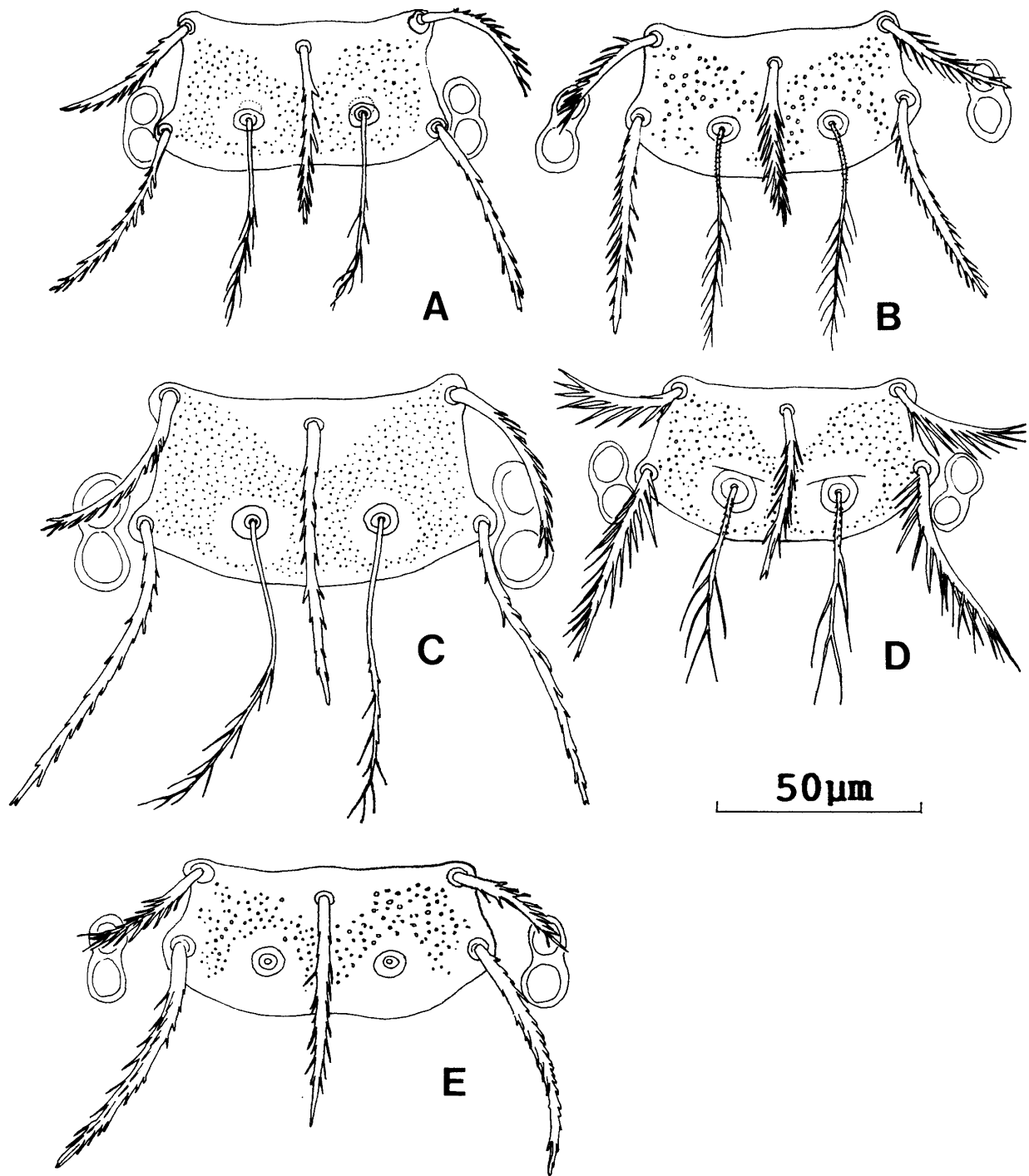


Fig. 2 Scutum of trombiculids of the subgenus *Leptotrombidium* collected.

A: *L. (L.) deliense*. B: *L. (L.)* sp. 1. C: *L. (L.) asanumai*. D: *L. (L.)* sp. 2. E: *L. (L.) kawamurai*.

28.

Remarks: This species is a typical *akamushi*-group mite, resembling closely *L. (L.) akamushi*, but is distinguished from the latter in having fewer dorsal setae (*cf.* Womersley, 1952). This species is widely distributed in Southeast Asia, South China and Taiwan,

and is known as the most important vector of Tsutsugamushi disease in these areas (*cf.* Womersley, 1952; Philip, 1964; Traub and Wisserman, 1974). This species was also recorded from the Tokara Islands (mostly from Nakanoshima Island), the Ryukyu Archipelago (Suzuki, 1983). The present

specimens differ from those on Nakanoshima Island in that in the latter the posterior border of the scutum is considerably convexed and the sensillae bases are situated at the same level or slightly posterior to the bases of posterolateral setae. Suzuki (1983) stated that the specimens from the Tokara Islands resemble those from New Guinea.

2) *Leptotrombidium* (*L.*) sp. 1

Only 1 individual was collected from *Rattus losea*.

Morphological features (Fig. 2B): Pale in color, length 0.49 mm. Palpal setal formula N/N/BNN/7BN. Galeala feathered. Scutum with prominently convexed posterior margin. Sensillae bases far posterior to bases of posterolateral setae. Sensillae with minute spines in basal 1/3 and with 15 barbs in distal 2/3. AW 58, PW 66, SB 27, ASB 26, PSB 12, AP 19, am 40, al 34, pl 52, s 54. Dorsal setae 2-8-6-6-6-4-2=32.

Remarks: This individual belongs to the *intermedia*-subgroup of the *akamushi*-group in that the sensillae bases are situated slightly posterior to bases of the posterolateral setae. It somewhat resembles *L. (L.) kawamurai* in the arrangement of dorsal setae but differs in having minute spines in the basal part of sensillae.

3) *Leptotrombidium* (*L.*) *asanumai*
Takada, 1977

Only 5 individuals were collected from *Apodemus draco* and *Niviventer confucianus* on Mt. Alishan.

Morphological features (Fig. 2C): Slightly orange in color, length 0.22–0.39 mm. Palpal setal formula N/N/BNN/7BN. Galeala feathered. Scutum square with slightly convexed posterior margin. Sensillae bases at same level of bases of posterolateral setae. Sensillae nude in basal 1/3 and with 13–15 barbs in distal 2/3. AW 66–73, PW 78–84, SB 30–33, ASB 31–34, PSB 14–18, AP 30–34, am 61–68, al 46–50, pl 74–100, s 62–80. Dorsal setae variable in arrangement, 2-8-8-8-6-4=36, 2-8-8-2-6-5-2=32, 2-8-8-2-8-4=34, 2-8-8-8-4-2=32, 2-8-7-8-6-4=35.

Remarks: *Leptotrombidium* (*L.*) *asanumai* is a member of the *akamushi*-subgroup and has intermediate characteristics between *L. (L.) akamushi* and *L. (L.) scutellare* (Takada, 1977). The present materials have somewhat longer posterolateral setae and

thinner dorsal and postanal setae than those of the Japanese mainland.

4) *Leptotrombidium* (*L.*) *kawamurai*
Fukuzumi and Obata, 1953

Fifteen individuals were collected from *Apodemus draco* on Mt. Alishan.

Morphological features (Fig. 2E): White in color, length 0.22–0.47 mm. Palpal setal formula N/N/BNN/7BN. Galeala feathered. Scutum square with prominently convexed posterior margin. Sensillae bases posterior to bases of posterolateral setae. Sensillae lost in the present individuals. AW 59–71, PW 72–84, SB 29–35, ASB 24–30, PSB 12–16, AP 18–20, am 50–60, al 34–40, pl 56–66. Dorsal setae 2-8-8-6-4-2=28.

Remarks: Because the present materials lack the sensillae, identification is difficult. However, most of morphological characteristics are identical with those of *L. (L.) kawamurai* although the arrangement of dorsal setae slightly differs (2-8-8-6-4-4-2=32 in the materials of the Japanese mainland; cf. Sasa, 1956). Takada *et al.* (1981) also recorded *L. (L.) kawamurai* from Mt. Alishan.

5) *Leptotrombidium* (*L.*) sp. 2

Only 2 individuals were collected from *Niviventer confucianus* on Mt. Alishan.

Morphological features (Fig. 2D): Reddish in color, length 0.22–0.52 mm. Palpal setal formula N/N/BNN/7BN. Galeala feathered. Scutum with prominently convexed posterior margin. Sensillae bases posterior to bases of posterolateral setae. Sensillae with minute spines in basal 1/3 and with 5–7 barbs in distal 2/3. AW 56–60, PW 70, SB 25–27, ASB 22, PSB 12–14, AP 42–44, am 42–44, al 32–44, pl 54–62, s 54–60. Dorsal setae variable in arrangement, 2-10-10-9-6-4-2=45 or 2-9-10-8-5-4-1=39.

Remarks: This species is identical with *L. (L.)* sp. B of Takada *et al.* (1981) in having the scutum of the *tenjin*-subgroup type and the sensillae with extremely fine spines in basal 1/3; also, the sensillae bases are situated posterior to the posterolateral setae (Takada *et al.*, 1981). This species is distinguished from *L. (L.)* sp. 1 in having fewer barbs on the sensillae and fewer dorsal setae.

DISCUSSION

In Taiwan, several endemic areas of Tsutsugamushi disease have been known from early in this century (*cf.* Santana *et al.*, 1976). More than 1,800 cases were recorded in the period from 1910 to 1975 on all islands of Taiwan (*cf.* Takada *et al.*, 1981). According to the statistics of the Taiwan Provincial Institute of Infectious Diseases, the total number of cases reported from 1985 to 1988 was 606. The vector of the disease has been considered to be *Leptotrombidium* (*L.*) *deliense*, which is widely distributed in the lowlands, some mountainous areas and on small islands of Taiwan (*cf.* Lien *et al.*, 1967; Lien, 1987). The infection occurs mostly in summer, resembling classical-type Tsutsugamushi disease in the Japanese mainland, but the low fatality is similar to new-type Tsutsugamushi disease (*cf.* Olson and Scheer, 1978; Lien, 1987).

In recent years, more than one hundred patients have been registered annually. Most of the patients acquired the infection on the Penghu Islands (*cf.* Fang *et al.*, 1975; Olson *et al.*, 1982; Wu, 1986), and some near Hualien, eastern Taiwan (Gale *et al.*, 1974). The isolation of *Rickettsia tsutsugamushi* from the mites has been successfully carried out also (*cf.* Gale *et al.*, 1974 in eastern Taiwan, Olson *et al.*, 1978 on the Penghu Islands).

The present survey also indicates that *L.* (*L.*) *deliense* is the main vector of Tsutsugamushi disease in these endemic areas because it is the only species of the subgenus *Leptotrombidium* collected from small mammals. Actually, on the Penghu Islands and Taitung, *R. tsutsugamushi* was also isolated from the viscera of rodents from which many *L.* (*L.*) *deliense* were collected (Otsuru *et al.*, unpublished). In both the Penghu Islands and Taitung, the rodents that harbored *L.* (*L.*) *deliense* were collected near the residential sites and/or cultivated fields, indicating that people are exposed to the infection in daily life.

In the high mountainous areas no case of Tsutsugamushi disease has been recorded recently. However, cases were recorded from Mt. Alishan in the prewar period (*cf.* Kato,

1911; Sano, 1914; Hatori, 1917; Matsumoto, 1930; Morishita, 1934). Some patients had acquired the infection in the railway construction site at Mt. Alishan. This fact suggests that there are some trombiculid mites other than *L.* (*L.*) *deliense* playing the role of vectors of *R. tsutsugamushi*. The natural environment of the coniferous forest in the highlands of Mt. Alishan resembles that of the lowland forests in the Japanese mainland where new-type Tsutsugamushi disease is prevalent.

It is of special interest that in the present survey *L.* (*L.*) *asanumai*, which is close to *L.* (*L.*) *scutellare*, was collected on Mt. Alishan. Moreover, Takada *et al.* (1981) detected *Leptotrombidium* (*L.*) sp. A belonging to the *pallidum*-subgroup on Mt. Alishan. Both *L.* (*L.*) *scutellare* and *L.* (*L.*) *pallidum* are known as potential vectors of new-type Tsutsugamushi disease in the Japanese mainland. These findings may indicate the possibility that *R. tsutsugamushi* is transmitted to rodents by the mites in the highland forests of Taiwan. The presence of *L.* (*L.*) *kawamurai* on Mt. Alishan also supports this assumption because *R. tsutsugamushi* has been detected from this mite in the Japanese mainland (*cf.* Tamiya, 1962; Kawamura and Tanaka, 1988). Thus, isolation of the *Rickettsia* from rodents or mites of the highland Taiwan is desirable for comparison with the strain of new-type Tsutsugamushi disease of Japan.

Although no trombiculid was collected from Okinawan rodents and insectivores in the present survey, there have been some reports on trombiculids from Okinawa. *Leptotrombidium* (*L.*) *kawamurai* was the only species of the subgenus *Leptotrombidium* collected from Okinawa (Suzuki, 1980; Asato and Suzuki, 1985). Because there has been no evidence that *L.* (*L.*) *kawamurai* parasitizes man, there is little possibility of occurrence of Tsutsugamushi disease on Okinawa Island at the present time (Asato and Suzuki, 1985).

The trombiculid fauna on the islands of the Ryukyu Archipelago north of Okinawa Island has been extensively studied (*cf.* Suzuki, 1980, 1983). Kano *et al.* (1961) recorded a species resembling *L.* (*L.*) *deliense* on Amami-oshima Island, and Suzuki (1983)

found *L. (L.) deliense* on the Tokara Islands. Recently one case each of Tsutsugamushi disease was registered on Amami-oshima and Tokunoshima Islands (Sato *et al.*, 1988). However, the vector mites in both cases have not yet been determined.

ACKNOWLEDGEMENTS

The authors are indebted to Dr. H. C. Hsieh and Dr. E. R. Chen, Kaohsiung Medical College, Kaohsiung, Taiwan, and to the late Dr. P. T. Tseng and Mr. H. M. Lin, Taiwan Provincial Institute of Infectious Diseases, Taipei, Taiwan. Thanks are also rendered to Dr. H. Suzuki, Nagasaki University Institute of Tropical Medicine, for his kindness in making available the related papers.

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摘 要

台湾および琉球諸島における恙虫病媒介 ツツガムシの疫学的調査

台湾と琉球諸島で恙虫病の媒介ツツガムシについて疫学調査を行った。台湾澎湖諸島および台東では齧歯類、食虫類から得られた *Leptotrombidium* 亜属のツツガムシは、アジア太平洋地域の恙虫病リケッチアの最有力媒介種デリーツツガムシ *L. (L.) deliense* だけであった。一方、阿里山では齧歯類からアサヌマツツガムシ *L. (L.) asanumai*, カワムラツツガムシ *L. (L.) kawamurai* と同定される種が得られ、恙虫病リケッチアの保有動物が台湾山地に存在することが示唆された。沖縄本島では齧歯類、食虫類からツツガムシ幼虫は得られなかった。