

*TROMBICULA MINOR* BERLESE (ACARINA, TROMBICULIDAE) :  
DESIGNATION OF NEOTYPE WITH LARVAL  
AND POST-LARVAL STAGES FROM MALAYAN BATS,  
AND NEW NAME, *MYOTROMBICULA DILARAMI*,  
FOR *T. MINOR*, COOREMAN 1960 *NEC* BERLESE 1905 <sup>1</sup>

BY

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CONTENTS.

	Page
1. THE GENUS <i>TROMBICULA</i> : VICISSITUDES	3
2. THE SPECIES <i>TROMBICULA MINOR</i> , GENERIC TYPE :	
A REVIEW OF AVAILABLE FACTS	6
2.1 Classical Descriptions of <i>Trombicula minor</i>	6
2.II-2.I4	6, 7, 8
2.2 BERLESE's "alcuni frammenti" and the fragments from DEPOK	8
2.3 Conclusions from analysis of descriptions	9
2.3I-2.34	10-11
2.4 Official list of specific names	11
3. JUSTIFICATION AND VALIDITY OF NEOTYPE-DESIGNATION	11
3.1 Article 75 (a). Admission of case	11
3.2 Article 75 (c). Qualifying conditions	12
3.2I <i>Differentiation of taxon</i>	12
3.22 <i>Adequate description</i>	12
3.23 <i>Evidence for loss of original type material</i>	12

1. This work was partly supported by U. S. Public Health Service Research Grant AI-03793 (formerly E-3793) from the National Institute of Allergy and Infectious Diseases.

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The authors wish to acknowledge their appreciation, for his studies of literature and correspondence concerning *Trombicula minor* and for his splendid drawings for the present paper, to Dr. P. H. VERCAMMEN-GRANDJEAN of the G. W. Hooper Foundation in San Francisco.

3.24	<i>Consistency of neotype with original type</i>	12
3.25	<i>Approximation to type locality</i>	13
3.26	<i>Appropriate institutional location of neotype</i>	15
3.27	<i>Consultation with specialists</i>	15
3.28	<i>Priority : invalid designation of neotype by COOREMAN (1960)</i>	16
3.29	<i>Summary discussion of material from AFGHANISTAN (COOREMAN, 1960)</i>	16
3.3	<i>Conclusions and designation of ? <i>Myotrombicula dilarami</i>, nomen novum for <i>T. minor</i>, Cooreman 1960, nec Berlese 1905</i>	18
4	DESIGNATION AND DESCRIPTION OF NEOTYPE	18
4.1	Family TROMBICULIDAE Ewing	18
4.2	Genus <i>Trombicula</i> Berlese 1905 : 155	19
4.3	Subgenus <i>Trombicula</i> Berlese	19
4.4	<i>Trombicula (Trombicula) minor</i> Berlese	19
4.41	DESIGNATION OF NEOTYPE : Type material	19
4.42	DESCRIPTION OF LARVA	20
4.43	DESCRIPTION OF NYMPH	21
4.44	DESCRIPTION OF ADULT	26
5	DISCUSSION OF TYPE MATERIAL AND ITS DISTRIBUTION	29
	SUMMARY	30
	REFERENCES	31

After the publication of its meagre original description, *Trombicula minor* Berlese 1905, type of the genus *Trombicula* Berlese 1905, was represented by two post-larval specimens mounted on one slide. One of these, a gravid female, was selected by WILLMANN (1941) for his revision. The slide containing this lectotype was destroyed during World War II.

This important species, being the type-species of the type-genus of an important family, has since then been involved in much confusion, summarized below. The confusion was extraordinary because *T. minor* was incompletely described from free-living post-larval specimens, while the classification of the TROMBICULIDAE is based on characters of the parasitic larvae. Even now, it is usually impossible to be confident even of the subgenus or genus — in some cases subfamily — of a given adult trombiculid. Most of the extraordinary confusion has developed by the frequent and free inclusion of a number of species in the genus *Trombicula*, and by permitting this heterogeneous genus to represent a family which includes vectors of disease and economic pests, all despite the fact that the generic type *T. minor* was for practical purposes almost unidentifiable at the generic level. A considerable effort by a number of acarologists over the last 20 years

has been concerned with the significance of being 'almost' unidentifiable in the present case; so also is a considerable part of the present paper.

The true affinities of *T. minor* have recently been crystallizing out of the rapidly growing structure of trombiculid classification. Nevertheless, the lack of adequate description and of a neotype leaves the genus *Trombicula* as an area of serious instability in taxonomy and nomenclature. The present paper designates a neotype to replace the lost type. The neotype is described in larval, nymphal, and adult stages so that for the first time genus and subgenera can be clearly diagnosed.

#### I. THE GENUS *TROMBICULA* : VICISSITUDES.

*Trombicula minor* was summarily described in 1905, but not until 1912 did BERLESE formally state that *T. minor* was the generic type of his new genus.

BERLESE, and also EWING in particular, developed this genus by ascribing many species to it. These species were mostly known only as larvae, and but few as adults. The genus thus took spurious shape. Even by the time EWING (1929) proposed a subfamily TROMBICULINAE in the family TROMBIDIIDAE, the classification of this taxon was being developed entirely on larval characters. The very uncertain nature of the generic type continued to be ignored while the considerable family TROMBICULIDAE Ewing, 1944, took shape.

WOMERSLEY (1952) in his comprehensive monograph described many new nymphs and adults, as well as larvae, and attempted a radical revision of the family on the basis of both post-larval and larval characters. It would be premature to attempt this even today, over 1,000 species and over 70 subgenera ahead of WOMERSLEY's time. *Trombicula minor* is a very small species, so that the sensillary bases (see figs. 5, 10, 11) of the adult scutum are relatively large compared with the area sensilligera itself. WOMERSLEY concluded erroneously that the chitinous rings of the sensillary bases, drawn semidiagrammatically by WILLMANN, were in fact parasensillary eyes such as were known to be present in adults of common American pest-chiggers of the genus *Eutrombicula* Ewing. This misinterpretation led WOMERSLEY to erect a very heterogeneous assemblage within the subgenus *Trombicula*, obscuring even further the few acceptable characters of the generic type.

WHARTON and FULLER (1952) made a most valuable contribution in a monograph based on a world checklist. They fully recognized that taxonomists were confronted with only two alternatives: (a) to leave *Trombicula* as a monotypic genus of which the larva and its precise relationships might never be known, or

(b) to divide the genus into whatever subgenera could be clearly designated. In either case, much more information was required for further stabilization. They rightly took the more conservative course of listing 8 subgenera in the genus *Trombicula*, sensu lato. The result was that all species (92 in number at that time) of uncertain status, not ascribable to these subgenera, were perforce put in the subgenus *Trombicula*. In other words, only the subgenus rather than a large genus was now a taxonomic trashcan.

In a taxonomic revision and in a later regional checklist, AUDY (1954, 1957) recommended the recognition of some or most of the subgenera as genera, and a narrow restriction of subgenus *Trombicula* by means of (a) recognizing a number of species as 'unallocated' *sub judice*, not presently assignable to *any* subgenus, (b) recognizing and naming species-groups as potential subgenera or genera, but without premature naming of new taxa, and (c) making a fresh attempt to compare the description and drawings of *T. minor* with known adult and nymphal trombiculids. He concluded that there was good evidence that *T. minor* was congeneric with perhaps two known Malaysian species of bat-chiggers : *Trombicula batui* Philip & Traub, 1950 (nymph not known, possible identity or relationship with *T. minor* discussed by the authors), or an undescribed species "R.32181 Audy in MS", the nymph and adults of which compared very well with the classical descriptions of *T. minor* (AUDY 1954 : 139, fig. 2, reproduced in VERCAMMEN-GRANDJEAN 1962a : 374). This, specimen, now designated in the present paper as the neotype, was later referred to by code as "NOR", from an anagram "normi" of *minor* (AUDY & VERCAMMEN-GRANDJEAN 1962b, 1963).

Shortly thereafter, it was recognized that *T. batui* was a member of a considerable group identifiable as *Microtrombicula* Ewing, with its main center of evolution in the Ethiopian region (VERCAMMEN-GRANDJEAN, 1960 ; AUDY & VERCAMMEN-GRANDJEAN 1961 : 125-133). *Microtrombicula* has now been revised as a genus by VERCAMMEN-GRANDJEAN (1965 : *Acarologia*, the present issue).

VERCAMMEN-GRANDJEAN (1960, and in MS) made a first step in a radical revision of the subfamily Trombiculinae, stressing hitherto neglected chetotactic characters which can now be seen as very important. In this revision, he based *Trombicula* on the Malaysian species "NOR", a series of which he had examined.

The present situation is summarized in the table on page 5 comparing taxa of various authors.

TROMBICULIDAE, SUBFAMILY TROMBICULINAE, GENUS *TROMBICULA* BERLESE :  
TABULATION OF EQUIVALENT GENERA AND SUBGENERA ASSOCIATED WITH *TROMBICULA* BY AUTHORS.

\* = genus/subgenus described since the publication concerned.

It is not practicable to give equivalents in detail for Womersley (1952) or for Radford (1954, not listed here).

VERCAMMEN- GRANDJEAN 1960, amended 1963 in MS	AUDY 1957 (Oriental-Australasian region)	AUDY 1954	WHARTON & FULLER 1952	WOMERSLEY 1952
TROMBICULA s.s. (Trombicula s.s.)	TROMBICULA s.s. (Trombicula s.s.)	TROMBICULA (Trombicula)	TROMBICULA s.l. (Trombicula s.l.)	TROMBICULA s.l. (Trombicula s.l. in part)
(Anomalaspis, s.l.)	—	ANOMALASPIS	*	*
(Cotrombicula)	*	*	*	*
(Sasatrombicula)	*	*	*	*
BLANKAARTIA s.s.	BLANKAARTIA s.s.	TROMBICULA (Blankaartia s.s.)	TROMBICULA s.l. (Blankaartia s.s.)	TRAGARDHULA s.l. ± TROMBICULA s.l. in part.
NEOTROMBICULOIDES (Crotiscella)	*	*	*	*
EUTROMBICULA	—	(Crotiscella)	(Crotiscella)	(Crotiscus)
LEPTOTROMBIDIUM	EUTROMBICULA	(Eutrombicula)	(Eutrombicula)	(Trombicula s.l. in part)
(Trombiculindus s.l.)	LEPTOTROMBIDIUM	(Leptotrombidium)	(Leptotrombidium s.s.)	(Leptotrombidium)
MICROTROMBICULA	(Trombiculindus s.l.)	(Trombiculindus s.l.)	(Trombiculindus s.s.)	(Trombiculindus s.s.).
NEOTROMBICULA	—	(Trombicula)	(Trombicula s.l.)	(Neotrombicula s.l. in part)
FONSECIA	NEOTROMBICULA	(Neotrombicula)	(Neotrombicula)	(Neotrombicula s.l. +)
	FONSECIA	FONSECIA	(Fonsecia)	(Fonsecia)

2. THE SPECIES *TROMBICULA MINOR*, GENERIC TYPE :  
A REVIEW OF AVAILABLE FACTS.

In the following account, *all excerpts quoted from the literature and italicized are translations*. The originals have been mimeographed and a copy will be sent on request.

2.1 **Classical Descriptions of *Trombicula minor*.**

GUNTHER (1951) gave a detailed review of the early history of *T. minor*. We are very grateful to Dr. VERCAMMEN-GRANDJEAN for a more recent review in which new information has come to light. In the analysis which follows, we have drawn freely upon his notes as well as his analysis (1962b).

For ease of reference, all excerpts and references to figures are serially lettered, (a), (b),...

2.11 — BERLESE (1905) based his very brief description of *T. minor* on two diminutive post-larval trombidiform mites obtained in March 1904 by sifting bat-guano from the floor of a cave (or caves?) at TJAMPEA (preferred spelling) near BOGOR (formerly BUITENZORG), JAVA. The two specimens were mounted on one slide in balsam.

- (a) 1905 : 156 — *Palpi elongate, claw strong and elongate, two long and robust spines internal to claw*. Also, his Plate 15, fig. 4 on photographic enlargement clearly shows only 2 accessory claws ('tibial spines'; *paraglyphs* or *paraglyphic ctenidia* of VERCAMMEN-GRANDJEAN 1962a : 375).
- (b) 1905 : 156 — Body measurement *up to 630  $\mu$  long*. This was repeated later (1912 : 94). See 2.2 below.

2.12 In 1912 BERLESE briefly redescribed *T. minor*, adding 3 new drawings of details of leg-I and palp, drawn from "some fragments" ("*... alcuni frammenti*") to be discussed later. The following excerpts (c-f) and BERLESE's figures (f) show that he regularly took care to distinguish between 2 and 3 accessory claws or *paraglyphs*; that he was unaware that 2 *paraglyphs* are characteristic of nymphs (see e — "no indication" that the specimen with 2 *paraglyphs* could be a nymph of *T. mediocris*); and that the specimen identified by him as *T. minor* definitely had 2 *paraglyphs* according to him.

- (c) 1912.4 — In his table of the genera of the family Trombidiidae, he first formally designated *T. minor* as the type of the genus *Trombicula* Berlese 1905. On p. 83 he explained the genus as "*nomen ex TROMBIDIUM*".

- (d) 1912 : 83, 88, 94 — On four occasions BERLESE mentions the presence of only 2 paraglyphs “laterointernally at the base of the claw” as characterizing *T. minor* and the subgenus *Trombicula*.
- (e) 1912 : 89 — *T. canestrinii* and *T. mediocris* are described as “evidently” females because they contained eggs or an egg (respectively 4 or 5 of 160  $\mu$  diameter, and a single one of diameter 190  $\mu$ ). This is important because BERLESE overlooked an egg in the second specimen on his slide of *T. minor*, which he regarded as conspecific. On p. 94 he says of *T. minor* : *This species is distinct from T. mediocris, ..., above all because of the measurements and also because there is no indication to think that this is a juvenile individual* [of *T. mediocris*, understood]. *In addition, the palpal claw is different...*
- (f) 1912 : figs. On p. 12, fig. 4 shows tibia and tarsus of the genus *Trombicula* with 3 paraglyphs. On p. 89, fig. 40A, B show palps of *T. canestrinii*, and on p. 91, fig. 41B shows the palp of *T. formicarum*, in both cases with 3 paraglyphs but with no mention of this in the text. On p. 95, fig. 44B shows the palp of *T. minor* with 2 paraglyphs, as repeatedly noted in the text and the diagnosis. It is clear that BERLESE regarded the presence of 2 paraglyphs as distinguishing his subgenus *Trombicula* from other members of the genus *sensu lato*.

2.13 In 1941, Carl WILLMANN redescribed *T. minor* from a study of the two specimens on the slide. He did not study the detached fragments. In 1905 BERLESE made it clear that his first description was only preliminary : the “formal” description and discussion was to come later — it came 7 years later but added no new information except measurements of the tarsus and tibia of leg-I. The question therefore raised is whether or not the two specimens on one slide may be regarded as syntypes, on which BERLESE based his species, and whether WILLMANN may be regarded as first reviser who also in effect designated a lectotype by making it abundantly clear that he was selecting the better of two specimens which also was indubitably an adult.

- (g) 1941 : 132 — *The type* [Typexemplar] *of Trombicula minor Berl. is by no means a nymph : it is an adult, in whose body a completely formed egg can clearly be distinguished. Later (p. 135) : The preparation of Trombicula minor has the following locality data : “Tjompea [sic], Java, 19.III.1904, sifted from cave-guano” (“... aus Hohlenguano gesiebt”). He then infers that this species, being a cave-dweller, may for this reason have degenerate eyes ; and the host of the yet unknown larva is presumably a “tropical bat”.*
- (h) 1941 : 132, 133 — *Despite the small size, which was responsible for some doubt expressed (Berlese gave the body length as 680  $\mu$  : the animal has somewhat shrunk in the preparation, since my measurements give only 630  $\mu$ ),*

it has been determined that the type specimen [Typenexemplar] is a gravid female... There is a second specimen without an egg in the preparation. This one is unfortunately very shrunk and folded. The internal organs are very difficult to distinguish in the Canada balsam mount. I do believe, however, that 3 pairs of genital discs [Genitaltaster] were visible in this specimen also. This last statement is speculative.

- (i) 1941 : 133, 134 — Unfortunately, in the type specimen [Typenexemplar], I could examine the palps only from the dorsal surface; but could determine that Berlese apparently made a mistake. In 1912 he wrote in his large monograph of the Trombidiidae that he possessed only a few fragments of this species. From these fragments he sketched the palp as having one strong and one weaker spine on the inner surface of the palpal tibia. In the type specimen, notwithstanding its poor orientation, there are clearly 3 spines visible on the inner surface... On p. 134 he gives measurements of the sensillae and crista : 107  $\mu$  and 127  $\mu$  respectively. On this page also he illustrates the area sensilifera and the palpal tibia (dorsal view) — see fig. 11.

We cannot be certain whether BERLESE's *alcuni frammenti* came from the crumpled specimen mounted on the same slide as the lectotype, from a third specimen also from TJAMPEA, or from a specimen from nearby DEPOK (see 2.2 below). We suspect that there were at least 3 and probably 4 specimens (2 fragmentary). No certain identification can be based on fragments, especially if the crista metopica is missing. Also, experience has repeatedly shown that post-larval stages collected from the same locality cannot be assumed to belong to the same species.

2.14 In 1947 WILLMANN in collaboration with SIG THOR writes :

- (j) 1947 : 348 — Leg I (fig. 413a) long and strong, tarsus I 100  $\mu$  long and 40  $\mu$  wide, tibia I 90  $\mu$  long. Length 680  $\mu$ .
- (k) VERCAMMEN-GRANDJEAN (1962a : 374) reproduces parts of a letter from WILLMANN dated 4 December 1961, confirming that the second specimen "war stark gequetscht und beschädigt" and that this specimen might possibly have been a nymph.

## 2.2 BERLESE'S "alcuni frammenti" and the fragments from DEPOK.

VERCAMMEN-GRANDJEAN (1962a) reproduced testimony that BERLESE's *alcuni frammenti* could not be found in BERLESE's collection at FIRENZE. Nor would the discovery of such fragments do anything more than confuse the issues which are already confused enough : the characters of such fragments could do nothing to help stabilize nomenclature of this genus and the subfamily. In 1963 Dr. Fausta PEGAZZANO discovered a slide containing fragments (palp and legs) of a trombiculid nymph and labelled thus : "123/14 *Trombicula minor* Berl. tipico. rotto. Depok, Giava. Kraepelin". DEPOK is very close to the type-locality, TJAMPEA.



This incomplete and unidentifiable specimen has been described as *Trombicula* *sp. indet.*, and the circumstances discussed, by VERCAMMEN-GRANDJEAN, AUDY & PEGAZZANO (1965).

### 2.3 Conclusions from analysis of descriptions.

There are some inconsistencies in the descriptions of BERLESE, of WILLMANN, and of VERCAMMEN-GRANDJEAN *et al.* We believe these descriptions are irreconcilable unless we accept the following.

A single slide including two specimens was in the Museum in HAMBURG. One specimen was undistorted and complete ; it was a female with an egg, but BERLESE did not record this either in 1905 or in 1912. WILLMANN did, however, see the egg (and also found 3 paraglyphs, as would be proper in an adult). The other specimen was considerably crushed and damaged.

A second slide contained some fragments, the *alcuni frammenti* of BERLESE. This may be identical with but probably was separate from the fragments now described as *Trombicula* *sp. indet.* Verc *et al.*

For the foregoing we have valid evidence. Since BERLESE (1905) drew a complete mite in outline, but overlooked the egg in the complete specimen, and saw only 2 paraglyphs or accessory claws on the palp (to which he evidently paid special attention), we suggest that he (a) assumed the two (or more) specimens belonged to the same species (only in the light of modern experience is this an outrageous assumption) ; (b) used the complete and undistorted specimen (gravid female) for drawing the entire mite, but apparently did not trouble to study this specimen closely for some reason (which we speculate may have been that the specimen was not very clear, while BERLESE's drawing shows the palps were fully extended and dorsally presented, and thus not easy to study) ; (c) used the fragment of a palp for the close study of the paraglyphs (a very reasonable choice for a very busy museum worker with large collections to work through). WILLMANN, 35 years later, possibly with a better microscope, ignored the crumpled specimen and studied the complete one. Let us assume that he detected the egg because he concentrated on this one undistorted specimen, which he studied closely enough to draw the area sensilligera and sensillae ; and perhaps also because the specimen had cleared thoroughly. But it would presumably have cleared enough in the 7 years between BERLESE's two descriptions. Therefore, we strongly suspect, after a careful study of all the evidence, that BERLESE in 1912 did no more than publish some more of the notes and sketches which he made in 1905, possibly reexamining the separate palp to confirm the number of paraglyphs, but not making any new thorough study of any slide.

The measurements of body-length are confusing. WILLMANN suggested (see *h*) that there may have been shrinkage with age, but we conclude that although BERLESE used the complete gravid female for both his drawing and his measurement of body-length (possibly taking measurements from his camera-lucida drawing),

he included the palps while WILLMANN (we have confirmed from correspondence directly) did not include the palps (see VERCAMMEN-GRANDJEAN 1962*b* : 375). There is some confirmatory evidence : if we take the given measurements of tarsus plus tibia of leg-I as 190  $\mu$ , and use this to scale BERLESE's drawing of the entire mite, the measurements of body-plus-palps, of body-plus-chelicers, and of body-plus-tectum (caudal setae included), come to approximately 675  $\mu$ , 545  $\mu$ , 506  $\mu$  respectively. Making comparative measurements of such drawings as these is of course hazardous.

Our conclusions regarding measurements are (i) that BERLESE used the same undistorted specimen as did WILLMANN for measurements of body length, and that discrepancies are explicable by a combination of observer error and including or excluding either palps or chelicers or even crista and tectum, and that it is a fruitless task to try to go any more deeply into interpretation ; (ii) that BERLESE may have used the separated fragment of leg-I for his drawing and measurements (length of tarsus plus tibia 190  $\mu$ ), or he may have used the foreleg of the same undistorted specimen which he drew, the latter being as probable as the former, perhaps more probable (measuring body length at the same time) ; and (iii) that WILLMANN & THOR (1947) simply quoted BERLESE's measurement of the foreleg segments (see *j* above) — these were obviously rounded-off originally and are repeated exactly.

Our summary conclusions are therefore as follows :

2.31 BERLESE based both his original description and his redescription on between 2 and 4 specimens which probably included 2 or more distinct species (compare the material from a similar source studied by COOREMAN, see 3.29 below).

BERLESE's specimens were probably as follows and were probably used as follows :

- (A) *Gravid female* : Used for outline drawing, BERLESE (1905 : Plate 15, fig. 4 — see *a* above). Also used for body-length, apparently “total” length including palps (1905 : 156 — see *b* above). This specimen was relatively undistorted and had an egg in the abdomen, overlooked by BERLESE possibly because of haste and lack of sufficient clearing.
- (B) *Distorted specimen on the same slide as (A)* : The distorted specimen was possibly not used at all for study by BERLESE, but he did pay special attention to the separately mounted palp (possibly the foreleg) in order to discern the oft-observed character of the accessory claws or paragyphs (see *d*, *f*, above).
- (C) *Fragments* : The *alcuni frammenti* from TJIAMPIA may have been obtained by dissection of specimen *B* but this seems unlikely. The fragments were probably from a macerated specimen or specimens which had died in the bat-guano. We assume that they were probably not identical with the

fragments from DEPOK, i.e., that there were probably 4 specimens in all, one a female, one possibly a crumpled nymph, and fragments of two nymphs.

2.32 Specimen *A* was a gravid adult female trombiculid. Specimen *B*, crumpled and damaged, may have been a nymph or adult, and it may readily have been a species different from *A*. The fragments had no taxonomic validity, being incomplete and belonging to an unknown third, probably third plus fourth, specimen or specimens.

2.33 In these circumstances, it is reasonable to regard the two specimens on the one slide as syntypes and quite possibly of 2 different species.

2.34 WILLMANN in 1941 was a first reviser and in effect designated specimen *A*, the undistorted adult female, as lectotype.

#### 2.4 Official list of specific names.

PHILIP (1961) has requested that *Trombicula minor* be placed on the official list of specific names by the International Commission of Zoological Nomenclature.

### 3. JUSTIFICATION AND VALIDITY OF NEOTYPE-DESIGNATION.

Since this species is of particular importance as the generic type of the type genus of an important family of parasitic acarines, and since there are both taxonomic and nomenclatorial problems involved, the requirements of Article 75 of the International Rules of Zoological Nomenclature are discussed as follows.

#### 3.1 Article 75 (a). Admission of case.

The admissibility of the case for designation of a neotype is in this particular instance unarguable. There is also an element of urgency since a major revision of classification of the family is developing as the result of intensive recent work by several authorities. A stable base for this is essential.

A long-term survey of trombiculids infesting bats was carried out in Malaya with the primary purpose of discovering the possible relationships of *Trombicula minor* and of ultimately rearing material for selection of a neotype.

It is essential, in the interests of stability of nomenclature in the typical subfamily Trombiculinae, that neotype material for this generic type species should be in larval correlated with postlarval stages. This is because *Trombicula minor* is based on postlarval specimens while the family is classified on larval characters. The taxonomy of the postlarval stages is several decades behind the taxonomy of the larvae. Furthermore, it is the larvae which are of much greater importance

than the postlarval stages, being common parasites of vertebrates over the world, transmitting some diseases and in various places causing skin lesions to the extent of being an economic pest to man and livestock.

### 3.2 Article 75 (c). Qualifying conditions.

The Rules specify 6 qualifying conditions and add one recommendation (75A) required to ensure a valid designation of a neotype.

3.21 — *Differentiation of taxon.* The description of the neotype includes a statement of characters which we regard as differentiating the neotype species, the subgenus, and the genus.

3.22 — *Adequate description.* All 3 stages — larva, nymph, and adult — are described and completely illustrated.

3.23 — *Evidence for loss of original type-material.* GUNTHER (1951) published evidence of the loss of the type slide in HAMBURG during the war. WILLMANN, who studied the slide in the Hamburg Museum in 1940, and Dr. Gisela RACK, Director, have more recently taken trouble to investigate again, and they report the certain loss of the lectotype by fire. The fragments, now described as *Trombicula sp. indet.* Verc.-G. *et al.*, lack many taxonomically essential parts and are unidentifiable, also they probably represent yet another species in the confused type-material; also these particular fragments were evidently not those described by BERLESE.

### 3.24 — *Consistency of neotype with original type.*

(A) The original descriptions of BERLESE and of WILLMANN are inadequate for sure identification at the specific level, probably at a subgeneric level. The designated neotype is consistent with what is known of the original type, as probably best testified by figs. 2-4, 9-11, and by the fact that Dr. WILLMANN himself has examined specimens of the nymph and adult of our neotype and agrees that, as far as he can judge by his own notes and drawings, they correspond closely enough with the original specimen to be indistinguishable from it. Since Dr. WILLMANN is the only living person who has studied the type and added illustrations, discussion, and measurements to the original description, we regard this as very strong justification for the present designation. The issue rests with the plain fact it would be fruitless to attempt to find some other species and try to show that it corresponds with *T. minor* any more closely in this character or that than the neotype.

(B) As already noted, there is a possible alternative for selection of a neotype, and that is a member of the genus *Microtrombicula*, such as the species *T. batui* (nymph or adult unknown) discussed by PHILIP & TRAUB (1950, see p. 4 above).

If this alternative were to be entertained, then (a) an Indonesian or at least Malaysian species of this group, *known in all 3 stages*, would have to be selected and designated neotype ; (b) *Microtrombicula*, a considerable genus of 61 species and 2 subgenera, now revised (see p. 4 above), would have to be synonymized with *Trombicula* ; and (c) a new genus created for what we here regard as *Trombicula* and for what has been regarded as *Trombicula* in a series of publications starting with AUDY 1954 and 1957, through AUDY & VERCAMMEN-GRANDJEAN 1961, to the revision of the Trombiculinae by VERCAMMEN-GRANDJEAN 1960. It is obvious that this would not be a forward step in the stabilization of the family. Furthermore, there are two taxonomic and biological objections to this course : (i) Post-larval stages of *Microtrombicula* are characterized by having the innermost parascutal seta distinctly longer than the others, a character shared by nymphs and adults of *Ascoschoengastia* (postlarval stages of these two genera are not distinguishable by present criteria). Even if BERLESE had overlooked this outstanding seta, it is unlikely that WILLMANN would have done so when he drew the scutum of *T. minor* : even though he did not draw the parascutal setae, this was because these setae were at that time taken for granted, " always " being the same as the anterior dorsal setae which together with the parascutal setae surround the scutum. (ii) Although it extends over both hemispheres, *Microtrombicula* apparently has its center of origin and major development in Africa. This is not a very significant point but it is noteworthy.

### 3.25 — *Approximation to type-locality.*

(A) The designated neotype is not strictly topotypic but comes from nearby in the same zoogeographical subregion, having been selected after a survey of trombiculid mites infesting many thousands of Malaysian bats of a large number of species (AUDY 1952 and others).

(B) Attempts have been made to obtain topotypic material. The first of these was by Dr. Cornelius B. PHILIP in 1947 and 1948, who approached Dr. A. DIAKONOFF, Director of what is now the Museum Zoologicum Bogoriense. Dr. PHILIP even sent sufficient shotgun cartridges by air from KUALA LUMPUR for collecting purposes. Attempts were resumed by one of us (AUDY) in 1953. Dr. M. A. LIEFTINCK, Director of the museum at Bogor at that time, wrote as follows (June 1953, see AUDY 1954 : 138) : " ... there are still difficulties in getting to the Tjiampia caves and I fear that there will be no chance of this at all since I have been informed that the bat caves at this locality are entirely spoiled, the fauna having disappeared almost completely. So there is no particular reason to visit the spot again, except for a pilgrimage. Since, as far as I know, there is no one in Indonesia working on Trombiculids at the moment, practically none of the former rich bat caves being at all accessible, I am afraid that I should not succeed in getting specimens for you from elsewhere. "

Third and fourth attempts were made to collect from TJIAMPEA caves in April-

June 1961 by LIE KIAN JOE and by DOMROW, with the support of funds from a U. S. Public Health Service research grant. There are a number of caves in limestone hills starting a few miles out from BOGOR. It was not possible, and apparently never will be possible, to identify with confidence the particular cave from which the type material was originally collected. This is a very important point, since the bat and trombiculid fauna have been found in Malayan surveys to vary from cave to adjacent cave. On these particular occasions 3 species of trombiculids were obtained from species of bats of 2 genera (DOMROW 1962a, b). These chiggers were : *Whartonia penthetor* Wom. from *Eonycteris spelaea*, *W. caobangensis* Schl. from two species of *Hipposideros*, and *Trombicula niehoffi* Dom. 1962b from two species of *Hipposideros*. This is a very interesting collection from as near the type locality as one may hope to get. No postlarval stages were recovered from guano and none was reared from larvae. *W. penthetor* was first collected in MALAYA from the fruit-bat *Cynopterus (Penthetor) lucasi* — thus this one species of chigger is found on a different species of bat in MALAYA and in JAVA. *W. caobangensis* was first collected (species "B" of AUDY 1956 : 100) in MALAYA in 1952-1953 and subsequently in VIETNAM and in KWANGTUNG, CHINA (as *W. recurvata* CHEN & HSU, synonym), later still in JAVA (DOMROW 1962a). All these places are in the same zoogeographical region but the distribution is obviously wide. There is no possibility whatsoever that *Whartonia* could be confused with *T. minor*. The third species, "*T.*" *niehoffi*, may belong to a new genus being described by NADCHATRAM. It shows several of the characters which we associate with convergent evolution among bat-infesting trombiculids, and therefore in some respects resembles *Microtrombicula* and *Trombicula (Sasatrombicula)*.

We may therefore conclude that (i) the same species of bat-chigger may be found spread through this zoogeographical region as widely as MALAYA, JAVA, VIETNAM, and CHINA ; (ii) the original cave from which *T. minor* was collected cannot be identified with certainty from among other such caves of varying sizes and collectively with a rich fauna ; (iii) there is evidence (LIEFTINCK *in litt.*) of changes in the character of caves due to human despoliation and guano-collecting, and possibly of abandonment and later re-population of caves by bats ; and (iv), since collecting in this area is increasingly difficult, and since there is no certainty whatever that a trombiculid collected in a cave at TJIAMPEA is necessarily closer to *T. minor* than one collected in MALAYA, and since it is essential for a neotype series to be not only collected but reared to nymphs and adults, therefore there is no good reason to continue attempts to collect strictly topotypic material. We are convinced that the general picture obtained by the extensive and intensive survey of bat-chiggers in Malaysia over the last 15 years is a more reliable guide to the relationships of *T. minor* than specimens which may be collected in a complex system of caves after over 50 years of guano exploitation.

(C) The host-species of *T. minor* is unknown. The assumption made by EWING and others that the larvae are parasitic on bats is fully acceptable. Trombiculid

species which are known to parasitize bats may be found in the postlarval stages in crevices in cave-roofs and in the guano on the cave-floor. The postlarval stages of the reared neotype would either regularly inhabit bat-guano, or at least be found in it.

(D) It is therefore proposed that the neotype conforms with the requirements of the *Rules* (Article 75 (c) (5)) in that it comes from "as nearly as practicable from the original type-locality" and that there is no inconsistency whatever in the habitats and host-preferences of the original and neotype.

### 3.26 — *Appropriate institutional location of neotype.*

In accordance with the requirement in Article 75 (c) (6) the neotype of *T. minor* is deposited with the U. S. National Museum collection, Washington, D. C. Paraneotypes, in all three stages, have been distributed to a number of other institutions which maintain reference collections of trombiculids.

### 3.27 — *Consultation with specialists.*

Recommendation 75A states that appropriate consultation and agreement of colleagues should be secured before designation of a neotype. The present neotype was the subject of discussion and correspondence with authorities on trombiculids since the publication of its relationships and probable identity with *T. minor* by AUDY (1954). In 1961, at a Conference on Acarology at the Tenth Pacific Science Congress, HONOLULU, HAWAII, the proposal that this species be designated neotype was discussed, and at this time a mimeographed summary of the situation (including that created by the invalid designation of a neotype by COOREMAN discussed below, see 3.28) entitled "Proposal to designate a neotype of *Trombicula minor* Berlese, generic type, from correlated adult, nymph, larva from Malayan bats" (AUDY 1961) was circulated to members of the Conference and to a large number of acarologists round the world. Except for a rejection of the neotype by Dr. Jean COOREMAN, there were no objections, and there was positive support at the Conference or subsequently in writing from the following authorities :

E. ABONNENC, G. ANASTOS, M. ANDRÉ, J. M. BRENNAN, E. BROWNING, D. A. CROSSLEY, Jr., M. DANIEL, G. O. EVANS, F. DA FONSECA, H. S. FULLER, D. P. FURMAN, J. L. GRESSITT, J. L. HARRISON, H. HOOGSTRAAL, E. W. JAMESON, Jr., H. L. KEEGAN, M. M. J. LAVOPIERRE, R. F. LAWRENCE, C. B. PHILIP, C. D. RADFORD, F. RADOVSKY, A. RUDNICK, M. SASA, J. G. SHEALS, R. W. STRANDTMANN, T. TAMIYA, R. TAUFFLIEB, M. G. R. VARMA, P. H. VERCAMMEN-GRANDJEAN, G. W. WHARTON, C. YUNKER. Also, R. DOMROW collaborated actively.

In addition, a letter outlining the situation created by the neotype designation of COOREMAN (1960), and also outlining the circumstances concerning the 8-years-old proposal to designate a neotype from reared Malaysian material, was sent for an unofficial opinion and advice as to procedure to The Secretary of the Interna-

tional Trust for Zoological Nomenclature on January 9, 1962. In a letter Z. N. (G) 34 dated January 18, 1962, Honorary Secretary N. D. RILEY gave an unofficial personal opinion as follows : " It appears to me that Cooreman, in setting up his neotype of *Trombicula minor*, has not fully complied with the provisions of Article 75 of the Code, especially paragraph 75 (c) (5). That being so, it is my *personal* opinion that the action is not valid.

" I suggest you go ahead with your proposed publication, setting up a neotype that does fully comply with the mandatory provisions of Article 75. If difficulties subsequently arise, they can be referred to the Commission for an Opinion. "

3.28 — *Priority : invalid designation of neotype by COOREMAN (1960).*

(A) Article 75 (d) defines *validity* of a neotype-designation as being " published for a given nominal species in accordance with the provisions of this Article. " The provisions of the Article having been met in the present neotype-designation, this designation is the first and thus retains priority.

(B) Dr. Jean COOREMAN in 1960 designated a neotype of *T. minor* from material collected from the floor of a cave in Afghanistan. According to Article 75 (e), this designation would take effect from the time when it fulfills all the provisions of the Article. The original designation was *invalid by definition* because its author failed to comply, in 1960 and since then, with several of the mandatory provisions of Article 75 of the Code, especially paragraphs 75 (a), 75 (c) (5), (4), and to some extent (2), and Recommendation 75A. These failures to comply are summarized in 3.29 below.

(C) Recommendations 75B and 75C propose that the author of an invalid neotype-designation published before 1961 should be given " opportunity to validate it before another zoologist designates a neotype for the same nominal taxon. " Also (75C), a specimen thus invalidly designated " should be given preference when a neotype is validly designated. " We have made every endeavor to respect these recommendations. Dr. COOREMAN has been given opportunity to validate his designation but (in correspondence) has stated that he takes his stand on the original designation.

A validation of COOREMAN's designation is, we concur, impossible because it simply is not possible for it to meet the requirements of Article 75. For this reason, it is impossible for us to give preference to the Afghanistan material, in deference to Recommendation 75 (C).

3.29 — *Summary discussion of material from AFGHANISTAN (COOREMAN 1960).*

(A) The type material (holotype and paratypes) of COOREMAN's neotype-designation is a mixture of species. This has been discussed by VERCAMMEN-GRANDJEAN (1962b). Through the kindness of Dr. CAPART, Director, 3 specimens were sent to Dr. VERCAMMEN-GRANDJEAN from the type series. These were labelled



"*Trombicula minor* Berlese 1905, R. I. Sc. Nat. Belg., I. G., No. 27646." These were part of the series of 9 described by COOREMAN (1960 : II, translated) : "*In the collection of Acarina collected in AFGHANISTAN by K. LINDBERG were found a series of 9 specimens undoubtedly belonging, in my view, to BERLESE's species, after examination of their morphological characters.*" The 3 specimens studied by VER-CAMMEN-GRANDJEAN comprised two species which have been fully described (1962a, b) :

(i) Specimen dissected and mounted on two slides : This was not an adult but a nymph, very distinctive and completely distinct from COOREMAN's description. Described as *Trombicula* (?) *caparti* Verc. Genus unidentifiable but probably not *Trombicula*.

(ii) Two specimens in spirit. These also were both nymphs, of one species, but distinct from (i) and clearly distinct from the neotype as described and illustrated by COOREMAN. This species was therefore described as *Trombicula* (?) *cooremani* Verc. The genus is unidentifiable by present standards.

The type specimen, which we have not examined, can be readily distinguished by its description from the other 2 species, so that we have 3 species in 4 out of the 9 original specimens. The original description is lacking in a number of characters but the illustration of the scutum shows 2 of the inner parascutal setae distinctly longer than the others, suggesting possible affinity with *Microtrombicula* (character also shared with *Ascoschoengastia* Ew. and some peculiar trombiculids such as *Doloisia* Ouds., *Oculicola* Dom.), though it seems a *Myotrombicula*.

(B) The sole purpose of designating a neotype is in the interests of stability of nomenclature. It is certain that neither COOREMAN's type nor the two other species confused with it in the paratypes can be identified with any known genus of trombiculids. The nature of the larvae of these three species cannot even be guessed, except that we would *expect* the holotype to be a *Myotrombicula*. COOREMAN's designation thus (a) does nothing whatsoever to stabilize nomenclature, (b) adds considerable confusion to the nomenclature because it ignores all previous studies of bat-chiggers in the Malaysian subregion and published revisions of the family and a checklist based on these, and because it makes the genus *Trombicula* indefinitely monotypic. This raises to us the question as to whether this neotype-designation is even admissible under article 75 (a). Some further confusion is added by the mixture of at least 3 species in COOREMAN's type series. The description of the neotype-designate lacks information which would determine that the specimen was an adult, and there is no mention of sex, but these characters could be determined by re-examination of the specimen.

(C) AFGHANISTAN is not in the same zoogeographical region as the type-locality of *T. minor*. The climate, vegetation, and fauna are very different (see VER-CAMMEN-GRANDJEAN 1962 b). In the face of considerable published accounts of

studies of trombiculids in general and bat-chiggers in particular in the region of the original type-locality, the designation of a neotype from AFGHANISTAN certainly does not comply with the requirement that the neotype should come "as nearly as practicable from the original type-locality". COOREMAN's observation about the coincidence in collection from JAVA and AFGHANISTAN at about the same month of the year does not help his argument : if anything, it does the opposite since the two localities are in northern and southern hemispheres.

3.3 **Conclusions and designation of *Myotrombicula dilarami*, nomen novum for *T. minor*, Cooreman 1960, nec Berlese 1905.**

We conclude that the neotype-designation of COOREMAN (1960) is invalid by definition and cannot be validated, also, in view of the fact that its acceptance will not stabilize nomenclature but will demand an upheaval, the designation may not be admissible under article 75 (a) of the Code.

The correct genus of COOREMAN's species cannot be determined but his figures and description are most consistent with the postlarval characters of bat-chiggers of the genus *Myotrombicula* (see VERCAMMEN-GRANDJEAN 1963). We accordingly give the new name ***Myotrombicula dilarami*** to COOREMAN's holotype specimen, the invalidated and presumably also inadmissible neotype-designate of *T. minor* COOREMAN 1960.

4. DESIGNATION AND DESCRIPTION OF NEOTYPE.

4.1 **Family TROMBICULIDAE Ewing.**

This Family is accepted in the sense of WHARTON & FULLER, 1952.

Subfamily TROMBICULINAE Ewing.

*Diagnosis of Subfamily* : Trombiculids whose larvae possess a single antero-median scutal seta, no median anterior scutal projection, no stigmata or tracheal trunks ; at least 4 sternal setae ; legs only exceptionally with 6 instead of 7 segments.

*Comments* : The diagnosis of WHARTON & FULLER (1952 : 41) is here modified in the light of studies by VERCAMMEN-GRANDJEAN (1961) and AUDY (1954).

4.2 Genus ***Trombicula*** Berlese 1905 : 155.

Type : *Trombicula minor* Berlese 1905 : 155.

*Diagnosis of Genus* : Small, pallid trombiculines ; larvae mostly parasitic on bats, with subpentagonal scutum ; posterolateral setae may be separated from scutum ; sensillae unexpanded, distally barbed ; eyes 2 + 2 ; palpal tarsus with tarsala and 4-6 barbed (or nude) setae ; simple chelicers with tricuspid cap ; legs

may be 6-segmented due to fusion of femora ; genualae on anterior, intermediate, and posterior legs respectively 2 (plus microgenuala), 1, 1. *Post-larval stages* pallid, small, of the usual figure-eight shape ; body setae with single shaft ; scutum not broad relative to length, tectum convex denticulate, sensillae unexpanded, barbed ; parascutal setae subequal ; eyes absent ; sternum present as a unicellular plate.

#### 4.3 Subgenus **Trombicula** Berlese.

*Diagnosis of subgenus* : VERCAMMEN-GRANDJEAN (1960) distinguished the 4 subgenera (*Trombicula* Berl.).

The characters he adopted are accepted here because they were based on his study of the neotype material here described. *Anomalaspis* Brennan is distinguished by the larger scutum and more anteriorly placed sensillary bases, and typically by the extra-scutal placement of the posterolateral setae. *Sasatrombicula* Verc. is distinguished by palpal tarsus with  $fT = 4B$  setae, a nude galeal seta, and a normally punctate scutum. *Cotrombicula* Verc. and *Trombicula* have similarly pitted or reticulate scuta but the latter has  $fT = 5B$  (former,  $fT = 6B$ ), galeal seta N or B (former B), and there may be 3 instead of the usual 2 genualae on the anterior leg of *Trombicula*.

#### 4.4 **Trombicula (Trombicula) minor** Berlese.

*Trombicula minor* BERLESE 1905 : 155, 1912 ; EWING 1920 : 389 ; LOMBARDINI 1936 ; WILLMANN 1941 : 131 ; PHILIP & TRAUB 1950 ; WOMERSLEY 1952 : in part ; WHARTON & FULLER 1952 : 61 ; GUNTHER 1951 ; AUDY 1954 : 137-140 ; VERCAMMEN-GRANDJEAN 1960 ; VERCAMMEN-GRANDJEAN & NADCHATRAM 1963 : 385 ; AUDY & VERCAMMEN-GRANDJEAN 1961. *Not* COOREMAN 1960 ; FINNEGAN 1945 ; GUNTHER 1939, 1940, 1941, 1942 ; JAYEWICKREME 1946 ; TAYLOR 1946 ; WILLIAMS 1944 ; WOMERSLEY 1952, in part, amended in WOMERSLEY & AUDY 1957.

*Trombicula* sp. near *T. minor*, AUDY 1954, VERCAMMEN-GRANDJEAN & NADCHATRAM 1963 : 385, plate p. 386.

*Trombicula* "NOR", AUDY 1956.

#### 4.4I — DESIGNATION OF NEOTYPE : Type material.

Because the classification of the TROMBICULIDAE is based on larval characters, the neotype here designated is a larva.

The neotype is slide CORU. 102934/1, I.M.R. Institute for Medical Research Malaya, larva from ear-lobes of R. 32180-4, Tomb-bat, *Taphozous affinis* (Dobson) (CHIROPTERA, EMBALLONURIDAE), cave in Kepong (Bukit Lagong) Forest Reserve, Selangor State, MALAYA, 1 May 1953. Neotype deposited in U. S. National Museum, Washington, D. C.,

Paraneotypes as follows : 84 larvae, 16 laboratory-reared nymphs (7 with correlated larval 'pelts' or exuviae), and 3 laboratory-reared adults (on 2 slides), all from larvae obtained in company with the neotype from 5 Tomb-bats, *Tapho-*

*zous affinis* (Dobson) (CHIROPTERA, EMBALLONURIDAE), serial numbers R. 32180-84, from a cave in Kepong (Bukit Lagong) Forest Reserve, near Kuala Lumpur, Selangor State, MALAYA, 1 May 1953. Details of collecting area summarized by AUDY & HARRISON (1954). Larval exuvia are usually mounted on a separate slide bearing the same number as that of the correlated nymph — the number being followed by (a) for exuvia and (b) for the nymph. (NB : *Bukit* : Malay for hill).

#### 4.42 — DESCRIPTION OF LARVA.

(A) *Diagnosis* : Very small species, legs with 6 segments (femora undivided) ; scutum verrucose-reticulate, with posterolateral setal attachment to scutum poorly sclerotized (appears to be off the scutum) ; distinguished from the African bat-chigger *T. (T.) reticulata* Verc. 1963 in having normal pretarsala, subterminala, and parasubterminala on anterior tarsus.

#### (B) *Description of Larva.*

*Body* : cream-white cordiform, about 280  $\mu$  when moderately engorged ; eyes 2 + 2 on ocular plate with trace of bright-red pigment ; *body setae* totaling 64, all barbed, dorsal setae arranged 2.8.6.6.6.4 = 32 DS ( $\mu$ ), caudals 4.2 = 6 CS, merging into ventrals 6.6.8.6 = 26 VS ; sternal setae 4.

*Scutum* : (cf. also fig. 2, AUDY 1954 : 139) shows a tendency for what VER-CAMMEN-GRANDJEAN calls *peniscutalization* or retraction of the sclerotized shield, so that the PL setae are almost but not completely off the scutum. Anterolateral scutal shoulders absent, posterior margin rounded convex ; surface verrucose-reticulate, resembling that of many species of *Microtrombicula*. Sensillary bases fairly close together, distance between them subequal to that which separates them from the anterior-posterior margins. Sensillae stout, almost the proximal half nude, 4-6 barbs distally. Scutal setae : PL > AM > AL, stout with a few inconspicuous barbules.

*Gnathosoma* : Segments broad and short ; cheliceral blades simple, with tricuspid cap, galeal setae barbed. Palpal setae (B)(B)-(B)BBG<sup>3</sup>-BBB(B)(P) ; thus  $fT = 5B$ .

*Legs* : Basifemora fused with telofemora, all legs 6-segmented. Tarsi showing tendency to develop supplementary sclerotized rings or bars : 2 on anterior, 1 on middle, and 2 half-bars on posterior leg. Subterminala and parasubterminala present on tarsus-I. Special sensory setae as illustrated ; genualae 2, 1, 1 ; one posterior tibiala. Falciform claws stouter than empodia.

TABLE I. — MEASUREMENTS OF 40 LARVAE, *T. MINOR*

Standard abbreviations of scutal measurements

pa, pm, pp — lengths of anterior, middle, posterior legs ;

Ip = pa + pm + pp, "indice-pattes" of VERCAMMEN-GRANDJEAN.

	Observed Range	Theoretical Range	Coeff. of Variation
AW	37-50	34.6-49.6	5.9
PW	60-68	57.3-69.5	3.2
SB	13-18	11.0-19.1	8.9
ASB	20-28	19.0-27.7	6.2
PSB	18-29	15.6-27.0	8.9
AP	28-34	26.3-34.8	4.6
AM	26-34	25.1-36.0	5.9
AL	25-29	23.5-30.5	4.4
PL	31-38	28.4-39.0	5.2
S	42-56	37.1-55.5	6.6
HS	31-38	27.6-39.1	5.8
DS <	25-31	24.8-33.8	5.2
	22-31	19.1-29.4	7.1
VS <	16-24	15.5-26.2	8.5
	20-26	18.6-27.8	6.6
pa	213-237	108.0-242.4	2.5
pm	183-202	178.0-205.6	2.4
pp	202-222	196.8-227.4	2.4
Ip	607-656	595.2-663.0	1.8

(C) *Type material.*

Neotype CORU. 102934/1, I.M.R. [Institute for Medical Research] Malaya, larva from ear-lobes of R. 32180-4, Tomb-bat, *Taphozous affinis* (Dobson) (CHIROPTERA EMBALLONURIDAE), cave in Kepong Forest Reserve, Selangor State, MALAYSIA, 1 May 1953.

Paraneotypes as follows : 84 larvae from the same 5 hosts and host-species, serial numbers R. 32180-84, as the neotype. Slides numbered CORU. 102934/2-5 (i. e. 4 slides) to 102938/1-9 (nine slides), and 36363/1-10 to 38451/1.

4.43 — DESCRIPTION OF NYMPH.

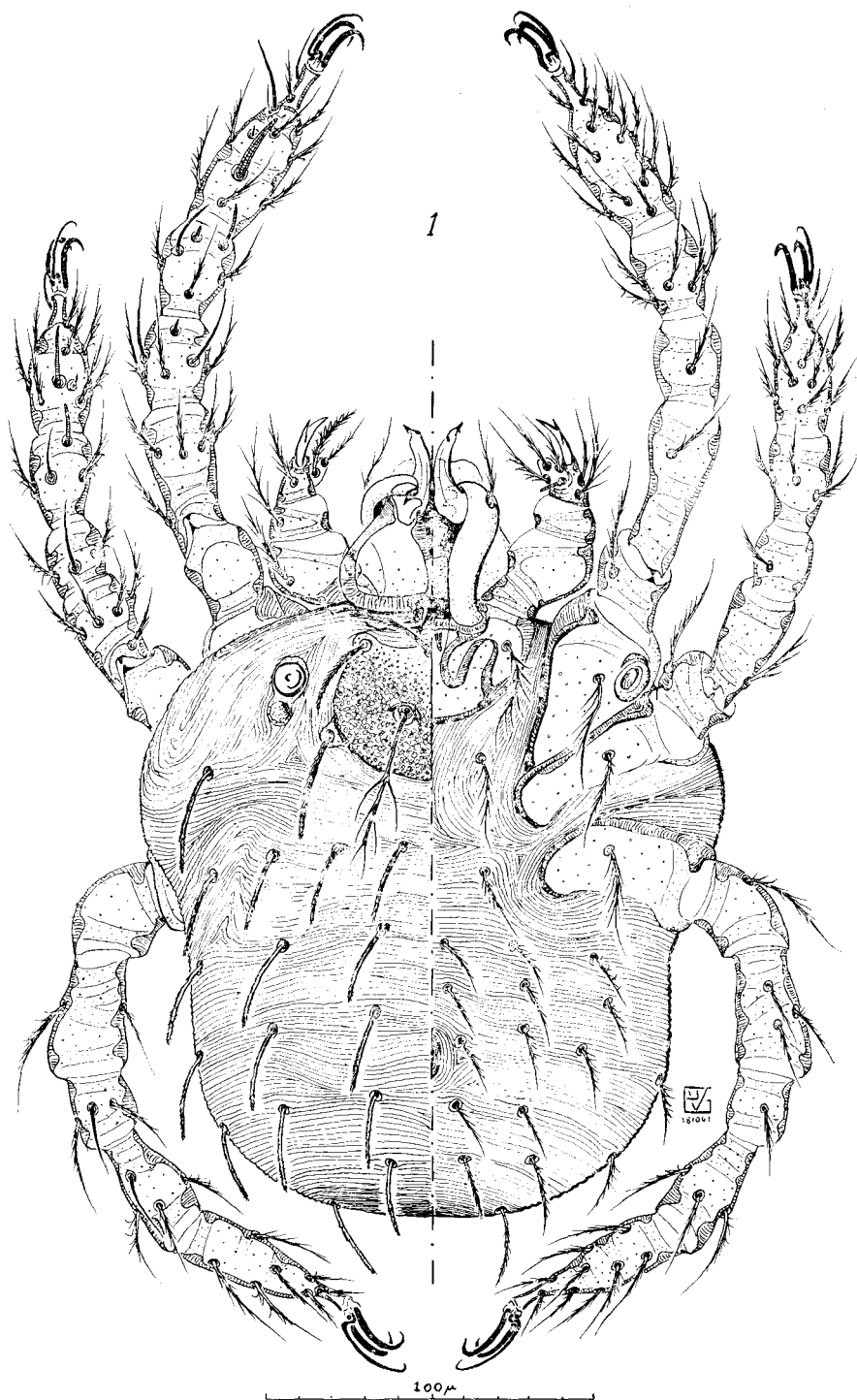
Described from 12 laboratory-reared specimens in good condition.

(A) *Size* : The differences in size between engorged larva, nymph, and adult are very slight. Nearly all other trombiculids increase markedly in size at each stage, but not so with *Trombicula*, which have been reared by one of us (NADCHATRAM). Measurements are tabulated below.

*TROMBICULA MINOR*

Berlese 1905 (Larva)

I



With acknowledgement to P. H. VERCAMMEN-GRANDJEAN, *del.*

(B) *Description of Nymph.*

*Body* : pallid, almost white ; small. Propodo-hysterosomal constriction marked. Body setae not increasing in size posteriorly ; densely barbed, with single shafts arising from sclerified discs.

TABLE 2. — MEASUREMENTS OF 12 NYMPHS, *T. MINOR*

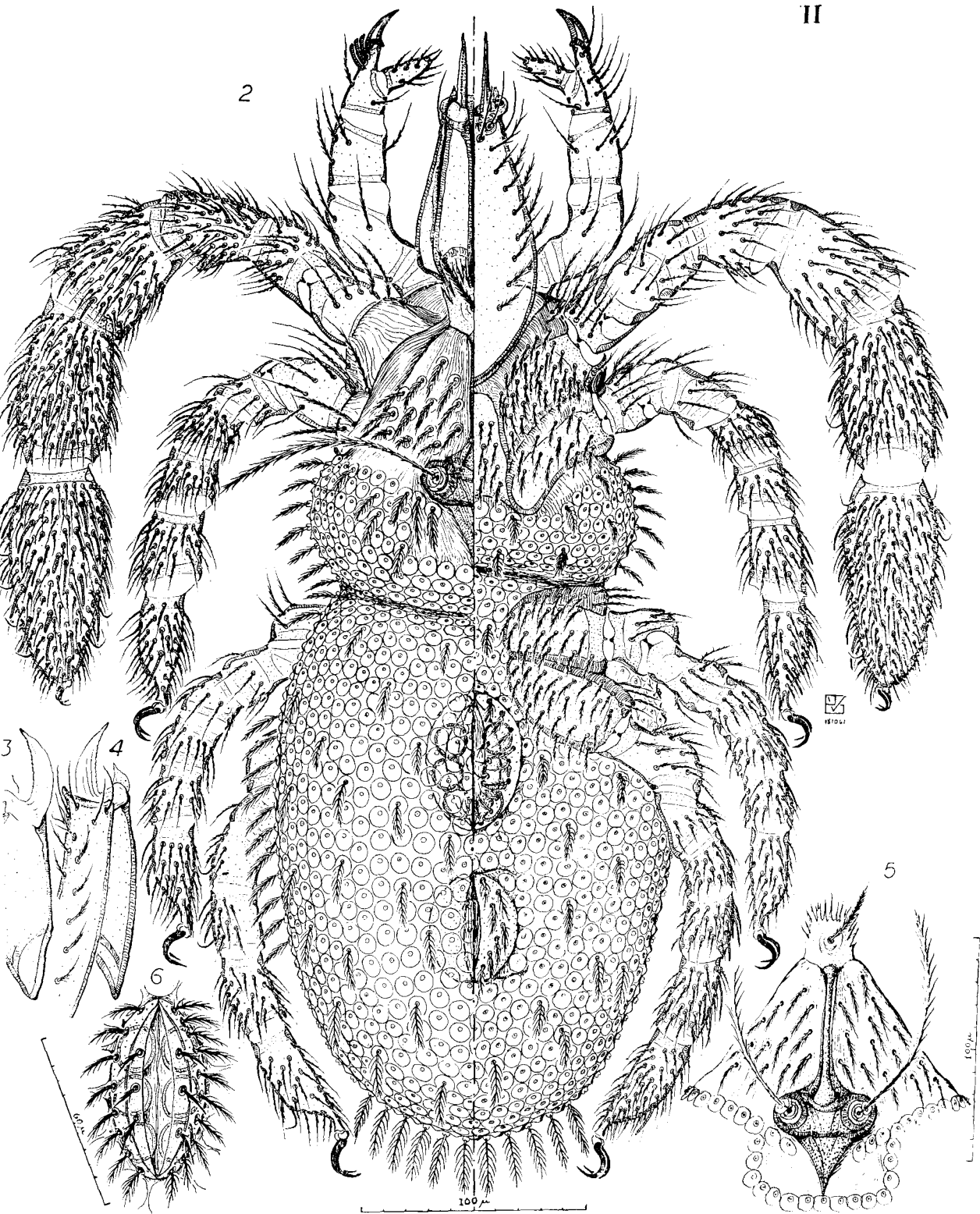
ASB — line of sensillary bases to anterior extremity of tectum ;  
Ip — sum of lengths of legs ("indice-pattes" of VERCAMMEN-GRANDJEAN) ;  
Lt — length tibia-I ; LT — length tarsus-I.  
P<sub>1</sub> & P<sub>4</sub> — lengths of legs 1 and 4 ; S — length of sensillae ;  
SB — distance between sensillary bases ; T — length of tectal seta.

	Observed Range	Theoretical Range	Coeff. of Variation
ASB	76-90	71.6-97.2	5.1
SB	26-35	23.3-39.0	8.4
S	82-94	74.1-96.5	4.4
T	19-26	17.3-28.9	8.4
P <sub>1</sub>	260-330	249.2-368.8	6.5
P <sub>2</sub>	168-206	150.1-223.0	6.5
P <sub>3</sub>	168-200	157.0-210.1	4.8
P <sub>4</sub>	206-242	192.6-262.7	5.1
Ip	808-966	763.6-1051.6	5.3
LT	66-80	61.8-84.1	5.1
WT	31-41	30.0-44.8	6.6
Lt	53-65	46.4-74.3	7.7

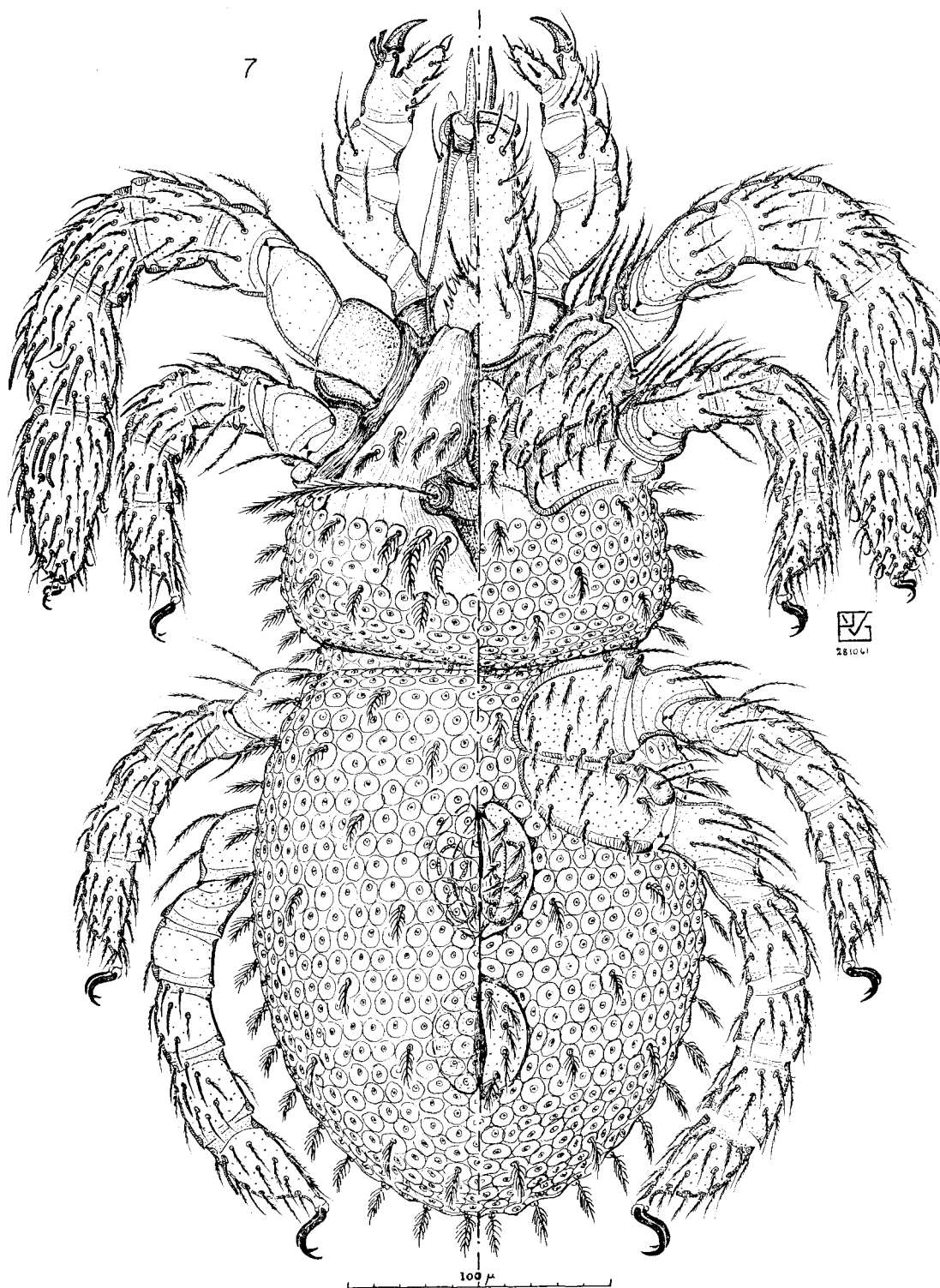
*Eyes* absent.

*Scutum* : unexceptional except that sensillary bases (SB 26-35  $\mu$ ) appear relatively somewhat large owing to the small overall size of the scutum. Anterior edge of tectum rounded with 14-18 marked subequal denticles ; tectal seta slender, with fine and numerous barbs (19-26  $\mu$ ). Sensillae stout, 82-94  $\mu$  long, basal third covered with barbules and remainder densely with longer barbs. Parascutal setae 5-6 on each side of scutum, and anterior submedian dorsal setae (separated from the other dorsal setae by subquadratic bare areas posterior and posterolateral to the scutum) distinctly longer than body setae.

*Genitalia and Uropore* : genital aperture immediately behind posterior coxae ; external shields or valves with 5-6 setae similar to those on coxae ; internal plates narrow and falciform, each with 3 short, stout setae bearing a few barbules. *Anal plates* with 5-6 barbed setae similar to those of coxae.







P. H. VERCAMMEN-GRANDJEAN *del.*

*Gnathosoma* : Cheliceral bases relatively narrow, 80  $\mu$  long ; unexceptional. Hypostome on each side with 4 nude apical setae and 8-10 fine barbed setae. Palp sparsely setose, setae with delicate barbs, arranged as follows ("palpal formula", fPp) : 5B-4B-5B.S.2Pg.C-T.8B.3S (in which B = barbed seta ; S = subterminal seta ; Pg = paraglyphs or accessory claws ; C = terminal claw ; T = the usual striated parabasal tarsala).

*Legs* : All with 7 relatively short and broad segments, relatively sparsely covered by barbed setae with free tips ; anterior leg longest. Anterior tarsus and tibia slightly swollen, bearing sensory setae of 5 different types (see fig.). Trochanteral setae few, slender and elongate ; proximal femoral setae longer than those seen distally. Anterior claws half as long and less stout than those of the other legs. Sternum present, single plate with anterior margin sclerotized, bearing 4-6 setae similar to coxal setae.

(C) *Type material* : 16 nymphal paraneotypes laboratory-reared (by M.N.) from larvae from type host series, bats R. 32180-84. Slides CORU. 36454, 36489, 36505-9, 36898, 36927 are nymphs for which satisfactory larval exuviae were not obtained ; slides CORU. 36455, 36460, 36461, 36488, 36490-91 are in pairs, (a) for larval exuviae or 'pelts' ("LP") and (b) for correlated nymphs ; both are mounted together on slide CORU. 36486.

#### 4.44 — DESCRIPTION OF ADULT.

Described from 3 adults reared in 1953 by M. NADCHATRAM. These mounts have deteriorated and the internal genitalia cannot be clearly seen. Therefore the sex cannot be determined. Specimen No. 37180/a is malformed, almost certainly as a result of laboratory rearing : it has only one pseudostigma (and thus one sensilla) and 4 instead of the usual 3 pairs of genital discs.

##### (A) *Description of Adult.*

*Body* : Fig. 2, very similar to that of the nymph, and scarcely larger. Body setae as described for those of *T. minor*. Area posterior to sensillary area completely clear, epicuticle pleated.

*Eyes* absent.

*Scutum* : Fig. 5. Crista only slightly longer than that of nymph but more sclerotized ; single slender tectal seta, finely barbed ; anterior edge of tectum rounded and deeply denticulate (14-18 denticles). Sensillae unbranched, with many barbs increasing in size from fine barbules starting at the base to longer barbs in the distal 2/3rds. Parascutal setae 12-15 on each side, finer than the dorsal setae and arising from much smaller discs.

*Genitalia and Uropore* : Genital aperture (Fig. 6) immediately behind the posterior coxae, with the two falciform interior valves slender and each bearing

3 stout short setae with 3-5 stout barbules ; external valves with 8-10 setae similar to those of the coxae. There are 3 pairs of internal genital discs (specimen 37180/a, malformed, has 4 pairs). Anal pore : each of the two kidney-shaped plates bear 6-8 setae similar to those of the coxae.

TABLE 3. — MEASUREMENTS OF 3 ADULTS COMPARED WITH NYMPHS, *T. MINOR*.

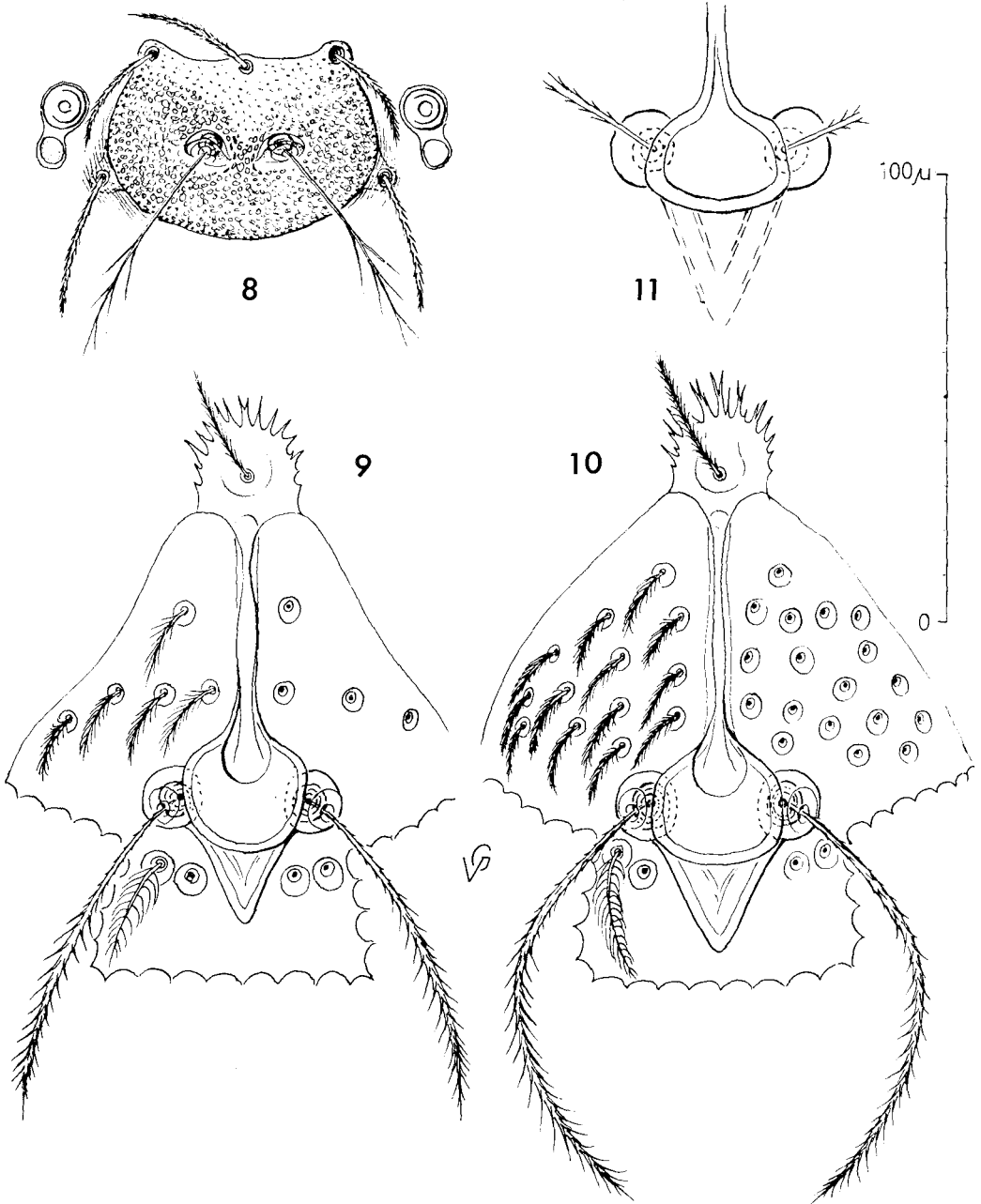
Abbreviations as for Table 2, plus : L, w, d prefixed in combination — length, width, and “depth”, the last being an estimate of depth obtained by reconstruction, calculated by Dr. VERCAMMEN-GRANDJEAN ; P, H, I, C, T, t in combination — propodosoma, hysterosoma, idiosoma, and propodo-hysterosomal constriction of body, and tarsus-I, tibia-I. For comparison, measurement of WILLMANN of a gravid female were : ASB + PSB = 127  $\mu$  ; SB = 30  $\mu$  ; S = 107  $\mu$  ; LI = 630  $\mu$ .

	ADULTS				Obs. Lim. — +	NYMPHS	
	37926	37180a	37180b	mean		mean	Obs. Lim. — +
ASB	104	82	101	96	82-104	84	76-90
PSB	19	12	14	15	12-19	13	11-16
SB	36	34	31	34	31-36	31	26-35
S	100	—	106	103	100-106	85	82-94
T	24	29	28	27	24-29	23	19-26
LP	147	115	61	108	61-147	98	66-128
LH	240	260	240	247	240-260	214	184-270
LI	387	375	301	355	301-387	312	261-399
WP	192	114	128	145	114-192	145	117-174
WH	238	146	136	173	136-238	172	145-210
WC	150	99	91	113	91-150	120	95-160
dP	160	94	106	120	94-160	122	82-142
dH	170	104	98	124	98-170	123	90-138
dC	125	82	75	94	75-125	100	94-117
P <sub>1</sub>	414	384	380	393	380-414	309	260-330
P <sub>2</sub>	230	216	213	220	213-230	187	168-206
P <sub>3</sub>	222	214	218	218	214-222	184	168-200
P <sub>4</sub>	270	262	259	264	259-270	228	206-242
Ip	1136	1076	1070	1095	1070-1136	908	808-966
LT	97	96	96	96	96-97	73	66-80
wT	48	42	41	44	41-48	37	31-41
Lt	84	80	79	81	79-84	60	53-65

*Gnathosoma-Chelicera* (Figs. 2, 3, 4) : Cheliceral blade has the usual form, about 45  $\mu$  long ; length of base about 90  $\mu$  ; mean total length 124  $\mu$ . *Palpi* (Fig. 2) : with relatively few setae, palpal formula,  $fPp = 6B-8B-9B.S.3Pg.G-T.14B.3S$  (see description of nymph) ; 3 paraglyphic spines or accessory claws, stout, the tip of each flattened and triangular, placed in a single longitudinal row from the base of the claw ; the claw is stout and firm with a small, sharp baso-ventral apophysis ; total length of palpi 100-150  $\mu$  (from base of trochanter to tip of claw). *Hypos-*

*Trombicula minor* Berlese, 1905

IV



Figs. 8-11, to the same scale for comparison. — 8, 9, 10, scutum or crista metopica, respectively of larva, nymph, adult of neotype, *Trombicula minor*, drawn semi-diagrammatically; 11, part of crista metopica of *T. minor* adult, after WILLMANN, 1941.

*tome* (Figs. 2, 4) : the two distal lobes bear 4 sub-apical nude setae, relatively strong and long, and one slender and long seta with 4-5 long barbs, rather different from the 10-12 barbed setae found on each side of the hypostome.

*Legs* : (Fig. 2, postero-lateral aspect at the left-antero-lateral aspect to the right). Each of the four pairs of legs is composed of 7 segments, relatively short and broad. Legs 1 : the longest and stoutest, also the most covered with barbed setae and also having, from the telofemur on, a number of diversified special setae which increase in numbers from segment to segment, becoming numerous on the tibia and very numerous on the tarsus ; leg 1 is essentially tactile and prehensile and its genu, tibia and especially its tarsus are stout and relatively swollen ; its terminal pair of claws is half as long and half as broad as those of the other three pairs of legs. Legs 2 and 3 (the shortest) and legs 4 have similar morphology ; they are about half as broad as leg 1. They are covered with barbed setae, more numerous than those of the nymph and decreasing in length from the trochanter to the tarsus ; from the telofemur distally there are also special setae increasing in number towards the tarsus but less differentiated and especially less numerous than on legs 1 ; stout claws attached to a small pretarsus. *Sternal cell* simple, joined to the four paired coxae of the anterior legs 1 and 2 and bearing 14-18 short barbed setae ; *coxae* also with many short barbed setae, except on their antero-external edge on which there are a few long slender setae (similar to those of the trochanter) and of which 3-4 are to be found on the dorsal side.

(B) *Type material* : Two paraneotypes (adults) specimens 37926, 37180/b plus one malformed adult 37180/a mounted on the same slide as 37180/b, reared in laboratory (M.N.) from larvae from R. 32180-84, *Taphozous affinis*, same host series as for the larval and nymphal material.

## 5. DISCUSSION OF TYPE MATERIAL AND ITS DISTRIBUTION.

We have assumed that, should a neotype be selected from a series of specimens taken from the identical host(s) at the same time and judged to be conspecific, then it is helpful for an author to designate these other specimens as the equivalent of a paratype series. Furthermore, in the case of trombiculid mites it is possible to rear nymphs and, less often, adults from larvae in such a way that an individual post-larval mite can be correlated with its own larval exuviae (or "pelt"). The larval exuviae often include all structures of taxonomic interest, and indeed are often easier to study than the larva itself. Unfortunately, it is very much more difficult to preserve the nymphal exuviae, correlated with the emergent adult. It is also very much more difficult to rear an isolated nymph to the adult stage than it is to obtain a nymph from an isolated engorged larva. Nevertheless, it is possible to preserve both larval and post-larval material of a single individual, which would make a good choice for a holotype. We have found some obvious

difficulties in assembling the type material for the neotype of *Trombicula minor*, namely (a) the need to designate a larva as neotype although the original type was an adult — this is necessary in the interests of stabilization of nomenclature ; (b) the wish to set aside a “ para-neotype ” series from the same collection as the neotype ; (c) the need to include larval, nymphal, and adult stages, some of the post-larval stages being correlated with larval exuviae (pelts), in the “ para-neotype ” series.

*Distribution of specimens* : The neotype larva, No. CORU. 102934/1 has been deposited in the U. S. National Museum, Washington, D. C., together with larval and nymphal paraneotypes. Paraneotypes comprising 84 larvae, 16 nymphs (u with correlated larval exuviae), and the 3 adults have been distributed to the following institutions as well as the collections of the authors and colleagues :

British Museum (Natural History) (London).  
Biological Institute, Czechoslovakian Academy of Sciences (Prague).  
Chicago Natural History Museum (Chicago).  
Gamalaya Institute (Moscow).  
Institut Royal des Sciences Naturelles Belgique (Brussels).  
Institute for Medical Research (Kuala Lumpur).  
Institute of Parasitology, Czechoslovakian Academy of Sciences (Prague).  
Muséum National d'Histoire Naturelle (Paris).  
Queensland Institute for Medical Research (Brisbane).  
Rocky Mountain Laboratory (Hamilton, Montana).  
South Australian Museum (Adelaide).  
Stazione di Entomologia Agraria (Florence).  
University of Maryland (Department of Zoology, College Park, Maryland).  
University of Ohio (Institute of Acarology, Columbus, Ohio).  
University of Tokyo.

#### SUMMARY.

1. The original type material of *Trombicula minor* Berlese 1905, generic type of *Trombicula* and representative of the family Trombiculidae, consisted of two specimens of post-larval trombiculids mounted on one slide plus (probably) fragments from a third specimen, all assumed to be identical. Of the two specimens on one slide, one was a complete adult, the other was greatly distorted. These specimens, from bat-guano in a cave or caves in JAVA, probably represented at least two species and probably included fragments of a nymph as well as an adult female.

2. Carl WILLMANN (1941) was the first reviser. He redescribed the complete adult female, containing an egg, and this specimen must be regarded as the lectotype.

3. The slide bearing the lectotype has been destroyed.

4. Some fragments (one palp and legs of a nymph), apparently regarded as conspecific by BERLESE, are unidentifiable and have been described as *Trombicula sp. indet.* by VERCAMMEN-GRANDJEAN, AUDY & PEGAZZANO (1965), not precisely topotypic.

5. The neotype designated by COOREMAN (1960) from an adult (?) from a cave in AFGHANISTAN is considered invalidated (a) for taxonomic reasons, as differing morphologically from the original descriptions too widely to be acceptable, and (b) for nomenclatorial reasons.

6. Nomenclatorial reasons for invalidating COOREMAN's neotype designation concern neglect of several mandatory provisions of the Rules of Zoological Nomenclature, especially failure to respect the need to stabilize the classification of the family, which is based on larval characters of the parasitic larvae and not on the adults — stabilization of classification being the prime requisite of neotype designations. The description and figures of COOREMAN suggest some relationship to *Myotrombicula*. The invalidated neotype from AFGHANISTAN has accordingly been renamed *Myotrombicula dilarami*, *nomen novum* for *T. minor*, Cooreman 1960 nec Berlese 1905.

7. A neotype of *Trombicula minor* Berlese is designated as a larva from a tomb-bat, *Taphozous affinis*, from a cave in MALAYA. A series has been reared to nymphs and adults and the species is described in all three stages. This is the same material as has been discussed as a potential neotype since 1954, on which the relationship of the genus *Trombicula* have been based by VERCAMMEN-GRANDJEAN (1960) and others.

8. The neotype, larva No. CORU. 102934/I, has been deposited in the U. S. National Museum (no number) and 84 larvae, 16 nymphs (7 with paired larval exuvia), and the 3 adults have been distributed to a number of institutions and acarologists.

#### REFERENCES

- AUDY (J. R.), 1952. — Trombiculid mites infesting bats in Malaya, with descriptions of three new species. *Bull. Raffles Mus., Singapore*, 24 : 132-159.
- AUDY (J. R.), 1954. — Malaysian parasites -IX. Notes on the taxonomy of trombiculid mites with description of a new subgenus. *Stud. Inst. Med. Res. Malaya* (1953), 26 : 123-170.
- AUDY (J. R.), 1956. — Malayan trombiculid mites. 2. Naked eye observations on attached chiggers, with a simple checklist of Malayan species, and details of preferred hosts. *Bull. Raffles Mus., Singapore*, 28 : 86-101.
- AUDY (J. R.), 1957. — A checklist of trombiculid mites of the Oriental and Australasia regions. *Parasitology*, 47 : 217-294.
- AUDY (J. R.), 1961. — Proposal to designate a neotype of *Trombicula minor* Berlese, generic type, from correlated adult, nymph, larva from Malayan bats. Mimeographed circular dated 19 March 1961, distributed to acarologists and to members, Symposium on Acarology, Tenth Pacific Science Congress, Honolulu, August 1961.
- AUDY (J. R.) and HARRISON (J. L.), 1954. — Malaysian parasites -I. Collections made in Malaya by the Colonial Office Scrub Typhus Research Unit. *Stud. Inst. Med. Res. Malaya* (1953), 26 : 1-22.
- AUDY (J. R.) and VERCAMMEN-GRANDJEAN (P. H.), 1961. — African Trombiculidae (Acarina). 1. An interim note on the genus *Trombicula* Berlese and the subgenus *Microtrombicula* Ewing. *Ann. Natal Mus.*, 15 : 125-133.
- BERLESE (A.), 1905. — Acari nuovi. Manipulus IV (Acari di Giava). *Redia*, 2 : 154-174.
- BERLESE (A.), 1912. — Trombididae. *Redia*, 8 : 1-291.
- CHINA (W. E.), 1960. — Proposed use of the plenary powers to designate a type-species for the nominal genus *Blankaartia* Oudemans, 1911 (Acarina). *Bull. Zool. Nomen.*, 17 : 9-11.
- COOREMAN (J.), 1960. — Contribution à l'étude de la faune d'Afghanistan. 28. Acariens recueillis dans le domaine souterrain. *Bull. Inst. Roy. Sci. Nat. Belgique*, 36 : 10-15.

- DOMROW (R.), 1962 a. — The Asian species of *Whartonia* (Acarina, Trombiculidae). *Treubia*, 26 : 1-9.
- DOMROW (R.), 1962 b. — Seven new Oriental-Australasian chiggers (Acarina, Trombiculidae). *Treubia*, 26 : 39-56.
- EWING (H. E.), 1920. — The genus *Trombicula* Berlese in America and the Orient. *Ann. Ent. Soc. Amer.*, 13 : 381-390.
- EWING (H. E.), 1929 c. — *A Manual of External Parasites*. Springfield, Ill., Thomas. xiv + 225 pages.
- EWING (H. E.), 1944. — Notes on taxonomy of type species of the mite genus *Trombicula* Berlese. *U. S. Nav. Med. Bull.*, 43 : 837-839.
- EWING (H. E.), 1944 a. — Notes on the taxonomy of the trombiculid mites. *Proc. Biol. Soc. Wash.*, 57 : 101-104.
- EWING (H. E.), 1946. — Notes on trombiculid mites with description of *Walchiinae*, n. subf., *Speotrombicula* n. g. and *Eutrombicula defecta* n. sp. *J. Parasitol.*, 32 : 435-440.
- FINNEGAN (S.), 1945. — Acari as agents transmitting typhus in India, Australia, and the Far East. *Brit. Mus. (Nat. Hist.) Econ. Series.*, 16 : 1-78.
- GUNTHER (C. E. M.), 1939 a. — The association between the larva described as *Trombicula hirsti* var. *buloloensis* Gunther, 1939 and *Trombicula minor* Berlese, 1904 (Acarina : Trombiculidae). *Proc. Linn. Soc. N.S.W.*, 64 : 466-470.
- GUNTHER (C. E. M.), 1940 b. — Notes on the synonyms of *Trombicula minor* Berlese, 1904. *Proc. Linn. Soc. N.S.W.*, 65 : 477-478.
- GUNTHER (C. E. M.), 1941. — Studies in Trombiculidae (Acarina : Trombiculidae). *Proc. Linn. Soc. N.S.W.*, 66 : 391-395.
- GUNTHER (C. E. M.), 1951. — On *Trombicula minor* Berlese, 1905. *Proc. Linn. Soc. N.S.W.*, 76 : 66-70.
- GUNTHER (C. E. M.), 1952. — A check list of the trombiculid larvae of Asia and Australia. *Proc. Linn. Soc. N.S.W.*, 77 : 1-60.
- JAYEWICKREME (S. H.), 1946. — A note on the breeding of nymphs of the Trombiculinae (Acarina). *Ceylon J. Sci., Sec. B, Zool.*, 23 : 95-96.
- LOMBARDINI (R.), 1936. — Elenco alfabetico di specie esistenti nell'acarotheca della R. Stazione di Entomologia Agraria di Firenze. *Redia*, 22 : 37-51.
- PHILIP (C. B.), 1961. — *Akamushi* (*Trombidium*) Brumpt, 1910 (Class Acarina) : Proposed validation under the plenary powers Z.N.(S.) 400. *Bull. Zool. Nomen.*, 18(2) : 140-142 (p. 141 : *Trombicula minor*).
- PHILIP (C. B.) and TRAUB (R.), 1950. — Two new species of trombiculid mites from Malayan bats. *J. Parasitol.*, 36 : 29-33.
- RADFORD (C. D.), 1954. — The larval genera and species of 'harvest mites' (Acarina, Trombiculidae). *Parasitology*, 44 : 247-276.
- TAYLOR (F. H.) and MURRAY (R. E.), 1946. — Spiders, ticks and mites, including the species harmful to man in Australia and New Guinea. *Commonwealth Australia Dept. Hlth. (Sch. Publ. Health and Trop. Med.) — Ser. Publ. 6* : 1-275.
- THOR (S.) and WILLMANN (C.), 1947. — Trombiculidae. In *Das Tierreich. Eine Zusammenstellung und Kennzeichnung der rezenten Tierformen. Acarina 3*, 71 : 187-541.
- VERCAMMEN-GRANDJEAN (P. H.), 1960. — Introduction à un essai de classification rationnelle des larves de Trombiculinae Ewing 1944 (Acarina-Trombiculidae). *Acarologia*, 2 : 469-471.



- VERCAMMEN-GRANDJEAN (P. H.), 1962 a. — A la recherche d'un néotype valable pour *Trombicula minor* Berlese 1905 le représentant disparu de l'importante famille des Trombiculidae (Acarina). *Acarologia*, 4 : 369-380.
- VERCAMMEN-GRANDJEAN (P. H.), 1962 b. — Contribution à l'étude de la faune d'Afghanistan. 75. I. Deux nouvelles espèces de nymphes de Trombiculidae recueillies dans une grotte d'Afghanistan. *Acarologia*, 4 : 362-368, 3 Plates.
- VERCAMMEN-GRANDJEAN (P. H.), 1963. — Valuable taxonomic characters of trombiculidae, including correlations between larvae and nymphs. *Advances in Acarology*, 1 : 399-407, Cornell University.
- VERCAMMEN-GRANDJEAN (P. H.), 1965. — Revision of the genera : *Eltonella* Audy, 1956 and *Microtrombicula* Ewing, 1950, with descriptions of fifty new species and transferal of subgenus *Chiroptella* to genus *Leptotrombidium* (Acarina, Trombiculidae). *Acarologia*.
- VERCAMMEN-GRANDJEAN (P. H.), AUDY (J. R.) and PEGAZZANO (F.), 1965. — *Trombicula* (?) sp. indet., from Depok, Java, being fragments in the Berlese collection misidentified as *Trombicula minor* Berlese, 1905. *Acarologia*.
- VERCAMMEN-GRANDJEAN (P. H.) and NADCHATRAM (M.), 1963. — Le genre *Trombicula* et ses sous-genres (Trombiculidae-Acarina). *Acarologia*, 5 : 384-393.
- WHARTON (G. W.) and FULLER (H. S.), 1952. — A manual of the chiggers. *Mem. Ent. Soc. Wash.*, 4 : 1-185.
- WILLIAMS (R. W.), 1944 a. — A bibliography pertaining to the mite family Trombidiidae. *Amer. Midland Nat.*, 32 : 699-712.
- WILLMANN (C.), 1941. — *Trombicula minor* Berl. 1905, Typenart der gattung *Trombicula* Berlese (Trombidiidae, Acari). *Zool. Anz.*, 133 : 131-136.
- WOMERSLEY (H.), 1952. — The scrub-typhus and scrub-itch mites of the Asiatic-Pacific region. *Rec. South Australian Mus.*, 10 : 1-435, 118 plates.
- WOMERSLEY (H.) and AUDY (J. R.), 1947. — Malaysian parasites -XXVII. The Trombiculidae (Acarina) of the Asiatic-Pacific region : A revised and annotated list of the species in Womersley (1952), with descriptions of larvae and nymphs. *Stud. Inst. Med. Res. Malaya*, 28 : 231-295.
- WOMERSLEY (H.) and HEASLIP (W. G.), 1943. — The Trombiculinae (Acarina) or itch-mites of the Austro-Malayan and Oriental regions. *Trans. Roy. Soc. South Australia*, 67 : 68-142.

#### ADDENDUM

Note added in press. — With reference to section 3.25(B) above, *Trombicula niehoffi* Domrow, 1992b from a bat from a cave at about the type locality of *T. minor* Berlese, has been placed in the genus *Chiroptella* Vercammen-Grandjean by M. NADCHATRAM ("Notes on the bat-infesting chiggers of the genus *Chiroptella* Vercammen-Grandjean, with descriptions of two new larval species and a nymph (Acarina, Trombiculidae)", to be published).