Trombiculid Mites infesting Bats in Malaya, with Descriptions of Three New Species

By J. R. AUDY, M.B., B.S., Ph.D.

THREE new larval trombiculid mites (chiggers) infesting bats in Malaya are here described. This opportunity is taken to give additional notes on those species so far described from bats and collected by the Colonial Office (Scrub Typhus) Research Unit at the Institute for Medical Research, Kuala Lumpur.

Bat-chiggers are of particular interest for several reasons. Firstly, the genotype *Trombicula minor* Berlese 1905 was described from two adults from bat-guano in a cave at Tjompea, Java. The larvae are presumed to have been infesting the bats but this is admittedly conjectural. The description is imperfect and the type specimens were destroyed during the recent war. Every effort should be made to breed out bat-chiggers in the hopes of rediscovering *T. minor:* as Philip and Traub (1950) have suggested, their species *T. batui* from Malaya might be very close to or even the same as *T. minor*. Secondly, though there are more species of bats than of any other order of mammals in Malaysia, only 8 out of a total of 84 Malaysian chiggers have so far been described from bats, so that there is presumably a large unexplored field here. Thirdly, though most chiggers attack several or many different hosts, some bat chiggers appear to be more host-specific, or it may be habitat-specific, and a study of them as a group may throw light on unsuspected relationships, both of the bats and of the chiggers. In any case, the parasite-patterns may give sadly-needed information on the ecology of different groups of bats, using the parasites as 'ecological labels' (Audy 1947; Inst. Med. Res., 1952).

There are interesting records of the recovery from bats of chiggers very closely related to *T. akamushi*, the vector of scrub typhus. These records, of great zoogeographical interest, are as follows: *T. myotis* Ewing from *Myotis* (and ? other bats) in North America, and *T. russica* (Oudemans) from a bat in Europe, are almost indistinguishable (Wharton 1947; Fuller 1948) from *T. akamushi* itself, which is a very common species in grassland from Japan to Malaysia. Though *T. akamushi* itself has not been recorded from bats, its very close relative, *T. deliensis*, also a vector of scrub typhus, was found by us infesting a

tomb-bat from a rock-cave on a tiny island off the coast of Malaya (see below). Another species, *T. natalensis* Lawrence 1949, from a South African horseshoe bat (*Rhinolophus geoffroyi*), appears to be very close indeed to *T. akamushi* and it is understood that Dr. R. F. Lawrence is comparing his species with material from Malaya.

The following species, some of which are described more fully in this paper, have been recorded from bats in the Oriental and Australasian regions: *T. schmitzi* from India; *T. batui* from Malaya, which may be very near to or identical with *T. minor* from Java; *T. insolli* Philip and Traub from Malaya, related to *T. piercei* Ewing from a bat in the Philippines; *T. leveri* Womersley, 1952, from Malaya and Fiji; *T. harrisoni*, the commonest bat-chigger in Malaya; *T. taphozous* Wom. from Malaya, related to *T. philipi* Wom. from a bat in New Guinea; *T. quadriense* Wom. (= *T. chiroptera* Wom.) from bats, rats, and marsupials in Australia; *Myotrombicula vespertilionis* Wom. from Australia; and *Euschöngastia lipoxena* (Wom. 1952)* from Malaya. To these we can now add a detailed record of *T. deliensis* and two new species of *Trombicula* and one of *Schöngastiella*, together with a reference to a new species of *Hannemannia* which has been described by Womersley (in MS).†

Trombicula deliensis Walch, 1922

A single specimen of *T. deliensis* was found attached to one (R. 9632) of 39 tomb-bats, *Taphozous melanopogon*, collected from a rock-cave in a tiny islet, Pulau Seletan, adjacent to Pulau Angsa (*pulau* = island), 6 miles from the coast of Selangor above Port Swettenham, on 1st February, 1950 (*Rep. Inst. Med. Res., Malaya for 1950*, 1951, p. 40). Mr. J. Wyatt-Smith, who accompanied the original collecting party, paid a second visit to this

* Womersley (1952) recognises only the two genera *Neoschöngastia* s.s. and *Schöngastia* s.l., the latter including only two Old World subgenera, subgenus *Schöngastia* s.s. and subgenus *Ascoschöngastia* s.l. This view is at present unfamiliar and has not had an opportunity to gain acceptance. In the present paper, therefore, the genera *Schöngastia* and *Ascoschöngastia* are both regarded in the restricted sense, and *Euschöngastia* as a genus in the broad sense, following Wharton *et al.* (1951).

† Since this paper went to press, two additional new species have been recovered from *Hipposideros* spp.: one a *Hannemannia*, the other a *Trombicula* near *T. harrisoni*. A batch of 18 hairless bulldog bats, *Cheiromeles torquatus*, obtained from a colony in a hollow tree, were found to be free of chiggers (but infested by *Arixenia ?esau*, Dermaptera); a nineteenth bat had been kept by the Sakais as a pet in their huts for three or four days, and this was found to have 7 chiggers attached to it, *viz.* 2 *T. deliensis* and 5 *T. ?muridia* Wom., of which the latter were bred to nymphs. The *T. deliensis* at least, and probably also the others, were doubtless picked up during captivity.

cave on 15th May, 1951, when he found there were relatively very few bats present. He collected one specimen, also of *T. melanopogon,* infested by three species of *Trombicula* (*taphozous, insolli, batui*).

Trombicula (? Trombicula) batui Philip & Traub, 1950

Described from 5 specimens from a cave fruit-bat, *Eonycteris spelaea,* from Batu Caves (limestone) near Kuala Lumpur. A single specimen was found later on a tomb-bat, *Taphozous melanopogon,* from Seletan island off the Selangor coast. The following notes may be added to the published description.

Except for the scutal and dorsal setae, there is a general tendency towards either nudity of setae or for the presence of a few long barbs. *Legs:*—Leg I: subterminala fairly short, with 2 nude (?few inconspicuous barbules) setae near base of pretarsus; spur short (15μ), microspur posterior and distal at about half length of spur; 3 tibialae, posterior ones in tandem, microtibiala at distal end of joint; 3 genualae, two dorsal in tandem, one posterior; tapering seta with few barbules on femur. Leg II: spur 19μ, longer than spur I, microspur anterior and distal to its base; 2 slender tibialae in tandem; 1 genuala. Leg III with tapering nude setae, apparently not striated or refractile, often outstanding: 1 on tarsus (ca. 2/3 length of tarsus); 2 in tandem on tibia, distal one long; 2 on genu, anterior one longer; 2, anterior and dorsal, about as long as genu, on telofemur, and an almost nude ventral seta; 1, dorsal, on basifemur. *Scutum:* in this specimen, the 'shoulders' of the anterior margin are much more prominent and convex than in the authors' drawing from the Batu Caves specimens. Standard measurements (slide No. 24, 972): AW 43, PW 50, SB 20, ASB 26, PSB 21, AP 27·5, AM 29·5, AL 27, PL 37·5, Sensilla missing. *Body setae:* DS in rows 2.8.8.6.6.4.2 = 36 DS (29μ, humerals 44·5μ) + 14 caudal setae, CS + 17 VS (22μ).

Trombicula insolli Philip & Traub, 1950. Fig. 4

Described from 3 larvae from *Eonycteris,* taken with *batui.* A further 30 larvae have since been taken, from two tomb-bats from Seletan island off the Selangor coast, on 1st February, 1950 and 15th May, 1951. The following notes are added from a study of these specimens.

Legs:—Ordinary leg setae fairly large with many long barbs (pectinate). Leg I: subterminala fairly short (about half length of spur) with parasubterminala about half its length; spur long (32μ), more pointed at tip than spur II, microspur

distally at about half length of spur, distinctly curved; 2 tibialae, long microtibiala; 2 genualae, posteroventral one slender, dorsal one fairly short, very fine and tapering, with long microgenuala distally in tandem. Leg II: spur slender but blunt-tipped, microspur proximal to its base; 2 pointed tibialae in tandem; pointed genuala. Leg III: tapering tibiala, about half length of tibia; 2 long slender genualæ, little longer than genu; 1 long slender femorala. *Scutum* in some specimens extended out to PL bases as a tongue. Standard Measurements of 6 specimens are shown in Table 1. *Body setae:* DS in rows, 2.8.8.8.6.6.4.4.2 = ca. 48 DS (50μ, humeral setae 51μ) + 30–34 caudal setae (CS) + 16–18 VS with fewer slender barbs.

TABLE 1

Standard Measurements of 6 Specimens of Trombicula insolli *Philip & Traub, 1956, from a Tomb-Bat, Seletan island, off Selangor coast*

No.	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	Sens
24,974	49	70	22	37	11.5	37.5	39.5	34.5	58.5	..
24,976	46	65.5	20	36	11.5	31	41.5	43	61	..
24,977	52.5	69.5	21.5	38	11.5	35	33	37	63	..
24,979	48	73	25	37	10	37	47.5	45	65	..
24,980	49.5	72	23	38.5	10.5	37	48	45	75	..
24,981	48.5	68	22.5	38	12	37	43	44.5	77	..
Means ..	48.9	69.7	22.3	37.4	11.2	35.8	42.1	41.5	66.6	..
Holotype	52	69	22	..	12	36	44	42	57	..

Trombicula (Neotrombicula) harrisoni Womersley, 1952. Fig. 2

Described from 10 larvae from *Hipposideros* sp. This is the commonest bat-chigger encountered so far, about one in ten specimens of *Hipposideros* being infested, often with 10–25 chiggers. The nymph has also been described, from a specimen bred out and correlated with the larva by Mr. M. Nadchatram of the Scrub Typhus Research Unit. To Womersley's description of the larva we can add the following notes.

Colour pinkish. *Legs:*—Leg I with long spur, distinctive microspur distally (2/3rd along length of spur), with a stout base and curved (talon-like) 2 tibialae, anterior blunt and fairly thick, posterior pointed, microtibiala distal to their bases; 2 genualae in tandem plus 1 posteriorly, tapering, and a microgenuala distally; seta with few barbs on femur, may be outstanding. Leg II: spur short (1/3 length of spur I), microspur

proximal and close to base; anterior tibiala blunt-tipped and as long as tibia, posterior and more proximal tibiala shorter, tapering; genuala as long as genu. Leg III: tapering tibiala reaching to tarsus; long genuala, nearly as long as tibiala and longer than genu. Coxal seta II shorter and more closely barbed than the others which tend also to be pectinate, with long barbs. *Palpal setae:* on femur and genu stout with many barbs; on tibia, dorsal seta strong with inconspicuous barbs, lateral seta generally forked, ventral branched. *Scutum* drawn for comparison with the following species at fig. 2. Scutal setae slender and tapering. *Body setae:* Dorsally in rows e.g. 2.6.6.6.2(4).2(4) = 28–32 DS (38μ, humeral setae 43μ) + 16–24 CS + ca. 16 VS (22μ) with fewer barbs.

Trombicula (? Neotrombicula) dimolinae sp. nov. Fig. 1, 2

A species distinguished from the related *T. harrisoni* by the sinuous anterior and posterior, and concave lateral, margins of the scutum and a very distinctive sensilla, and by the presence of a third pair of sternal setae.

Description of Larva.—Body oval; partly engorged larva 400μ × 200μ. Colour yellowish. Eyes 2 + 2, indistinct, well to to the side, fairly large, posterior eye the smaller. Body striae faint. *Gnathosome:* Cheliceral bases rounded, with few inconspicuous punctae; blade short (30μ), very deep (14μ), and broad at base, rapidly narrowing down to the small dorsally pointing tricuspid cap; paired pseudochelae 8μ long prominent in one specimen. Galeal seta nude. Palp: fairly slender with rounded tubercle at angle of femur; setae on femur and genu long, stout, with long lateral barbs; on tibia, dorsal seta long nude, others with several fairly long barbs; tarsus with a thick apical seta with terminal barbs or branches, sensory rod, and 4 barbed setae, one of which appears almost nude in some specimens. Claw 3-pronged, axial (25μ) slightly curved, two subequal accessory prongs. *Legs:* all 7-jointed slender with elongate joints, I–III 230μ, 185μ, and 210μ long. Sensory setae tend to be fairly long and tapering. Leg I: spur (tarsala or sensory rod) long with small microspur distally; 2 tibialae, distal one longer and tapering with microtibiala near base; 3 genualae (one being posterior), microgenuala. Leg II: fairly long spur, microspur proximally; 2 tibialae in tandem, distal tibiala longer and stouter and about the same length as the tibia; slender tapering genuala. Leg III: unusually long, tapering, curved tibiala and genuala, the latter about the same length as the tibia and the tibiala a little shorter than this—these two setae are striated and

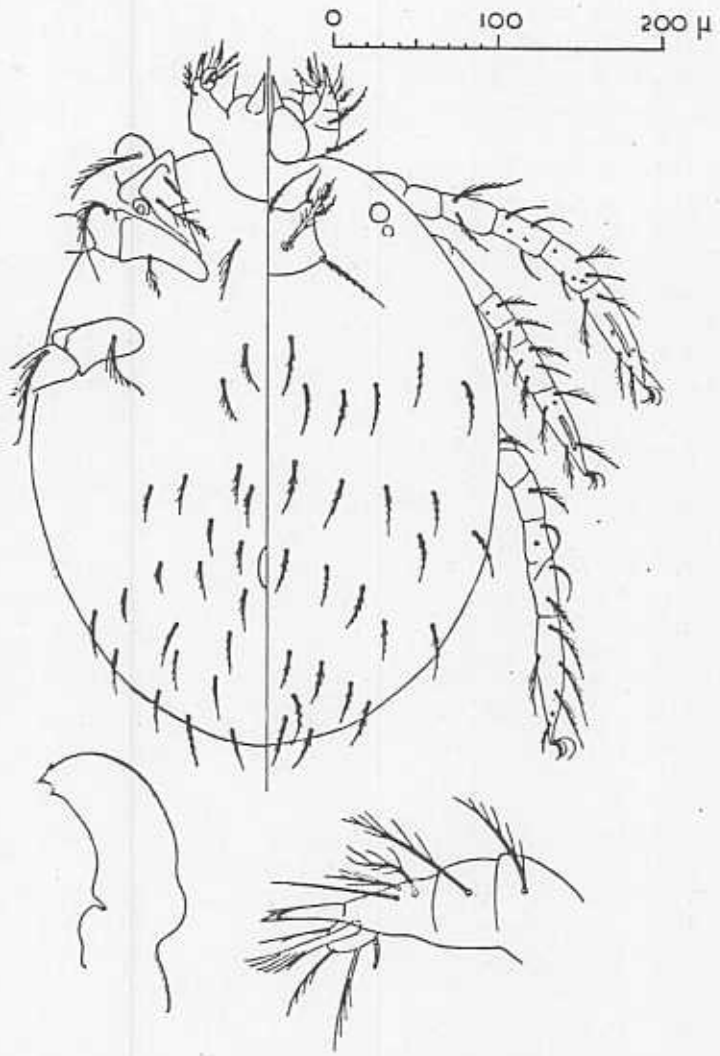

Fig. 1. *Trombicula dimolinae* sp.n., including palp and chelicer (lateral view).

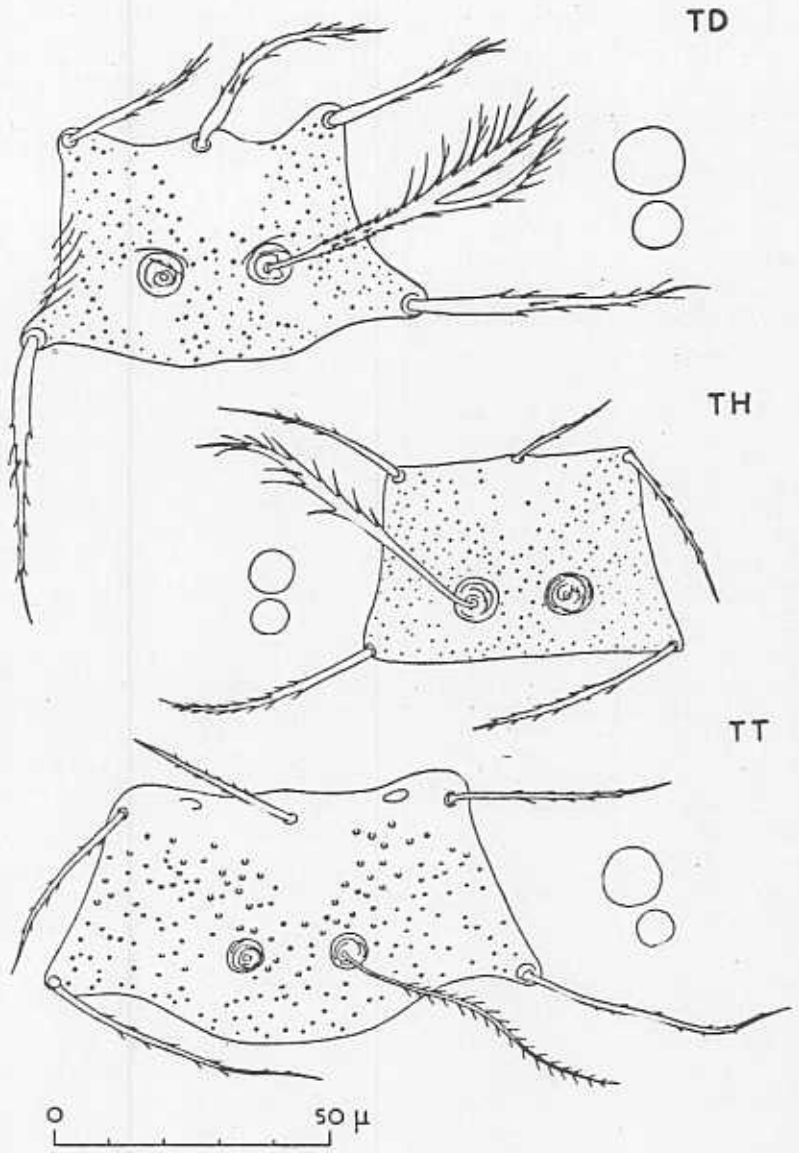

Fig. 2. Scuta (and eyes) of bat-chiggers: TD—*Trombicula dimolinae* sp.n. TH—*T. harrisoni* Womersley, 1952. TT—*T. taphozous*, Womersley, 1952, topotype No. 24793.

clearly show the hollow central appearance of the typical short sensory setae and so they differ in character from the usual whiplike and outstanding and nude setae. Though they tend to curl, these setae may however give the appearance of a mastitibiala and a mastigenuala. *Scutum* (fig. 2) : trapezoidal, anterior and posterior margins sinuate, punctae coarse but not conspicuous. The scutum appears to be poorly chitinised and there is a tendency for striae to appear as artefacts; further, there is a tendency for the lateral and posterolateral margins to be submerged in the cuticle. In several specimens (fresh mounts) the PL setae thus appear to be cut off from the scutum and if these were to be examined alone there would be great difficulty in not deciding that the PLs were separated from the scutum, which would place the specimens in the subgenus *Tecomatlana* (= *Trisetica* ?). It will thus be necessary to bear this possibility in mind when distinguishing this subgenus on scanty or defective material. Scutal setae with short barbs; AL setae obviously the shortest. Interval between SBs less than twice their diameter. Only one specimen (holotype) had a single sensilla, and this was very distinctive, thickened in the middle of the shaft and tapering at each end, bifurcate with a few long barbs on the smaller branch, the main shaft conspicuously spiculate near the base (cf. *pallida* Nagayo *et al.*) and then bearing a number of lateral barbs up to 15μ long, several of which are bifurcate. The Standard Data of the scutum are shown in Table 2. *Body setae:* DS

TABLE 2

Standard Measurements of Holotype and 11 Paratypes of Trombicula dimolinae *sp.n.*

No.	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	Sens
24,007	46	67.5	18	28	17	35.5	51	34.5	53	68
23,996	44	64	18.5	25.5	19	37.5	45	37.5	58.5	..
23,997	43	64.5	17	23	18	34	46	32	58.5	..
23,998	45	64.5	18	23.5	17	32.5	..	36	56	..
23,999	47	67.5	19	27.5	17	35.5	..	34.5	57.5	..
24,000	46	61.5	18.5	24.5	16	32	..	29.5	59.5	..
24,001	46.5	65	19	23	11.5	32	..	31.5	56.5	..
24,002	43.5	62	19	21.5	18	31.5	45	38	56	..
24,003	42	61.5	17	24	15	33	50	32	55	..
24,004	46	65	18	26	16.5	35	51	41	58.5	..
24,005	45	65	19.5	25	17.5	33.5	44.5	43	54.5	..
24,006	44	64.5	19	22.5	17	35	45	37.5	58	..
Means ..	44.9	64.4	18.4	24.5	16.4	33.9	47.4	35.6	56.8	68

fairly slender, similar to PL scutal setae, with short barbs, arranged in rows but with irregular setae medially and laterally in the first row and laterally in other rows, e.g. 2.4.10.4.12.6.6.4, totalling 44–60 DS (42 to 32μ; humeral setae 45μ) + caudal setae (CS) in rows on level of and behind anus, 14–16 CS (total setae of dorsal type 64–74) + 22–26 VS (27μ) more slender, with two or three lateral barbs and a free pointed tip, arranged roughly in rows and more or less distinct from the caudal setae. One pair of sternal setae between coxae I and two pairs of sternal setae between coxae III.

Type Material.—Holotype (No. 24,007) and 11 paratypes from the ears of a horseshoe bat (R. 17,041) *Rhinolophus* sp., from Bukit Lagong Forest Reserve, Kepong, Selangor, on 25th January, 1952. Holotype and paratypes to be deposited in the British Museum (Natural History), paratypes in the Raffles Museum, South Australian Museum, and U.S. National Museum.

Remarks.—These larvae all appeared dead and shrivelled and no attempt was made to breed them. They were all attached to the inner face of the edge of one ear of the bat. The peculiar sensilla recalls the medially thickened sensilla of *T. harrisoni*, which is distinguished from *dimolinae* as shown in the Key. Because of the general relationship of *dimolinae* to *harrisoni* in larval characters and association with bats, this species probably belongs to the subgenus *Neotrombicula*, in which *harrisoni* has been placed on nymphal characters.

This species has been named for Miss Susan Dimoline, who was a voluntary helper in the Scrub Typhus Research Unit for a year from September 1948. Without her very welcome assistance in examining thousands of slides the routine identification of mites could not have been brought up to date in such good time.

Trombicula revelae sp. nov. Fig. 3, 4

A species with a broadly trapezoidal scutum with a sinuous posterior margin, sensillary bases near the line of PLs.

Description of Larva.—Body broad oval; partly engorged larvae 339μ × 300μ. Colour pink. Eyes 2+2, indistinct, on ? ocular plate level with PL bases. Cuticular striae distinct. *Gnathosome:* Cheliceral base with few punctae; blade 24μ, dorsally curved to a small tricuspid cap. Caleal seta nude. Palp: small tubercle at angle of femur; palpal setae nude and long (on genu, 31μ), tarsus with stout apical brush-like seta, fairly long spur, and 6 setae, mostly barbed but two with one or two barbules only. Claw 2-pronged, slender with smaller outer prong. *Legs:* all

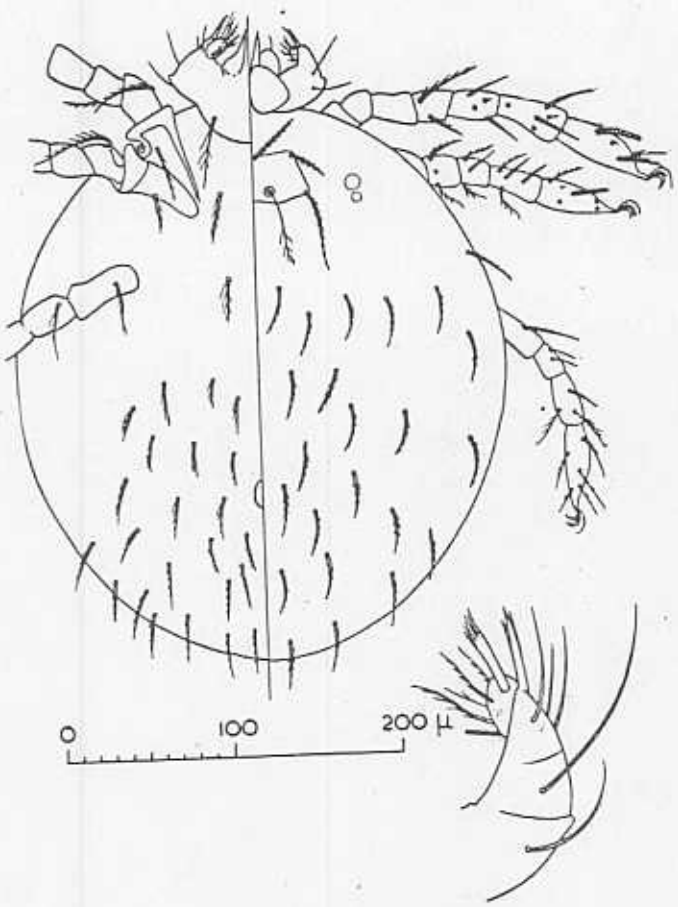

Fig. 3. *Trombicula revelae* sp.n., including palp.

7-jointed, joints relatively slender. Leg I: spur long (22μ), microspur curved, distal to base of spur and near its tip; 2 tibialae in distal half of tibia, posterior proximal one pointed, anterior and distal one with blunt tip and a long microtibiala (nearly 1/3 of tibiala) behind its base; 2 genualae, posterior one more slender, long microgenuala anteriorly. Leg II: spur fairly long, microspur antero-proximal and close to its base (proximal, in tandem, on one leg of one specimen); 2 tibialae in tandem, distal one relatively blunt; 1 genuala. Leg III: slender tibiala; 2 slender long genualae not in tandem (about as long as genu); long (25μ) tapering curved telofemorala (cf. masti-femorala),

about as long as tibia; all these setae refractile. *Scutum* (fig. 4): roughly rectangular, the anterior corners rounded off in front of the AL bases, anterior margin slightly sinuous; AL and AM bases in line; unusually large area behind AM base free of punctae. Scutal setae slender with short barbs or stipules, PLs distinctly long (56μ). Sensillary bases well separated, very near posterior margin producing a slight sinuosity. Sensillae normal, with *ca.* 10 fairly long barbs on distal half. The Standard Measurements are shown in Table 3. *Body setae:* DS slender with small barbs or stipules, similar to PLs, in irregular rows (cf. those of *dimolinae*), e.g. 2.12.4.10.10.8+8–14 = 46–52 DS (40μ, humeral setae 42μ) + caudal setae becoming confused with VS in the long para-anal row, total 26–34 CS (total setae of dorsal type, 72–86) + 10–16 VS (29μ), with fewer and longer barbs, arranged roughly in rows but irregularly. In two specimens, a ventral seta was double, two setae arising from the same base. This appears to occur more frequently with chiggers which have irregular and asymmetrical body setae.

Type Material.—Holotype (No. 24, 251) and 3 paratypes from R. 17,108, and 3 paratypes from 3 other horseshoe bats (R. 17,107, –9, –10), *Hipposideros* sp., from a cave in a limestone hill, at about 6° 27′ N., 100° 15′ E., near Kangar, Perlis, collected on 4th February, 1952 by staff of the Selangor Museum.

TABLE 3

Standard Measurements of Holotype and 6 Paratypes of Trombicula revelae *sp.n.*

No.	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	Sens
24,251	49.5	65	21	25	8.5	24.5	37	32	54	55
24,250	54	68	22	29	9	26	44	35	61	..
24,252	49.5	64	20.5	24	9	22	40	31	55	54.5
24,253	49.5	65	20.5	26	8	25	41.5	30	46.5	55.5
24,254	49.5	58.5	19	24	9	21	..	..	58	..
24,256	45	59.5	19	24.5	9	22	40	28	54	..
24,260	51	65	22	26	10	24	..	30	62	..
Means ..	49.7	63.6	20.6	25.5	8.9	23.5	40.5	31.0	55.8	55.0

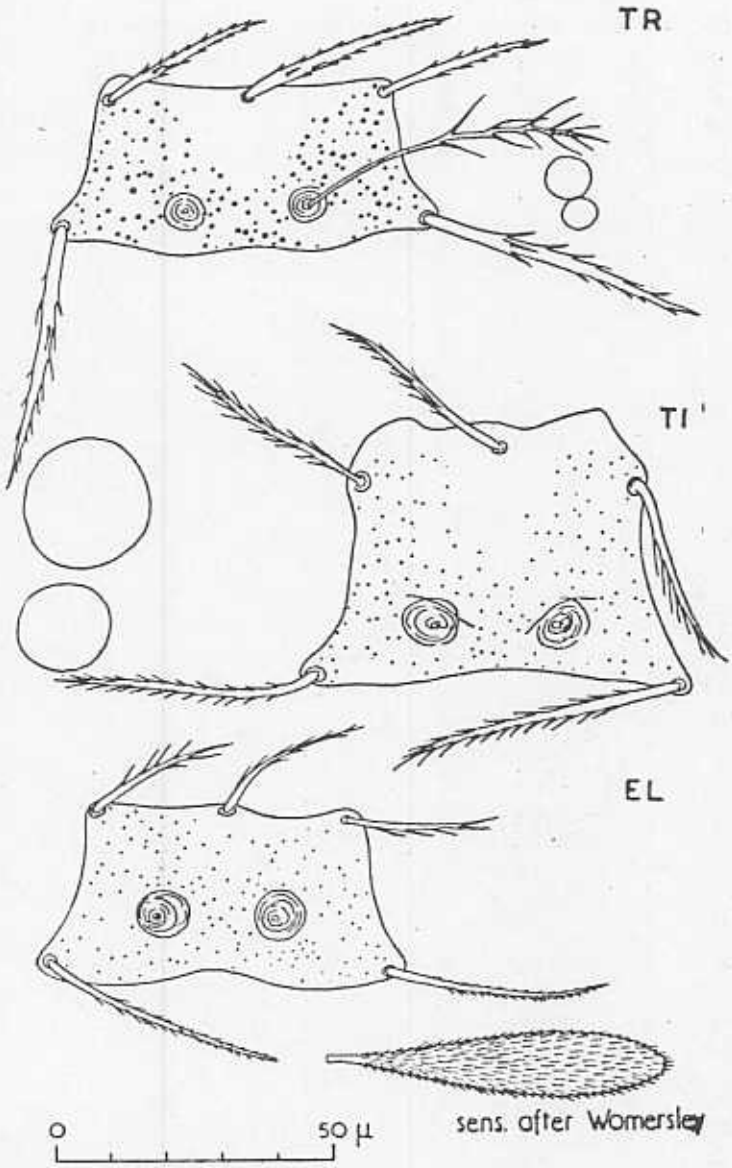

Fig. 4. *Scuta* (and eyes) of bat-chiggers: TR—*Trombicula revelae* sp.n. TI—*T. insolli* Philip & Traub, 1950, from a tomb-bat, Seletan Island, EL—*Euschöngastia lipoxena* (Womersley, 1952), of which no specimen with sensillae was available for drawing: the sensilla has been drawn from the description and figure given by Womersley (1952) ("broadly lanceolate, strongly setulose, without a distinct basal stem") mean length 61·6$_\mu$ with head 8·4 wide.

Trombicula taphozous Womersley 1952. Fig. 2

Described from a single specimen from a tomb-bat, *Taphozous melanopogon,* from the cave on Seletan island on 1st February, 1950. We have since seen 8 specimens of this species, collected by Mr. Wyatt-Smith from the same cave and host on 15th May, 1951. The following data can be added to Womersley's description.

Colour orange or pink. Eyes 2 + 2, the posterior one distinctly smaller. Galeal seta nude. Palpal setae: on femur long with short serried barbs or ciliations; on genu fairly long, nude or with a few barbs; on the tibia, dorsal seta nude or with a single barb, lateral nude, ventral with long branches. Claw 3-pronged, the ventrolateral accessory prong being inconspicuous in some specimens. Chelicers dorsally curved at tip to a small tricuspid cap. *Legs* 7-jointed. Leg I: the spur is long (25μ) and fairly slender, with long microspur distally; 2 tibialae, the posterior one more slender and tapering, microtibiala long (6μ); 2 dorsal and 1 posterior pointed genualae, long microgenuala. Leg II: long spur, long microspur proximally; 2 tibialae not in tandem, distal one one stouter and blunt; 1 genuala. Leg III: a slender tapering seta on the tarsus and on the tibia carries only a few small barbs and may appear nude; slender pointed tibiala; fairly long slender pointed genuala, at least as long as the genu. *Scutum* drawn to the same scale as others, at fig. 2. There are two small plates near the anterior margin of the scutum which can be seen only with difficulty in some fresh mounts. The Standard Data of eight larvae (topotypes) from one collection are shown in Table 4. *Body Setae:* dorsal setae blunt-tipped with inconspicuous barbules, irregularly arranged roughly in rows with many setae caudally, difficult to count, first row 14–18, e.g. 2.14.15.12.10.12 + 18 = ca. 80–90 DS (34μ) + ca. 20–28 CS + ca. 30–36 VS (27μ) also irregularly arranged and sharp-pointed with longer barbs. Total body setae about 140.

Remarks.—The peculiar plates on the scutum are indistinct in several of the larvae from Seletan island, but in a recent collection of 14 horseshoe bats (*Hipposideros* sp.) from a limestone cave in north Malaya (near Kangar, Perlis) there were 6 specimens of *T. taphozous* or a form very near to it, in which the plates were more distinct. This relates *taphozous* to *T. philipi* Wom. 1952, but the two can be distinguished on details of the scutum and on the palpal setae, as shown in the Key later.

TABLE 4

Standard Measurements of ♂ Topotypes of Trombicula taphozous *Womersley, 1952*

No.	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	Sens
24,787	60	84	19	28.5	14.5	35	..	38.5	49.5	64
24,788	58.5	89	17	29.5	14	34	..	36	48	63
24,789	62.5	80	17.5	29.5	15	32	..	41	51	62
24,790	63	91.5	18	32	17	39.5	40	37	48	..
24,791	57	78	16	31	14	41.5	40	36	50.5	57
24,792	57	78	16	30	13	33	37	37	46.5	..
24,793	58.5	83	18	32	14.5	36	..	42	52.5	63
24,794	59.5	84	17	32.5	14.5	37	42	38	53	..
Means ..	59.5	83.4	17.3	30.6	14.6	36.0	39.8	38.1	49.9	61.8
Holotype	64.4	87.0	19.6	33.6	14	39.2	20+	40	50	56

KEY TO SPECIES OF *Trombicula* ON BATS, ORIENTAL AND AUSTRALASIAN REGIONS

Myotrombicula is included in this Key because a specimen with the chelicers missing may cause confusion. So that details of the palpal setae may be seen at a glance, they are when convenient shown as a palpal formula which the writer has found very useful as an aid to memory. The letters B (branched or barbed), b (with inconspicuous barbs or ciliations), and N (nude) are used to describe setae in the following order on the palps: femur/genu/dorsal-lateral-ventral setae on the tibia. The palpal formula for the *akamushi*-group is thus N/N/BNN, in which only the dorsal tibial seta is barbed.

In the section on Chaetotaxy, it will be seen that on the characters of the leg-setae *T. batui* is distinct from the others, while *insolli* and *revelae* share characters which separate them from *taphozous, harrisoni* and *dimolinae.*

1. Chelicers and palpi short, stout, modified (apparently for grasping hair); scutum a shallow rectangle, AW:AP = 63:16μ; apparently without eyes. From a bat, Australia. *Myotrombicula vespertilionis* Wom.
   Not so ..... 2.
2. Very small mite; scutum small, almost quadrate, AW:AP = ca. 40:25μ; sensillae bifurcate, without barbs, bases about central (ASB approx. = PSB = 20μ); DS short (26μ); palp B/B(b)/NNN, claw 2-pronged. From *Eonycteris, Taphozous,* Malaya ..... *T. batui* Philip & Traub.
   Not so ..... 3.

3. Scutum trapezoidal, SB very close to posterior margin or in line of PLs; sensillae not thickened medially; all palpal setae N .....4.
   Scutum trapezoidal or almost rectangular; SB more centrally placed; palpal setae B/B/— or b/b/—.....7.
4. Scutum relatively deep, AP nearly equal to AW .....5.
   Scutum shallower, AP about half AW .....6.
5. Scutum larger and deeper, AW:AP = 60:42–57μ; AM longer than AL (ca. 52:33μ), with bases nearly in line and close to anterior border; posterior margin convex (?). From *Hipposideros*, Philippines ..... *T. piercei* Ewing.
   Scutum smaller, AW:AP = 50:35μ; AL and AM subequal (42:45μ); with AM base slightly in advance of AL bases, all distinctly behind anterior margin. From *Eonycteris, Taphozous*, Malaya ..... *T. insolli* Ph. & Traub.
6. Scutum posteriorly broadened with evenly convex posterior margin (AW:PW = 59:84μ); SB near line of PLs but ASB:PSB = 21:17μ; galeal seta B; palp B/B/NNB; DS 28, in rows 2.8.6.6.4.2. From bats, rats, marsupials, Australia and ?Solomons ..... *T. quadriense* Wom. = *T. chiroptera* Wom.
   Scutum more nearly rectangular; SBs close to posterior margin which is shallower and sinuous, ASB:PSB = 26:9μ; galeal seta N; DS ca. 50 in irregular rows 2.12.14.10, etc. From *Hipposideros*, Malaya ..... *T. revelae* sp. n.
7. Scutum almost rectangular, PW:AW = 78:62μ; without plates near anterior margin; SB midway between lines of AL and PL; AM, AL, PL setae 57, 35, 62μ. From *Emballonura*, Fiji and Malaya ..... *T. leveri* Wom.
   Scutum trapezoidal, AM less than 45μ, PL less than 50μ .. 8.
8. AW:AP less than 50:40μ; PW less than 65μ; sensillae peculiar, thickened medially .....9.
   Scutum larger, AW:AP = 55–65: 24–37μ; PW about 80μ; anterior margin extended in front of AL–AM bases, with pair of small plates near anterior margin (may be difficult to detect in *taphozous*); sensillae normal .....10.
9. Scutal margins relatively straight, posterior margin slightly concave medially, approaching SB (PSB 14μ); AM and AL bases almost in line on anterior edge of scutum; sensillae thickened medially with basal quarter of shaft smooth; DS

less than 36, in regular rows 2.6.6.6. etc.; one pair sternal setae between coxae III; palp B/B/BBB, claw 3-pronged. From *Hipposideros,* Malaya ..... *T. harrisoni* Wom.

Lateral scutal margins concave, anterior and posterior margins sinuous and broadly convex (PSB 16μ); AM bases slightly behind AL bases and not so close to the sinuous anterior margin; sensillae markedly thickened medially, bifurcate, with fairly long simple and bifurcate barbs, and proximal third of shaft spiculate (only one sensilla seen); DS over 40, in irregular rows, 2.14.16.6 etc.; two pairs sternal setae between coxae III; palp B/B/NBB, claw 2-pronged. From *Rhinolophus,* Malaya .. *T. dimolinae* sp. n.

10. Scutum broad trapezoidal, PW:AW:AP = 87:64:39μ; lateral margins straight, posterior margin sinuous, acutely concave immediately medial to the PLs; ASB:PSB = 34:14μ; plates near anterior margin not regularly developed and may be indistinct, lying anterior to line of ALs; AL and AM subequal; sensillae with many barbs; setae on palpal femur and genu stout with many small barbs or ciliations. From *Taphozous,* Malaya ..... *T. taphozous* Wom.

Scutum shallower, PW:AW:AP = 80:64:24μ; posterior margin evenly convex, ASB:PSB = 25:15μ; line across scutum in front of AM-AL bases, with pair of small plates immediately behind it, in line of or behind line of ALs; AL setae shorter than AM by 5μ; sensilla with only 2–3 barbs; setae on palpal femur and genu less stout, with long branches or barbs. From *Hipposideros,* New Guinea ... *T. philipi* Wom.

TABLE 5

Standard Measurements of Species of Trombicula *on Bats*

Species	No.	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	Sens
M. vespertilionis	1	62.5	65.5	24.0	16.0	11.0	16.0	23.0	19.0	27.0	..
batui ..	5	39.8	48.2	18.6	..	19.6	24.7	27.4	23.2	30.0	39.6
pierceі											
Holotype ..	1	58.7	81.5	26.1	34.5	27.6	41.5	55.2	43.5	76.0	..
pierceі ..	75	60.0	83.5	26.5	..	..	50.5	50.0	33.0	70.0	..
insolli											
from Selotan ..	6	48.9	69.7	22.3	37.4	11.2	35.8	42.1	41.5	66.6	..
quadriense ..	5	58.8	83.8	20.2	21.0	16.8	23.5	30.8	27.0	44.0	50.0
revelae ..	7	49.7	65.6	20.6	25.5	8.9	23.5	40.5	31.0	55.8	55.9
leceri ..	3	62.0	78.3	24.0	24.0	24.0	38.3	57.0	35.0	62.0	..
harrisoni ..	10	47.9	61.9	19.6	30.2	14.0	38.1	41.1	42.4	47.6	68.6
dimolinae ..	12	44.9	64.4	18.4	24.5	16.4	33.9	47.4	35.6	56.8	68
taphozous											
topotypes ..	8	59.5	83.4	17.3	30.6	14.6	36.0	39.8	38.1	49.9	61.8
philipi ..	25	64.5	79.5	22.6	24.9	15.3	23.6	35.8	27.8	30.0	55.3

Schöngastia (Ascoschöngastia) lipoxena Womersley, 1952. Fig. 4
= *Euschöngastia lipoxena* (Wom.), after American authorities.

Described from 31 specimens from a horseshoe bat, *Hipposideros* sp. Including the original collection, 288 specimens of *lipoxena* have been found on 29 out of 300 horseshoe bats (*Hipposideros* spp.) from the forest reserves in Selangor, together with a larger number of *T. harrisoni*. The following notes may be added to those already published.

Larvae large, engorged ones broad and tick-like in appearance but pallid, light brownish or pinkish, in colour, attached all over wings and body of host but especially on inner surface of the wing membranes. Body tending to broaden rapidly with engorgement. Eyes absent, represented by a whorl of cuticular striae. *Legs:* Leg I: microspur distal to base of spur on tarsus; more slender proximal and thicker distal tarsalae with a long microtarsala posterior to base of the latter; 2 genualae in tandem, third genuala posterior or ventroposterior, with exceptionally long microgenuala. Leg II: microspur proximally in tandem with spur; 2 pointed tibialae in tandem; one genuala. Leg III: fairly long slender tibiala and genuala. *Scutum* (fig. 4): with posterior margin conspicuously indented, in old mounts the posterior and lateral margins may become very difficult to define. *Body Setae* characteristically arranged, the first row of DS starting well behind the scutum and the posterior rows rapidly becoming crowded together, confused with the caudal setae, and difficult to count. The caudal tuft of long setae (40-45μ) may be conspicuous. The ventral setae, numbering about 10 anterior and lateral to the anus, are nearly as long as the dorsal setae but have longer barbs.

Schöngastiella hipposideros sp. n. Fig. 5, 6

A small mite in the *bengalensis*-group, close to *S. punctata* Radford but distinguished by the narrower scutum and unisetose coxae.

Description of Larva.—Body oval, unengorged specimen 185μ × 125μ. Colour pallid. Eyes 2+2, small and laterally narrowed, on ocular plate (17μ × 6μ). Cuticular striae fine and close. *Gnathosome:* Cheliceral base with scattered punctae; blade 30μ long, narrowing rapidly near tip to small tricuspid cap. Galeal seta nude. Palp: femur with small tubercle at angle; all setae on femur, genu, and tibia nude; tarsus obscured in specimen. Claw obscured but apparently 2-pronged; with axial prong

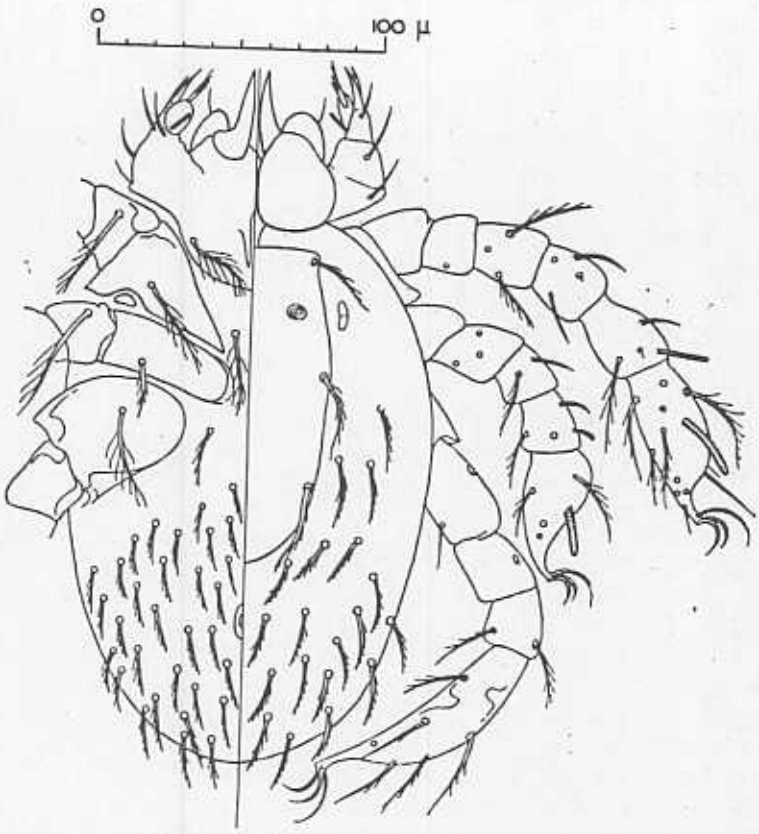

Fig. 5. *Schöngastiella hipposideros* sp.n.

slightly curved, 15μ, with shorter dorsal accessory prong. *Legs:* I 7-jointed, II and III 6-jointed; fairly short with relatively stout joints, I–III 155μ, ca. 120μ, and ca. 150μ respectively. Coxae unisetose, setae with long barbs. Leg I: the spur is thick and short with a small microspur proximal and slightly posterior to its base, near the margin of the tarsus; 2 tibialae in tandem, proximal slender and pointed, distal thick and blunt with long microspur immediately posterior to its base; anterior and posterior genualae with long microgenuala. Leg II: microspur obscured, apparently small and proximal to and near to base of spur; thick blunt distal and pointed proximal tibialae in tandem; pointed genuala. Leg III: short genuala; a posteroventral seta on femur, nude or with a single inconspicuous barb, about as long as the genu. This seta may appear to be a femorala. *Scutum*

(fig. 6) : large and deep, extending to third dow of DS in unengorged specimen; punctae close, extending to edges; anterior margin very slightly but evenly convex, almost straight; one anterior and two posterior pairs of setae all stout and close to edge of scutum, ALs slightly shorter and less stout than posterior setae and with fairly long barbs, longer than with posterior setae. Sensillae missing, presumably subclavate. The *Standard Data* of the unique holotype are as follows: AW 46, PW 56, SB 35, ASB 21, PSB 93, AP 41, AL 25, PL 34μ. *Body setae* stout with conspicuous basal rings and short barbs; in rows 2.4.1.4.4. 8.2.8.4.2. = 40 DS (28μ; humerals 30μ), the first rows 4.1.4 interrupted by the scutum, the asymmetrical seta being on the left side of the single specimen. Caudal setae 28, + 30 VS (17μ) more slender and with longer, pectinate barbs. Sternal setae 2+2, 28 and 20μ long.

Type Material.—A single specimen, No. 20,960, on a horseshoe bat (R. 16,025) *Hipposideros* sp., from Bk. Lagong F.R., Kepong, Selangor, on 5th September, 1951. Taken together with 16 specimens of *T. harrisoni* and 4 of *Eusch. lipoxena*. Holotype to be deposited in the British Museum (Natural History).

Remarks.—This species is very close to *S. punctata* Radford, from shrews and rodents in Manipur (India), Burma, and Ceylon, but differs in the narrower scutum (posterior setae close to the edge) and the unisetose coxa-III, which is 2-setose in *punctata* (and 4-setose in the closely related *S. kumaonensis* Wom.), and in the arrangement of body setae lateral to the scutum (2.4.4. in *hipposideros* and 2.2.2. in *punctata*). In *punctata* the scutum at the level of the PLs is some 7–10μ wider than PW (see Fig. 6). The tendency to lateral extension of the scutum beyond the PL setae, with angulation, observable in *punctata*, reaches its extreme development in *S. brevis* Radford.

Two undescribed species from Malaya are intermediate in scutal characters between *bengalensis* and *hipposideros*. One of these (No. 24,680) has the anus borne on a plate. The leg setae of these two species have been compared with those of *punctata*, *hipposideros*, and *bengalensis* (from Kashmir). They all have the microseta of tarsus I very small and well proximal to the spur, but the other microsetae fairly long. The unusual nude seta (sometimes with a single ciliation or barb) on femur III is short in *bengalensis* and the two undescribed species and may be mistaken for a femorala; in *punctata* and *hipposideros* this seta is about twice as long.

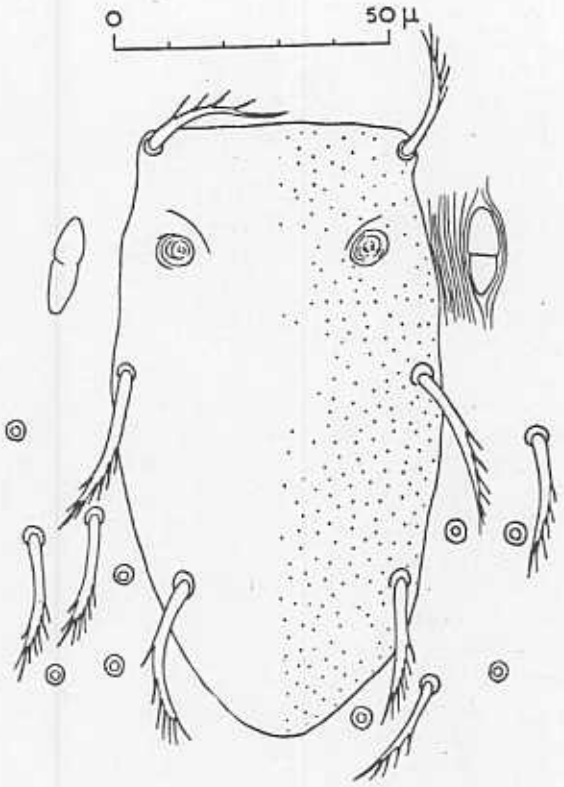

Fig. 6. Scutum of *Schöngastiella hipposideros* sp.n.

Hannemannia sp. nov. Womersley, in MS

This species has been described by Womersley (in MS) from 33 larvae on 9 fruit-bats, *Cynopterus* (*Penthetor*) *lucasi*, Bukit Lagong F.R., Kepong, Selangor. The only other *Hannemannia* described from bats is *Hannemannia perplexa* Brennan 1947 from *Eptesicus* in North America, but the Malayan species is very different from it, with a broad shallow scutum, the SBs posterior to the line of the PLs and very close to the posterior margin.

Notes on Chaetotaxy

The following notes concern some difficulties which have arisen while making comparative morphological studies of chiggers from our Malayan collection.

1. *Specialised Leg Setae.*—The nomenclature devised by Wharton (1948) and summarised in Wharton *et al.* (1951) has been used in this paper. Womersley (1952) criticises the use of the term 'spur' for the blunt sensory rod on tarsi I and II as this is certainly not a spur in the current entomological sense. But a short simple term is necessary and in the present paper Wharton's nomenclature has been used unchanged, with the observation that the tibia may carry a tibiala which has all the characters (thickness and bluntness) of the tarsal 'spur', so that it may be worth while renaming the spur a tarsala and the microspur a microtarsala before long-continued usage establishes the specially redefined 'spur'. A number of interesting differences are appearing in the leg chaetotaxy of related species and Wharton's stimulus in this direction has clearly been necessary and valuable. But a comparative description of the specialised setae and their relationships is required in addition to a simple enumeration.

The use of the terms mastigenuala, etc. would seem to need redefining, as the whiplike setae usually to be found on leg III appear to be of two quite distinct kinds. The most familiar ones are the long outstanding setae, but these appear to be simple long nude setae and in some cases they carry traces of barbs or ciliations near the base. The setae on leg III of *T. batui* and the shorter posterior femoralae in all members of the *Schöngastiella bengalensis* group are examples of such setae, though these particular setae are not very long and whiplike. The other kind of seta is more specialised, is hollow, refractile, and probably always striated though the striae may be very difficult to detect on the finer setae. There is always a characteristic tubular appearance near the base of these setae, which range in form from the short stout blunt rods of tarsi I and II, through the more slender and often tapering setae on the tibia and genu, to long whiplike setae such as those on leg III of *T. insolli* and *T. dimolinae.* These setae are characteristically curved, often very much so, while the less-specialised nude setae tend to be straight and frequently outstanding. It would seem that the 'mastifemorala' and 'mastigenuala' of say *T. insolli* are different structures from the mastifemoralae and mastigenualae of, say, *T. batui* or *T. microti,* and that it would therefore be misleading to assume that they are homologous. In the present paper, this difficulty has been met by describing the whiplike setae such as those of *T. insolli* as long, tapering femoralae and genualae, and not as mastifemoralae and mastigenualae. Also, the specialised femoral seta on

S. hipposideros is not a true femorala if these terms (*viz.*, tibiala, genuala, and femorala) are to be reserved as Wharton apparently intended them for the hollow striated refractile setae, which incidentally appear never to carry barbs.

The writer has examined six of the species of *Trombicula* discussed in this paper, and these fall into three groups on the characters of the leg setae alone, as follows:—

Group 1. Leg I with 2 genualae and unusually long microgenuala (longer in *revelae*). Leg III with 2 fairly long genualae and 1 long telofemorala (longer in *revelae*) . . . *T. insolli, T. revelae.*

In *revelae,* microspur II usually anterior to base of spur; proximal in *insolli.*

Group 2. Leg I with 3 genualae, shorter microgenuala. Leg III with 1 genuala, no femoralae. All these setae getting longer in the order: . . . . . *T. taphozous, T. harrisoni, T. dimolinae.*

In *harrisoni,* tibialae II not in tandem, with anterior one long slender blunt-tipped, posterior much shorter and tapering; microspur I curved, talon-like; spur II about 1/3rd length of spur I. Other species with no unusual characters.

Group 3. Leg I with spur (15μ) shorter than spur II (19μ); 3 tibialae (not 2) and microtibiala; 3 genualae but apparently no microgenuala. Leg II with microspur anterior and distal to base of spur (not proximal). Leg III setae not hollow refractile, mostly outstanding: 2 nude setae near subterminala and 1 other on tarsus; 2 on tibia; 2 on genu; 2 on telofemur; 1 on basifemur. *T. batui.*

2. *Body Setae.*—It is customary to count and record as dorsal and ventral setae those body-setae (often excepting the sternal setae) which lie on one surface or the other of the mounted specimen. Some authors have occasionally referred also to the postero-ventral or caudal setae. The dorsal body-setae continue round the posterior curve of the larva to end in the neighbourhood of the anus. The posterior folding of the mounted specimen cuts across these 'dorsal' setae in a completely artificial way and there is no anatomical justification for making a division between 'dorsum' and 'venter' there. The true ventral setae

lie grouped in front of the anus, with one or two para-anal pairs (or even rows) and sometimes a post-anal pair. These latter ventral setae lie alongside caudal and lateral setae which are part of the main body-setae of dorsal type. The true ventral setae usually differ from the dorsal and caudal setae, e.g. in being shorter and less freely or more delicately barbed. In the region lateral to and behind the anus, the caudal setae of dorsal type and the true ventral setae may be readily distinguished in many species, but in others they pass insensibly from one type to the other. In the latter case, one may reasonably if rather arbitrarily count one or two para-anal pairs or rows in with the ventral setae. The proportion of main body-setae of dorsal type which appear on the so-called 'venter' varies with the degree of engorgement of the larva.

These setae are of taxonomic importance and a complete description must include not only numbers and descriptions of the setae, but a comparison of the ventral and caudal setae, with a note as to whether they appear distinct or not. It is suggested that a useful standard form of description is that which has been used in the present paper, *viz.*:—Description of conventional dorsal setae (DS) with enumeration and size of DS and humeral setae + number of caudal setae (CS) + ventral setae (VS), enumeration, size, and whether or not they intergrade with the caudal setae. The sternal setae require description if there are more than 2 pairs or if they differ from the ventral setae or among themselves.

Host Relationships

The following records give some idea of the distribution of chiggers on bats collected in Malaya by the Scrub Typhus Research Unit. Many of these bats are brought to us in bulk in spirit by aboriginal collectors in the forests. I am grateful to my colleague Mr. J. L. Harrison for all the identifications. The very large genera *Hipposideros* and *Rhinolophus* have not yet been worked out in detail, which is why the species of type hosts in the present paper have been omitted.

It appears from these records that bats are not nearly so frequently infested by chiggers as are most other mammals, nor do the bat-chiggers appear to be particularly rich in species, in spite of the expectation of host-specificity and the undoubted richness of the order Chiroptera. This may probably be explained by the relatively slight direct contact which bats have with a

milieu in which the non-parasitic stages of the mites can thrive and produce larvae to which the bats are readily accessible. Birds, on the other hand, have very close contact with their nests and frequently also with the ground, and they are much more freely infested with a variety of chiggers.

The following list summarises the results of examination of 682 bats in our Malayan collection:—

Pteropodidae (76 examined):

43 *Cynopteris* sens. lat. (fruit bats) examined, with *Hannemannia* sp. (33 mites on 9 bats, all of which were identified as *C. lucasi*).

[*Eonycteris spelaea* (cave fruit bats) (Philip and Traub coll.) with *T. batui* (5) and *T. insolli* (3).]

The following 33 bats were uninfested by chiggers:

21 *Pteropus* (flying foxes), 3 *Rousettus* (rousettes), 6 *Balionycterus* (spotted-winged fruit bats), 3 *Macroglossus* (long-tongued fruit-bats).

Emballonuridae (54 examined):

15 *Emballonura* (sheath-tailed bats) with 1 *T. leveri* (originally from an *Emballonura* in Fiji).

39 *Taphozous* (tomb-bats) with *T. taphozous* (11 on 2 bats), *T. insolli* (30 on 2), *T. batui* (1), and *T. deliensis* (1).

Rhinolophidae (382 examined):

7 *Rhinolophus* spp. (leafnosed bats) with *T. dimolinae* (12 on 1).

361 *Hipposideros* spp. with *T. harrisoni* (475 on 37) and *E. lipoxena* (288 on 29) plus 154 mites of these two species (in a pooled batch of 61 bats) also with 1 *S. hipposideros;* an additional batch of 14 *Hipposideros* sp. from a cave in Perlis with *T. taphozous* (6 on 4) and *T. revelae* (7 on 4).

Vespertilionidae (161 examined):

All uninfested:—99 *Myotis* (mouse-eared bats), 16 *Pipistrellus* (pipistrelles), 33 *Tylonycteris* (club-footed bats), 6 *Nyctalus* (noctules), 1 *Scotophilus*, 6 *Kerivoula* (forest bats).

Molossidae:

All of 9 bats uninfested:—1 *Cheiromeles* (hairless bat), 8 *Chaerephon* (wrinkle-lipped bat).

The chiggers have been recorded from particular hosts as follows:—

T. deliensis	Recorded from every order of land-mammals in Malaysia (except for the Edentates which have not been adequately examined).
T. batui	*Eonycteris spelaea,* Batu Caves (limestone), Selangor; *Taphozous melanopogon,* cave (metamorphic rocks), Seletan Island, Selangor coast.
T. piercei	*Hipposideros diadema griseus,* Barrio Buyog, Negros, Philippines.
T. insolli	*E. spelaea,* with batui; *Taphozous melanopogon,* Seletan Island.
T. quadriense	Unidentified bat and *Chalinolobus gouldii* (Vespertilionidae), Australia (?South); and on *Rattus* sp., *Rattus assimilis, Hydromys chrysogaster,* a bandicoot and a possum, Queensland; uncertain host, ?Solomons.
T. revelae	*Hipposideros* sp., limestone cave, nr. Kangar, Perlis.
T. leveri	*Emballonura* spp., Fiji, and Forest Reserve, Kepong, Selangor.
T. harrisoni	*Hipposideros* spp., forest fringe, etc. Commonest species in Malaya.
T. dimolinae	*Rhinolophus* sp., Forest Reserve, Kepong, Selangor.
T. taphozous	*Taphozous melanopogon* and *T. affinis,* Seletan Island; *Hipposideros* sp., limestone cave nr. Kangar, Perlis.
T. philipi	*Hipposideros cervinus,* Hollandia, Dutch New Guinea.
M. vespertilionis	Unidentified bat, probably South Australia.
E. lipoxena	*Hipposideros* spp. from forests, Selangor, with *harrisoni.* Fairly common species.
S. hipposideros	*Hipposideros* sp., Forest Reserve, Kepong, Selangor.
Hannemannia sp.	*Cynopteris (Penthetor) lucasi,* Forest Reserve, Kepong.

Trombicula schmitzi (Ouds. 1914) is also from the Oriental region, from a bat from Khandala, India (mountains between Bombay and Poona). Womersley describes this (after Oudemans) : it is distinguished by having an almost pentagonal scutum, eyes 2+2 on an ocular plate, 42 DS and some 116 VS, and a peculiar small porous disc ventrally behind each coxa III. The palpal formula is B/B/NNN, galeal N. The legs have no long nude setae. The scutum is about 60μ wide and about 50μ deep.

Other bat-chiggers from outside this region are recorded below for the sake of completeness, but owing to a local inaccessibility of some of the literature, this list is imperfect, though it is probably complete for the African species:—

Trombicula minutissimum (Ouds.)	*Hipposideros caffer*, Durban, S. Africa.
T. natalensis Law.	*Rhinolophus geoffroyi zuluensis*, Noodsberg, Natal, and Sterkfontein Caves, Transvaal, S. Africa.
T. myotis Ewing	*Myotis lucifugus*, Mt. Katahdin, Me. and Pocono Lakes Preserve, Monroe Co., Pa., U.S.A.
T. eptesici Brennan 1947	*Eptesicus fuscus pallidus*, Hamilton, Montana, U.S.A.
T. mexicana Ew.	Bat, San Luis Potosini, Mexico.
T. fahrenholzi (Ouds.)	*Miniopterus schreibersi*, Bremen, Europe.
T. muscae (Ouds.)	Bat (?), Europe.
T. myops Vitzthum	Bat, Europe.
T. russicum (Ouds.)	Bat, Europe.
Doloisia synoti Ouds.	*Barbastella barbastellas*, Bremen, Germany.
Tecomatlana sandovali Hoffman	A bat, Mexico.
Ascoschöngastia—aethiopica (Hirst)	A small grey bat, Accra, W. Africa; and *Myotis goudoutii*, Madagascar.
Eusch. hamiltoni Brennan	*Eptesicus fuscus fuscus*, Millertown, New York; and *Myotis subulatus leibii*, Germantown, New York.

E. pipistrelli Brennan	*Pipistrellus subflavus subflavus*, Mud Cave, Stone County, Missouri, U.S.A.
Gahrliepia nanus (Ouds.)	*Hipposideros caffer*, Durban, S. Africa.
Acomatacarus polydiscum (Ouds.)	*H. caffer*, Durban, S. Africa.
Hannemannia perplexa Brennan	*Eptesicus fuscus pallidus*, Custer, Montana, U.S.A.

There are in addition several species found as adults or larvae in caves, fairly often in bat-guano, and the larvae of these might be feeding on bats. Examples are *T. cavicola* Ew. (Reynold's Cave, Ky., U.S.A.), *T. cavernarum* Ew. (Panama), *T. camilla* Wharton (Oxolodt Caves, Yucatan), *T. moesica* Andre (Gradje Cave, Yugoslavia), *T. russica*, Vitzthum (bat guano, cave near Trieste, Italy), and *Trisetica* [*Tecomatlana* ?] *melvini* Traub and Evans (bat cave nr. Myitkyina, North Burma).

Summary

1. The trombiculid mites infesting bats are of particular interest for several reasons, one of which is the occurrence on bats in Europe, North America, and probably Africa, of mites very closely related to *Trombicula akamushi*, the vector of scrub typhus in south-east Asia.

2. Two new species of *Trombicula*, and one of *Schöngastiella*, are described, and supplementary descriptions are given of six other species infesting bats in Malaya. A key to the species of *Trombicula* is presented.

3. A comparative study of the leg chaetotaxy has been made. The whiplike and other specialised setae on leg III may be of two distinct kinds and these should be differentiated. A more realistic description of the dorsal and ventral body-setae is recommended.

4. Lists are presented as the results of examining 682 bats in Malaya, and also of the host-relationships of 15 species of trombiculids from the Oriental and Australasian regions, 6 from Europe, 5 from Africa, and 7 from the Americas. Six other species, suspected bat-chiggers, are recorded from caves.

References

AUDY, J. R., 1947. Scrub typhus as a study in ecology. *Nature, Lond., 159,* 295–296.

BRENNAN, J. M., 1947. New species of chiggers (Acarina, Trombiculidae) from bats of the nearctic region. *J. Parasit., 33,* 245–252.

FULLER, H. S., 1948. Some remarks on the Trombiculinae Ewing, 1929, in Das Tierreich, Trombidiidae, by Sig Thor and Willman. *Bull. Brooklyn ent. Soc., 43,* 101–111.

INSTITUTE FOR MEDICAL RESEARCH, 1952. Colonial Office Research Unit. *Rep. Inst. Med. Res., Malaya, for 1951* (in press).

LAWRENCE, R. F., The larval trombiculid mites of South African vertebrates. *Ann. Natal Mus., 11,* 405–486.

PHILIP, C. B. and TRAUB, R., 1950. Two new species of trombiculid mites from Malayan bats. *J. Parasit., 36,* 29–33.

WHARTON, G. W., 1947. Studies on North American chiggers. 1. The 'akamushi' group. *J. Parasit., 33,* 260–264.

————, 1948. Four new Peruvian chiggers (Acarina, Trombiculidae). *Psyche, 55,* 87–100.

WHARTON, G. W., JENKINS, D. W., BRENNAN, J. M., FULLER, H. S., KOHLS, G. M., and PHILIP, C. B., 1950. The terminology and classification of trombiculid mites (Acarina, Trombiculidae). *J. Parasit., 37,* 13–31.

WOMERSLEY, H., 1952. The scrub-typhus and scrub-itch mites (Trombiculidae, Acarina) of the Asiatic-Pacific region. Parts I and II. *Rec. S. Aust. Mus., 10,* 676 pp.