

SMITHSONIAN MISCELLANEOUS COLLECTIONS  
VOLUME 128, NUMBER 6

A REVISION OF THE CHIGGERS OF  
THE SUBGENUS GAHRLIEPIA  
(ACARINA: TROMBICULIDAE)

By  
ROBERT TRAUB

AND  
MARY LOU MORROW

Department of Entomology  
Army Medical Service Graduate School  
Walter Reed Army Medical Center  
Washington, D. C.



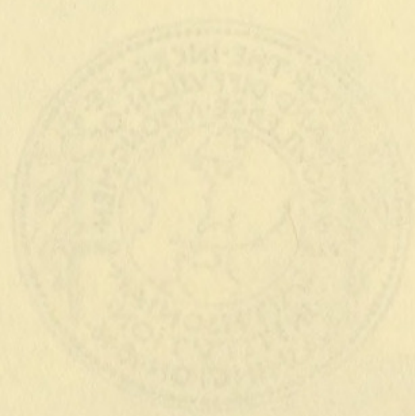
(PUBLICATION 4215)

CITY OF WASHINGTON  
PUBLISHED BY THE SMITHSONIAN INSTITUTION  
JUNE 30, 1955

SMITHSONIAN INSTITUTION  
NATIONAL MUSEUM

A REVISION OF THE CHICKENS OF  
THE SUBGENUS *CAPIBARA*  
IN THE TROPICAL ZONE

The Lord Baltimore Press  
BALTIMORE, MD., U. S. A.



CITY OF WASHINGTON  
PUBLISHED BY THE SMITHSONIAN INSTITUTION  
JUNE 1, 1923



## CONTENTS

|                                                                                  | Page |
|----------------------------------------------------------------------------------|------|
| Introduction .....                                                               | I    |
| Taxonomic status of the subgenus <i>Gahrliepia</i> .....                         | 2    |
| List of abbreviations.....                                                       | 5    |
| Descriptions of species.....                                                     | 6    |
| <i>Gahrliepia</i> ( <i>Gahrliepia</i> ) <i>exilis</i> , new species.....         | 6    |
| <i>fimbriata</i> , new species.....                                              | 10   |
| <i>darita</i> , new species.....                                                 | 12   |
| <i>neterella</i> , new species.....                                              | 14   |
| <i>tenella</i> , new species.....                                                | 16   |
| <i>elbeli</i> , new species.....                                                 | 18   |
| <i>tylana</i> , new species.....                                                 | 21   |
| <i>gemina</i> , new species.....                                                 | 23   |
| <i>dupliseta</i> , new species.....                                              | 26   |
| <i>plurisetae</i> , new species.....                                             | 28   |
| <i>evansi</i> , new species.....                                                 | 30   |
| <i>picta</i> , new species.....                                                  | 31   |
| <i>tessellata</i> , new species.....                                             | 34   |
| <i>laciniata</i> , new species.....                                              | 37   |
| <i>tuberculata</i> , new species.....                                            | 40   |
| <i>ampullata</i> , new species.....                                              | 43   |
| <i>penetrans</i> , new species.....                                              | 45   |
| <i>granulata</i> , new species.....                                              | 50   |
| <i>nanus</i> (Oudemans, 1910).....                                               | 52   |
| <i>fletcheri</i> Gater, 1932.....                                                | 55   |
| <i>cetrata</i> Gater, 1932.....                                                  | 59   |
| <i>hirsuta</i> (Radford, 1946).....                                              | 61   |
| <i>saduski</i> Womersley, 1952.....                                              | 62   |
| <i>ornata</i> Womersley, 1952.....                                               | 63   |
| <i>decora</i> Womersley, 1952.....                                               | 64   |
| <i>insigne</i> Womersley, 1952.....                                              | 66   |
| <i>philipi</i> (Jadin and Vercammen-Grandjean, 1952).....                        | 67   |
| <i>lawrencei</i> Jadin and Vercammen-Grandjean, 1952.....                        | 67   |
| <i>ciliata</i> Gater, 1932.....                                                  | 68   |
| <i>rutila</i> Gater, 1932.....                                                   | 70   |
| <i>crocidura</i> (Radford, 1946).....                                            | 71   |
| <i>longipili</i> (Radford, 1946).....                                            | 72   |
| <i>romeri</i> Womersley, 1952.....                                               | 74   |
| Key for the identification of the larvae of the subgenus <i>Gahrliepia</i> ..... | 75   |
| Comments on the subgenus <i>Gahrliepia</i> .....                                 | 78   |
| Taxonomic notes .....                                                            | 78   |
| Host preference and habitats of the subgenus <i>Gahrliepia</i> .....             | 81   |
| Summary .....                                                                    | 86   |
| Acknowledgments .....                                                            | 87   |
| References cited .....                                                           | 88   |







# A REVISION OF THE CHIGGERS OF THE SUBGENUS GAHRLIEPIA (ACARINA: TROMBICULIDAE)

By

ROBERT TRAUB

AND

MARY LOU MORROW

*Department of Entomology*

*Army Medical Service Graduate School*

*Walter Reed Army Medical Center*

*Washington, D. C.*

## INTRODUCTION

The chiggers parasitic on small mammals have been attracting considerable attention during recent years because of their potentialities as vectors of disease. The chigger fauna is nevertheless relatively little known, as is indicated by the fact that 18 of the 33 mites of the subgenus *Gahrлиеpia* discussed in this paper are new to science. In southeast Asia the *Gahrлиеpia* complex is rich in numbers of species, but individuals are not as commonly collected as are trombiculids of the genera *Trombicula* Berlese, 1905, and *Euschöngastia* Ewing, 1938. However, there is reason to believe that the relative scarcity of individuals may perhaps be apparent rather than actual. For example, one of the new species described herein was found to burrow completely into the perineum of the host and thus very easily could have been overlooked. A second *Gahrлиеpia* was "rare" until it was observed that this species had unusual but specific areas of attachment.

The current study is based largely upon material collected in Malaya and Borneo by field teams of the U. S. Medical Research Unit (Malaya)<sup>1</sup> and the Colonial Office Medical Research Unit, both headquartered at the Institute for Medical Research, Kuala Lumpur, and upon the wartime collections of the India-Burma Field Party of the United States of America Typhus Commission. Thanks to the activities of the U. S. Special Technical and Economic Mission to Thailand, some Siamese specimens have also been made available for study.

---

<sup>1</sup> Supported in part by the Medical Research and Development Division, Office of the Surgeon General, Department of the Army.



This revision commences with a discussion of the taxonomic status of the subgenus *Gahrlepiea*, and there then follow descriptions of new species. The first such species is characterized in detail, and in the subsequent descriptions only the important differences from the first are stressed. The known species are then diagnosed and discussed. A key for the identification of all 33 species precedes some general taxonomic notes and comments on the hosts and habitats of the subgenus. The new *Gahrlepiea* are illustrated in detail, as are the genotype and some of the other important species. The remaining forms are illustrated insofar as possible or necessary for the purposes of the key. It was felt that this paper would be most useful if it were made revisionary in nature and if all described species were included even though it was impossible to examine specimens of all the known forms. It was necessary to rely wholly on the literature or unpublished notes<sup>2</sup> for the discussion and illustrations of the following species: *crocidura* (Radford, 1946), *hirsuta* (Radford, 1946), *longipili* (Radford, 1946), *romeri* Womersley, 1952, *spinulosa* (Radford, 1946), *lancearia* (Radford, 1946), *ciliata* Gater, 1932, *lawrencei* Jadin and Vercammen-Grandjean, 1952, and *philipi* (Jadin and Vercammen-Grandjean, 1952).

#### TAXONOMIC STATUS OF THE SUBGENUS *GAHRLIEPIA*

There is considerable confusion in the literature as to what species should be included in the genus *Gahrlepiea*. Mainly for convenience we are considering *Walchia* Ewing (1931) and *Schöngastiella* Hirst (1915) as subgenera of *Gahrlepiea*, and the species therein are dealt with elsewhere (Traub and Evans, 1954, and MS.). However, for reasons discussed below, *Gateria* Ewing, 1938, is treated as an outright synonym of *Gahrlepiea* (*Gahrlepiea*). The taxonomic and bibliographic citations for the subgenus *Gahrlepiea* are therefore as follows:

#### **GAHRLIEPIA (GAHRLIEPIA) Oudemans, 1912**

Genotype: *Typhlothrombium nanus* Oudemans, 1910, by original designation.

1910. *Typhlothrombium* OUDEMANS, Ent. Ber. Amsterdam, vol. 3, No. 56, p. 105.

1912. *Typhlothrombium* OUDEMANS, Oudemans, Zool. Jahrb., Suppl., vol. 14, No. 1, p. 83.

---

<sup>2</sup> Dr. H. S. Fuller and Dr. J. R. Audy kindly allowed us access to manuscript notes each had independently prepared during a study of type specimens at the British Museum.



1912. *Typhlothrombium* OUDEMANS, Berlese, Redia, vol. 8, p. 281 (preoccupied by *Typhlothrombium* Berlese, July 8, 1910).
1912. *Gahrлиеpia* OUDEMANS, Ent. Ber. Amsterdam, vol. 3, No. 67, p. 273; *nomen novum* for *Typhlothrombium* Oudemans, November 1, 1910, preoccupied.
1928. *Typhlothrombium* OUDEMANS, Methlagl, Denkschr. Akad. Wiss. Wien., vol. 101, p. 214.
1928. *Typhlothrombidium* OUDEMANS, Treubia, 8th suppl., p. 91; *nomen novum* for *Typhlothrombium* Oudemans, November 1, 1910, preoccupied.
1931. *Gahrлиеpia* OUDEMANS, Vitzthum, Kükenthal's Handbuch der Zoologie, vol. 3, 2d half, No. 9, pp. 48, 63, 146.
1932. *Gahrлиеpia* OUDEMANS, Gater, Parasitol., vol. 24, No. 2, p. 161 (equals *Typhlothrombium* Oudemans, 1910, and *Schöngastiella* Hirst, 1915, synonyms).
1935. *Gahrлиеpia* OUDEMANS, Sig Thor, Zool. Anz., vol. 109, Nos. 5-6, p. 110.
1937. *Gahrлиеpia* OUDEMANS, Womersley, Rec. South Australia Mus., vol. 6, No. 1, p. 79.
1938. *Gahrлиеpia* OUDEMANS, Ewing, Journ. Washington Acad. Sci., vol. 28, No. 6, pp. 291, 292.
1938. *Gateria* EWING, Ewing, op. cit., pp. 291-295.
1939. *Gahrлиеpia* OUDEMANS, Neave, Nomenclator Zoologicus, vol. 2, p. 431.
1939. *Gahrлиеpia* OUDEMANS, Abdussalam, Indian Journ. Ent., vol. 1, No. 3, pp. 84-85.
1940. *Typhlothrombium* OUDEMANS, Neave, Nomenclator Zoologicus, vol. 4, p. 602 (preoccupied; synonym of *Gahrлиеpia* Oudemans, 1912).
1940. *Gahrлиеpia* OUDEMANS, Gunther, Proc. Linn. Soc. New South Wales, vol. 65, parts 5-6, Nos. 291-292, p. 481 (equals *Typhlothrombium* Oudemans, 1910, and *Schöngastiella* Hirst, 1915, synonyms).
1941. *Gahrлиеpia* OUDEMANS, Vitzthum, Bronn's Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 4, p. 624.
1942. *Gahrлиеpia* OUDEMANS, Vitzthum, op. cit., Lfg. 6, p. 829 (equals *Typhlothrombium* Oudemans, 1910, preoccupied).
1942. *Gateria* EWING, Vitzthum, Bronn's Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 6, p. 829.
1942. *Gahrлиеpia* OUDEMANS, Radford, Parasitol., vol. 34, No. 1, pp. 64, 79.
1942. *Gateria* EWING, Radford, op. cit., p. 67.
1943. *Gahrлиеpia* OUDEMANS, Womersley and Heaslip, Trans. Roy. Soc. South Australia, vol. 67, No. 1, pp. 72, 136-137 (equals *Typhlothrombium* Oudemans, 1910; *Schöngastiella* Hirst, 1915; and *Gateria* Ewing, 1938, synonyms).
1944. *Gahrлиеpia* OUDEMANS, Ewing, Journ. Parasitol., vol. 30, No. 6, p. 348.
1944. *Gateria* EWING, Ewing, *ibid.*
1945. *Gahrлиеpia* OUDEMANS, Finnegan, British Mus. (Nat. Hist.), Econ. Ser., No. 16, pp. 14, 57, 75 (equals *Schöngastiella* Hirst, 1915, and *Gateria* Ewing, 1938, synonyms).
1946. *Gahrлиеpia* OUDEMANS, Taylor, Comm. Australia Serv. Publ. No. 6, p. 147 (equals *Schöngastiella* Hirst, 1915, and *Gateria* Ewing, 1938, synonyms).
1946. *Gahrлиеpia* OUDEMANS, Ewing, Journ. Parasitol., vol. 32, No. 5, p. 436.
1946. *Gateria* EWING, Ewing, *ibid.*
1946. *Gahrлиеpia* OUDEMANS, Radford, Proc. Zool. Soc. London, vol. 116, pt. 2, p. 247.



1946. *Gateria* EWING, Radford, *ibid.*
1947. *Gahrliepia* OUDEMANS, Sig Thor and Willmann, Trombidiidae, Das Tierreich, Lfg. 71b, p. 332.
1947. *Gateria* EWING, Sig Thor and Willmann, *op. cit.*, pp. 338-339.
1948. *Gahrliepia* OUDEMANS, Fuller, Bull. Brooklyn Ent. Soc., vol. 43, No. 4, p. 109.
1948. *Gateria* EWING, Fuller, *op. cit.*, p. 110.
1949. *Gahrliepia* OUDEMANS, Ewing, Journ. Washington Acad. Sci., vol. 39, No. 7, p. 235.
1949. *Gateria* EWING, Ewing, *ibid.*
1950. *Gahrliepia* OUDEMANS, Radford, Internat. Union Biol. Sci. (Paris), ser. C, No. 1, p. 98.
1950. *Gateria* EWING, Radford, *ibid.*
1951. *Gahrliepia* OUDEMANS, Wharton et al., Journ. Parasitol., vol. 37, No. 1, p. 27.
1951. *Gateria* EWING, Wharton et al., *ibid.*
1952. *Gahrliepia* OUDEMANS, Wharton and Fuller, Mem. Ent. Soc. Washington, No. 4, p. 93.
1952. *Gateria* EWING, Wharton and Fuller, *ibid.*
1952. *Gahrliepia* OUDEMANS, Jameson, Keegan, and Toshioka, Parasitic mites found on small mammals in Japan and Korea, Office of the Surgeon, Far East Command (U.S. Army, Tokyo), p. 8.
1952. *Gahrliepia* (*Gahrliepia*) OUDEMANS, Womersley, Rec. South Australia Mus., vol. 10, Nos. 1-2, pp. 19, 22, 279-280, 282. (Considers *Walchia* Ewing, *Schöngastiella* Hirst, *Gateria* Ewing, all as subgenera of *Gahrliepia*.)
1952. *Gahrliepia* OUDEMANS, Gunther, Proc. Linn. Soc. New South Wales vol. 77, Nos. 1-2, p. 46.
1952. *Gahrliepia* OUDEMANS, Jadin and Vercammen-Grandjean, Ann. Soc. Belge Med. Trop., vol. 32, No. 6, p. 625.
1952. *Gateria* EWING, Jadin and Vercammen-Grandjean, *op. cit.*, p. 629.
1952. *Gahrliepia* OUDEMANS, Vercammen-Grandjean, Ann. Soc. Belge Med. Trop., vol. 32, No. 6, pp. 642-643.
1952. *Gateria* EWING, Vercammen-Grandjean, *ibid.* (Questions validity of generic status of *Walchia*, *Schöngastiella*, and *Gateria* but treats them as distinct genera.)
1952. *Gahrliepia* OUDEMANS, Fuller, Zool. Verh., No. 18, pp. 212-213.
1952. *Gateria* EWING, Fuller, *op. cit.*, pp. 216-217.
1954. *Gahrliepia* (*Gahrliepia*) OUDEMANS, Sasa and Jameson, Proc. California Acad. Sci., ser. 4, vol. 28, No. 5, p. 250.

References in the literature concerning the comparative status of *Gateria* and *Gahrliepia* are reviewed by Womersley (1952) and Fuller (1952). The only criterion for separating the two genera is whether the dorsal setae which are usurped by the scutum are marginal or submedian in position. On this basis, only *nanus* Oudemans, 1910 (the genotype) and *cetrata* Gater, 1932, have been considered *Gahrliepia*, and the remaining eight described species have often been deemed *Gateria*. However, our examination of paratype material disclosed



that in *cetrata* the four false scutal setae (the usurped setae) were in reality submedian in position, not marginal. Gater's original figure (1932) is also incorrect insofar as the holotype is concerned, as Fuller (1952) points out, although Fuller made no nomenclatorial changes. Womersley (1952) and other authors, without access to type material, assumed Gater's drawing was correct. This means that only *nanus* remains in the genus *Gahrлиеpia* if the position of the usurped setae is a valid distinction. In our opinion, the character is a wholly superficial one and not even worthy of subgeneric rank. Those *Gahrлиеpia* with a scrobiculate ("ornate") scutum, i.e., one adorned with very large pits or scrobiculi (cf. fig. 94, scrobiculate, and fig. 5, non-scrobiculate), can be separated at a glance from the forms with a nonmodified scutum. It would seem that such a great morphological distinction would be a far superior criterion for grouping the species into genera than is the position of the usurped setae. However, six of the ornate species included in this paper would fall into *Gateria* and five into *Gahrлиеpia*. For these reasons, *Gateria* is considered by us to be synonym of the subgenus *Gahrлиеpia*. The subgenus *Gahrлиеpia* may be defined as follows: Gahrлиеpine chiggers in which four or more dorsal abdominal setae have been usurped by the scutum so that there is at least a total of 8 scutal setae.<sup>3</sup> Scutum produced posteriorly beyond *PLs* (see list of abbreviations, below) so that *SD* is thrice or more than *A-P* (except for *G. saduski* Womersley, 1952). Galeal seta nude. Palpal coxal seta plumose. Palpal femoral seta usually barbed.

#### LIST OF ABBREVIATIONS

- AL* length <sup>4</sup> of anterolateral seta.
- ALs* the anterolateral setae.
- A-P* distance between bases of anterolateral and posterolateral setae.
- A.P.* anal plate.
- ASB* perpendicular distance between a line connecting sensillary bases and anteriormost margin of scutum.
- AW* distance between bases of anterolateral setae.
- B* symbol for a seta that is heavily branched or barbed.
- b* a seta that is sparsely branched, i.e., only 3 to 6 barbs.
- C.C.* central core, a rather dense patch of small scrobiculi in the middle of the scutum which differ from marginal scrobiculi.
- D.S.* length of typical dorsal seta.

<sup>3</sup> An occasional specimen of *G. saduski* has only 6 scutal setae. The presence of 4 or 5 setae on coxa III separates this species from all other *Gahrлиеpia* (*Gahrлиеpia*) and from all *G.* (*Schöngastiella*) except *G. (S.) kalrata* Traub and Evans 1954, which is readily distinguishable otherwise.

<sup>4</sup> All measurements expressed in microns.



- f* a seta that is merely frayed, i.e., with only 1 or 2 barbs.  
*FL* dorsal flap extending posteriorly from cheliceral base.  
*I.C.* intersensillary crater, a delimited circular area on the scutum, anterior to *SB* and between *ALs*, that is devoid of pits or punctae.  
*N* a seta that is nude.  
*PL* length of posterolateral seta.  
*PLs* the posterolateral setae.  
*PPP-1* perpendicular distance between a line connecting first pair of usurped setae and posterior margin of scutum.  
*PPP-2* perpendicular distance between a line connecting second pair of usurped setae and posterior margin of scutum.  
*PPW-1* distance between first or anterior pair of usurped scutal setae.  
*PPW-2* distance between second or posterior pair of usurped scutal setae.  
*PSB* perpendicular distance between a line connecting sensillary bases and posterior margin of scutum.  
*PW* distance between bases of posterolateral setae.  
*SB* distance between bases of sensillae.  
*SD* length of *ASB* plus *PSB*.

## DESCRIPTIONS OF SPECIES

### GAHRLIEPIA (GAHRLIEPIA) EXILIS, new species

Figures 1-10

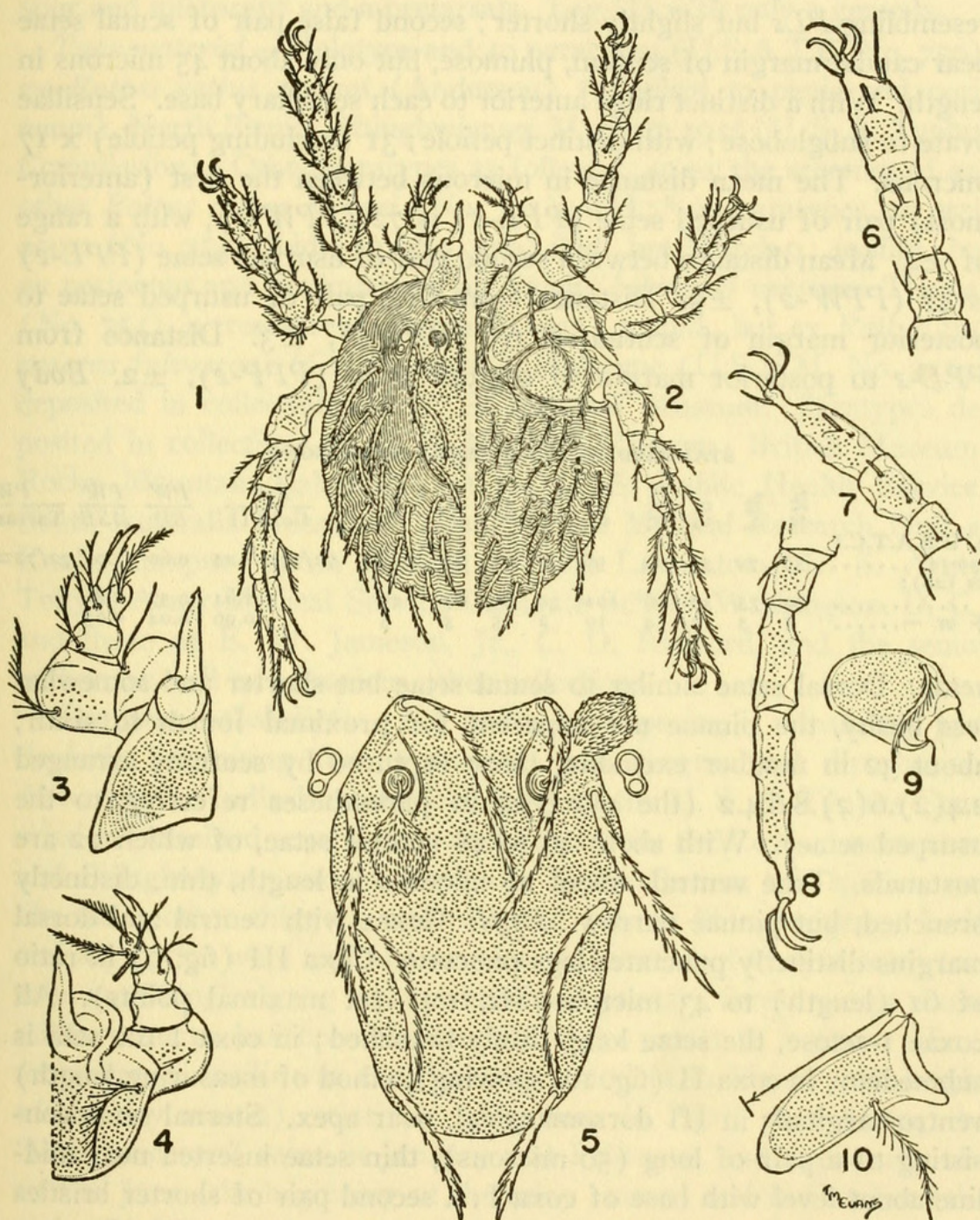
*Diagnosis of larva.*—Agrees with *G. (G.) cetrata* Gater, 1932, and *G. (G.) saduski* Womersley, 1952, in that the scutum lacks very large pits or scrobiculi and in having a total of 8 scutal setae (*G. saduski* somewhat variable in this regard). Instantly separable from both species in that the false or usurped scutal setae are marginal, not submedian; further distinguishable from *G. saduski* in that coxae III are 1-setose instead of bearing 4 setae; *AL* over 62 microns instead of approximately 35. The very long *AL* bristles also readily distinguish this species from *G. cetrata*, where the *ALs* are about 36 microns.

*Description of larva.*—*Body*: Subovate, about 244 x 155 microns when unengorged. Eyes double, anterior eye about 10 x 5 microns, about twice the size of the posterior one; on an ocular plate; at level of sensillary bases; plate near but not contiguous with scutum. *Gnathosoma*: Chelicerae long, about five to six times as long as broad at base; with a distinct apical tricuspid cap. Cheliceral bases and palpal coxae and femora punctate. Palpal setal formula as follows: *B/B/BBB*,<sup>5</sup> the setae (barbs) usually subpectinate. Palpal tarsus with a basal striated rod and four plumed setae. Palpal claw 3-pronged but usually

<sup>5</sup> The first letter in the palpal formula refers to the seta on the palpal femur, the second to that of the genu, and the next three to those of the tibia—dorsal, lateral, and ventral, respectively. The letter *N* in the palpal formula signifies the seta is nude; *B*, branched, *b*, sparsely branched; and *f*, frayed.



appearing 2-pronged, the mesal (dorsal) prong slightly the longest, the inconspicuous third prong about two-thirds the length of the others. *Scutum*: Long, broadly and evenly tongue-shaped; 120 x 84 microns



FIGS. 1-10.—*Gahrlepiea* (*Gahrlepiea*) *exilis*, new species.

at maxima in holotype. Anterior margin concave. Posterior margin evenly rounded. Lateral margins somewhat convex, broadest immediately below insertion of *PLs*, at times slightly angled here. Uniformly micropunctate, the micropunctations about 0.5 micron in size, all subequal. *AL* setae at anterolateral angles of scutum; bushy, long,



as long as *PLs*. Posterolateral setae marginal, inserted at a level somewhat caudad to bases of sensillae; similar to *ALs* in structure. The two pair of scutal setae usurped<sup>6</sup> from dorsal rows are marginal in position; first usurped pair as far from *PLs* as latter is from *ALs*, and resembling *PLs* but slightly shorter; second false pair of scutal setae near caudal margin of scutum, plumose, but only about 45 microns in length. With a distinct ridge anterior to each sensillary base. Sensillae ovate to subglobose; with distinct petiole; 31 (including petiole) x 17 microns. The mean distance in microns between the first (anterior-most) pair of usurped setae (*PPL-1*) is 72 (*PPW-1*), with a range of  $\pm 4$ . Mean distance between second pair of usurped setae (*PPL-2*) is 47 (*PPW-2*),  $\pm 5$ . Distance from first pair of usurped setae to posterior margin of scutum is 63 (*PPP-1*),  $\pm 3$ . Distance from *PPL-2* to posterior margin of scutum is 16 (*PPP-2*),  $\pm 2$ . *Body*

STANDARD MEASUREMENTS IN MICRONS

|                                   | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A-P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa\ II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus\ III}$ |
|-----------------------------------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|-----------------------|-----------------|------------------|--------------------------|
| Holotype, U.S.A.T.C. <sup>7</sup> |           |           |           |            |            |            |           |           |             |                       |                 |                  |                          |
| No. 750-14 .....                  | 39        | 72        | 38        | 24         | 96         | 30         | 67        | 67        | 40/57       | 72/58=1.24            | 0.60            | 3.0              | 72/72=1.00               |
| Paratypes (28):                   |           |           |           |            |            |            |           |           |             |                       |                 |                  |                          |
| Mean .....                        | 40        | 73        | 39        | 26         | 101        | 30         | 69        | 69        | 49          | 1.24                  | 0.57            | 2.8              | 0.99                     |
| Range + or - .....                | 3         | 3         | 3         | 4          | 10         | 2          | 5         | 3         | 3           | 0.06                  | 0.04            | 0.05             | 0.07                     |

*setae*: Dorsal setae similar to scutal setae but shorter and somewhat less bushy, the pinnae not apparent for proximal fourth to sixth; about 32 in number excluding those captured by scutum; arranged 2.4(2).6(2).8.6.4.2 (the numbers in parentheses referring to the usurped setae). With about 46 to 48 ventral setae, of which 22 are postanals. True ventrals about 28 microns in length, thin, distinctly branched, but pinnae narrow. *Legs*: Coxae with ventral and dorsal margins distinctly punctate; legs punctate. Coxa III (fig. 9) in ratio of 61 (length) to 43 microns, viz, 1.41 (at maximal points). All coxae 1-setose, the setae long, thinly branched; in coxa I the seta is submedian; in coxa II (fig. 10, showing method of measuring length) ventromarginal; in III dorsomarginal, near apex. Sternal setae consisting of a pair of long (50 microns), thin setae inserted near midline about level with base of coxa I; a second pair of shorter bristles (30 microns), each member inserted near base of coxa III. Sensory

<sup>6</sup> The dorsal setae which arise directly from the dorsal plate by virtue of its posterior prolongation are henceforth referred to as *usurped setae*. The *Als* and *PLs* are therefore not usurped setae.

<sup>7</sup> Abbreviations accompanying specimen numbers throughout "Description of Species": U.S.A.T.C. = United States of America Typhus Commission; U.S.N.M. = U. S. National Museum; C.O.M.R.U. = Colonial Office Medical Research Unit; B = Traub accessions.



setae as follows: Leg I with two genualae and a microgenuala, a tibiala, a spur and an adjacent microtibiala; a tarsal spur, a microtarsala proximad of this, a subterminala, a parasubterminala, and a pretarsala. Leg II with a genuala; a tibiala and a spur; tarsus with a spur and microspur and a pretarsala. Leg III with only a genuala.

*Type material*.—Holotype and 40 paratypes (U.S.A.T.C. No. 750), ex *Rattus rattus sladeni* (Anderson) (attached to penis and perineum), North Burma, Shingbuiyang, March 7, 1945 (U. S. A. Typhus Commission). Other paratypes as follows: 40 ex the scrotum of another *Rattus rattus sladeni* (No. 751), *ibid.*; <sup>8</sup> 20 paratypes ex perineum (No. 753), *ibid.*; 12 (No. 756) *ibid.*, but March 9; 40 *ibid.*, but ex perineum and hindquarters of *Tupaia belangeri versurae* Thomas (No. 754), a tree shrew, March 8, 1945; 3, *ibid.*, but ex *Rattus fulvescens fulvescens* (Gray), April 6. Holotype (U.S.N.M. No. 2154) deposited in collections of U. S. National Museum. Paratypes deposited in collections of U. S. National Museum; British Museum; Rocky Mountain Laboratory of the U. S. Public Health Service; South Australia Museum; Colonial Office Medical Research Unit at Kuala Lumpur; 406th Medical General Laboratory, U. S. Army, Tokyo; Army Medical Service Graduate School, Washington, D. C.; and those of E. W. Jameson, Jr., C. D. Radford, and the senior author, as well as in various other collections.

*Comment*.—*Gahrliopia* (*G.*) *exilis*, new species, is apparently particularly interesting for its seasonal and geographical distribution. Although the India-Burma Field Party of the U. S. A. Typhus Commission examined several thousand hosts from the Ledo, Assam area, and Shingbuiyang and Myitkyina in North Burma, this species, unlike many other chiggers, was collected only at Shingbuiyang. Ledo and Myitkyina were typical examples of secondary forest or scrub terrain, but Shingbuiyang was essentially all primary forest except where military camps had been constructed in the past 1 to 2 years. Here, moreover, *G. exilis* was exceptionally abundant in March (the height of the dry season), relatively uncommon in April, rare during the "little monsoon" rains in January and February, and apparently absent in June (the beginning of the rainy season) and in October (the end of the monsoon season). No collections were made at Shingbuiyang in other months. *G. exilis* is, therefore, apparently a characteristic inhabitant of primary forest during the dry season. It was collected on 12 occasions—nine times from *Rattus rattus sladeni*, twice

<sup>8</sup> In these descriptions, *ibid.* refers to the data for the holotype and not to the record immediately preceding. Only the differences in data between the particular paratype and holotype are cited.



ex *Rattus fulvescens fulvescens*, and once on a tree shrew, *Tupaia*. In March, whenever this species was found, it was the dominant form present on the host—four times out of five over 92 percent of the chiggers examined were *G. exilis*. The above *Tupaia* carried over 200 trombiculids, and all of 50 examined were *G. exilis*. In April, when *G. exilis* occurred, it usually constituted 20 to 30 percent of the chiggers sampled. The usual site of attachment of *G. exilis* was on the perineum or external genitalia of the host. This chigger did not readily detach from the host, and at times could be found firmly in situ 24 to 48 hours after death.

# GAHRLIEPIA (GAHRLIEPIA) FIMBRIATA, new species

Figures 11-18

*Diagnosis of larva*.—Agrees with *G. (G.) exilis*, new species, in that there are four usurped marginal setae on the scutum; separable in that the *AL* setae are much shorter, approximately 45 microns, not 68, and much less bushy; the punctations on the scutum are of two sizes, not all subequal; the *PL* setae are much closer to *AL* than to *PPL-1*, instead of being midway; the palpal formula *B/B/bNB* instead of all being plumed.

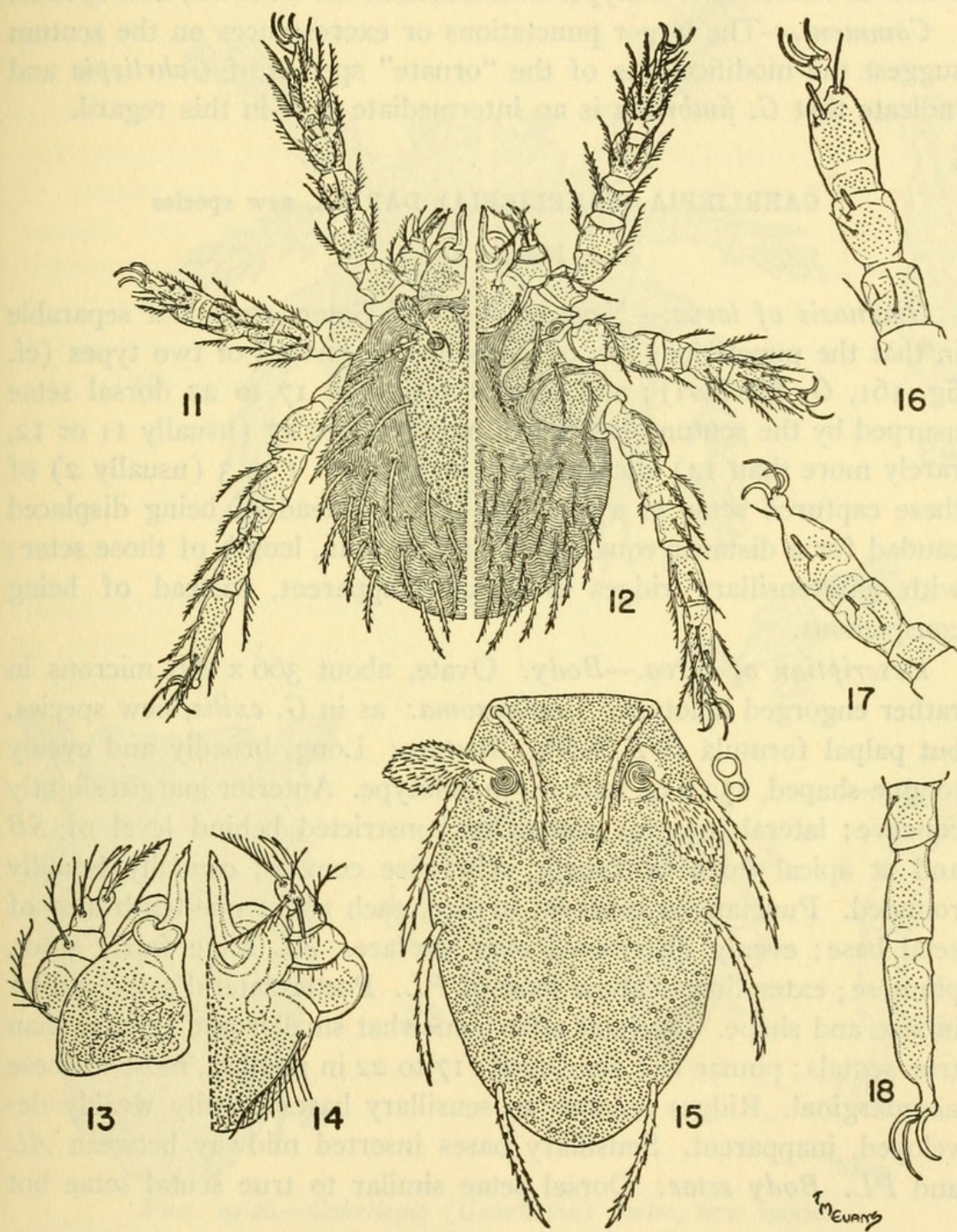
*Description of larva*.—*Body*: Subovate, about 305 x 188 microns in partially engorged holotype. Eyes 2+2; anterior eye the larger. *Gnathosoma*: Chelicerae about four and a half to five times as long as broad at base; with a distinct tricuspid cap. Palpal setal formula *B/B/bNB*; the femoral and genual setae thinly subpectinate. Palpal claw 3-pronged. *Scutum*: Essentially as *G. exilis* regarding shape; 132 x 90 microns. Micropunctations densely and uniformly scattered, but with additional, much less numerous, coarser punctae about 1 to 2 microns in size, especially noticeable toward rear of scutum. Scutal setae rather bushy, but pinnae short. *AL* setae about two-thirds length of *PL*. Sensillae bases inserted almost at level of *PLs*. The mean distance in microns between the first (anteriormost) pair of usurped setae (*PPL-1*), is 80 (*PPW-1*), with a range  $\pm 8$ . Mean distance between second pair of usurped setae (*PPL-2*) is 49 (*PPW-2*),  $\pm 5$ . Distance from first pair of usurped setae to posterior margin of scutum is 68 (*PPP-1*),  $\pm 7$ . Distance from *PPL-2* to

## STANDARD MEASUREMENTS IN MICRONS

|                      | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A-P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus III}$ |
|----------------------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|----------------------|-----------------|------------------|-------------------------|
| Holotype, U.S.A.T.C. |           |           |           |            |            |            |           |           |             |                      |                 |                  |                         |
| No. 972-27           | 43        | 71        | 43        | 23         | 109        | 28         | 42        | 60        | 48          | 71/59=1.20           | 0.54            | 3.09             | 71/70=1.01              |
| Paratypes (8):       |           |           |           |            |            |            |           |           |             |                      |                 |                  |                         |
| Mean                 | 46        | 76        | 45        | 25         | 116        | 27         | 44        | 66        | 50          | 1.24                 | 0.58            | 3.0              | 1.09                    |
| Range + or -         | 3         | 5         | 3         | 2          | 8          | 2          | 3         | 5         | 4           | 0.05                 | 0.08            | 0.1              | 0.08                    |



posterior margin of scutum is 17 ( $PPP-2$ ),  $\pm 3$ . *Dorsal setae*: As scutal setae, but pinnae usually more evident; about 34 to 36 in number (excluding setae usurped by scutum) often arranged: 2.2(2).2.8(2).8.6.4.2 (the numbers in parentheses referring to false scutals or



FIGS. 11-18.—*Gahrlepiea* (*Gahrlepiea*) *fimbriata*, new species.

usurped setae). With about 54 to 56 ventral setae, of which approximately 24 are postanal. True ventrals thin, about 23 to 28 microns in length, subpectinate. *Legs*: As in *G. exilis*, including sensory setae. Coxa III in ratio of 67 (length) : 46 = 1.46.



*Type material*.—Holotype and 24 paratypes (U.S.A.T.C. No. 972) ex *Rattus flavipectus yunnanensis* (Anderson), China-Burma Border, Stilwell Road, April 30, 1945 (D. D. Millspaugh, for U. S. A. Typhus Commission). Holotype (U.S.N.M. No. 2155) deposited in U. S. National Museum. Paratypes distributed as for *G. exilis*, new species.

*Comment*.—The larger punctations or excrescences on the scutum suggest the modifications of the "ornate" species of *Gahrlepiea* and indicate that *G. fimbriata* is an intermediate type in this regard.

### GAHRLIEPIA (GAHRLIEPIA) DARITA, new species

Figures 19-26

*Diagnosis of larva*.—Near *G. fletcheri* Gater, 1932, but separable in that the punctations are of uniform size instead of two types (cf. fig. 161, *G. fletcheri*); and in that there are 17 to 22 dorsal setae usurped by the scutum, instead of merely 10 to 17 (usually 11 or 12, rarely more than 14) such usurped setae; with 1 to 3 (usually 2) of these captured setae in a line with *PLs*, instead of being displaced caudad for a distance equal to, or greater than, length of those setae; with antesensillary ridges weak or inapparent, instead of being conspicuous.

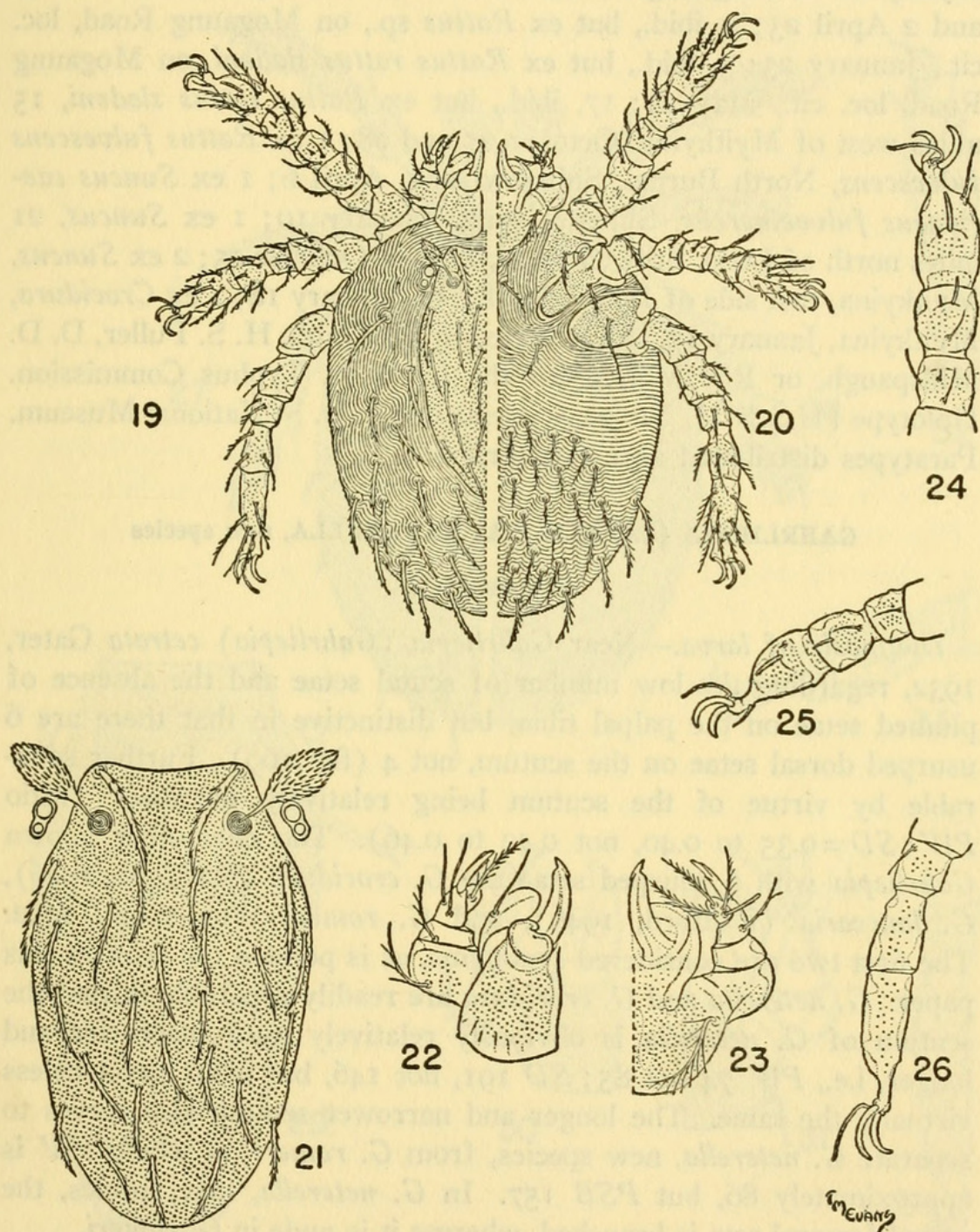
*Description of larva*.—*Body*: Ovate, about 366 x 260 microns in rather engorged holotype. *Gnathosoma*: as in *G. exilis*, new species, but palpal formula *B/B/NNb*. *Scutum*: Long, broadly and evenly tongue-shaped, 152 x 94 microns in holotype. Anterior margin slightly concave; lateral margins somewhat constricted behind level of *SB* and at apical third or fourth, otherwise convex; caudally broadly rounded. Punctations uniform in size, each about one-tenth size of setal base; evenly distributed over surface. *AL* setae fairly stout, plumose; extending to about base of *PL*. Posterolateral setae similar in size and shape. Usurped setae somewhat smaller and thinner than true scutals; pinnae less developed; 17 to 22 in number, most of these nonmarginal. Ridges anterior to sensillary bases usually weakly developed, inapparent. Sensillary bases inserted midway between *AL* and *PL*. *Body setae*: Dorsal setae similar to true scutal setae but

#### STANDARD MEASUREMENTS IN MICRONS

|                      | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A-P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus III}$ |
|----------------------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|----------------------|-----------------|------------------|-------------------------|
| Holotype, U.S.A.T.C. |           |           |           |            |            |            |           |           |             |                      |                 |                  |                         |
| No. 3219-1           | 42        | 72        | 43        | 20         | 132        | 35         | 38        | 38        | 33          | 72/55=1.31           | 0.49            | 3.6              | 72/50=1.44              |
| Paratypes (8):       |           |           |           |            |            |            |           |           |             |                      |                 |                  |                         |
| Mean                 | 44        | 78        | 48        | 21         | 144        | 37         | 38        | 38        | 34          | 1.35                 | 0.47            | 3.7              | 1.42                    |
| Range + or -         | 6         | 10        | 5         | 2          | 17         | 4          | 3         | 3         | 3           | 0.08                 | 0.08            | 0.10             | 0.13                    |



somewhat bushier than usurped setae; about 32 in number, excluding the 17 to 22 usurped setae, the rows commencing 2.4(6).4(4), the rest irregular. Ventral setae about 48 in number, of which perhaps



FIGS. 19-26.—*Gahrlepieia (Gahrlepieia) darita*, new species.

22 are postanals. True ventral setae thin, sparsely plumed, about 21 microns in length. *Legs*: Seta on coxa III submedian in insertion. Coxa III in ratio of 66 (length) : 40 = 1.65.

*Type material*.—Holotype (U.S.A.T.C. No. 3219-1) ex *Rattus rattus sladeni*, North Burma, 6 miles north of Myitkyina, October 12,



1945. Thirty-eight paratypes as follows: 1 with same data as holotype; 1, *ibid.*, but June 14; 1, *ibid.*, but July 10; 2, *ibid.*, but September 11; 5, *ibid.*, but ex *Tupaia belangeri versurae*, 20 miles west of Myitkyina on Mogaung Road, 2 of these February 16, 1 March 9, and 2 April 23; 2, *ibid.*, but ex *Rattus* sp., on Mogaung Road, loc. cit., January 25; 3, *ibid.*, but ex *Rattus rattus sladeni*, on Mogaung Road, loc. cit., May 22; 17, *ibid.*, but ex *Rattus rattus sladeni*, 15 miles west of Myitkyina, October 25 and 28; 1 ex *Rattus fulvescens fulvescens*, North Burma, Shingbuiyang, April 6; 1 ex *Suncus caeruleus fulvocinereus*, Shingbuiyang, January 10; 1 ex *Suncus*, 21 miles north of Ledo, Stilwell Road, Assam, October 25; 2 ex *Suncus*, Myitkyina, east side of Irrawaddy River, January 18; 1 ex *Crocidura*, Myitkyina, January 17. All collected by R. Traub, H. S. Fuller, D. D. Millspaugh, or Roy Melvin for the U. S. A. Typhus Commission. Holotype (U.S.N.M. No. 2156) deposited in U. S. National Museum. Paratypes distributed as for *G. exilis*.

**GAHRLIEPIA (GAHRLIEPIA) NETERELLA, new species**

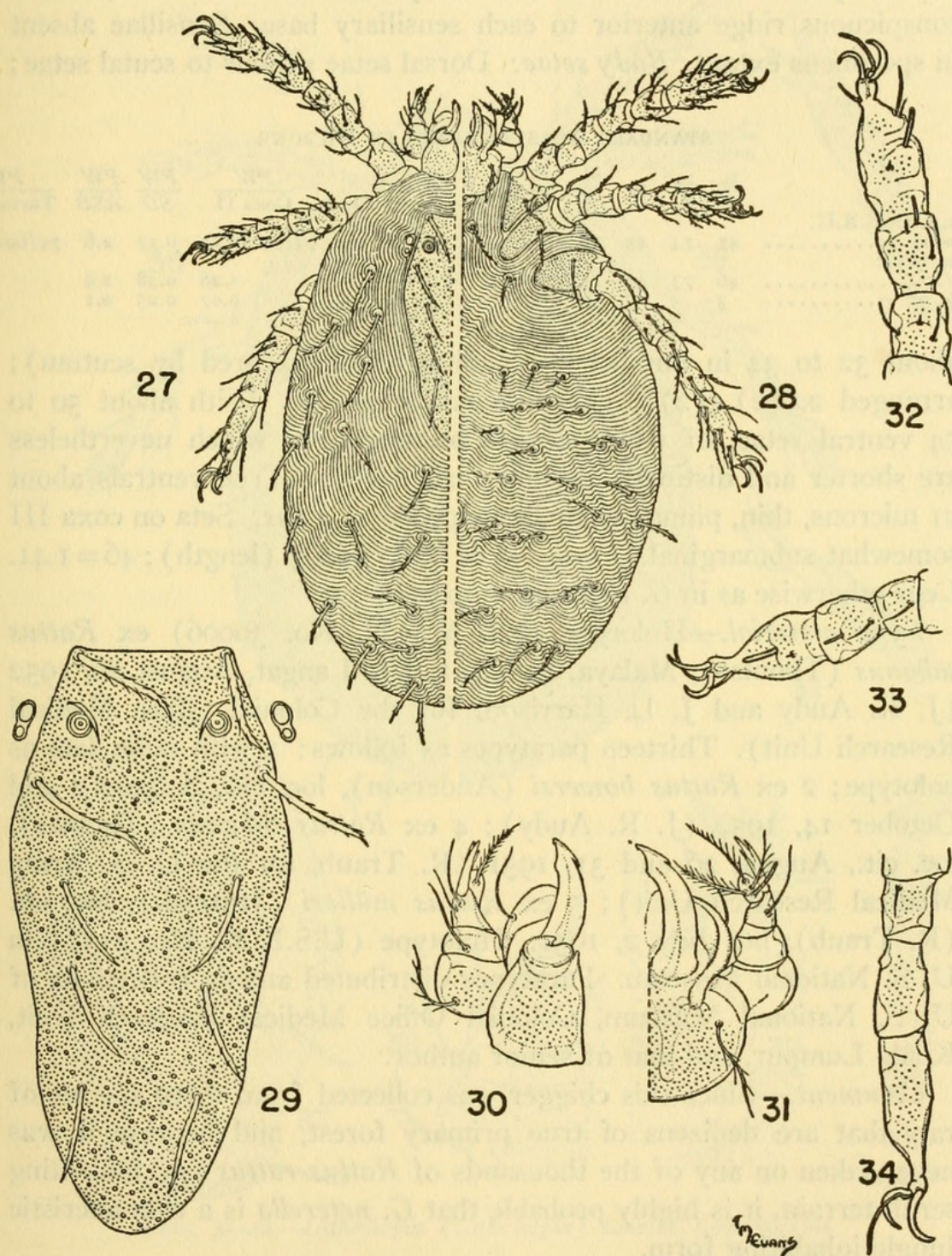
Figures 27-34

*Diagnosis of larva.*—Near *Gahrlepiea* (*Gahrlepiea*) *cetrata* Gater, 1932, regarding the low number of scutal setae and the absence of plumed setae on the palpal tibia, but distinctive in that there are 6 usurped dorsal setae on the scutum, not 4 (fig. 169). Further separable by virtue of the scutum being relatively narrower (ratio  $PW:SD=0.35$  to  $0.40$ , not  $0.42$  to  $0.46$ ). The only other known *Gahrlepiea* with 6 usurped setae are *G. crocidura* (Radford, 1946), *G. lancearia* (Radford, 1946), and *G. romeri* Womersley, 1952. The first two are considered synonyms, as is pointed out later in this paper. *G. neterella* and *G. crocidura* are readily separable in that the scutum of *G. neterella* is obviously relatively much narrower and longer, i.e.,  $PW$  74 not 85;  $SD$  191, not 146, but  $ASB$  nevertheless virtually the same. The longer and narrower scutum also serves to separate *G. neterella*, new species, from *G. romeri*, in which  $PW$  is approximately 86, but  $PSB$  157. In *G. neterella*, new species, the palpal femoral seta is branched, whereas it is nude in *G. romeri*.

*Description of larva.*—*Body*: Subovate, about  $454 \times 273$  microns when somewhat engorged. Eyes double, anteriormost the largest. *Gnathosoma*: Chelicerae about three and a half to four times as long as broad at base; with distinct apical tricuspid cap. Palpal setal formula  $B/N/NNN$ . Palpal claw 3-pronged. *Scutum*: Long and fairly narrow, about  $200 \times 96$  microns at maxima in rather large holotype. Anterior margin quite straight. Lateral margins with rounded shoul-



ders at anterior third, slightly concave below shoulders but becoming slightly convex at posterior third, only to narrow rapidly toward evenly convex caudal margin. Uniformly micropunctate, but in addi-



FIGS. 27-34.—*Gahrlepiea (Gahrlepiea) neterella*, new species.

tion with coarser, much less numerous punctae. *AL* setae at antero-lateral angles of scutum; fairly stout and at times somewhat bushy, but pinnae usually appressed, often inapparent. *PL* setae similar, but slightly longer. Usurped scutal setae submedial in position; first



pair slightly below lateral "shoulders" of scutum; second pair at level of scutal midline; third pair at posterior third. All usurped setae with adpressed setae; somewhat shorter and thinner than true scutals. Sensillary bases inserted at level midway between *AL* and *PL*, with a conspicuous ridge anterior to each sensillary base. Sensillae absent in specimens extant. *Body setae*: Dorsal setae similar to scutal setae;

## STANDARD MEASUREMENTS IN MICRONS

|                                         | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A-P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa\ II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus\ III}$ |
|-----------------------------------------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|-----------------------|-----------------|------------------|--------------------------|
| Holotype, C.O.M.R.U.<br>No. 30006 ..... | 47        | 74        | 45        | 26         | 174        | 43         | 35        | 42        | 36          | 74/59=1.25            | 0.37            | 2.8              | 74/60=1.23               |
| Paratypes (11):<br>Mean .....           | 46        | 73        | 43        | 25         | 166        | 41         | 35        | 39        | 35          | 1.28                  | 0.38            | 2.9              | 1.25                     |
| Range + or - .....                      | 3         | 3         | 3         | 2          | 12         | 3          | 3         | 3         | 3           | 0.07                  | 0.05            | 0.1              | 0.06                     |

about 32 to 34 in number (excluding those captured by scutum); arranged 2.4(2).4(2).4(2).6, the rest irregular. With about 50 to 54 ventral setae, of which 20 are postanals but which nevertheless are shorter and distinctly thinner than dorsals. True ventrals about 21 microns, thin, pinnae virtually inapparent. *Legs*: Seta on coxa III somewhat submarginal. Coxa III in ratio of 65 (length) : 46 = 1.41. Legs otherwise as in *G. exilis*, new species.

*Type material*.—Holotype (C.O.M.R.U. No. 30006) ex *Rattus sabanus* (Thomas), Malaya, Selangor, Ulu Langat, August 26, 1952 (J. R. Audy and J. L. Harrison, for the Colonial Office Medical Research Unit). Thirteen paratypes as follows: 2 with same data as holotype; 2 ex *Rattus bowersi* (Anderson), loc. cit., August 2 and October 14, 1952 (J. R. Audy); 4 ex *Rattus sabanus* (Thomas), loc. cit., August 26 and 31, 1951 (R. Traub, for the U. S. Army Medical Research Unit); 5 ex *Rattus mülleri* (Jentink), loc. cit. (R. Traub), but July 2, 1951. Holotype (U.S.N.M. No. 2157) in U. S. National Museum. Paratypes distributed among collections of U. S. National Museum, Colonial Office Medical Research Unit, Kuala Lumpur, and that of senior author.

*Comment*.—Since this chigger was collected from three species of rats that are denizens of true primary forest, and because it was never taken on any of the thousands of *Rattus rattus* ssp. inhabiting scrub terrain, it is highly probable that *G. neterella* is a characteristic jungle-inhabiting form.

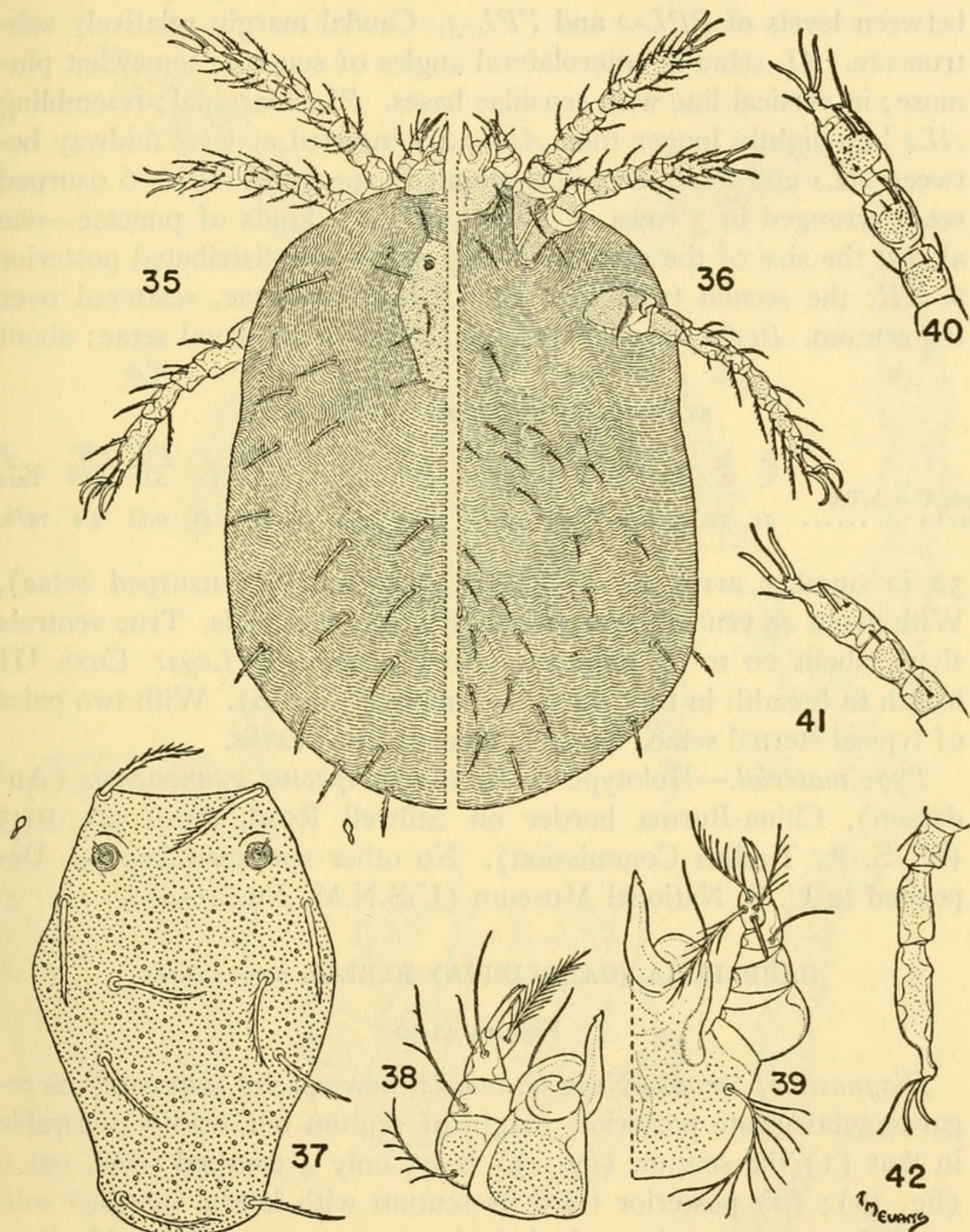
## GAHRLIEPIA (GAHRLIEPIA) TENELLA, new species

Figures 35-42

*Diagnosis of larva*.—Distinguished from all other nonscrobiculate species in the subgenus which possess normal *ALs* and *PLs* (i.e.,



*PLs* not moved forward so as to be contiguous with *ALs*) by the following combination of characters: (1) scutum subcaudally constricted and posterior margin subtruncate (fig. 37), and (2) with 6



FIGS. 35-42.—*Gahrlepiea* (*Gahrlepiea*) *tenella*, new species.

usurped setae. Agreeing with *G. (G.) neterella* regarding number of usurped setae, but instantly separable by shape of scutum (cf. fig. 29) and by *PSB* being 123, not 166.

*Description of larva.*—*Body*: Subovate, but only specimen extant ruptured on remounting. Eyes double, but quite reduced. *Gna*-



*thosoma*: Chelicerae about four and a half times as long as broad near base. Palpal setal formula  $B/f/NNN$ . Palpal claw 3-pronged. *Scutum*: Somewhat less than  $1\frac{1}{2}$  times as long as broad ( $146 \times 102$  microns); broadest at about level of anterior third; slightly constricted between levels of *PPL-2* and *PPL-3*. Caudal margin relatively subtruncate. *AL* setae at anterolateral angles of scutum; somewhat plumose; in vertical line with sensillae bases. *PLs* marginal; resembling *ALs* but slightly longer than *ALs*. *SB* inserted at level midway between *ALs* and *PLs*. Sensillae absent in specimen. With 6 usurped setae arranged in 3 rows of 2 each. With 2 kinds of punctae—one almost the size of the setal bases and uniformly distributed posterior to *SB*; the second type, the ordinary micropunctae, scattered over the scutum. *Body setae*: Dorsal setae similar to scutal setae; about

## STANDARD MEASUREMENTS IN MICRONS

|                                         | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A-P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa\ II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus\ III}$ |
|-----------------------------------------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|-----------------------|-----------------|------------------|--------------------------|
| Holotype, U.S.A.T.C.<br>No. 971-1 ..... | 51        | 79        | 51        | 23         | 123        | 40         | 33        | 36        | 30/37       | $79/60=1.31$          | 0.54            | 3.4              | $79/63=1.25$             |

32 in number arranged 2.4.4.6.6.4.4.2 (excluding usurped setae). With about 48 ventral setae, of which 18 are postanals. True ventrals short, about 20 to 23 microns; sparsely plumed. *Legs*: Coxa III length to breadth in ratio of 63:40 microns ( $=1.6$ ). With two pairs of typical sternal setae. Sensory setae as in *G. exilis*.

*Type material*.—Holotype ex *Rattus flavipectus yunnanensis* (Anderson), China-Burma border on Stilwell Road, April 30, 1945 (U. S. A. Typhus Commission). No other specimen known. Deposited in U. S. National Museum (U.S.N.M. No. 2158).

## GAHRLIEPIA (GAHRLIEPIA) ELBELI, new species

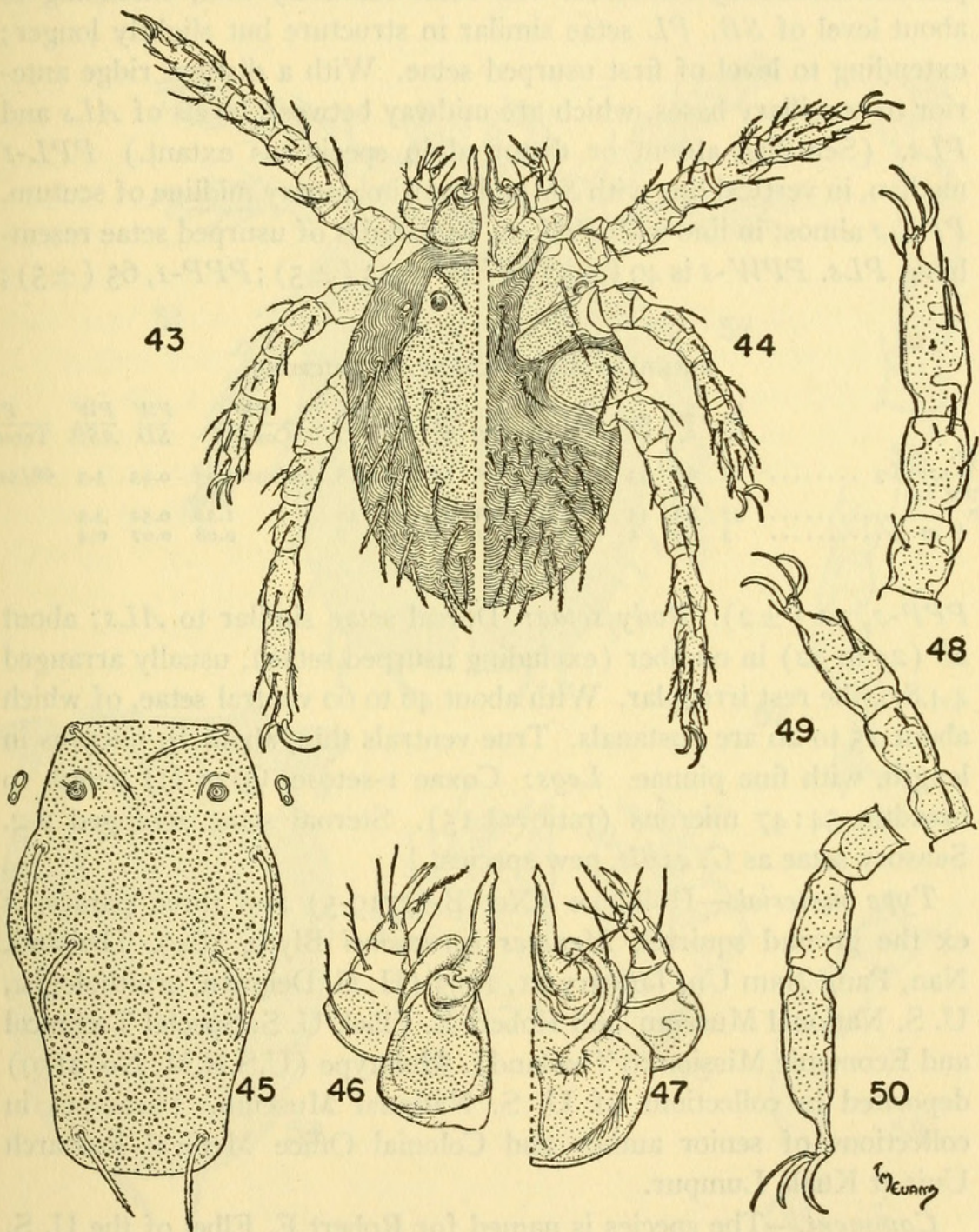
Figures 43-50

*Diagnosis of larva*.—Near *G. tenella*, new species, especially as regards subtruncate posterior margin of scutum but readily separable in that (1) the scutum (fig. 45) bears only 4 usurped setae, not 6 (fig. 37); (2) posterior third of scutum with lateral margins subparallel to near apex instead of sloping to near apex. Separable from other nonscrobiculate *Gahrliopia* with 4 usurped setae in that the posterior margin of the scutum is subtruncate. Near *G. cetrata* Gater, 1932, but further distinguishable in that *PW* is less than 75 microns, instead of in the vicinity of 90, and in that *PPL-2* is immediately in front of the posterior margin of the scutum (less than 14 microns) instead of being midway between *PPL-1* and the posterior margin. Re-



sembling *G. exilis*, new species, but with dorsal and scutal setae far less bushy and much shorter than that species, e.g., *AL* 28 microns, not 68.

*Description of larva.*—*Body*: Subovate, about 245 x 142 microns in virtually unengorged holotype. Eyes double; anterior ones the



FIGS. 43-50.—*Gahrlepiea (Gahrlepiea) elbeli*, new species.

larger. Chelicerae about three times as long as broad at base. Palpal setal formula *b/b/NNN(f)*. Palpal claw 3-pronged. *Scutum*: About 85 x 127 microns; broadest at about anterior third. Anterior margin fairly straight. Lateral margins with anterior fourth declivate; con-



vex between *PL* and *PLL-1* and then becoming sinuate, but posterior portion subparallel. Posterior margin definitely squarish. With two kinds of punctae, the larger pits somewhat smaller than the setal bases and scattered over the caudal three-fourths of scutum; the micro-punctae uniformly scattered. *AL* setae relatively thin, extending to about level of *SB*. *PL* setae similar in structure but slightly longer; extending to level of first usurped setae. With a distinct ridge anterior to sensillary bases, which are midway between levels of *ALs* and *PLs*. (Sensillae absent or distorted in specimens extant.) *PPL-1* median, in vertical line with *SB* and near imaginary midline of scutum. *PPL-2* almost in line with *PPL-1*. Both pairs of usurped setae resembling *PLs*. *PPW-1* is 49 ( $\pm 4$ ); *PPW-2*, 43 ( $\pm 5$ ); *PPP-1*, 65 ( $\pm 5$ );

STANDARD MEASUREMENTS IN MICRONS

|                                  | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>AP</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa\ II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus\ III}$ |
|----------------------------------|-----------|-----------|-----------|------------|------------|-----------|-----------|-----------|-------------|-----------------------|-----------------|------------------|--------------------------|
| Holotype,<br>No. B-17719-5 ..... | 46        | 66        | 43        | 20         | 107        | 38        | 26        | 30        | 28          | 66/49=1.35            | 0.53            | 3.3              | 68/52=1.27               |
| Paratypes (3):<br>Mean .....     | 47        | 70        | 45        | 20         | 114        | 38        | 27        | 32        | 30          | 1.36                  | 0.52            | 3.5              | 1.32                     |
| Range + or - .....               | 3         | 4         | 4         | 3          | 8          | 2         | 3         | 3         | 3           | 0.08                  | 0.07            | 0.4              | 0.08                     |

*PPP-2*, 12 ( $\pm 2$ ). *Body setae*: Dorsal setae similar to *ALs*; about 28 (24 to 32) in number (excluding usurped setae), usually arranged 4.4.8.6, the rest irregular. With about 46 to 60 ventral setae, of which about 15 to 20 are postanals. True ventrals thin, about 19 microns in length, with fine pinnae. *Legs*: Coxae 1-setose. Coxa III length to breadth, 54:47 microns (ratio=1.15). Sternal setae arranged 2-2. Sensory setae as *G. exilis*, new species.

*Type material*.—Holotype (No. B-17719-5) and three paratypes ex the ground squirrel, *Menetes berdmorei* Blyth, 1849, Thailand, Nan, Pang Nam Un, January 21, 1953 (H. G. Deignan, ornithologist, U. S. National Museum, and Robert E. Elbel, U. S. Special Technical and Economic Mission to Thailand). Holotype (U.S.N.M. No. 2159) deposited in collections of U. S. National Museum. Paratypes in collections of senior author and Colonial Office Medical Research Unit at Kuala Lumpur.

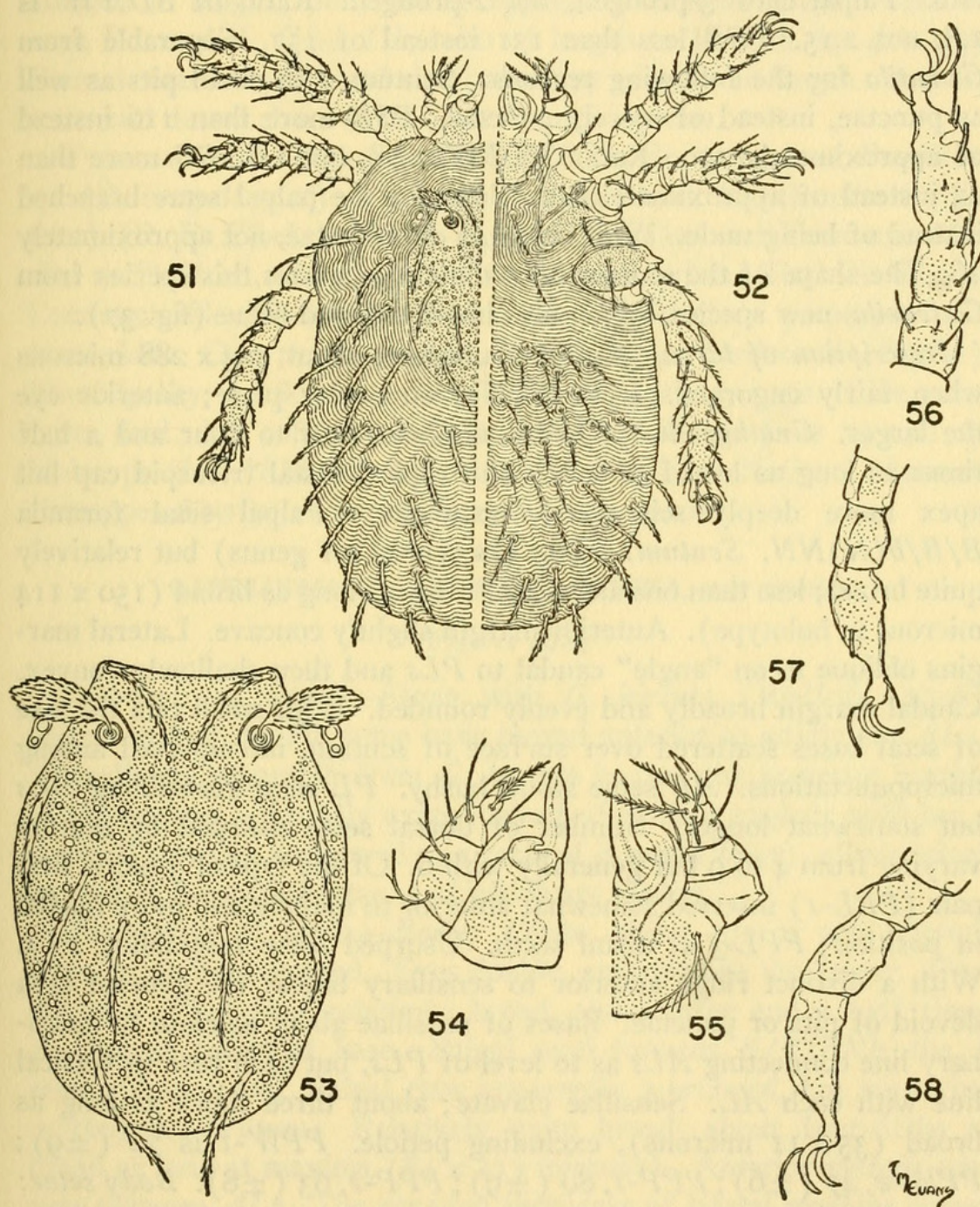
*Comment*.—The species is named for Robert E. Elbel of the U. S. Special Technical and Economic Mission to Thailand, who, while working with the Thai Ministry of Public Health Division of Communicable Diseases on the control of arthropod-born diseases of Thailand, also contributed much to our knowledge of potential vectors of disease in that country.



## GAHRLIEPIA (GAHRLIEPIA) TYLANA, new species

Figures 51-58

*Diagnosis of larva.*—Near *G. (G.) saduski* Womersley, 1952, in the shape of the scutum and the rather bushy character of the dorsal

FIGS. 51-58.—*Gahrлиеpia (Gahrлиеpia) tylana*, new species.

setae. Immediately separable because of the 1-setose character of coxa III in contrast to the 4 to 5 setae in *G. saduski*; by the presence of eyes; by possessing 4 to 9 usurped setae (usually 6) instead of 2 to 5, and by possessing small scutal pits in addition to punctae, in-



stead of merely punctae. Agreeing with *G. (G.) rutila* Gater, 1932, and *G. (G.) romeri* Womersley, 1952 (new combination) in the approximate number of dorsal setae captured by the scutum. Distinguishable from *G. romeri* as follows: Scutum with scattered small pits in addition to punctae, instead of being merely uniformly punctate. Palpal claw 3-pronged, not 2-pronged. Ratio of  $SD:PW$  is 1.8, not 2.15.  $PSB$  less than 131 instead of 157. Separable from *G. rutila* for the following reasons: Scutum with small pits as well as punctae, instead of merely punctae.  $PSB$  more than 116 instead of approximately 100. Ratio  $SD:PW=1.8$ , not 1.6.  $SB$  more than 45 instead of approximately 41. Some of the palpal setae branched instead of being nude. With about 40 dorsal setae, not approximately 26. The shape of the scutum immediately separates this species from *G. tenella*, new species, which also has 6 usurped setae (fig. 37).

*Description of larva.*—*Body*: Subovate, about  $424 \times 288$  microns when fairly engorged. Eyes double; on ocular plate; anterior eye the larger. *Gnathosoma*: Chelicerae about four to four and a half times as long as broad at base; with typical distal tricuspid cap but apex more deeply sclerotized, acuminate. Palpal setal formula  $B/B/b(N)NN$ . *Scutum*: Long (as typical for genus) but relatively quite broad; less than one and a half times as long as broad ( $150 \times 114$  microns in holotype). Anterior margin slightly concave. Lateral margins oblique to an "angle" caudal to  $PL$ s and then shallowly convex. Caudal margin broadly and evenly rounded. With small pits the size of setal bases scattered over surface of scutum, interspersed among micropunctations.  $AL$  setae stout, bushy.  $PL$  setae resembling  $AL$ s but somewhat longer. Number of dorsal setae usurped by scutum varying from 4 to 9 but generally with 6. Of the typical 3 pairs, first pair ( $PPL-1$ ) inserted somewhat anterior to midline and more medial in position;  $PPL-3$  at distal sixth. Usurped setae resembling  $PL$ s. With a distinct ridge anterior to sensillary bases; the general area devoid of pits or punctae. Bases of sensillae about as close to imaginary line connecting  $AL$ s as to level of  $PL$ s, but each base in vertical line with each  $AL$ . Sensillae clavate; about three times as long as broad ( $35 \times 11$  microns), excluding petiole.  $PPW-1$  is  $72 (\pm 9)$ ;  $PPW-2$ ,  $47 (\pm 6)$ ;  $PPP-1$ ,  $80 (\pm 9)$ ;  $PPP-2$ ,  $63 (\pm 8)$ . *Body setae*:

## STANDARD MEASUREMENTS IN MICRONS

|                                         | $AW$ | $PW$ | $SB$ | $ASB$ | $PBS$ | $A-P$ | $AL$ | $PL$ | $D.S.$ | $\frac{PW}{Coxa II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus III}$ |
|-----------------------------------------|------|------|------|-------|-------|-------|------|------|--------|----------------------|-----------------|------------------|-------------------------|
| Holotype, C.O.M.R.U.<br>No. 32133 ..... | 51   | 85   | 49   | 22    | 128   | 39    | 32   | 39   | 39     | $85/53=1.60$         | 0.56            | 4.0              | $85/53=1.60$            |
| Paratypes (8):<br>Mean .....            | 49   | 80   | 49   | 22    | 123   | 38    | 33   | 39   | 39     | 1.52                 | 0.52            | 3.6              | 1.61                    |
| Range + or - .....                      | 3    | 6    | 4    | 2     | 7     | 2     | 3    | 4    | 5      | 0.08                 | 0.06            | 0.5              | 0.08                    |



Dorsal setae resembling scutal setae; about 42 to 46 in number, excluding those on scutum; the rows erratic but at times arranged 4.4(4).6(2).8.8, the rest irregular. Ventral setae about 62 to 66 in number of which about 20 are postanals. Caudal and lateral setae approximating dorsals in length and breadth. True ventrals about 22 microns in length; thin, pinnae appressed to stem. *Legs*: Seta on coxa III medial. Coxa III, ratio of length to breadth  $64:42=1.55$ . Sternal setae 2-2; in usual sites; about 27 microns in length. Sensory setae and dorsal claws as in *G. exilis*, new species.

*Type material*.—Holotype (C.O.M.R.U. No. 32133) ex *Bandicota* sp. (*B. bengalensis*?), Thailand, Kanchanaburi, Kanchanaburi (district) (R. E. Elbel, for U. S. Special Technical and Economic Mission to Thailand, and plague control workers of the Thai Division of Communicable Diseases), June 9, 1952. Fourteen paratypes with same data. One paratype, *ibid.*, but *Menetes berdmorei* (Blythe), Municipality, 1 kilo. west (R. E. Elbel), June 9, 1952. Five paratypes, *ibid.*, but collected at Rat Buri, Ban Pong, June 14 and 17. Holotype (U.S.N.M. No. 2160) deposited in U. S. National Museum. Paratypes distributed as for *G. exilis*, new species.

#### GAHRLIEPIA (GAHRLIEPIA) GEMINA, new species

Figures 59-67

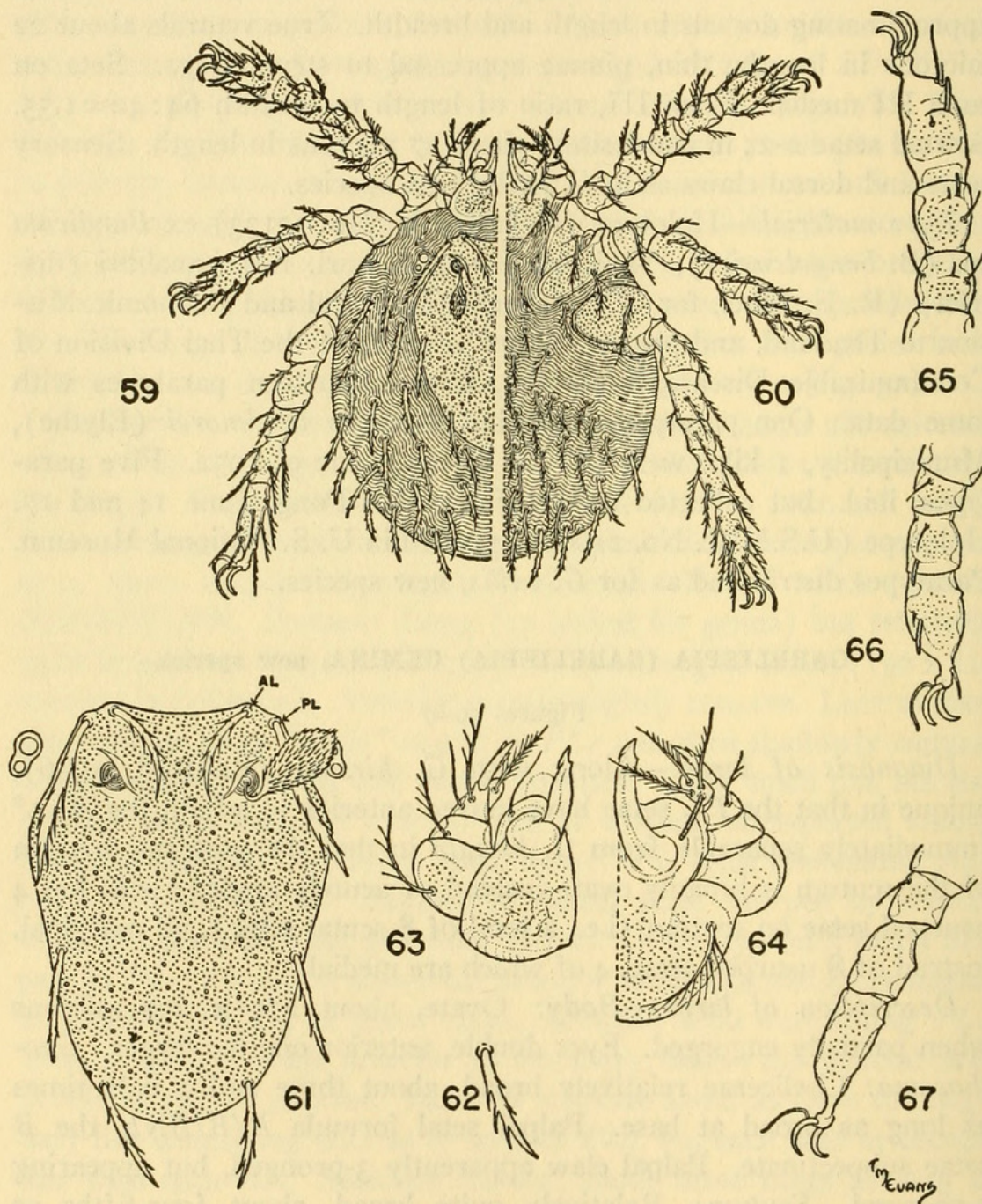
*Diagnosis of larva*.—Along with *G. hirsuta* (Radford, 1946), unique in that the *PL* setae have moved anterior to adjoin the *ALs*.<sup>9</sup> Immediately separable from *G. hirsuta* in that the posterior margin of the scutum is broadly ovate instead of acutely angled; with but 4 usurped setae on scutum (i.e., a total of 8 scutal setae), all marginal, instead of 8 usurped setae, 4 of which are medial.

*Description of larva*.—*Body*: Ovate, about 271 x 200 microns when partially engorged. Eyes double, anterior one the larger. *Gnathosoma*: Chelicerae relatively broad, about three and a half times as long as broad at base. Palpal setal formula *B/B/BNb*, the *B* setae subpectinate. Palpal claw apparently 3-pronged, but appearing 2-pronged. *Scutum*: Relatively quite broad, about four-fifths as broad as long at maxima (84 x 113 microns). Anterior margin concave between *ALs*. The rounded shoulders of lateral margins occurring at anterior two-fifths. Lateral margins posterior to shoulders gently but irregularly sinuate. Caudal margin somewhat convex. With two kinds of punctae, i.e., with coarser punctae about one-half to one-

<sup>9</sup> Two new species subsequently described herein also possess *PLs* adjacent to *ALs*.



fourth size of setal bases scattered among the more numerous micro-punctations. *AL* setae (fig. 61, *AL*) bushy, thick, displaced from anterolateral angles by the nearly contiguous *PL*s. Posterolateral



FIGS. 59-67.—*Gahrlepiea* (*Gahrlepiea*) *gemina*, new species.

setae (fig. 61, *PL*) longer than *AL*s, in ratio of 10:7; thick and bushy; bases almost in line with those of *AL*. With two pairs of dorsal setae usurped by scutum; both pairs marginal, resembling *AL*s; of these usurped setae, one pair inserted well below shoulders and somewhat below midline; second pair near posterior margin. With a pronounced oblique ridge anterior to sensillae bases. Sensillae inserted



at level of anterior sixth of scutum. Sensillae clavate; with a long petiole; three and a half times as long as broad. *PPW-1* is 70 ( $\pm 6$ ); *PPW-2*, 40 ( $\pm 6$ ); *PPP-1*, 54 ( $\pm 7$ ); *PPP-2*, 15 ( $\pm 4$ ). *Body setae*:

| STANDARD MEASUREMENTS IN MICRONS |           |           |           |            |            |            |           |           |             |                      |                 |                  |                         |
|----------------------------------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|----------------------|-----------------|------------------|-------------------------|
|                                  | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A-P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus III}$ |
| holotype, U.S.A.T.C.             |           |           |           |            |            |            |           |           |             |                      |                 |                  |                         |
| No. 1035-6 .....                 | 36        | 52        | 41        | 21         | 92         | 10         | 35        | 50        | 36          | 52/58=0.9            | 0.46            | 2.5              | 52/53=0.98              |
| Paratypes (16):                  |           |           |           |            |            |            |           |           |             |                      |                 |                  |                         |
| Mean .....                       | 37        | 54        | 42        | 21         | 97         | 10         | 34        | 49        | 36          | 0.96                 | 0.45            | 2.5              | 0.94                    |
| Range + or - .....               | 4         | 6         | 5         | 3          | 5          | 2          | 4         | 4         | 3           | 0.07                 | 0.06            | 0.5              | 0.06                    |

Dorsal setae (fig. 62) usually thicker than usurped scutal setae; with but 3 to 5 fairly stout barbs, these subpectinate in appearance; about 32 to 36 in number (excluding usurped setae), arranged 4.4(2).6 (2).8, the rest irregular. Ventral setae about 50 in number, of which about 22 to 26 are postanals rather resembling dorsal setae. True ventrals thin, short, about 15 to 18 microns, with fine pinnae. *Legs*: Coxae 1-setose. Coxa III relatively broad, ratio of length to breadth about 1.17; with seta almost anteromarginal. First pair of sternal setae long, extending almost to bases of posterior sternals. With 4 sternal setae between coxae III, the extra pair probably due to forward displacement of two true ventral setae. Sensory setae as in *G. exilis*, new species.

*Type material*.—Holotype (U.S.A.T.C. No. 1035-6) ex *Rattus rattus sladeni* (Anderson), North Burma, 20 miles northwest of Myitkyina on Mogaung Road (in the forest edge), May 22, 1945 (U. S. A. Typhus Commission). Thirty-three paratypes as follows (all collected U.S.A.T.C. unless otherwise specified): 17 with same data as holotype; 8, *ibid.*, but ex *Rattus fulvescens fulvescens* (Gray), April 23, 1945; 3, *ibid.*, but ex *Rattus* sp., January 24; 3 ex *Tupaia* at Shadazup, September 2, 1944 (H. S. Fuller); 1 ex *Rattus r. sladeni*, at Shingbuiyang, May 8; 1 ex *Crocidura vorax* Allen at Shingbuiyang, January 10. Holotype (U.S.N.M. No. 2161) and three paratypes deposited in U. S. National Museum. Paratypes distributed as for *G. exilis*, new species.

*Comment*.—*G. gemina* was collected on 16 occasions in North Burma. In all instances it was taken in primary jungle or heavy forest but only during the dry season. When collected, this chigger constituted between 2 and 4 percent of all the trombiculids examined from the particular host, but the percentage was usually less than 10 percent.

The specific name was suggested by the approximation of the *PL* and *AL* setae. What we have here called the posterolateral setae



(*PLs*) are longer and stouter than the *ALs*, as is usually the case in typical *Gahrlepiea*. Both pairs of setae are better developed than the other setae on the scutum. This indicates that our ideas of homology are correct, and that there are not two pairs of *ALs*.

**GAHRLIEPIA (GAHRLIEPIA) DUPLISETA, new species**

Figures 68-75

*Diagnosis of larva.*—Agrees with *G. gemina*, new species, in that the *PL* setae adjoin the *ALs* and the scutum is caudally rounded, not angled. Immediately separable in that the usurped scutal setae are submedian, not marginal; the *PL* setae are nearly twice the length of the *ALs*, instead of merely being in the ratio of 10:7; *PSB* proportionately far greater (*PSB*, 122 microns; *PSB/SB* ratio 3:1, not approximately 2:1), so that scutum is merely three-fifths as broad as long, not three-fourths.

*Description of larva.*—*Body*: Subovate, about 236 x 134 microns in partially engorged holotype. Eyes double, anterior one the larger. *Gnathosoma*: Chelicerae about four and a half times as long as broad at base. Palpal setal formula *B/B/BNB*. Palpal claw 3-pronged. *Scutum*: Relatively long, about three-fifths as broad as long at maxima (82 x 143 microns). Anterior margin slightly concave. Lateral margins fairly evenly convex, lacking distinct shoulders, slightly sinuate below level of sensillae bases and at about level of apical three-fourths. Caudal margin convex. With two kinds of punctae as in *G. gemina*, new species. *AL* setae relatively thin, somewhat plumose. *PL* setae similar in structure, but extending caudal to slightly below level of first usurped setae. Bases of *PL* almost contiguous with *AL*, the separation distance being about twice the diameter of the setal bases. The two pair of dorsal setae captured by scutum are in line with sensillary bases; thinly but distinctly barbed; anterior pair about 40 microns in length, inserted about level of midline; posterior pair 36 microns, inserted at posterior seven-eighths. With a distinct ridge anterior to sensillae bases. Sensillae inserted at level of anterior eighth of scutum. Sensillae clavate. *PPW-1* is 43; *PPW-2*, 39; *PPP-1*, 76; *PPP-2*, 26. *Body setae*: Dorsal setae similar to

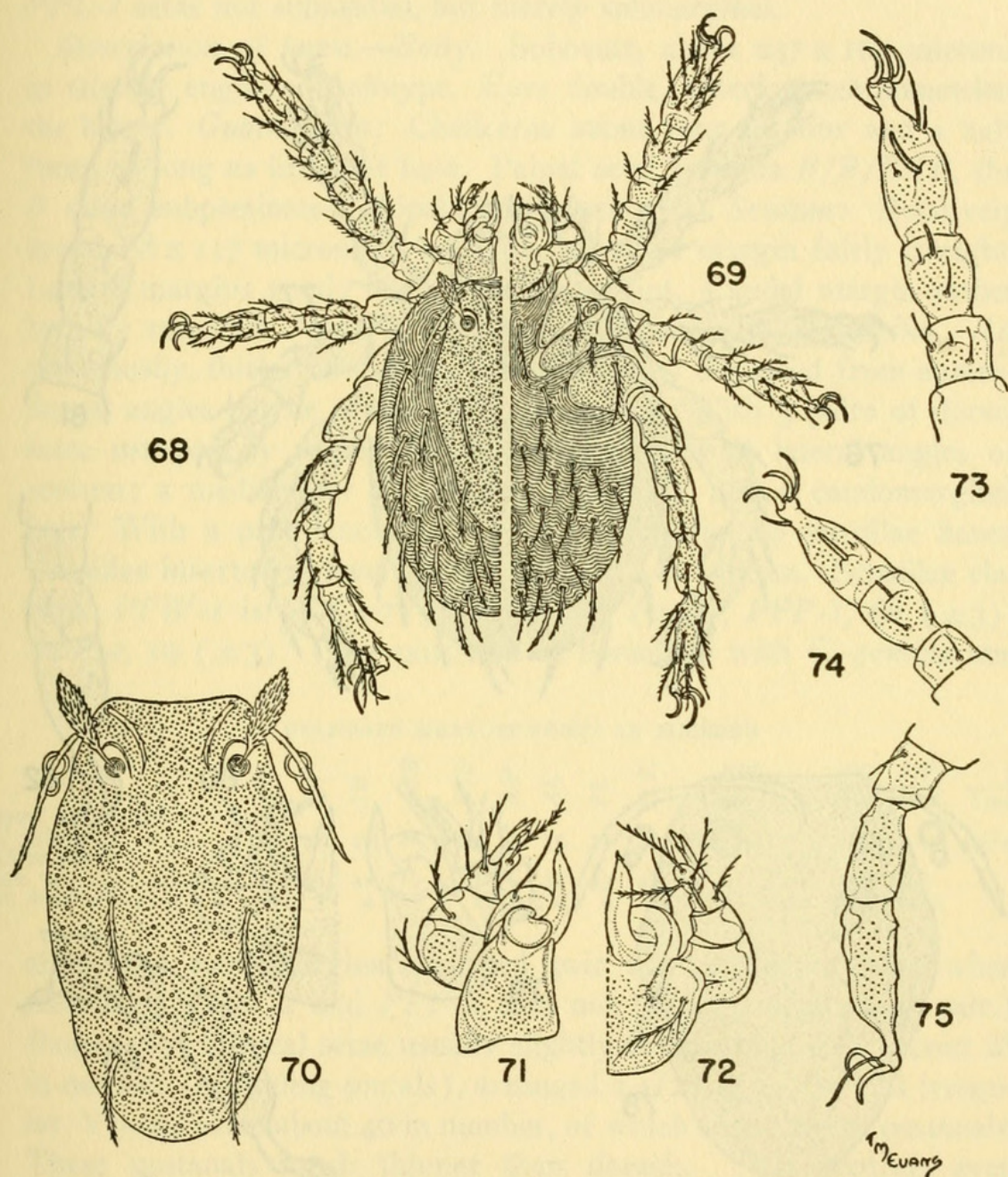
STANDARD MEASUREMENTS IN MICRONS

|                                          | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A-P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus III}$ |
|------------------------------------------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|----------------------|-----------------|------------------|-------------------------|
| Holotype, U.S.A.T.C.<br>No. 3562-1 ..... | 42        | 56        | 40        | 21         | 122        | 8          | 36        | 60        | 35          | 56/52=1.1            | 0.4             | 2.7              | 56/51=1.09              |

*ALs*; about 30 in number (excluding usurped setae) irregularly arranged. Ventral setae about 44 in number, of which about 26 are



postanals. True ventrals thin, fairly short, about 26 microns in length, with fine pinnae. *Legs*: Coxae 1-setose. Coxa III relatively broad, ratio of length to breadth about 1.17 with seta almost anteromarginal. Sternal setae arranged 2-2. Sensory setae as in *G. exilis*, new species.



FIGS. 68-75.—*Gahrлиеpia (Gahrлиеpia) dupliseta*, new species.

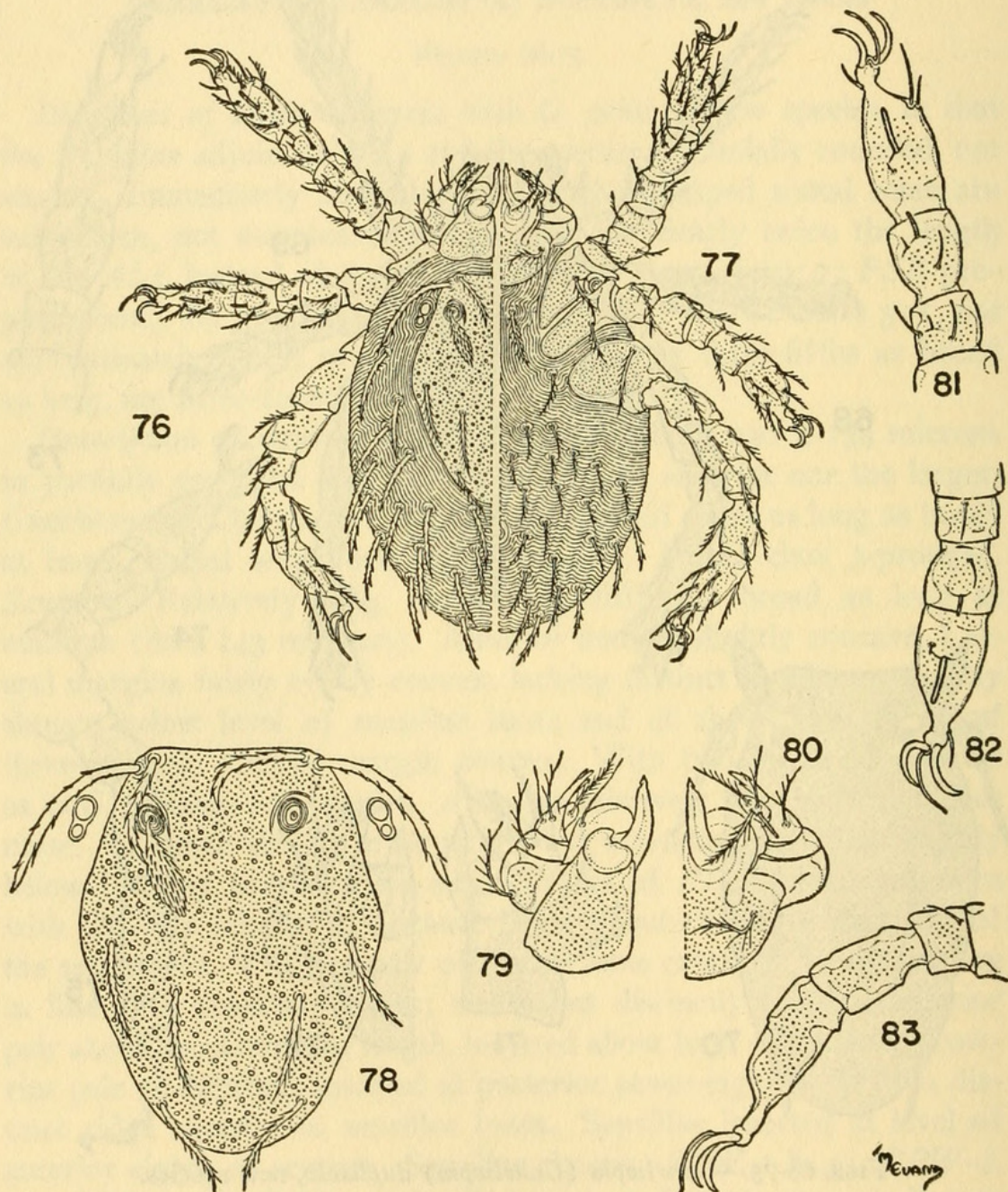
*Type material*.—Holotype (U.S.A.T.C. No. 3562-1) ex *Suncus caeruleus fulvocinereus* (Anderson), the white-toothed shrew, Assam, 21 miles north of Ledo on Stilwell Road (in scrub terrain), August 28, 1945 (U. S. A. Typhus Commission). Holotype (U.S.N.M. No. 2162) deposited in U. S. National Museum. A paratype from same host and locality in collection of senior author.



**GAHRLIEPIA (GAHRLIEPIA) PLURISETAE, new species**

Figures 76-83

*Diagnosis of larva.*—Similar to *G. gemina* and *G. dupliseta*, new species, in that the *PL* setae adjoin the *ALs* and in that the scutum is



FIGS. 76-83.—*Gahrlepiea (Gahrlepiea) plurisetae*, new species.

caudally rounded, not angled. Readily separable from both by virtue of possessing an additional 2 medial setae on the scutum. Further distinguishable from *G. gemina* as follows: The lateral angles of the scutum much nearer midline instead of being at anterior fifth (cf. figs. 61 and 78); *PPL-1* virtually at level of scutal angles instead of



far posterior; *PPL-1* submarginal, not marginal; with but one pair of sternal setae between coxae III. Further separable from *G. dupliseta* in that the scutum is relatively broader, three-fourths as broad as long instead of three-fifths as broad as long, as in *G. dupliseta*; the *PPL-1* setae not submedial, but merely submarginal.

*Description of larva.*—*Body*: Subovate, about 247 x 165 microns in slightly engorged holotype. Eyes double, anteriormost somewhat the larger. *Gnathosoma*: Chelicerae about four to four and a half times as long as broad at base. Palpal setal formula *B/B/BNB*, the *B* setae subpectinate. Palpal claw 3-pronged. *Scutum*: Relatively broad, 88 x 117 microns in holotype. Anterior margin fairly straight. Lateral margins gently angled near midpoint. Caudal margin rather broadly rounded. With 2 kinds of punctae as in *G. gemina*. *AL* setae bushy, thick, three-fifths length of *PLs*; displaced from anterolateral angles by the nearly contiguous *PLs*. With 3 pairs of dorsal setae usurped by scutum; a submarginal pair at lateral angles of scutum; a medial pair at three-fourths level, and a caudomarginal pair. With a pronounced oblique ridge anterior to sensillae bases. Sensillae inserted at level of anterior sixth of scutum. Sensillae clavate. *PPW-1* is 64 ( $\pm 7$ ); *PPW-2*, 37 ( $\pm 4$ ); *PPP-1*, 62 ( $\pm 3$ ); *PPP-2*, 19 ( $\pm 3$ ). (For purposes of homology with *G. gemina* and

STANDARD MEASUREMENTS IN MICRONS

|                                          | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A-P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{\text{Coxa II}}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{\text{Tarsus III}}$ |
|------------------------------------------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|-----------------------------|-----------------|------------------|--------------------------------|
| Holotype, U.S.A.T.C.<br>No. 3562-2 ..... | 37        | 52        | 39        | 20         | 97         | 9          | 32        | 51        | 35          | 52/52=1.0                   | 0.45            | 2.65             | 52/46=1.13                     |
| Paratypes (2):                           |           |           |           |            |            |            |           |           |             |                             |                 |                  |                                |
| Mean .....                               | 40        | 54        | 42        | 19         | 103        | 8          | 34        | 53        | 36          | 1.0                         | 0.45            | 2.8              | 1.09                           |
| Range + or - .....                       | 2         | 2         | 4         | 1          | 6          | 1          | 4         | 4         | 4           | 0.05                        | 0.04            | 0.15             | 0.05                           |

allies, the caudomarginal usurped pair are considered here when measuring *PPW-2* and *PPP-2*, and not the submedial third pair.) *Body setae*: Dorsal setae usually slightly thicker than *PLs*; about 28 in number (excluding scutals), arranged 2.4(2).4(2), the rest irregular. Ventral setae about 40 in number, of which about 22 are postanals. These postanals much thinner than dorsals. True ventrals even thinner; short, about 15 to 18 microns, with fine pinnae. *Legs*: Coxae 1-setose. Coxa III relatively broad, ratio of length to breadth about 1.18; with seta almost anteromarginal. Sternal setae of usual type (as in *G. exilis*, new species). Sensory setae as in *G. exilis*.

*Type material.*—Holotype (U.S.A.T.C. No. 3562-2) ex *Suncus caeruleus fulvocinereus* (Anderson), the white-toothed shrew, Assam, 21 miles north of Ledo on Stilwell Road (in scrub terrain), August 28, 1945 (U. S. A. Typhus Commission) (along with *G. dup-*



*liseta*, new species). Paratypes as follows: 1, *ibid.*, but June 17; 1, *ibid.*, but June 29. Holotype (U.S.N.M. No. 2163) deposited in U. S. National Museum. One paratype in U. S. National Museum, other in collection of senior author.

*Comment.*—The three specimens of this species were all taken in scrub terrain in Assam in the rainy season, in contrast with the many specimens of the related *G. gemina*, new species, which were collected at intervals in the jungles of North Burma in the dry season.

**GAHRLIEPIA (GAHRLIEPIA) EVANSI, new species**

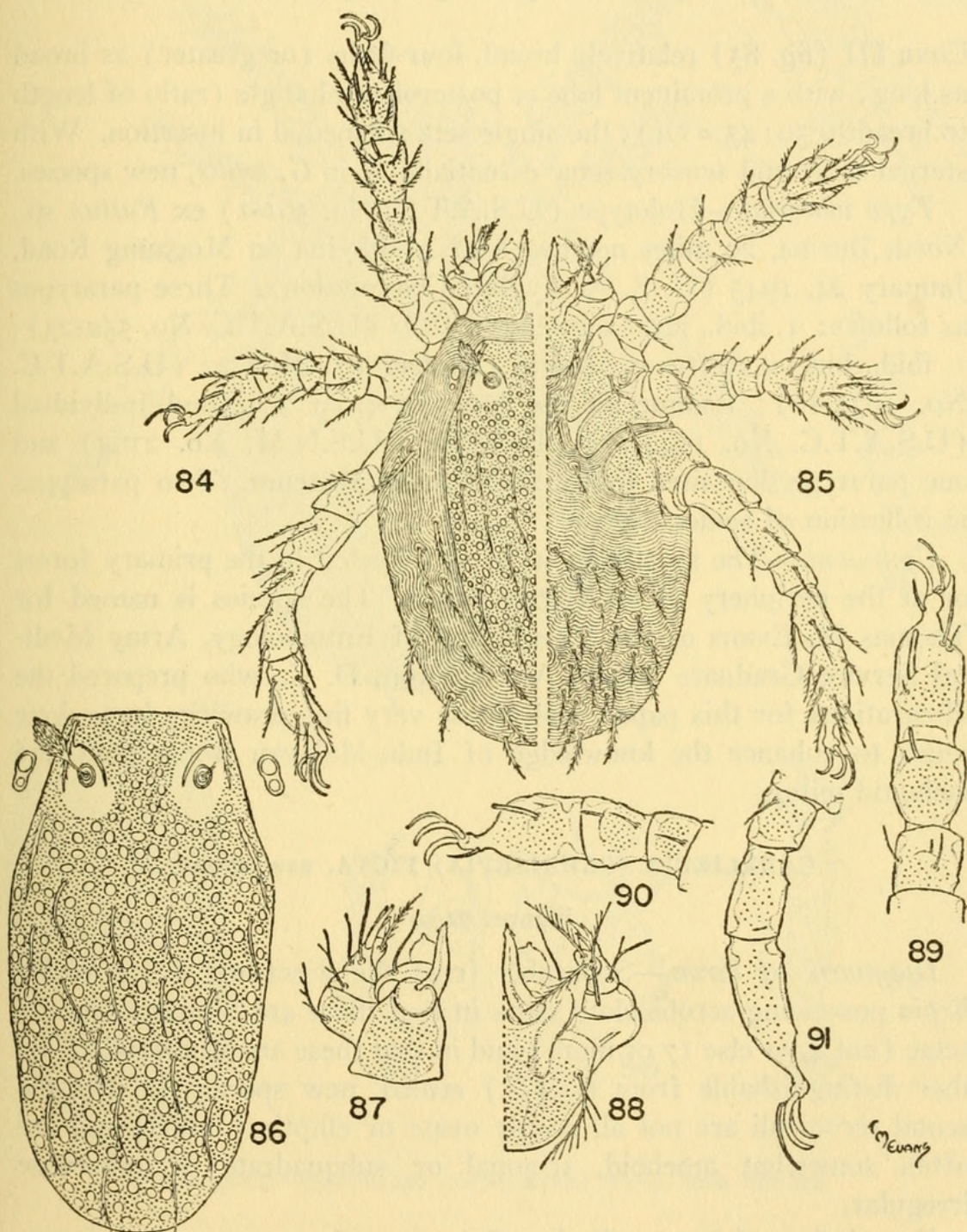
Figures 84-91

*Diagnosis of larva.*—Unique among described Asiatic *Gahrlepiea* with a scrobiculate or “ornate” scutum (*insigne* Womersley, 1952; *decora* Womersley, 1952, and *ornata* Womersley, 1952) in that there are about 17 dorsal setae usurped by the scutum, not merely 4, and most of them are medial instead of all being marginal.

*Description of larva.*—*Body*: Subovate, about 234 x 146 microns in slightly engorged holotype. Eyes double; anterior eye the larger; at level of sensillary bases; ocular plate adjacent to scutal margins. *Gnathosoma*: Chelicerae about four to five times as long as broad at base; with a distinct distal tricuspid cap; apex quite long, acuminate. Palpal setal formula *b/b/NNb*. Palpal claw 3-pronged; innermost prong slightly shorter than others; middle one longest. *Scutum*: Long, broadly and evenly tongue-shaped; about 155 x 81 microns at maximum (in holotype). Anterior margin essentially straight except for slight “shoulders” at insertion of *ALs*. Lateral margins fairly straight but oblique to level of a weak angle somewhat below *PLs*, thence very shallowly convex and almost subparallel most of its length. Lateral margins most heavily sclerotized between *AL* and *PL*. Posterior margin broadly rounded. Uniformly micropunctate except around *SB* and where scutum is ornamented by conspicuous subovate scrobiculi, dimples or pits two to four times the diameter of the setal bases. Scrobiculi distributed evenly over portion of scutum behind *SB* at rate of about 6 to 9 pits between each pair of usurped setae. Scrobiculi anterior to *SB* about one-third to one-half diameter of those posterior to *PL*. *AL* setae at anterolateral angles of scutum; thin but plumose. *PL* setae similar but slightly longer, inserted at about same distance from *SB* as are *ALs*. Usurped setae virtually all caudal to apices of *PL*; first row containing 4 or 5 setae resembling *PLs* but a trifle shorter and less obviously branched. Usurped setae 17 to 20 in number, roughly arranged in 4 highly ir-



regular rows or groups. With distinct ridges anterior to sensillae bases. Sensillae clavate; 26 (excluding petiole, 30 including it) x 9.5 microns. Sensillae bases surrounded by an area free of punctae and scrobiculi. *Body setae*: Dorsal setae similar to scutal setae;



FIGS. 84-91.—*Gahrlepiea (Gahrlepiea) evansi*, new species.

about 18 or 20 in number (excluding those captured by scutum), not clearly arranged in rows. With about 52 to 56 ventral setae, of which 20 to 26 are postanals. True ventrals about 15 microns in length; thin; pinnae sparse. *Legs*: Coxae I and II as in *G. exilis*, new species.



## STANDARD MEASUREMENTS IN MICRONS

|                                         | AW | PW | SB | ASB | PSB | A-P | AL | PL | D.S. | $\frac{PW}{\text{Coxa II}}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{\text{Tarsus III}}$ |
|-----------------------------------------|----|----|----|-----|-----|-----|----|----|------|-----------------------------|-----------------|------------------|--------------------------------|
| Holotype, U.S.A.T.C.<br>No. 561-1 ..... | 40 | 56 | 34 | 19  | 136 | 30  | 22 | 26 | 24   | 56/46=1.22                  | 0.36            | 2.9              | 56/43=1.31                     |
| Paratypes (3):<br>Mean .....            | 40 | 60 | 37 | 19  | 134 | 32  | 23 | 26 | 24   | 1.20                        | 0.39            | 3.2              | 1.36                           |
| Range + or - .....                      | 1  | 4  | 3  | 1   | 5   | 2   | 3  | 3  | 4    | 0.04                        | 0.04            | 0.3              | 0.05                           |

Coxa III (fig. 85) relatively broad, four-fifths (or greater) as broad as long; with a prominent lobe at posterolateral angle (ratio of length to breadth, 50:45=1.1); the single seta submedial in insertion. With sternal setae and sensory setae essentially as in *G. exilis*, new species.

*Type material*.—Holotype (U.S.A.T.C. No. 561-1) ex *Rattus* sp., North Burma, 20 miles northwest of Myitkyina on Mogaung Road, January 24, 1945 (U. S. A. Typhus Commission). Three paratypes as follows: 1, *ibid.*, but ex another *Rattus* (U.S.A.T.C. No. 552-23); 1, *ibid.*, but ex *Rattus r. sladeni* (Anderson), May 22 (U.S.A.T.C. No. 1035-10); 1 same as the last but from a second individual (U.S.A.T.C. No. 1044-13). Holotype (U.S.N.M. No. 2164) and one paratype deposited in U. S. National Museum. Two paratypes in collection of senior author.

*Comment*.—The specimens were all collected in the primary forest or at the periphery of such true jungle. The species is named for Thomas M. Evans of the Department of Entomology, Army Medical Service Graduate School, Washington, D. C., who prepared the illustrations for this paper, and whose very fine drawings have done much to enhance the knowledge of Indo-Malayan trombiculid and laelaptid mites.

## GAHRLIEPIA (GAHRLIEPIA) PICTA, new species

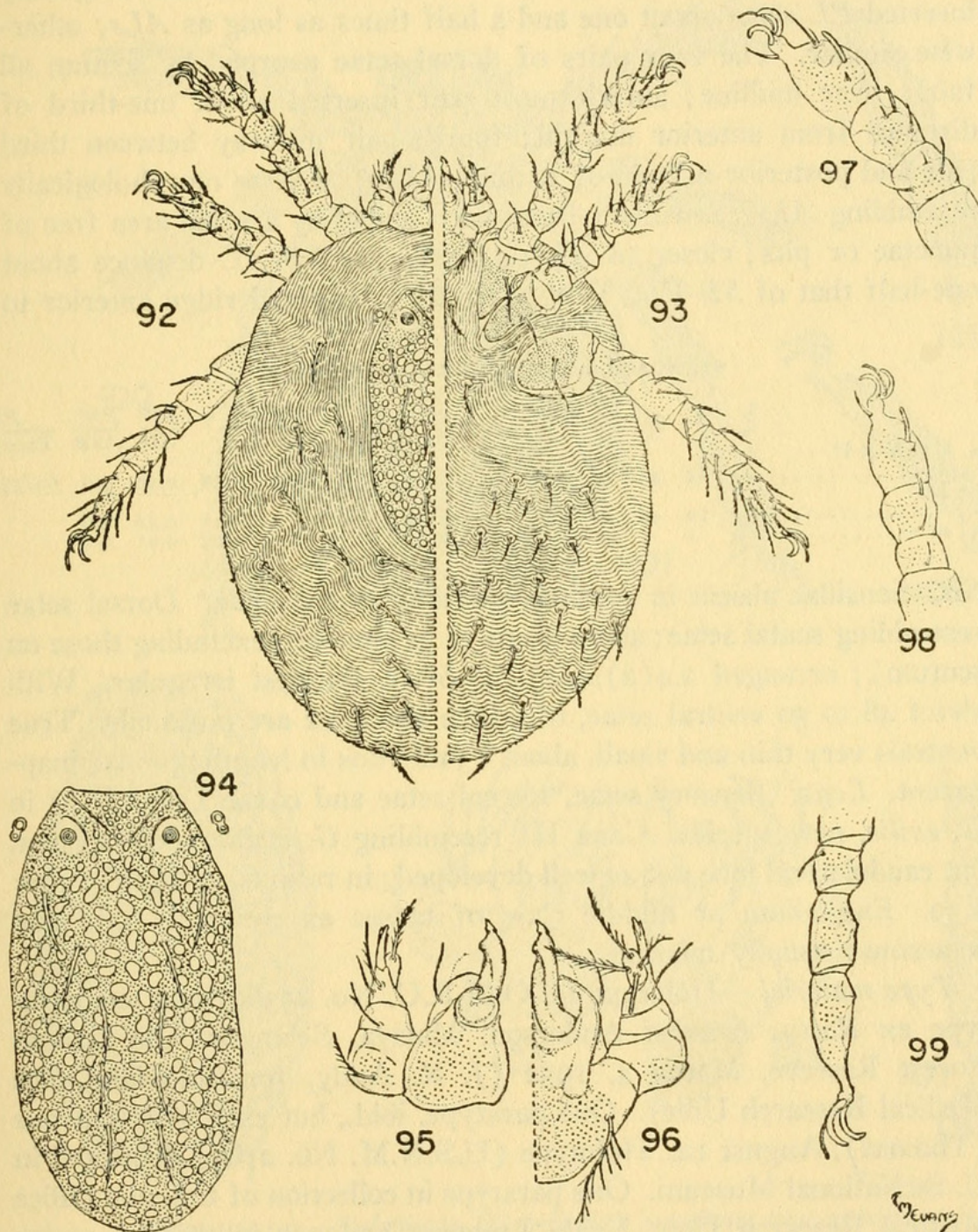
Figures 92-99

*Diagnosis of larva*.—Separable from the described Asian *Gahr-liepia* possessing scrobiculate scuta in that there are 8 usurped scutal setae (not 4, or else 17 or more) and in that these are all medial. Further distinguishable from *G. (G.) evansi*, new species, in that the scutal scrobiculi are not all evenly ovate or elliptical but instead are often somewhat ameboid, trigonal or subquadrate or otherwise irregular.

*Description of larva*.—*Body*: Subovate, about 423 x 282 microns in fairly engorged holotype. Eyes apparently double. *Gnathosoma*: Chelicerae about four to five times as long as broad; apex of distal tricuspid cap long, acuminate; with a distinct nubbin somewhat proximal of base of cap. Palpal setal formula  $b/b/b?Nb$ . Palpal claw 3-pronged. *Scutum*: Long, broadly and evenly tongue-shaped; 179



x 92 microns at maxima (in holotype). Anterior margin straight. "Shoulders" at insertion of *ALs* inconspicuous. Posterior margin broadly and evenly rounded. Lateral margins somewhat flattened



FIGS. 92-99.—*Gahrlepiea* (*Gahrlepiea*) *picta*, new species.

medially; remainder evenly but shallowly convex. Micropunctations uniformly distributed except for around *SB*. Scrobiculi conspicuous, extending over scutum behind *SB*; in general about equal in diameter of sclerotized portion of sensillae bases or approximately six times diameter of setal bases. Scrobiculi usually subovate or irregularly



elliptical or slightly ameboid; at times trigonal or subquadrate; largest ones medial; the dimples anterior to *SB* are about one-fourth length of those between *PLs*. *AL* setae at anterolateral angles of scutum; fairly thin and sparsely plumed; branches inapparent. Submarginally inserted *PL* setae about one and a half times as long as *ALs*; otherwise similar. The four pairs of dorsal setae usurped by scutum all fairly near midline; anteriormost pair inserted about one-third of distance from anterior margin; fourth pair midway between third pair and posterior margin of scutum. Usurped setae morphologically resembling *ALs*. Sensillary bases surrounded by a small area free of punctae or pits; closer to *AL* than *PL*, the *SB-AL* distance about one-half that of *SB-PL*. With a lightly sclerotized ridge anterior to

## STANDARD MEASUREMENTS IN MICRONS

|                                         | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A-P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa\ II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus\ III}$ |
|-----------------------------------------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|-----------------------|-----------------|------------------|--------------------------|
| Holotype, C.O.M.R.U.<br>No. 25369 ..... | 42        | 69        | 44        | 19         | 160        | 41         | 26        | 34        | 31          | 69/50=1.38            | 0.38            | 3.6              | 69/53=1.31               |
| Paratypes (2):<br>Mean .....            | 42        | 70        | 40        | 19         | 162        | 41         | 26        | 33        | 30          | 1.41                  | 0.38            | 3.6              | 1.36                     |
| Range + or - .....                      | 2         | 1         | 1         | 1          | 3          | 1          | 2         | 1         | 3           | 0.04                  | 0.01            | 0.2              | 0.05                     |

*SB*. Sensillae absent in specimens extant. *Body setae*: Dorsal setae resembling scutal setae; about 30 to 32 in number (excluding those on scutum); arranged 2.4(2).4(2).(2).6(2), the rest irregular. With about 48 to 50 ventral setae, of which about 22 are postanals. True ventrals very thin and small, about 15 microns in length; pinnae inapparent. *Legs*: Sensory setae, sternal setae and coxae I and II as in *G. exilis*, new species. Coxa III resembling *G. evansi*, new species, but caudolateral lobe not as well developed; in ratio 60 (length): 46=1.30. Empodium or middle claw of tarsus exceptionally thin and setaceous; usually missing.

*Type material*.—Holotype (C.O.M.R.U. No. 25369) and one paratype ex *Rattus bowersi* Anderson, Malaya, Selangor, Ulu Langat Forest Reserve, March 4, 1952 (J. R. Audy, for Colonial Office Medical Research Unit). One paratype, *ibid.*, but ex *Rattus sabanus* (Thomas), August 12. Holotype (U.S.N.M. No. 2165) deposited in U. S. National Museum. One paratype in collection of Colonial Office Medical Research Unit, Kuala Lumpur, and one in that of senior author.

*Comment*.—This species has been taken only in the primary forest.

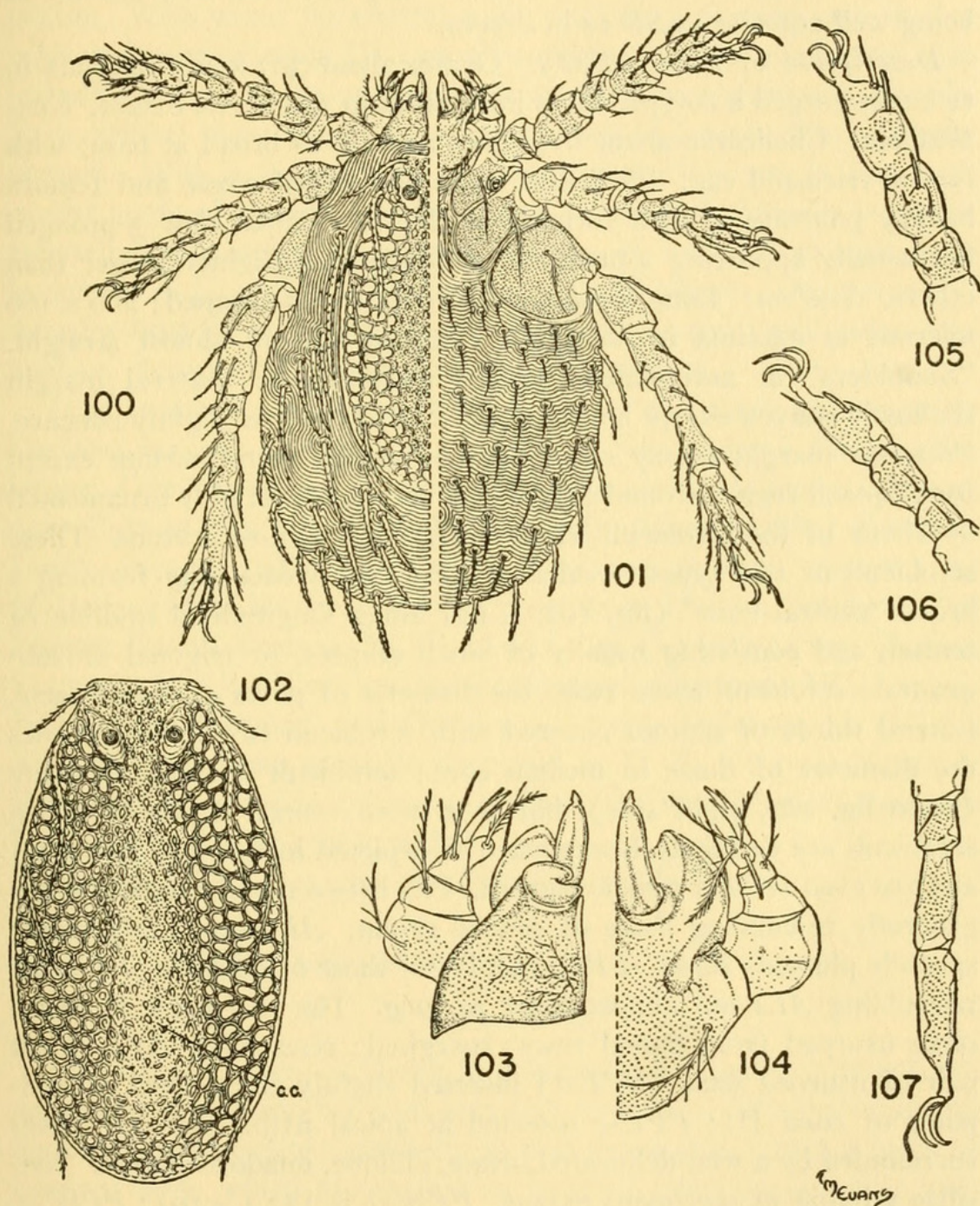
## GAHRLIEPIA (GAHRLIEPIA) TESSELLATA, new species

Figures 100-107

*Diagnosis of larva*.—A scrobiculate species with enormously broad coxa III and with but 2 pairs of usurped setae on the scutum, which



also are marginal, thereby agreeing with the three "ornate" species described by Womersley in 1952: *insigne*, *decora*, and *ornata*. Immediately separable from *insigne* and *ornata* in the shape, size, and dis-



FIGS. 100-107.—*Gahrlepiea (Gahrlepiea) tessellata*, new species.

tribution of the scutal pits or scrobiculi. In the new species the scrobiculi at their maxima are about six or seven times the diameter of the setal bases, not 15 to 20 (cf. figs. 102, 174, and 184). Near *G. decorata* but distinguished as follows: With two distinct sizes of scrobiculi—one along medial third of scutum and the second type on each side of this. The group along midline consisting of trigonal,



subquadrate, or rhomboidal pits which are only one-third to one-half the diameter of the ovoid scrobiculi on lateral thirds of scutum. In *G. decora* (fig. 182) the medial pits are subequal in size to the lateral ones. In the new species the *PLs* are in a line with *SB*, instead of being well anterior to *SB* as in *decora*.

*Description of larva.*—*Body*: Ovate, about 363 x 205 microns in rather engorged holotype. Eyes inapparent in specimens extant. *Gnathosoma*: Chelicerae about five times as long as broad at base; with typical tricuspid cap. Cheliceral bases and palpal coxae and femora heavily punctate. Palpal formula *B/B/bNb*. Palpal claw 3-pronged but usually appearing 2-pronged; middle prong slightly longer than others. *Scutum*: Long, broad, and evenly tongue-shaped; 266 x 166 microns at maxima in holotype. Anterior margin almost straight. "Shoulders" at anterolateral angles undeveloped. Lateral margin shallowly convex except between *AL-PL*, where it is slightly concave. Posterior margin evenly rounded. Uniformly micropunctate except for elliptical region around *SB* and for scrobiculi. Highly ornamented by virtue of the scrobiculi which extend over entire scutum. These scrobiculi of two types—medial and lateral. Medial pits forming a broad "central core" (fig. 102, C.C.) along longitudinal midline of scutum and consisting usually of small ellipses, or trigonal or subquadrate scrobiculi about twice the diameter of pores of dorsal setae. Lateral thirds of scutum covered with scrobiculi two to three times the diameter of those in median core; scrobiculi dorsally subovate (as in fig. 102, right side), but at a more ventral depth of focus, scrobiculi are definitely hexagonal (as depicted in fig. 102, left side) and are even set in a mosaic pattern. Pits between and anterior to *SB* generally resembling those of central group. *AL* setae fairly stout; sparsely plumed. Bases of *PLs* just below those of sensillae. *PL* setae resembling *ALs* but almost twice as long. The two pairs of scutal setae usurped from dorsal rows; marginal; resembling *ALs*. First pair of usurped setae (*PPL-1*) inserted slightly above level of mid-point of coxa III; *PPL-2* inserted at apical fifth. Sensillae bases surrounded by a well-delineated, ovate, oblique, unadorned area. Sensillae missing in specimens extant. *PPW-1* is 132 ( $\pm 10$ ); *PPW-2*, 126 ( $\pm 9$ ); *PPP-1*, 165 ( $\pm 15$ ); *PPP-2*, 36 ( $\pm 5$ ). *Body setae*:

STANDARD MEASUREMENTS IN MICRONS

|                           | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A.P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{\text{Coxa II}}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{\text{Tarsus III}}$ |
|---------------------------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|-----------------------------|-----------------|------------------|--------------------------------|
| Holotype,<br>No. 8160-1 * | 37        | 73        | 38        | 26         | 240        | 23         | 54        | 94        | 92          | 70/73=0.96                  | 0.27            | 2.7              | 73/79=0.92                     |
| Paratypes (6):            |           |           |           |            |            |            |           |           |             |                             |                 |                  |                                |
| Mean                      | 34        | 66        | 35        | 27         | 240        | 25         | 56        | 97        | 85          | 0.97                        | 0.21            | 2.5              | 0.83                           |
| Range + or -              | 4         | 7         | 3         | 2          | 10         | 2          | 4         | 6         | 10          | 0.07                        | 0.06            | 0.2              | 0.09                           |

\* Traub collection.



Dorsal setae similar to scutal setae; about 34 to 36 in number excluding those usurped by scutum. The great breadth of scutum resulting in crowding of dorsal setae along sides of body; rows hence inapparent. With about 82 ventral setae, including 6 which are in line with midpoint of coxa III and thus replace true sternals, and also including about 24 to 26 postanals resembling caudalmost dorsals. True ventral setae about 17 to 26 microns in length, thin, sparsely plumed. With a typical pair of sternal setae inserted in line with caudal angle of coxa I. *Legs*: Coxae particularly heavily punctate, appearing shagreened or beaded. Coxae II and III exceptionally broad (as in *G. ornata* Womersley, 1952, and allies). Thus, coxa III actually broader than long (ratio  $86 \text{ to } 93 = 0.92$ ); with seta submedian. Sensory setae as in *G. exilis*, new species.

*Type material*.—Holotype (No. 8160-1) and three paratypes ex *Lariscus insignis* (Cuvier), a ground-dwelling squirrel, Malaya, Selangor, Gombak Forest Reserve, 16 miles north of Kuala Lumpur, near Pahang Road (R. Traub, for U. S. Army Medical Research Unit), July 7, 1948. One paratype (drawn in figs. 100-107) ex *Hylomys suillus* Müller, the lesser gymnuran, Malaya, Selangor, Ulu Langat Forest Reserve (J. R. Audy, for Colonial Office Medical Research Unit). Three ex *Rattus bowersi* Anderson, Ulu Langat, February 8, March 4, and October 14, 1952. Holotype (U.S.N.M. No. 2166) and one paratype deposited in U. S. National Museum. Paratypes deposited in collection of Colonial Office Medical Research Unit and in that of senior author.

*Comment*.—This species has been taken only in primary forest.

#### GAHRLIEPIA (GAHRLIEPIA) LACINIATA, new species

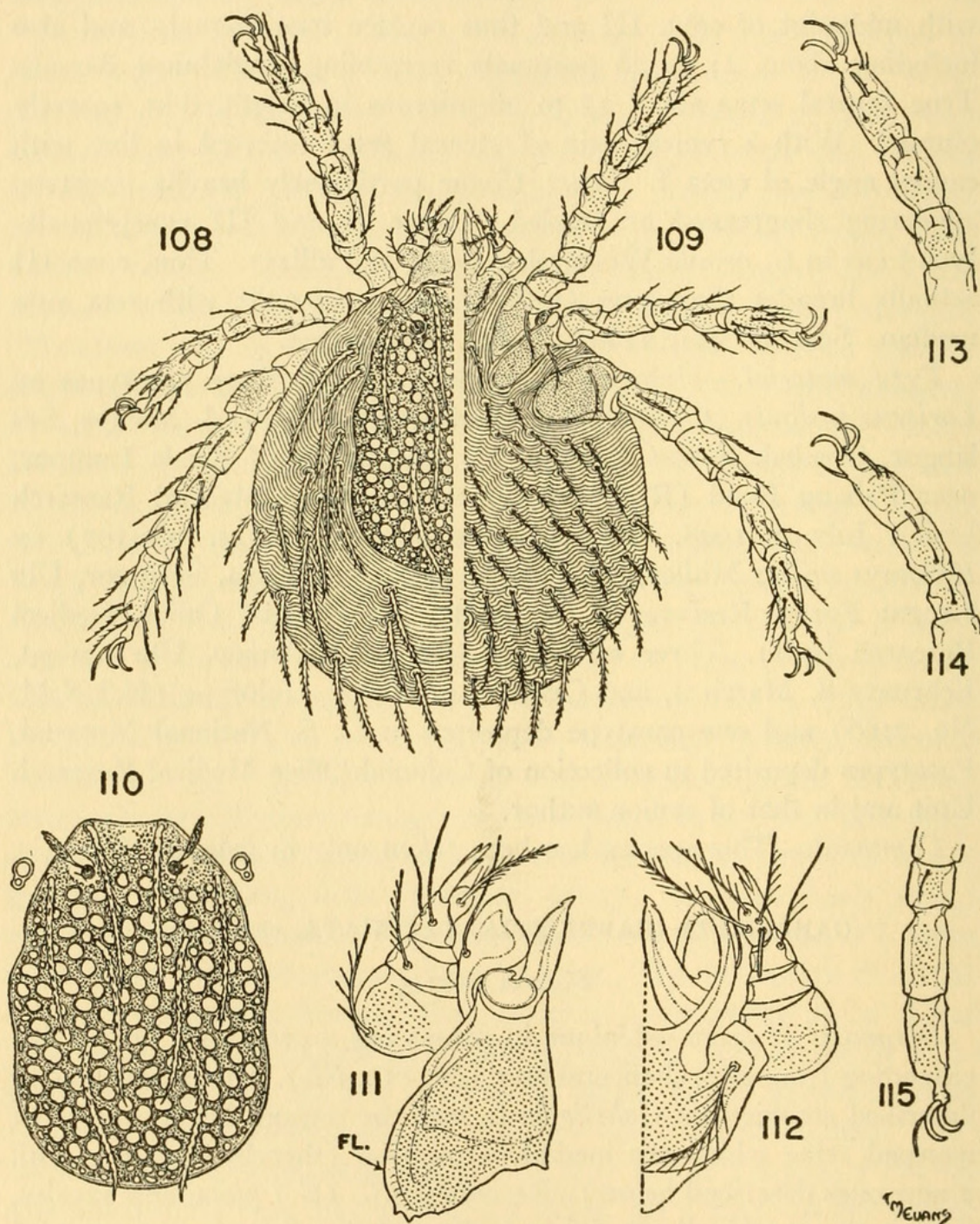
Figures 108-115

*Diagnosis of larva*.—Unique in possessing a prominent dorsal flap extending from each cheliceral base (fig. 111, *FL*). Distinctive among described scrobiculate *Gahrliopia* in that the scutum bears 2 pairs of usurped setae which are medial in position (thereby agreeing with 2 new ones described below). Resembling *G. (G.) picta*, new species, in that the scrobiculi are fairly large and distributed over most of scutum. Further separable from *G. picta* in that the pits are mainly subcircular instead of elliptical or ameboid, and by virtue of the great breadth of the scutum (ratio of scutal depth to width is 1.3, and not 2).

*Description of larva*.—*Body*: Ovate, about  $408 \times 304$  microns in fairly engorged holotype. Eyes double; apparent as a raised, bead-



like structure inserted near level of *SB*. *Gnathosoma*: Chelicerae long and narrow, apically acuminate; about six times as long as broad at base; cheliceral bases modified, possessing a posterolateral exten-



FIGS. 108-115.—*Gahrlepiea* (*Gahrlepiea*) *laciniata*, new species.

sion in the form of a conspicuous dorsal flap which is basally thickened and apically produced into a broad flange. Palpal setal formula *B/B/NNb*. Palpal claw 3-pronged. *Scutum*: Very long, as in other species in subgenus, but relatively quite broad; 234 x 165 microns in holotype. Anterior margin somewhat concave. Lateral margins some-



what sinuate beyond *PLs*. Posterior half to two-thirds of scutum of fairly uniform breadth. Caudal margin very broadly rounded. Scutum appearing reticulated by virtue of prominent subcircular scrobiculi scattered over entire surface. Majority of pits (approximately 110 in number) subequal in size and about two and a half to three times the diameter of setal bases; smallest scrobiculi near margins of scutum, and these are flattened ellipses or oblate spheroids. With the usual micropunctae uniformly distributed over remainder of scutum except for a narrow bare area around sensillae bases. *AL* setae inserted slightly behind low “shoulders” at anterolateral angles of scutum; fairly stout and bushy; quite long, extending to about midpoint of scutum; subequal to *PL* in length. *PLs* inserted at level of about anterior fifth of scutum; resembling *ALs*. First pair of usurped setae (*PPL-1*) inserted at level of anterior third of scutum and in vertical line with sensillae bases; resembling *PLs* but even longer (118 microns). *PPL-2* at posterior third; in line with *SB* and *PPL-1*, similar to *PLs* in morphology and in length. Sensillae bases inserted slightly anterior to line of *PLs*. Sensillae narrowly clavate; most of club cylindrical in shape. With a weakly sclerotized ridge anterior to each sensillary base. *PPW-1* is 55 ( $\pm 6$ ); *PPW-2*, 52 ( $\pm 13$ ); *PPP-1*, 159 ( $\pm 8$ ); *PPP-2*, 94 ( $\pm 6$ ). *Body setae*: Dorsal setae

STANDARD MEASUREMENTS IN MICRONS

|                                | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A-P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa\ II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus\ III}$ |
|--------------------------------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|-----------------------|-----------------|------------------|--------------------------|
| Holotype,<br>No. B-19365-5 ... | 42        | 104       | 59        | 28         | 216        | 45         | 120       | 123       | 105         | 104/82=1.27           | 0.43            | 3.7              | 104/70=1.49              |
| Paratypes (20):                |           |           |           |            |            |            |           |           |             |                       |                 |                  |                          |
| Mean .....                     | 43        | 103       | 58        | 28         | 216        | 43         | 119       | 126       | 119         | 1.31                  | 0.42            | 3.6              | 1.44                     |
| Range + or - ....              | 5         | 8         | 6         | 2          | 20         | 7          | 11        | 13        | 6           | 0.09                  | 0.02            | 0.3              | 0.05                     |

resembling scutal setae; about 26 to 30 in number (excluding those captured by scutum); rows obscure, but apparently arranged 2.2.8 (2).8(2), the rest irregular. With about 70 to 76 ventral setae, of which about 24 are postanals but which nevertheless are shorter and distinctly thinner than dorsals. True ventrals thin, short, about 18 microns in length, sparsely plumed. Sternal setae arranged 2-4(5), the latter row resembling ventrals. *Legs*: Coxa I with a distinctive spur at caudolateral angle. Coxa III about one and a half times as long as broad (71 by 46 microns=1.54 in holotype). With seta submarginal in position. Sensory setae essentially as in *G. exilis*, new species.

*Type material*.—Holotype (No. B-19365-5) ex *Rattus alticola alticola* Thomas, North Borneo, Mount Kinabalu, Mari Parei, elevation 5,100 feet (R. Traub, for joint U. S. Army-Colonial Office



Medical Research Unit), August 25, 1953. Ten paratypes, *ibid.*; 46 paratypes with same data (No. B-19370); 18 paratypes, *ibid.*, but at Tenompak, 4,500 feet, August 20, 1953 (No. B-19319); 2 paratypes as No. B-19319 but collected July 16, 1951; 22 paratypes as No. B-19319 but collected August 31, 1953; 3 as No. B-19319 but collected September 1, 1953; 1 paratype, *ibid.*, but ex *Rattus* of the *rajah* group, Tenompak, 4,500 feet, July 19, 1951; 1 paratype, *ibid.*, but ex *Rattus rapit* Bonhote, at Tenompak, 4,000 feet, August 29, 1953 (No. B-19412); 10 paratypes, *ibid.*, but ex *Rattus sabanus*, at Tenompak, 4,500 feet, August 29, 1953 (No. B-19414). Holotype (U.S.N.M. No. 2167) deposited in U. S. National Museum. Paratypes distributed as for *G. exilis*.

*Comment.*—*Gahrlepiea laciniata*, new species, exhibits an interesting and specific preference regarding site of attachment on the host. Virtually every specimen was found firmly attached at the bases of vibrissae and adjacent short hairs or spines on the muzzle of the rat. Invariably the chigger was solitary, and frequently was standing vertically, dorsally appressed to the stout hairs and hence difficult to see. Once this attachment site was discovered (in 1953), it was easy to collect this chigger which had previously been considered rare. Thus, only three specimens were collected by the 1951 expedition and none in 1952. Over 90 percent of the records are from *Rattus alticola*.

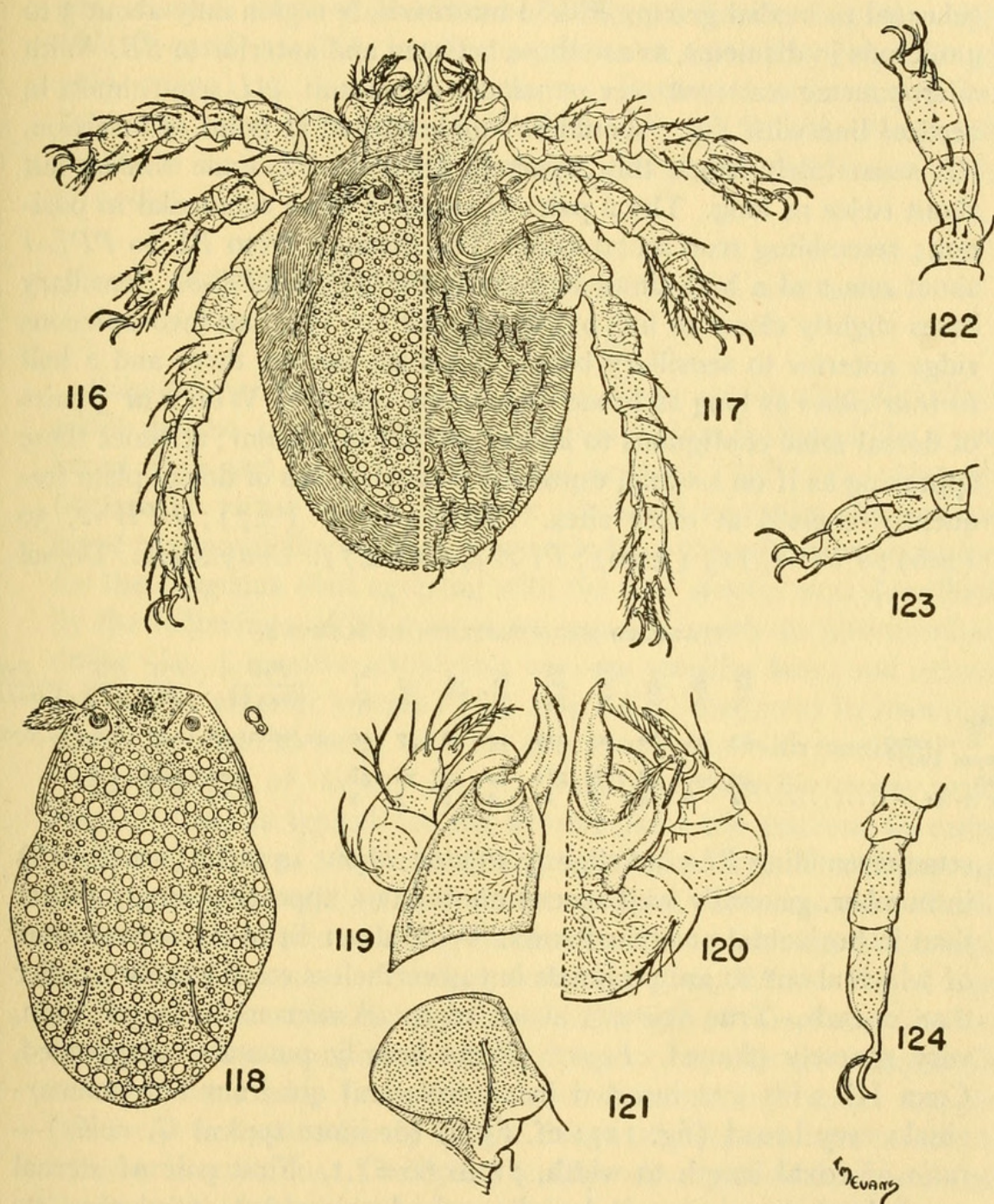
#### GAHRLIEPIA (GAHRLIEPIA) TUBERCULATA, new species

Figures 116-124

*Diagnosis of larva.*—Agrees with *G. laciniata*, new species, regarding presence of a scrobiculate scutum and 4 submedian usurped setae. Readily separable as follows: Lacking a flap extending from about the cheliceral bases. *PL* setae shorter than 40 microns and about twice the length of *ALs*, instead of being over 110 microns in length and subequal to *ALs*. Scutum subovate, becoming narrow at distal third; relatively longer (ratio of *SD* to maximum width is 1.5 to 1.6), whereas in *G. laciniata* the scutum is evenly broad until near caudal margin, and the ratio *SD* to maximum width is 1.3. In the new species the large scrobiculi are not evenly distributed over the scutum but instead are most conspicuous (and largest) along the longitudinal midline or core. Another group of large scrobiculi border the lateral margins. There is, therefore, a narrow, relatively nonornate gap between the marginal group and the imaginary vertical line linking each *PPL*. In *G. laciniata* the large dimples are subequal in size and uniformly pit the scutum.



*Description of larva.*—*Body*: Remarkably ovate caudad of insertion of leg III. About 351 x 206 microns in somewhat engorged holotype. Eyes double, but posterior eye reduced. *Gnathosoma*: Chelic-



FIGS. 116-124.—*Gahrlepiea* (*Gahrlepiea*) *tuberculata*, new species.

erae about four times as long as broad at base; apical tricuspid cap distally fairly acuminate. Palpal formula *B/B/NNN*. Palpal claw 3-pronged. *Scutum*: Long, broad, and evenly tongue-shaped; 239 x 143 microns in holotype. Anterior margin fairly straight; anterolateral margins rounded. Lateral margins gently sinuate; slightly



flared distal of midpoint. Caudal margin evenly convex. With large ovate pits or scrobiculi scattered over most of scutum. Largest scrobiculi in core region, about 10 microns in length (about four times diameter of base of scutal seta). Typical submarginal scrobiculi subequal to medial group. Pits in intermediate region only about 3 to 4 microns in diameter, as are those between and anterior to *SB*. With micropunctae scattered over remainder of scutum. *AL* setae almost in vertical line with *SB*; "shoulders" undeveloped at point of insertion. *AL* setae fairly short, thin, sparsely plumed. *PL* setae similar but about twice as long. The 2 pairs of usurped setae submedial in position; resembling true scutal setae. The distance from *PL* to *PPL-1* about one and a half times that from *PPL-1* to *PPL-2*. Sensillary bases slightly closer to line of *ALs* than *PLs*. With an inconspicuous ridge anterior to sensillary bases. Sensillae clavate, three and a half to four times as long as broad (excluding petiole). With 2 or 3 pairs of dorsal setae contiguous to lateral margin of scutum; at times these appearing as if on scutum, especially since margins of dorsal plate frequently excised at these sites. *PPW-1* is 61 ( $\pm 7$ ); *PPW-2*, 50 ( $\pm 6$ ); *PPP-1*, 115 ( $\pm 10$ ); *PPP-2*, 60 ( $\pm 7$ ). *Body setae*: Dorsal

## STANDARD MEASUREMENTS IN MICRONS

|                                  | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A-P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus III}$ |
|----------------------------------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|----------------------|-----------------|------------------|-------------------------|
| Holotype,<br>No. B-19327-7 ..... | 43        | 91        | 50        | 20         | 219        | 40         | 20        | 37        | 40          | 91/66=1.38           | 0.30            | 4.6              | 91/67=1.36              |
| Paratypes (20):                  |           |           |           |            |            |            |           |           |             |                      |                 |                  |                         |
| Mean .....                       | 43        | 94        | 48        | 18         | 211        | 40         | 18        | 36        | 38          | 1.40                 | 0.39            | 5.2              | 1.45                    |
| Range + or - .....               | 4         | 8         | 3         | 2          | 11         | 4          | 5         | 3         | 5           | 0.05                 | 0.10            | 0.6              | 0.09                    |

setae resembling *PLs* but slightly stouter; about 14 to 18 (usually 16) in number, generally well spaced on dorsum, appearing singly rather than in horizontal or arched rows. With about 64 to 70 ventral setae of which about 20 are postanals but nevertheless considerably smaller than dorsals. True ventrals about 16 to 18 microns in length, thin, very sparsely plumed. *Legs*: Coxae heavily punctate, shagreened. Coxa III with seta inserted in anterolateral quadrant but nonmarginal; very broad (fig. 121; cf. fig. 9 for more typical *G. exilis*)—ratio of coxal length to width, 71 to 66=1.1. First pair of sternal setae about 29 microns in length; second pair about 21 microns, its base at level of midline of coxa III. Sensory setae as in *G. exilis*, new species.

*Type material*.—Holotype (No. B-19327-7) ex *Rattus whiteheadi* *whiteheadi* Thomas, North Borneo, Mount Kinabalu, Tenompak, elevation 4,500 feet (R. Traub, for joint U. S. Army-Colonial Office Medical Research Unit), August 21, 1953. Paratypes as follows: 1,



ibid.; 1, ibid., but August 17, 1953; 2, ibid., but ex *Rattus sabanus*, September 21, 1953 (No. B-19476); 1, ibid., but ex nest of *Rattus* sp., August 20, 1953; 2, ibid., but ex *Rattus rajah* at Paring, elevation 1,600 feet, July 18, 1953 (No. B-19058); 34, ibid., but ex *Rattus mülleri*, 10 miles north of Jesselton at Menggatal Estate, August 4, 1951 (No. B-9108); 1, ibid., but Ranau, elevation 1,500 feet, July 15, 1953 (No. 20523); 3, ibid., but *Rattus* sp., Ranau, elevation 1,500 feet, July 28, 1953 (No. B-19151). Holotype (U.S.N.M. No. 2168) deposited in U. S. National Museum. Paratypes distributed as for *G. exilis*.

### GAHRLIEPIA (GAHRLIEPIA) AMPULLATA, new species

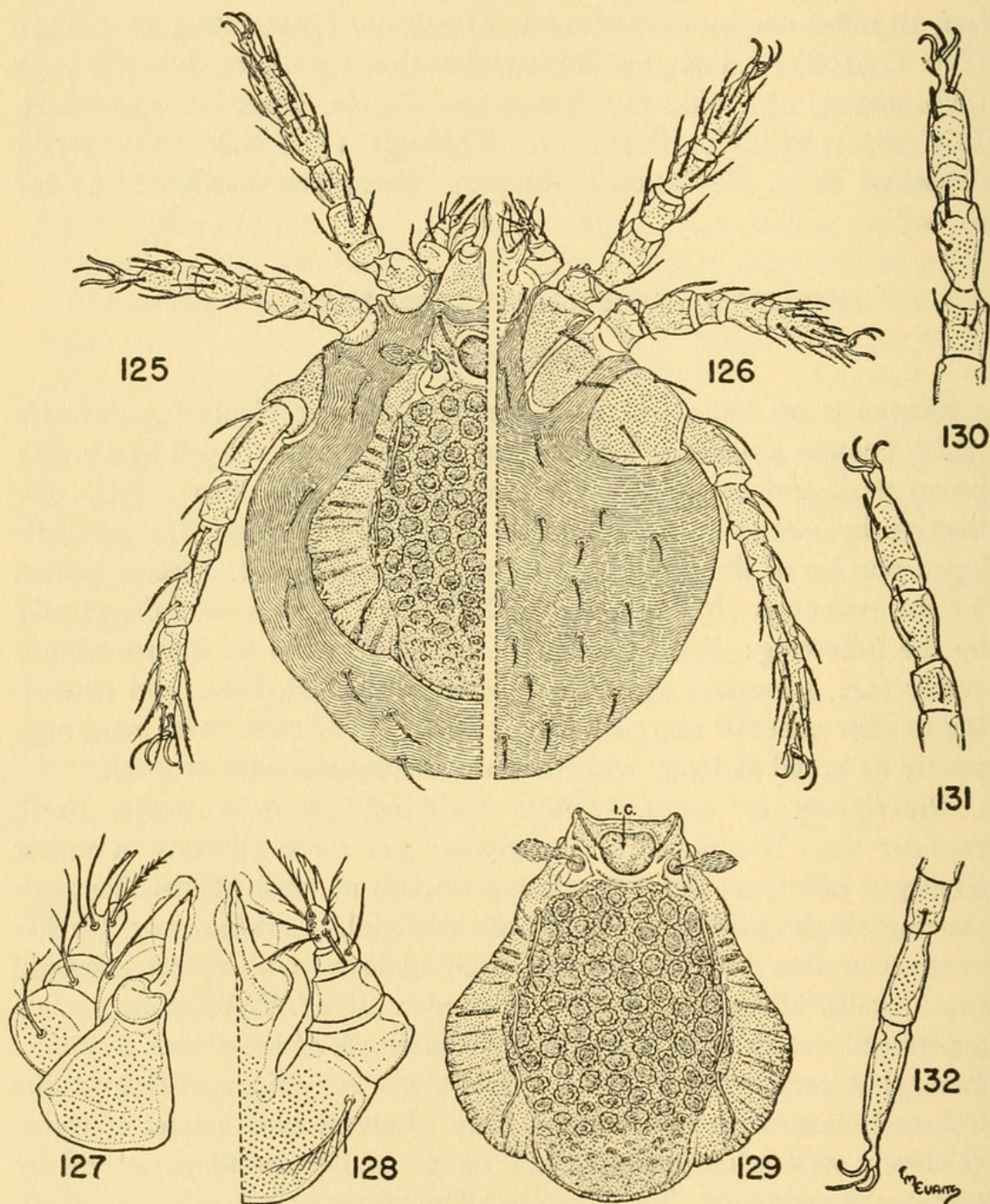
Figures 125-132

*Diagnosis of larva.*—Unique among those scrobiculate *Gahrлиеpia* which possess 4 usurped setae in that the scutum is shaped like a very broad flask and bears deep marginal scallops (fig. 129). Also distinctive by virtue of the crenulate scrobiculi adorning the nonscalloped portion of the scutum. Separable from the other species known for the subgenus (but agreeing with the new species next described) by the following: With 2 setae on coxa III; with an intersensillary crater (i.e., a massive scrobiculus between sensillae bases and extending to near anterior margin) (fig. 129, *I.C.*); scutum at its maximum nearly as broad as long; with the eyes contiguous with scutum.

*Description of larva.*—*Body*: Relatively broadly ovate, much rounder than is typical for the genus; 327 x 260 microns in rather engorged holotype. Eyes bordering scutum at level of sensillae; appearing single, posterior eye almost vestigial. *Gnathosoma*: Chelicerae about four times as long as broad at base; with apical tricuspid cap distally acuminate. Palpal formula: *B/b/NNN*. Palpal claw 3-pronged; lateralmost prong two-thirds length of mesal one. *Scutum*: Long, but very broad at apical third; 230 x 203 microns; shaped like a broad flask with subrounded base. Lateral and caudal margins relatively well sclerotized; with a flange of deep scallops set off by transverse striations. The apical scallops about one-fifth or one-sixth the breadth of the scutum. Remainder of scutum with irregular rows of conspicuous crenulate scrobiculi which are four to five times the diameter of the setal bases; the pits distributed equally over entire scutum between level of *SB* and caudal margin. Caudomarginal scrobiculi crowded, smaller, contiguous and indistinct. With an enormous scrobiculus, the intersensillary crater (fig. 129, *I.C.*) dominating the scutal region between and in front of *SB*. Minutely punctate



between pits and on scalloped portion. *AL* setae short, fairly thin, and weakly pinnatifid. *PLs* about subequal to *ALs* and otherwise similar; the distance *A-P* about equal to *AL* and *PL*. *PPL-1* and



FIGS. 125-132.—*Gahrlepiea* (*Gahrlepiea*) *ampullata*, new species.

*PPL-2* resembling *PLs*, but *PPL-2* slightly shorter. Usurped setae fairly well removed from margin. The distance between *PPL-1* and *PPL-2* equal to that between *PPL-1* and *PL*. Sensillary bases at level midway between *AL* and *PL*; inserted on a somewhat semi-circular plate whose anteromesal margins constitute the characteristic antesensillary ridges. Sensillae clavate; somewhat fusiform; about



three and a half times as long as broad, excluding long petiole (dimensions, with petiole: 38 x 9.5 microns). *PPW-1* in holotype is 120; *PPW-2*, 118; *PPP-1*, 127; *PPP-2*, 75. *Body setae*: Dorsal setae

STANDARD MEASUREMENTS IN MICRONS

|                                  | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A.P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa\ II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus\ III}$ |
|----------------------------------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|-----------------------|-----------------|------------------|--------------------------|
| Holotype,<br>No. B-19409-3 ..... | 58        | 96        | 57        | 32         | 197        | 63         | 28        | 50        | 27/30       | 96/70=1.37            | 0.42            | 3.0              | 96/64=1.5                |
| Paratypes (5):                   |           |           |           |            |            |            |           |           |             |                       |                 |                  |                          |
| Mean .....                       | 58        | 98        | 59        | 32         | 196        | 60         | 29        | 55        | 23/32       | 1.40                  | 0.44            | 3.0              | 1.5                      |
| Range + or - .....               | 2         | 4         | 6         | 1          | 8          | 4          | 2         | 5         | 4           | 0.06                  | 0.05            | 0.05             | 0.04                     |

greatly reduced in number, apparently because of enlarged scutum; only 10 in number (excluding those usurped by scutum) and these submarginal, short (20 to 47 microns), sparsely plumed. With only about 34 ventral setae, including about 18 postanals. True ventrals about 24 microns in length, thin and with few pinnae. Sternal setae 2-2. *Legs*: Coxae I and II as in *G. exilis*. Coxa III relatively broad, almost as broad (54 microns) as long (59 microns); with 2 setae, one anteromarginal and sublateral, the second submedian. Sensory setae as typical for genus.

*Type material*.—Holotype (No. B-19409-3) ex *Rattus whiteheadi whiteheadi* Thomas, North Borneo, Mount Kinabalu, Tenompak, elevation 4,500 feet (R. Traub, for joint U. S. Army-Colonial Office Medical Research Unit), August 29, 1953. Four paratypes with same data; a fifth, *ibid.*, but July 16, 1951, and from the same host or from *Rattus cremoriventer kina* Bonhote. Holotype (U.S.N.M. No. 2169) and one paratype deposited in U. S. National Museum. One paratype in collection of Colonial Office Medical Research Unit, Kuala Lumpur. Remainder in collection of senior author.

*Comment*.—The possibility that this is a chigger that burrows into the subcutaneous tissues of the host is discussed after the description of the next species, a true burrowing form.

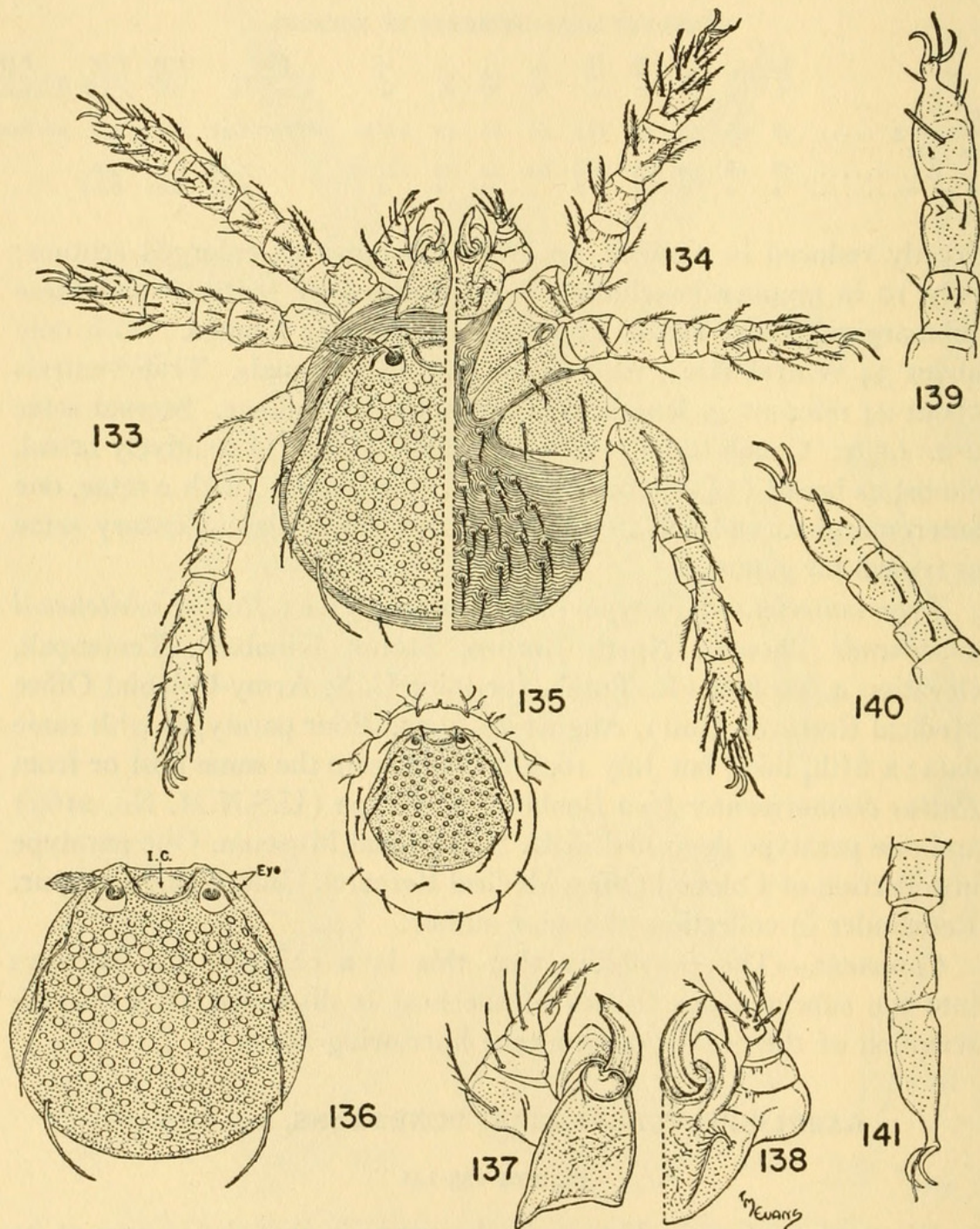
GAHRLIEPIA (GAHRLIEPIA) PENETRANS, new species

Figures 133-141

*Diagnosis of larva*.—Unique in the genus in that the scutum at its maximum is as broad as long, instead of being one and a quarter to two times as long as broad. Separable from known *Gahrлиеpia*, except for *G. (G.) ampullata*, new species, by each of the following: With 2 setae on coxa III; eyes contiguous with scutum; with an intersensillary crater, i.e., a huge scrobiculus extending from level of *SB* to near anterior margin (fig. 136, *I.C.*). Readily distinguishable from



*G. ampullata*, new species, in that the scutum lacks marginal scallops and in that the margins of the scrobiculi are also smooth, not crenulate. Further diagnosed by the spherical body, the presence of 4



FIGS. 133-141.—*Gahrlepiea* (*Gahrlepiea*) *penetrans*, new species.

usurped dorsal setae on scutum submarginal in position; eyes contiguous with scutum and with rounded or ovate scrobiculi, the size of sensillary bases, scattered over much of scutum.

*Description of larva.*—*Body*: Relatively spherical, 258 x 224 microns when moderately engorged. Eyes double; posterior eye greatly



reduced; lying against scutum at anterolateral angles. *Gnathosoma*: Cheliceral bases caudally emarginate and with laterocaudal angles produced, accentuated. Chelicerae about four to five times as long as broad at base; with a distinct apical acuminate cap. Palpal setal formula:  $B/B(b)/NNN$ . Palpal claw 3-pronged. *Scutum*: Long and relatively very broad; about  $165 \times 169$  microns (holotype). Anterior margin slightly concave. Broadest at distal two-fifths; virtually covering entire dorsum in unengorged specimens (as fig. 133). Caudal margin broadly and evenly convex. Lateral margins somewhat sinuate to point of maximum width. The punctations of scutum interspersed among irregular rows of circular or subovate scrobiculi, which are about 80 in number and subequal to sensillary bases. With conspicuous sclerotized lines or seams connecting bases of *ALs* with *PLs* and with first pair of usurped setae. The scrobiculi restricted to that part of the scutum encompassed by these sclerotized lines and by the levels of the usurped setae; evenly scattered within this area; the smaller pits nearer the margins. Region between sutures and true margins of scutum evenly punctate. Intersensillary crater about  $14$  by  $29$  microns. *AL* setae small, not extending beyond posterior margin of crater; thin and weakly pinnatifid; displaced from anterolateral angles and actually somewhat nearer to midline than are *SBs*. *PL* setae submarginal, inserted twice as far from *SB* as are *ALs*; long, with appressed pinnae. *PW* about two and a half times *AW*. First pair of usurped setae somewhat more lateral than *PL* but equidistant from margin or slightly farther from margin, as far from *PL* as is *AL*; midway between *PL* and second pair of usurped setae, which usually is in line with *PL*. Usurped setae morphologically resembling *PLs*. Sensillary bases surrounded by a triangle of ridges, of which lateral ones are best developed. Sensillae clavate, with head about twice as long as broad. *PPW-1* is  $123 (\pm 7)$ ; *PPW-2*,  $119 (\pm 6)$ ; *PPP-1*,  $86 (\pm 5)$ ; *PPP-2*,  $37 (\pm 7)$ . *Body setae*: Dorsal setae reduced in

## STANDARD MEASUREMENTS IN MICRONS

|                                  | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A.P.</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus III}$ |
|----------------------------------|-----------|-----------|-----------|------------|------------|-------------|-----------|-----------|-------------|----------------------|-----------------|------------------|-------------------------|
| Holotype,<br>No. B-19389-5 ..... | 38        | 104       | 51        | 15         | 150        | 49          | 14        | 55        | 23          | $104/73=1.43$        | 0.63            | 6.9              | $104/53=1.96$           |
| Paratypes (18):                  |           |           |           |            |            |             |           |           |             |                      |                 |                  |                         |
| Mean .....                       | 39        | 101       | 51        | 16         | 147        | 46          | 14        | 54        | 24          | 1.45                 | 0.63            | 6.8              | 1.84                    |
| Range + or - .....               | 2         | 4         | 3         | 2          | 6          | 4           | 2         | 3         | 3           | 0.09                 | 0.05            | 0.06             | 0.12                    |

number and size—true dorsals nearly always only 8 in number, but engorged specimens with 4 to 6 additional setae which usually appear marginal but which may actually be dorsal regarding insertion; true dorsals widely separated from one another; less than half length of



scutal setae; thin; very sparsely plumed. With about 42 ventral setae of which about 16 are postanals. True ventrals about 18 to 21 microns in length; thin; pinnae inapparent. *Legs*: Coxal setae all thin, weakly plumed. Coxa III with 2 setae, one near anterolateral angle, the second near base of coxa. Coxa III broad, in ratio of 66 (length) to 59 microns ( $=1.12$ ). First pair of sternal setae with bases almost contiguous, about 28 microns in length. Second pair of sternals at level of coxa III; widely separated so that each is in line with base of coxa II; resembling coxal setae. Sensory setae as in *G. exilis*, new species.

*Type material*.—Holotype (No. B-19389-5) and 55 paratypes (No. B-19389) ex *Rattus whiteheadi whiteheadi* Thomas (completely embedded in female perineum), North Borneo, Mount Kinabalu, Mari Parei, elevation 5,100 feet, August 27, 1953 (R. Traub, for joint U. S. Army-Colonial Office Medical Research Unit). Two paratypes, *ibid.*, but August 25, and recovered by washing the host by a modification of the Lipovsky detergent method (Lipovsky, 1951). One paratype, *ibid.*, but at Tenompak, elevation 4,500 feet, August 29 (along with 5 *G. ampullata*, new species). Holotype (U.S.N.M. No. 2170) deposited in U. S. National Museum. Paratypes distributed as for *G. exilis*, new species.

*Comment*.—It is of interest that this species can burrow completely into the superficial skin tissues of the host. The No. B-19389 series was collected by dissection after noting that the surface of perineum of the rat was pock-marked by a series of smooth pores. The pores were thereupon enlarged by means of fine forceps or dissecting needles and the chiggers were found just below the opening. Except in the instance of unengorged (hence recently attached) chiggers, the chiggers were entirely within the pocket, and no part of the body protruded through the aperture. If present, the chiggers were solitary within these pockets. Many of the larger pores led to empty pockets, indicating that the chiggers had emerged. This burrowing phenomenon has not been noted for any other species of chigger by the American and British field teams in Assam, Burma, Malaya, or Borneo, and this is apparently the first report of a chigger which may characteristically burrow into mammalian tissues.<sup>10</sup> It is obvious, however, that a chigger that penetrates into the tissues of a host may readily escape detection, and other such species may in reality be common in nature. In this regard it should be pointed out that subsequent to the

<sup>10</sup> *Apolonia tigipioensis* Torres and Braga, 1939, penetrates the quills of South American birds and has been once reported as having entered the skin on the buttocks of a human in Brazil (Carneiro, 1949).



discovery of the burrowing habit of *G. penetrans*, new species, particular attention was paid to examining the perinea of Borneo rats, squirrels, and other hosts by means of the stereoscopic microscope. Despite the examination of 150 such mammals from Mari Parei, Tenompak, and Ranau, no such overt lesions were observed and no further specimens were collected other than the type series.

*G. penetrans*, new species, exhibits some noteworthy morphological modifications that are characteristic of the species and rare or absent in other members of the subgenus. These are: (1) The body is quite rounded, virtually as broad as long even when rather engorged. (2) The eyes appear single and are contiguous with the scutum. (3) The laterocaudal angles of the cheliceral bases are prominently developed. (4) *PW* is two and a half times that of *AW*, instead of being about twice that. (5) The ratio of *PW* to *ASB* is 6.8 instead of the usual 2-3 (with a maximum of 5) in other species. (6) The reduction in the number and size of the dorsal setae. (7) Two-setose coxa III. The first six of these modifications may be adaptations in connection with, or as a result of, its burrowing habit. The stout body of this chigger and its locus in superficial skin layers is reminiscent of the engorged burrowing chigoe flea, *Tunga penetrans*. In each parasite, advantage is in effect taken of the physical principle that the ratio of surface area to volume is a minimum in a sphere. In other words, a spherical parasite packs the greatest possible volume in the smallest possible area, thus mechanically traumatizing the host the least, provided the parasite is stationary when in situ, as in these instances. Certain of these modifications are expressions of, or are concomitant with, the development of a spherical shape, i.e. (4) and (5), inasmuch as a broad *PW* is to be expected in a stout species. Loss of bristles, or reduction in their size, is characteristic of other ectoparasites with a burrowing or semisedentary habit, as exemplified by the tungid and hectopsyllid fleas.

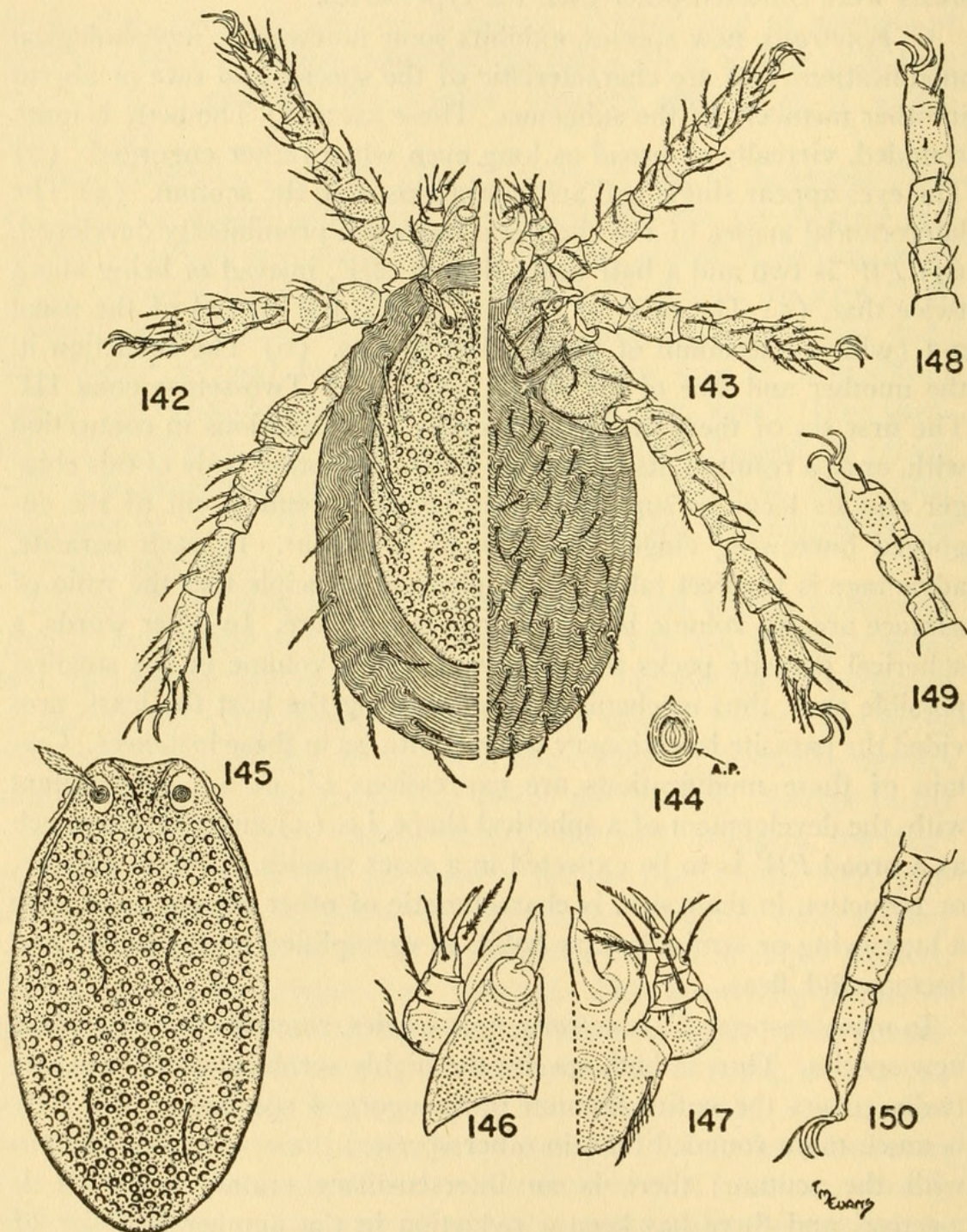
In many respects *G. penetrans*, new species, resembles *G. ampullata*, new species. Thus in both species the highly scrobiculate scutum virtually covers the entire dorsum in unengorged specimens; the body is much more rounded than in other species; the eyes are contiguous with the scutum; there is an intersensillary crater; coxa III is 2-setose, and there has been a reduction in the number and size of dorsal setae as compared with others in the subgenus. *G. ampullata* has been collected only twice, despite extensive trapping of the type host in the type locality. It is possible that it, too, is a burrowing species and hence has been overlooked.



**GAHRLIEPIA (GAHRLIEPIA) GRANULATA, new species**

Figures 142-150

*Diagnosis of larva.*—Separable from other scrobiculate species in the subgenus that have 4 usurped dorsal setae on the scutum by the



FIGS. 142-150.—*Gahrlepiea (Gahrlepiea) granulata*, new species.

fact that the scrobiculi are almost uniformly scattered over the dorsal surface of the scutum and range from the size of the setal bases to that of the sensillary bases. Agrees with *G. (G.) tuberculata*, *G. (G.)*



*penetrans*, and *G. (G.) ampullata*, new species, in that *PW* is over 90 instead of below 80 as in other species. Nearest to *G. tuberculata* but significantly differs as follows: Although *AW* is approximately the same in both species, *ASB* 25 or greater in *granulata*, not approximately 18; *AL* over 40, not 18; *PL* over 60, not merely less than 40; *PSB* approximately 300, not 215. The long ovate scutum immediately distinguishes this species from *G. penetrans* and *G. ampullata* (cf. figs. 129, 136, and 145).

*Description of larva.*—*Body*: Subovate, about 473 x 252 microns in engorged holotype. Eyes double; anterior eye the larger. Chelicerae about three and a half times as long as broad at base; with a distinct distal tricuspid cap. Palpal setal formula: *B/B/NNf*. Palpal claw 3-pronged but usually appearing 2-pronged. *Scutum*: Long, ovate, about 329 x 182 microns in holotype. Anterior margin concave between *ALs*. Lateral margins slightly sinuate to level of *PLs*; remainder evenly but shallowly convex. Posterior margin short; convex. Interspersed among micropunctae is a fairly uniformly distributed series of subequal ovate scrobiculi most of which are about the size of sensillary bases; marginal craters or pits slightly larger than medial ones. Virtually entire scutal surface thus appearing granulated (although in reality pitted) or shagreened. The scrobiculi fewest in number in the region between the usurped setae and the group along lateral margins of the scutum. *AL* setae somewhat removed from anterolateral angles to a point just mesad to sensillary bases; stout and plumose but barbs short. *PL* setae similar but about one and a third times as long; inserted slightly farther from *SB* than are *ALs*; well lateral to level of *ALs*. Usurped setae roughly in line with *ALs*; first pair inserted approximately at anterior third of scutum; second pair slightly caudad of posterior third; each about 47 microns long, with pinnae appressed. With ridges anterior to sensillae bases. Sensillae clavate, about 49 x 9 microns. Sensillary area free of punctae and scrobiculi. *PPW-1* is 68 ( $\pm 8$ ); *PPW-2*, 70 ( $\pm 5$ ); *PPP-1*, 210

STANDARD MEASUREMENTS IN MICRONS

|                              | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A-P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa\ II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus\ III}$ |
|------------------------------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|-----------------------|-----------------|------------------|--------------------------|
| Holotype,<br>No. B-196001 .. | 44        | 100       | 55        | 25         | 304        | 49         | 47        | 63        | 82 & 50     | 100/80=1.25           | 0.3             | 4.0              | 100/88=1.14              |
| Paratypes (2):               |           |           |           |            |            |            |           |           |             |                       |                 |                  |                          |
| Mean .....                   | 45        | 101       | 55        | 26         | 302        | 47         | 46        | 64        | 80 & 48     | 1.26                  | 0.3             | 3.9              | 1.05                     |
| Range + or -...              | 1         | 2         | 3         | 1          | 5          | 2          | 3         | 3         | 5 & 4       | 0.03                  | 0.03            | 0.1              | 0.09                     |

( $\pm 10$ ); *PPP-2*, 102 ( $\pm 12$ ). *Body setae*: Dorsal setae of two types—a line of 4 or 5 single large, stout setae bordering each side of middle third of scutum, about 80 microns in length; the remainder more



caudad and distant from scutum; about 50 microns and proportionately thinner. Dorsal setae about 28 in number; single or not arranged in rows except for those posterior to scutum, and those in 2 or 3 irregular rows. With about 62 ventral setae of which about 24 are postanals. True ventrals about 28 microns; thin; very sparsely plumed. With a suggestion of a small, ovate anal plate about  $28 \times 19$  microns (fig. 144, *A.P.*) surrounding the chitinized anal ring. *Legs*: As in *G. exilis*, new species, but with coxa III much broader, ratio of length to breadth 90 to 75 microns = 1.2 (as measured to apex of caudolateral flange or lobe). Sternal and sensory setae essentially as in *G. exilis*.

*Type material*.—Holotype (No. B-19601) and one paratype ex *Rattus alticola alticola* Thomas, North Borneo, Mount Trus Madi, Pamang, Ulu Kaingaran, 4,000 feet elevation, July 18, 1953 (J. R. Audy, for joint U. S. Army-Colonial Office Medical Research Unit). Sixteen other paratypes from Mount Kinabalu, Tenompak, 4,200-4,500 feet elevation; 11 of these ex 4 *Rattus a. alticola*, August 12-21, 1953 (R. Traub); 1 ex *Rattus whiteheadi whiteheadi* Thomas, August 21; 1 ex *Rattus* sp., September 1, 1953 (R. Traub); 2 ex *Rattus a. alticola*, August 25 (H. D. Newson and B. C. Walton); 1 ex *Rattus a. alticola*, August 8 (Phang Ang Wah). Holotype (U.S.N.M. No. 2171) and one paratype deposited in U. S. National Museum. One paratype in collection of Colonial Office Medical Research Unit, Kuala Lumpur, and others in that of senior author or distributed among various acarological collections.

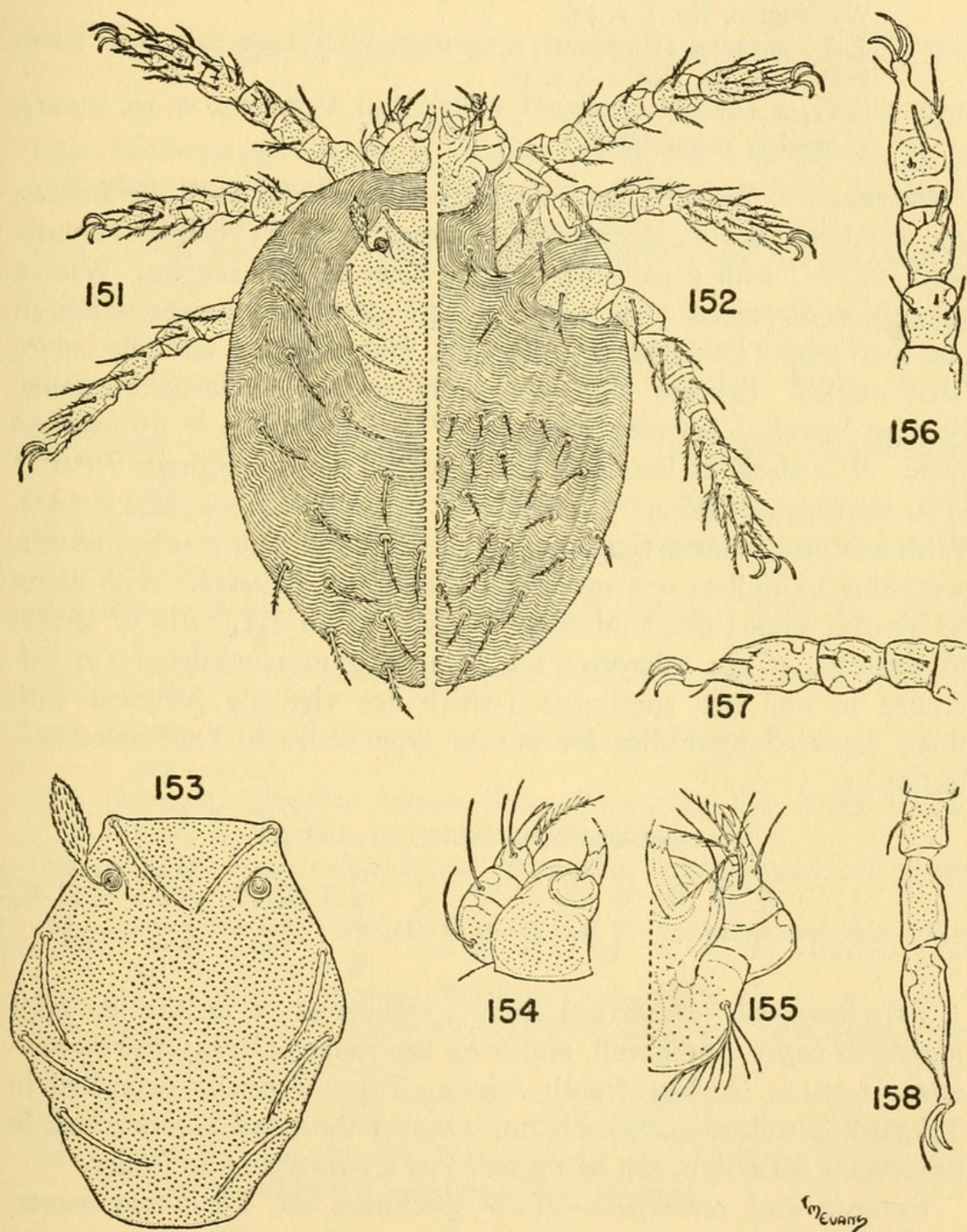
#### GAHRLIEPIA (GAHRLIEPIA) NANUS (Oudemans, 1910)

Figures 151-158

- 1910. *Typhlothrombium nanus* OUDEMANS, Ent. Ber. Amsterdam, vol. 3, No. 56, p. 105.
- 1911. *Typhlothrombium nanus* OUDEMANS, Oudemans, Ent. Ber. Amsterdam, vol. 3, No. 57, p. 122.
- 1912. *Typhlothrombium nanus* OUDEMANS, Oudemans, Zool. Jahrb., Suppl. 14, Heft 1, pp. 83-86, 192, 203, fig. U.
- 1930. *Typhlothrombium nanus* OUDEMANS, Stiles and Nolan, Nat. Inst. Health Bull. 155, pt. 1, p. 640.
- 1931. *Gahrlepiea nana* (OUDEMANS), Vitzthum, Zeitschr. Parasitenk., vol. 4, No. 1, p. 7.
- 1938. *Gahrlepiea nanus* (OUDEMANS), Ewing, Journ. Washington Acad. Sci., vol. 28, No. 6, pp. 291-292.
- 1939. *Gahrlepiea nanus* (OUDEMANS), Abdussalam, Indian Journ. Ent., vol. 1, No. 3, pp. 83-86.
- 1940. *Gahrlepiea nanus* (OUDEMANS), Gunther, Proc. Linn. Soc. New South Wales, vol. 65, pts. 5-6, Nos. 291-292, p. 481.



1942. *Gahrlepiea nanus* (OUDEMANS), Radford, Parasitol., vol. 34, No. 1, p. 64, fig. 33.  
 1943. *Gahrlepiea nanus* (OUDEMANS), Womersley and Heaslip, Trans. Roy. Soc. South Australia, vol. 67, No. 1, pp. 136, 138.



FIGS. 151-158.—*Gahrlepiea* (*Gahrlepiea*) *nanus* (Oudemans, 1910).

1945. *Gahrlepiea nana* (OUDEMANS), Buitendijk, Zool. Meded., vol. 24, p. 337.  
 1947. *Gahrlepiea nanus* (OUDEMANS), Sig Thor and Willmann, Trombidiidae, Das Tierreich, Lfg. 71b, p. 333, fig. 398, a, b, c.  
 1948. *Gahrlepiea nanus* (OUDEMANS), Fuller, Bull. Brooklyn Ent. Soc., vol. 43, No. 4, p. 109.



1949. *Gahrlepiea nanus* (OUDEMANS), Lawrence, Ann. Natal Mus., vol. 11, No. 3, pp. 409, 469.  
 1951. *Gahrlepiea nanus* (OUDEMANS), Lawrence, Ann. Natal Mus., vol. 12, No. 1, p. 117.  
 1952. *Gahrlepiea nana* (OUDEMANS), Wharton and Fuller, Mem. Ent. Soc. Washington, No. 4, p. 93.  
 1952. *Gahrlepiea nanus* (OUDEMANS), Gunther, Proc. Linn. Soc. New South Wales, vol. 77, Nos. 1-2, p. 46.  
 1952. *Gahrlepiea nanus* (OUDEMANS), Fuller, Zool. Verh., No. 18, pp. 213-214. (Complete redescription.)

*Diagnosis of larva.*—The only known *Gahrlepiea* with the following combination of characters: Coxae 1-setose; palpal formula  $N/N/NNN$ ; with 2 pairs of usurped setae on the scutum. With a suggestion of paired eyes, according to Fuller, but no eyes visible in our specimens. Palpal claw 3-pronged. Palpal femur laterally somewhat angled. Scutum with uniformly scattered micropunctations. Scutum broadest between levels of *PLs* and first pair of usurped setae. *ALs* about as long as *PLs*. Usurped setae marginal. *PPW-1* is 84 microns; *PPW-2*, 65; *PPP-1*, 65; *PPP-2*, 54; sensillae clavate. With 24 dorsal setae arranged 2.2.4.6.4.4.2 (excluding usurped setae), according to Fuller; our specimens with 28 to 30 setae. With about 38 ventral setae; these minutely barbed. Coxa III, ratio of length to breadth, 46:34 microns=1.3. Standard measurements (in microns) of our two specimens (which are virtually identical with those reported by Fuller for one of type series in Oudemans collection):

STANDARD MEASUREMENTS IN MICRONS

|             | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A-P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus III}$ |
|-------------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|----------------------|-----------------|------------------|-------------------------|
| Mean .....  | 43        | 74        | 38        | 17         | 92         | 36         | 29        | 22/35     | 20          | 1.6                  | 0.67            | 4.4              | 1.37                    |
| Range ..... | 2         | 2         | 3         | 3          | 1          | 1          | 3         | ...       | ..          | 0.07                 | 0.02            | 0.8              | 0.02                    |

*Type material.*—Described from 3 specimens—I ex the bat *Hipposideros caffer* Sundewall, and 2 ex the rodent *Georhynchus hottentottus* Lesson, Durban, South Africa. Type originally deposited in Trägårdh's collection, Stockholm. One of these, ex *Georhynchus*, in Oudemans collection, can be regarded as a paratype, fide Fuller.

*Records and comments.*—Two specimens ex *Thallomys namaquensis* (a rodent), South Africa, Johannesburg, February 5, 1950 (received from Dr. F. Zumpt, through courtesy of Dr. J. R. Audy).

This species, the genotype, is the only one in the subgenus collected from a bat. However, two of the original specimens were from a rodent, as were ours. The specimens from *Thallomys* agree with the published figures and descriptions in all significant respects. How-



ever, Oudemans states that the sternal setae and coxal setae are nude. Fuller verifies this, but points out that he believes the nude condition is apparent, rather than real, and due to trauma. These bristles bear pinnae in our specimens.

**GAHRLIEPIA (GAHRLIEPIA) FLETCHERI** Gater, 1932

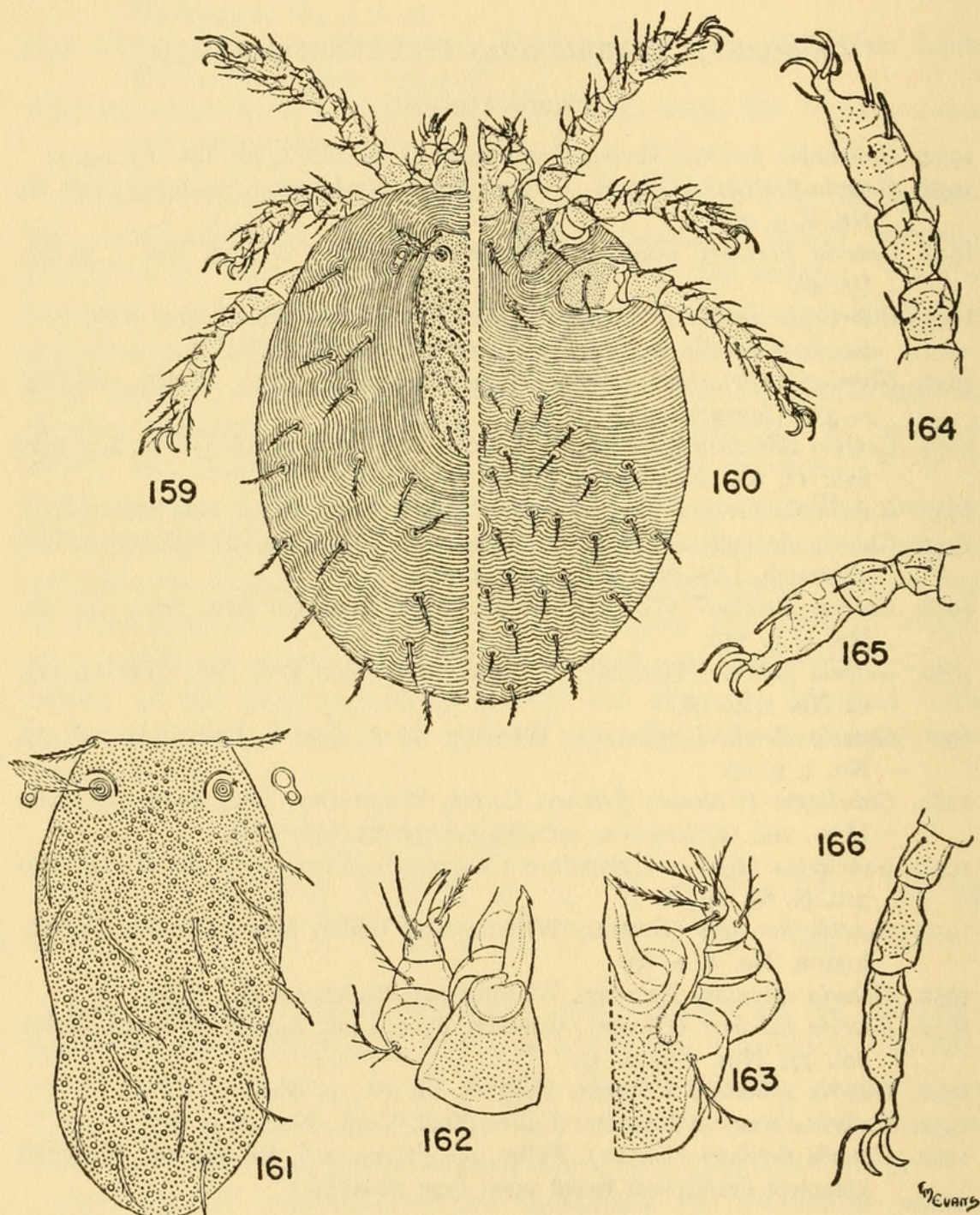
Figures 159-163

- 1932. *Gahrlipeia fletcheri* GATER, Parasitol., vol. 24, No. 2, pp. 161-163, fig. 9.
- 1938. *Gateria fletcheri* (GATER), Ewing, Journ. Washington Acad. Sci., vol. 28, No. 6, p. 295.
- 1942. *Gateria fletcheri* (GATER), Radford, Parasitol., vol. 34, No. 1, p. 67, fig. 48.
- 1943. *Gahrlipeia fletcheri* GATER, Womersley and Heaslip, Trans. Roy. Soc. South Australia, vol. 67, No. 1, pp. 138, 140, pl. 13, fig. 3.
- 1945. *Gahrlipeia fletscheri* (sic!) GATER, Buitendijk, Zool. Meded., vol. 24, p. 337 (lapsus).
- 1946. *Gateria spinulosa* RADFORD, Proc. Zool. Soc. London, vol. 116, pt. 2, p. 252, figs. 11, 12. New synonymy.
- 1947. *Gahrlipeia fletcheri* GATER, Audy, Nature, London, vol. 159, pp. 295-296.
- 1947. *Gateria fletcheri* (GATER), Sig Thor and Willmann, Trombidiidae, Das Tierreich, Lfg. 71b, p. 339, fig. 405.
- 1948. *Gateria fletcheri* (GATER), Fuller, Bull. Brooklyn Ent. Soc., vol. 43, No. 4, p. 110.
- 1950. *Gateria fletcheri* (GATER), Radford, Int. Union Biol. Sci. (Paris), ser. C, No. 1, p. 98.
- 1951. *Gateria fletcheri* (GATER), Wharton et al., Journ. Parasitol., vol. 37, No. 1, p. 27.
- 1952. *Gahrlipeia* (*Gateria*) *fletcheri* GATER, Womersley, Rec. South Australia Mus., vol. 10, Nos. 1-2, pp. 285, 311, pl. 83, figs. F-H.
- 1952. *Gahrlipeia* (*Gateria*) *spinulosa* (RADFORD), Womersley, op. cit., pp. 309-310, pl. 83, fig. E.
- 1952. *Gateria fletcheri* (GATER), Wharton and Fuller, Mem. Ent. Soc. Washington, No. 4, p. 93.
- 1952. *Gateria spinulosa* RADFORD, Wharton and Fuller, op. cit., p. 94.
- 1952. *Gateria fletcheri* (GATER), Gunther, Proc. Linn. Soc. New South Wales, vol. 77, Nos. 1-2, p. 47.
- 1952. *Gateria spinulosa* RADFORD, Gunther, op. cit., p. 48.
- 1952. *Gateria spinulosa* RADFORD, Fuller, Zool. Verh., No. 18, p. 217.
- 1952. *Gateria fletcheri* (GATER), Fuller, op. cit., pp. 216, 218, fig. 7d. (Includes complete description based upon type material.)

*Diagnosis of larva.*—A nonscrobiculate species which is highly variable regarding standard measurements and chaetotaxy. Palpal formula  $B/B/NNb(N)$ . Palpal claw 3-pronged. Eyes double. With 10 to 17 (usually 12 or 13, rarely more than 14) usurped setae on scutum; most of these nonmarginal and arranged in 3 or 4 highly irregular rows. First row of usurped setae definitely caudad to line



of *PLs*. Scutum about one and nine-tenths times as long as broad at maximum. With 2 types of pits on scutum: one the size of setal bases, evenly distributed beyond *PLs*, and the second type consisting



FIGS. 159-166.—*Gahrlepiea* (*Gahrlepiea*) *fletcheri* Gater, 1932.

of scattered minute punctae. With 26 to 32 dorsal setae (excluding usurped setae), often arranged 2.4.4.6.6.4, the rest irregular. About 50 to 60 ventral setae present, including 20 to 26 postanals. The ratio of length to breadth of coxa III is 23 to 20 = 1.15. Coxae I-setose.



## STANDARD MEASUREMENTS IN MICRONS

|                 | AW | PW | SB | ASB | PSB | A-P | AL | PL | D.S. | $\frac{PW}{Coxa II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus III}$ |
|-----------------|----|----|----|-----|-----|-----|----|----|------|----------------------|-----------------|------------------|-------------------------|
| Holotype *      | 53 | 78 | 48 | 22  | 160 | 42  | 35 | 38 | 35   | ...                  | 0.43            | 3.6              | ...                     |
| 50 specimens: † |    |    |    |     |     |     |    |    |      |                      |                 |                  |                         |
| Mean            | 48 | 73 | 44 | 21  | 144 | 37  | 32 | 34 | 33   | $72/53=1.34$         | 0.44            | 3.47             | 1.4                     |
| Range + or -    | 6  | 10 | 7  | 4   | 22  | 6   | 6  | 6  | 5    | 0.09                 | 0.05            | 0.3              | 0.07                    |

\* After Fuller, 1952.

† Based upon material from Malaya (including 5 paratypes), Assam, and Burma.

*Type material.*—Ex *Rattus rattus diardi* (Jentink) (equals *Rattus rattus argentiventer*, partim?—vide Harrison and Audy, 1951), Malaya, Selangor. "Holotype, No. 1932-7-18-22 and paratypes Nos. 1932-7-18-23 and 24 in the British Museum (Natural History); paratypes in the United States National Museum (two specimens, both No. 1056); Molteno Institute, Cambridge, England; King Edward VII College of Medicine, Singapore; and Rijksmuseum van Natuurlijke Historie, Leiden" (Fuller, 1952).

*Comment and records.*—The measurements for Assam and Burma specimens usually were 3 microns less than the mean cited in the above table. However, such specimens were otherwise indistinguishable from typical Malayan *G. fletcheri*, and occasionally large Assam-Burma individuals and small Malayan ones were noted. All extremes encountered were, therefore, considered merely variants of *G. fletcheri*.

Gater (1932) pointed out that *G. fletcheri* is very variable morphologically, and stated "since the extremes of variation can be found among specimens of the same cluster and in some cases in the same individual, it would be unjustifiable to form more than one species." Some extent of the individual differences encountered by us can be judged by the range cited in the table of standard measurements above. This surprising variability, fully demonstrable only when long series of specimens are available for study, is believed to have led Womersley (1952) and Radford (1946) astray. The differences Womersley cites (p. 310) to separate *G. fletcheri* and *G. spinulosa* do not hold, because even paratype *G. fletcheri* often have the scutal shape and arrangement and number of scutal setae ascribed to Malayan "*spinulosa*." Radford apparently described *G. spinulosa* on the basis of one specimen, and there is nothing in the description or measurements to separate this specimen from *G. fletcheri* as we now know it. Fuller (1952) examined the type of each species but discussed only *G. fletcheri*. In his key to *Gateria* he treats *G. spinulosa* as a valid species, separating it from *G. fletcheri* by virtue of the scutum's bearing only minute punctae instead of the two types found in *G. fletcheri*. An examination of Fuller's manuscript notes reveals



no further distinctions. The absence of the larger pits may indeed prove to be a valid character for establishing *G. spinulosa* as a true species. However, the secondary scutal pits of *G. fletcheri* are often very difficult to see, and at times show up only in freshly mounted specimens. All the Burma specimens, as well as those from Malaya, possessed pits the size of setal pores, in addition to punctae, and hence could not be *G. spinulosa*. (Such pits were always absent in the related *G. darita*, new species, which is also separable on other grounds.) For these reasons *G. spinulosa* is considered a synonym of *G. fletcheri*.

Gater, at the time of the original description, listed the following hosts, all from Selangor during the months March through November, 1929: *Rattus rattus diardi* (= *Rattus rattus argentiventer*, at least in part) at Kuala Lumpur; "*Rattus sabanus vociferans* Miller," "*Sciurus caniceps concolor* Blyth" (= *Callosciurus*), *Tupaia glis ferruginea* and *Rhinosciurus tupaoides laticaudatus* (Blyth) (as *tupaoides*, sic!) at Sungei Buloh. The U. S. Army Medical Research Unit's records are as follows: In the primary forest of Ulu Langat, 20 miles east of Kuala Lumpur, 14 specimens ex 4 *Rattus sabanus* (Thomas). In the primary forest of Ulu Gombak, 16 miles north of Kuala Lumpur, 24 specimens ex one *Rattus canus malaisia* Kloss, 1 from *Rattus mülleri* (Jentink), and 1 from *Tupaia minor* Gunther. In the scrub terrain of Sungei Way, 8 miles southwest of Kuala Lumpur, 13 ex a single *Rattus exulans concolor* (Blyth) and 2 from *Rattus rattus argentiventer* (Robinson and Kloss). The Colonial Office Medical Research Unit has records as follows: 1 ex *Rattus bowersi* (Anderson) and 3 ex *Tupaia glis* (Diard) at Ulu Langat. *G. fletcheri* was therefore collected on a variety of small mammals in Malaya in both primary forest and secondary vegetation. Both Gater's and our records indicate no seasonal preference, for it was found during rainy months as well as during the short relatively dry spells.

*Gahrliepia* (*G.*) *fletcheri* was collected by the U. S. A. Typhus Commission in Assam and North Burma on only 63 occasions out of a total of 1,400 mammals and 260 birds examined in the period December 1944 to December 1945. In all, 249 specimens were collected. As a rule *G. fletcheri* constituted from 5 to 20 percent of the chiggers examined in these instances, but rarely as many as 40 to 50 percent of the chiggers on a shrew belonged to this species. The hosts and general locality distribution are listed in table 1.

Approximately one-fourth of the hosts were captured in true primary forest and the remainder in secondary or scrub growth. Almost one-third, i.e., 19, of the mammals carrying *G. fletcheri* were collected in the dry season, but 16 of the hosts were taken during the height



of the rainy season. In summary it may be said that in North Burma and Assam this species was collected relatively infrequently, but only from mammals, and that it exhibited little definite ecological preference as concerns type of terrain or season, and it was taken in all three of the geographical areas studied. Virtually half of the records were from real shrews or tree shrews.

TABLE I.—*Hosts and general locality distribution of Gahrлиеpia (G.) fletcheri*

| Host                                                 | Geographical location |              |           |
|------------------------------------------------------|-----------------------|--------------|-----------|
|                                                      | Ledo                  | Shingbuiyang | Myitkyina |
| "Shrew" .....                                        | I                     |              | I         |
| <i>Crocidura vorax</i> G. M. Allen.....              |                       | 2            |           |
| <i>Suncus caeruleus fulvocinereus</i> (Anderson) ..  | 14                    | 4            |           |
| <i>Tupaia belangeri versurae</i> Thomas.....         | I                     | 2            | 6         |
| "Rat" .....                                          |                       |              | I         |
| <i>Rattus f. fulvescens</i> (Gray).....              |                       | I            | 3         |
| <i>Rattus flavipectus yunnanensis</i> (Anderson) ... | I                     | 4            |           |
| <i>Rattus rattus sladeni</i> (Anderson).....         |                       | 14           | 8         |
| Total number collections.....                        | 17                    | 27           | 19        |

Gater called attention to the reluctance of *G. fletcheri* to leave its host, and stated that it was "the only [chigger] found on some rats which had been dead for twelve hours or more when received." This observation was often repeated in Burma and Malaya. In fact *G. fletcheri* would often stay attached to the ears and legs of rats which had been severed and placed in the refrigerator for 48 to 72 hours.

GAHRLIEPIA (GAHRLIEPIA) CETRATA Gater, 1932

Figures 167-169

1932. *Gahrлиеpia cetrata* GATER, Parasitol., vol. 24, No. 2, pp. 165-167, fig. 12.  
1942. *Gahrлиеpia cetrata* GATER, Radford, Parasitol., vol. 34, No. 1, p. 64, fig. 35.  
1943. *Gahrлиеpia cetrata* GATER, Womersley and Heaslip, Trans. Roy. Soc. South Australia, vol. 67, No. 1, pp. 138, 140, pl. 13, fig. 1.  
1945. *Gahrлиеpia cetrata* GATER, Buitendijk, Zool. Meded., vol. 24, p. 336.  
1947. *Gahrлиеpia cetrata* GATER, Sig Thor and Willmann, Trombidiidae, Das Tierreich, Lfg. 71b, pp. 333-334, fig. 399.  
1948. *Gahrлиеpia cetrata* GATER, Fuller, Bull. Brooklyn Ent. Soc., vol. 43, No. 4, p. 109.  
1952. *Gahrлиеpia (Gahrлиеpia) cetrata* GATER, Womersley, Rec. South Australia Mus., vol. 10, Nos. 1-2, pp. 283, 304, pl. 82, fig. A.  
1952. *Gahrлиеpia cetrata* GATER, Wharton and Fuller, Mem. Ent. Soc. Washington, No. 4, p. 93.  
1952. *Gahrлиеpia cetrata* GATER, Gunther, Proc. Linn. Soc. New South Wales, vol. 77, Nos. 1-2, p. 46.  
1952. *Gahrлиеpia cetrata* GATER, Fuller, Zool. Verh., No. 18, pp. 215-216. (Complete redescription based upon holotype and three paratypes.)



*Diagnosis of larva.*—A nonscrobiculate species with 2 pairs of submarginal or submedial usurped setae on the scutum. Palpal setal formula  $B/N(b)/NNF$ . Palpal claw 3-pronged. Two pairs of eyes but these somewhat reduced.  $PPL-1$  almost midway between  $PL$  and  $PPL-2$  but nearer  $PL$ s.  $PPL-2$  midway between posterior margin of scutum and  $PPL-1$ .  $PPW-1$  is 53 microns ( $\pm 3$ );  $PPW-2$ , 41 ( $\pm 8$ );  $PPP-1$ , 109 ( $\pm 7$ );  $PPP-2$ , 59 ( $\pm 4$ ). Scutum about one and nine-tenths times as long as broad at maximum. With two types of pits on scutum: one slightly smaller than setal bases, evenly distributed beyond sensillary bases; and the second type consisting of scattered minute punctae. With about 32 dorsal setae (excluding usurped setae) usually arranged 2.4.4.6.6.4.4.2. With about 50 to 60 ventral abdominal setae, including approximately 20 postanals. Coxae 1-setose. The ratio of length to breadth of coxa III is 1.42.

STANDARD MEASUREMENTS IN MICRONS

|              | $AW$ | $PW$ | $SB$ | $ASB$ | $PSB$ | $A-P$ | $AL$ | $PL$ | $D.S.$ | $\frac{PW}{Coxa II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus III}$ |
|--------------|------|------|------|-------|-------|-------|------|------|--------|----------------------|-----------------|------------------|-------------------------|
| Holotype *   | 51   | 77   | 48   | 24    | ...   | 40    | 32   | 42   | ...    | ...                  | ...             | ..               | ...                     |
| Others:      |      |      |      |       |       |       |      |      |        |                      |                 |                  |                         |
| Mean         | 49   | 80   | 47   | 23    | 166   | 39    | 35   | 43   | 39-44  | $80/58=1.4$          | 0.44            | 3.5              | 1.32                    |
| Range + or - | 4    | 5    | 3    | 2     | 10    | 3     | 3    | 6    | 5      | 0.08                 | 0.05            | 0.2              | 0.10                    |

\* After Fuller, 1952.

*Type material.*—Holotype and 12 paratypes ex "*Rattus edwardsi ciliatus* Bonhote," Malaya, Pahang, Fraser's Hill, elevation 4,500 feet. According to Fuller (1952), "Holotype No. 1932-7-18-19 and two paratypes, Nos. 1932-7-18-20 and 21, in British Museum (Natural History). Paratypes . . . also in . . . U. S. National Museum; the Molteno Institute, Cambridge, England; King Edward VII College of Medicine, Singapore; and the Rijksmuseum van Natuurlijke Historie, Leiden."

*Records and comment.*—One specimen ex *Rattus edwardsi*, Malaya, Pahang, Fraser's Hill, elevation 4,500 feet (R. Traub, for U. S. Army Medical Research Unit), January 3, 1950. Five ex *Rattus sabanus*, Malaya, Selangor, Ulu Langat, in primary forest at approximately 2,500 feet elevation; Colonial Office Medical Research Unit, January 15, 1952. One ex *Rattus mülleri*, *ibid.*, but August 5, 1952.

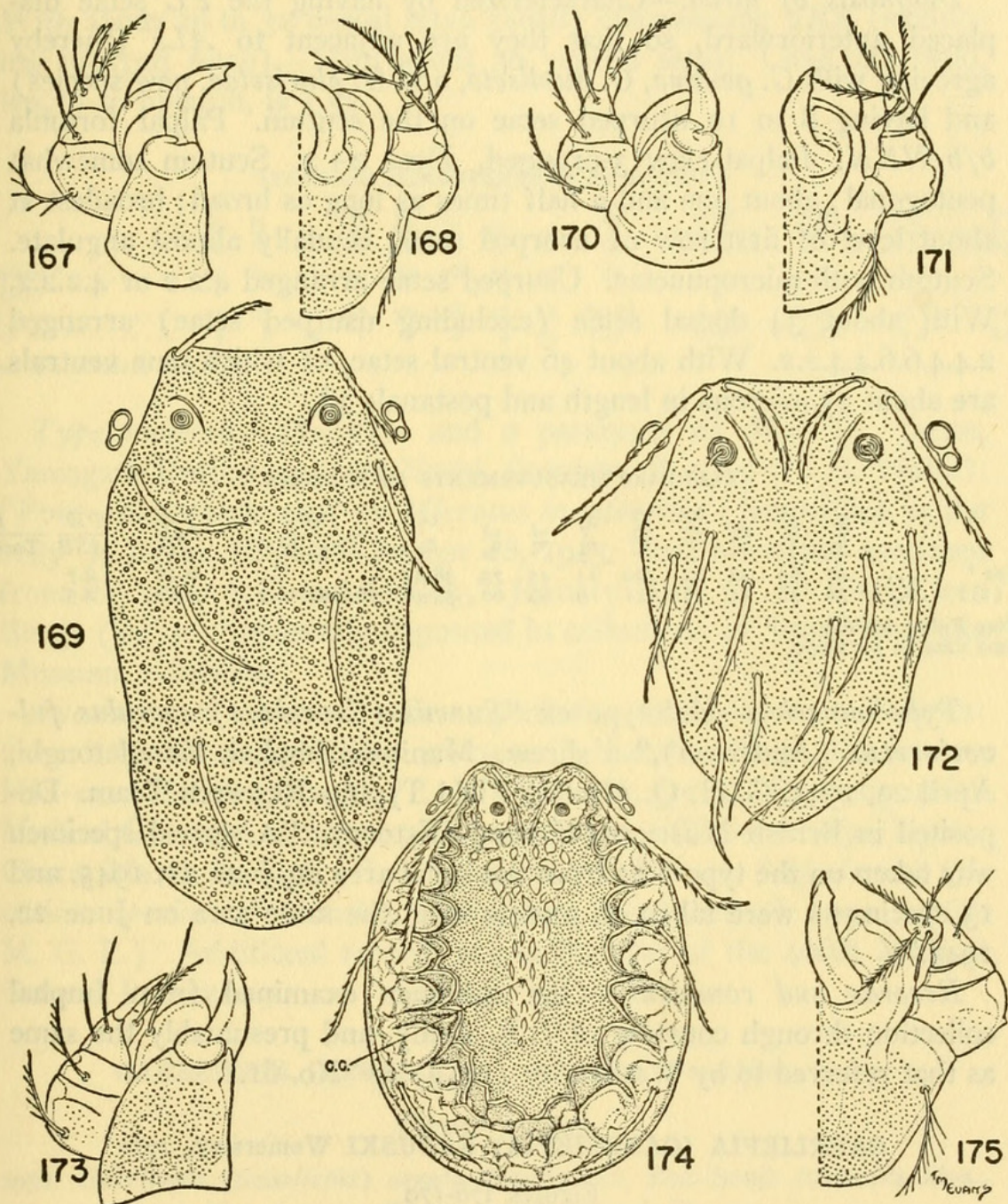
These are the first records since the original description. As can be seen from the records, this species seems to be a characteristic inhabitant of the mountain forests of Malaya. Despite intensive collecting by the Colonial Office Medical Research Unit and the U. S. Army Medical Research Units in the vicinity of Kuala Lumpur, this species has not been encountered in scrub terrain.



**GAHRLIEPIA (GAHRLIEPIA) HIRSUTA (Radford, 1946)**

Figures 170-172

1946. *Gateria hirsuta* RADFORD, Proc. Zool. Soc. London, vol. 116, No. 2, pp. 249, 252, figs. 5-6.



FIGS. 167-169.—*Gahrlepiea* (*Gahrlepiea*) *cetrata* Gater, 1932.

FIGS. 170-172.—*Gahrlepiea* (*Gahrlepiea*) *hirsuta* (Radford, 1946).

FIGS. 173-175.—*Gahrlepiea* (*Gahrlepiea*) *ornata* Womersley, 1952.

1947. *Gateria hirsuta* RADFORD, Lawrence, in Audy et al., War Office, Army Medical Directorate 7, appendix 7, p. 5.

1952. *Gahrlepiea* (*Gateria*) *hirsuta* (RADFORD), Womersley, Rec. South Australia Mus., vol. 10, Nos. 1-2, pp. 305, 306, pl. 82, figs. B-D.



1952. *Gateria hirsuta* RADFORD, Wharton and Fuller, Mem. Ent. Soc. Washington, No. 4, p. 94.  
 1952. *Gateria hirsuta* RADFORD, Gunther, Proc. Linn. Soc. New South Wales, vol. 77, Nos. 1-2, p. 47.  
 1952. *Gateria hirsuta* RADFORD, Fuller, Zool. Verh., No. 18, p. 217.

*Diagnosis of larva.*—Characterized by having the *PL* setae displaced anteriorward, so that they are adjacent to *ALs* (thereby agreeing with *G. gemina*, *G. dupliseta*, and *G. plurisetæ*, new species) and having 8 to 10 usurped setae on the scutum. Palpal formula *b/b/NNN*. Palpal claw 3-pronged. Eyes 2+2. Scutum somewhat pentagonal; about one and a half times as long as broad; broadest at about level of first row of usurped setae, caudally almost angulate. Scutum with micropunctae. Usurped setae arranged 4.2.2 or 4.2.2.2. With about 34 dorsal setae (excluding usurped setae) arranged 2.4.4.6.6.4.4.2.2. With about 46 ventral setae, of which true ventrals are about 23 microns in length and postanals 38.

## STANDARD MEASUREMENTS IN MICRONS

|            | AW | PW | SB | ASB | PSB | A-P | AL | PL | D.S.  | $\frac{PW}{\text{Coxa II}}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{\text{Tarsus III}}$ |
|------------|----|----|----|-----|-----|-----|----|----|-------|-----------------------------|-----------------|------------------|--------------------------------|
| Holotype * | 41 | 60 | 46 | 22  | 122 | 11  | 45 | 72 | 38-45 |                             |                 |                  |                                |
| Other (1)† | 38 | 56 | 44 | 23  | 111 | 9   | 39 | 60 | 35-46 | 56/103=0.9                  | 0.42<br>0.42    | 2.7<br>2.5       | ...<br>1.05                    |

\* After Fuller in MS.

† Same data as paratype.

*Type material.*—Holotype ex "*Suncus (Crocidura) caerulus fuscovocinereus* (Anderson)," a shrew. Manipur, Imphal, Kanglatongbi, April 29, 1945, G. H. Q. (India) Field Typhus Research Team. Deposited in British Museum (Natural History). "A second specimen was taken on the type host from the same area on June 21, 1945, and 13 specimens were taken on a mole from the same area on June 22, 1945."

*Records and comment.*—One specimen examined from Imphal collection through courtesy of J. R. Audy, and presumably the same as that referred to by Womersley (1952) as "No. 61."

## GAHRLIEPIA (GAHRLIEPIA) SADUSKI Womersley, 1952

Figures 176-179

1952. *Gahrlepiea (Gahrlepiea) saduski* WOMERSLEY, Rec. South Australia Mus., vol. 10, Nos. 1-2, pp. 283, 301-302, pl. 78, figs. H-J. (As *Gateria* on pl. 78.)  
 1952. *Gahrlepiea* sp. JAMESON, KEEGAN, and TOSHIOKA, Parasitic mites found on small mammals in Japan and Korea, Office of the Surgeon, Far East Command (U. S. Army, Tokyo), p. 11, fig. 10C.  
 1954. *Gahrlepiea (Gahrlepiea) saduski* WOMERSLEY, Sasa and Jameson, Proc. California Acad. Sci., ser. 4, vol. 28, No. 5, p. 254, fig. 3.



*Diagnosis of larva.*—The only species in the subgenus with more than 2 setae on coxa III, i.e., 4 or 5. Palpal setal formula  $b(N?)/B/NNB$ . Palpal claw 3-pronged. Eyes 2+2. Scutum non-ornate, with the usual micropunctae. With 2 to 5 usurped setae on scutum; these often in 2 rows, often including a caudomarginal pair. With about 28 to 32 dorsal setae usually commencing 2.8.8 (excluding usurped setae). With about 36 ventral setae. Coxa III ratio, length to breadth, is 1.51.

STANDARD MEASUREMENTS IN MICRONS

|                     | AW | PW | SB | ASB | PSB | A-P | AL | PL | D.S.  | $\frac{PW}{Coxa\ II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus\ III}$ |
|---------------------|----|----|----|-----|-----|-----|----|----|-------|-----------------------|-----------------|------------------|--------------------------|
| Type series * ..... | 49 | 64 | 41 | 22  | 65  | 38  | 36 | 35 | 50    | ...                   | 0.74            | 2.9              | ...                      |
| Others (6):         |    |    |    |     |     |     |    |    |       |                       |                 |                  |                          |
| Mean .....          | 49 | 65 | 42 | 22  | 70  | 38  | 37 | 41 | 35.46 | 1.21                  | 0.7             | 3.1              | 1.26                     |
| Range + or - .....  | 2  | 3  | 3  | 1   | 4   | 3   | 3  | 4  | ...   | 0.08                  | 0.03            | 0.4              | 1.08                     |

\* After Womersley, modified.

*Type material.*—Holotype and 2 paratypes ex *Mus* sp., Japan, Yamagata Prefecture, near Yachi, October 28, 1945 (C. B. Philip). "Four other specimens" ex *Microtus montebelloi* ("embedded in the belly"), Japan, Niigata, October 18, 1945, "and a further specimen from the latter host and locality," January 1946 (T. O. Berge, nec Berga (sic)). Apparently deposited in collections of South Australia Museum, Adelaide.

*Records and comment.*—Five specimens from Japan as follows: 2 ex "*Apodemus sylvaticus speciosus*," Honshu, Shiga Prefecture, Hiei-zan, March 27, 1952 (E. W. Jameson, for U. S. Army 406th Medical General Laboratory, Tokyo). One ex *Clethrionomys*, Kyoto, Chara, March 8, 1952 (E. W. Jameson). Two ex "*Apodemus sylvaticus speciosus*," Honshu, Murayama, December 18, 1952 (406th M. G. L.). Additional records are in the files of the 406th Medical General Laboratory.

#### GAHRLIEPIA (GAHRLIEPIA) ORNATA Womersley, 1952

Figures 173-175

1952. *Gahrлиеpia* (*Gahrлиеpia*) *ornata* WOMERSLEY, Rec. South Australia Mus., vol. 10, Nos. 1-2, pp. 283, 304, pl. 81, figs. A-D.

*Diagnosis of larva.*—With a highly scrobiculate scutum bearing 2 pairs of usurped submarginal setae. Scutum with a medial cluster of ovate scrobiculi about three to four times the diameter of setal bases and with a submarginal row of huge scalloped scrobiculi about three to four times as large as those in the medial patch, the scallops pointing inward, the portion between these scrobiculi densely granuled ex-



cept for region beyond *PLs*, which bears a few ovate pits. *PLs* moved anteriorward, quite close to *ALs* and well anterior to line of *SB*. *PLs* about thrice as long as *ALs* and much stouter. Palpal setal formula *B/B/NNb*. Palpal claw 2-pronged (not clear in holotype). Eyes double; posterior eye almost vestigial. *PPW-1* is about 154 microns; *PPW-2*, 124; *PPP-1*, 139; *PPP-2*, 48; *PPL-1* and *PPL-2*, about 56 microns in length. With about 36 to 44 long, stout, well-ciliated dorsal setae, which in holotype, according to Womersley, are arranged 2.4.8.8.8.6 (excluding usurped setae). With 2 rows of 4 setae between coxae III and with about 40 additional ventral setae, of which about 16 are postanals. True ventrals about 20 microns; postanals about 42 microns in length. Coxa III very broad; ratio of length to breadth is 1.07.

## STANDARD MEASUREMENTS IN MICRONS

|              | <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A-P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa\ II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus\ III}$ |
|--------------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|-----------------------|-----------------|------------------|--------------------------|
| Holotype *   | 40        | 59        | 34        | 25         | 218        | 12         | 28        | 98        | 60-84       | ...                   | 0.24            | 0.24             | ...                      |
| Others:      |           |           |           |            |            |            |           |           |             |                       |                 |                  |                          |
| Mean         | 39        | 67        | 32        | 24         | 211        | 16         | 47        | 106       | 52-104      | 63/74=0.92            | 0.28            | 0.28             | 67/64=0.96               |
| Range + or - | 4         | 8         | 3         | 1          | 10         | 4          | 3         | 6         | ....        | 0.08                  | 0.04            | 0.04             | 0.06                     |

\* After Womersley, modified so as to delete decimals.

*Type material*.—Unique holotype ex *Rattus sabanus*, Malaya, Selangor, Ulu Langat Forest Reserve, November 18, 1949 (J. R. Audy, for Colonial Office Medical Research Unit).

*Records and comment*.—Three specimens ex type locality, viz, 1 ex *Rattus sabanus*, September 6, 1951 (R. Traub, for U. S. Army Medical Research Unit); 1 ex *Rattus* sp., July 29, 1950 (J. R. Audy); 1 ex *Rattus mülleri*, September 4, 1951 (J. R. Audy).

## GAHRLIEPIA (GAHRLIEPIA) DECORA Womersley, 1952

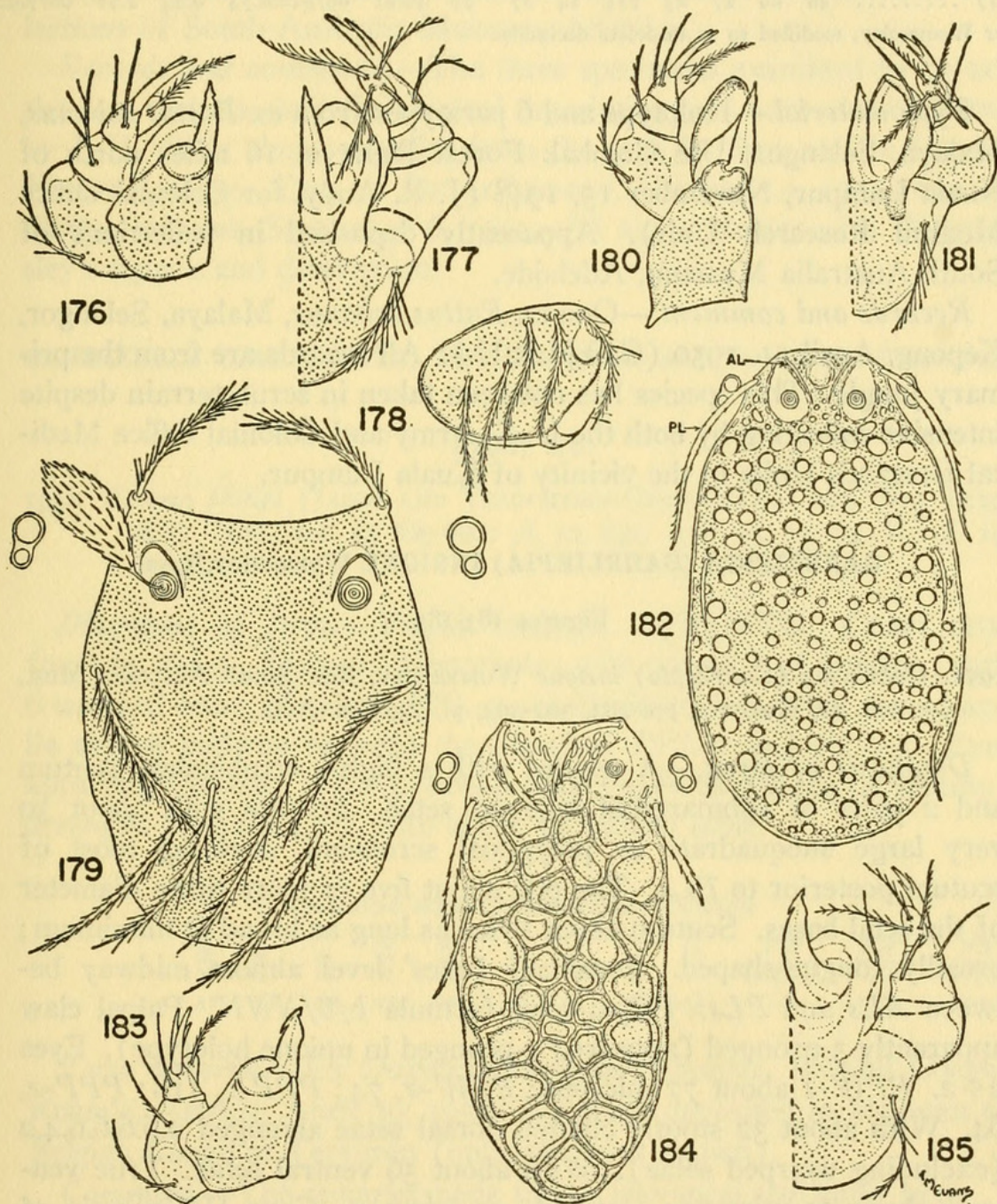
Figures 180-182

1952. *Gahrlepiea* (*Gahrlepiea*) *decora* WOMERSLEY, Rec. South Australia Mus., vol. 10, Nos. 1-2, pp. 283, 303-304, pl. 80, figs. A-D.

*Diagnosis of larva*.—A scrobiculate species with 4 submarginal usurped setae, and in which the scrobiculi on the scutum are subovate pits three to four times the diameter of the setal bases and are evenly distributed posterior to *SB*. Scrobiculi usually separated from one another by a distance equivalent to about three to four times their diameters. Scutum broadly tongue-shaped. *PLs* moved forward to near *ALs* so that they are in a line slightly anterior to *SB*; more than thrice as long as *ALs* and also much stouter, heavily pinnatifid. *PPW-1* and *PPW-2* both 121 microns. *PPP-1* is 134 microns;



PPP-2, 58. Palpal formula:  $b/b/NNb(?)$ . Palpal claw stated to be 3-pronged. Dorsal setae about 28 to 34 in number, in original description stated to be arranged 2.6.6.6.4.4.2.2.2 (excluding usurped



FIGS. 176-179.—*Gahrlepieia* (*Gahrlepieia*) *saduski* Womersley, 1952.

FIGS. 180-182.—*Gahrlepieia* (*Gahrlepieia*) *decora* Womersley, 1952.

FIGS. 183-185.—*Gahrlepieia* (*Gahrlepieia*) *insigne* Womersley, 1952.

setae). With about 56 ventral setae, of which approximately 17 are postanals. True ventrals about 15 microns in length; postanals 30 microns. Coxae I-setose. Coxa III very broad; ratio of length to breadth, 1.12.



## STANDARD MEASUREMENTS IN MICRONS

|                     | AW | PW | SB | ASB | PSB | A-P | AL | PL  | D.S.  | $\frac{PW}{Coxa II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus III}$ |
|---------------------|----|----|----|-----|-----|-----|----|-----|-------|----------------------|-----------------|------------------|-------------------------|
| Type series * ..... | 42 | 67 | 31 | 22  | 240 | 17  | 27 | 108 | 36-92 | ...                  | ...             | ...              | ...                     |
| Range * .....       | 3  | 3  | 0  | 0   | 17  | 3   | 2  | 5   | ...   | ...                  | ...             | ...              | ...                     |
| Other (1) .....     | 40 | 60 | 27 | 23  | 223 | 14  | 27 | 98  | 46-81 | 60/81=0.74           | 0.24            | 2.61             | 60/70=0.86              |

\* After Womersley, modified so as to delete decimals.

*Type material*.—Holotype and 6 paratypes from ex *Rattus sabanus*, Malaya, Selangor, Ulu Gombak Forest Reserve, 16 miles north of Kuala Lumpur, November 15, 1948 (J. R. Audy, for Colonial Office Medical Research Unit). Apparently deposited in collections of South Australia Museum, Adelaide.

*Records and comment*.—One ex *Rattus sabanus*, Malaya, Selangor, Kepong, April 11, 1950 (C.O.M.R.U.). All records are from the primary jungle. This species has not been taken in scrub terrain despite intensive collecting by both the U. S. Army and Colonial Office Medical Research Units in the vicinity of Kuala Lumpur.

## GAHRLIEPIA (GAHRLIEPIA) INSIGNE Womersley, 1952

Figures 183-185

1952. *Gahrlepiea (Gahrlepiea) insigne* WOMERSLEY, Rec. South Australia Mus., vol. 10, Nos. 1-2, pp. 283, 302-303, pl. 79, figs. A-D.

*Diagnosis of larva*.—A species with a highly scrobiculate scutum and 2 pairs of submarginal usurped setae. Scutum with about 30 very large subquadrate or polygonal scrobiculi, covering most of scutum posterior to *PLs*. The pits about five or more times diameter of the setal bases. Scutum about twice as long as broad at maximum; broadly tongue-shaped. Sensillary bases' level almost midway between *ALs* and *PLs*. Palpal setal formula *b/b/NNN*. Palpal claw apparently 3-pronged (appeared 2-pronged in unique holotype). Eyes 2+2. *PPW-1* about 77 microns; *PPW-2*, 74; *PPP-1*, 118; *PPP-2*, 64. With about 32 stoutly ciliated dorsal setae arranged 2.6.6.6.6.4.2 (excluding usurped setae). With about 56 ventral setae. True ventrals about 30 microns; postanals 40 microns. Coxa III in ratio of 1.33.

## STANDARD MEASUREMENTS IN MICRONS

|                    | AW | PW | SB | ASB | PSB | A-P | AL | PL | D.S.  | $\frac{PW}{Coxa II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus III}$ |
|--------------------|----|----|----|-----|-----|-----|----|----|-------|----------------------|-----------------|------------------|-------------------------|
| Holotype * .....   | 45 | 76 | 45 | 22  | 174 | 31  | 40 | 53 | ....  | ...                  | 0.39            | 3.45             | ...                     |
| Others (3):        |    |    |    |     |     |     |    |    |       |                      |                 |                  |                         |
| Mean .....         | 41 | 68 | 40 | 19  | 168 | 29  | 39 | 52 | ....  | 68/59=1.16           | 0.36            | 3.48             | 68/81=1.19              |
| Range + or - ..... | 2  | 2  | 2  | 2   | 14  | 2   | 2  | 4  | 37-46 | 0.06                 | 0.04            | 0.06             | 0.04                    |

\* After Womersley, 1952, modified so as to delete decimals.



*Type material*.—Unique holotype ex *Tupaia glis*, a tree shrew, Malaya, Selangor, Ulu Gombak Forest Reserve, Pahang Road (about 16 miles north of Kuala Lumpur—authors), August 18, 1948 (J. R. Audy, for Colonial Office Medical Research Unit). Deposited in collections of South Australia Museum, Adelaide.

*Records and comments*.—The three specimens examined by us are the first records since the original description and were also collected by J. R. Audy about 10 miles from the type locality, at Ulu Langat Forest Reserve. Two ex *Rattus bowersi*, October 14, 1951; one ex *Rattus sabanus*, September 6, 1951. All agree closely with Womersley's figures and description.

**GAHRLIEPIA (GAHRLIEPIA) PHILIPI** (Jadin and Vercammen-Grandjean, 1952)

Figure 186

1952. *Gateria philipi* (JADIN AND VERCAMMEN-GRANDJEAN), Ann. Soc. Belge Med. Trop., vol. 33, 629-630; pl. 10, figs. A-F; pl. 17, fig. H; pl. 19, fig. H.

*Diagnosis of larva*.—Palpal formula,  $N/N/NNN$ . Coxal setal formula, 1-1-2. *Scutum*: Nonornate; with one kind of punctae; with 6 usurped setae, of which *PPL-2* are displaced somewhat mesad and lie almost midway between the marginal *PPL-1* and *PPL-3*. Eyes apparently absent. With 30 dorsal setae (excluding those on scutum) arranged 2.2.4.6.6.4.4.2, with about 56 ventral setae.

STANDARD MEASUREMENTS IN MICRONS

| <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A.P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ |
|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|----------------------|-----------------|------------------|
| 41        | 71        | 43        | 23         | 101        | 38         | 34        | 18        | 42          | ...                  | 0.57            | 3.09             |

*Type material*.—Ex *Dasymys bentleyae* Thomas, Belgian Congo: Ruanda, Astrida, April 30, 1952. Holotype deposited in Museum of Belgian Congo at Tervuren (only specimen known).

*Comment*.—The remarks made for *G. lawrencei* also apply here.

**GAHRLIEPIA (GAHRLIEPIA) LAWRENCEI** Jadin and Vercammen-Grandjean, 1952

Figure 187

1952. *Gahrlipeia lawrencei* JADIN AND VERCAMMEN-GRANDJEAN, Ann. Soc. Belge Med. Trop., vol. 33, No. 6, pp. 625-627, pl. 9, fig. A-E; pl. 17, fig. G; pl. 19, fig. G.



*Diagnosis of larva.*—Palpal formula  $N/N/NNN$ . Coxal setal formula, 1-1-2. *Scutum*: Nonornate; with one kind of punctae; with 4 usurped setae, which are submarginal and first two of which are in line with angles of scutum. Eyes apparently absent. With 28 dorsal setae (excluding those on scutum) and 46 ventral setae. This species is well described and fully illustrated in detail in the original description.

## STANDARD MEASUREMENTS IN MICRONS

| <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A-P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | <i>PPW-1</i> | <i>PPW-2</i> |
|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|----------------------|-----------------|------------------|--------------|--------------|
| 38        | 22*       | 37        | 20         | 95         | 34         | 21        | 15        | 28          | ...                  | 0.19            | 1.1              | 71           | 48           |

\* Sic! Apparently a *lapsus*, for *PW* is obviously greater than *AW*.

*Type material.*—Ex *Dasymys bentleyae* Thomas, Belgian Congo: Ruanda, Astrida, March 28, 1952. Holotype deposited in museum of Belgian Congo at Tervuren (only specimen known).

*Record and comment.*—The above data and diagnosis are from Jadin and Vercammen-Grandjean, but modified in accordance with terminology employed herein. Thus, what Jadin and Vercammen-Grandjean (1952) call the "mediolateral setae" are referred to as *PLs* by us, whereas our *PPL-1* are designated the posterolaterals by Jadin and Vercammen-Grandjean because they are at the maximum width of the scutum.

## GAHRLIEPIA (GAHRLIEPIA) CILIATA Gater, 1932

## Figure 188

1932. *Gahrliopia ciliata* GATER, Parasitol., vol. 24, No. 2, pp. 163-164, fig. 10.  
 1938. *Gateria ciliata* (GATER), Ewing, Journ. Washington Acad. Sci., vol. 28, No. 6, p. 295.  
 1940. *Gahrliopia ciliata* GATER, Gunther, Proc. Linn. Soc. New South Wales, vol. 65, Nos. 5-6, p. 481.  
 1942. *Gateria ciliata* (GATER), Radford, Parasitol., vol. 34, No. 1, p. 67, fig. 49.  
 1943. *Gahrliopia ciliata* GATER, Womersley and Heaslip, Trans. Roy. Soc. South Australia, vol. 67, No. 1, p. 140, pl. 13, fig. 2.  
 1947. *Gateria ciliata* (GATER), Sig Thor and Willmann, Trombidiidae, Das Tierreich, Lfg. 71b, pp. 339-340, fig. 406.  
 1948. *Gateria ciliata* (GATER), Fuller, Bull. Brooklyn Ent. Soc., vol. 43, No. 4, p. 110.  
 1952. *Gahrliopia (Gateria) ciliata* GATER, Womersley, Rec. South Australia Mus., vol. 10, Nos. 1-2, p. 309, pl. 83, fig. D.  
 1952. *Gateria ciliata* (GATER), Wharton and Fuller, Mem. Ent. Soc. Washington, No. 4, p. 93.  
 1952. *Gateria (?) ciliata* (GATER), Gunther, Proc. Linn. Soc. New South Wales, vol. 77, Nos. 1-2, p. 47.  
 1952. *Gateria ciliata* (GATER), Fuller, Zool. Verh., No. 18, p. 217.



*Diagnosis of larva.*—Apparently near *G. fletcheri* Gater but with only 2 usurped setae submedial and 8 submarginal, instead of most being submedial, and with first 2 palpal setae nude, not barbed. Palpal

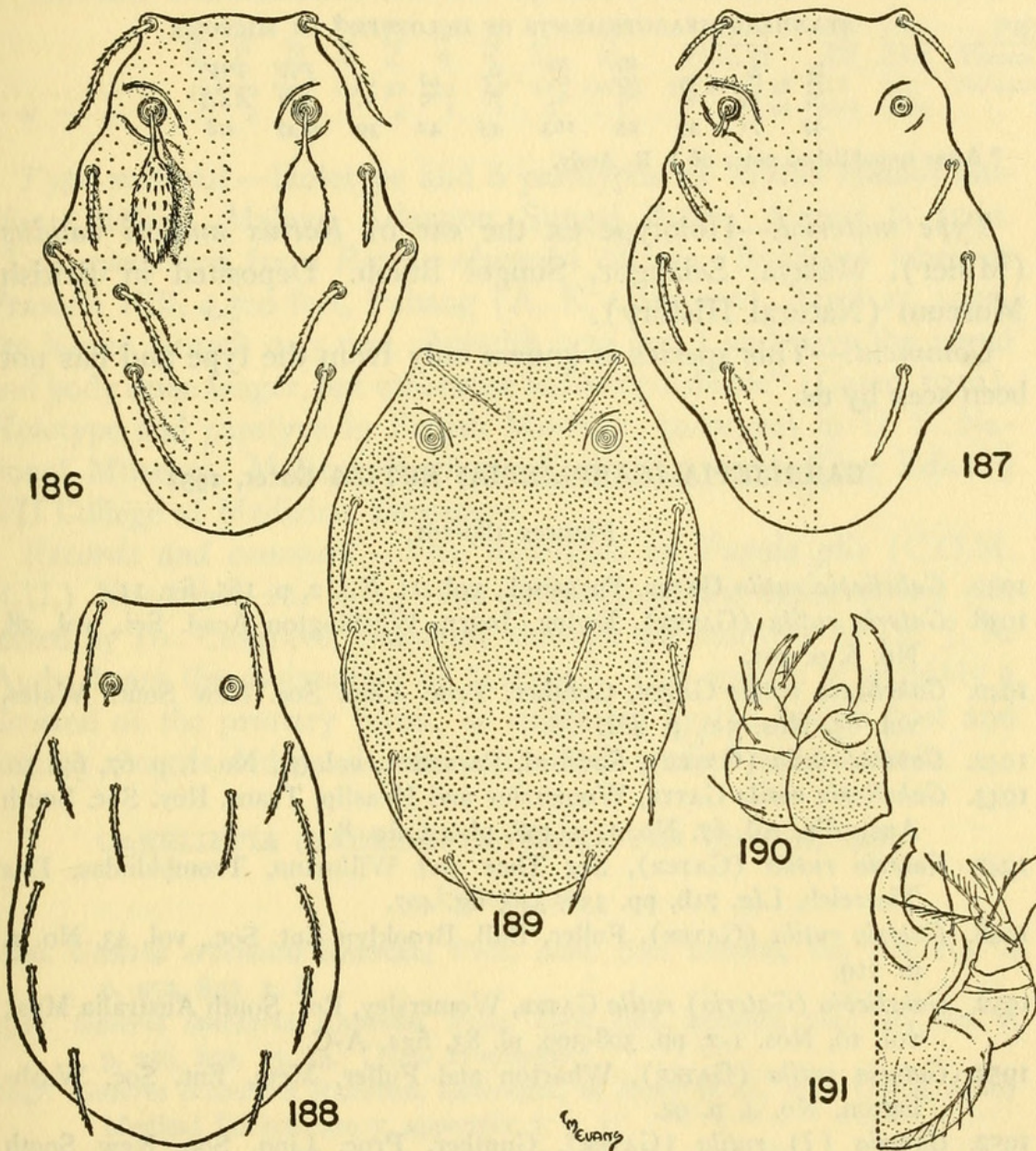


FIG. 186.—*Gahrlepiea (Gahrlepiea) philipi* (Jadin and Vercammen-Grandjean, 1952).  
 FIG. 187.—*Gahrlepiea (Gahrlepiea) lawrencei* Jadin and Vercammen-Grandjean, 1952.  
 FIG. 188.—*Gahrlepiea (Gahrlepiea) ciliata*, Gater, 1932.  
 FIGS. 189-191.—*Gahrlepiea (Gahrlepiea) rutila* Gater, 1932.

formula, *N/N/NNN*. Palpal claw 3-pronged. Eyes 2+2. Scutum uniformly micropunctate; very large; broadly tongue-shaped but with lateral margins slightly sinuate; broadest at about one-fourth from posterior end. With 4 pairs of submarginal usurped setae and a medial pair inserted near anterior third. *SB* about midway between



*ALs* and *PLs*. Sensillae missing. *ALs* and *PLs* coarsely pilose, more so than are usurped setae. Dorsal setae long, stout, "coarsely pilose, almost pectinate" arranged 2.4.4.4.6.4.2.4.2. Coxae 1-setose.

STANDARD MEASUREMENTS OF HOLOTYPE \* IN MICRONS

| <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A-P</i> | <i>AL</i> | <i>PL</i> | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ |
|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-----------------|------------------|
| 47        | 71        | 39        | 25         | 163        | 45         | 42        | 39        | 0.37            | 2.8              |

\* After unpublished notes of J. R. Audy.

*Type material*.—Holotype ex the ear of *Rattus mülleri validus* (Miller), Malaya, Selangor, Sungei Buloh. Deposited in British Museum (Natural History).

*Comment*.—This species is known only from the type and has not been seen by us.

**GAHRLIEPIA (GAHRLIEPIA) RUTILA** Gater, 1932

Figures 189-191

1932. *Gahrlepiea rutila* GATER, Parasitol., vol. 24, No. 2, p. 165, fig. 11.  
 1938. *Gateria rutila* (GATER), Ewing, Journ. Washington Acad. Sci., vol. 28, No. 6, p. 295.  
 1940. *Gahrlepiea rutila* GATER, Gunther, Proc. Linn. Soc. New South Wales, vol. 65, Nos. 5-6, p. 481.  
 1942. *Gateria rutila* (GATER), Radford, Parasitol., vol. 34, No. 1, p. 67, fig. 50.  
 1943. *Gahrlepiea rutila* GATER, Womersley and Heaslip, Trans. Roy. Soc. South Australia, vol. 67, No. 1, p. 138, pl. 12, fig. 8.  
 1947. *Gateria rutila* (GATER), Sig Thor and Willmann, Trombidiidae, Das Tierreich, Lfg. 71b, pp. 339, 340, fig. 407.  
 1948. *Gateria rutila* (GATER), Fuller, Bull. Brooklyn Ent. Soc., vol. 43, No. 4, p. 110.  
 1952. *Gahrlepiea (Gateria) rutila* GATER, Womersley, Rec. South Australia Mus., vol. 10, Nos. 1-2, pp. 308-309, pl. 83, figs. A-C.  
 1952. *Gateria rutila* (GATER), Wharton and Fuller, Mem. Ent. Soc. Washington, No. 4, p. 94.  
 1952. *Gateria (?) rutila* (GATER), Gunther, Proc. Linn. Soc. New South Wales, vol. 77, Nos. 1-2, p. 47.  
 1952. *Gateria rutila* (GATER), Fuller, Zool. Verh., No. 18, p. 217.

*Diagnosis of larva*.—Characterized by having 8 usurped setae on the scutum; of these 3 pairs are submarginal and 1 pair submedial near horizontal midline of scutum. Palpal formula apparently *N/N/NNN*. Palpal claw 3-pronged. Eyes double. Scutum with micropunctations, broadly tongue-shaped; broadest slightly beyond *PLs*, posterior margin broadly rounded. Both *AL* and *PL* setae short, subequal. Sensillae bases slightly nearer *ALs* than *PLs*; sensillae unknown. With 24 to 26 dorsal setae; usually arranged 2.2.2.6.4.4.4.2 (excluding



usurped setae). With about 32 to 35 ventral setae, of which 12 to 14 are postanals. True ventrals about 12 microns in length.

STANDARD MEASUREMENTS IN MICRONS OF FIVE TOPOTYPES AND ONE COTYPE

|                   | AW | PW | SB | ASB | PSB | A-P | AL | PL | D.S.  | $\frac{PW}{Coxa II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus III}$ |
|-------------------|----|----|----|-----|-----|-----|----|----|-------|----------------------|-----------------|------------------|-------------------------|
| Mean .....        | 42 | 70 | 37 | 19  | 97  | 35  | 17 | 17 | 12/23 | 70/48=1.48           | 0.6             | 3.7              | 70/44=1.58              |
| Range + or -..... | 1  | 3  | 2  | 1   | 4   | 1   | 1  | 2  | ...   | 0.05                 | 0.04            | 0.05             | 0.06                    |

Type material.—Holotype and 6 paratypes ex *Rattus mülleri validus* (Miller), Malaya, Selangor, Sungei Buloh, August 8, 1930. “Two specimens from *Rattus edwardsi ciliatus* (Bonhote) taken at Fraser’s Hill, 4,500 feet, Pahang (A. K. Cosgrave), April 25, 1930, are larger (length 0.43 mm.; breadth 0.34 mm.) and have the scutal and body setae longer, but otherwise indistinguishable” (Gater, 1932). Holotype and paratype in British Museum; paratypes in U. S. National Museum; Moltens Institute, Cambridge; and King Edward VII College of Medicine, Singapore.

Records and comment.—Five topotypes ex *Tupaia glis* (C.O.M. R.U.) November 20, 1951. One specimen of the types series, collected by Dr. Cosgrave, examined through the courtesy of Dr. J. R. Audy, bears the designation of “cotype.” This species is probably a denizen of the primary forest, as suggested by the known host and locality records and its absence in the well-studied scrub terrain.

GAHRLIEPIA (GAHRLIEPIA) CROCIDURA (Radford, 1946)

Figure 192

1946. *Gateria crocidura* RADFORD, Proc. Zool. Soc. London, vol. 116, No. 2, p. 252, figs. 7, 8.  
1946. *Gateria lancearia* RADFORD, Proc. Zool. Soc. London, vol. 116, No. 2, p. 256, figs. 13, 14. (New synonymy.)  
1947. *Gateria crocidura* RADFORD, Lawrence, in Audy et al., War Office, Army Medical Directorate 7, appendix 7, p. 5.  
1947. *Gateria lancearia* RADFORD, Lawrence, in Audy et al., ibid.  
1952. *Gahrлиеpia (Gateria) crocidura* (RADFORD), Womersley, Rec. South Australia Mus., vol. 10, Nos. 1-2, p. 307, pl. 82, fig. G.  
1952. *Gahrлиеpia (Gateria) lancearia* (RADFORD), Womersley, op. cit., pp. 284, 306-307, pl. 82, fig. F (not *E. lapsus*).  
1952. *Gateria crocidura* RADFORD, Gunther, Proc. Linn. Soc. New South Wales, vol. 77, Nos. 1-2, p. 47.  
1952. *Gateria lancearia* RADFORD, Gunther, op. cit., p. 48.  
1952. *Gateria crocidura* RADFORD, Wharton and Fuller, Mem. Ent. Soc. Washington, No. 4, p. 93.  
1952. *Gateria lancearia* RADFORD, Wharton and Fuller, op. cit., p. 94.  
1952. *Gateria crocidura* RADFORD, Fuller, Zool. Verh., No. 18, pp. 217-218.  
1952. *Gateria lancearia* RADFORD, Fuller, ibid.



*Diagnosis of larva.*—A nonscrobiculate species with 6 usurped setae on the scutum. Palpal setal formula  $B/B/BNb$ . Palpal claw 3-pronged. Scutum somewhat pentagonal in shape by virtue of being angled at level of  $PL$ . Sensillary bases with anteromedial ridges; inserted almost midway between  $AL$  and  $PL$ . Scutum with uniform micropunctations. With 38 dorsal setae arranged 2.4.6.6.8.8.4. With approximately 62 ventral setae, of which the true ventrals are 30 to 32 microns in length; postanals 60 microns.

STANDARD MEASUREMENTS OF HOLOTYPE IN MICRONS

|      |      |      |       |       |       |      |      |        |
|------|------|------|-------|-------|-------|------|------|--------|
| $AW$ | $PW$ | $SB$ | $ASB$ | $PSB$ | $A-P$ | $AL$ | $PL$ | $D.S.$ |
| 51   | 92   | 49   | 30    | 120   | 38    | 45   | 60   | 42-58  |

*Type material.*—Holotype ex a shrew, *Suncus caeruleus fulvocinereus* (Anderson), India, Manipur, Imphal, March 8, 1945,<sup>11</sup> G. H. Q. (India) Field Typhus Research Team. Deposited in the British Museum (Natural History) (B.M.N.H. No. 1948-2-3-16). Lawrence (1947) adds "Kanglatongbi" to the locality data, and states "appeared in brief period only, not recorded since July 1945. Not common," indicating that more specimens may be extant.

*Comment.*—*G. lancearia* was described from a single specimen ex a mole, *Talpa micrura* Hodgson, from the type locality of *G. crocidura*, and, like the latter, was collected by the Field Typhus Research Team. *G. lancearia* was considered to be distinctive by virtue of a "lanceolate" sensilla, present only on one side. It is otherwise morphologically indistinguishable from *G. crocidura*, as indicated by the original descriptions and by the unpublished studies of Audy and of Fuller. Careful study by Audy indicates that Radford was understandably misled by an artifact—the sensilla is collapsed on the medial side and its short basal stem is twisted back. *G. lancearia* is hence considered a synonym of *G. crocidura*.

The above description, as well as those which follow, is based upon the literature and upon manuscript notes and drawings prepared by Dr. H. S. Fuller and Dr. J. R. Audy while independently studying the types of the *Gahrliopia* species described by Radford in 1946.

**GAHRLIEPIA (GAHRLIEPIA) LONGIPILI (Radford, 1946)**

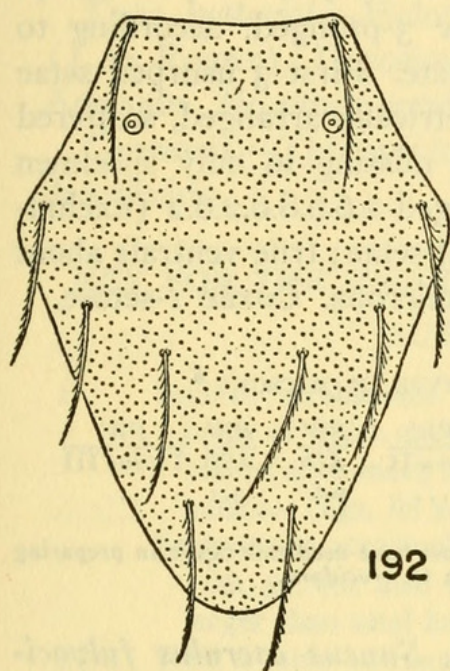
Figure 193

1946. *Gateria longipili* RADFORD, Proc. Zool. Soc. London, vol. 116, No. 2, p. 252, figs. 9-10.

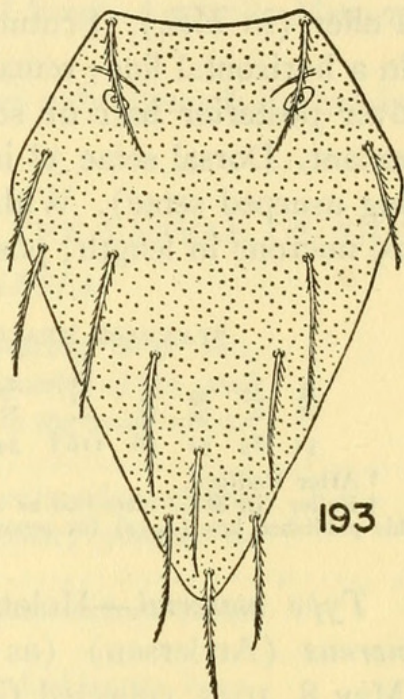
<sup>11</sup> Radford cites the month as May, but Audy, in litt., notes the month as March.



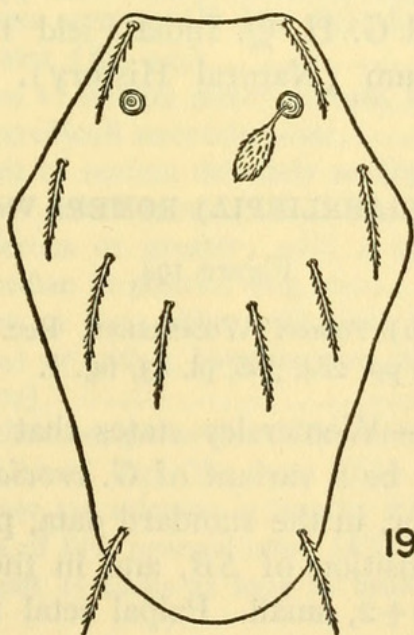
1947. *Gateria longipili* RADFORD, Lawrence, in Audy et al., War Office Army Medical Directorate 7, appendix 7, p. 5.  
 1952. *Gahrlepiea* (*Gateria*) *longipilis* (sic!) (RADFORD, 1946), Womersley, Rec. South Australia Mus., vol. 10, Nos. 1-2, p. 307, pl. 82, fig. E (not F, lapsus.)



192



193



194

McEvans

FIG. 192.—*Gahrlepiea* (*Gahrlepiea*) *crocidura* (Radford, 1946).  
 FIG. 193.—*Gahrlepiea* (*Gahrlepiea*) *longipili* (Radford, 1946).  
 FIG. 194.—*Gahrlepiea* (*Gahrlepiea*) *romeri* Womersley, 1952.

1952. *Gateria longipili* RADFORD, Wharton and Fuller, Mem. Ent. Soc. Washington, No. 4, p. 94.  
 1952. *Gateria longipili* RADFORD, Gunther, Proc. Linn. Soc. New South Wales, vol. 77, Nos. 1-2, p. 48.  
 1952. *Gateria longipili* RADFORD, Fuller, Zool. Verh., No. 18, p. 217.



*Diagnosis of larva.*—Close to *G. crocidura* (Radford, 1946) but separable in that there are 9 usurped setae on the scutum, not 6. Resembles *G. crocidura* regarding measurements, but scutum stated to be even more pentagonal than in *G. lancearia* (Radford, 1946), which we deem a synonym of *G. crocidura*, almost pointed posteriorly. Palpal formula, *B/B/BNB*. Palpal claw 3-pronged, according to Fuller (in MS.). Scutum strongly punctate. First 3 usurped setae in a horizontal line; remainder not symmetrically arranged, scattered over posterior half of scutum. Sensillae missing in only specimen extant. Dorsal setae 38 in number; arranged 2.6.6.8.6.2.6.2 (excluding usurped setae). With about 66 ventral setae; true ventrals about 29 microns in length; postanals about 60 microns. Coxae 1-setose.

STANDARD MEASUREMENTS OF HOLOTYPE IN MICRONS \*

| <i>AW</i> | <i>PW</i> | <i>SB</i> | <i>ASB</i> | <i>PSB</i> | <i>A-P</i> | <i>AL</i> | <i>PL</i> | <i>D.S.</i> | $\frac{PW}{Coxa II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus III}$ |
|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|-------------|----------------------|-----------------|------------------|-------------------------|
| 51        | 85        | 51        | 26         | 116†       | 34         | 46        | 57        | 48-54       | ...                  | 0.6             | 3.3              | ...                     |

\* After Radford.

† Fuller (in MS.) cites this as 85.5 in the type and must have used this figure in preparing his published key (1952) for separating *G. longipili* from *G. crocidura*.

*Type material.*—Holotype ex a shrew, *Suncus caeruleus fulvoci-nereus* (Anderson) (as *Suncus (Crocidura)*), Manipur, Imphal, May 8, 1945, collected G. H. Q. India Field Typhus Unit. Deposited in British Museum (Natural History). No other specimen known.

**GAHRLIEPIA (GAHRLIEPIA) ROMERI** Womersley, 1952

Figure 194

1952. *Gahrliēpia (Gateria) romeri* WOMERSLEY, Rec. South Australia Mus., vol. 10, Nos. 1-2, pp. 284, 308, pl. 83, fig. I.

*Diagnosis of larva.*—Womersley states that "this species is very near to, and may only be a variant of *G. crocidura* Radford. It appears to differ, however, in the standard data, particularly the larger *PSB* and *A-P*, the position of *SB*, and in the smaller number of dorsal setae." Eyes 2+2, small. Palpal setal formula, *N/N/NNb*. Palpal claw described as 2-pronged. Scutum nonornate, "finely punctate . . . strongly produced behind line of *PL* and taking in 6 extra setae of the second and third dorsal rows; *SB* wide apart and about midway between *AL* and *PL*." With 36 dorsal setae arranged 2.8.6.6.6.4.2.2 (excluding usurped setae); from 36 to 42 microns long (the shorter ones posteriormost). With about 54 ventral setae; true ventrals apparently 22 microns in length; postanals 36 microns.



STANDARD MEASUREMENTS OF HOLOTYPE IN MICRONS \*

| AW | PW | SB | ASB | PSB | A.P | AL | PL | $\frac{PW}{Coxa\ II}$ | $\frac{PW}{SD}$ | $\frac{PW}{ASB}$ | $\frac{PW}{Tarsus\ III}$ |
|----|----|----|-----|-----|-----|----|----|-----------------------|-----------------|------------------|--------------------------|
| 50 | 86 | 50 | 28  | 157 | 50  | 39 | 42 | ...                   | 0.47            | 3.1              | ...                      |

\* After Womersley, modified.

*Type material*.—Holotype ex *Rattus rattus*, Hong Kong, 1950 (J. D. Romer). Deposited in collections of South Australia Museum, Adelaide. No other specimen known.

*Comment*.—This specimen is known to us only through the original description.

KEY FOR THE IDENTIFICATION OF THE LARVAE OF THE  
SUBGENUS GAHRLIEPIA

- I Scutum scrobiculate ("ornate"), i.e., bearing large pits, many of which are at least twice the diameter of the setal bases (often much larger), in addition to the usual micropunctae (figs. 86 and 110).....2
- Scutum not scrobiculate, often bearing only micropunctae (fig. 5) but also at times with secondary punctae no larger than setal bases (fig. 15).....12
- 2(1) With 2 setae on coxa III (fig. 134); intersensillary crater present (fig. 129, *I.C.*).....3
- With only 1 seta on coxa III (fig. 85); lacking an intersensillary crater (fig. 145).....4
- 3(2) Lateral margins of scutum mildly sinuate, lacking scallops (fig. 136); scrobiculi smoothly ovate.....*penetrans*, n. sp. (p. 45)
- Lateral margins of scutum definitely scalloped (fig. 129); scrobiculi with crenulate margins.....*ampullata*, n. sp. (p. 43)
- 4(2) *PW* is 90 microns or greater; with 4 usurped<sup>12</sup> setae, which are median in position (fig. 110).....5
- PW* 70 microns or less; either with more than 4 usurped setae (fig. 94) or with 4, but these are marginal in position (fig. 102).....7
- 5(4) With base of chelicera posterolaterally produced into a distinct, broad dorsal flap (fig. 111, *FL*); *ALs* and *PLs* very long, over 110 microns in length; *PLs* reaching far beyond bases of first usurped setae (*PPL-I*) (fig. 110); coxa III about 1½ times as long as broad (fig. 109).  

*laciniata*, n. sp. (p. 37)
- With base of chelicera only slightly produced posterolaterally, caudolateral angle acuminate (figs. 146 and 119); *ALs* and *PLs* much shorter, less than 67 microns; *PLs* not extending as far as *PPL-I*; coxa III virtually as broad as long (fig. 121).....6

<sup>12</sup> Usurped setae are those dorsal setae which arise from the dorsal plate by virtue of its posterior prolongation, i.e., all setae on the scutum except *ALs* and *PLs*.



- 6(5) Scutum ovate and evenly convex (fig. 145); scutum very long, *PSB* more than  $6\frac{1}{2}$  times *AW*.....*granulata*, n. sp. (p. 50)  
 Scutum somewhat constricted at anterior fourth (fig. 118);  
*PSB* only about 5 times *AW*.....*tuberculata*, n. sp. (p. 40)
- 7(4) Marginal scrobiculi on scutum relatively large, size of each equal to about one-fourth to one-third width of scutum (fig. 174) .....8  
 Marginal scrobiculi on scutum much smaller, only about size of sensillary bases.....9
- 8(7) *PLs* displaced anteriorward, so that bases of *PLs* are anterior to line of *SB* (fig. 174); marginal scrobiculi scalloped, pointing inward, and more than 8 times diameter of median pits.....*ornata* Womersley, 1952 (p. 63)  
*PLs* well beyond line of *SB* (fig. 184); marginal scrobiculi only about 2 or 3 times diameter of median ones.  
*insigne* Womersley, 1952 (p. 66)
- 9(7) With 4 usurped setae on scutum; *PLs* at least  $1\frac{1}{2}$  times length of *ALs* (fig. 102).....10  
 With 8 or more usurped setae on scutum; *PLs* scarcely longer than *ALs* (fig. 94).....11
- 10(9) Scutum with a central core of small trigonal scrobiculi (fig. 102, *C.C.*); submarginal scrobiculi definitely larger than those of core; coxa III slightly broader than long (fig. 101) .....*tessellata*, n. sp. (p. 34)  
 Scutum lacking a central core; median scrobiculi similar to others on scutum (fig. 182); coxa III somewhat longer than broad.....*decora* Womersley, 1952 (p. 64)
- 11(9) With 8 usurped setae on scutum (fig. 94).....*picta*, n. sp. (p. 31)  
 With 17 to 20 usurped setae on scutum (fig. 86)....*evansi*, n. sp. (p. 30)
- 12(1) Posterolateral setae (*PLs*) moved far anteriorward, adjacent to anterolaterals (*ALs*) so that there appear to be two pairs of *ALs* (fig. 61); *PLs* separated from *ALs* by a distance not greater than the diameter of sensillae bases .....13  
 Posterolateral setae separated from *ALs* by a distance at least thrice the diameter of sensillae bases (fig. 5).....16
- 13(12) With 8 or 10 usurped setae on the scutum (fig. 172); scutum caudally angled; with all palpal tibial setae nude (figs. 170, 171).....*hirsuta* (Radford, 1946) (p. 61)  
 With 4 or 6 usurped setae on the scutum (figs. 70 and 78); scutum caudally rounded; with at least one barbed seta on palpal tibia (fig. 63).....14
- 14(13) With 6 usurped setae; first pair of usurped setae (*PPL-1*) submarginal (fig. 78).....*plurisetae*, n. sp. (p. 28)  
 With 4 usurped setae; *PPL-1* not necessarily marginal in position .....15
- 15(14) Usurped setae all submedian (fig. 70); *PSB:SB* ratio = 3:1 .....*dupliseta*, n. sp. (p. 26)  
 Usurped setae marginal (fig. 61); *PSB:SB* ratio = 2:1.  
*gemina*, n. sp. (p. 23)



- 16(12) With 4 to 5 setae on coxa III (fig. 178).  
*saduski* Womersley, 1952 (p. 62)  
 With 1 or 2 setae on coxa III.....17
- 17(16) With 2 setae on coxa III; anterior portion of lateral margins of scutum markedly sinuate (figs. 186, 187).....18  
 With only 1 seta on coxa III; anterior portion of lateral margins of scutum evenly curved or mildly sinuate (figs. 5, 188) .....19
- 18(17) With 6 usurped setae on scutum, including a submedian pair (fig. 186)...*philipi* (Jadin and Vercammen-Grandjean, 1952) (p. 67)  
 With only 4 usurped setae, all submarginal (fig. 187).  
*lawrencei* Jadin and Vercammen-Grandjean, 1952 (p. 67)
- 19(17) With only 4 usurped setae on scutum.....20  
 With 6 or more usurped setae.....25
- 20(19) *PSB* greater than 160 microns; ratio  $\frac{PW}{SD}$  approximately 0.42 .....*cetrata* Gater, 1932 (p. 59)  
*PSB* less than 131 microns; ratio  $\frac{PW}{SD}$  usually greater than 0.50 .....21
- 21(20) *PL* over 60 microns; ventral palpal tibial seta definitely barbed (fig. 4).....22  
*PL* less than 45 microns; ventral palpal tibial seta nude or at most frayed (fig. 168).....23
- 22(21) *ALs* less than 48 microns in length; scutum with 2 types of punctae<sup>13</sup> (i.e., with pits the size of setal bases in addition to micropunctae) (fig. 15); *PLs* much closer to *ALs* than to *PPL-I*.....*fimbriata*, n. sp. (p. 10)  
*ALs* more than 62 microns in length; scutum with only micropunctae (fig. 5); *PLs* midway between *ALs* and *PPL-I*.....*exilis*, n. sp. (p. 6)
- 23(21) All four usurped setae marginal (fig. 153); palpal formula *N/N/NNN*; *PSB* less than 95 microns.  
*nanus* (Oudemans, 1910) (p. 52)  
 With at least one pair of usurped setae submedian or submarginal; with at least palpal femoral and/or genual bristle somewhat barbed; *PSB* more than 105 microns.....24
- 24(23) Posterior margin of scutum subtruncate (fig. 45); with fewer than 34 dorsal setae (fig. 43); coxa III only slightly longer than broad (ratio 1.15).....*elbeli*, n. sp. (p. 18)  
 Posterior margin of scutum evenly but shallowly convex (fig. 53); with more than 40 dorsal setae (fig. 51); coxa III more than 1.5 times as long as broad.....*tylana*,<sup>14</sup> n. sp. (p. 21)
- 25(19) With 10 or more usurped setae on scutum.....26  
 With 6 to 9 usurped setae.....28

<sup>13</sup> This character is best seen in freshly mounted specimens or when examined under oil.

<sup>14</sup> *G. tylana* has from 4 to 9 usurped setae (usually 6) and hence appears again farther down in the key.



- 26(25) With only 10 usurped setae, of which one pair is median (fig. 188); palpal femoral and genual setae nude.  
*ciliata* Gater, 1932 (p. 68)  
 Usually with more than 10 usurped setae (rarely with 10 in *G. fletcheri*); of these at least 3 pairs median; palpal femoral and genual setae barbed (figs. 22 and 162).....27
- 27(26) With two types of punctae on the scutum—i.e., micropunctae, and some the size of setal bases (fig. 161); usually with 11 or 12 usurped setae (but rarely with as few as 10 or as many as 17); none of usurped setae in line with *PLs*; antesensillary ridges well developed.  
*fletcheri* Gater, 1932 (= *spinulosa* Radford, 1946) (p. 55)  
 With only micropunctae on scutum (fig. 21); with 17 to 20 usurped setae of which 1 to 3 (usually 2) are in line with *PLs*; antesensillary ridges weakly developed, usually inapparent .....*darita*, n. sp. (p. 12)
- 28(25) Scutum roughly pentagonal by virtue of being broadest at *PLs*, and being angled here, and with lateral margins beyond *PLs* declivate; caudally rather angulate (figs. 192, 193) .....29  
 Scutum subovate behind *ALs*; caudal margin rounded (fig. 29) or subtruncate (fig. 37).....30
- 29(28) With 9 usurped scutal setae (fig. 193)..*longipili* (Radford, 1946) (p. 72)  
 With 6 usurped scutal setae (fig. 192).  
*crocidura* (Radford, 1946) (= *lancearia* Radford, 1946) (p. 71)
- 30(28) *PSB* approximately 100 microns; *PLs* very short, only about 17 microns in length; with 8 usurped setae on scutum (fig. 189) .....*rutila* Gater, 1932 (p. 70)  
*PSB* greater than 116; *PLs* over 36 microns in length; usually with 6 usurped setae, rarely with 7 to 9 (fig. 53).....31
- 31(30) Scutum more than twice as long as broad (fig. 29).  
*neterella*, n. sp. (p. 14)  
 Scutum  $1\frac{1}{2}$  times as long as broad (fig. 37) or less (fig. 53).....32
- 32(31) With *PSB* more than 3 times *AW* (fig. 194); palpal femoral seta nude.....*romeri* Womersley, 1952 (p. 74)  
 With *PSB*  $2\frac{1}{2}$  times *AW* or less (figs. 37 and 53); palpal femoral seta barbed (figs. 38 and 54).....33
- 33(32) With all usurped setae approximately equidistant from midline (fig. 37); scutum distinctly constricted near caudal margin .....*tenella*, n. sp. (p. 16)  
 With the first pair of usurped setae displaced lateral, not in line with others (fig. 53); scutum broadly and evenly ovate .....*tylana*, n. sp. (p. 21)

COMMENTS ON THE SUBGENUS *GAHRLIEPIA*

## TAXONOMIC NOTES

Although the species of this subgenus often differ markedly from one another in regard to ornamentation of the scutum and numbers



and position of scutal setae, they are remarkably uniform in certain particulars. The sensory setae of the legs, described for *G. exilis*, new species, are the same in all known chiggers of the subgenus *Gahrliopia*, and incidentally the same pattern occurs without variation in the subgenus *Schöngastiella*. (The subgenus *Walchia* has not yet been studied by us in this regard.) This may very well prove to be a generic character. This group of chiggers is, therefore, in marked contrast to *Trombicula*, in which the setal pattern varies considerably and in which highly modified sensory setae may be present. The palpal setal formula is an excellent taxonomic character in *Trombicula* because of the many specific variations one encounters, but here again the subgenus *Gahrliopia* seems to be much more consistent. The palpal femoral seta is barbed in 28 of the 33 species. (The exceptions are: *rutila* Gater, 1932; *ciliata* Gater, 1932; *romeri* Womersley, 1952; *lawrencei* Jadin and Vercammen-Grandjean, 1952; and *philipi* (Jadin and Vercammen-Grandjean, 1952).) The dorsal seta of the palpal tibia is nude in 26 species, while the lateral seta of this tibia is barbed only in *G. exilis*, new species.

It is difficult to place the species of *G. (Gahrliopia)* in natural groups. At first thought it would seem that an obvious division would be to classify the species as scrobiculate ("ornate") versus nonscrobiculate. However, there is no real evidence to indicate that the scrobiculate species are truly related to one another. On the contrary, the *Gahrliopia* with scrobiculi may more likely prove to form a heterogeneous group. For example, in *G. evansi*, new species, *tessellata*, new species, *tuberculata*, new species, *ampullata*, new species, *pene-trans*, new species, *ornata* Womersley, 1952, and *decora* Womersley, 1952, coxa III is nearly or actually as broad as long. However, in the other 4 "ornate" species, this coxa is one and two-tenths to one and a half times as long as broad, thus agreeing with the vast majority of nonscrobiculate species. The exceptions in the last group are interesting—3 of the 4 species in which the *PL* setae are displaced so as to be very close to the *ALs* also have very broad coxae III. The ratio of *PW* to the length of the third tarsus varies in this subgenus from 0.75 to 1.84. Again no systematic groupings are possible, for both the extremes noted appear in scrobiculate species. Half of the known forms have only 4 usurped setae, but these chiggers share no other exclusive feature in common. It is apparent that as yet too little is known about this subgenus of trombiculids to properly delimit groups of species.

An African genus near *Gahrliopia* is discussed at the present time in order to compare it with *Gahrliopia* and to avoid bibliographic difficulties in future citations.



## GIROUDIA Vercammen-Grandjean, 1952

1952. *Giroudia* VERCAMMEN-GRANDJEAN, Ann. Soc. Belge Med. Trop., vol. 32, No. 6, pp. 643-644. (Generic description in detail, classification, explanation of name and designation of genotype: *Giroudia longiscutullata* Jadin and Vercammen-Grandjean, 1952.)
1952. *Giroudia* JADIN AND VERCAMMEN-GRANDJEAN, Ann. Soc. Belge Med. Trop., vol. 32, No. 6, p. 637. (Brief generic description, explanation of name and designation and description of genotype: *Giroudia longiscutullata* Jadin and Vercammen-Grandjean, 1952.)

The genus *Giroudia* includes two unusual gahrlepiines from the Belgian Congo. The above citation of Vercammen-Grandjean alone as the author of the genus is based upon the obvious intention of both Jadin and Vercammen-Grandjean rather than upon a strict interpretation of the rule of page priority which would result only in confusion. Our citation is in accordance with paragraph 123, Article 28, of the Copenhagen Decisions on Zoological Nomenclature (1953), under which a decision to ignore page priority in special cases may be made by the first reviser.

The presence of well-developed dorsal teeth on the chelicerae serves to separate *Giroudia* from *Gahrlepiea*, although the other characters listed by Vercammen-Grandjean (distance between usurped scutal setae, presence of well-developed eyes, and large size of scutum) apply equally well to certain of the species considered herein by us as *Gahrlepiea* (*Gahrlepiea*).

It is pertinent to discuss some of Jadin and Vercammen-Grandjean's concepts regarding chaetotaxy. Owing to the limited number of species of *Gahrlepiea* available to these authors for study, they designated as "posterolateral setae" those setae which we call *PPL-1*, while the more anterior pair, which we call posterolaterals, were designated as "mediolaterals." In their opinion, the determining factor regarding the homology of the *PL* setae is the level of the maximum breadth of the scutum. The extensive series of *Gahrlepiea* in our possession includes setal patterns never seen by Jadin and Vercammen-Grandjean, and supports our contention that the second pair of scutal setae are the true posterolaterals, regardless of position. Thus, in *G. exilis*, *G. laciniata*, and certain other species, there is no pair of setae at the level of the maximum breadth of the scutum, while the *PLs* are in the site of the "mediolateral setae" (figs. 5 and 110). What we call *PLs* are in this same position in many species which also possess usurped setae at the point of maximum breadth. The second pair of scutal setae, regardless of position, almost invariably are definitely longer and stouter than the usurped setae, and this is another argument for our point of view. In *G. gemina*, new species,



*G. plurisetae*, new species, and *G. hirsuta* (Radford, 1946), according to our belief, the *PLs* have moved anteriorward until they are adjacent to *ALs*, and thus there appear to be two pairs of *ALs*. If such were not the case, and the Jadin and Vercammen-Grandjean theory were correct, in the case of *G. dupliseta* (fig. 70) one would have to postulate the appearance of 2 sets of *ALs*, of which the second pair is more than twice the length of the first, coupled with the disappearance of *PLs* or the migration of the latter well toward the middle of the scutum.

#### HOST PREFERENCE AND HABITATS OF THE SUBGENUS GAHRLIEPIA

Gahrlepiine chiggers have apparently attained their maximum development in the oriental region (Audy, 1954) (in contrast to the New World, for example, where only one species is known). Nevertheless, they are collected far less often than are *Trombicula* and *Euschöngastia* in southeast Asia. This is particularly true of the subgenus *Gahrlepieia*, especially insofar as concerns the species with scrobiculate or honeycombed scutum. Despite intensive collecting in Assam, Burma, Malaya, and Borneo by U. S. Army and Colonial Office Medical Research Units, four scrobiculate species have been described on the basis of only four or fewer specimens, as shown in table 2.

It is quite probable that this scarcity of *Gahrlepieia* in collections is apparent rather than real, and is due to our ignorance of the habits of these chiggers rather than to low numbers in nature. For example, until the 1953 Borneo expedition, *G. ampullata*, new species, was represented by but one specimen, and *G. laciniata*, new species, was known only from three specimens, collected from two different kinds of rats. The latter species was collected readily only when it was discovered that instead of clustering in the ears of the rats, as do most *Trombicula* and many *Euschöngastia*, *G. laciniata* invariably was found singly and the specimens were strongly attached deep in the skin at the base of the stout hairs or vibrissae on the bridge of the nose or muzzle of the hosts. Inasmuch as the chiggers in situ were head down, partially embedded in the hair follicle, and also appressed to the stout hairs in areas where the fur was short and dense, it was difficult to see these *Gahrlepieia* without special search. Since they usually stayed firmly attached even when the host had been dead two days, they were not readily dislodged or activated by the usual collecting techniques. Even the detergent washing method usually failed to dislodge them. Once its particular attachment site was observed,



however, it became easy to collect this species by picking specimens up singly by fine-pointed forceps.

This persistence of attachment after death of the host has been noted for other species of *Gahrlepiea*. Gater called attention to this habit in *G. fletcheri* in the original description (1932). Fuller (1952) refers to similar but unpublished observations made by the U. S. A. Typhus Commission in Burma regarding undescribed species (referring to *G. exilis*, new species, q.v., and the small form of *G. fletcheri* occurring in Assam and Burma).

Perhaps when we learn more about the true hosts, attachment sites, and ecological requirements of these chiggers, they may be collected more readily. There is another possibility worth investigating,

TABLE 2.—*Number of specimens and hosts in type series of certain ornate Gahrlepiea*

| Species of<br><i>Gahrlepiea</i>      | Number of<br>specimens in<br>type series | Number of hosts |         |
|--------------------------------------|------------------------------------------|-----------------|---------|
|                                      |                                          | Individuals     | Species |
| <i>ornata</i> Womersley, 1952.....   | 1                                        | 1               | 1       |
| <i>insigne</i> Womersley, 1952.....  | 1                                        | 1               | 1       |
| <i>decora</i> Womersley, 1952.....   | 7                                        | 1               | 1       |
| <i>picta</i> , new species.....      | 3                                        | 3               | 2       |
| <i>tessellata</i> , new species..... | 8                                        | 5               | 4       |
| <i>evansi</i> , new species.....     | 4                                        | 3               | 2       |
| <i>ampullata</i> , new species.....  | 6                                        | 2               | 1       |
| <i>granulata</i> , new species.....  | 6                                        | 5               | 3       |

and that is that these species may be burrowing forms, similar to *G. penetrans* (q.v., above).

The function of the deeply pitted scutum can only be guessed in the present stage of our knowledge, if indeed there is a function. If the anterior end of a chigger is deeply inserted into a hair follicle or skin (as *G. laciniata*), or if the species completely burrows into the superficial layers of the skin (as *G. penetrans*), the large pits of the scutum may serve to entrap and hold a useful supply of air. It should be pointed out, however, that scrobiculate scuta are not known to occur in chiggers of the genus *Hannemania*, which burrow into or live under the skin of Amphibia, or in *Apolonia tigipioensis* Torres and Braga, which burrows into the quills of chickens.

When discussing host records of chiggers, one must bear in mind a distinction between ecological and physiological host preferences. Ecological host preferences are those infestations of chiggers which are primarily due to the host's predilection for that specific habitat or terrain which is also favored by the nonparasitic stages of the chigger. A variety of mammals living in or entering that microclimate may ac-



quire heavy infestations of such a species of chigger. Physiological host preferences, in contrast, refer to regular or fairly specific infestations of a particular species of host, regardless of the ecological habitat involved. The instance of *Trombicula* (*Leptotrombidium*) *pallida* (Nagayo et al., 1919) in Korea may be cited as an example of ecological preference. Here it was found that 61 percent of the chiggers from the reed vole, *Microtus fortis pelliceus* Thomas, were *T. pallida* (Traub et al., 1953). Such a high percentage at first glance suggests a large degree of host specificity. However, 40 percent of the chiggers on the black-striped field mouse, *Apodemus agrarius mantchuricus* Thomas, also were *T. pallida*, and, in fact, 67 percent of all the *T. pallida* examined were from *A. agrarius*. In contrast, less than 1 percent of the chiggers on the red-backed vole, *Clethrionomys rufocanus regulus* Thomas, were *T. pallida*. *Microtus* could be found only in very specialized habitats—the thick grass growing along the side of a few streams. On the other hand, *Apodemus agrarius* was common everywhere. Along streamsides it was just as abundant as *Microtus*, and it frequently was found in such habitats when *Microtus* was apparently absent. *Clethrionomys* inhabited the woody slopes 150 feet away from such streamsides and never was trapped near the water. *T. pallida* was therefore apparently most prevalent along the margins of streams, and parasitized the mice that inhabited such areas rather than favoring *Microtus* for purely physiological reasons. Unfortunately, the precise ecological requirements are as yet largely unknown for most groups of trombiculids, but it has been shown that the degree of ground moisture is a major factor in determining which of two North American species, *Trombicula* (*Eutrombicula*) *alfreddugesi* (Oudemans) or *T. (E.) splendens* (Ewing), may be found in circumscribed areas, and the two populations may coexist only 100 feet apart (Wharton and Fuller, 1952).

The subgenus *Gahrлиеpia*, as a whole, exhibits some rather pronounced host preferences, which to a great extent are apparently physiological and not ecological. That is, they are apt to be found regularly or frequently on certain kinds of mammals but not on others found in the same environment and with much the same habits, as illustrated in North Borneo on Mount Kinabalu at Tenompak (4,500 feet elevation). Although *Rattus w. whiteheadi* Thomas, *Rattus cremoriventer* Miller, *Rattus a. alticola* Thomas, and *Rattus rajah* Thomas were frequently trapped alongside the lesser gymnuran, *Hylomys suillus dorsalis* Thomas (an insectivore), these mammals differed greatly as regards their infestations of chiggers. *Hylomys*



invariably was very heavily parasitized with chiggers, carrying an average of at least 250 chiggers per individual. Samples of 25 to 75 chiggers from 32 such *Hylomys* have failed to yield any *Gahrliepia*. Twenty-nine of these *Hylomys* had been examined carefully by means of the dissecting microscope and particular attention paid to known anatomical sites for *Gahrliepia*, as along bases of hairs of the snout and in or on the perineum. On the other hand, certain of the rats, particularly *Rattus whiteheadi* and *R. alticola*, living in the immediate vicinity were parasitized with *Gahrliepia*, as shown in table 3. The tree shrews, *Tupaia montana baluensis* Lyon, frequently trapped or shot on the ground in the same environment as the *Hylomys* and *Rattus*, never carried *Gahrliepia* even though inevitably very heavily infested with chiggers. Many specimens of *Trombicula* and *Euschöngastia* were collected from ground-dwelling and tree-dwelling squirrels, but no *Gahrliepia* were ever taken, as noted in the table. The absence of *Gahrliepia* on tree-dwelling squirrels may be partially ecological in nature.

The subgenus *Gahrliepia* in general exhibits much the same sort of host preference as indicated for the Borneo species just discussed. We have been able to locate a total of 720<sup>15</sup> actual specimens or individual specific determinations of *Gahrliepia* in the literature. Of these, 462 specimens (64 percent) were from various species of rats; 107 (15 percent) were from shrews, 114 (16 percent) were from *Tupaia*, a tree shrew; 14 specimens were from moles; 31 from ground-dwelling squirrels (*Menetes* and *Lariscus*); one from an African bat (i.e., *G. nanus*), and one from a Malayan *Hylomys*. It will be noted that no specimens are listed as having been from amphibians, reptiles, birds, or tree squirrels. However, Gater mentions an unspecified number of *G. fletcheri* as having been collected on the tree-dwelling *Callosciurus caniceps* Gray. The other references in the literature, which cite only hosts and do not include data on numbers of specimens, all mention only ground-dwelling rodents or insectivores as hosts. Despite the fact that *Gahrliepia* specimens are collected only relatively infrequently, as compared to *Trombicula* and *Euschöngastia*, it is safe to conclude that the subgenus mainly parasitizes rats, mice, shrews, and tree shrews, and rarely if ever occurs on tree squirrels or birds or cold-blooded vertebrates.

The subgenus *Gahrliepia* includes a relatively high proportion of species that have been found only in the primary forest. Although these species have been collected only infrequently, it is probable that

---

<sup>15</sup> It is reiterated that this number refers to individual specimens or records of such, and not to numbers of collections or to hosts.



TABLE 3.—Comparison of certain mammals as hosts for Gahrlepiea (Gahrlepiea) species and for other chiggers at Tenompak region (4,500 feet elevation), Mount Kinabalu, North Borneo

| Host                                    | Habitat | <i>Gahrlepiea</i><br><i>lactiniata</i> | <i>Gahrlepiea</i><br><i>tuberculata</i> | <i>Gahrlepiea</i><br><i>penetrans</i> | <i>Gahrlepiea</i><br><i>granulata</i> | <i>Gahrlepiea</i><br><i>ampullata</i> | <i>Trombicula</i><br>species | <i>Euschönogastia</i><br>species |
|-----------------------------------------|---------|----------------------------------------|-----------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|------------------------------|----------------------------------|
| <i>Rattus whiteheadi</i> .....          | G.      | 0                                      | Few                                     | Rare(?)                               | Rare                                  | Rare                                  | Common                       | Common                           |
| <i>Rattus alticola</i> .....            | G.      | Common                                 | 0                                       | 0                                     | Few                                   | 0                                     | Rare                         | Few                              |
| <i>Rattus sabanus</i> .....             | G.      | Rare                                   | Few                                     | 0                                     | 0                                     | 0                                     | Few                          | Common                           |
| <i>Rattus rajah</i> .....               | G.      | Rare                                   | Few                                     | 0                                     | 0                                     | 0                                     | 0                            | 0                                |
| <i>Hylomys suillus</i> .....            | G.      | 0                                      | 0                                       | 0                                     | 0                                     | 0                                     | Common                       | Common                           |
| <i>Callosciurus notatus</i> .....       | T.      | 0                                      | 0                                       | 0                                     | 0                                     | 0                                     | Common                       | Common                           |
| <i>Callosciurus nigrovittatus</i> ..... | T.      | 0                                      | 0                                       | 0                                     | 0                                     | 0                                     | Common                       | Common                           |
| <i>Callosciurus hippurus</i> .....      | T.      | 0                                      | 0                                       | 0                                     | 0                                     | 0                                     | Common                       | Common                           |
| <i>Callosciurus adamsi</i> .....        | T.      | 0                                      | 0                                       | 0                                     | 0                                     | 0                                     | Common                       | Common                           |
| <i>Glyphotes sinus</i> .....            | T.      | 0                                      | 0                                       | 0                                     | 0                                     | 0                                     | Common                       | Common                           |
| <i>Dremomys everetti</i> .....          | T. & G. | 0                                      | 0                                       | 0                                     | 0                                     | 0                                     | Common                       | Common                           |
| <i>Nannosciurus whiteheadi</i> .....    | T. & G. | 0                                      | 0                                       | 0                                     | 0                                     | 0                                     | Common                       | Common                           |
| <i>Callosciurus jentinki</i> .....      | T. & G. | 0                                      | 0                                       | 0                                     | 0                                     | 0                                     | Common                       | Common                           |
| <i>Tupaia montana</i> .....             | T. & G. | 0                                      | 0                                       | 0                                     | 0                                     | 0                                     | Common                       | Common                           |
| <i>Dendrogale melanura</i> .....        | T. & G. | 0                                      | 0                                       | 0                                     | 0                                     | 0                                     | Common                       | Common                           |

0 = absence of chiggers; G. = ground-dwelling host; T. = tree-dwelling host; T. & G. = hosts dwelling on both trees and ground.



they are true denizens of the uncut jungle because these forms were never taken in secondary vegetation or scrub terrain despite particularly intensive collecting therein by the U. S. A. Typhus Commission, the U. S. Army Medical Research Units, and the Colonial Office Medical Research Unit. The following are therefore considered inhabitants of *primary* forest: *G. exilis*, new species, *G. neterella*, new species, *G. gemina*, new species, *G. evansi*, new species, *G. picta*, new species, *G. laciniata*, new species, *G. tessellata*, new species, *G. crenulata*, new species, *G. cetrata* Gater, 1932, *G. ornata* Womersley, 1952, *G. decora* Womersley, 1952, *G. insigne* Womersley, 1952, and *G. rutila* Gater, 1932. The following chiggers are known only from the *mountain* forests of Borneo or Malaya (elevation approximately 4,500-5,500 feet): *G. laciniata*, *tessellata*, *ampullata*, *penetrans*, *granulata*, and *cetrata*. Ten of the eleven scrobiculate ("ornate") species (all except *G. tuberculata*, new species) are included in this list of jungle forms.

#### SUMMARY

The subgenus *Gahrliepia* includes 33 species, of which 3 are African and the remainder from Asia. Eighteen new species, from Burma, Assam, Thailand, Malaya, and Borneo are described and figured in detail. All previously known species are discussed, and critical structures are illustrated where possible. A key to the species is included. *Gateria* Ewing, 1938, is considered an outright synonym of the subgenus *Gahrliepia* as here defined. It is pointed out that the rarity of many of the species of *Gahrliepia* may be apparent rather than real, owing to our ignorance of the true hosts and particular sites of attachment of the chiggers. Thus, one new scrobiculate ("ornate") chigger, *G. (G.) laciniata*, was found in abundance only after it was noted that, unlike most trombiculids, this chigger did not attach to the ears, but instead attached at the bases of the stout spiny hairs on the muzzle of the host, *Rattus alticola*. *G. penetrans*, new species; another scrobiculate form from Borneo, burrows completely into the perineum of the host, *Rattus whiteheadi*. Names and data for additional new species follow, and those with a scrobiculate scutum are marked with an \*: *exilis* (primary jungles of North Burma); *fimbriata* (North Burma); *darita* (Assam and North Burma); *neterella* (from various jungle-inhabiting rats in Malaya); *tenella* (Malaya); *elbeli* (from *Menetes*, a ground-inhabiting squirrel in Thailand); *tylana* (from *Bandicota* and *Menetes* in Thailand); *gemina* (from rats and shrews in primary jungle in North Burma); *dupliseta* (Assam); *plurisetae* (from the shrew *Suncus*, Assam);



*evansi* \* (from *Rattus* in primary forest of North Burma); *picta* \* (from jungle-inhabiting *Rattus* in Malaya); *tessellata* \* (from various *Rattus* and from a ground squirrel and gymnuran in the primary jungle in Malaya); *tuberculata* \* (from several kinds of rats in various ecological formations in Borneo); *ampullata* \* (North Borneo); *granulata* \* (North Borneo rats in mountain forest).

#### ACKNOWLEDGMENTS

We are grateful to Dr. J. R. Audy, director of the Division of Virus Diseases and Medical Zoology, Institute for Medical Research, Kuala Lumpur, who was also director of the Colonial Office Medical Research Unit, for his great assistance in obtaining specimens from Malaya and Borneo. Dr. Audy also kindly allowed us to use his unpublished notes based upon a study of types in the British Museum. Thanks are likewise due to those who served with the senior author while with the United States of America Typhus Commission in Assam and Burma and with the U. S. Army Medical Research Units in Borneo and Malaya, particularly Dr. H. S. Fuller, Dr. Kenneth Stager, D. D. Millspaugh, and Roy Melvin of the former organization, and Capt. H. D. Newson, Capt. Bryce C. Walton, Robert E. Elbel, and Dr. David H. Johnson of the latter.

The North Borneo field projects were greatly facilitated by the whole-hearted cooperation of the residents of the west coast (the Honorable Mr. Sykes and the Honorable Mr. Combe), and that of other North Borneo officials, such as Dr. William L. Neal, Director of Medical Services, Dr. T. K. Abbott, Acting Director of Medical Services, and T. White and J. P. Vyvyan, assistant district officers, Ranau. The following members of the Colonial Office Medical Research Unit greatly assisted in obtaining specimens in Borneo: John L. Harrison, Ben Insoll, Phang Ang Wah, M. Nadchatram, and Lim Boo-Liat. The Thai species were received through the cooperation of Robert E. Elbel of the U. S. Special Technical and Economic Mission to Thailand, and through the offices of the Thai Division of Communicable Diseases, particularly Dr. Pramern Chandavimol, chief of the division, and Dr. Mali Thaineua, director of the Banpong Plague Laboratory. We are indebted to Thomas Evans of the Department of Entomology, Army Medical Service Graduate School, Walter Reed Army Medical Center, Washington, D. C., for having prepared the illustrations. H. Womersley of the South Australia Museum kindly furnished us with study specimens of some of the little-known *Gahrliopia*. Dr. H. S. Fuller, now with our depart-



ment, generously allowed us access to his manuscript notes on a study of Radford's types at the British Museum. We are also grateful to Dr. Fuller for critically reviewing sections of our manuscript.

## REFERENCES CITED

AUDY, J. R.

1954. Malaysian parasites, III. A summary review of the collections of trombiculid mites in the Asiatic-Pacific area. Stud. Inst. Med. Res. Malaya, vol. 26, pp. 29-44.

CARNEIRO, L. S.

1949. Parasitose humana provocada per *Apollonia tegipioiensis* (sic) Torres e Braga, 1938 (Trombidiidae). Bol., S.A.I.C., vol. 16, Nos. 3-4, pp. 3-8.

EWING, H. E.

1931. A catalogue of the Trombiculinae, or chigger mites, of the New World with new genera and species and a key to the genera. Proc. U. S. Nat. Mus., vol. 80, art. 8, pp. 1-19.

FULLER, H. S.

1952. The mite larvae of the family Trombiculidae in the Oudemans collection: taxonomy and medical importance. Zool. Verh., No. 18, pp. 1-261.

GATER, B. A. R.

1932. Malayan trombidiid larvae, I (Acarina: Trombidiidae), with descriptions of seventeen new species. Parasitol., vol. 24, No. 2, pp. 143-174.

HARRISON, J. L., and AUDY, J. R.

1951. Hosts of the mite vector of scrub typhus. I. A check-list of the recorded hosts. Ann. Trop. Med. and Parasitol., vol. 45, Nos. 3-4, pp. 171-185.

HIRST, S.

1915. On some new acarine parasites of rats. Bull. Ent. Res., vol. 6, pp. 183-190.

JADIN, J., and VERCAMMEN-GRANDJEAN, P. H.

1952. Les Trombiculidae larvaires du Ruanda-Urundi. Ann. Soc. Belge Med. Trop., vol. 32, No. 6, pp. 593-656.

LAWRENCE, T. J.

1947. Species of trombiculid mites in Manipur and Burma. In Audy, J. R., et al., Scrub typhus investigations in South East Asia. III, Appendices, Appendix 7, 6 pp. London War Office, Army Medical Directorate 7. March.

LIPOVSKY, L. J.

1951. A washing method of ectoparasite recovery with particular reference to chiggers (Acarina—Trombiculidae). Journ. Kansas Ent. Soc., vol. 24, No. 4, pp. 151-156.

RADFORD, C. D.

1946. New species of larval mites (Acarina: Trombiculidae) from Manipur State, India. Proc. Zool. Soc. London, vol. 116, No. 2, pp. 247-265.



TRAUB, R., and EVANS, T. M.

1954. Malayan parasites, VI. Indo-Malaysian mites of the subgenus *Schöngastiella* (Hirst). Stud. Inst. Med. Res., Malaya, vol. 26, pp. 87-107.

A revision of the subgenus *Walchia* (Acarina: Trombiculidae). (MS. in preparation.)

TRAUB, R.; HERTIG, M.; LAWRENCE W.; and HARRISS, T.

1953. Entomological observations during studies on epidemic hemorrhagic fever in Korea, May-December, 1952. Preliminary Rep., Ann. Meet. Commission on Hemorrhagic Fever of the Armed Forces Epidemiological Board, Office of the Surgeon General (U. S. Army), Washington. January.

WHARTON, G. W., and FULLER, H. S.

1952. A manual of the chiggers. Mem. Ent. Soc. Washington, No. 4, pp. 1-185.

WOMERSLEY, H.

1952. The scrub-typhus and scrub-itch mites (Trombiculidae, Acarina) of the Asiatic-Pacific region. Rec. South Australia Mus., vol. 10, pp. 1-435.





Traub, Robert and Morrow, Mary Lou. 1956. "A revision of the chiggers of the subgenus Gahrliopia (Acarina: Trombiculidae)." *Smithsonian miscellaneous collections* 128, 1–89.

**View This Item Online:** <https://www.biodiversitylibrary.org/item/86739>

**Permalink:** <https://www.biodiversitylibrary.org/partpdf/91898>

**Holding Institution**

Smithsonian Libraries and Archives

**Sponsored by**

Smithsonian

**Copyright & Reuse**

Copyright Status: Public domain. The BHL considers that this work is no longer under copyright protection.

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.