THE MITE LARVAE OF THE FAMILY TROMBICULIDAE IN THE OUDEMANS COLLECTION: TAXONOMY AND MEDICAL IMPORTANCE[1])

by

HENRY S. FULLER[2])

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1) From the Department of Microbiology, Harvard School of Public Health, Boston, Massachusetts.

2) Assistant Professor of Microbiology, Harvard School of Public Health. These studies were made in 1946-1947, during tenure of a Moseley Travelling Fellowship awarded by Harvard Medical School.

INTRODUCTION

The mites of the family Trombiculidae are of particular interest to the parasitologist and to the medical entomologist. In their larval stage only, they are parasitic upon several classes of vertebrates, including amphibians, reptiles, birds and mammals. A few species have been recorded for arthropods, which are the usual hosts of larvae of the closely allied family Trombidiidae. Man is an accidental host for trombiculid larvae. In certain parts of eastern Asia and the adjacent Pacific region, these larvae may transmit the rickettsial disease known as scrub typhus (tsutsugamushi disease). During World War II, many troops of Allied land forces were exposed to the hazard of infection, and this disease became a major military medical problem in certain commands. Thus it is not surprising that recent years have been marked by intensive studies of this group of mites. The writer's interest in the group as disease vectors was aroused while he was in Burma, and he subsequently became engaged in full time work on the epidemiology of scrub typhus. Since the cessation of hostilities, the writer's studies have been devoted to the taxonomy of trombiculid mites.

In attempting to make the precise identifications which are essential to critical work in applied entomology, it is apparent that reference to original type material is frequently necessary. Furthermore, a dependable, up-to-date catalogue is a sine qua non of sound taxonomy, and at present there is no such catalogue of trombiculid mites. With these points in mind, the writer has been compiling a catalogue, and has availed himself of every opportunity to study type specimens.

Numerous species of Trombiculidae were described by the great Dutch acarologist, Dr. A. C. Oudemans, and several others are also represented in his collection. This collection of specimens and drawings is preserved in excellent condition in the Rijksmuseum van Natuurlijke Historie, Leiden, Holland. A preliminary catalogue of the Acarina in the Oudemans collection was published by Buitendijk (1945).

The purpose of the present paper is to report the writer's studies of the species of trombiculid mites represented in this collection. In doing so, it seems essential to make the treatment of each species as complete as possible. For purposes of orientation, and in the hope of making the paper useful to others, the writer has included original keys to subfamilies, genera, and in some instances, to species. It is repeatedly emphasized that our concepts of this group are in a state of flux, as will be easily appreciated by those who study these mites. This fact must be borne in mind, and the present paper is to be regarded as a preliminary effort in the field of taxonomy.

GENERAL REMARKS

At present the mites of this family are best known in the larval stage. Approximately three hundred species have been based on larval forms, and the nymphal and adult stages have been described for relatively few of these. In a small number of instances, the larvae, nymphs, and adults are known for a given species. The explanation lies in the fact that these mites are most easily accessible in nature in the parasitic larval stage, attached to a host. It is a difficult task to find nymphs and adults in the field. Until the reports of Michener (1946), Wharton and Hardcastle (1946), Wharton (1946), and Jenkins (1947), there was no uniformly satisfactory method available for rearing colonies of these mites in the laboratory. Furthermore, investigators were hampered by the misconceptions of their predecessors, concerning the food habits of nymphs and adults. Japanese workers stated that these stages fed upon vegetable matter. Other reports strongly suggested that they were coprophagous in habit. However, those who have maintained biologically successful colonies of these mites have found it necessary to provide living arthropods as food material for the free-living stages. Thus it appears that the nymphs and adults are predatory.

Jenkins (1947) has listed the following stages in the life history of three species of *Eutrombicula* studied by him: egg, deutovum, larva (unfed, feeding on host, fed), nymphochrysalis, nymph, imagochrysalis, and adult.

The family is worldwide in distribution. Some species are highly host specific, while others accept a wide variety of hosts. The medically important species belong to the latter group. *Trombicula akamushi* (Brumpt, 1910), and *T. akamushi* var. *deliensis* Walch, 1922, are the known important vectors of scrub typhus (tsutsugamushi disease). The following species attack man with the production of itching local lesions at the site of attachment: *Eutrombicula alfreddugèsi* (Oudemans, 1910); *E. batatas* (Linnaeus, 1758); *E. brasiliensis* (Ewing, 1925); *E. masoni* (Ewing, 1943); *E. samboni* (Womersley, 1939); *E. wichmanni* (Oudemans, 1905); *Euschöngastia nuñezi* (Hoffmann, 1944); *Schöngastia katonis* Womersley and Heaslip, 1943; *S. schüffneri* (Walch, 1922); *S. vandersandei* (Oudemans, 1905); *Trombicula autumnalis* (Shaw, 1790); *T. desaleri* Methlagl, 1928; and *Acomatacarus australiensis* (Hirst, 1925).

The writer has found little detailed information on the veterinary importance of the Trombiculidae. Two species are reported to be injurious to young domestic fowl in the United States: *Eutrombicula alfreddugèsi* (Oudemans, 1910), and *Neoschöngastia americana* (Hirst, 1921). *Trombicula autumnalis* (Shaw, 1790) has been reported as attacking dogs, goats, fowl, and other domestic animals in Europe. The potential role of these mites as

vectors of pathogenic organisms to domestic animals has not been studied.

The systematic position of the Trombiculidae is a matter of considerable interest to students of the group. The phylogeny of the higher categories of the Acarina is a controversial subject, and it is not the writer's purpose to discuss it here. The majority of published interpretations of group phylogenetic relationships are based on adult characters. Relatively few genera of Trombiculidae are known as adults. Thus it is impossible to integrate most of the genera into a classification based on adults. These questions have been considered and reviewed by André and Lamy (1937, Les Idées actuelles sur la Phylogénie des Acariens). They have reproduced the schematic table published by Sig Thor (1928), concerning the phylogeny of the various groups of Acarina. They adopted a classification in which the Trombidiidae (and consequently the Trombiculidae) fall into the order Holacarina, suborder Trombidiiformes (Thrombidiiformes), superfamily Prostigmata, section Parasitengona.

Vitzthum (1943) divided the Acarina into six suborders, of which the fourth is Trombidiformes Reuter, 1909. This is divided into three cohors: Tarsonemini Canestrini and Fanzago, 1877; Endeostigmata Grandjean, 1937; and Prostigmata Kramer, 1877. The Prostigmata are divided into the subcohors Eleutherengona Oudemans, 1909, and Parasitengona Oudemans, 1909. Forty-four families are grouped under Parasitengona, of which the family Trombidiidae is the first. In dividing the Trombidiidae into ten subfamilies, Vitzthum adopted the classification of Sig Thor (1935), in which the sixth subfamily is Trombiculinae Ewing, 1929.

Oudemans, cited by Sig Thor and Willmann (1947, pp. 514-516), was concerned with the phylogeny and inter-relationships of the subfamilies of Trombidiidae, based on studies of adult morphology. His interpretations were based on the following hypothesis: That many dorsal shields are more primitive than few; that the crista is a rudimentary dorsal shield; that two areolae with two sensillae are more primitive than one, and this in turn is more primitive than none (loss of the structure); that groups with two double eyes are more primitive than those with two single eyes, and these in turn are older than blind forms; that eyes with movable stalks are more recent than immovable eyes; that shear-like mandibles are more primitive than sickle-like mandibles; and that simple hairs are more primitive than feathered, combed, forked, or ramified hairs.

Oudemans then derived a key to the subfamilies of Trombidiidae, in which the adult Trombiculinae are distinguished by the following characters: propodosoma with a crista, either united with a shield, or lying free in the integu-

ment; a single pair of pseudostigmata, which arise in an area sensilligera; a single eye on each side, or blind; body constricted in the middle; integument without platelets; hairs long, thin, and ciliated; no "Nase".

A problem of the future is the study of adult stages of as many species as possible, with a view to a clear understanding of the genera and subfamilies now based on larvae. The present classification of Trombiculidae is obviously but a preliminary step, and studies of larvae must eventually be correlated with those of nymphs and adults.

It is noted by Brennan (1947, p. 245) that the descriptive terms used in the diagnosis of species, in the absence of a standardized terminology, have been applied somewhat loosely, primarily for convenience and secondarily because of our inadequate knowledge of the morphology of larval Trombiculidae. The writer's terminology follows that used in the publications of Wharton and Brennan. The stated number of scutal setae is understood to be exclusive of the pseudostigmatic organs. When a pattern for dorsal setae is expressed as a formula, the setae are understood to be counted in convex rows. In naming scutal setae of *Schöngastiella* Hirst, 1915, *Gahrliepia* Oudemans, 1912, and *Gateria* Ewing, 1938, the posterior lateral (PL) setae are understood to be the second marginal pair.

Womersley and Heaslip (1943) proposed a series of measurements for the scutum and dorsal setae. As pointed out by Brennan (1947), these are taken from centers of setal and sensillary bases, and recorded in micra (microns). Brennan defined the measurements in a very precise manner, and the writer has adopted his definitions with slight modifications. The terms "standard data", and "standard measurements", have been applied in the literature. In the present paper, abbreviations are used as follows:

AW — distance between bases of anterior lateral setae.
PW — distance between bases of posterior lateral setae.
SB — distance between bases of pseudostigmatic organs.
ASB — perpendicular distance between one sensillary base and anterior scutal margin.
PSB — perpendicular distance between one sensillary base and posterior scutal margin.
AP — distance between bases of anterior lateral and posterior lateral setae.
AM — length of anterior median seta.
AL — length of anterior lateral seta.
PL — length of posterior lateral seta.
SENS — length of pseudostigmatic organ (sensilla).
DSA — length of a dorsal seta from anterior row.
DSP — length of a dorsal seta from posterior row.
SD — length (depth) of scutum; in many instances equal to ASB plus PSB.

The writer has preserved the original orthography of specific names, not attempting to make them agree in gender with a generic name whose gender

may be other than that of the genus in which the species was originally described. The writer agrees with the school of thought which maintains that a name is only a name. References are cited, using the abbreviations in World List of Scientific Periodicals, published in the years 1900-1933, edited by W. A. Smith, 1934, Oxford University Press, 779 pages. When synonymy is proposed by an author, it is indicated in parentheses following the reference by a brief note or comment. The writer has followed Oudemans (1912) in dating certain of Trägårdh's species from 1904, although some authorities date them from 1905. The monograph of Trombidiidae by Sig Thor and Willmann was received too late for references to be included under each species. It has been reviewed by the writer, and it does not affect any of the synonymy proposed in the present paper.

METHODS OF STUDY

The obvious source of larvae is the infested host. Wild hosts may be trapped alive or dead, or they may be shot. Live trapping is essential if one is studying infestation rates. Suitable hosts may be confined in cages or pens in likely areas in the field, and this use of bait animals has been described by numerous workers. Unfed larvae of some species can be obtained from the observer's shoes, or on white dishes, or pieces of cardboard placed on the surface of the ground. Cockings (1948) found that flagging, as applied to the collection of Ixodidae, is not useful in obtaining trombiculid larvae. Cockings' field light trap is applicable to the collection of large numbers of unattached larvae in appropriate places.

Nymphs and adults have been collected mainly by the laborious process of flotation of surface soil, or debris obtained from burrows, tree holes, bromeliads, bat guano, etc. Attempts to use a Berlese funnel type of apparatus for this purpose have not proved successful in the writer's hands.

In order to obtain engorged larvae which have dropped naturally from their hosts, the writer recommends the laboratory light trap devised by Cockings. In choosing rearing methods, one must define his objectives. If correlations of larvae, nymphs and adults are desired for systematic purposes, it is necessary to use individual rearing containers. If large numbers or colonies are desired for experimental purposes, methods similar to those used by Jenkins (1947) will be applicable The writer ventures to suggest that a table "meadow", as described by Smith, *et al.* (1946), in their study of the tick, *Dermacentor variabilis* (Say), would yield valuable information on the movements and activities of the different stages in natural surroundings. In any event, the provision of food is essential, remembering that the nymphs and adults whose feeding habits are known are predaceous

upon small arthropods, and that they may become cannibalistic if adequate food is not provided. Cultures must be free of contamination by unwanted predatory arthropods, including the various and ubiquitous predatory mites. Clean culture containers can usually be protected from contamination by surrounding them with bibulous paper impregnated with dimethyl- or dibutyl-phthalate, but DDT is not satisfactory for this purpose. The control of temperature, humidity, and gross moisture droplets, is essential, and information on these matters is contained in the references listed below.

Eighty-five per cent alcohol (ethyl) is satisfactory for preservation of unmounted larvae, nymphs, or adults.

Many mounting media have been devised. One group of formulae consists of chloral hydrate, plus gum acacia or arabic, water, acetic, lactic, or carbolic acid, and other substances in various proportions. Subsequent crystallization may obscure the preparation, necessitating remounting, as discussed by Womersley and Heaslip (1943).

A medium which is widely used in the Unted States at present is made of polyvinyl alcohol, "P. V. A.". Dr. George W. Wharton has kindly supplied the following directions for its preparation:

1. Dissolve "Elvanol" 71-24 (Du Pont polyvinyl alcohol) in four volumes of water by stirring at about 90° C.

2. Filter the solution until it is no longer murky.

3. Concentrate the clear filtrate on a water bath until it has the viscosity of corn syrup. (A scum will form on the surface during the process of evaporation, but it will redissolve when stirred into the solution).

4. Add 22 parts of chemically pure glacial lactic acid to 56 parts of the P. V. A. concentrate to make the finished mounting medium.

5. Use like any mountant. Materials may be mounted directly from life, or from any aqueous solution, or alcohol.

Some workers add a small amount of picric acid to the mountant. This serves to outline certain delicate structures which may be difficult to distinguish otherwise. The exact amount to be added must be determined by trial and error.

The writer deplores the use of potassium hydroxide or similar strong alkalies for clearing trombiculid mites, even when followed by the use of a dye for staining. He has examined numerous preparations treated in this manner. They are usually unsatisfactory because important structures have been distorted, or rendered invisible, or destroyed.

A method of shipping quantities of living trombiculid mites is described by Farrell and Wharton (1948).

Useful methods for the demonstration of rickettsial infection in trom-

biculid mites are described and previous work is reviewed by Davis, *et al.* (1947).

Finally, the reader's attention is drawn to the useful reference sources contained in the publications of Ewing (1944), Farner and Katsampes (1944), Blake, *et al.* (1945), and Sig Thor and Willmann (1947). The writer has found so many mistakes in the bibliography published by Williams (1944) that he hesitates to recommend it to other workers.

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The original drawings in this paper were made by Miss Pamela Sanina, of the Department of Entomology, London School of Hygiene and Tropical Medicine. The writer is indebted to Prof. Dr. H. Boschma for permission to include Oudemans' original unpublished drawings of *Eutrombicula wichmanni* (Oudemans, 1905), *Neoschöngastia salmi* (Oudemans, 1922), and *Walchia disparunguis* (Oudemans, 1929).

The studies reported in this paper were made during 1946-1947, while the writer held a Moseley Travelling Fellowship, granted by Harvard Medical

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Family TROMBICULIDAE Ewing, 1944

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It is difficult to formulate a precise definition that will characterize the larval and adult mites which belong to this group. As noted by Wharton (1947), our present concepts of this family and its larval genera are based mainly on the work of Dr. H. E. Ewing. In 1929 Ewing separated "chiggers" from other genera of mites then included in the family Trombidiidae Leach, proposing for them the subfamily Trombiculinae. At that time he gave a key to the larvae of the following genera: *Hannemania* Oudemans, 1911; *Leeuwenhoekia* Oudemans, 1911; *Schöngastia* Oudemans, 1910; *Neoschöngastia* Ewing, 1929; *Odontacarus* Ewing, 1929; and *Trombicula* Berlese, 1905. The subfamily was actually defined by giving a synopsis of the genera which it comprised.

In 1931 Ewing gave a key to the genera included in his subfamily Trombiculinae, adding descriptions of two new genera. He emphasized that the larvae of most species are normally parasitic upon vertebrates. He stated that the boundaries of the subfamily should be restricted to those given originally by Berlese to his collective genus *Trombicula,* but this statement is not helpful with regard to larvae, since Berlese was concerned only with adults. Ewing did not specify the morphological characters which separated the *larvae* of his subfamily from those of other Trombidiidae.

In 1935 Sig Thor discussed a division of the Trombidiidae into ten subfamilies, of which eight were new. He listed the genera which he included in the Trombiculinae. Sig Thor's classification into subfamilies was followed by Vitzthum (1940-1943), and by Sig Thor and Willmann (1947), the Trombiculinae being maintained at subfamily level.

In 1938 Ewing gave a key to fifteen larval genera of Trombiculinae recognized at that time. He stated that the only genera included in the subfamily were those whose species were believed to have vertebrates as their natural hosts. The distinction was thus maintained on biological grounds, and supplementary data of a morphological nature were not given. In 1942 Ewing wrote, "Chiggers are parasitic larvae of mites of the subfamily Trombiculinae and infest vertebrates exclusively".

In 1944 Ewing elevated the group to full familial rank, separating it from the Trombidiidae. However, morphological criteria for separating the larvae from those of the Trombidiidae were not given. In a comprehensive paper published in the same year, Ewing gave a revised key to the genera of Trombiculidae, based on larval characters, but he did not tell the reader how to distinguish them from the larvae of Trombidiidae.

Sig Thor and Willmann (1947) have given a key based on larval characters. In this key, the Trombiculinae (consequently Trombiculidae) are separated on the basis of having a single, median, dorsal scutum, which bears only one pair of sensillary hairs or pseudostigmatic organs. These characters serve to separate them from most of the Trombidiidae. The assignment of the following larval genera is regarded by the writer as controversial, and his present opinion is that they do not belong to the Trombiculidae: *Heterotrombidium* Verdun, 1909; *Blankaartia* Oudemans, 1911; *Polydiscia* Methlagl, 1928; *Manriquia* Boshell and Kerr, 1942; *Womersleyia* Radford, 1946; and *Nothotrombicula* Dumbleton, 1947. (These last three genera were not treated by Sig Thor and Willmann, but are included here for the sake of completeness).

Apparently the first clear definition of the family Trombiculidae from the standpoint of larval morphology is that given by Wharton (1947). According to his definition, the Hemitrombiculinae Ewing, 1944, are excluded. On the basis of the writer's examination of the type material of *Hemitrombicula simplex* Ewing, 1938, he agrees with Wharton's action. For purposes of clarity, Wharton's definition of larval Trombiculidae is reproduced herewith:

"*Larval Diagnosis*: Chelicerae with two segments; the basal segment stout and muscular, the distal segment a sclerotized curved blade with or without projections called teeth. Palps with five segments: the basal segments are fused along the midline and have a median anterior laminar projection that extends beyond the basal segment of the chelicerae, and a pair of lateral wings or galeae that curl dorsad about the chelicerae and bear a seta on each side, each basal segment also bears a seta posterior to the junction with the palpal femur; the second palpal segment or femur bears a single seta; the

third or genu bears a single seta; the fourth or tibia has three setae; one dorsal, one lateral, and one ventral and a terminal palpal claw; the fifth or tarsus articulates ventrally with the tibia and opposes the palpal claw in thumb-like fashion, it bears several setae (usually eight) the basal one of which is a striated sensory seta. The body is usually red in color but may be almost colorless; it bears: a dorsal plate or scutum at the level of the anterior two pairs of legs, usually two pairs of eyes that flank the scutum, several rows of dorsal setae, several rows of ventral setae, occasionally a posterior plate or a posterior group of specialized setae, a ventral anus, three pairs of legs, an urstigma or sclerotized pit associated with the posterior distal angle of coxa I, and at times a pair of tracheal trunks that open through stigmata in the region of the gnathosoma. The scutum bears from three to six marginal scutal setae or infrequently more and a pair of pseudostigmata from which the sensillae or pseudostigmatic organs arise. The legs are composed of six segments if the femur is undivided and of seven if the femur consists of a basifemur and telofemur".

If one combines these morphological characters with the biological fact that the larvae are *usually* parasitic upon vertebrates, he has a clear conception of those larvae which can be referred to the family Trombiculidae. It is probable that phylogenetic significance can be attributed to this selective parasitism of vertebrates, but the exceptions cannot be disregarded. At this time the writer is unable to discuss the phylogeny of the group as a whole, or of the contained genera.

Objections have been raised to Ewing's elevation of Trombiculinae to familial rank, on the ground that it is inconsistent to do this without granting familial rank to the other subfamilies of Trombidiidae. This may be so, but the writer's studies are not sufficiently extensive to qualify him to discuss this matter. For the present, therefore, the Trombiculidae will be retained as a separate family, comprising four subfamilies, as indicated by Wharton (1947):

Key to Subfamilies of Trombiculidae.

1.	All legs with six segments, two setae on coxa I	Leeuwenhoekiinae
	First pair of legs with seven segments	2
2(1).	Legs II and III with six segments	Walchiinae
	Legs II and III with seven segments	3
3(2).	With true stigmata and tracheae	Apoloniinae
	True stigmata and tracheae absent	Trombiculinae

The subfamily Apoloniinae Wharton, 1947, is not represented in the Oudemans collection.

Subfamily TROMBICULINAE Ewing, 1929

1929. Trombiculinae Ewing, Manual of External Parasites, p. 22.
1931. Trombiculinae Ewing. Ewing, Proc. U. S. nat. Mus., *80,* no. 2908, Art. 8, pp. 1-19.
1935. Trombiculinae Ewing. Sig Thor, Zool. Anz., *109,* nos. 5/6, pp. 109-110.
1937. Trombiculinae —. Ewing, Proc. biol. Soc. Wash., *50,* pp. 167-174.
1937. Trombiculinae Ewing. Womersley, Rec. S. Aust. Mus., *6,* no. 1, pp. 78-82.
1938. Trombiculinae —. Ewing, J Wash. Acad. Sci., *28,* no. 6, pp. 288-295.
1941. Trombiculinae —. Willmann, Zool. Anz., *133,* nos. 5/6, pp. 131-136.
1941. Trombiculinae —. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, *5,* Abt. IV, Buch 5, Lfg. 4, p. 532.
1942. Trombiculinae Ewing. Vitzthum, *op. cit.,* Lfg. 6, pp. 828-829.
1942. Trombiculinae Ewing. Boshell and Kerr, Rev. Acad. Colomb. Ciencias Exact., *5,* no. 17, pp. 110-127.
1942. Trombiculinae —. Ewing, J. Parasit., *28,* no. 6, pp. 485-493.
1943. Trombiculinae —. Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 68-142.
1944. Trombiculinae —. Hoffmann, Tesis, Univ. Nac. Mexico, pp. 48-59.
1944. Trombiculinae Ewing. Womersley, Trans. roy. Soc. S. Aust., *68,* no. 1, pp. 83-102.
1944. Trombiculinae Ewing. Ewing, J. Parasit., *30,* no. 6, pp. 344, 345-348.
1945. Trombiculinae —. Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, pp. 56-76.
1946. Trombiculinae —. Taylor, Comm. Aust. Serv. Publ. no. 6, pp. 145-234.
1946. Trombiculinae Ewing. Michener, Ann. Ent. Soc. Amer., *39,* p. 349.
1946. Trombiculinae Ewing. Ewing, J. Parasit., *32,* no. 5, p. 435.
1947. Trombiculinae Ewing. Sig Thor and Willmann, Das Tierreich, Acarina 3, Lfg. 71 b, pp. 196, 198, 251-354, 484, 516.
1947. Trombiculinae Ewing. Wharton, J. Parasit., *33,* no. 4, p. 381.

Prior to Ewing's recognition of a family as distinct from Trombidiidae, the history of this subfamily has been summarized in the discussion of the family. In deciding what genera are to be included in the Trombiculinae, the writer has followed Wharton (1947). He pointed out that *Odontacarus* Ewing, 1929, belongs in the Leeuwenhoekiinae. The remainder of genera are those included by Ewing (1946).

The following characters are common to the described genera of larval Trombiculinae: spiracles and tracheae absent; all legs composed of seven segments; scutum bearing a single anterior median seta, in addition to lateral scutal setae; eyes present or absent; four or more sternal setae; pseudostigmatic organs flagelliform or clavate.

The included genera can be separated by the following key:

Key to the Genera of Larval Trombiculinae Ewing, 1929.

1.	Empodium swollen	*Riedlinia* Oudemans, 1914
	Empodium claw-like, not swollen	2
2(1).	Chelicerae with several terminal or subterminal processes	3
	Chelicerae blade-like	4
3(2).	With eyes	*Oenoschöngastia* Womersley and Kohls, 1947
	Without eyes	*Myotrombicula* Womersley and Heaslip, 1943

4(2). With nine scutal setae . . . . . *Heaslipia* Ewing, 1944
With less than nine scutal setae 5
5(4). Pseudostigmatic organs expanded distally 6
Pseudostigmatic organs filiform or flagelliform 12
6(5). Caudal plate present . . . *Guntherana* Womersley and Heaslip, 1943
No caudal plate 7
7(6). Scutum partially submerged beneath cuticular striae . . . . . *Neoschöngastia* Ewing, 1929
Scutum not at all submerged 8
8(7). Coxa II with more than one seta . . . . *Doloisia* Oudemans, 1910
Coxa II with a single seta 9
9(8). Chelicerae with a single dorsal tooth 10
Chelicerae with several dorsal teeth 11
10(9). Posterior lateral setae on scutum . . . *Euschöngastia* Ewing, 1938
Posterior lateral setae not on scutum . . *Ascoschöngastia* Ewing, 1946
11(9). Chelicerae with three to six large, prominent, recurved, dorsal hooks, which increase in size proximally . . . . *Endotrombicula* Ewing, 1931
Chelicerae with a series of dorsal teeth which diminish in size proximally . *Schöngastia* Oudemans, 1910
12(5). With seven scutal setae . . *Novotrombicula* Womersley and Kohls, 1947
With less than seven scutal setae 13
13(12). Scutum with three setae, i.e., posterior lateral setae not on scutum . . *Tecomatlana* Hoffmann, 1947
Scutum with five setae 14
14(13). Anterior lateral setae short, stout, peg-like . . *Fonsecia* Radford, 1942
Anterior lateral setae elongate, normal 15
15(14). Palpal claw simple, not forked . . . . . *Crotiscus* Ewing, 1944
Palpal claw forked 16
16(15). Palpal claw consistently bifurcate, the inner prong being the smaller (accessory) one; scutum of large dimensions, not produced posteriorly; tarsus III bearing at least one long, nude, whip-like seta . . . *Eutrombicula* Ewing, 1938
Without this combination of characters . . . . . *Trombicula* sensu lato of authors, as applied to larvae, not necessarily of Berlese, 1905

Eight of the above genera are represented in the Oudemans collection. Certain of these genera contain the Trombiculinae whose larvae are believed to be of medical importance.

Genus **Trombicula** Berlese, 1905

Genotype: *Trombicula minor* Berlese, 1905, by monotypy.

1905. *Trombicula* Berlese, Redia, *2,* fasc. 2, p. 155.
1909. *Thrombidium* —. Oudemans, Tijdschr. Ent., *52,* nos. 1/2, pp. 19-60, in part: *muscae* Oudemans; *russicum* Oudemans; *inopinatum* Oudemans; and *meridionale* Oudemans.
1912. *Microthrombidium* (*not* of Haller, 1882) Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 5-45, in part: *russicum* Oudemans; *bruyanti* Oudemans; *pusillum* (*not* of Hermann) Oudemans; *muris* Oudemans; *fahrenholzi* Oudemans; *trägårdhi* Oudemans; *ardeae* Trägårdh; and *minutissimum* Oudemans.
1912. *Trombicula* Berlese. Berlese, Redia, *8,* pp. 9, 12, 14, 15-17, 83-98.

1915. *Trombicula* —. Banks, U. S. Dept. Agric., Rept. no. 108, p. 43.
1916. *Leptotrombidium* Nagayo, Miyagawa, Mitamura and Imamura, Dobuts. Zasshi, *28,* pt. 10, no. 336, pp. 392-394.
1917. *Leptotrombidium* Nagayo, Miyagawa, Mitamura and Imamura, Verh. jap. path. Ges., *7,* p. 135.
1917. *Leptotrombidium* Nagayo, *et al.* Miyajima and Okumura, Kitasato Arch., 1, no. *1,* no. 1, p. 13. (These authors cite Nagayo, *et al.,* Iji-shinshi, no. 958, September, 1916, but the writer has not seen the paper. It would antedate the paper in Dobuts. Zasshi by one month).
1917. *Kedania* Kishida, Iji Shimbun, no. 974, pp. 671-675, with figures; May 25. (Latin names in Latin characters; description in Japanese characters).
1918. *Trombicula* Berlese. Kitashima and Miyajima, Kitasato Arch., *2,* nos. 2-3, pp. 188-191.
1920. *Trombicula* Berlese. Ewing, Ann. ent. Soc. Amer., *13,* no. 4, pp. 381-390.
1921. *Leptotrombidium* Nagayo, *et al.* Toomey, Urol. and Cut. Rev., *25,* p. 606.
1921. *Microtrombidium* (*not* of Haller, 1882) Toomey, *loc. cit.,* p. 606.
1925. *Trombicula* —. Ewing, Amer. J. trop. Med., *5,* no. 3, pp. 256-260.
1925. *Neotrombicula* Hirst, Nature, *116,* p. 209.
1926. *Trombicula* Berlese. Ewing, Ent. News, *37,* no. 4, pp. 111-113.
1927. *Trombicula* Berlese. Stiles and Hassall, Hyg. Lab. Bull. no. 148, p. 269 (equals *Neotrombicula* Hirst, 1925; *Leptotrombidium* Nagayo, *et al.,* 1916, synonyms).
1928. *Trombicula* Berlese. Methlagl, Denkschr. Akad. Wiss. Wien, *101,* pp. 214-218, 221-225.
1928. *Trombicula* —. Ewing, Proc. ent. Soc. Wash., *30,* no. 5, pp. 77-80.
1929. *Trombicula* —. Stiles and Nolan, Hyg. Lab. Bull. no. 152, p. 485.
1929. *Microtrombidium* —. Stiles and Nolan, *op. cit.,* p. 485.
1929. *Trombicula* Berlese. Hirst, Proc. zool. Soc. Lond., 1929, pp. 172-174.
1929. *Trombicula* —. Oudemans, Tijdschr. Ent., *72* Suppl., pp. 343, 346.
1929. *Trombicula* Berlese. Vitzthum, Tierwelt Mitteleuropas, *3,* Lfg. 3, pp. 61, 63, 67, 68.
1929. *Trombicula* Berlese. Ewing, Manual of External Parasites, pp. 22, 23-25 (equals *Leptotrombidium* Nagayo, *et al.,* 1916; and *Neotrombicula* Hirst, 1925, synonyms).
1930. *Thrombicula* Berlese. André, Mém. Soc. zool. Fr., *29,* no. 2, pp. 108-110: emendation.
1931. *Trombicula* Berlese. Ewing, Proc. U. S. Nat. Mus., *80,* no. 2908, Art. 8, pp. 2, 6-10.
1931. *Trombicula* Berlese. Vitzthum, Z. Parasitenk., *4,* Heft 1, p. 7.
1931. *Otonyssus* Kolenati. Vitzthum, *op. cit.,* pp. 7-8.
1931. *Trombicula* Berlese. Vitzthum, Kükenthal's Handbuch der Zoologie, *3,* 2nd half (9), pp. 59, 67, 146.
1932. *Trombicula* Berlese. Gater, Parasitology, *24,* no. 2, pp. 145-146 (equals *Microthrombidium* Oudemans, 1909, 1912; *Leptotrombidium* Nagayo, *et al.,* "1917" (sic), synonyms).
1933. *Trombicula* —. Ewing, Proc. U. S. nat. Mus., *82,* no. 2970, Art. 29, pp. 1-6.
1934. *Trombicula* Berlese. Womersley, Rec. S. Aust. Mus., *5,* no. 2, pp. 213-214, 217.
1935. *Trombicula* Berlese. Sig Thor, Zool. Anz., *109,* nos. 5/6, p. 109.
1935. *Neotrombicula* Hirst. Sig Thor, *op. cit.,* p. 110: subgenus.
1936. *Pentagonella* Sig Thor, Zool. Anz., *114,* nos. 1/2, pp. 29-30.
1936. *Trombicula* Berlese. Womersley, J. Linn. Soc. (Zool.), *40,* no. 269, pp. 110-114.
1937. *Otonyssus* Kolenati. Oudemans, Kritisch Historisch Overzicht der Acaralogie, III, D, pp. 1362-1364: designates *Trombicula minor* Berlese, 1905, as genotype. (Synonymy: equals *Microthrombidium* Oudemans, 1912 (*not Microtrombidium* Haller, 1882); and *Trombicula* Berlese, 1905, synonyms).
1937. *Trombicula* —. Ewing, Proc. biol. Soc. Wash., *50,* pp. 170-171.

1937. *Trombicula* Berlese. Womersley, Rec. S. Aust. Mus., *6,* no. 1, pp. 79-81 (equals *Neotrombicula* Hirst, 1925, synonym).
1937. *Pentagonella* Sig Thor. Womersley, *op. cit.,* p. 80.
1938. *Trombicula* Berlese. Neveu-Lemaire, Traité d'Entomologie etc., pp. 479-493.
1938. *Microtrombidium* (*not* of Haller, 1882) Neveu-Lemaire, *op. cit.,* pp. 479, 493-494, in part: *M. fahrenholzi* Oudemans, and *M. guineense* Bruyant and Joyeux.
1938. *Trombicula* Berlese. Ewing, J. Wash. Acad. Sci., *28,* no. 6, pp. 291, 292: *not* a synonym of *Otonissus* Kolenati, 1856.
1938. *Leptotrombidium* Nagayo, *et al.* Ewing, *op. cit.,* p. 292 (equals *Neotrombicula* Hirst, 1925, synonym).
1939. *Trombicula* Berlese. Torres and Braga, Bol. Sec. Agr. Indust. Com., *4,* pp. 39, 42.
1939. *Trombicula* Berlese. Gunther, Proc. Linn. Soc. N. S. W., *64,* pts. 1-2, nos. 281-282, pp. 78-81.
1939. *Trombicula* Berlese. Womersley, Trans. roy. Soc. S. Aust., *63,* pt. 2, pp. 152-154.
1939. *Leptotrombidium* Nagayo, Miyagawa, Mitamura and Imamura. Neave, Nomenclator Zoologicus, II, p. 922.
1940. *Neotrombicula* Hirst. Neave, *op. cit.,* III, p. 313.
1940. *Trombicula* Berlese. Neave, *op. cit.,* IV, p. 577.
1940. *Kedania* Kishida. Neave, *op. cit.,* IV Suppl., p. 741: citing Tanaka, *et al.,* 1930, Zbl. Bakt., *116* (1), p. 353.
1940. *Trombicula* Berlese. Gunther, Proc. Linn. Soc. N. S. W., *65,* pts. 3-4, nos. 289-290, pp. 252-254.
1940. *Trombicula* Berlese. Gunther, Proc. Linn. Soc. N. S. W., *65,* pts. 5-6, nos. 291-292, pp. 479-481.
1940. *Trombicula* —. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 3, pp. 381, 384.
1941. *Trombicula* Berlese. Willmann, Zool. Anz., *133,* nos. 5/6, pp. 131-136: redescription of the genotype.
1941. *Trombicula* —. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 4, pp. 527, 622, 624, 625.
1941. *Pentagonella* —. Vitzthum, *op. cit.,* Lfg. 4, pp. 624, 625.
1942. *Trombicula* Berlese. Vitzthum, *op. cit.,* Lfg. 6, p. 828 (equals *Neotrombicula* Hirst, 1925, synonym; probably equals *Otonissus* Kolenati, 1856, synonym); two subgenera: *Trombicula* s. str. (equals *Leptotrombidium* Nagayo 1917 (sic), synonym); *Eutrombicula* Ewing, 1938.
1942. *Pentagonella* Sig Thor. Vitzthum, *op. cit.,* p. 829.
1942. *Trombicula* Berlese. Radford, Parasitology, *34,* no. 1, pp. 57-64, 79.
1942. *Trombicula* Berlese. Womersley, Rec. S. Aust. Mus., *7,* no. 2, pp. 173-174.
1943. *Trombicula* Berlese. Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 72, 73-79, including *Pentagonella* Sig Thor, 1936, as a subgenus.
1944. *Trombicula* Berlese. Hoffmann, Tesis, Univ. Nac. Mexico, pp. 48, 51-55.
1944. *Trombicula* Berlese. Ewing, J. Parasit., *30,* no. 6, p. 346.
1945. *Trombicula* Berlese. Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, pp. 14-15, 58, 60-69 (equals *Pentagonella* Sig Thor, 1936, synonym).
1945. *Trombicula* —. Wharton, J. Parasit., *31,* no. 6, p. 401.
1946. *Trombicula* Berlese. Ewing, Proc. biol. Soc. Wash., *59,* p. 23.
1946. *Trombicula* Berlese. Michener, Ann. ent. Soc. Amer., *39,* pp. 431-433 (equals *Pentagonella* Sig Thor, 1936, synonym).
1946. *Leptotrombidium* Nagayo, *et al.* Michener, *op. cit.,* pp. 431-432.
1946. *Kedania* Kishida. Michener, *op. cit.,* pp. 431-432: validity of publication not yet established.
1946. *Megatrombicula* Michener, *op. cit.,* pp. 432-434.
1946. *Neotrombicula* Hirst. Ewing, J. Parasit., *32,* no. 5, p. 437.

1946. *Trombicula* Berlese. Taylor, Comm. Aust. Serv. Publ. no. 6, pp. 147-177.
1946. *Trombicula* —. Wharton, Proc. ent. Soc. Wash., *48,* no. 7, pp. 171-178.
1946. *Pentagonella* Sig Thor. Ewing, J. Parasit., *32,* no. 5, p. 437.
1947. *Trombicula* Berlese. Radford, Proc. zool. Soc. Lond., *116,* pt. III, pp. 585-593.
1947. *Trombicula* Berlese. Philip, Amer. J. Hyg., *46,* no. 1, p. 61.
1947. *Leptotrombidium* Nagayo, *et al.* Philip, *op. cit.,* pp. 61, 64 (equals *Kedania* Kishida, 1917, synonym).
1947. *Trombicula* Berlese. Dumbleton, Trans. roy. Soc. N. Z., *76,* pt. 3, pp. 412-413.

This genus is based on an inadequately described adult mite, which was thought, for many years, to be a nymph, until Willmann (1941) redescribed the type material. Willmann's findings have been discussed by Ewing (1944). The larva of the genotype has not been associated with the adult, although Gunther (1939) erroneously concluded that he had done so. As things stand at present, therefore, the inclusion of larvae in this genus is more or less a matter of speculation. However, the adults which have been correlated with their larvae are sufficiently close to *T. minor* Berlese, 1905, to warrant the tentative inclusion of the larvae and related larval forms in this genus, provided it is understood that the generic name is used in a broad, collective sense. Furthermore, studies of certain adults of *Eutrombicula* Ewing, 1938, suggest that they may be congeneric with *T. minor* Berlese, 1905. Thus the possibility of synonymy must be borne in mind, but for the present the species whose larvae are considered to be related to the genotype of *Eutrombicula* have been maintained in that genus. The remainder of larvae with certain characters in common have been referred to *Trombicula sensu lato,* as applied to larvae by various authors. This corresponds to *Trombicula "sensu stricto"* as defined by Michener (1946, p. 432, and footnote), also applied to larvae. It does not necessarily infer *Trombicula sensu stricto* Berlese (1905, 1912), as applied by him to adult or nymphal forms.

Species whose larvae possess the following characters are referred to the collective genus *Trombicula sensu lato*: legs consisting of seven segments; spiracles and tracheae absent; pseudostigmatic organs flagelliform, with or without cilia; five normal scutal setae: one anterior median, two anterior laterals, and two posterior laterals; scutum of various forms, sometimes produced posteriorly to form an angle; coxae I and II unisetose; coxa III bearing one or more setae; palpal claw consisting of at least two prongs, but when consisting of only two prongs, the associated characters that would warrant inclusion in *Eutrombicula* are lacking; presence or absence of one or more long, nude, whip-like setae on one or more segments of leg III not accompanied by characters that would warrant inclusion in *Eutrombicula.* (The inclusion of negative statements is open to criticism). This broad definition merely serves to group together many unrelated species. The

situation is comparable to that existing many years ago, when the majority of fleas were placed in the genus *Pulex* Linnaeus, 1758. The recognition of genera and/or subgenera will be a slow process, if it is to be done on a sound basis.

Precedent for the present application of *Trombicula* to larvae has been set by previous authors, as discussed by Michener (1946, pp. 431-432). According to the writer's studies of the literature, this generic name was first applied to a larval form by Kneissl (1916). From larvae of *T. autumnalis* (Shaw, 1790), collected off *Talpa europaea*, he reared several nymphs, and on this basis he assigned the species to the genus *Trombicula*. His publication, appearing January 11, 1916, antedates any validly published Japanese usage of the generic name known to the writer. It is possible that further research may reveal an earlier application to larvae.

Through the kindness of Dr. C. B. Philip, the writer has seen a translation of the article by Miyajima and Okumura (1917, Saikingaku Zasshi, no. 266 (November 10), pp. 893-908), in which they applied the name *Trombicula* to certain Japanese and Formosan species. They mentioned earlier reports, but apparently failed to cite exact references. Ewing (1938) stated that the generic name appeared to have been first applied to a larval form of the subfamily Trombiculinae by Kitashima and Miyajima (1918); but this is antedated by the references cited above.

Before discussing possible generic groups within *Trombicula sensu lato*, it is necessary to consider Oudemans' application of *Otonyssus* Kolenati, 1858, to trombiculid mite larvae. In 1856 Kolenati described seven species in the genus *Otonissus* (sic). The following were described as having eight legs: *O. aurantiacus, O. flavus, O.* var. *puniceus,* and *O. pinnipes.* It is difficult to regard any eight-legged Acarina as Trombiculid larvae, unless one can see the actual specimens and convince himself that the original description was incorrect. Three species were described as having six legs: *O. amplificatus, O. moneta* and *O. seminulum.* According to Stiles and Nolan (1931, citing Neumann (1911)), the three species described with six legs are all probably larvae of the tick, *Argas vespertilionis* (Latreille, 1796).

The name *Otonissus* Kolenati, 1856, was later emended to *Otonyssus* Kolenati, 1858, but no genotype was ever designated by Kolenati. The genus has been discussed under the emended name by Oudemans (1937), who designated *Trombicula minor* Berlese, 1905, as genotype. He assumed that Kolenati's description of four species and his figure of one of these as eight-legged constituted a lapsus. He stated that the larva described and figured by himself as *Microthrombidium russicum* (Oudemans, 1902) is the same as one of Kolenati's species. Then, citing Hirst (1926), he pointed

out that in 1912 he had treated as *Microthrombidium pusillum* the species which we now know as *Trombicula autumnalis* (Shaw, 1790). Thus he assumed that *russicum* and *autumnalis* are congeneric, and this is open to question. He then concluded that *Otonyssus* Kolenati, 1856 (sic) = *Microthrombidium* Oudemans, 1912 (*not Microtrombidium* Haller, 1882) = *Trombicula* Berlese, 1905.

It is possible that *Otonissus* Kolenati, 1856, may eventually be found to apply to some of the trombiculid larvae found on bats. But the writer cannot see that it is applicable at present to any known species. Furthermore, Oudemans did not settle anything by designating *Trombicula minor* Berlese, 1905, as the type of Kolenati's genus. According to Article 30 of the International Rules of Zoological Nomenclature, species which were not included under the generic name at the time of its original publication are excluded from consideration in determining the types of genera. This view is restated in Opinion 35. It is true that Opinion 62 states that Article 30 does not exclude the type species of other genera from consideration in the selection of the type of a given genus. But Oudemans failed to present actual evidence indicating that *Trombicula minor* Berlese, 1905, based on an adult mite from Java, is conspecific with any known European or Egyptian bat mite corresponding to one of Kolenati's species. Such data, to be critical, would of necessity be based on correlations of larval and post-larval stages, and this information is lacking. Thus, according to the writer's interpretation, the designation by Oudemans (1937, p. 1362) of *Trombicula minor* Berlese, 1905, as type species of any of Kolenati's genera is not valid, and it has no standing under the International Rules and Opinions. Perhaps the most constructive approach to the problem of the application of *Otonissus* Kolenati, 1856, to trombiculid larvae is that of Willmann (1941, p. 136), whose ideas have been incorporated in the above discussion. Other writers who have considered the matter are Ewing (1938) and Vitzthum (1942). Buitendijk (1945) included in *Otonyssus* many species in the Oudemans collection labelled as *Trombicula* or *Microtrombidium,* and which the present writer has referred to *Trombicula sensu lato, Eutrombicula* Ewing, 1938, *Crotiscus* Ewing, 1944, *Schöngastia* Oudemans, 1910, *Euschöngastia* Ewing, 1938; and in one instance (larvae only), to a new genus. The fault lies not in Buitendijk's catalogue, but in the labels on the slides from which the catalogue was made. Oudemans (1938, Tijdschr. Ent., *81* (Verslag), pp. VIII-IX) corrected his error and recognized *Trombicula* as a distinct genus, not a synonym of *Otonissus* or *Otonyssus.*

Within the assemblage of species referred to *Trombicula sensu lato,* exclusive of those species known only as nymphs or adults, there are certain

groups of larvae to which generic names have been applied. These will be considered in chronological order of proposal.

Leptotrombidium Nagayo, Miyagawa, Mitamura and Imamura, 1916, was monotypic for *Trombidium akamushi* Brumpt, 1910. *Kedania* Kishida, 1917, was proposed for *Kedania tanakai* Kishida, 1917, which is assumed to be synonymous with *T. akamushi,* as discussed later in detail. (Kishida's paper of 1909 is not considered to constitute a valid publication, and his names are dated from 1917). Therefore *Kedania* Kishida, 1917, must be regarded as a synonym of *Leptotrombidium* Nagayo, *et al.,* 1916. Nagayo, *et al.* (1921) included certain species in a tsutsugamushi group, without defining the limits thereof. Walch (1923, 1924) considered that *T. deliensis* Walch, 1922, and *T. keukenschrijveri* Walch, 1924, belonged to this tsutsugamushi group. *Leptotrombidium* was synonymized under *Trombicula* Berlese, 1905, by Stiles and Hassall (1927), Ewing (1929), Gater (1932), and Vitzthum (1942); while Ewing (1938) considered that *Neotrombicula* Hirst, 1925, was a synonym of *Leptotrombidium.* Wharton (1946) has defined the tsutsugamushi group as possessing the following larval characters: palpal segment I bearing a plumose seta; II and III bearing nude setae; IV, dorsal seta plumose, lateral and ventral setae nude; galeal seta plumose; chelicerae with a lateral angular expansion of the basal segment (epistome, tectum, of other authors). Wharton definitely included the following species: *T. akamushi* (Brumpt, 1910), with its synonyms, *T. fletcheri* Womersley and Heaslip, 1943, and *T. obscura* Womersley, 1944; *T. pallida* Nagayo, *et al.,* 1919; *T. scutellaris* Nagayo, *et al.,* 1920; *T. intermedia* Nagayo, *et al.,* 1920; *T. deliensis* Walch, 1922; and *T. fulleri* Ewing, 1945. Wharton (1947) pointed out that *T. myotis* Ewing, 1929, also belongs to this group. The writer has noted that *T. russicum* (Oudemans, 1902) is also a member of the group, as defined by Wharton. The definition of this group will probably be modified in the light of future studies, and eventually it may merit subgeneric or generic standing.

Neotrombicula Hirst, 1925, was monotypic for *T. autumnalis* (Shaw, 1790), based on the unusually elongate nymph of this species, first described by Hirst. It is noteworthy that several other species have larvae whose scutum is similar in size and shape to that of *T. autumnalis* (Shaw, 1790), but for the most part their nymphs and adults are unknown. They are discussed in a paper by Philip and Fuller, in press. At present it is not possible to define clearly the limits of the group of species whose larvae appear to be related to *T. autumnalis* (Shaw, 1790). If further data, including the rearing of nymphs and adults, indicate the need for generic separation of this group of "harvest mites", then *Neotrombicula* Hirst would apply.

Pentagonella Sig Thor, 1936, was proposed for *Trombidium ardeae* Trägårdh, 1904, genotype, to include certain other species with a pentagonal scutum. Sig Thor also referred the following species to it: *P. fahrenholzi* (Oudemans, 1910); *P. trägårdhi* (Oudemans, 1910); *P. muris* (Oudemans, 1910); *P. acuscutellaris* (Walch, 1922); and *P. yorkei* (Sambon, 1928). The writer has examined authentic specimens of all except *P. fahrenholzi*. *P. yorkei* is actually not even close to *P. ardeae,* and the writer would exclude it from this group. *P. acuscutellaris* shares many characters with *P. ardeae,* and they are obviously congeneric, no matter to what degree splitting is carried. *P. muris* and *P. trägårdhi* are of dubious relationship, and they may eventually prove to be closer to *T. autumnalis* (Shaw, 1790) than to the type of *Pentagonella.* Full generic standing was accorded *Pentagonella* by Vitzthum (1942). It was regarded as a subgenus of *Trombicula* by Womersley and Heaslip (1943), and as a synonym by Michener (1946). The writer believes that its standing cannot be decided, nor its limits defined, on the basis of available data.

Megatrombicula Michener, 1946, was proposed as a subgenus for a group of Neotropical species. The type is *Trombicula alleei* Ewing, 1926, and Michener also included *T. (M.) peruviana* Ewing, 1926; *T. (M.) velascoi* Boshell and Kerr, 1942; and *T. (M.) attenuata* Michener, 1946. Although Michener's criteria apparently separate a distinctive group of adults, it seems to the writer that the larvae are close to the genotype of *Pentagonella* Sig Thor, 1936. Since the writer has not studied specimens, however, he is not in a position to make further comments at this time.

Some authors, notably André, spell the generic name as *Thrombicula.* This matter has been discussed by Gater (1932, pp. 145-146), who cited Opinion 34 of the International Commission on Zoological Nomenclature. The point is that since evidence of the ultimate Greek derivation of the word is not contained in the original publication, the original spelling should be preserved. Thus the writer has followed Gater and others in adhering to Berlese's spelling of the generic name.

A synopsis of larval species referred to *Trombicula sensu lato* would be premature at this time, and the construction of a critical and useful key requires further studies. Therefore the writer has had to be content to discuss the apparent relationships of the thirteen species of this "genus" contained in the Oudemans collection. These have been grouped under the following headings:

Tsutsugamushi group — *T. akamushi* (Brumpt, 1910); *T. akamushi* var. *deliensis* Walch, 1922; and *T. russicum* (Oudemans, 1902).

Neotrombicula group — *T. autumnalis* (Shaw, 1790).

Borderline group, between *Neotrombicula* and *Pentagonella* — *T. muris* (Oudemans, 1910); *T. trägårdhi* (Oudemans, 1910); and *T. fahrenholzi* (Oudemans, 1910).

Pentagonella group — *T. ardeae* (Trägårdh, 1904); *T. acuscutellaris* Walch, 1922.

Miscellaneous group, relationship not clear — *T. bruyanti* (Oudemans, 1910); *T. minutissimum* (Oudemans, 1910); *T. muscae* (Oudemans, 1906); and *T. schmitzi* (Oudemans, 1916).

Trombicula akamushi (Brumpt, 1910)

1910. *Trombidium akamushi* Brumpt, Précis de Parasitologie, p. 506; fig. 335.
1912. Gen. ? *sp.* ? (sic) Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 4-5, 201.
1913. *Trombidium akamushi* Brumpt. Brumpt, Précis de Parasitologie, 2nd ed., pp. 566-567; fig. 365.
1913. *Trombidium akamushi* Brumpt. Galli-Valerio, Zbl. Bakt., 1 Abt. Ref., *56,* nos. 5/6, pp. 132, 141, 142, 144.
1915. *Microtrombidium akamushi* (Brumpt). Hirst, J. econ. Biol., *10,* pt. 4, pp. 79-82; figs. 1, 2.
1915. *Microtrombidium brumpti* Hirst, *op. cit.,* p. 82.
1916. *Trombidium akamushi* —. Miyajima and Okumura, Saikingaku Zasshi, no. 253, pp. 1-16; plates.
1916. *Leptotrombidium akamushi* —. Nagayo, Miyagawa, Mitamura and Imamura, Dobutsugaku Zasshi (Zool. Mag., Tokyo), *28,* pt. 10, no. 336, pp. 392-394; 423: genotype by monotypy.
1916. *Leptotrombidium akamushi* —. Nagayo, *et al.,* Taiwan Igakkai Zasshi, no. 168, Oct. 28, p. 859. (Cited in review in Chin. med. J., 1917, *31,* p. 179).
1916. *Trombidium akamushi* —. Miyajima and Okumura, Saikingaku Zasshi, no. 254, Nov. 20, pp. 5-38; plates. (Cited in review in Chin. med. J., 1917, *31,* p. 344).
1916. *Trombidium akamushi* —. Tanaka, Tokyo Igakkai Zasshi, *30,* no. 22, pp. 49-51; plate. (Cited in review in Chin. med. J., 1917e *31,* p. 347).
1917. *Microtrombidium akamushi* (Brumpt). Hirst, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 6, p. 24; pl. I.
1917. *Leptotrombidium akamushi* (Brumpt). Nagayo, Miyagawa, Mitamura and Imamura, J. exp. Med., *25,* no. 2, pp. 255-272; pls. 24-27.
1917. *Leptotrombidium akamushi* (Brumpt). Nagayo, *et al.,* Verh. jap. path. Ges., *7,* pp. 133-135.
1917. *Leptus akamushi* (Brumpt). Miyajima and Okumura, Kitasato Arch., *1,* no. 1, pp. 1-14; text-fig. 1; plates.
1917. *Trombidium akamushi* —. Miyajima and Okumura, Saikingaku Zasshi, no. 266, pp. 893-908; plates. (Cited in review in Chin. med. J., 1919, *33,* pp. 371-374).
1918. *Microthrombidium* sp. Ewing and Hartzell, J. econ. Ent., *11,* no. 2, p. 259.
1918. *Leptus akamushi* (Brumpt). Kitashima and Miyajima, Kitasato Arch., *2,* nos. 2-3, pp. 171-191, 243; text-fig. 3 a-g; pl. VII, fig. 1 a-c.
1918. *Trombicula coarctata* (*not* of Berlese) Kitashima and Miyajima, *op. cit.,* pp. 190-191, 243; pl. VIII, fig. 1 a-c: adult.
1918. *Trombidium akamushi* Brumpt. Teodoro, Redia, *13,* pp. 105-114.
1918. *Leptus akamushi* (Brumpt). Teodoro, *op. cit.,* p. 108.
1919. *Trombicula akamushi* (Brumpt). Hatori, Ann. trop. Med. Parasit., *13,* no. 3, p. 241 (equals *Leptus akamushi,* editor's note, *loc. cit.*).

1920. *Trombicula coarctata* (*not* of Berlese) Ewing, Ann. ent. Soc. Amer., *13,* no. 4, pp. 382-384, 389, 390; fig. 1 a-c (equals *Trombidium akamushi* Brumpt; *Microtrombidium brumpti* Hirst, synonyms).
1921. *Leptotrombidium brumpti* (Hirst). Toomey, Urol. and Cut. Rev., *25,* p. 602; figure.
1921. *Leptotrombidium akamushi* (Brumpt). Toomey, *op. cit.,* pp. 603, 606.
1921. *Thrombidium akamushi* Brumpt. Toldt, Wien, klin. Wschr., *34,* no. 34, p. 412.
1921. *Trombicula akamushi* (Brumpt). Kawamura and Yamaguchi, Kitasato Arch., *4,* no. 3, pp. 182, 184, 185, 186, 201-202; pl. II, figs. 1-7 (larva); pl. III, figs. 1-6 (post-larval stages).
1921. *Trombicula akamushi* (Brumpt). Nagayo, Miyagawa, Mitamura, Tamiya and Tenjin, Amer. J. Hyg., *1,* nos. 5-6, pp. 569-591; pl. XXXIV, figs. 1, 2; pl. XXXV, fig. 11; pl. XXXVI, fig. 13; pl. XXXVII, fig. 18; pl. XXXVIII, figs. 23-28.
1922. *Trombicula akamushi* (Brumpt). Brumpt, Précis de Parasitologie, 3rd ed., pp. 729-730; fig. 402 A-G.
1922. *Trombidium akamushi* —. Ribeyro and Bambarén, Arch. Asoc. Peruana Prog. Ciencia, *2,* no. 2, p. 115.
1922. *Trombicula akamushi* (Brumpt). Mukoyama, Trans. jap. path. Soc., *12,* p. 47.
1922. *Trombicula akamushi* (Brumpt). Walch, Geneesk. Tijdschr. Ned. Ind., *62,* no. 5, pp. 554-558, 565, 568.
1923. *Trombicula akamushi* —. Walch, Kitasato Arch., *5,* no. 3, pp. 66, 71-75.
1924. *Trombicula akamushi* (Brumpt). Walch, Trans. 5th Bienn. Congr. Far East Assoc. trop. Med. (1923), pp. 583, 584, 588, 589, 615-619.
1924. *Trombicula akamushi* —. Walch and Keukenschrijver, Geneesk. Tijdschr. Ned. Ind., *64,* pp. 247, 255, 260.
1924. *Trombicula akamushi* —. Walch, Geneesk. Tijdschr. Ned. Ind., *64,* pp. 514-517, 524.
1925. *Trombicula akamushi* —. Fletcher and Lesslar, Bull. Inst. med. Res., F. M. S., no. 2 of 1925, pp. 9, 11.
1925. *Trombicula akamushi* (Brumpt). Ewing, Amer. J. trop. Med., *5,* no. 3, pp. 255-256.
1925. *Trombicula akamushi* (Brumpt). Walch, Kitasato Arch., *6,* no. 3, pp. 237, 246-247.
1925. *Trombicula coarctata* (*not* of Berlese) Miller, Ohio Agric. Exp. Sta. Bull. 386, p. 118.
1926. *Trombicula akamushi* (Brumpt). Bequaert, Med. Rept. Hamilton Rice Seventh Exped. etc., pp. 152, 176.
1926. *Trombicula akamushi* (Brumpt). Kawamura, Studies on Tsutsugamushi Disease, pp. 182-302, 205, 207; pl. XVIII, fig. 41; pl. XIX, fig. 50; pl. XX, figs. 51-55; pl. XXII, figs. 62-65; pl. XXIII, figs. 66-69.
1926. *Trombicula akamushi* —. Ewing, Ann. ent. Soc. Amer., *19,* no. 3, p. 266.
1927. *Trombicula akamushi* (Brumpt). Stiles and Hassall, Hyg. Lab. Bull. no. 148, pp. 266, 269, 270 (equals *Trombicula coarctata* of Japanese authors, not of Berlese, 1888; *Microtrombidium brumpti* Hirst, 1915, synonyms).
1927. *Trombicul akamushi* —. Fletcher and Field, Bull. Inst. med. Res., F. M. S., no. 1 of 1927, pp. 1, 18, 19, 23.
1927. *Trombicula akamushi* —. Walch, Geneesk. Tijdschr. Ned. Ind., *67,* p. 927.
1928. *Trombicula akamushi* (Brumpt). Methlagl, Denkschr. Akad. Wiss. Wien, *101,* pp. 216, 223, 224.
1928. *Trombicula akamushi* (Brumpt). Ewing, Proc. ent. Soc. Wash., *30,* no. 5, pp. 78, 80.
1928. *Trombicula akamushi* (Brumpt). Warburton, Parasitology, *20,* no. 2, p. 228.
1929. *Trombicula akamushi* (Brumpt). Ewing, Manual of External Parasites, pp. 23-24; fig. 10.
1929. *Trombicula akamushi* —. Patton and Evans, Insects, Mites etc., pp. 646-647, 687, 688; figs. 350, 351.

1929. *Trombicula akamushi* —. Stiles and Nolan, Hyg. Lab. Bull. no. 152, p. 485.
1929. *Trombicula akamushi* —. Hirst, Ann. Mag. nat. Hist., Ser. 10, *3,* p. 565.
1929. *Trombicula akamushi* (Brumpt). Vitzthum, Z. Parasitenk., *2,* Heft *2,* pp. 235-236; fig. 4.
1929. *Trombicula akamushi* (Brumpt). Hirst, Trans. roy. Soc. S. Aust., *53,* p. 24.
1930. *Trombicula akamushi* —. Lewthwaite, Bull. Inst. med. Res., F. M. S., no. 1 of 1930, p. 40.
1930. *Trombicula akamushi* (Brumpt). Kawamura, Chapter XXVI in Handbuch der pathogenen Mikroorganismen, by Kolle and Wassermann, 3 Aufl., *8,* pt. 2, pp. 1405-1410; figs. 15-20.
1930. *Thrombicula* (sic) *akamushi* (Brumpt). Gater, Trans. 8th Congr. Far East. Assoc. trop. Med., pp. 134, 140, 141. (Suggests that this and *T. deliensis* Walch, 1922, are merely forms of the same species).
1930. *Trombidium akamushi* Brumpt. André, Mém. Soc. zool. Fr., *29,* no. 2, p. 70.
1930. *Thrombicula* (sic) *akamushi* (Brumpt). André, *op. cit.,* p. 109.
1930. *Kedania tanakai* K. Kishida 1909 (sic). Tanaka, Kaiwa, Teramura and Kagaya, Zbl. Bakt., 1 Abt. Orig., *116,* Heft 6/8, pp. 353-357; pl. 1, figs. 1, 2, 4, 8; pl. II, figs. 15-22; pl. V, figs. 38-40.
1931. *Trombicula akamushi* —. Stiles and Stanley, Nat. Inst. Hlth. Bull. no. 159, p. 832.
1931. *Trombicula akamushi* (Brumpt). Ewing, Proc. U. S. nat. Mus., *80,* no. 2908, Art. 8, p. 7. (States that it is distinct from *Trombicula coarctata* (Berlese, 1888)).
1931. *Trombicula akamushi* (Brumpt). Kawamura and Imagawa, Zbl. Bakt., *122,* 1 Abt. Orig., pp. 253-261; fig. 1.
1931. *Trombicula akamushi* (Brumpt). Vitzthum, Kükenthal's Handbuch der Zoologie, *3,* 2nd half (9), p. 127; fig. 157.
1932. *Trombicula akamushi* (Brumpt). Fonseca, Mem. Inst. Butantan, *7,* p. 128.
1932. *Trombicula akamushi* (Brumpt). Gater, Parasitology, *24,* no. 2, p. 146.
1932. *Trombicula akamushi* (Brumpt). Fonseca, Mem. Inst. Butantan, *7,* pp. 156, 158.
1932. *Trombicula akamushi* (Brumpt). Vitzthum, Zool. Jb., Abt. Syst., *63,* nos. 5/6, p. 688.
1934. *Trombicula akamushi* —. Stiles and Baker, Nat. Inst. Hlth. Bull. no. 163, p. 1012.
1934. *Microtrombidium akamushi* (Brumpt). Womersley, Rec. S. Aust. Mus., *5* no. 2, p. 179.
1936. *Trombicula akamushi* (Brumpt). Sugimoto, J. Jap. Soc. vet. Sci., *15,* p. 205.
1937. *Trombicula akamushi* —. Mehta, Ind. J. med. Res., *25,* no. 2, p. 363.
1937. *Trombicula akamushi* (Brumpt). Ewing, Proc. biol. Soc. Wash., *50,* pp. 170-171.
1938. *Trombicula akamushi* (Brumpt). Neveu-Lemaire, Traité d'Entomologie etc., pp. 487-490; fig. 193 A-G.
1938. *Trombicula akamushi* (Brumpt). Wharton, Carnegie Inst. Wash. Publ. no. 491, p. 137.
1938. *Trombicula akamushi* (Brumpt). Ewing, J. Wash. Acad. Sci., *28,* no. 6, p. 292.
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1940. *Trombicula akamushi* —. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, *5,* Abt. IV, Buch 5, Lfg. 1, p. 64.
1941. *Trombicula akamushi* —. Vitzthum, *op. cit.,* Lfg. 4, p. 623.
1942. *Trombicula akamushi* (Brumpt). Morishita, Proc. Sixth Pacific Sci. Congr. 1939, p. 644.
1942. *Trombicula akamushi* (Brumpt). Radford, Parasitology, *34,* no. 1, p. 58; fig. 5.
1942. *Trombicula akamushi* (Brumpt). Ewing, J. Parasit., *28,* no. 6, p. 486.
1943. *Trombicula akamushi* (Brumpt). Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 74, 76, 83, 84-85, 86, 90, 98, 99; pl. III, fig. 5 (equals *Trombicula coarctata* of Kitashima and Miyajima, 1918; *Kedania tanakai* Kishida, 1909,

cited by Tanaka, *et al.*, 1930; *Microtrombidium brumpti* Hirst, 1915, synonyms).
1943. *Trombicula fletcheri* Womersley and Heaslip, *op. cit.*, pp. 74, 86; text-fig. 4 A-F; pl. III, fig. 8.
1944. *Trombicula akamushi* (Brumpt). Hoffmann, Univ. Nac. Mexico, Tesis, p. 51.
1944. *Trombicula akamushi* (Brumpt). Madden, Lindquist and Knipling, J. econ. Ent., *37*, no. 2, p. 283.
1944. *Trombicula akamushi* —. Womersley, Trans. roy. Soc. S. Aust., *68*, no. 1, p. 84.
1944. *Trombicula obscura* Womersley, *op. cit.*, pp. 86-87; figs. 3 A-C.
1944. *Trombicula fletcheri* Womersley and Heaslip. Womersley, *op. cit.*, p. 89.
1944. *Trombicula akamushi* (Brumpt). Ewing, U. S. Nav. med. Bull. Wash., *43*, no. 4, p. 838.
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1944. *Trombicula fletcheri* Womersley and Heaslip. McCulloch, Med. J. Aust., 31st year *2*, no. 21, pp. 544, 545.
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1945. *Trombicula akamushi* (Brumpt). Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, pp. 11, 28, 30, 31, 61, 62-64; fig. 30.
1945. *Trombicula fletcheri* Womersley and Heaslip. Finnegan, *op. cit.*, pp. 62, 64-66; fig. 32.
1945. *Otonyssus akamushi* (Brumpt). Buitendijk, Zool. Meded., *24*, p. 337.
1945. *Trombicula akamushi* (Brumpt). Blake, Maxcy, Sadusk, Kohls and Bell, Amer. J. Hyg., *41*, no. 3, pp. 253-256, 257, 262-263, 280, 292.
1945. *Trombicula fletcheri* Womersley and Heaslip. Blake, *et al.*, *op. cit.*, pp. 293, 295, 297, 299, 300-302, 344; fig. 10.
1945. *Trombicula fletcheri* —. Kohls, Armbrust, Irons and Philip, Amer. J. Hyg., *41*, no. 3, pp. 379-380, 381, 395-396.
1945. *Trombicula akamushi* (Brumpt). Blake, *et al.*, Science, 102, no. 2638, pp. 61-64.
1945. *Trombicula fletcheri* Womersley and Heaslip. Blake, *et al.*, Science, *102*, no. 2638, pp. 61-64.
1945. *Trombicula akamushi* —. Blake, *et al.*, Amer. J. publ. Hlth., *35*, no. 11, pp. 1123, 1128.
1945. *Trombicula fletcheri* Womersley and Heaslip. Blake, *et al.*, Amer. J. publ. Hlth., *35*, no. 11, pp. 1128-1129.
1945. *Trombicula akamushi* —. Wharton, J. Parasit., *31*, Suppl., p. 14.
1945. *Trombicula fletcheri* —. Wharton, *op. cit.*, p. 14.
1945. *Trombicula obscura* —. Wharton, *op. cit.*, p. 14.
1946. *Trombicula akamushi* —. Philip, Woodward and Sullivan, Amer. J. trop. Med., *26*, no. 2, pp. 239, 241.
1946. *Trombicula fletcheri* —. Bushland, Amer. J. Hyg., *43*, no. 3, p. 221.
1946. *Trombicula fletcheri* —. McCulloch, Med. J. Aust., 33rd year *1*, no. 21, pp. 727, 734, 735.
1946. *Trombicula akamushi* (Brumpt). Michener, Ann. ent. Soc. Amer., *39*, p. 431.
1946. *Trombicula akamushi* —. Wharton and Carver, Science, *104*, no. 2691, p. 76.
1946. *Trombicula akamushi* (Brumpt). Mackie, *et al.*, Trans. R. Soc. trop. Med. Hyg., *40*, no. 1, pp. 16-17.
1946. *Trombicula akamushi* (Brumpt). Taylor, Comm. Aust. Serv. Publ. no. 6, p. 148.
1946. *Trombicula fletcheri* Womersley and Heaslip. Taylor, *op. cit.*, pp. 148, 155-156, 268; fig. 153.
1946. *Trombicula obscura* Womersley. Taylor, *op. cit.*, pp. 161-162; fig. 156.
1946. *Trombicula akamushi* (Brumpt). Wharton, Proc. ent. Soc. Wash., *48*, no. 7, pp. 172, 173; figs. 1, 2.

1946. *Trombicula fletcheri* Womersley and Heaslip. Wharton, *op. cit.*, pp. 173, 174.
1946. *Trombicula obscura* Womersley. Wharton, *op. cit.*, pp. 173, 174.
1946. *Trombicula akamushi* —. Philip and Woodward, J. Parasit., *32*, no. 5, pp. 503-507, 511.
1947. *Trombicula akamushi* —. Audy, Nature, *159*, pp. 295-296.
1947. *Trombicula akamushi* —. Mohr, Ecology, *28*, no. 2, pp. 194-199.
1947. *Trombicula akamushi* (Brumpt). Wharton, J. Parasit., *33*, no. 3, pp. 260-264.
1947. *Trombicula akamushi* (Brumpt). Philip, Amer. J. Hyg., *46*, no. 1, pp. 50, 53, 54, 55, 56, 57, 60-62, 64.
1947. *Trombicula akamushi* —. Davis, Austrian and Bell, Amer. J. Hyg., *46*, no. 2, p. 283.
1947. *Trombicula fletcheri* —. Southcott, Med. J. Aust., 34th year *2*, no. 15, p. 446.

This species is represented in the Oudemans collection by a single specimen, labelled "*Otonyssus akamushi* (Brumpt)", from Sungei Buloh, Selangor, Federated Malay States, 24 October 1929, off *Rattus rattus diardi* (Jentink), collected and presented by B. A. R. Gater. The dorsal setal pattern corresponds to that given for *T. fletcheri* Womersley and Heaslip, 1943, which was described from the same locality.

The writer has also studied Japanese specimens of *T. akamushi* in the British Museum (Natural History); Institut Pasteur, Paris; Museum of Comparative Zoölogy, Harvard College; U.S. National Museum; and specimens from Niigata Prefecture, kindly presented to the writer by Dr. C. B. Philip. He has studied material collected in New Guinea by G. M. Kohls, nominally *T. fletcheri*. Finally he has seen numerous specimens from Assam and Burma, collected by the U.S.A. Typhus Commission, and specimens from the Philippine Islands, collected by Dr. Philip.

The following descriptive notes are based mainly on specimens from Niigata Prefecture, Japan, collected by Dr. Philip.

DIAGNOSIS: The body of the uncleared larva is vermilion in color and ovate in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. On either side of the scutum, in rather close apposition with it, is an ocular shield, bearing two eyes. The larger, better developed, anterior eye is located at the level of the pseudostigmata, while the posterior eye is at the level of the posterior scutal corners. The anterior scutal margin is biconcave, the lateral margins are slightly concave, while the posterior margin projects only a short distance behind the line of the posterior lateral scutal setae. The posterior margin may be evenly rounded, or flattened medially, or slightly sinuate. The surface of the scutum is ornamented with stippling or "pitting", of small to medium size. A constant feature is that the line of the pseudostigmata is always anterior to the line of the posterior lateral setal pores. The five normal scutal setae bear barbs, arising mainly from the convex side of the shaft, except in the case

of the anterior median seta on which they arise from several sides of the shaft. The pseudostigmatic organs are flagelliform, bearing about ten cilia at irregular intervals along the distal half of the shaft.

The palpal claw is usually trifurcate, although variations are noted in a large series of specimens. The main element is curved inward distally, and pointed. The lateral accessory prongs are considerably shorter, and almost straight. Each chelicera bears a small, dorsal, subapical, recurved toothlet, and there is a trace of a vestigial toothlet on the ventral margin.

The dorsal abdominal setae are similar in form to the posterior lateral scutal setae. Their number and arrangement are variable, although examination of small series from a given locality may give the impression of consistency. The total numbers of dorsal setae may range from thirty to an ill-defined probable upper limit in the forties. In the series from Malaya, analyzed by Gater (1930), thirty-four setae were present on the greatest number of specimens, as opposed to twenty-eight for specimens nominally *T. deliensis*. Gater's statement that, "In some cases it was extremely difficult to decide to which of the two species a specimen belonged", has been borne out by the writer's experience in the study of several thousand specimens from Assam and Burma. Philip and Woodward (1946) encountered similar difficulties in the determination of material from the Philippine Islands. In the Japanese material reported by Hirst (1915), and restudied by the writer, one specimen shows the arrangement: 2 — 8 — 6 — 10 — 7 — 4 (total 37); and it is difficult to allocate many of the posterior setae to rows. Lack of symmetry is the rule, rather than the exception, but one does not realize this fact when examining published figures of this species. On the Malayan specimen in the Oudemans collection, the setae are arranged: 2 — 10 — 8 — 9 — 6 — 4 — 2 (total 41), corresponding to *T. fletcheri* Womersley and Heaslip, 1943. This general arrangement holds for much of the New Guinea material collected by Kohls, but the frequent presence of variants cannot be ignored. *T. obscura* Womersley, 1944, was described with the pattern: 2 — 8 — 8 — 8 — 6 — 4 — 2 (total 38), and the writer has a series from Shingbwiyang, Burma, conforming to this pattern. Specimens conforming to the above setal patterns, mingled with intergrading forms, have been observed in series from Japan, Philippine Islands, Ceylon, New Guinea, Assam, and Burma. Finally it must be emphasized that Miyajima and Okumura (1917) reported Japanese larvae with as few as twenty-four dorsal setae. When one encounters Japanese specimens, nominally *T. akamushi*, with twenty-eight dorsal setae, arranged 2 — 8 — 6 — 6 — 4 — 2, what are his criteria for separating them from *T. deliensis?* Or are they to be ignored as not conforming to previously held views regarding taxonomy? The writer

agrees with Philip (*in litt.*) that one must include Japan in the range of *T. deliensis.*

There are two plumose sternal setae between coxae I and two between coxae III. The numbers of the remainder of the ventral setae are variable, and their patterns may be asymmetrical. There are usually more ventral setae than one observes in Sumatran *T. deliensis,* and an increase in number of dorsal setae is usually accompanied by an increase in number of ventral setae in a series.

Palpal segment I bears a plumose seta with long, delicate cilia. Segments II and III each possess a nude seta. The dorsal seta on segment IV bears several cilia, while the lateral and ventral setae are nude. Segment V bears a basal, ventral, striated seta, plus six plumose setae of various forms, one of which is rather prominent. The uniformly plumose galeal seta bears several delicate lateral cilia. The chaetotaxy of the mouth parts is therefore typical of the tsutsugamushi group, as defined by Wharton (1946).

Each coxa bears a single plumose seta. The vestiture of the remainder of the leg segments is not remarkable, being apparently identical with Sumatran *T. deliensis,* despite certain differences reported by Walch (1922).

Measurements are recorded for seven specimens from Japan, and one from Malaya, as indicated below.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
Japan: Yamagata Prefecture, Coll. Tamiya — British Museum (Natural History)											
60	72	26	26	15	27	60	42	57	72	44	48
60	69	28	24	14	22	54	36	50	69	51	50
60	72	28	21	15	24	60	39	56	75	48	—
60	72	27	28	15	30	58	36	51	69	45	—
Japan: Takamori, Kyushu — British Museum (Natural History)											
76	84	33	26	15	28	—	39	—	—	48	51
69	78	33	27	15	32	51	39	57	—	45	—
66	76	32	26	16	30	—	38	54	—	48	48
Malaya — Oudemans Collection											
66	77	32	21	14	25	53	36	48	59	42	42

Philip and Woodward (1946, p. 504, table 2) have tabulated measurements for series from Luzon, P. I., Negros, P. I., and Japan, comparing them with measurements for *T. fletcheri* and *T. deliensis,* as given by Womersley (1944). They point out, "that in certain geographic locations the respective mite populations of *akamushi* and/or *deliensis* are relatively constant and usually readily assignable by known taxonomic standards, whereas in some localities including the classical endemic areas in northwestern Honshu, the

chraracters become mutable, and very confusing". This is a concise statement of the problem, as borne out by the writer's observations. Furthermore, he doubts that it can be settled solely by the application of biometrical methods to larvae collected from their wild hosts.

TYPE MATERIAL: *Trombidium akamushi* Brumpt, 1910, was described from Japan, no specific locality, as attacking human beings and transmitting tsutsugamushi disease. The description was illustrated by an inaccurate drawing after Max Braun. The figure had been published by Tanaka (1899, Zbl. Bakt., *26,* nos. 14/15, pp. 432-439; figs. 1-3). In Tanaka's paper, it is stated that the figures were drawn by K. Chikasawa. Although Brumpt did not name a specific type locality, the matter has been discussed by Philip (1947, p. 61), who believes that we can assume only that Tanaka's material from Akita Prefecture was most applicable. This assumption appears reasonable to the writer. No holotype was designated, and it is doubtful that Brumpt's original specimens are in existence.

Microtrombidium brumpti Hirst, 1915, was proposed for "a number of specimens", no holotype designated, from Yechigo, Japan, off "field mouse". Some of these are deposited in the British Museum (Natural History), without accession numbers. Hirst proposed this name in case the specimens which he was treating as *Microtrombidium akamushi* should eventually prove to belong to a different species. The writer has studied Hirst's specimens, and they appear to be indistinguishable from other Japanese specimens, for example, those collected in Niigata Prefecture by Dr. C. B. Philip.

The name *Kedania tanakai* Kishida first appeared in 1909. It was proposed in a private pamphlet, said to have been circulated among about a hundred acquaintances, according to Philip (1947, p. 60). Does this constitute valid publication? The writer is inclined to agree with Stiles (1928, Science, *67,* no. 1741, pp. 471-478), who concluded (p. 472) that: "... a zoological document is published when it is addressed, through regular standard channels of communication, and therefore made potentially available, to the entire zoological public, i.e., the zoologists of the world". Therefore, the writer's interpretation is that Kishida's 1909 pamplet does not constitute valid publication. Thus the name should date from Kishida, 1917. The existence of type material has not been ascertained. Kishida believed he was describing the vector of tsutsugamushi disease. The writer has seen Kishida's 1917 paper, and although the synonymy of his species is somewhat uncertain, it is based on assumptions discussed by Philip (1947).

The name *Trombicula coarctata,* as applied to the adult by various authors, is the result of a misidentification. Therefore it is a homonym, a dead name, only to be cited in synonymy. It is not *Trombicula coarctatum* (Berlese, 1888).

Trombicula fletcheri Womersley and Heaslip, 1943, was described from two specimens from Sungei Buloh, Selangor, Federated Malay States, 14 October 1930, off *Rattus rattus* (*diardi* or *jalorensis*), designated as type and paratype. Presumably the specimens are in the South Australian Museum, Adelaide. They were sent from the Institute for Medical Research, Kuala Lumpur, F. M. S., labelled as *Trombicula akamushi* (Brumpt). A single topotypic specimen, whose setal pattern corresponds to that of *T. fletcheri* Womersley and Heaslip, 1943, is in the Oudemans collection.

Trombicula obscura Womersley, 1944, was described from Milne Bay, New Guinea, off "rat". Womersley designated a type and three paratypes. Presumably these are in the South Australian Museum, Adelaide.

According to the writer's interpretation, *Trombicula fletcheri* and *Trombicula obscura* are names applied to variants of *T. akamushi* (Brumpt, 1910). One observes similar variants in specimens from Japan, and specific names for them appear to be unnecessary and even misleading.

GEOGRAPHICAL DISTRIBUTION:

Japan: Honshu Island:	
Akita Prefecture: Omono River	Type locality (presumably)
Niigata Prefecture: Shinano and Akano Rivers	Miyajima and Okumura (1917)
Koshi District	Kitashima and Miyajima (1918)
Yamagata Prefecture: Yachi	Nagayo, *et al.* (1917, *et seq.*)
Yechigo	Hirst (1915)
Pescadores Islands: Boko Island	Kawamura and Yamamiya (1939)
Korea: Kyungki Province — Suwon and Rhesan	Miyajima and Okumura (1917)
Mizuhara	Miyajima and Okumura (1917)
Formosa: Karenko District	Hatori (1919)
Kagi District, zone of Mount Ari	Matsumoto (1935)
Philippine Islands:	
Luzon: Lingayen, Bagabag and Dagupin	Philip and Woodward (1946)
Negros	Philip and Woodward (1946)
British New Guinea:	
Milne Bay	Womersley (1944)
Buna	Womersley (1944)
Dobadura	McCulloch (1944)
Donabadu	McCulloch (1944)
Nadzab, lower Markham Valley	McCulloch (1944)
Selangor, Federated Malay States:	
Sungei Buloh	Gater (1932)
Elmina	Ewing (1944)
Burma: Myitkyina	U. S. A. Typhus Comm. (unpubl.)
Shingbwiyang	U. S. A. Typhus Comm. (unpubl.)
India: Ledo, Assam	U. S. A. Typhus Comm. (unpubl.)
Southern India	Radford (1947, *in litt.*)
Ceylon	Philip and Woodward (1946), citing unpublished data

RECORDED HOSTS:

Man, *Homo sapiens* Linnaeus	Type host (presumably)
"Rats"	Womersley (1944)
Rattus calcis	Philip and Woodward (1946)
Rattus concolor browni	Blake, *et al.* (1945)
Rattus coxinga (Swinhoe)	Morishita (1942)
Rattus exulans	Philip, *et al.* (1946)
Rattus gestri	Blake, *et al.* (1945)
Rattus losea (Swinhoe)	Morishita (1942)
Rattus mindanensis	Philip and Woodward (1946)
Rattus mordax	Blake, *et al.* (1945)
Rattus norvegicus (Berkenhout)	Morishita (1942)
Rattus praetor (?)	Blake, *et al.* (1945)
Rattus rattus rattus	Morishita (1942)
Rattus rattus alexandrinus (I. Geoffroy)	Kawamura and Yamaguchi (1921)
Rattus rattus diardi (Jentink)	Gater (1932)
Rattus rattus jalorensis (Bonhote)	Gater (1932)
Rattus rattus rufescens (Gray)	Hatori (1919)
Rattus rattus umbriventer	Philip, *et al.* (1946)
"Field mice"	Hirst (1915)
Apodemus agrarius	Hatori (1919)
Apodemus agrarius coreae Thomas	Miyajima and Okumura (1917)
Apodemus agrarius ningpoensis (Swinhoe)	Morishita (1942)
Apodemus semotus	Kawamura and Yamaguchi (1921)
Microtus montebelli (Milne-Edwards)	Miyajima and Okumura (1917)
Microtus agrestis	Kawamura (1926)
Mus formosanus	Morishita (1942)
Mus jerdoni	Kawamura (1926)
Mus musculus taiwanus	Morishita (1942)
Trichys fasciculata fasciculata (Shaw)	Gater (1932)
Buffalo	Morishita (1942)
Ox	Morishita (1942)
Dog, *Canis familiaris*	Hatori (1919)
Cat, *Felis catus*	Hatori (1919)
Rabbits (experimental)	Kawamura (1926)
Guinea pigs (experimental)	Kawamura (1926)
Mice (experimental)	Kawamura (1926)
Echymipera cockerelli	Blake, *et al.* (1945)
Uromys lamington	Kohls, *et al.* (1945)
Striped opossum, *Dactylopsila* sp.	Kohls, *et al.* (1945)
Wallaby	Kohls, *et al.* (1945)
Crocidura tanakae Kuroda (= ? *Sorex dzinezumi*)	Hatori (1919)
Suncus myosurus swinhoei (Blyth) (= *Crocidura muschata*)	Hatori (1919)
Pachyura murina	Stiles and Stanley (1931)
Silenus fuscatus	Stiles and Nolan (1929)
Birds:	
Acrocephalus stentoreus orientalis (Temminck and Schlegel)	Sugimoto (1936)
Centropus bengalensis lignator Swinhoe	Sugimoto (1936)
Centropus javanicus	Morishita (1942)
Gallus gallus domesticus Brisson	Sugimoto (1936)
Phasianus colchicus formosanus Elliott	Sugimoto (1936)

Turnix sylvatica dussumieri (Temminck)	Sugimoto (1936)
Turnix taigoon	Morishita (1942)
"Chickens"	Hatori (1919)
"Pheasants"	Hatori (1919)
"Small quail"	Kohls, *et al.* (1945)
"Wachtelhuhn"	Kawamura and Yamaguchi (1921)

MEDICAL IMPORTANCE: The importance of this species lies in its well known role as a vector of scrub typhus (tsutsugamushi disease). The history of the investigation of this disease has been well summarized by Blake, *et al.* (1945). Inasmuch as the literature of the subject is voluminous, the present discussion will be limited to fundamental facts concerning the etiologic agent and the vectors.

According to Philip (1947, p. 49) the correct name of the etiologic agent is *Rickettsia tsutsugamushi* (Hayashi, 1920). Important synonyms are: *Rickettsia nipponica* Sellards, 1923 (not valid, since Sellards was unknowingly dealing with a different organism); *Rickettsia orientalis* Nagayo, Tamiya, Mitamura and Sato, 1930; *Rickettsia akamushi* Kawamura and Imagawa, 1931; and others listed by Steinhaus (1946, p. 290). Strains of the causative rickettsiae have been recorded from larvae of *T. akamushi* by numerous workers in Japan and elsewhere. It has been proved by animal experimentation that this species transmits the rickettsiae during feeding. Kawamura and Imagawa (1931) reported the presence of the rickettsiae in the salivary glands of mites taken from infected field mice. Presumably they are transmitted by the actual "bite" or piqûre, although other possibilities have not been excluded (crushed mite?; mite feces?; coxal fluid (existence unknown)?).

According to available information, trombiculid mite larvae are the only important arthropod vectors of scrub typhus. (See Wharton (1946)). Suggestions that other arthropods may act as vectors are unsubstantiated by conclusive evidence, as discussed by Steinhaus (1946, pp. 291-292).

Although the larval mite transmits the infection during feeding, there is no experimental evidence concerning the ability of uninfected larvae to acquire the rickettsiae while feeding on an infected animal. Various writers have assumed that the larvae can become infected in this manner, and the assumption is reasonable from the epidemiologic standpoint. The importance of deciding this point is obvious, if one is to assess the role of infected wild animals in maintaining the rickettsiae in nature. A critical review of the reported recoveries of *R. tsutsugamushi* from mammalian tissues has been presented by Blake, *et al.* (1945). Reports of infection in the following mammals are supported by sufficient evidence to be conclusive:

Japan: *Microtus montebelli* (Milne-Edwards)	Kawamura and Imagawa (1931)
Malaya: *Rattus* sp. undet.	Lewthwaite and Savoor (1936)
New Guinea: *Rattus concolor browni*	Kohls, *et al.* (1945)
Assam: *Rattus flavipectus yunnanensis* (Anderson)	Davis, *et al.* (1947)
Burma: *Tupaia belangeri versurae* Thomas	Davis, *et al.* (1947)

The role of these and other mammals as hosts and disseminators of trombiculid mites is well established. The significance of the recovery of riskettsiae from the above named species is worthy of further investigation. According to Blake, *et al.* (1945), the published reports of the recovery of these riskettsiae from birds are inconclusive.

In the case of the morphological variety, *T. akamushi* var. *deliensis* Walch, 1922, it has been proved that the rickettsiae are transmitted to the larvae by means of the eggs. (See Mackie, *et al.* (1946), and Davis, *et al.* (1947)). Miyajima and Okumura had previously shown that unfed larvae of the Japanese form can harbor the causative agent and transmit it to experimental animals, and the only gap in their evidence was the fact that they did not recover and identify the organisms in the infected animals. As a rule, the trombiculid mite larva takes but one meal from a single host, during its life cycle under normal conditions. Thus transovarial transmission could be predicated on a knowledge of the feeding habits of the vector. It is true that partially fed larvae can be detached and be caused to re-attach under experimental conditions. It seems extremely unlikely, however, that this type of interrupted feeding occurs sufficiently frequently in nature to be of importance. Since the larvae which attach to man are previously unfed individuals, the importance of transovarial transmission is obvious. It is even more important in maintaining the infection in nature, and in starting new lines of infection in vertebrates, provided one assumes that normal larvae can become infected by feeding on these infected animals.

The numerous negative attempts to demonstrate infection in larvae suggest that the proportion of infected larvae in nature may be very small. It has been suggested that when present in the nymphal and adult mites, the rickettsiae are in an "inactive state", and this matter merits investigation. The infection in the adult stage of *T. akamushi* was demonstrated by the work of Nagayo, *et al.* (1921). Again, the importance of trans-stadial transmission is obvious. It would be desirable to know the distribution of the rickettsiae within the tissues of the larvae, nymphs and adults.

Philip (1947, p. 50, fig. 3) has published a diagram, showing the "rickettsial stream" of *R. tsutsugamushi* in nature through two generations of infected mites. This shows continuity through transovarial (hereditary) passage to parasitic larvae, and thence by trans-stadial passage to nymphs

and adults, and possible new lines of infection from infected small mammals (e. g., rats). Infection in man is purely accidental and it is not a part of the natural history of these rickettsiae, for it results in the termination of a line of infection. Thus human beings are not essential to the maintenance of the rickettsiae in nature.

The role of man in the natural history of this disease lies in his inadvertent activities which frequently create local conditions favoring the natural larval hosts, and/or enhancing the mite population. The situation can be made complex or simple, depending upon the extent and thoroughness of one's studies of human, animal, and plant ecology. Much pertinent information has been presented by Audy and his co-workers (Scrub Typhus Investigations in South East Asia. Army Medical Directorate, The War Office, Great Britain, March, 1947).

The present discussion serves to point out some of the lacunae in our knowledge of the biology of *R. tsutsugamushi* and its acarine and mammalian hosts. These and other aspects of the disease are under investigation by workers in various parts of the world, and it is probable that the coming years will be marked by further fundamental contributions to the epidemiology of scrub typhus.

REMARKS: The synonymy of this species is based on studies of specimens from nearly all of the localities from which it has been recorded. It is considered of significance that one finds in Japan specimens of larvae whose dorsal setal pattern corresponds to that of Sumatran *T. deliensis,* i.e., 2 — 8 — 6 — 6 — 4 — 2. According to a key given by Philip and Woodward (1946, p. 511), in *T. akamushi* the total number of dorsal setae is usually more than thirty, with more than one row of eight or more; whereas in *T. deliensis* the total number of dorsal setae is normally twenty-eight, arranged 2 — 8 — 6 — 6 — 4 — 2.

Comparative studies of actual specimens of nymphs and adults have thus far failed to reveal uniform criteria for species differentiation of these forms. Conclusions based on comparisons of illustrations and/or descriptions are apt to be unsound, in the absence of specimens for study. It has been thought that the body setae of these stages of *T. akamushi* are pointed distally, while the nymphs and adults of *T. deliensis* have clubbed body setae. However, Kohls has informed the writer that his reared New Guinea nymphs, nominally *T. fletcheri,* have clubbed body setae. The writer has noted clubbed body setae on the Japanese specimens of adult *T. akamushi* examined by him. Thus a species distinction on this basis does not appear to be valid.

The writer regards *T. deliensis* Walch, 1922, as a morphological variety of *T. akamushi* (Brumpt, 1910). The distinction is hereby maintained on

morphological grounds to avoid ultimate confusion, in the event that it later becomes apparent that they really are distinct species.

The nymphal and adult stages have been described and figured by Miyajima and Okumura (1916, 1917), by Nagayo, Miyagawa, Mitamura and Imamura (1917), and by subequent investigators. Much confusion was introduced by Nagayo, *et al.* (1921), in conveying the impression that the nymphs fed upon "vegetable debris". The writer has not seen reports of actual observations of nymphs feeding upon such material. By analogy with the known habits of certain other species, it is probable that the nymphs and adults are predaceous, feeding on small arthropods.

By the application of currently available methods of rearing, it should be possible to study colonies of this species under controlled laboratory conditions.

Trombicula akamushi var. **deliensis** Walch, 1922

1922. *Trombicula deliensis* Walch, Geneesk. Tijdschr. Ned. Ind., *62,* no. 5, pp. 543, 552-558, 559, 561, 562, 565-568; tables I, II, III; figs. 6-9.
1923. *Trombicula deliensis* Walch, Kitasato Arch., *5,* no. 3, pp. 64, 70-75; tables I, II, III; pl. I, figs. 5-8.
1924. *Trombicula deliensis* —. Walch, Trans. 5th Bienn. Congr. Far East. Assoc. Trop. Med. (1923), pp. 584, 585-591, 596-597, 601, 602, 607, 608-609, 610, 615-619; tables I, II, III, IV; figs. 1-4, 19, 24-27.
1924. *Trombicula deliensis* —. Walch and Keukenschrijver, Geneesk. Tijdschr. Ned. Ind., *64,* pp. 247, 250-254, 255, 256, 257, 258, 259, 261, 262, 263, 264, 267-270.
1924. *Trombicula deliensis* —. Walch, Geneesk. Tijdschr. Ned. Ind., *64,* pp. 499, 500, 502, 508, 514-517, 523, 524; tables I, II; figs. 1, 6-9.
1925. *Trombicula deliensis.* —. Fletcher and Lesslar, Bull. Inst. med. Res., F. M. S., no. 2 of 1925, p. 11.
1925. *Trombicula deliensis* —. Walch, Kitasato Arch., *6,* no. 3, pp. 235-238, 240, 242, 244-248; tables III, IV; pl. III, fig. 8; pl. IV, figs. 13-16.
1926. *Trombicula deliensis* Walch. Bequaert, Med. Rept. Hamilton Rice Seventh Exped. etc., pp. 152, 177.
1927. *Trombicula deliensis* Walch. Stiles and Hassall, Hyg. Lab. Bull. no. 148, p. 269.
1927. *Trombicula deliensis* —. Fletcher and Field, Bull. Inst. med. Res., F. M. S., no. 1 of 1927, pp. 18-19.
1927. *Trombicula deliensis.* —. Walch, Geneesk. Tijdschr. Ned. Ind., *67,* pp. 922, 924, 927, 928, 930, 931, 932.
1928. *Trombicula deliensis* Walch. Ewing, Proc. ent. Soc. Wash.,*30,* no. 5, p. 77.
1928. *Trombicula deliensis* Walch. Warburton, Parasitology, *20,* no. 2, p. 228.
1928. *Trombicula deliensis.* —. Fletcher, Lesslar and Lewthwaite, Trans. R. Soc. trop. Med. Hyg., *22,* no. 2, p. 170; figs. 5, 6.
1929. *Trombicula deliensis* —. Patton and Evans, Insects, Mites etc., pp. 649, 653-654; fig. 331.
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1942. *Trombicula deliensis* Walch. Radford, Parasitology, *34,* no. 1, p. 58; fig. 6.
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1945. *Trombicula walchi* Womersley and Heaslip. Ewing, *op. cit.,* p. 65.
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1945. *Trombicula deliensis* —. Blake, *et al.,* Amer. J. publ. Hlth., *35,* no. 11, pp. 1123, 1127, 1128.
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1945. *Trombicula walchi* —. Wharton, J. Parasit., *31* Suppl., p. 14.
1945. *Trombicula deliensis* —. Wharton, *op. cit.,* p. 14.
1946. *Trombicula deliensis* Walch. Radford, Parasitology, *37,* nos. 1, 2, pp. 42-45; figs. 1-9: adult. Pp. 46, 48; figs. 1-4: larva. P. 51; fig. 24: nymph.
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1946. *Trombicula deliensis* —. Wharton, Ecol. Monogr., *16,* no. 3, p. 153.
1946. *Trombicula deliensis* Walch. Mackie, *et al.,* Trans. R. Soc. trop. Med. Hyg., *40,* no. 1, pp 17-20, 37-39, 40, 42, 43-44.
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1946. *Trombicula deliensis* Walch. Taylor, *op. cit.,* pp. 148, 157-161, 268; figs. 154, 155 (equals *Trombicula vanderghinstei* Gunther, 1940, synonym).
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1947. *Trombicula deliensis* —. Welt, Amer. J. trop. Med., *27,* no. 2, p. 223.
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1947. *Trombicula deliensis* Walch. Fuller, Amer. J. Hyg., *45,* no. 3, pp. 363-371.
1947. *Trombicula deliensis* —. Wharton, J. Parasit., *33,* no. 3, p. 263.
1947. *Trombicula walchi* Womersley (sic). Dumbleton, Trans. roy. Soc. N. Z., *76,* pt. 3, p. 413.
1947. *Trombicula deliensis* —. Philip, Amer. J. Hyg., *46,* no. 1, pp. 50, 62.
1947. *Trombicula deliensis* Walch. Davis, Austrian and Bell, Amer. J. Hyg., *46,* no. 2, pp. 268-286.
1947. *Trombicula deliensis* —. Southcott, Med. J. Aust., 34th year *2,* no. 15, p. 450.
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The above list of references is not complete. This species is represented in the Oudemans collection by two slides. Cat. no. 1 has specimens from Medan, Deli, Sumatra, 14 March 1922, no host data, collected by Dr. E. W. Walch. These specimens were cleared and remounted by the writer. The second slide, Cat. no. 2, bears specimens from Sungei Buloh, Selangor, Federated Malay States, 23 September 1929, off *Rattus rattus jalorensis* (Bonhote), collected by Prof. B. A. R. Gater.

There are several mounted specimens in the Instituut voor Hygiene en Tropische Geneeskunde, Leiden. These were removed by Walch from human beings in Sumatra, and since they are topotypic material, special study was devoted to them. The following descriptive notes are based on one of these topotypic specimens, which was kindly presented to the writer by Prof. P. H. van Thiel.

Through the courtesy of many workers, the writer has also examined specimens from Sumatra; Malaya; India (Simla Hills, Imphal, Assam); New Guinea (several localities); Bat Island, Purdy Group; Ceylon; Philippine Islands; Burma; and China (Yünnan). Material from Japan will be discussed also. The writer has examined a paratype of *T. vanderghinstei* Gunther, 1940, in the British Museum (Natural History); and authentic specimens determined as *T. walchi* Womersley and Heaslip, 1943.

DIAGNOSIS: The body of the uncleared larva is vermilion in color, and ovoid in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. On either side of the scutum, at the level of the posterior corners, is a well developed ocular shield, bearing two eyes. The anterior eye is slightly larger, and the posterior eye is less well developed. The scutum is of the shape depicted by Walch and subsequent writers. The anterior margin is biconcave, and the lateral margins are slightly and irregularly incurved. In topotypic specimens the posterior scutal margin is variable, being evenly rounded, or flattened in its middle third, or sinuate. This variability was originally pointed out by Walch. The pseudostigmata are situated in advance of the line of the posterior lateral setal pores. The normal scutal setae bear numerous short cilia, arising from several sides of the shaft. The pseudostigmatic organs bear about ten cilia, arising at irregular intervals along the distal half of the shaft.

The palpal claw is usually trifurcate, but one of the accessory prongs may be missing, as noted originally by Walch. The main element is pointed and only slightly curved distally; the two external elements are shorter, straight, pointed, and lie above and below the main element. If an accessory element is absent, it is usually the ventral one. It may be present on one side and absent from the other side of a single individual. Each chelicera bears a

small, sharp, dorsal, subapical, recurved toothlet. There is a vestigial toothlet on the ventral margin, which is located more proximally than is the dorsal toothlet.

The dorsal abdominal setae are similar in form to the posterior lateral scutal setae. In all Sumatran specimens examined by the writer, they are arranged: 2 — 8 — 6 — 6 —4 — 2. Variability in setal patterns of specimens from other localities will be discussed subsequently; uniformity in pattern has been noted by the writer only in this Sumatran material. There are two plumose sternal setae between coxae I and two between coxae III. Sumatran specimens have twenty to twenty-one additional ventral abdominal setae. Walch (1923, p. 70) stated: "... the ventral ones vary in number and place. To classify them into rows is always arbitrary. The anus is situated in the row preceding the last but one, but sometimes more in front or behind". It is usual to find twelve smaller, more delicate, plumose, pre-anal setae, similar to the sternal setae, but shorter; and a total of eight para- and post-anal setae which are longer and stouter, bearing short barbs. However, if one ignores the fact of variation in this instance, placing too much reliance on setal pattern as a specific differential character, he may be tempted to propose numerous names for "races" or "varieties" of *deliensis,* which are merely variants or mutants, according to one's interpretation. The naming of these would result in useless and unnecessary synonymy.

The seta on palpal segment I bears about six long, delicate cilia. The setae on segments II and III are consistently nude. On segment IV, the dorsal seta bears three or four lateral cilia, while the lateral and ventral setae are consistently nude. Segment V bears a rather short, basal, ventral, striated seta, plus six plumose setae of various forms, of which a dorsal, proximal one is prominent, having the stoutest and longest shaft, and the most cilia. The galeal seta is consistently plumose, bearing five or six delicate, lateral cilia.

Each coxa bears a single plumose seta, similar in form to the sternal setae. The vestiture of the remainder of the leg segments was discussed by Walch (1923, p. 72), who pointed out the similarity to those of *T. akamushi* (Brumpt, 1910), as described and figured by Hirst (1915) and by Nagayo, *et al.* (1921). Walch recorded certain differences between the setae of the terminal segment of leg II of *T. deliensis* and the same segment of *T. akamushi* as figured by these workers. The writer has compared the legs of his topotypic specimen of *T. deliensis* with those of Hirst's specimens in the British Museum (Natural History), and with specimens of *T. akamushi* from Niigata Prefecture, Japan. He is unable to discern differences in the setal vestiture of the legs.

Measurements are recorded for eleven topotypic specimens from Sumatra, and a single specimen from Selangor, Federated Malay States.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
62	70	27	27	14	28	52	39	48	57	41	38
56	67	27	27	14	28	53	34	48	—	43	36
55	67	25	27	14	28	50	38	52	—	46	42
56	66	24	27	14	27	48	35	45	—	42	39
59	76	31	28	15	32	49	35	50	63	45	41
59	70	29	26	14	27	52	35	55	—	49	39
56	69	25	27	14	28	45	35	52	—	35	39
53	70	27	28	15	28	45	36	48	—	39	39
53	65	25	27	14	28	50	35	46	60	40	38
56	70	29	27	14	24	49	35	49	—	42	36
63	78	31	28	15	27	49	36	50	63	42	36
Federated Malay States											
53	64	24	22	16	27	41	29	43	56	38	36

TYPE MATERIAL: *Trombicula deliensis* Walch, 1922, was described from Deli, Sumatra, off man and "rats", collected by Dr. E. W. Walch, no holotype designated. According to a personal communication from Mrs. Walch, his original material is deposited in the Koningin Wilhelmina Instituut voor Hygiene en Bacteriologie, Batavia, Java. According to a recent letter from Prof. Dr. R. Gispen, this species is represented in the collections of the Instituut, but none of the slides is labelled as the type. It is probable that Walch did not have a particular specimen in mind, when he described this species. It has already been stated that topotypic specimens, collected and determined by Walch, are in the Rijksmuseum van Natuurlijke Historie, and the Instituut voor Hygiene en Tropische Geneeskunde, Leiden, and in the writer's personal collection.

Trombicula vanderghinstei Gunther, 1940, was described from Bulolo, British New Guinea, off *Rattus mordax* (sensu lato) Thomas, and *Rattus browni* Alston, collected by Dr. C. E. M. Gunther. According to him, the type is in the School of Public Health and Tropical Medicine, University of Sydney, Sydney, Australia. He stated: "*T. vanderghinstei* is probably only a local variant of *T. deliensis,* but it is described here as a distinct species ...". The type and paratypes were studied by Womersley and Heaslip (1943), who synonymized it. The writer has examined a paratype in the British Museum (Natural History), no. 1947-3-13-13. He has compared it with a topotypic specimen of *T. deliensis,* and he agrees with the synonymy.

Trombicula walchi Womersley and Heaslip, 1943, was based on two specimens. The type was "... on a slide (IA, 1C, I) from Prof. Dinger, of the Institute for Bacteriology, Batavia". Apparently the locality and host data are unpublished. The paratype was from Sardang, Selangor, Federated

Malay States, 21 April 1932, off *Rattus rattus diardi* (Jentink). Presumably these specimens are now in the South Australian Museum, Adelaide. The synonymy with *T. deliensis* was suggested by Blake, *et al.* (1945), Kohls, *et al.* (1945), and definitive action was taken by Philip and Kohls (1945), with which the writer is in accord.

GEOGRAPHICAL DISTRIBUTION:

Sumatra: Deli	Type locality
Tandjong Morowa	Walch (1923)
Lampong Districts	Walch (1927)
Malaya (Federated Malay States)	Fletcher, *et al.* (1928)
Selangor: Sungei Buloh	Gater (1932)
Kuala Lumpur	Gater (1932)
Sardang	Womersley and Heaslip (1943)
Pahang: Fraser's Hill (4,500 ft.)	Gater (1932)
Raub	Gater (1932)
Negri Sembilan: Port Dickson	Gater (1932)
India: Simla Hills — Kasauli and Sabathu	Mehta (1937)
Ledo, Assam	Mackie, *et al.* (1946)
Imphal, Manipur State	Radford (1946)
Territory of New Guinea (British):	
Bulolo	Gunther (1940)
Buna	Womersley (1944)
Abidari	Womersley (1944)
Milne Bay	Womersley (1944)
Donabadu	McCulloch (1944)
Dobadura	McCulloch (1944); Blake, *et al.* (1945); Kohls, *et al.* (1945)
Dutch New Guinea: Hollandia	Bushland (1946)
Sansapor	Mohr (1947)
Bat Island, Purdy Group	Philip and Kohls (1945)
Australia: Cairns, Queensland	Womersley and Heaslip (1943)
Ceylon	Radford (1946)
Philippine Islands: Mindoro	Philip and Woodward (1946)
Luzon	Philip and Woodward (1946)
Negros	Philip and Woodward (1946)
Mindanao	Philip and Woodward (1946)
Samar: Guiuan	Wharton (1946)
Burma: Myitkyina	Mackie, *et al.* (1946)
Bougainville Island: mouth of Jaba River	Wharton (1946)
China: Kunming, Yünnan Prov., 6,000 ft.	Millspaugh and Fuller (1947)

RECORDED HOSTS:

Man, *Homo sapiens* Linnaeus	Type host
Macacca mulatta mulatta (Zimmermann) (exptl.)	Fuller (1947)
"Rats"	Walch (1922, 1927); Walch and Keukenschrijver (1924); and others
Rattus concolor	Walch and Keukenschrijver (1924)
Rattus rattus diardi (Jentink)	Gater (1930, 1932)

Rattus rattus jalorensis (Bonhote)	Gater (1930, 1932)
Rattus concolor concolor (Blyth)	Gater (1932)
Rattus mülleri validus (Miller)	Gater (1932)
Rattus edwardsi ciliatus (Bonhote)	Gater (1932)
Rattus sabanus vociferans (Miller)	Gater (1932)
Rattus browni	Gunther (1940)
Rattus mordax sens. lat.	Gunther (1940)
Rattus praetor	Blake, *et al.* (1945)
Rattus gestri	Blake, *et al.* (1945)
Rattus concolor browni	Kohls, *et al.* (1945)
Rattus rattus kandianus Kelaart	Radford (1946)
Rattus mindanensis mindanensis	Philip and Woodward (1946)
Rattus rattus umbriventer	Philip, Woodward and Sullivan (1946)
Rattus vigoratus	Philip, Woodward and Sullivan (1946)
Rattus calcis	Philip and Woodward (1946)
Rattus flavipectus yunnanensis (Anderson)	Mackie, *et al.* (1946)
Rattus rattus sladeni (Anderson)	Mackie, *et al.* (1946)
Rattus manipulus Thomas	Mackie, *et al.* (1946)
Rattus fulvescens fulvescens (Gray)	Mackie, *et al.* (1946)
Rattus nitidus nitidus (Hodgson)	Mackie, *et al.* (1946)
Rattus rattus rattus (Linnaeus)	Mackie, *et al.* (1946)
Mus bactrianus kakhyenensis (Anderson)	Mackie, *et al.* (1946)
Bandicota nemorivaga (Hodgson)	Mackie, *et al.* (1946)
Rattus confucianus confucianus (Milne Edwards)	Millspaugh and Fuller (1947)

Other rodents:

Trichys fasciculata fasciculata (Shaw)	Gater (1932)
Sciurus prevosti humei Bonhote	Gater (1932)
Sciurus notatus miniatus Miller	Gater (1932)
Sciurus nigrovittatus bilimitatus Miller	Gater (1932)
Rhinosciurus laticaudatus tupaiodes (Blyth)	Gater (1932)
Melomys sp.	Blake, *et al.* (1945)
Bandicota malabarica Shaw	Radford (1946)
Tatera indica ceylonica Wroughton	Radford (1946)
Funambulus palmarum favonicus Thomas & Wroughton	Radford (1946)
Eothenomys miletus miletus (Thomas)	Millspaugh and Fuller (1947)
Drenomys pernyi flavior Allen	Millspaugh and Fuller (1947)

Insectivora:

Tupaia glis ferruginea Raffles	Gater (1932)
Suncus caeruleus giganteus Geoffroy	Radford (1946)
Crocidura occultidens	Philip and Woodward (1946)
Tupaia belangeri versurae Thomas	Mackie, *et al.* (1946)
Suncus murinus fulvo-cinerea Anderson	Mackie, *et al.* (1946)
Crocidura vorax Allen	Mackie, *et al.* (1946)
Anourosorex squamipes assamensis Anderson	Mackie, *et al.* (1946)
Tupaia belangeri chinensis Anderson	Millspaugh and Fuller (1946)

Other Mammals:	
Paradoxurus hermaphroditus (Pallas)	Gater (1932)
Tragulus kanchil fulviventer Gray	Gater (1932)
Isoodon torosus	Womersley and Heaslip (1943)
Echymipera cockerelli	Blake, *et al.* (1945)
Wallaby	Blake, *et al.* (1945)
Viverra zibetha picta Wroughton	Mackie, *et al.* (1946)
Paradoxurus hermaphroditus pallasii Gray	Mackie, *et al.* (1946)
Muntiacus muntjak vaginalis (Boddaert)	Mackie, *et al.* (1946)
Herpestes sp. undet.	Mackie, *et al.* (1946)
Birds:	
Centropus javanicus	Walch and Keukenschrijver (1924)
Rhinorthra chlorophaea	Walch and Keukenschrijver (1924)
Rallus philippensis ssp.	Philip and Kohls (1945)
Corvus splendens	Radford (1946)
Centropus sinensis parroti Stresemann	Radford (1946)
Eudynamis scolopaceus Linnaeus	Radford (1946)
Centropus sinensis intermedius (Hume)	Mackie, *et al.* (1946)
Gallus gallus gallus (Linnaeus)	Mackie, *et al.* (1946)
Turnix suscitator plumbipes (Hodgson)	Mackie, *et al.* (1946)
Upupa epops longirostris Jerdon	Mackie, *et al.* (1946)
Dryonastes sannio (Swinhoe)	Millspaugh and Fuller (1947)

The fact that this species accepts a wide variety of hosts is obvious. Small, ground-frequenting mammals are common hosts, such as rats and shrews. An attempt to evaluate the role of mammalian hosts in determining the local spotty distribution in a given area is complicated by the variety of birds that are also acceptable hosts. Their possible role in establishing the mites in areas which have become unsuitable during the dry season is worthy of investigation, as suggested elsewhere in the present paper.

MEDICAL IMPORTANCE: This matter has been discussed under *T. akamushi* (Brumpt, 1910). Data discussed by Fuller (1947) suggest that *T. a.* var. *deliensis* attacks man with relative reluctance, and possibly only under extreme conditions of exposure. The necessary degree of exposure cannot be precisely defined. The local skin reaction to an uninfected "bite" is insignificant and usually insufficient to attract attention. This species or variety does not cause scrub itch, nor does typical *T. akamushi.*

REMARKS: The writer's studies have confirmed the synonymy previously published by other investigators. Although specimens from Sumatra have revealed uniform dorsal setal patterns, the series examined by the writer is small, and many variants and intergrades have been observed in larger series from other localities. Also one encounters specimens with a pattern 2 — 8 — 6 — 6 — 4 — 2 in series from Japan.

The nymph was first described and figured by Walch (1924, Geneesk. Tijdschr. Ned. Ind., *64*, pp. 514-517, tables I, II; figs. 1, 6-9. 1924, Trans.

Far East. Assoc. Trop. Med. (1923), pp. 615-619, tables III, IV; figs. 19, 24-27. 1925, Kitasato Arch., *6*, no. 3, pp. 244-248, tables III, IV; pl. III, fig. 8; pl. IV, figs. 13-16). Based on material collected in Ceylon, the nymph was redescribed and figured by Radford (1946, p. 51; figs. 24 a-d). The adult mite was first described and figured by Radford (1946, pp. 42-45; figs. 1-9).

Much valuable information on rearing methods was given by Walch and by Radford, although they did not evolve methods applicable to the maintenance of colonies of this species, nor did they accurately define the food habits of nymphs and adults.

This variety and also *T. akamushi* will survive in a variety of environments, some of which have been associated especially with scrub typhus outbreaks. For example, in the Dobadura area of New Guinea, Blake *et al.* (1945) reported that the environments in which human infections were known to have originated were kunai grass fields, in which natural conditions were undisturbed at the time of occupation. Decline in attack rate, owing to decrease in exposure, was correlated with progressive changes produced by development and use of the camp site, presumably creating conditions unfavorable to continued activity and survival of the vector. Kohls, *et al.* (1945) noted that known foci of infection in New Guinea and adjacent islands comprised four ecological types: (1) restricted, open grassy terrain in which kunai grass is usually dominant; (2) abandoned native gardens, banana and coconut groves with neglected undergrowth of grass and shrubbery, either on small islands or in clearings margining rain forests of larger land areas; (3) sparse, coarse growths of native vegetation overlying coralline ridges and breaks in the interior of certain islands; and possibly (4) restricted areas in the edges of virgin, climax rain forests.

The occurrence of outbreaks of infection acquired on an oil-palm estate in Malaya is summarized by Lewthwaite (1930). Outbreaks on rubber plantations in Sumatra have been described in several earlier reports by Walch and Keukenschrijver. For a detailed discussion of the ecological aspects of this mite, and its relation to scrub typhus, the reader is referred to the report by Audy, *et al.* (1947), mentioned previously.

Trombicula russicum (Oudemans 1902)

1897. *Trombidium* (*Otonyssus*) *aurantiacum* (*not* of Kolenati) Oudemans, Tijdschr. Ent., *40*, p. 118. (Cited in synonymy by Oudemans (1912, p. 5)).
1902. *Thrombidium russicum* Oudemans, Ent. Ber., *1*, no. 7, p. 43.
1903. *Thrombidium russicum* Oudemans, Tijdschr. Ent., *45*, pp. 125, 142-143; pl. 12, figs. 39-42.
1903. *Thrombidium russicum* Oudemans. Oudemans, Tijdschr. Ent., *46*, p. 5.

1906. *Allothrombidium russicum* (Oudemans). Oudemans, Ent. Ber., *2,* no. 29, p. 87.
1909. *Thrombidium russicum* Oudemans. Oudemans, Tijdschr. Ent., *52,* nos. 1/2, pp. 41-43, 55; pl. 7, figs. 31-36.
1909. *Trombidium* (*Heterotrombidium*) *russicum* Oudemans. Verdun, C. R. Soc. Biol. Paris, *67,* p. 246.
1909. *Microthrombidium russicum* (Oudemans). Oudemans, Ent. Ber., *3,* no. 50, p. 20.
1910. *Microthrombidium russicum* —. Oudemans, Ent. Ber., *3,* no. 52, p. 47: (equals *muscae* Oudemans, 1906, synonym (ex errore)).
1912. *Microthrombidium russicum* (Oudemans). Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 5-6, 188, 201: (equals *Allothrombidium muscae* Oudemans, 1906, synonym (ex errore)); in part, but *not Allothrombidium muscae* Oudemans, 1906, which is a distinct species.
1928. *Trombicula russica* (Oudemans). Methlagl, Denkschr. Akad. Wiss. Wien, *101,* pp. 217, 223, 224.
1929. *Microtrombidium russicum* (Oudemans). Vitzthum, Tierwelt Mitteleuropas, *3,* Lfg. 3 Acari, p. 68.
1929. *Microtrombidium russicum* (Oudemans). Oudemans, Tijdschr. Ent., *72* Suppl., pp. 342-343, 933.
1930. *Microthrombdiium russicum* (Oudemans). André, Mém. Soc. zool. Fr., *29,* no. 2, p. 70 (equals *muscae* Oudemans, synonym (ex errore)).
1931. *Trombicula russica* (Oudemans). Vitzthum, Z. Parasitenk., *4,* Heft 1, p. 7 (equals *Trombidium* (*Otonyssus*) *aurantiacum* Oudemans, 1897: nomen nudum).
1932. *Thrombicula autumnalis* ? (sic) (*not* of Shaw) André, Arch. zool. ital., *16,* pp. 1355-1358; fig. 1 (nymph, reared from larvae from a bat).
1932. *Trombicula russica* (Oudemans). Vitzthum, Zool. Jb., Abt. Syst., *63,* nos. 5/6, pp. 687-691.
1933. *Thrombicula russica* (Oudemans). André, Bull. Soc. ent. France, *38,* no. 10, pp. 154-156; fig. 2 (equals *muscae* Oudemans, synonym (ex errore)).
1941. *Trombicula russica* (Oudemans). Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, *5,* Abt. IV, Buch 5, Lfg. 4, p. 512.
1941. *Trombicula russica* (Oudemans). Willmann, Zool. Anz., *133,* nos. 5/6, p. 136.
1944. *Trombicula russica* (Oudemans). Willmann, Mitt. Biol. Sta. Hofeberg, in Sammelheft 116. Jahresber. Schles. Gesellsch. f. vaterl. Cult. (1943), pp. 66, 68, 69.
1945. *Otonyssus russicum* (Oudemans). Buitendijk, Zool. Meded., *24,* p. 338.

This species is represented in the Oudemans collection by several specimens, among them, the type labelled as such in Oudemans' handwriting, and bearing the data: "Vleermuis, Rusland, Prof. Jul. Wagner, Aug. 1898, donum A. S. Poppe". Certain specimens from Maastricht, collected off *Myotis myotis* by H. Schmitz, belong to this species. Certain other specimens from the same and other localities, labelled by Oudemans as this species, are regarded by the writer as belonging to *Trombicula muscae* (Oudemans, 1906), and are treated as such in this paper. The writer has also studied material in the Muséum National d'Histoire Naturelle, Paris, borrowed for comparison with the type in Leiden. He has also studied the type and other specimens of *Trombicula myotis* Ewing, 1929, which is here regarded as a geographical race or variety of *Trombicula russicum* (Oudemans, 1902).

The type specimen is nearly fully engorged and it is in fairly good con-

dition, except that the pseudostigmatic organs and galeal setae are missing, and the palpi are folded inward upon themselves. The following descriptive notes are based on the type and other specimens compared with it.

DIAGNOSIS: The body of the engorged larva is ovoid in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. A well developed ocular shield is situated on either side of the scutum at the level of the posterior corners, each bearing a large anterior eye and a smaller posterior one. The outline of the scutum is similar to that depicted by Oudemans (1909, pl. 7, fig. 31). The pseudostigmata are practically in the line of the posterior lateral setal pores. The posterior scutal margin is rather unevenly rounded, projecting for about ten to eleven micra behind the line of the posterior lateral setal pores in the series in the Paris museum. On the type specimen, the posterior scutal margin lies under a fold of the dorsal integument, making its visualization difficult; also the scutum is tipped forward. The five normal scutal setae bear regularly spaced, delicate barbs, arising from both sides of the shaft. The proximal one-third of the shaft of the pseudostigmatic organs is nude, while the distal two-thirds bears eleven or twelve delicate cilia.

The palpal claw is trifurcate, the main element being curved inward distally, and the accessory elements being shorter and straight. Each chelicera bears a dorsal, subapical, recurved toothlet, and a minute, vestigial, ventral toothlet.

The dorsal setae are variable in number and arrangement. On the type specimen, they are arranged: 2— 7 — 6 — 6 — 4 — 2, i.e., a total of twenty-seven. On a series in the Paris museum from Buré, they are arranged as follows:

PATTERNS	TOTALS
2 — 8 — 7 — 6 — 6 — 4 — 2	35
2 — 9 — 6 — 6 — 6 — 4 — 2	35
2 — 8 — 6 — 6 — 6 — 4 — 2	34
2 — 8 — 8 — 6 — 6 — 5 — 2	37
2 — 8 — 6 — 6 — 6 — 4 — 2	34

Similar variations occur in the series from Maastricht, Holland.

There are two plumose sternal setae between coxae I, and two between coxae III. The remainder of the ventral adominal setae exhibit variations in number and arrangement. The type specimen has twelve small, pre-anal setae; then there are larger para- and post-anal setae, arranged 4 — 4 — 2 — 2, the last two being caudal. On other specimens, there may be sixteen or more

small, pre-anal setae, and additional numbers of post-anals and/or marginals.

The seta on palpal segment I bears several delicate cilia. Palpal segment II is angulate laterally, and its seta is uniformly nude. Segment III bears a consistently nude seta, which is slightly longer than that on the preceding segment. The dorsal seta on segment IV bears five or six cilia; the lateral and ventral setae are uniformly nude. Segment V bears the usual basal, ventral, striated seta, plus five or six plumose setae, of which a dorsal one is long, stout, and prominent. Only the stumps of the galeal setae remain on the type specimen. On the other specimens examined, these setae are consistently plumose, although Oudemans (1909, p. 42; pl. 7, fig. 31) described and figured them as nude, giving rise to confusion.

Each coxa bears a single plumose seta, and the vestiture of the remainder of the leg segments is not remarkable.

It is difficult to find specimens suitable for measurements, because in many of them the scutum is tipped forward, owing to engorgement, or setae have been lost. Measurements are recorded for three specimens in the following order: (1) the type in the Oudemans collection; (2) a specimen from Maastricht, Holland, 20 January 1910, off *Myotis myotis,* collected by H. Schmitz, S.J. (cat. no. 3); and (3) a specimen in the writer's personal collection from Buré d'Orval, France, 1 May 1930, off *Myotis daubentoni,* collected by F. Heim de Balsac, which Dr. Marc André kindly allowed the writer to remove from the bat in his collection in the Muséum National d'Histoire Naturelle, Paris.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
60	69	24	21	?	21	49	35	55	—	49	48
70	84	29	28	14	25	53	36	—	—	50	49
78	92	38	28	17	24	49	39	62	70	56	48

It may be objected that these are different species on the basis of scutal measurements. However, one can find all intergrades in a series, although these have not been recorded because the specimens are imperfect. The measurements on the type specimen should be compared with those recorded for the type of *T. myotis* Ewing, 1929, by Wharton (1947), quoted below.

TYPE MATERIAL: Described from a single specimen from southern Russia, collected in August, 1898, off an undetermined bat, by Prof. J. Wagner. The holotype is in the Oudemans collection.

GEOGRAPHICAL DISTRIBUTION:

Southern Russia	Type locality
Maastricht, Holland	Oudemans (1912)
Buré d'Orval, France	André (1933)

RECORDED HOSTS:

Bat, species undetermined	Type host
Myotis myotis	Oudemans (1912)
Myotis daubentoni	André (1933)

REMARKS: Although Oudemans (1910, 1912) placed *T. muscae* (Oudemans, 1906) in synonymy with this species, the writer has studied the material on which Oudemans' decision was based, and has therefore restored *T. muscae* to full standing as a distinct species. Details are given in the discussion of *T. muscae*. The writer has also studied the specimens recorded by André (1933), who considered that they were probably *T. autumnalis* (Shaw, 1790). Four of these were kindly loaned to the writer, who compared them with the type of *T. russicum* (Oudemans, 1902) in Leiden. They possess more dorsal abdominal setae and the scuta are somewhat larger, although geometrically similar. The galeal setae are plumose on all specimens examined.

Since these larvae of André's are *T. russicum* (Oudemans, 1902), and not *T. autumnalis* (Shaw, 1790), it follows that the nymphs reared from larvae collected off this bat are not *T. autumnalis*. It is probable that the nymphs belong to *T. russicum,* but one cannot be absolutely certain, since the writer also removed larvae of *T. muscae* (Oudemans, 1906) from the same bat! (Vide infra).

In the light of recent studies by workers in the United States, the writer has decided to regard *Trombicula myotis* Ewing, 1929, as a variety of this species. It seems useful, therefore, to present pertinent data concerning this new combination:

Trombicula russicum var. **myotis** Ewing, 1929

1929. *Trombicula myotis* Ewing, Ent. News, *40,* no. 9, pp. 294-295.
1931. *Trombicula myotis* Ewing. Ewing, Proc. U. S. nat. Mus., *80,* no. 2908, Art. 8, p. 9.
1937. *Trombicula mexicana* Ewing, Proc. biol. Soc. Wash., *50,* pp. 171, 172-173, in part: Columbia, Missouri. (The specimens from type locality San Luis Potosi are true *T. mexicana*; those from Missouri represent *T. russicum* var. *myotis* Ewing, 1929).
1938. *Eutrombicula myotis* (Ewing). Ewing, J. Wash. Acad. Sci., *28,* no. 6, p. 294.
1942. *Eutrombicula myotis* (Ewing). Radford, Parasitology, *34,* no. 1, p. 66.
1943. *Acariscus myotis* (Ewing). Ewing, Proc. ent. Soc. Wash., *45,* no. 3, pp. 58, 65, 66.
1947. *Trombicula eptesici* Brennan, J. Parasit., *33,* no. 3, pp. 247-248; figs. 1 A-D.
1947. *Trombicula myotis* Ewing. Wharton, J. Parasit., *33,* no. 3, pp. 260-264; figs. 1 A-E: redescription.

Although the American form is not represented in the Oudemans collection, it is treated here for the sake of completeness, and to point out its

close morphological similarity to the European form. In the absence of biological data, including nymphal and adult stages, its taxonomic standing is admittedly controversial, and the writer's present treatment of it as a "variety" is to be considered preliminary.

After comparison with the type specimen of *T. russicum* (Oudemans, 1902), four of André's specimens were brought to the United States, where the writer has compared them with the type of *Trombicula myotis* Ewing, 1929, with other specimens of this mite studied by Wharton, and with paratypes of *T. eptesici* Brennan, 1947. Two of them have been seen by Drs. Wharton and Brennan. Brennan (1948, personal communication) believes that his species is a synonym of *myotis,* with which the writer agrees. The writer has also examined Ewing's original series of *T. mexicana* Ewing, 1937, which was a composite. Those from the type locality are *T. mexicana,* and they are somewhat similar to *T. piercei* Ewing, 1931. However, at least one of the five specimens from Columbia, Missouri, U.S.A., is indistinguishable from the type of *T. myotis,* and the other four are unsuitable for study. Measurements on this specimen indicate the similarity of its scutal dimensions to those of *myotis.*

The following data are tabulated for purposes of comparison. Those for *T. russicum* from France are taken from one of André's specimens. Those for *T. eptesici* from Montana, U.S.A., are taken from the means given by Brennan (1947) for ten specimens. Those for *T. myotis* from Missouri are taken from a specimen in the U.S. National Museum, determined by Ewing as *T. mexicana.* Those for *T. myotis* from Maine and Pennsylvania, U.S.A., are the means given for six specimens by Wharton (1947). Those for *T. russicum* from Russia are taken from the holotype.

Locality	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP	Total D
France (*russicum*)	78	92	38	28	17	24	49	39	62	70	56	48	34-37
Montana (*eptesici*)	71	81	31	25	15	24	43	31	47	47	46	34	37-45
Missouri (*myotis*)	68	76	29	22	15	21	28	20	47	56	44	41	36
Maine; Pa. (*myotis*)	65	73	29	27	15	23	47	37	51	61	51	48	36
Russia (*russicum*)	60	69	24	21	?	21	49	35	55	—	49	48	28

As tabulated, there is progressive decrease in size of the scutum, but this does not appear to be correlated with setal measurements or with total numbers of dorsal setae. The writer has been unable to discern differences in the chaetotaxy of the palpi or of the legs, and he is unable to offer key morphological characters for separation of specimens from America and Europa. It would be interesting to know whether this constitutes what Goldschmidt would call a "Rassenkreis".

TYPE MATERIAL: *Trombicula myotis* Ewing, 1929, was described from three specimens from Basin Pond, Mount Katahdin, Maine, 7 September 1928, off *Myotis lucifugus lucifugus,* collected by Francis Harper, no holotype designated. The three cotypes are deposited in the U.S. National Museum, no. 991.

Trombicula eptesici Brennan, 1947, was described from twelve specimens from Hamilton, Montana, 24 August 1935, off *Eptesicus fuscus pallidus,* collected by R. A. Cooley, A P no. 11305. The holotype and five paratypes are in the Rocky Mountain Laboratory, Hamilton, Montana. There are two paratypes each in the U.S. National Museum, the British Museum (Natural History), and the South Australian Museum, Adelaide.

GEOGRAPHICAL DISTRIBUTION:

Maine: Basin Pond, Mount Katahdin	Type locality
Missouri: Columbia	Ewing (1937, in part)
Montana: Hamilton	Brennan (1947)
Pennsylvania: Pocono Lakes Preserve, Monroe Co.	Wharton (1947)

RECORDED HOSTS:

Myotis lucifugus lucifugus	Type host
Eptesicus sp.	Ewing (1937)
Eptesicus fuscus pallidus	Brennan (1947)

REMARKS: The writer's treatment of *T. myotis* Ewing, 1929, as a form of *T. russicum* (Oudemans, 1902) is open to severe criticism on several grounds. It is based solely on morphological similarities of larvae. It is not in line with basic principles of faunal zones of distribution, as well as host specificity. It lacks the support of comparative studies of nymphal and adult stages. Thus it should serve as a stimulus for further investigative work. When the nymph of the American form is reared, it must be compared with the nymphs reared and reported as *T. autumnalis* by André (1932), and discussed as *T. russicum* by Vitzthum (1932).

As pointed out by Wharton (1947), *T. russicum* var. *myotis* Ewing, 1929, is morphologically related to the "akamushi" or "tsutsugamushi" group of trombiculid mite larvae. It follows that the European form is also related to this group. It would be of interest to investigate the potentialities of these bat parasites as experimental vectors of the rickettsiae of scrub typhus.

Trombicula autumnalis (Shaw, 1790)

1790. *Acarus autumnalis* Shaw, Naturae Vivarii (The Naturalist's Miscellany), *2,* (no pagination) text, and pl. 42.

1806. *Leptus autumnalis* (Shaw). Latreille, Genera Crustaceorum et Insectorum, etc., *1,* p. 162. (Cited by Oudemans, 1937, K. H. O. A., III, D, pp. 1367, 1913).

1806. *Acarus autumnalis* —. Shaw, General Zoology or Systematic Natural History, *6,* part II, Insecta, pp. 464-465; pl. 124. (The plate is dated, "1805, Oct.r 1.").
1842. *Ixodes sanguineus* (*not* of authors) Hering, Specielle Pathol. Therap., p. 162. (Cited by Oudemans, 1937, K. H. O. A., III, D, p. 1376). Homonym, dead name.
1843. *Acarus reduvius* (*not* of Linnaeus, 1758) Raspail, Hist. nat. de la Santé, etc., *1,* pp. 373, 422, 425, 492 (equals *Leptus autumnalis,* synonym, ex errore): homonym, dead name. (Cited by Oudemans, 1937, K. H. O. A., III, B, p. 727; and III, D, pp. 1376-1377. See Oudemans, 1937, *op. cit.,* A, pp. 28, footnote, and 46-48, for criticism of Raspail's work).
1844. *Trombidium autumnale* (sic) —. Gervais, Apterès, *3,* p. 184. (Cited by Oudemans, 1937, K. H. O. A., III, D, p. 1377).
1847. *Acarus ruber autumnalis* —. Krahmer, Hautkrh. durch *A. r. aut.,* in Amtl. Ber., 24 Vers. deu. Naturf. Aerzte Kiel, 1846, p. 165. (Cited by Oudemans, 1937, K. H. O. A., III, D, p. 1380).
1871. *Leptus autumnalis* —. Gudden, Virchows Arch., *52,* pp. 255-259; pl. IV, figs. 1-4.
1872. *Leptus autumnalis* —. Cobbold, Worms, Case LXXIX, pp. 140-141.
1872. *Leptus autumnalis* (Latreille) (sic) Kraemer, Virchow Archiv, *55,* Heft 3/4, pp. 354-367; pl. XIX-XX.
1872. *Leptus major Talpae* (sic) Kraemer, *op. cit.,* p. 366; pl. XIX, figs. 1, 3.
1872. *Leptus minor Talpae* (sic) Kraemer, *op. cit.,* p. 366; pl. XIX, figs. 2, 4.
1872. *Leptus Talpae* (sic) Kraemer, *op. cit.,* p. 366; pl. XIX, figs. 5, 6.
1872. *Leptus major Sambuci* (sic) Kraemer, *op. cit.,* p. 366; pl. XIX, fig. 7.
1872. *Leptus minor Sambuci* (sic) Kraemer, *op. cit.,* p. 366; pl. XIX, fig. 8.
1872. *Leptus Sambuci* (sic) Kraemer, *op. cit.,* p. 366; pl. XIX, figs. 9, 10; pl. XX, figs. 14, 15.
1872. *Leptus major Hypudaei* (sic) Kraemer, *op. cit.,* p. 366; pl. XX, fig. 11.
1872. *Leptus minor Hypudaei* (sic) Kraemer, *op. cit.,* p. 366; pl. XX, fig. 12.
1872. *Leptus Hypudaei* (sic) Kraemer, *op. cit.,* p. 366; pl. XX, figs. 13, 16.
1873. *Leptus autumnalis* —. Riley, Amer. Nat., *7,* p. 17.
1874. *Leptus autumnalis* —. Heiberg, Nord. med. Ark., *6,* no. 25. (Cited by Huber (1899)).
1876. *Leptus autumnalis* —. Weir, Proc. ent. Soc. Lond., 1876, p. xxvi.
1876. *Trombidium holosericeum* (*not* of Linnaeus) Mégnin, Ann. Sci. Nat., Zool., 6e sér., *4,* pp. 11-14, 19; pl. 12, figs. 3-9 (larva): homonym, dead name, according to Vitzthum (1929, p. 225).
1877. *Tetranychus autumnalis* (Shaw). Murray, Economic Entomology, Aptera, pp. 109-113; figure on p. 109.
1880. *Trombidium holosericeum* (*not* of Linnaeus) Mégnin, Les parasites et les maladies parasitaires, pp. 253-255; pl. XXV, figs. 3-8 (larva): homonym, dead name, according to Vitzthum (1929, p. 225).
1887. *Leptus autumnalis* —. Riley, Extr. Ref. Handb. Med. Sci., *5,* p. 746.
1887. *Tetranychus autumnalis* —. Riley, *op. cit.,* p. 746.
1892. Trombidion soyeux —. Mégnin, Les Acariens Parasites, pp. 74-75; fig. 8 (larva).
1893. *Trombidium holosericeum* (*not* of Linnaeus) Berlese, Prostigmata, p. 102: equals *Leptus autumnalis* Latreille (sic), larva, synonym, ex errore; and p. 110, but not figs. on pl. XIV. Homonym, dead name; erroneous synonymy.
1893. *Trombidium gymnopterorum* (*not* of Linnaeus) Berlese, *op. cit.,* pp. 92, 93, 94-95, 97, 98, 99, 115, 140; pl. XIII, figs. 2, 3; pl. XV, figs. 1-6 (larva): homonym, dead name, according to Stiles and Hassall (1927).
1896. *Leptus autumnalis* (Shaw). Hassall, U. S. Dept. Agric., Bur. Animal Ind., Cir. no. 9, p. 7.
1896. *Leptus autumnalis* —. Osborn, U. S. Dept. Agric., Div. Ent., Bull. no. 5, New Ser., p. 252.

1897. *Trombidium gymnopterorum* (*not* of Linnaeus) Brucker, C. R. Acad. Sci., Paris, *125,* pp. 879-880 (larva): homonym, dead name, according to Vitzthum (1929, p. 225).
1899. *Leptus autumnalis* (Shaw). Huber, Bibliog. klin. Ent., Heft 2, pp. 8-10.
1899. *Trombidium holosericeum* (in part, *not* of Linnaeus) Jourdain, Arch. Parasit., *2,* no. 1, pp. 31-32; figs. 3, 4 ("Rouget"): homonym, dead name.
1899. *Trombidium holosericeum* (*not* of Linnaeus) Trouessart, Arch. Parasit., *2,* pp. 286-290; figs. A-H (larva): homonym, dead name.
1899. *Leptus autumnalis* —. Tanaka, Zbl. Bakt., *26,* nos. 14/15, p. 433.
1903. *Thrombidium gymnopterorum* (*not* of Linnaeus) Oudemans, Tijdschr. Ent., *45,* p. 143 (larva): homonym, dead name.
1903. *Thrombidium gymnopterorum* (*not* of Linnaeus) Oudemans, Tijdschr. Ent., *46,* p. 5.
1904. *Thrombidium gymnopterorum* (*not* of Linnaeus) Heim and Oudemans, C. R. Acad. Sci., *138,* pp. 704-706 (larva): homonym, dead name, according to Stiles and Hassall (1927).
1905. *Leptus autumnalis* (Shaw). Galli-Valerio, Zool. Anz., *28,* nos. 14/15, pp. 521, 522.
1906. *Thrombidium holosericeum* (*not* of Linnaeus) Oudemans, Nova Guinea, *5,* Livr. I, p. 148 (larva): homonym, dead name.
1906. *Leptus autumnalis* —. Roth, Wschr. Tierheilk. Viehz., *50,* no. 18-20. (Reviewed in Rev. vét., Toulouse, 1906, *31* (63rd year), p. 737).
1908. *Leptus autumnalis* —. Notthaft, Münch. med. Wchnschr., 1908, p. 848.
1909. *Trombidium holosericeum* (*not* of Linnaeus) Blanchard, L'insecte et l'infection, fasc. I, p. 160 (larva): homonym, dead name.
1909. *Leptus autumnalis* —. Blanchard, *op. cit.,* p. 160.
1909. *Thrombidium inopinatum* Oudemans, Tijdschr., Ent., *52,* nos. 1/2, pp. 43-45, 55; pl. 7, figs. 37-40.
1909. *Thrombidium meridionale* Oudemans, *op. cit.,* pp. 45-48: nomen novum for *Trombidium gymnopterorum* (*not* of Linnaeus) Berlese, 1893, Prostigmata, p. 93, pl. XII, figs. 2, 3, and pl. XV.
1909. *Trombidium inopinatum* Oudemans. Bruyant, C. R. Soc. Biol. Paris, *67,* p. 208.
1909. *Trombidium gymnopterorum* (*fuliginosum*) (sic) Bruyant, *op. cit.,* p. 207: cited in synonymy by Oudemans (1912, p. 31).
1909. *Allotrombidium gymnopterorum* (*fuliginosum*) (sic) Bruyant, *op. cit.,* p. 207: cited in synonymy by Oudemans (1912, p. 31).
1909. *Trombidium* (*Heterotrombidium*) *meridionale* Oudemans. Verdun, C. R. Soc. Biol., *67,* p. 246.
1909. *Trombidium* (*Heterotrombidium*) *inopinatum* Oudemans. Verdun, *op. cit.,* p. 246.
1909. *Microthrombidium inopinatum* (Oudemans). Oudemans, Ent. Ber., *3,* no. 50, p. 20.
1909. *Microthrombidium meridionale* (Oudemans). Oudemans, *op. cit.,* p. 21.
1909. *Leptus autumnalis* —. Liebert, Deut. Tierärztl. Wchnschr., 1909, no. 34, p. 501.
1910. *Microtrombidium pusillum* (*not* of Hermann) Bruyant, Zool. Anz., *35,* no. 11, p. 351 (larva): homonym, dead name.
1912. *Microthrombidium pusillum* (*not* of Hermann) Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 31-33, 189, 202 (larva; equals *Acarus autumnalis* Shaw, 1806 (sic); *Trombidium gymnopterorum* (*not* of Linnaeus) Berlese, 1893, and subsequent authors, for larva; *Thrombidium inopinatum* Oudemans, 1909; and *Thrombidium meridionale* Oudemans, 1909, synonyms): homonym, dead name.
1912. *Microthrombidium pusillum* (Haller) (*Thrombidium pusillum* Hermann) (sic, but *not* of Hermann) Galli-Valerio, Zbl. Bakt., I Abt. Orig., *65,* Heft 4/5, pp. 309-310 (larva): homonym, dead name.
1913. *Microtrombidium pusillum* (*not* of Hermann) Brumpt, Précis de Parasitologie, 2e ed., pp. 564-566; fig. 364 (larva, but *not* adult; equals *Leptus autumnalis* Shaw,

1790, *pro parte* (sic); *Trombidium purpureum* Koch, 1837; *Thrombidium inopinatum* Oudemans, 1909, synonyms): homonym, dead name. Furthermore, *Trombidium purpureum* Koch, 1837 is *not* a synonym of *Acarus autumnalis* Shaw, 1790.

1913. *Microtrombidium pusillum* (*not* of Hermann) Galli-Valerio, Zbl. Bakt., 1 Abt. Ref., *56,* nos. 5/6, pp. 130-131: homonym, dead name.

1913. *Microthrombidium autumnalis* (Shaw). Oudemans, Arch. Naturgesch., *79,* Abt. A, Heft 9, pp. 127-129; pl. XII, figs. 1-6 (nymph; equals *Thrombidium inopinatum* Oudemans, 1909; *Microthrombidium pusillum* (*not* of Hermann) Oudemans, 1912, synonyms).

1914. *Microtrombidium pusillum* (*not* of Hermann) Galli-Valerio, Zbl. Bakt., 1 Abt. Orig., *72,* Heft 6/7, pp. 488-490; fig. *2* (larva, lesions on human skin): homonym, dead name.

1914. *Trombidium holosericeum* (*not* of Linnaeus) Shipley, Brit. med. J., *2,* pp. 750-752; figs. 2-4 (larva): homonym, dead name.

1914. *Leptus autumnalis* —. Shipley, *op. cit.,* pp. 750-752; figs. 2-4.

1915. *Leptus autumnalis* (Shaw). Braun, in Braun and Seifert, Die Tierische Parasiten des Menschen, I, p. 279; fig. 327.

1915. *Trombidium inopinatum* Oudemans. Banks, U. S. Dept. Agric. Rept. no. 108, p. 42.

1915. *Microtrombidium autumnalis* (Shaw). Hirst, J. econ. Biol., *10,* pt. 4, pp. 73-77; figs 1, *2.*

1916. *Trombicula autumnalis* (Shaw). Kneissl, Zool. Anz., *46,* no. 8, p. 253 (equals *Thrombidium inopinatum* Oudemans, 1909; *Microtrombidium pusillum* (*not* of Hermann) Bruyant, 1910, synonyms).

1916. *Leptus autumnalis* —. Nagayo, Miyagawa, Mitamura and Imamura, Dobuts. Zasshi, *28,* pt. 10, no. 336, pp. 381, 382, 393.

1916. *Leptus autumnalis* —. Miyajima and Okumura, Saikingaku Zasshi, no. 254, pp. 5-38; pl. V, figs. 1-3. (Cited in review in Chin. med. J., 1917, *31,* p. 344. The figures are taken from Hirst (1915)).

1916. *Leptus autumnalis* —. Giovanoli, Schweiz. Arch. Tierheilk., *58,* no. *2,* pp. 66-71. (Review in Rev. Appl. Ent., 1917, *5,* p. 32).

1917. *Microtrombidium autumnale* (sic) (Shaw). Hirst, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 6, p. 25; pl. II.

1917. *Leptus autumnalis* (Shaw). Nagayo, Miyagawa, Mitamura and Imamura, J. exp. Med., *25,* no. 2, pp. 273-276.

1917. *Leptus autumnalis* (Shaw). Miyajima and Okumura, Kitasato Arch., *1,* no. 1, pp. 1-14; fig. *2.*

1917. *Microthrombidium pusillum* (*not* of Hermann) Galli-Valerio, Zbl. Bakt., 1 Abt. Orig., *80,* Heft 5, pp. 265-266: homonym, dead name.

1918. *Microthrombidium pusillum* (*not* of Hermann) Ewing and Hartzell, J. econ. Ent., *11,* no. 2, pp. 258-259: homonym, dead name.

1918. *Leptus autumnalis* (Shaw). Teodoro, Redia, *13,* pp. 107, 108.

1920. *Leptus autumnalis* —. Hull, Vasculum, *6,* nos. 3-4, pp. 73-76. (Review in Rev. Appl. Ent., 1922, *10,* p. 119).

1921. *Leptus autumnalis* (Shaw). Hirst, Ann. Mag. nat. Hist., Ser. 9, *7,* p. 37.

1921. *Microthrombidium pusillum* (*not* of Hermann) Toldt, Wien. klin. Wschr., *34,* no. 34, p. 412: homonym, dead name.

1921. *Leptus autumnalis* —. Nagayo, Miyagawa, Mitamura, Tamiya and Tenjin, Amer. J. Hyg., *1,* nos. 5-6, p. 583.

1921. *Microtrombidium pusillum* (*not* of Hermann) Toomey, Urol. Cutan. Rev., *25,* p. 606 (equals *Thrombidium inopinatum* Oudemans, 1909, synonym): homonym, dead name.

1922. *Leptus* (*Trombicula?*) *autumnalis* (Shaw). Hirst, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 13, p. 77.
1922. *Microtrombidium pusillum* (*not* of Hermann) Brumpt, Précis de Parasitologie, 3rd ed., pp. 727-729, but not fig. 400 (adult) (synonymy as of Brumpt (1913)): homonym, dead name.
1922. *Microtrombidium pusillum* (*not* of Hermann) Ribeyro and Bambarén, Arch. Asoc. Peruana Prog. Ciencia, *2,* no. 2, p. 115: homonym, dead name.
1922. *Microtrombidium autumnalis* —. Walch, Geneesk. Tijdschr. Ned. Ind., *62,* no. 5, p. 561.
1923. *Leptus autumnalis* —. Toldt, Wien. klin. Wschr., *36,* no. 6, pp. 108-111.
1923. *Leptus autumnalis* —. Toldt, Wien. klin. Wschr., *36,* no. 33, pp. 592-596.
1923. *Leptus autumnalis* (Shaw). Toldt, Veröff. Mus. Ferdinand., Heft 3, pp. 1-35; figs. 2, 6, 7 (larva).
1923. *Microtrombidium pusillum* (*not* of Hermann) Toldt, Veröff. Mus. Ferdinand., Heft 3, pp. 4, 9, text only: homonym, dead name. (Fig. 3 is labelled as *Microtrombidium pusillum* Hermann, adult, but it is actually *Microtrombidium italicum* Berlese, 1910, according to Vitzthum (1929, p. 226)).
1925. *Leptus autumnalis* —. Toldt, Wien. klin. Wschr., *38,* no. 21, pp. 559-561.
1925. *Trombicula* (*Neotrombicula*) *autumnale* (sic) —. Hirst, Nature, *116,* p. 609, nymph: type of subgenus *Neotrombicula* Hirst.
1926. *Trombidium pusillum* (*not* of Hermann) Oudemans, Tijdschr. Ent., *69,* Suppl., mite no. 44, pp. 131-133, 392, 403, 405, 407, 414, 443; figs. 28, 29 (larva): homonym, dead name.
1926. *Microtrombidium pusillum* (*not* of Hermann) Bequaert, Med. Rept. Hamilton Rice Seventh Exped. etc., Chapt. XIV, p. 176: homonym, dead name.
1926. *Leptus autumnalis* (Shaw). Bequaert, *op. cit.,* p. 176.
1926. *Trombicula* (*Neotrombicula*) *autumnalis* (Shaw). Hirst, Ann. appl. Biol., *13,* no. 1, pp. 140-143; figs. 1, 2 (nymph).
1926. *Thrombicula* (*Neothrombicula*) *autumnalis* (Shaw). André, Bull. Mus. Hist. nat. Paris, no. 6, pp. 375-377.
1927. *Leptus autumnalis* —. Picard, Bull. Soc. zool. Fr., *52,* pp. 189-193.
1927. *Allothrombidium fuliginosum* (*not* of Hermann) Picard, *op. cit.,* pp. 189-193: homonym, dead name, according to André (1927).
1927. *Leptus autumnalis* (Shaw). André, Bull. Soc. zool. Fr., 52, no. 5, pp. 313-319; fig. 1 (equals *Thrombidium inopinatum* Oudemans, 1909; *Trombidium gymnopterorum* (*not* of Linnaeus) Berlese, 1893; *Allothrombium fuliginosum* (*not* of Hermann) Picard, 1927, synonyms).
1927. *Trombicula autumnalis* (Shaw). Stiles and Hassall, Hyg. Lab. Bull. no. 148, p. 269.
1927. *Microtrombidium pusillum* (*not* of Hermann) Stiles and Hassall, Hyg. Lab. Bull. no. 148, p. 270 (equals *Trombidium gymnopterorum* (*not* of Linnaeus) Berlese, 1893; *Thrombidium meridionale* Oudemans, 1909, synonyms): homonym, dead name.
1927. *Leptus autumnalis* —. Fletcher and Field, Bull. Inst. Med. Res., F. M. S., no. 1 of 1927, p. 18.
1927. *Microtrombidium pusillum* (*not* of Hermann) Lahille, Bol. Inst. Clin. quir. B. Aires, *3,* p. 773: homonym, dead name.
1927. *Leptus autumnalis* (Shaw). André, Bull. Mus. Hist. nat. Paris, no. 6, pp. 509-516; figs. A, B.
1927. *Trombicula autumnalis* (Shaw). Oudemans, Ent. Ber., *7,* no. 158, pp. 265-266.
1928. *Trombicula autumnalis* (Shaw). Methlagl, Denkschr. Akad. Wiss. Wien, *101,* pp. 213-249.
1928. *Trombicula autumnalis* (Shaw). Oudemans, Ent. Ber., *7,* no. 161, pp. 325-326.

1928. *Trombicula autumnalis* (Shaw). Ewing, Proc. ent. Soc. Wash., *30,* no. 5, p. 78.
1928. *Trombicula autumnalis* (Shaw). Sambon, Ann. trop. Med. Parasit., *22,* no. 1, pp. 74-76.
1928. *Leptus autumnalis* (Shaw). Warburton, Parasitology, *20,* no. 2, p. 228; figs. 1, 2.
1928. *Thrombicula autumnalis* (Shaw). André, Bull. Soc. zool. Fr., *53,* no. 6, pp. 368-370.
1928. *Leptus autumnalis* (Shaw). André, C. R. Acad. Sci. Paris, *187,* pp. 842-844 (equals *Thrombidium inopinatum* Oudemans, 1909, synonym).
1928. *Thrombicula autumnalis* (Shaw). André, Bull. Mus. Hist. nat. Paris, 2e sér., no. 3, pp. 208-211.
1928. *Leptus autumnalis* (Shaw). André, Assoc. Franç. Avanc. Sci., Congr. de La Rochelle, 1928, separate, pp. 1-3.
1929. *Thrombicula autumnalis* (Shaw). André, Bull. Mus. Hist. nat. Paris, *1,* no. 1, pp. 100-103; figs. C-G.
1929. *Trombicula autumnalis* (Shaw). Ewing, Proc. ent. Soc. Wash., *31,* no. 1, p. 10.
1929. *Thrombicula autumnalis* (Shaw). André, Bull. Soc. zool., Fr., *54,* no 5, pp. 484-489; figs. 1-3.
1929. *Trombicula autumnalis* (Shaw). Vitzthum, Tierwelt Mitteleuropas, *3,* Lfg. 3, pp. 63, 68; figs. 93, 94.
1929. *Thrombicula autumnalis* (Shaw). André, C. R. Acad. Sci. Paris, *189,* pp. 545-546; one figure.
1929. *Trombicula autumnalis* (Shaw). Vitzthum, Z. Parasitenk., *2,* Heft 2, pp. 223-247; figs. 1, 2, 6, 7 (detailed history and synonymy).
1929. *Trombicula autumnalis* —. Talice, Ann. Parasit. hum. comp., *7,* no. 6, pp. 484-486.
1929. *Trombicula autumnalis* (Shaw). Ewing, Ent. News, *40,* no. 9, pp. 295, 296.
1929. *Thrombicula autumnalis* (Shaw). André, Bull. Mus. Hist. nat. Paris, 2e sér., *1,* no. 6, pp. 394-400; figs. 1-3 (adult).
1929. *Leptus autumnalis* (Shaw). André, Bull. Mus. Hist. nat. Paris, 2e sér., *1,* no. 6, pp. 401, 405.
1929. *Trombicula autumnalis* (Shaw). Ewing, Manual of External Parasites, p. 24.
1929. *Trombicula autumnalis* —. Patton and Evans, Insects, Ticks, etc., pp. 656-657; figs. 337, 338.
1929. *Neotrombicula autumnalis* (Shaw). Hirst, Proc. zool. Soc. Lond., 1929, p. 173.
1929. *Acarus autumnalis* Shaw. Oudemans, Tijdschr. Ent., *72,* Suppl., mite no. 122, pp. 343-346, 916, 917, 918, 925, 935, 938, 939, 946, 964, 971; fig. 97.
1929. *Thrombidium inopinatum* Oudemans. Oudemans, *op. cit.,* mite no. 123, pp. 346-348, 916, 918, 925, 935, 939, 948, 964.
1930. *Thrombicula autumnalis* (Shaw). André, Mém. Soc. zool., Fr., *29,* no. 2, pp. 39-138; figs. 1-25 (monograph).
1930. *Leptus autumnalis* (Shaw). André, Ann. Parasit. hum. comp., 8, nos. 3-4, p. 361.
1930. *Thrombicula autumnalis* (Shaw). André, Assoc. Franç. Avanc. Sci., Congr. du Havre, 1929, pp. 433-434.
1930. *Microtrombidium pusillum* (*not* of Hermann) Stiles and Nolan, Nat. Inst. Hlth. Bull. no. 155 (1), p. 639: homonym, dead name. Recorded for bats; therefore probably refers to a misidentification of *Trombicula russicum* (Oudemans, 1902), as suggested by the writer's studies.
1931. *Trombicula autumnalis* —: Stiles and Stanley, Nat. Inst. Hlth. Bull. no. 159, p. 832.
1931. *Microtrombidium pusillum* (*not* of Hermann) Stiles and Stanley, *op. cit.,* p. 832: homonym, dead name.
1931. *Trombicula autumnalis* (Shaw). Vitzthum, Kükenthal's Handbuch der Zoologie, *3,* 2nd half (9), pp. 50, 52, 72, 127; figs. 66, 68, 92.
1931. *Trombicula autumnalis* (Shaw). Elton, Ford, Baker and Gardner, Proc. zool. Soc. Lond., 1931, pt. 3, pp. 710-712.

1931. *Thrombicula autumnalis* (Shaw). André, Arch. zool. ital., *16,* pp. 1355-1362; fig. 1 (nymph): reared from larvae off *Myotis daubentoni,* therefore probably a misidentification for *T. russicum* (Oudemans, 1902), as suggested by the writer's study of these specimens.
1932. *Thrombicula autumnalis* (Shaw). André, Bull. Soc. zool. Fr., *57,* no. 4, pp. 285, 286.
1932. *Thrombicula autumnalis* (Shaw). André, Assoc. Franc. Avanç. Sci., Congr. de Bruxelles, 1932, 65e sess., pp. 273, 275.
1932. *Trombicula autumnalis* (Shaw). Vitzthum, Zool. Jb., Abt. Syst., *63,* nos. 5/6, pp. 687, 689.
1933. *Leptus autumnalis* (Shaw). Fuss and Hanser, Arch. Derm. Syph., Wien, *167,* Heft 3, pp. 644-658.
1933. *Thrombicula autumnalis* (Shaw). André, Bull. Soc. ent. Fr., *38,* no. 10, pp. 154-156; fig. 1.
1933. *Leptus autumnalis* —. Feng and Hoeppli, Chin. med. J., *47,* p. 1191.
1933. *Microtrombidium pusillum* (*not* of Hermann) Feng and Hoeppli, *op. cit.,* p. 1192: homonym, dead name.
1934. *Trombicula autumnalis* —. Stiles and Baker, Nat. Inst. Hlth. Bull. no. 163, p. 1012.
1936. *Trombicula autumnalis* (Shaw). Elton and Keay, Parasitology, *28,* no. 1, pp. 110-114.
1936. *Trombicul autumnalis* (Shaw). Sugimoto, J. Jap. Soc. vet. Sci., *15,* p. 204.
1937. *Trombidium autumnalis* (Shaw). Oudemans, Kritisch Historisch Overzicht der Acarologie, III, D, pp. 1364-1384.
1937. *Otonyssus autumnalis* (Shaw). Oudemans, *op. cit.,* pp. 1994-1996.
1937. *Otonyssus autumnalis* (Shaw). Oudemans, *op. cit.,* G, pp. 2933-2936, 2938-2940, 2947, 2948, 2951, 2954, 2968, 2969, 3069.
1937. *Thrombicula autumnalis* (Shaw). André, Bull. Mus. Hist. nat. Paris, 2e sér., *9,* no. 4, pp. 258-261.
1937. *Thrombicula autumnalis* (Shaw). André, Bull. Mus. Hist. nat. Paris, 2e sér., *9,* pp. 313, 314-316.
1937. *Thrombicula autumnalis* (Shaw). André, Bull. Mus. Hist. nat. Paris, 2e sér., *9,* pp. 379-383.
1938. *Trombicula autumnalis* (Shaw). Neveu-Lemaire, Traité d'Entomologie etc., pp. 481-486; figs. 189, 190 (equals *Trombidium gymnopterorum* (*not* of Linnaeus) Berlese, 1893; *Thrombidium inopinatum* Oudemans, 1909; *Thrombidium meridionale* Oudemans, 1909, synonyms).
1938. *Trombicula autumnalis* (Shaw). Ewing, Proc. helm. Soc. Wash., *5,* no. 1, pp. 26-27 (probably equals *Tetranychus tlalsahuate* Murray, 1877, a name applied to a specimen taken in France).
1938. *Thrombicula autumnalis* (Shaw). André, Bull. Soc. zool. Fr., *63,* pp. 45-47.
1939. *Thrombicula autumnalis* (Shaw). André, Bull. Soc. ent. Fr., 1939, January, p. 16.
1940. *Trombicula autumnalis* (Shaw). Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, *5,* Abt. IV, Buch 5, Lfg. 1, pp. 60, 62, 63, 64, 95; figs. *22, 24, 26, 27,* 83. Lfg. 3, p. 384, fig. 375.
1940. *Trombicula* (*Leptus*) *autumnalis* —. Van Thiel and Van Ommeren, Geneesk. Tijdschr. Ned. Ind., *80,* no. *27,* pp. 1646, 1651.
1941. *Trombicula autumnalis* (Shaw). Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, *5,* Abt. IV, Buch 5, Lfg. 4, pp. 622, 623.
1941. *Trombicula autumnalis* (Shaw). Willmann, Zool. Anz., *133,* nos. 5/6, pp. 132, 136.
1942. *Trombicula autumnalis* (Shaw). Radford, Parasitology, *34,* no. 1, p. 62; fig. *27.*
1942. *Trombicula autumnalis* (Shaw). Willmann, Z. Parasitenk., *12,* Heft 6, pp. 639, 642.
1942. *Trombicula autumnalis* (Shaw). Ewing, J. Parasit., *28,* no. 6, p. 486.

1943. *Trombicula autumnalis* (Shaw). Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 77, 98; pl. II, fig. 7.
1943. *Thrombicula autumnalis* (Shaw). André, Bull. Mus. Hist. nat. Paris, 2e sér.,*15,* no. 6, p. 408.
1944. *Trombicula autumnalis* (Shaw). Willmann, Sammelheft 116 Jahresbericht Schles. Gesellsch. vaterl. Cultur (1943), pp. 66, 67, 68.
1944. *Trombicula autumnalis* (Shaw). Williams, Amer. J. trop. Med., *24,* no. 6, pp. 356-357.
1944. *Trombicula autumnalis* (Shaw). Ewing, J. Parasit., *30,* no. 6, pp. 349, 352; fig. 6 — map.
1945. *Trombicula autumnalis* —. Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, pp. 15, 17, 18; figs. 4, 5, 5A.
1945. *Trombicula autumnalis* (Shaw). Blake, Maxcy, Sadusk, Kohls and Bell, Amer. J. Hyg., *41,* no. 3, p. 255.
1945. *Otonyssus pusillum* (*not* of Hermann) Buitendijk, Zool. Meded., *24,* p. 338: (larvae only, *not* adults): homonym, dead name. The larvae are *T. autumnalis* (Shaw, 1790); the adults are *Microtrombidium* sp., but not *T. autumnalis* (Shaw, 1790).
1945. *Otonyssus inopinatum* (Oudemans). Buitendijk, *op. cit.,* p. 338 (equals *Otonyssus autumnalis* (Shaw), synonym). A reversal of the correct synonymy.
1946. *Trombicula autumnalis* (Shaw). Michener, Ann. ent. Soc. Amer., *39,* p. 431.
1946. *Trombicula autumnalis* —. Wharton, Ecol. Monogr., *16,* no. 3, p. 154.
1946. *Microthrombidium autumnalis* (Shaw). Ewing, J. Parasit., *32,* no. 5, p. 437; fig. 2.
1947. *Trombicula autumnalis* (Shaw). Fuller, Amer. J. Hyg., *45,* no. 3, p. 368.
1947. *Trombicula autumnalis* —. Philip, Amer. J. Hyg., *46,* no. 1, p. 63.

The above list of references is quite incomplete. For additional references prior to 1850, the reader should consult Oudemans (1926, 1929, 1937, Kritisch Historisch Overzicht der Acarologie). A useful bibliography was presented by André (1930) in his monograph on this species.

T. autumnalis (Shaw, 1790) is represented in the Oudemans collection by seven slides of larvae, all labelled "*Microthrombidium pusillum* (Hermann)" in Oudemans' handwriting. These bear the following data:

(1) Valkenburg, 16 September 1912, off *Talpa europaea,* coll. F. Heselhaus, two specimens.

(2) Arnhem, Holland, 29 March 1909, off *Parus major* L., coll. Oudemans, six specimens in poor condition for study.

(3) Arnhem, Holland, 24 September 1904, off *Mustela vulgaris,* coll. Oudemans, one specimen.

(4) Steenwijk, Holland, March, 1901, off *Crossopus fodiens,* coll. Oudemans, one specimen.

(5) Lille, August, 1908, off *Arvicola arvalis,* coll. Bruyant, two specimens.

(6) Lille, August, 1908, off *Mus sylvaticus,* coll. Bruyant, two specimens.

(7) Buré, August, 1903, off *Canis familiaris,* coll. F. Heim, two specimens.

Slides no. 8 and 9, bearing the same determination, are adult mites which are not *T. autumnalis,* nor do they appear to belong to *Trombicula.* There is a series of larvae, to be discussed as *autumnalis,* labelled *"Trombicula inopinatum* Oudemans, 1909", from Broût Vernet (Allier), 1899, off *Lepus cuniculus,* sent to Oudemans by André.

The writer has also studied André's material in the Muséum National d'Histoire Naturelle, Paris, and the material of Hirst and others in the British Museum (Natural History). Through the kindness of Dr. W. S. Richards and Mr. K. L. Cockings, he has seen many British specimens, illustrating variations. The following descriptive notes are based mainly on the material from Great Britain studied by Hirst (1915).

DIAGNOSIS: The body of the uncleared larva is vermilion in color and ovate to rotund in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. On either side of the scutum, in close apposition with it, is an ocular shield, bearing two eyes. The well developed anterior eye is located at the level of the pseudostigmata, while the smaller, poorly developed posterior eye is at the level of the posterior scutal corners. The scutum is of the shape depicted by Hirst (1925, p. 74, fig. 1), with the anterior margin biconcave, and the lateral margins slightly incurved just in front of the posterior corners. The posterior margin is rather evenly rounded, projecting about 30 micra behind the line of the posterior lateral setal pores. The pseudostigmata are slightly in advance of this line. There is a short diagonal line, or chitinous fold, behind each pseudostigma. The normal scutal setae bear barbs arising from several sides of their shafts. The writer has seen variants with two posterior lateral setae, arising from two separate pores on each side. Except in the region of the anterior median setal pore, the scutum bears numerous pits or stipples of medium size. The flagelliform pseudostigmatic organs bear eight or nine delicate cilia, arising from the distal two-thirds of the shaft.

The palpal claw is trifurcate, the main element being curved inward distally, and pointed. The accessory prongs are about two-thirds the length of the main element, pointed, and almost straight. Each chelicera bears a small, sharp, subapical, recurved dorsal toothlet. There is a more proximal flap-like process on the medial aspect of the ventral margin.

The dorsal and ventral abdominal setae vary considerably in numbers and patterns. For specimens from Ventnor, Isle of Wight, Hirst (1915, p. 75) recorded: 2 — 6 — 6 — 6 — 4 — 4 — plus a few posterior setae. He noted that a series from Berwick revealed patterns of 2 — 8 — 8 — 6 — etc., or 2 — 9 — 8 — 6 — etc. Oudemans (1909, fig. 37) figured for *T. inopinatum*: 2 — 8 — 6 — 6 — 6 — 4 — 4, apparently based on a very

slightly fed specimen. The specimen in the Oudemans collection from Arnhem, 24 September 1904, off *Mustela vulgaris*, has two humeral setae on each side, and the writer has noted this condition in examining specimens from Great Britain; it will receive further comment. There are two plumose sternal setae between coxae I, and two between coxae III. The remainder of the ventral setae vary in numbers and patterns, apparently increasing in number with an increase in total dorsal setae.

The seta on palpal segment I bears several long delicate cilia. The seta on segment II bears shorter delicate cilia. The seta on segment III bears one to three cilia, the number varying on two sides of a single individual. On segment IV, the dorsal and lateral setae are nude, while the ventral seta bears about six long delicate cilia. Segment V bears a blunt, basal, ventral, striated seta; a longer, curved, spine-like seta, arising about the mid-point of the segment; and six plumose setae of various forms, of which a dorsal one is most prominent. Although the galeal seta is characteristically nude, the writer has observed variants in which this seta bears one or two distinct cilia.

A characteristic, long, nude, whip-like seta arises near the base of tarsus III. The coxae are unisetose, although one observes variants in which there are two plumose setae on one or both coxae III. The vestiture of the remainder of the leg segments is not remarkable.

Measurements are recorded for several series in the British Museum (Natural History), and for a specimen in the Oudemans collection.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
Berwick											
86	98	36	33	30	33	46	42	55	—	51	45
83	98	30	34	34	30	51	45	63	—	52	51
84	98	36	34	32	34	46	48	57	—	51	48
81	98	33	30	32	30	—	50	60	84	54	39
Oxford: Bagley Woods											
84	110	36	34	33	36	48	52	70	83	66	58
Eton											
80	94	31	30	36	30	46	46	63	80	56	46
76	98	32	33	32	34	50	44	57	—	51	45
Isle of Wight: Ventnor											
80	94	32	30	34	30	50	39	60	—	58	46
81	100	33	30	34	33	—	39	51	—	52	42
88	102	34	33	30	32	45	44	62	—	56	48
81	104	34	30	32	33	50	46	58	—	56	46
Somerset: Catcott											
84	100	34	32	32	33	45	48	64	83	57	46
84	99	34	30	34	34	42	48	60	75	51	48

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
80	98	33	32	32	34	40	44	57	—	56	48
81	98	33	32	32	34	44	45	63	—	57	50
79	94	31	30	32	30	44	45	58	75	54	46
France: Versailles											
75	93	33	26	34	32	38	44	58	77	52	—
Holland: Arnhem, off *Mustela vulgaris*											
73	91	28	35	28	29	55	50	60	81	56	52

The writer has not attempted to correlate the above data with other morphological characters. The matter of variation in shape of the scutum, with particular reference to the posterior margin, was discussed by Methlagl (1928).

TYPE MATERIAL: *Acarus autumnalis* Shaw, 1790, was based on "The Autumnal Acarus or Harvest-Bug", attacking human beings in Great Britain, with the production of skin lesions accompanied by irritation. The writer has been unable to locate specimens which might have been examined by Shaw. The morphological characters given in the original description do not permit species differentiation according to present standards. However, according to available data, there is but one species of trombiculid mite larva attacking human beings in Great Britain. It is recognizable from the description and figures published by Hirst (1915), based on specimens taken at St. Boniface Downs, Ventnor, Isle of Wight, off the coast of southern England.

The names published by Kramer (1872), *Leptus Talpae,* etc., *Leptus Sambuci* etc., and *Leptus Hypudaei* etc., were based on specimens from Göttingen, Germany, off *Talpa europaea, Sambucus nigra,* and *Hypudaeus* (*glareolus*?) respectively. From his descriptions and figures, it is apparent that Kramer was dealing with larvae in various stages of engorgement. His multiple synonyms originate mainly in the labelling of his figures.

The name, *Tetranychus tlalsahuate* Murray, 1877, was applied to a specimen which Murray never saw. It had been reported by Lemaire (1867) as having been taken from the eye of a child in France, and the specimen was soon lost. It was originally thought that the mite had been introduced from Mexico in the packing and contents of boxes subsequently placed close to the lawn where the child played. Ewing (1938) has pointed out the unlikelihood of introducing trombiculid mite larvae in this manner. Since the species commonly attacking man in France is *T. autumnalis* (Shaw, 1790), Murray's name probably concerns a larva of this mite.

When Berlese (1893) applied the name *Trombidium gymnopterorum* to a larva attacking man, he was under the mistaken impression that he had associated it with the adult mite named by Linnaeus, hence the homonym.

When Oudemans (1909) proposed *Thrombidium meridionale* as a new name for Berlese's larva, he therefore created a synonym, as he (1912) later pointed out. It should be realized also that certain references to the following species must be cited under *T. autumnalis,* as homonyms, for analogous reasons: *Allothrombium fuliginosum* (Hermann, 1804), *Trombidium holosericeum* (Linnaeus, 1758), and *Microtrombidium pusillum* (Hermann, 1804).

Thrombidium inopinatum Oudemans, 1909, was proposed for specimens from Bremen, Germany, off *Crossopus fodiens,* no holotype designated. The synonymy with *T. autumnalis* (Shaw, 1790) was pointed out by Oudemans (1912, p. 31). The writer has been unable to locate the original specimens. The slide in the Oudemans collection ,labelled "*Trombicula inopinatum* Oudemans", bears a series of specimens mounted in balsam, with variable numbers and patterns of dorsal setae. On the basis of this material, and a study of the original description and figures, it appears that the name was applied to variants possessing larger numbers of dorsal setae. Should the need for their separation arise, then the name *T. inopinatum* (Oudemans, 1909) would be applicable.

GEOGRAPHICAL DISTRIBUTION: This has been mapped by Ewing (1944, p. 349, fig. 6). Available evidence indicates that this is the only species attacking man in Great Britain. However, on the European continent, *T. desalcri* Methlagl, 1928, attacks man in Schlern, with the production of similar symptoms, and its larva might be confused with *T. autumnalis* on cursory examination. If the description is correct, it is a distinct species, and it may occur in other localities as well. Thus one cannot attribute all reports of human attack to *T. autumnalis,* unless supported by morphological studies of actual specimens. Consequently the writer believes that reports of *T. autumnalis* published prior to 1928 should be reviewed critically as specimens from each locality become available for study. As pointed out by previous workers, much of the recorded distribution is probably open to question. With these points in mind, the reader may justly criticize the list compiled below.

Great Britain:	
No specific locality	Type locality
Berwick	Hirst (1915)
Wiltshire: Keevil	Llewelyn (1865)
Surrey	Hirst (1915)
Oxford: Bagley Woods	Elton and Keay (1936)
Wye	Hirst (1925)
Isle of Wight	Weir (1876); Hirst (1915)

France:	
Nord, near Lille	Bruyant (1911)
Seine: Bicêtre	Brucker (1900)
Choisy-le-Roi	André (1928)
Montreuil-sous-Bois	André (1928)
Seine-et-Oise: Saint Cloud	André (1928)
Versailles	André (1928)
Sucy-en-Brie	André (1928)
Seine-et-Marne: La Croix-en-Brie	André (1928)
Aube: Romilly-sur-Seine	André (1928)
Meurthe-et-Moselle: Buré-la-Forge	Heim (1904)
Côte-d'Or: Semur-en-Auxois	Brucker (1897)
Dijon	Picard (1927)
Allier: Broût-Vernet	André (1928)
Vienne: Poitiers	André (1928)
Indre	André (1928)
Manche: Port-Bail	Jourdain (1896)
Sarthe: Conlie	André (1928)
Maine-et-Loire: Ecouflant	André (1928)
Deux-Sèvres: Sainte-Marie-de-Bernegoue	André (1928)
Charente-Inférieure: Sainte-Palais	André (1928)
Tarn-et-Garonne	André (1928)
Auvergne (alt. 1250 meters)	André (1937)
Pyrénées Orientales: Banyuls-sur-Mer	André (1937)
Amelie-les-Bains	André (1937)
Alsace: Strasbourg	André (1937)
Denmark	Heiberg (1874)
Belgium	Bruyant (1911), cited by André (1928)
Holland:	
Arnhem	Oudemans (1912)
Steenwijk	Buitendijk (1945)
Valkenburg	Buitendijk (1945)
Germany:	
Bartenstein (Wurtemburg)	Toldt (1923)
Bierden (Hannover)	Oudemans (1912)
Bonn	Methlagl (1927)
Bremen	Oudemans (1909)
Königsberg	Buitendijk (1945)
Krefeld	Buitendijk (1945)
Lesum (near Bremen)	Oudemans (1912)
Mannheim	Methlagl (1928)
Meiningen	Brandis (1897)
Munich	Notthaft (1908); Kneissl (1916)
Teplitz (Bohemia)	Methlagl (1927)
Werneck	Gudden (1871)
Wurzburg	Gudden (1871)
Austria:	
Gaaden	Methlagl (1928)
Vienna	Methlagl (1928)
Schlern	Toldt (1923)
Dolomite Alps, South Tyrol	Toldt (1923)
Switzerland:	

Canton of Grisons (Graubünden)	Giovanoli (1916)
Canton of Fribourg (Freiburg)	Galli-Valerio, cited by André (1928)
Canton of Valais	Galli-Valerio, cited by André (1928)
Wallis (alt. 925 meters)	Galli-Valerio (1917)
Vintschgau (Val Venosta)	Toldt, cited by André (1928)
Italy:	
Valteline Alps	Galli-Valerio (1905, 1912)
Marsciana (V. Malenco)	Galli-Valerio (1914)
V. Fontana	Galli-Valerio (1914)
Lombardy	Giovanoli (1909)
Carinthia	Methlagl, cited by André (1928)

RECORDED HOSTS:

Man, *Homo sapiens* Linnaeus	Type host
Domestic dog, *Canis familiaris*	Mégnin (1892); *et al.*
Domestic cat, *Felis catus*	Bruyant (1909)
Domestic cattle	Neveu-Lemaire (1938)
Horse	Neveu-Lemaire (1938)
Goat	Galli-Valerio (1914)
Sheep	Giovanoli (1916)
Rabbit (species not specified)	Mégnin (1892); *et al.*
Oryctolagus cuniculus (Linnaeus)	Elton and Keay (1936)
Field mouse ("mulot", "campagnol")	Bruyant (1909)
Apodemus sylvaticus Linnaeus	Oudemans (1912); *et al.*
Clethrionomys glareolus brittanicus (Miller)	Elton and Keay (1936)
Microtus agrestis hirtus (Bellamy)	Elton and Keay (1936)
Rattus rattus ssp.	Brucker (1897)
Sciurus vulgaris	Oudemans (1912)
Arvicola amphibius	Oudemans (1912)
Arvicola nivalis	Galli-Valerio (1905)
Crossopus fodiens (Pallas)	Oudemans (1909)
Erinaceus sp.	Stiles and Stanley (1931)
Talpa europaea Linnaeus	Oudemans (1909); *et al.*
Mustela vulgaris Linnaeus	Oudemans (1912)
Birds:	
Domestic chicken, *Gallus domesticus*	Hirst (1925)
Blackbird ("merles")	Brucker (1897)
Parus major Linnaeus	Oudemans (1912)
Perdix cinerea	Vitzthum (1932)
Sylvia tithys	Oudemans (1912)
Turdus sp.	Vitzthum 1932)

COMMENT: Under various names, this species has been recorded for bats. Oudemans (1912, p. 32) wrote, "Dass diese Art an Vespertilionen schmarotze (1893, Berlese), muss vorläufig bezweifelt werden". It will be noted that Stiles and Stanley (1931, p. 639) record "*Microtrombidium pusillum*" for *Plecotus auritus,* and (p. 640) "*Trombidium gymnopterorum*" for the same species of bat. These names of mites are homonyms, and in this instance they actually refer to *T. autumnalis,* but the mites themselves were not studied critically, and it is doubtful that they really were this species. Further-

more, the writer has studied the larvae recorded from bats by André (1931). Some are *T. russicum* (Oudemans, 1902) and others are *T. muscae* (Oudemans, 1906), but *T. autumnalis* (Shaw, 1790) is not represented. Thus the writer has not seen authentic specimens of this species taken from bats, and he doubts that it parasitizes Chiroptera.

MEDICAL IMPORTANCE: Under the name "Harvest-bug", the first recognizable account of this species as a pest in Great Britain was published by Baker (1753, Employment for the Microscope, etc., pp. 393-395; pl. XV, fig. 11). Extracts of Baker's remarks have been published by Oudemans (1926, pp. 131-132). Baker noted that, "They are extremely troublesome to those that Walk in the Fields in Time of Harvest, especially to the Ladies, for they know what Skins are finest and easiest to pierce".

The larval mite is known by various common names in several languages. In English it is known as the harvest bug, harvest mite, harvester, red bug, or wheal worm. The British do not ordinarily apply the term chigger to trombiculid mite larvae. French common names are: acare des regains, aoûta, aoûtat, aoûti, bec d'août, bête d'août, bête rouge (also applied to trombiculid mite larvae in South America), Lepte automnal, Lepte d'automne, Lepte rouget, midas (1705, Dict. de Trévoux), mite, mite à pinces, mite d'automne, mite des faucheurs, pique d'août, rouget, sanguin, tique d'automne (sic), Trombidion rouget, vendangeron, vendangeur. The following common names appear in the German literature: Aerndtewanze, Aerntewanze, Aerntemilbe, Ernde Wanze, Erndtewanze, Erntemilbe, Feldwanze, Herbst-Leptus, Herbstmilbe, Rothe Grasmilbe. In the Dutch translation of Baker's early work (1756), it is referred to as the Oogst-weegluis. The condition caused by its attachment to the human skin has received several names: trombidiosis, trombidiasis, Trombidiose, Herbstbeisse, August-knuder, Sendlinger Beiss, Schlernbeisse, erytheme automnal, gratte charolaise, etc. According to Vitzthum (1929), "Stachelbeerkrankheit" is not caused by *T. autumnalis* (Shaw, 1790), although one finds it attributed to this species in the literature.

The pathogenesis and clinical picture of human infestation with this mite are apparently comparable and similar to attack by *Eutrombicula alfreddugèsi* (Oudemans, 1910), described elsewhere in this paper. It is obvious that the severity of the clinical picture depends upon the degree of infestation and the immunity or susceptibility of the individual. The medical importance of this species lies mainly in its role as a pest, and it is usually a pest of individual persons, rather than of large groups. However, Shipley (1914) states: "During September the soldiers of the Sixth Division, stationed in and about Cambridge, suffered severely from their 'bites' ".

The larvae can be found on small mammals throughout the year in certain

localities, for example, Bagley Woods, Oxford, the area studied by Elton and Keay (1936). However, human attack has a rather strict seasonal incidence, occurring mainly at the time of harvest, during August, September, and October. This phenological observation is of long standing, and it has been recorded repeatedly by writers since the time of Baker (1753).

Since *T. autumnalis* (Shaw, 1790) attacks human beings, it can be regarded as a potential vector of pathogenic organisms, although it has not been incriminated in the tranmission of disease. It is possible that new data bearing on this matter may be forthcoming in the near future.

The most detailed observations on this species have been contributed by the work of Dr. Marc André, and they will be discussed subsequently.

VETERINARY IMPORTANCE: The writer's information on this matter has been gained mainly from the account of Neveu-Lemaire (1938, pp. 484-486). According to him, dogs, cats, oxen, sheep, goats, horses, and domestic fowl may be attacked by this species.

Dogs, particularly hunting dogs, are frequently exposed to attack, as noted first by Defrance, cited by Duméril (1823). Considerable itching is caused at the sites of attachment, for example, the region of the nose and eyes, the inner surfaces of the legs, the skin of the chest and abdomen, and between the toes. Local vesicular or pustular lesions may occur. Attachment inside the ears may be accompanied by severe otitis.

Cats are not immune to the attack of this mite, which may be found particularly between the toes and at the end of the tail.

On oxen the larvae generally attach around the lips, cheeks, neck, and withers, and on the lower part of the legs. Neveu-Lemaire states that the disease known as "rafle", or "feu d'herbe", is probably none other than infestation with this mite. The animals tend to scratch and rub the affected areas.

Numerous observations on the effect on sheep and goats were published by Galli-Valerio (1914, 1917), Giovanoli (1916), and Toldt (1923). When grazing in alpine pastures, these animals are frequently attacked from the middle of October through November. The mites attach to areas of sparse hair, such as the eyelids, eyebrows, ears, nose, top of the head, and the under side of the feet. Generally there are no serious consequences, except those arising when a sheep injures itself while scratching.

It is stated that when these mites attack horses, the condition may be accompanied by intolerable itching. There may be erythematous lesions under the knees and hocks.

Neveu-Lemaire, citing Railliet and Lucet, notes that baby chicks which are hatched in the late summer or autumn may be commonly attacked by

T. autumnalis (Shaw, 1790), and may die in large numbers as a result. The mites attach at the base of feathers and around feather follicles, causing irritation which is sometimes of sufficient degree to result in convulsions, followed by death in several days. Apparently the adult fowl can withstand such ill effects, although they are not immune to the attack of the mites.

REMARKS: The following quotations from the original description by Shaw (1790) are of historical interest:

"This troublesome insect will make itself sufficiently known to most people during the months of August and September; it is much smaller than a common mite, and can just be perceived upon the skin, to which it adheres by its claws, and particularly by the two short arms or tentacula situated above the upper legs".

"It can scarcely be separated from the skin without violence, when once it has fixed itself: its motion when disengaged is considerably quick, though by no means equal to that of some other species of acari. On the part where it fixes, it causes a tumor, generally about the size of a pea; sometimes much larger, accompanied with a severe itching. The colour of this diminutive insect is a bright red; and when microscopically examined, the lower part of the body appears to be coated with stiff white bristles. It seems to be provided with a tubular snout, which is generally concealed or sheathed, but which may sometimes be distinctly seen. On the top of the head are two little processes or sharp implements which turn outwards each way. These insects abound on vegetables, and are generally contracted by walking in gardens, amongst long grass, or corn fields".

"It is a species which seems to have escaped the notice of systematic Naturalists; and is not to be found either in Linnaeus or Fabricius. A slight general description of it is given in Baker's Employment for the Microscope, accompanied by a figure; but as the figure was evidently taken from a dried specimen, it gives but a very imperfect idea of the animal".

Shaw and Nodder's figure shows a mite with three pairs of legs. There are two chelicerae, and on the palpi one can distinguish the fifth segment or thumb, the palpal claw, and some of the palpal setae. Each tarsus is drawn with two claws, but no empodium. Shaw did not depict a scutum and there are too many dorsal setae. This figure has been reproduced by Oudemans (1929, p. 345, fig. 97), and by André (1930, p. 40, text-figure). Further historical information is given by Oudemans (1926, 1929, 1937).

The larva must be distinguished from that of *T. desaleri* Methlagl, 1928, which is described as having a plumose lateral seta on palpal segment IV, and a long, nude, whip-like seta on tibia III as well as on tarsus III. The characters of several other species whose larvae are possibly related to

T. autumnalis (Shaw, 1790) are discussed by Philip and Fuller (1948, in press). *T. japonica* Tanaka, Kaiwa, Teramura and Kagaya, 1930, was originally given a trinomial name as a variety of the European form. It has two humeral setae on each side. The galeal setae are usually nude, sometimes forked. The dorsal and lateral setae on palpal segment IV are sometimes nude, as is the case with *autumnalis,* but usually forked, or with three or four cilia in varying combinations. This Japanese form may represent no more than a morphological variety of the European species, but it is regarded as distinct, in the absence of conclusive data. The writer has not found authentic records of its occurrence on man, or its causing irritation of the skin.

The nymph of *T. autumnalis* (Shaw, 1790) has been reared and described by Oudemans (1913), Kneissl (1916), Hirst (1925, 1926), André (1928, pp. 842-844), André (1929, pp. 484-489), and André (1930, pp. 110-112). On the basis of his nymph, Hirst (1925) proposed the new subgenus *Neotrombicula,* for which *autumnalis* is monotypic. This subgeneric name has not been generally adopted. Should further data on *autumnalis* and apparently related species now known only as larvae, including rearing of post-larval stages, indicate the need for subgeneric or generic separation from *Trombicula,* then Hirst's name would apply.

An adult mite has been described as this species by André (1929, pp. 545-546), (1929, pp. 394-400), and (1930, pp. 122-131). André found his specimen in earth at a depth of 15 to 20 centimeters. It was collected in a strawberry patch where larvae were common. Although this adult probably represents *T. autumnalis* (Shaw, 1790), it was not associated with larvae by a rearing experiment. Its identity should be viewed critically until it has been compared with adult specimens that have been associated with larvae.

Neither the process of oviposition, nor the eggs themselves, have been described. Presumably, if observations of other species are applicable, the eggs are laid singly, not in masses. The studies of Cockings (1948, in press) suggest that only a few eggs are laid at a time by a given female.

Detailed observations on the unfed larvae in nature have been recorded by André (1938, pp. 45-47). He studied these mites during August, 1937, in a garden at La Croix-en-Brie (Seine-et-Marne). On a single bean plant, the distribution of the larvae differed according to the time of day. During the morning the larvae were sparsely scattered, isolated individuals running here and there on the earth, and rarely on the under side of the bean leaves. Toward afternoon they became more numerous. About five o'clock and especially at six, when the sun began to set, André observed thousands of larvae in groups or little masses, each covering a surface three or four

millimeters in diameter. The mites remained in these agglomerated masses throughout the night, dispersing only when the dew began to fall. André concluded that this depended upon a definite positive thermotaxis, rather than heliotropism, but this interpretation requires further confirmatory evidence in the writer's opinion. André states that humidity is the principal factor conditioning the existence of larvae, an atmosphere in the neighborhood of saturation being most suitable. (This observation has been confirmed by laboratory studies of other species). André noted that the mites sought refuge under the humid shade of the bean plants, and they soon departed after the latter had been dug up, owing to the modification of the environment. On the plants themselves, André found only a few larvae on the stems, or on the under surface of the leaves, where they assembled near the tip. Moreover, the mites were found on low plants only, such as groundsel (*Senecio* sp.), couch grass (*Agropyron repens*), and dandelion (*Taraxacum officinale*). On climbing beans the colonies of mites were never found more than twenty centimeters above the surface of the soil.

Although seeking a humid atmosphere, the larvae apparently avoid actual contact with wet surfaces; in fact, on soil particles or small dead twigs, they remain only on the dry distal portion and never on the moist base. André (1927, p. 318) noted that rain causes rapid dispersal of the larvae.

In short, the larvae tend to group themselves at the tips of leaves, or on a small pebble, or on pieces of animal or vegetable debris, at the most salient or projecting point. They may be suspended from one another, thus forming actual colonies of 10 to 150 individuals. For example, on a small fallen apple, resting with its stem in the air, they assemble at the extremity of the peduncle.

While presumably awaiting an animal host, the larvae remain perfectly motionless, but they will drop to the ground if their support is jarred. Moreover, their dispersal can be brought about by the most minimal cause, such as the commotion of air currents produced by a sudden loud voice nearby, whereas they are not affected by a relatively strong, but continuous breeze.

Numerous writers have described patches of ground where the surface was literally covered by larvae of this species. The term, "Trombidioseherde", has been applied in the German literature. Vitzthum (1941, p. 532) cites the Trombiculinae as an example of Deegener's (1917) "Synchoropaedium: Die vergesellschafteten Kinder entstammen den an demselben günstigen Ort abgelegten Eiern verschiedener Mütter". Apparently, however, the unfed larvae may wander considerably, and André (1937, p. 386; and 1938, p. 47) has pointed out that larvae in a small patch of heavily infested soil surface did not necessarily hatch from eggs deposited in the *immediate* vicinity. A con-

dition of massive infestation of the surface of a single small patch of ground may persist for several weeks under suitable conditions.

Further observations on the behavior of unfed larvae have been recorded by Cockings (1948, in press). He noted their natural tendency to climb upward and to move toward light. These facts were applied in designing a highly efficient field trap, enabling the collection of large numbers of unfed larvae for experimental purposes, as well as the comparison of degrees of infestation in various patches of terrain.

The preferred natural larval host appears to be the common European rabbit, *Oryctolagus cuniculus* (Linnaeus). Cockings (1948, in press) found that guinea pigs and golden hamsters are suitable experimental hosts. The writer has not found detailed data concerning the distribution of larvae on wild rabbits, although it is known that they commonly attach inside the ears. On guinea pigs, Cockings observed that over seventy per cent of all larvae were found grouped around the genital area, near the anus. Approximately twenty per cent were found attached to the soft skin of the perineum, and less than ten per cent were in the ears. Larvae attached to golden hamsters were more evenly distributed between these areas.

The mechanism of larval feeding has received detailed study by André (1927, pp. 509-516; and 1930, pp. 89-105). The first observations were recorded by Gudden (1871), but some of his interpretations were incorrect. Trouessart (1899) figured an imaginary organ which he apparently thought was extruded by the larva. This has been the subject of considerable controversy, and Trouessart's figure was recently reproduced by Vitzthum (1940, p. 64, fig. 27), whose account of the feeding mechanism is completely misleading.

According to André's observations, the act of feeding can be considered in two stages. The first begins after the larva has become attached by insertion of the chelicerae. The mite injects a cytolytic substance, capable of dissolving certain tissues. This substance may be produced in the salivary glands, but its origin is not known with certainty. Histolysis and necrosis of host tissue at the site of attachment are accompanied by the production of a hyaline tubular formation, with varying degrees of cellular reaction in the neighboring tissue. André termed this stage of histolysis as extra-intestinal digestion. The second stage consists in the aspiration of the liquid thus produced, and the completion of its chemical digestion in the intestinal tract of the larva. Observations of other species indicate that this mode of nutrition is shared generally by larval Trombiculidae. Although it is theoretically possible for the extra-intestinal digestive process to invade a capillary, it has not been observed to do so. Available evidence indicates that the

larva takes a meal of dissolved tissue and tissue fluid. It has not been shown to ingest blood, although the literature contains uncritical references to a presumed "blood meal".

The tubular structure produced by the host's reaction has been termed the stylostome, histosiphon, sucking tube, suction tube, etc.

André (1928, p. 843) noted that the duration of larval feeding on a rabbit occupied about seventy hours. Cockings (1948, in press) reported observations on ten guinea pigs, showing that over eighty per cent of the larvae left the animal between thirty and sixty hours after attachment. The actual time required for feeding to repletion will vary according to host and environmental factors, and field observations are apparently lacking.

After feeding to repletion, the larva drops from its host. Cockings (1948, in press) has devised a laboratory light trap which makes use of the fact that engorged larvae tend to move toward light. Under experimental conditions, André (1928, p. 843) noted the presence of active nymphs fourteen days after the engorged larvae had dropped from their host. The duration of this period under various experimental and natural conditions is not known. The respiratory apparatus of the nymph was described by André (1929, pp. 433-434 and figure), but there is little published information on other aspects of the biology and behavior of nymphs.

Field observation on the adults of this species have been recorded by Cockings (1948). His studies were carried out near Compton, Berkshire, on chalk down, where pure chalk is covered by a relatively thin layer of soil, bearing short grass, a variety of small herbaceous plants, and low bushes of gorse and juniper. The depth of the soil was almost uniformly twelve inches. Adults were found to be most numerous in soil samples taken within fifteen feet of rabbit burrows; of these, greater numbers were found beneath the cover of bushes than beneath short grass. Cockings observed that the adults rise toward the surface of humid soil when the air temperature is high, and go deeper into humid soil when air temperatures are at or near the freezing point. Under very dry conditions, the adult appears to go deeper, toward moist soil, and to rise after the first rainfall following a prolonged dry period. Adults near the surface of the soil under turf appear to go deeper after heavy or continuous rainfall, irrespective of air temperature.

Unpublished observations by Dr. W. S. Richards indicate that the nymphs and adults are predaceous, feeding upon small arthropods, and sometimes attacking other individuals of their own species.

Apparently the biotope of a chalk down is particularly well suited to the requirements of *T. autumnalis* (Shaw, 1790). In fact, in his "Natural

History and Antiquities of Selborne", Gilbert White (1789, Letter 35) noted that the "harvest-bug" was especially common in "chalky districts". However, the recorded distribution indicates the possibility of successful survival and breeding under a variety of natural and man-made environments.

We do not know the number of generations per year under a variety of circumstances, nor is it clear in which stage the species mainly passes the winter months. These matters have been considered by André (1937, pp. 379-383). He cites the opinion of Bruyant (1909, p. 675), who had found numerous larvae in the ear of a field mouse collected in January. Bruyant believed that larvae which attached during the late autumn might remain on their hosts throughout the winter, dropping and metomorphosing to nymphs during May and June of the following year. André believes that Bruyant's theory is supported by the findings of Elton and Keay (1936), who observed larvae on rabbits and on bank voles (*Clethrionomys glareolus brittanicus* (Miller)) throughout the winter and following spring. Elton and Keay concluded that rabbits and *Clethrionomys* are of importance in maintaining the stock of harvest mites in some areas in the southern part of England. It should be noted, however, that the entire life cycle under various natural conditions has not been worked out. Available methods are easily applicable to this problem, which is being considered in Great Britain by Dr. W. S. Richards.

Trombicula trägårdhi (Oudemans, 1910)

1910. *Microthrombidium trägårdhi* Oudemans, Ent. Ber., *3,* no. 54, p. 86.
1912. *Microthrombidium trägårdhi* Oudemans. Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 37-39, 190, 202; fig. K.
1928. *Trombicula trägårdhi* (Oudemans). Methlagl, Denkschr. Akad. Wiss. Wien, *101,* pp. 216, 218, 223, 224.
1929. *Microtrombidium trägårdhi* Oudemans. Stiles and Nolan, Hyg. Lab. Bull. no. 152, p. 485.
1929. *Microthrombidium Trägaardhi* (sic) Oudemans. André, Bull. Mus. Hist. nat. Paris, 2e sér., *1,* no. 6, p. 405.
1936. *Pentagonella trägardhi* (sic) (Oudemans). Sig Thor, Zool. Anz., *114,* nos. 1/2, p. 30.
1942. *Trombicula tragardhi* (sic) (Oudemans). Radford, Parasitology, *34,* no. 1, p. 60; fig. 17.
1945. *Otonyssus trägårdhi* (Oudemans). Buitendijk, Zool. Meded., *24,* p. 338.
1946. *Trombicula trägardhi* (sic) (Oudemans). Michener, Ann. ent. Soc. Amer., *39,* p. 432.

This species is represented in the Oudemans collection by a single specimen, bearing the data of the original series. This example is in good condition for study, except for the fact that the palpi are folded upon themselves.

DIAGNOSIS: The body of the engorged larva is elongate-ovate in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. On either side of the scutum at the level of the posterior corners, is an ocular shield, bearing two eyes, of which the anterior is the larger, the posterior eye being less well developed. The scutum is of the pentagonal shape depicted by Oudemans (1912, fig. K 1), with the posterior margin projecting to a rather blunt angle. The normal scutal setae bear short barbs, arising from a single side of the shaft. The pseudostigmatic organs bear four to six cilia, arising from the distal half of the shaft. The pseudostigmata are well anterior to the line of the posterior lateral setal pores.

The palpal claw is trifurcate. The main element is curved inward distally and pointed; the two accessory elements are lateral to it, pointed, and almost straight. Each chelicera has a small, sharp, subapical, recurved, dorsal toothlet. On the mesial aspect of the ventral margin is a process similar to that seen in *T. autumnalis* (Shaw, 1790). These details were not figured by Oudemans, who depicted the dorsal and ventral margins of the chelicerae as being smooth.

The dorsal setae are similar in form to the normal scutal setae, and they are arranged: 1 — 8 — 8 — 8 — 4 — 2 — 2, plus four posterior marginal setae (two on either side). There are two plumose sternal setae between coxae I and two between coxae III. There are approximately fourteen plumose pre-anal setae, and six post-anal setae. These were not well visualized in the specimen studied by the writer.

The seta on palpal segment I bears five or six long, delicate cilia. The seta on segment II bears small, short cilia, arising from opposite sides of the shaft. The seta on segment III bears six or seven delicate cilia, arising from the lateral aspect of the shaft. On segment IV, the dorsal seta bears several short cilia, the lateral seta is nude, and the ventral seta bears six delicate cilia. According to Oudemans (1912, p. 39), segment V bears a basal, ventral, striated seta; two plumose setae; and two nude setae. The galeal seta is nude.

Each coxa bears a single plumose seta, similar in form to the sternal setae. A long, nude, whip-like seta arises from the proximal one-fourth of the dorso-lateral aspect of tarsus III. There is no similar seta on tibia III, and the vestiture of the remainder of the leg segments is not remarkable.

The following measurements were made on the specimen in the Oudemans collection: AW 62; PW 70; SB 22; ASB 22; PSB 28; AP 28; AM 36; AL 29; PL 46; SENS 60; DSA 38; DSP 32. The writer forgot to measure the legs, but Oudemans (1912) gives the following data: I — 214; II — 147; and III — 195 micra in length.

TYPE MATERIAL: Described from four specimens from the White Nile, Egypt, March, 1901, off *Cercopithecus griseus,* collected by Dr. Ivar Trägårdh. According to Oudemans (1912, p. 39), the type was in the collection of Dr. Trägårdh, Stockholm, Sweden. The writer has been unable to ascertain the present existence of the type specimen.

REMARKS: This species is known only from the original material. It is possible that more setae are actually present on palpal segment V than were described or figured; at least similar species possess more setae on this segment. It will be noted that this species was included by Sig Thor (1936) in the genus *Pentagonella.* It may be related to this species, but the lengths of the legs are not of the same order of magnitude as those of the genotype, *T. ardeae* (Trägårdh, 1904). According to the writer's preliminary studies, *T. trägårdhi* (Oudemans, 1910) appears to be more closely related to *T. autumnalis* (Shaw, 1790).

Trombicula muris (Oudemans, 1910)

1910. *Microthrombidium muris* Oudemans, Ent. Ber., *3,* no. 54, p. 85.
1912. *Microthrombidium muris* Oudemans. Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 33-35, 190, 202; fig. H.
1928. *Trombicula muris* (Oudemans). Methlagl, Denkschr. Akad. Wiss. Wien, *101,* pp. 216, 218, 221, 223, 224.
1936. *Pentagonella muris* (Oudemans). Sig Thor, Zool. Anz., *114,* nos. 1/2, p. 30.
1942. *Trombicula muris* (Oudemans). Radford, Parasitology, *34,* no. 1, p. 60.
1945. *Otonyssus muris* (Oudemans). Buitendijk, Zool. Meded., *24,* p. 338.
1946. *Trombicula muris* (Oudemans). Michener, Ann. ent. Soc. Amer., *39,* p. 432.

This species is represented in the Oudemans collection by two specimens, mounted on one slide, bearing the data of the original series. They are not labelled as types. Both specimens are in poor condition for study, owing to their position and the fact that they are insufficiently cleared. Air has entered one of the specimens, obscuring the details, but it was deemed inadvisable to remount the preparation.

DIAGNOSIS: The body of the engorged larva is ovoid in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. On either side of the scutum, at the level of the posterior corners, is an ocular shield bearing two eyes. The anterior eye is the larger one, and the posterior eye is less well developed. The scutum is of the pentagonal shape depicted by Oudemans (1912, fig. H 1), and the angle of the posterior margin is more acute than that of *T. autumnalis* (Shaw, 1790). There are "eyebrows" over the pseudostigmata. According to Oudemans' figure and description, the pseudostigmata are in the line of the posterior lateral setal

pores, but the writer's examination of these specimens suggests that they are actually anterior to this line. The normal scutal setae are short, bearing cilia which arise from opposite sides of their shafts. The pseudostigmatic organs are relatively short, bearing several short cilia on the distal portion of the shaft.

The palpal claw is definitely trifurcate. The main element is curved and pointed distally, and the two accessory elements are pointed and almost straight. The ventral accessory element is the shorter of the two. Each chelicera bears a dorsal, subapical, recurved toothlet, as described and figured by Oudemans. The ventral margin of the chelicerae was not seen.

The dorsal setae are relatively short, stout, and bushy in appearance, bearing cilia which arise from opposite sides of the shaft. Oudemans expressed their pattern as a formula. A single humeral seta is discernable on either side, and there is a total of fifty-six additional dorsal abdominal setae. There are two plumose sternal setae between coxae I, and two between coxae III. There is a total of thirty-two additional plumose, ventral, abdominal setae, but these were not well visualized in the material studied.

The seta on palpal segment I bears seven long, delicate cilia. On segment II, the plumose seta is short and bushy. The seta on segment III bears four or five delicate cilia. On segment IV, the dorsal seta bears a few short cilia, the lateral seta is nude, and the ventral seta bears three long, delicate cilia. Segment V bears a basal, ventral, striated seta; a long, nude seta; and four plumose setae of various forms. The galeal seta is nude.

Each coxa bears a single plumose seta. A long, nude, whip-like seta arises from the dorso-lateral aspect of the proximal one-fourth of tarsus III. There is no similar seta on tibia III, and the vestiture of the remainder of the leg segments is not remarkable.

Since the scutum is askew in the single specimen in which it can be seen, measurements are apt to be unreliable. The following approximations were made: AW 50; PW 62; SB 17; AP 21; DSA 35. Oudemans recorded the length of the scutum (SD) as 45, and the width as 64. The latter is compatible with the writer's observation for PW. The lengths of the legs are as follows: I 170; II 135; III 180.

TYPE MATERIAL: Described from two specimens from Bremen, Germany, 1898, off *Mus sylvaticus,* collected by H. Fahrenholz. According to Oudemans (1912, p. 35), the type was in the Fahrenholz collection, Hannover, Germany. However, since the species was described from two specimens, and there are only two in the Oudemans collection, it is probable that these represent the types. They would be regarded by the writer as cotypes, although not so labelled by Oudemans.

REMARKS: This species is known only from the original material. Its relationships are not clearly understood by the writer. On the basis of the shape of the scutum alone, Sig Thor (1936) included it in *Pentagonella*. The lengths of the legs are not of the same order of magnitude as those of *T. ardeae* Trägårdh, 1904), and the chelicerae are not similar. In these features, *T. muris* (Oudemans, 1910) is much closer to *T. autumnalis* (Shaw, 1790). The pseudostigmatic organs, normal scutal setae, and dorsal abdominal setae are reminiscent of *T. cynos* Ewing, 1937, of which the writer has examined the holotype. Their bushy appearance is quite unlike the setae of *T. autumnalis* (Shaw, 1790).

Trombicula fahrenholzi (Oudemans, 1910)

1910. *Microthrombidium fahrenholzi* Oudemans, Ent. Ber., *3,* no. 54, p. 85.
1912. *Microthrombidium fahrenholzi* Oudemans. Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 35-37, 190, 202; fig. J.
1926. *Microthrombidium fahrenholzi* —. Toldt, Wien. klin. Wchnschr., *39,* no. 1, p. 892.
1928. *Trombicula fahrenholzi* (Oudemans). Methlagl, Denkschr. Akad. Wiss. Wien, *101,* pp. 215, 216, 218, 221, 222, 223, 224.
1929. *Microthrombidium Fahrenholzi* Oudemans. André, Bull. Mus. Hist. nat. Paris, 2e sér., *1,* no. 6, p. 405.
1930. *Thrombicula Fahrenholzi* (Oudemans). André Mém. Soc. zool. Fr., *29,* no. 2, pp. 59, 109.
1930. *Microtrombidium fahrenholzi* Oudemans. Stiles and Nolan, Nat. Inst. Hlth. Bull. no. 155(1), p. 639.
1936. *Pentagonella fahrenholzi* (Oudemans). Sig Thor, Zool. Anz., *114,* nos. 1/2, p. 30.
1938. *Microtrombidium fahrenholzi* Oudemans. Neveu-Lemaire, Traité d'Entomologie etc., p. 494.
1942. *Trombicula fahrenholzi* (Oudemans). Radford, Parasitology, *34,* no. 1, p. 60; fig. 16.
1945. *Otonyssus fahrenholzi* (Oudemans). Buitendijk, Zool. Meded., *24,* p. 338.
1946. *Trombicula fahrenholzi* (Oudemans). Michener, Ann. ent. Soc. Amer., *39,* p. 431.

There are no specimens of this species in the Oudemans collection, and it is represented only by his drawings. The following descriptive remarks are taken from the description and figures published by Oudemans (1912), based on a single imperfect specimen.

DIAGNOSIS: The body is broadly ovoid in shape, being slightly constricted posterior to coxae III. Since the legs were broken, their segmentation cannot be described with certainty. Presumably they consist of seven segments. The form of the tarsal claws is unknown. On either side of the scutum is a well developed ocular shield, bearing two eyes, of which the anterior is the larger, the posterior one being poorly developed. The pentagonal scutum was depicted by Oudemans (1912, fig. J 1). The angle of the posterior margin is pointed. The pseudostigmata are located in the line of the posterior lateral

setal pores. The normal scutal setae bear short barbs. The pseudostigmatic organs are figured as having seven cilia on the distal half of the shaft.

The palpal claw is trifurcate, the prongs apparently being blunt, and the lateral accessory elements being shorter than the main element. Although the chelicerae are figured without a dorsal tooth, the writer doubts the accuracy of this observation. Oudemans states (1912, p. 36): "Mandibelkrallen gebogen, glatt".

The dorsal setae are long, similar in form to the posterior lateral scutal setae, and bearing short barbs. A humeral seta is present on either side. There are fifty-four additional dorsal setae. There are two plumose sternal setae between coxae I and two between coxae III. There are forty additional ventral setae, bearing short barbs.

The seta on palpal segment I bears four delicate cilia. The plumose setae on segments II and III each bear four cilia. On segment IV, the dorsal and lateral setae are nude, while the ventral seta bears six short cilia. Segment V bears a basal, ventral striated seta; a nude, spine-like seta, plus seven plumose setae of various forms. The galeal seta is nude and relatively long, reaching beyond the tips of the chelicerae.

Each coxa bears a single plumose seta. The vestiture of the tibiae and tarsi is unknown, since these segments were missing from the type specimen.

According to Oudemans (1912, p. 35), the length of the scutum (SD) is 100 micra, and the width is 133 micra. Presumably one could calculate the other measurements from Oudemans' figure, provided he knew with certainty that the drawing is mathematically precise. The writer hesitates to make this assumption.

TYPE MATERIAL: Described from a single specimen (holotype) from Bremen, Germany, 1909, off *Miniopterus schreibersi,* collected by H. Fahrenholz. According to Oudemans (1912), the type was at that time in the collection of Fahrenholz, in Hannover, Germany. The writer has not ascertained the present existence or location of this specimen.

REMARKS: In view of our imperfect knowledge of this species, it is unsatisfactory to attempt a discussion of its relationships. On the basis of the scutum alone, it may be related to *T. autumnalis* (Shaw, 1790), or to *T. ardeae* (Trägårdh, 1904).

Toldt (1926) reported that mites belonging to this species attacked human beings in the Dolomites, South Tyrol. In the absence of evidence of comparison with the type specimen, the writer doubts their determination. André (1929) cited Methlagl as having shown that these cases were actually due to attack by *T. autumnalis* (Shaw, 1790). The writer knows of no authentic human record for a species which characteristically parasitizes bats. It is

pointed out elsewhere in this paper that records of *T. autumnalis* (Shaw, 1790) from bats have proved to be based on misidentification, when the specimens were examined by the writer.

Trombicula ardeae (Trägårdh, 1904)

1904. *Trombidium ardeae* Trägårdh, Results Swedish zool. Exped. Egypt White Nile, no. 20, I, p. 83; pl. 4, figs. 28, 29, 32.
1910. *Microthrombidium ardeae* (Trägårdh). Oudemans, Ent. Ber., *3,* no. 54, p. 86.
1912. *Microthrombidium ardeae* (Trägårdh). Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 40-42, 190, 202; fig. L.
1928. *Trombicula ardeae* (Trägårdh). Methlagl, Denkschr. Akad. Wiss. Wien, *101* pp. 216, 218, 223, 224.
1928. *Trombicula ardeae* (Trägårdh). Ewing, Proc. ent. Soc. Wash., *30,* no. 5, p. 78.
1928. *Microthrombidium ardeae* (Trägårdh). André, Bull. Mus. Hist. nat. Paris, 2e sér., *1,* no. 6, p. 405.
1936. *Pentagonella ardeae* (Trägårdh). Sig Thor, Zool. Anz., *114,* nos. 1/2, p. 30: genotype.
1941. *Pentagonella ardeae* (Trägårdh). Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 4, p. 624.
1942. *Trombicula ardeae* (Trägårdh). Radford, Parasitology, 34, no. 1, p. 60; fig. 15.
1945. *Otonyssus ardea* (sic) (Trägårdh). Buitendijk, Zool. Meded., *24,* p. 337: lapsus.
1946. *Trombicula ardeae* (Trägårdh). Michener, Ann. ent. Soc. Amer., *39,* p. 431.

This species is represented in the Oudemans collection by two specimens of the original series, mounted on a single slide. They are in good condition for study.

DIAGNOSIS: The body of the unengorged larva is broadly oval in shape, with lateral bulges on either side at the level of coxae II, suggestive of shoulders. The leg segmentation is characteristic of the subfamily and the legs are unusually long: I — 333 micra; II — 285 micra; III — 338 micra. The tarsal claws are normal. On either side of the scutum, at the level of the posterior lateral setal pores, is an ocular shield, bearing two eyes with well developed corneae, of which the anterior is the larger. The scutum is of the shape depicted by Oudemans (1912, fig. L 1), with the posterior margin acutely angulate, and projecting far behind the line of the posterior lateral setal pores. The normal scutal setae bear relatively coarse, rather long barbs. The flagelliform pseudostigmatic organs bear about nine cilia, arising from the distal half of the shaft.

The palpal claw is trifurcate, the main element being strongly curved distally and pointed. The accessory elements lie lateral to it, one above and the other below, and they are shorter, but less strongly curved. Each chelicera bears a sharp, dorsal, subapical, recurved toothlet; a more proximal dorsal notch; and a blunt, recurved, tooth-like or gouge-like process on the ventral margin. This is reminiscent of the chelicera of *E. wichmanni* (Oudemans, 1905).

The dorsal abdominal setae are similar in form to the normal scutal setae. They are unusually long, and their finely tapered distal portions tend to curl. The anterior and posterior setae are approximately equal in length. It will be noted that there is considerable disparity between the setal measurements of the two specimens studied. This may be due to poor visibility of the finely tapered portions of these setae in the specimen mounted with the ventral surface upward; or it may be due to variation. These specimens are identical in other respects. The pattern given by Oudemans (1912, p. 41) was 2 — 6 — 6 — 8 — 8, but since the specimens are not engorged, the writer believes that an attempt to formulate a pattern gives a false impression in this instance. There are two rather long, plumose, sternal setae between coxae I, and two between coxae III. The remainder of the ventral setae are arranged: 6 — 6 — 2 — 4 — 2 (flanking the anus) — 2 — 2.

The seta on palpal segment I bears long, delicate cilia. The long seta on segment II bears numerous fine cilia, arising from opposite sides of the shaft. The shorter seta on segment III bears eight or nine delicate cilia. According to Oudemans (1912, figs. L 3 and L 5), the dorsal seta on segment IV is nude, and the lateral seta bears two or three cilia. However, according to the writer's observation of these specimens, it is the dorsal seta which bears two or three cilia, and the lateral seta which is nude. The ventral seta on segment IV is unusually long, and it bears numerous delicate cilia, arising from both sides of the shaft. Segment V bears a long, curved, basal, ventral, striated seta, and a similar one at the mid-point of the segment, also on the ventral aspect; plus four plumose setae of various forms. The galeal seta was not seen on these specimens, but it was figured by Oudemans (1912, fig. L 3) as bearing two cilia.

Each coxa bears a single, long, plumose seta, with delicate cilia, similar to the sternal setae. The dorsal aspect of tarsus III bears a long, nude, whip-like seta, arising from the basal one-fourth of the segment. The vestiture of the remainder of the leg segments is not remarkable.

Measurements on the two specimens in the Oudemans collection are as follows:

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
67	81	29	31	55	32	80	64	126	115	112	112
71	85	32	29	46	29	54	55	?	98	80	70

TYPE MATERIAL: Described from several specimens from the White Nile, Egypt, March, 1901, collected from the legs of *Ardea cinerea* by Dr. Ivar Trägårdh. A holotype was not designated in the original description, but according to Oudemans (1912, p. 42), the type is in the Trägårdh collection,

Stockholm, Sweden. The writer has been unable to ascertain the present existence of the type material.

REMARKS: This species is known only from the original material. The description and figures published by Trägårdh (1904) are inaccurate and incomplete, but these deficiencies were remedied by Oudemans (1912), whose description and figures are dependable. The relationships of this species are discussed elsewhere in this paper.

Trombicula acuscutellaris Walch, 1922

1922. *Trombicula? acuscutellaris* Walch, Geneesk. Tijdschr. Ned. Ind., *62* no. 5, p. 564; tables II, III; figs. 22-25.
1923. *Trombicula acuscutellaris* Walch, Kitasato Arch., *5,* no. 3, p. 78; tables I, II; pl. II, figs. 21-24.
1924. *Trombicula acuscutellaris* —. Walch and Keukenschrijver, Geneesk. Tijdschr. Ned. Ind., *64,* p. 254.
1924. *Trombicula acuscutellaris* —. Walch, Geneesk. Tijdschr. Ned. Ind., *64,* p. 509.
1925. *Trombicula acuscutellaris* —. Walch, Kitasato Arch., *6,* no. 3, p. 239.
1927. *Trombidium acuscutellare* —. Walch, Geneesk. Tijdschr. Ned. Ind., *67,* pp. 924, 928, 929, 932.
1929. *Trombicula acuscutellaris* —. Patton and Evans, Insects, Mites, etc., pp. 650, 656; fig. 335.
1930. *Thrombicula acuscutellaris* Walch. Gater, Trans. 8th Bienn. Congr. Far East. Assoc. trop. Med., p. 136.
1932. *Trombicula acuscutellaris* Walch. Gater, Parasitology, *24,* no. 2, p. 148.
1936. *Pentagonella acuscutellaris* (Walch). Sig Thor, Zool. Anz., *114,* nos. 1/2, p. 30.
1937. *Trombicula acuscutellaris* —. Mehta, Indian J. med. Res., *25,* no. 2, pp. 358, 359, 363, 364.
1938. *Trombicula acuscutellaris* Walch. Neveu-Lemaire, Traité d'Entomologie, etc., p. 491.
1941. *Trombicula acuscutellaris* Walch. Gunther, Proc. Linn. Soc. N. S. W., *66,* pts. 5-6, nos. 297-298, p. 394.
1942. *Trombicula acuscutellaris* Walch. Radford, Parasitology, *34,* no. 1, p. 58; fig. 12.
1943. *Trombicula* (*Pentagonella*) *acuscutellaris* Walch. Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 73, 78, 79, 97; pl. II, fig. 5.
1944. *Trombicula acuscutellaris* Walch. Williams, Amer. J. trop. Med., *24,* no. 6, p. 356.
1945. *Trombicula acuscutellaris* Walch. Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, pp. 27, 28, 61, 66-67; fig. 33.
1945. *Trombicula acuscutellaris* Walch. Blake, Maxcy, Sadusk, Kohls and Bell, Amer. J. Hyg., *41,* no. 3, pp. 264, 278.
1945. *Otonyssus acuscutellaris* (Walch). Buitendijk, Zool. Meded., *24,* p. 337.
1946. *Trombicula acuscutellaris* Walch. Taylor, Comm. Aust. Serv. Publ. no. 6, p. 148.
1946. *Trombicula acuscutellaris* Walch. Radford, Parasitology, *37,* nos. 1, 2, pp. 46, 48, 51; figs. 5-8, and 27.
1946. *Trombicula acuscutellaris* —. Philip, Woodward and Sullivan, Amer. J. trop. Med., *26,* no. 2, p. 240.
1946. *Trombicula acuscutellaris* Walch. Michener, Ann. ent. Soc. Amer., *39,* p. 433.
1946. *Trombicula acuscutellaris* —. Mackie, Davis, Fuller, *et al.,* Amer. J. Hyg., *43,* no. 3, p. 196.
1946. *Trombicula acuscutellaris* —. Jayewickreme and Niles, Nature, *157,* no. 4000, p. 878.

1946. *Trombicula acuscutellaris* Walch. Wharton, Ecol. Monogr., *16,* no. 3, pp. 173, 174.
1946. *Trombicula acuscutellaris* —. Mackie, *et al.,* Trans. R. Soc. trop. Med. Hyg., *40,* no. 1, p. 19.
1946. *Trombicula acuscutellaris* Walch. Ewing, J. Parasit., *32,* no. 5, p. 437.
1946. *Trombicula acuscutellaris* —. Philip and Woodward, J. Parasit., *32,* no. 5, pp. 508, 511.
1947. *Trombicula acuscutellaris* Walch. Fuller, Amer. J. Hyg., *45,* no. 3, p. 369.
1947. *Trombicula acuscutellaris* —. Philip, Amer. J. Hyg., *46,* no. 1, p. 63.
1947. *Trombicula acuscutellaris* Walch. Jayewickreme and Niles, Nature, *160,* no. 4069, p. 578.

This species is represented in the Oudemans collection by a single specimen from Sungei Buloh, Selangor, Federated Malay States, 12 December 1929, off *Rattus rattus diardi* (Jentink), collected and determined by Prof. B. A. R. Gater. The writer has also studied specimens from Gan, Maldive Islands, collected by Dr. C. D. Radford, and specimens from Burma, collected by the U.S.A. Typhus Commission.

DIAGNOSIS: The uncleared larva is vermilion in color and ovoid in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. The legs are quite long: I — 289; II — 249; III — 317 micra (Walch, 1923). On either side of the scutum, in close apposition with it, is a well developed ocular shield. This bears an anterior eye, having a well developed cornea, and a smaller, poorly developed, posterior eye. The scutum is pentagonal in outline, the posterior margin projecting to form an acute angle; the lateral margins being nearly straight; and the anterior margin projecting forward on either side beyond the anterior lateral setal pores, giving rise to the appearance of scutal shoulders. The pseudostigmata are in advance of the line of the posterior lateral setal pores, and there are rather indistinct diagonal lines just anterior and posterior to them. The shafts of the normal scutal setae are rather stout basally, tapered distally, and provided with numerous barbs which are easily lost. The long pseudostigmatic organs bear eight or more cilia, arising from a single side of the distal half of the shaft.

The palpal claw is trifurcate. The main element is somewhat curved distally, and pointed. The accessory elements are lateral to it, one lying above and the other below. They are straight and pointed. The cheliceral morphology is practically identical to that of *T. ardeae* (Trägårdh, 1904).

The dorsal setae are similar in form to the normal scutal setae, becoming longer posteriorly. In the material studied, their pattern is consistently: 2 — 6 — 6 — 6 — 4 — 2, and this pattern was observed by Womersley and Heaslip (1943). There are two long, plumose, sternal setae between coxae I, and two between coxae III. There are eleven or twelve pre-anal setae, similar in form to the sternals. The remainder of the ventral abdominal setae have

stouter and longer shafts, provided with short barbs, instead of long, delicate cilia. They are arranged: 2 (flanking the anus) — 2 — 4.

The seta on palpal segment I bears several long, fine cilia. The seta on segment II is provided with similar, more numerous cilia. The seta on segment III is shorter than that on II, and it bears four to six delicate cilia. On segment IV, the dorsal and lateral setae are nude, while the much longer ventral seta bears several delicate cilia. Segment V bears a basal, ventral, striated seta, plus apparently eight plumose setae of various forms, of which a dorsal proximal one is very stout, long, and prominent. The galeal seta bears a single short cilia, which may be lost.

Each coxa bears a single plumose seta, similar in form to the sternal setae. Tarsus III bears a long, nude, whip-like seta, arising from the dorso-lateral aspect of the proximal one-fourth of the segment. The vestiture of the remainder of the leg segments is not remarkable.

Measurements are recorded for four specimens in the following order: the single specimen in the Oudemans collection, and three examples from the Maldive Islands.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
73	78	30	29	41	25	56	36	76	76	70	60
84	90	34	32	52	32	57	40	75	87	75	60
86	88	32	36	44	30	57	40	75	87	72	58
81	86	32	33	46	30	57	40	75	84	75	57

TYPE MATERIAL: Described from a single specimen from Deli, Sumatra, off *Rattus* sp., collected by Dr. E. W. Walch. The existence or location of the holotype is unknown. According to a personal communication from Prof. Dr. R. Gispen, this species is represented in the collection of the Koningin Wilhelmina Instituut voor Hygiene en Bacteriologie, Batavia, Java. However, he states that there is no slide labelled as type. The writer has not seen topotypic material.

GEOGRAPHICAL DISTRIBUTION:

Sumatra: Deli	Type locality
Lampong Districts	Walch (1927)
Federated Malay States:	
Sungei Buloh, Selangor	Gater (1932)
Kuala Lumpur, Selangor	Gater (1932)
Setapak, Selangor	Gater (1932)
Raub, Pahang	Gater (1932)
India (Simla Hills): Kasauli	Mehta (1937)
Sabathu	Mehta (1937)
Maldive Islands	Radford (1946)
Ceylon: Colombo	Jayewickreme and Niles (1946)

Guam	Wharton (1946)
Philippine Islands: Luzon, Mindoro, Negros	Philip and Woodward (1946)
Burma: Myitkyina	Fuller (1947)

RECORDED HOSTS:

Rattus sp.	Type host
"Rats"	Walch (1927)
Man, *Homo sapiens* Linnaeus	Walch (1927); Gater (1932)
Rattus rattus diardi (Jentink)	Gater (1932)
Rattus rattus norvegicus Berkenhout	Radford (1946)
Bandicota malabarica	Jayewickreme and Niles (1946)
Rattus mindanensis	Philip and Woodward (1946)
Rattus umbriventer	Philip and Woodward (1946)
Birds:	
Ixobrychus sinensis	Wharton (1946)
Ardea purpurea manilensis Meyen	Fuller (1947)

MEDICAL IMPORTANCE: Walch (1927) first reported this species for man, recording two specimens from the Lampong Districts, South Sumatra. At the same time he recorded 244 specimens from rats in the same area. Gater (1930, 1932) recorded two specimens collected by Dr. Enid Robertson at Setapak, Selangor, where they attacked a woman school teacher in a rice field. One does not know whether or not itching occurred at the site of attachment in these cases. Since this species occurs on rats in certain localities and has been recorded occasionally from human beings, it may be regarded as a potential incidental vector of scrub typhus. Its potentialities as a vector have not been investigated from an experimental standpoint.

REMARKS: This species is very similar to *T. ardeae* (Trägårdh, 1904), and both were included by Sig Thor (1936) in *Pentagonella.* The long legs are especially distinctive and noteworthy, being shared by both species. The dense stippling on the scutum, capitulum, palpal segments, coxae, and all other leg segments, is characteristic and distinctive. These apparently minor points, in addition to a long, nude, whip-like seta on tarsus III, were not mentioned by Sig Thor in his characterization of *Pentagonella.* The writer believes that they are suggestive of relationships, and consequently worthy of emphasis. This species shares several characters with certain species of *Eutrombicula* Ewing, 1938. These are: long, nude, whip-like seta on tarsus III; cheliceral morphology; arrangement of pre-anal ventral setae; denseness and transverse linear arrangement of stippling, particularly on the coxae of the pedipalps and those of the legs; and the form of the pseudostigmatic organs, with cilia arising from a single side of the shaft in an undistorted specimen. Further studies of nymphs and adults are needed, in order to determine whether characters are shared by these stages.

The nymph of this species was first described by Radford (1946, pp. 51,

52; figs. 27 a-d). His description does not mention eyes, but these structures are present, which is not the case with the nymph of *T. autumnalis* (Shaw, 1790). This fact is mentioned because the larvae of these species share several characters, suggesting that they may be related.

Jayewickreme and Niles (1946, 1947) found the adults of this species crawling on leaves of *Salvinia* in nature, at Colombo, Ceylon. The morphology of these adults has not been published, but these workers obtained larvae from them that were indistinguishable from those collected off *Bandicota malabarica*. The adult mites were fed in the laboratory on eggs, ovaries and adults of mosquitoes. It is possible that these mites may be a natural enemy of mosquitoes, feeding upon their eggs under natural conditions. The writer ventures the suggestion that this species, *T. ardeae* (Trägårdh, 1904), and possibly others which are morphologically related, may prefer the biotope of a swamp habitat. This suggestion is based on the field observations of Jayewickreme and Niles, plus the published records of habitats in which hosts of the larvae were found.

Trombicula bruyanti (Oudemans, 1910)

1910. *Microthrombidium bruyanti* Oudemans, Ent. Ber., *3,* no. 54, p. 85.
1912. *Microthrombidium bruyanti* Oudemans. Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 26-28, 189, 202; fig. F.
1921. *Microtrombidium bruyanti* Oudemans. Toomey, Urol. and Cutan. Rev., *25,* p. 606.
1928. *Trombicula bruyanti* (Oudemans). Ewing, Proc. ent. Soc. Wash., *30,* no. 5, p. 77.
1928. *Trombicula bruyanti* (Oudemans). Methlagl, Denkschr. Akad. Wiss. Wien, *101,* pp. 216, 223, 224.
1929. *Microthrombidium Bruyanti* Oudemans. André, Bull. Mus. Hist. nat. Paris, 2e ser. *1,* no. 6, p. 405.
1929. *Trombicula bruyanti* (Oudemans). Ewing, Proc. ent. Soc. Wash., *31,* no. 1, p. 11.
1930. *Trombicula bruyanti* (Oudemans). Van Thiel, Parasitology, *22,* no. 3, p. 352.
1931. *Trombicula bruyanti* (Oudemans). Ewing, Proc. U. S. nat. Mus., *80,* no. 2908, Art. 8, p. 7.
1938. *Eutrombicula bruyanti* (Oudemans). Ewing, J. Wash. Acad. Sci., *28,* no. 6, p. 294.
1942. *Eutrombicula bruyanti* (Oudemans). Radford, Parasitology, *34,* no. 1, p. 66; fig. 42.
1943. *Acariscus bruyanti* (Oudemans). Ewing, Proc. ent. Soc. Wash., *45,* no. 3, pp. 58, 59, 66.
1945. *Otonyssus bruyanti* (Oudemans). Buitendijk, Zool. Meded., *24,* p. 337.
1946. *Trombicula bruyanti* (Oudemans). Michener, Ann. ent. Soc. Amer., *39,* p. 417.

This species is represented in the Oudemans collection by two specimens mounted on one slide, bearing the data of the original series in Oudemans' handwriting. The writer has also examined the types and other specimens in the Trouessart collection in the Muséum National d'Histoire Naturelle, Paris.

DIAGNOSIS: The body of the partially engorged larva is ovoid, being

somewhat expanded laterally, just anterior to coxae III. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. On either side of the scutum is a well developed ocular shield, bearing a prominent anterior eye and a less distinct, smaller, posterior eye. The scutum is of the shape depicted by Oudemans (1912, fig. F 1), except that his figure exaggerates the convexity of the lateral margins, which are actually almost straight lines. The normal scutal setae are rather stout and blunt, bearing coarse cilia. The flagelliform pseudostigmatic organs bear about nine cilia, which arise from opposite sides of the distal half of the shaft.

Although the palpal claw was described and figured by Oudemans (1912) as bifurcate, it is actually trifurcate. This fact was kindly confirmed by Dr. Marc André when he and the writer examined the types together, and it applies to all of the specimens examined by us. The main element is curved distally and pointed. The two accessory prongs are one-half to two-thirds the length of the main element, straight, and pointed. They are easily seen on the specimen on the cotype slide mounted with the ventral surface facing the cover slip. Each chelicera bears a small, dorsal, subapical, recurved toothlet. There is a trace of a vestigial ventral toothlet, but it is so small that the ventral margin appears to be continuous.

The dorsal setae are similar in form to the normal scutal setae. They are arranged approximately: 2 — 6 — 6 — 6 — 6 — 4 — 2, but the three posterior rows are irregular. There are two plumose sternal setae between coxae I, and two between coxae III. There are ten rather delicate pre-anal setae. The remainder of the ventral setae are stouter, similar in form to the dorsal setae, and arranged: 4 (flanking the anus) — 4 — 2.

The seta on palpal segment I bears numerous long, delicate cilia. The plumose seta on segment II has a stout shaft and numerous fine cilia, giving it a bushy appearance. The seta on segment III bears four long, delicate, lateral cilia. On segment IV, the dorsal seta is nude, the lateral seta bears a single cilia, and the ventral seta bears three (Oudemans figured seven to nine!) long, delicate, lateral cilia. Segment V bears a basal, ventral, curved, striated seta, plus five plumose setae of various forms. The galeal seta is nude.

Each coxa bears a single plumose seta. Tarsus III was incorrectly described and figured by Oudemans (1912) as bearing a long, nude, whip-like seta ("mit langem Tasthaar"). Its absence was confirmed by Dr. André when he and the writer examined the type material. Tibia III bears a delicate seta, which superficially appears to be nude, but which actually bears minute cilia. The vestiture of the remainder of the leg segments is not remarkable.

Measurements are recorded for six specimens in the following order:

the cotype with its dorsal surface upward; four additional specimens in Paris; and one of the specimens in the Oudemans collection.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
62	78	25	28	27	31	29	35	49	53	42	42
63	83	27	25	27	28	36	41	50	60	45	39
63	84	27	27	27	28	35	34	50	63	42	39
63	83	24	25	25	28	34	36	56	62	42	45
66	84	27	27	27	29	34	35	52	62	45	38
63	81	27	25	25	28	—	39	49	—	42	45

TYPE MATERIAL: Described from southern Brazil, no specific locality, off *Didelphys opossum* Seba, collected by E. A. Göldi. Two specimens are mounted on a single slide, labelled "Types" in Oudemans' handwriting, in the Muséum National d'Histoire Naturelle, Paris. The writer regards these as cotypes. In the same museum are two additional slides, one with nine specimens of the same series, the other with ten. Reference has already been made to the material in the Oudemans collection.

REMARKS: This species is known only from the original material and descriptions. Oudeman's incorrect description of the palpal claw caused Ewing to place this species first in *Eutrombicula* Ewing, 1938, and subsequently in *Acariscus* Ewing, 1943, but it does not belong in either genus. Furthermore, it should be realized that there is no long, nude seta on tarsus III. The writer knows of no close relatives of this species described from South America, and he has not examined sufficient North American material to discuss its relationships.

Trombicula minutissimum (Oudemans, 1910)

1910. *Microthrombidium minutissimum* Oudemans, Ent. Ber., *3,* no. 56, p. 104.
1912. *Microthrombidium minutissimum* Oudemans. Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 42-45, 190, 202; fig. M.
1928. *Trombicula* (*Microthrombidium*) *minutissima* (Oudemans). Methlagl, Denkschr. Akad. Wiss. Wien, *101,* p. 215: emendation.
1929. *Microthrombidium minutissimum* Oudemans. André, Bull. Mus. Hist. nat. Paris, 2e sér., *1,* no. 6, p. 405.
1930. *Microtrombidium minutissimum* Oudemans. Stiles and Nolan, Nat. Inst. Hlth. Bull. no. 155 (1), p. 639.
1942. *Trombicula minutissimum* (Oudemans). Radford, Parasitology, *34,* no. 1, p. 60; fig. 18.
1945. *Otonyssus minutissimus* (Oudemans). Buitendijk, Zool. Meded., *24,* p. 338: emendation.

This species is represented in the Oudemans collection by two specimens mounted on a single slide, bearing the data of the original series. The integument has become shrunken, distorting the dorsal and ventral setal patterns.

Also, because of the position of the palpi, one must rely upon the data given by Oudemans (1912).

DIAGNOSIS: The body of the engorged larva is elongate ovate in shape, with a constriction posterior to the level of coxae III. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. On either side of the scutum is a pair of eyes which are subequal in size. The posterior eye is located at the level of the posterior lateral setal pores. The scutum is of the pentagonal shape depicted by Oudemans (1912, fig. M 3), with the anterior margin projecting forward to form an acute angle at the site of the anterior median setal pore, and the posterior margin only very slightly emarginate. The writer has not noted this type of scutum in any other described species of this family. The five normal scutal setae bear barbs, arising from several sides of the shaft. The pseudostigmata are located well forward of the mid-point of the scutum. The pseudostigmatic organs are forked, one branch being somewhat shorter than the other. Their morphology is unique.

The palpal claw is bifurcate, confirmed on the material examined. The prongs are blunt, lying above and below each other, the ventral one being the shorter. Each chelicera bears a minute, dorsal, subapical, recurved toothlet. The ventral margin of the chelicerae is apparently smooth and continuous.

As figured by Oudemans (1912, fig. M 1), the dorsal abdominal setae are barbed and are arranged: 2 — 6 — 6 — 6 — 4 — 2 — 2. There is a pair of sternal setae between coxae I, each bearing a single cilia, and a pair of apparently nude setae between coxae III. According to Oudemans, the remainder of the ventral setae are nude, and they are arranged: 4 — 4 — 4 — 6 — 4 — 2. According to his figure, they become shorter posteriorly.

The seta on palpal segment I bears two long, delicate cilia, each reaching almost to the tip of the main shaft of the seta. Each of the setae on segments II and III bears three delicate cilia. On segment IV, the dorsal and lateral setae are nude, and the ventral seta is forked basally, one branch being about three times the length of the other. Segment V bears a basal, ventral, striated seta; a similar apical one; plus four plumose setae. The galeal seta is nude.

Coxa I has a single seta which bears two long cilia. Coxae II and III each have a forked seta. The vestiture of the remainder of the leg segments is not remarkable.

The following measurements are recorded for the specimen which is mounted with the dorsal surface facing the cover slip. ASB is measured to the level of the anterior median setal pore. The distance from the level of the pseudostigmata to the level of the anterior lateral setal pores is 9.8 micra.

PSB is measured to the posterior margin. None of the dorsal setae are suitable for measurements. AW 29; PW 39; SB 15; ASB 15; PSB 25; AP 27; AM 31; AL 21; PL 28; SENS 42.

TYPE MATERIAL: Described from fourteen specimens from Durban, Africa, January, 1905, off *Hipposideros caffer,* collected by Dr. Ivar Trägårdh, no holotype designated. According to Oudemans (1912, p. 45), the types (presumably cotypes ?) are in the collection of Dr. Trägårdh, Stockholm, Sweden. The writer has been unable to ascertain the present existence of these types.

REMARKS: This distinctive species is known only from the orginal material. It is not related to other described species and it probably merits a genus of its own. For the present, however, it is placed provisionally in *Trombicula sens. lat.*

Trombicula munda Gater, 1932 (fig. 1 a)

1932. *Trombicula munda* Gater, Parasitology, *24,* no. 2, p. 149; fig. 1.
1942. *Trombicula munda* Gater. Radford, Parasitology, *34,* no. 1, p. 62; fig. 24.
1943. *Trombicula munda* Gater. Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 73, 76; pl. II, fig. 3.
1945. *Trombicula munda* Gater. Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, p. 61.
1945. *Otonyssus munda* (Gater). Buitendijk, Zool. Meded., *24,* p. 338.
1946. *Trombicula munda* Gater. Taylor, Comm. Aust. Serv. Publ. no. 6, p. 148.
1947. *Trombicula munda* Gater. Audy, Nature, *159,* pp. 295-296.

This species is represented in the Oudemans collection by a single paratype presented by Prof. B. A. R. Gater. The writer has also studied the type material in the British Museum (Natural History) and the United States National Museum.

DIAGNOSIS: The body of the larva is ovoid in shape, with a constriction posterior to the level of coxae III, reminiscent of certain species of the genus *Walchia* Ewing, 1931. The leg segmentation is characteristic of the subfamily. It appears that the anterior lateral claw of each pair is slightly longer than the posterior one, while the empodium is normal. This character has been confirmed on the holotype and other paratypes examined. The presence of an eye is extremely difficult to demonstrate, and the writer has not studied this species under a phase contrast microscope. On the holotype, the writer saw a questionable structure which could be interpreted as an eye, but it was not noted on the paratypes studied. Gater stated (1932, p. 149): "*Ocular shield* apparently absent; a single eye, situated at some distance from the scutum on the mid-line, is visible in some mounts". The scutum is small, roughly pentagonal, of the shape depicted by Gater (1932, fig. 1). However, since Gater's figure depicts the anterior lateral setae too close to the anterior

margin, the scutum has been redrawn from the holotype by Miss Sanina (fig. 1 a). The five normal scutal setae bear minute, delicate barbs which are easily lost, giving these setae a serrated appearance. This statement applies

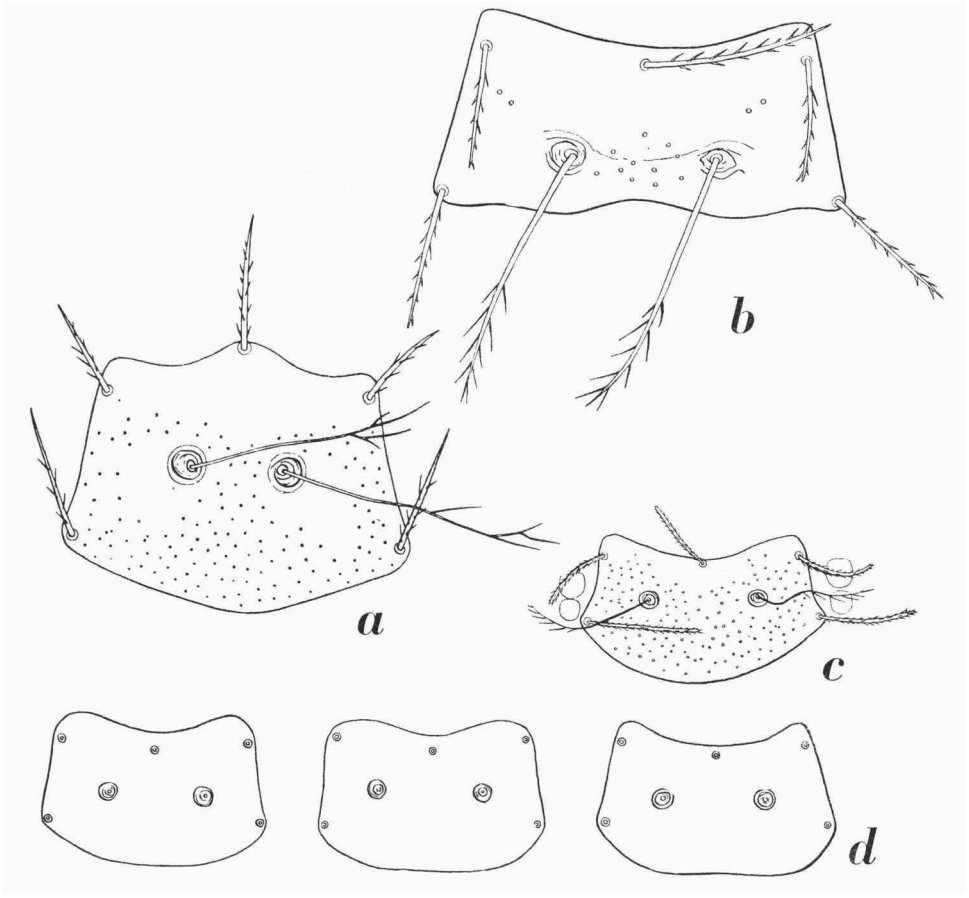

Fig. 1. *a, Trombicula munda* Gater, 1932, scutum; *b, Trombicula muscae* (Oudemans, 1906), scutum; *c, Eutrombicula vanommereni* (Schierbeek, 1937), scutum and eyes; *d, Eutrombicula wichmanni* (Oudemans, 1905), outlines of scuta of three topotypic specimens. Original (Sanina).

also to the dorsal and ventral abdominal setae. The pseudostigmatic organs bear four or five rather long cilia distally, and the proximal portion of the shaft is apparently nude.

The palpal claw is bifurcate, the outer accessory prong being sharp, and shorter than the main element. This is not the configuration seen in species related to the genotype of *Eutrombicula* Ewing, 1938. Each chelicera bears

a sharp, minute, dorsal, subapical, recurved toothlet, and an inconspicuous toothlet on the medial aspect of the ventral margin.

The dorsal setae are arranged 2 — 6 — 6 — 2 — 4 — 4 — 2, as depicted by Gater. The posterior ones are only slightly shorter than the anterior ones. There are two sternal setae between coxae I, and two between coxae III. There are about twenty-four additional ventral setae, whose arrangement is not constant.

The seta on palpal segment I bears four or five long, delicate cilia. Palpal segment II is provided with a minute lateral tubercle near its articulation with segment III, and the seta on this segment is variable, being either nude, or provided with a few short barbs. The seta on segment III is likewise variable on the two sides of a single specimen. With regard to the three setae on segment IV, Gater stated that they were nude or provided with a few barbs of varying length. In the specimens examined by the writer, the dorsal and lateral setae are usually nude, while the ventral seta is forked, or provided with two or three cilia. Segment V is difficult to visualize. It is provided with a basal, ventral, striated seta, a prominent, plumose seta mentioned by Gater, and several (exact number ?) additional plumose setae of various forms.

The coxae are unisetose. The vestiture of the remainder of the leg segments is not remarkable, except that most of the setae bear only a few short, delicate barbs, instead of the rather long cilia seen on the leg setae of many other species placed in this collective genus. There is no long, nude, whip-like seta on tarsus III.

Measurements are recorded for four specimens in the following order: the holotype and two paratypes in the British Museum (Natural History), and the paratype in the Oudemans collection.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
32	42	10	17	20	18	22	18	27	39	21	19
36	49	14	17	20	21	22	20	28	39	22	21
37	46	14	17	20	20	22	20	30	—	22	20
34	45	13	17	17	18	22	21	28	—	24	—

TYPE MATERIAL: Described from "numerous specimens" (number not stated) from Kuala Lumpur, Selangor, Federated Malay States, off *Rattus rattus diardi* (Jentink). In the British Museum (Natural History) are the holotype, no. 1932-7-18-3, and two paratypes, nos. 1932-7-18-4 and 5. Two paratypes in the U.S. National Museum bear the accession number 1050. Paratypes are also in the Molteno Institute, Cambridge, England; King

Edward VII College of Medicine, Singapore; and Rijksmuseum van Natuurlijke Historie.

GEOGRAPHICAL DISTRIBUTION:

Federated Malay States: Selangor	
Kuala Lumpur	Type locality
Sungei Buloh	Gater (1932)

RECORDED HOSTS:

Rattus rattus diardi (Jentink)	Type host
Rattus mülleri validus (Miller)	Gater (1932)
Rattus malaisia Kloss	Gater (1932)

REMARKS: Gater noted that this species was more common on rats from the town than on those from the country; the possible explanations for this observation are not clear. Gater also noted duplication of the anterior median seta on one specimen. The writer has observed this sort of variation in other species and genera of this subfamily.

Trombicula muscae (Oudemans, 1906) (fig. 1 b)

1906. *Allothrombidium muscae* Oudemans, Ent. Ber., *2*, no. *27*, p. 43.
1909. *Thrombidium muscae* Oudemans. Oudemans, Tijdschr. Ent., *52*, nos. 1/2, pp. 35-38, 42, 53, 55; pl. 6, figs. 26-30.
1909. *Trombidium* (*Heterotrombidium*) *muscae* (Oudemans). Verdun, C. R. Soc. Biol., Paris, *67*, p. 246.
1909. *Microthrombidium muscae* (Oudemans). Oudemans, Ent. Ber., *3*, no. 50, p. 20.
1912. *Microthrombidium russicum* (Oudemans). Oudemans, Zool. Jb., Suppl. *14*, Heft 1, pp. 5-6: partim.
1928. *Trombicula muscae* (Oudemans). Methlagl, Denkschr. Akad. Wiss. Wien, *101*, pp. 217, 223, 224.
1930. *Allothrombium muscae* (Oudemans). Stiles and Nolan, Nat. Inst. Hlth. Bull. no. 155 (1), p. 639.

This species is represented in the Oudemans collection by several specimens as follows:

Catalogue no. 2: Maastricht, Holland, 20 January 1910, off *Myotis dasycneme*, five specimens collected by H. Schmitz, S.J. These were remounted on separate slides in polyvinyl alcohol by the writer.

Catalogue no. 4: Arnhem, Holland, March 1902, off *Pipistrellus pipistrellus*, one specimen, collected by A. C. Oudemans. The scutum of this specimen is almost identical with that figured by Oudemans (1909).

Catalogue no. 5: Arnhem, Holland, 5 December 1903, off *Eptesicus serotinus* (Schreber), six specimens, collected by A. C. Oudemans. After being remounted by the writer, some of these specimens were suitable for study.

The above slides had been filed by Oudemans under the specific name *russicum.*

In addition, the writer has studied topotypic material from Buré d'Orval, 1 May 1930, off *Myotis daubentoni,* collected by M. Heim de Balsac. These were provided by Dr. Marc André, who kindly allowed the writer to remove larvae from the same bat from which André had studied material, and on which he had published previously. (See André, 1933, Bull. Soc. ent. Fr., *38,* no. 10, pp. 154-156). The bat is in alcohol in the Muséum National d'Histoire Naturelle, Paris. The mites removed by the writer are in his own personal collection. The following descriptive notes are based mainly on these topotypic specimens, and they apply equally to the material in the Oudemans collection. It seems wise to base a description on topotypic material.

DIAGNOSIS: The body of the engorged larva is elongate-ovate in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. On either side of the scutum are two eyes, but the writer does not distinguish an actual ocular shield. The anterior eye, located at the level of the pseudostigmata, has a large, well developed cornea. The posterior eye has a somewhat less well developed cornea, about two-thirds the diameter of the anterior eye. The scutum is of the shape depicted by Oudemans (1909, pl. 6, fig. 27), with similar ornamentation. There is a curved diagonal line on either side of the anterior median setal pore, projecting posteriorly toward the midline, between the pseudostigmata. There are "eyebrows" over the pseudostigmata. The latter are located well in advance of the line of the posterior lateral setal pores. The scutum bears a few scattered "pits" or stipple marks, of medium size. The posterior scutal margin is irregular, being indented or sinuate medially, and projecting only very slightly behind the line of the posterior lateral setal pores. The normal scutal setae bear short barbs, arising from several sides of the shaft. These are easily lost, and the setae may appear blunt apically. The pseudostigmatic organs bear ten or eleven relatively long, delicate cilia on the distal half of the shaft, the proximal half being nude. The accompanying figure (fig. 1 b on page 89) was made by Miss Sanina from one of the specimens in the Oudemans collection.

The palpal claw is trifurcate, the main element being pointed and slightly curved apically; the dorsal and ventral accessory elements being lateral to it, pointed, and almost straight. Each chelicera bears a sharp, dorsal, subapical, recurved toothlet, but there appears to be no toothlet on the ventral margin.

The dorsal setae are similar in form to the normal scutal setae and many of them appear to be blunt apically. A humeral seta is present on either side.

Although Oudemans (1909, pl. 6, fig. 26) depicted a regular and symmetrical pattern, there is much variation in the material studied by the writer. Oudemans' figure shows 2 — 12 — 10 — plus eighteen setae whose positions are not expressable as a formula. There are two plumose sternal setae, bearing long, delicate cilia, between coxae I, and a similar pair between coxae III. There are twenty to twenty-two plumose pre-anal setae, bearing rather long, delicate cilia. There are about ten stouter, longer, post-anal setae, similar in form to the posterior dorsal setae, bearing short barbs.

The seta on palpal segment I bears about ten very long, delicate cilia. The seta on segment II is nude. The seta on segment III is nude and longer than that on II. The dorsal, lateral, and ventral setae on segment IV are nude. Segment V bears a basal, ventral, striated seta, plus about seven plumose setae of various forms, of which a dorsal apical one is the stoutest, longest, and most prominent. The galeal seta is consistently plumose, bearing about six fine, long cilia.

Each coxa is provided with a long, plumose seta, bearing long, fine cilia. The vestiture of the remainder of the leg segments is not remarkable, and their plumose setae bear delicate cilia. There is no long, nude seta on tarsus III.

Measurements are recorded on thirteen specimens in the following order: five topotypic specimens in the writer's collection; and in the Oudemans collection, four of cat. no. 2; one of cat. no. 4; and three of cat. no. 5.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
67	84	29	31	11	32	36	29	35	—	25	—
59	71	25	28	13	31	38	28	41	53	29	—
64	78	28	29	11	31	41	31	46	56	29	—
64	76	27	28	11	32	36	29	43	57	27	32
64	80	29	28	11	28	—	31	39	—	28	—
67	82	29	31	11	34	35	28	39	48	29	36
69	81	31	29	12	31	36	32	42	56	31	29
67	78	28	27	11	30	41	29	42	—	—	34
64	78	27	27	10	31	34	28	43	49	29	32
66	81	28	25	14	32	38	32	42	55	29	35
70	80	31	25	11	32	39	31	45	—	32	32
70	84	32	29	11	31	38	31	45	—	29	31
66	78	27	25	11	28	34	27	39	50	29	29

TYPE MATERIAL: In the original description of this species, the following records are cited: "*Musca domestica,* Buré, Dr. F. Heim; *Vesperugo pipistrellus,* Arnhem, 3, 9, Oudemans; *Vesperugo serotinus,* Arnhem, 3, Oudemans; Nijkerk, K. J. W. Kempers; *Plecotus auritus,* Arnhem, 11, 12, Oudemans; Utrecht, 3, Van den Brink". Although no holotype was desig-

nated, one can assume that the type host was *Musca domestica,* because this host is listed first, and because of the name of the mite. Thus the type locality is Buré, France. The writer has been unable to locate this specimen. The type host was undoubtedly an accidental one, as this species normally parasitizes bats. It has been noted above that topotypic specimens are in the writer's collection.

GEOGRAPHICAL DISTRIBUTION:

France: Buré	Type locality
Holland: Arnhem	Oudemans (1906)
Nijkerk	Oudemans (1906)
Utrecht	Oudemans (1906)
Maastricht	Oudemans (1912)

RECORDED HOSTS:

Musca domestica	Type host
Pipistrellus pipistrellus	Oudemans (1906)
Eptesicus serotinus	Oudemans (1906)
Plecotus auritus	Oudemans (1906)
Myotis dasycneme	Oudemans (1912)
Myotis daubentoni	Present paper

REMARKS: This species was synonymized under *T. russicum* (Oudemans, 1902) by Oudemans (1912). His erroneous synonymy was based on studies of inadequately cleared specimens. The writer's conclusions as to the distinction between these two species are based on a study of the same specimens after they had been cleared and remounted. They are easily separated by the characters mentioned in the following table.

Character	*T. muscae*	*T. russicum*
Scutal ornamentation:		
eyebrows, arcuate lines	Present	Absent
Pseudostigmata	Anterior to line PL	In line PL
Normal scutal and dorsal setae	Blunt apically, bearing very short barbs	Pointed apically, bearing delicate cilia
Palpal segment IV:		
Dorsal seta	Nude	Plumose
(Lateral and ventral)	Nude	Nude

It should be noted that the galeal seta is plumose in both species. It was incorrectly described and figured by Oudemans (1909) as nude in the case of *T. russicum* (Oudemans 1902). It is hoped that the above tabulation will clarify the points of distinction between these two species.

Trombicula schmitzi (Oudemans, 1914)

1914. *Microthrombidium schmitzi* Oudemans, Ent. Ber., *4,* no. 77, pp. 87-88.
1916. *Microtrombidium schmitzi* Oudemans. Oudemans, Tijdschr. Ent., *59,* nos. 1-2, pp. 22-25; figs. 10-16.
1921. *Microtrombidium schmitzi* Oudemans. Toomey, Urol. and Cutan. Rev., *25,* p. 606.
1928. *Trombicula schmitzi* (Oudemans). Methlagl, Denkschr. Akad. Wiss. Wien, *101,* p. 216.
1930. *Microtrombidium schmitzi* Oudemans. Stiles and Nolan, Nat. Inst. Hlth. Bull. no. 155 (1), p. 639.
1945. *Otonyssus schmitzi* (Oudemans). Buitendijk, Zool. Meded., *24,* p. 338.

This species is represented in the Oudemans collection by a single specimen bearing the data of the original series in Oudemans' handwriting, but not labelled as a type.

DIAGNOSIS: The body of the fully engorged larva is ovoid in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. On either side of the scutum is an ocular shield bearing two eyes, of which the posterior one is at the level of the posterior lateral setal pores. The eyes possess well developed corneae, and the anterior one is the larger of the two. The shape of the scutum is that depicted by Oudemans (1916, fig. 14). Its surface is covered with medium-sized stippling. The five normal scutal setae bear delicate lateral cilia; the anterior median seta is missing. The basal portion of one pseudostigmatic organ is present, sufficient to indicate that these structures are flagelliform, but there are no barbs or cilia on this intact portion.

The palpal claw is definitely trifurcate, the prongs being sharply pointed, with the accessory ones shorter than the main element. The chelicerae are missing from this specimen, and Oudemans was unable to give a precise description of them.

The dorsal setae are similar in form to the posterior lateral scutal setae and they are arranged: 2 — 6 — 6 — 6 — 6 — 6 — 2 — 4 — 2 — 2, as patterned in Oudemans' drawing (1916, fig. 10). They become shorter posteriorly. There are two plumose sternal setae between coxae I, and two between coxae III. The remainder of the ventral abdominal setae are short and delicate, and there are about ninety of them.

A plumose seta arises from the first palpal segment, near its articulation with segment II. Segment II bears a lateral tubercle, near its articulation with segment III, and segment III is angulate medially. Segments II and III each bear a plumose seta. On segment IV, the dorsal and lateral setae are nude, while the ventral seta bears seven delicate cilia. Segment V was not well visualized by the writer. Oudemans described and figured it with a basal, ventral, striated seta; a nude seta; and three plumose setae. The galeal seta is nude.

Each coxa bears a single plumose seta, and the vestiture of the remainder of the leg segments is not remarkable.

The following measurements were made on this specimen: AW 57; PW 67; SB 21; ASB 28; PSB 21; AP 35; AL 27; PL 45; DSA 35; DSP 21. These measurements are compatible with those given by Oudemans.

TYPE MATERIAL: Described from Khandala, Bombay Province, India, 1911, off a bat, species undetermined, collected by P. Assmuth. Oudemans did not designate a holotype, nor did he state how many specimens were in the series. It seems quite likely that he had only one specimen and that the one in his collection is the type. The writer hereby designates the specimen in the Oudemans collection as lectotype.

REMARKS: This species is known only from the original material. Additional collection and study of topotypic specimens is necessary before its relationships are understood, particularly inasmuch as it was described from imperfect material.

Genus **Eutrombicula** Ewing, 1938

Genotype: *Microthrombidium alfreddugèsi* Oudemans, 1910, by original designation.

1938. *Eutrombicula* Ewing, J. Wash. Acad. Sci., *28,* no. 6, pp. 291, 293-294.
1942. *Eutrombicula* Ewing. Radford, Parasitology, *34,* no. 1, pp. 66-67, 79.
1942. *Eutrombicula* Ewing. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 6, p. 829: treated as a subgenus of *Trombicula* Berlese.
1943. *Eutrombicula* Ewing. Ewing, Proc. ent. Soc. Wash., *45,* no. 3, p. 57: restricted.
1943. *Acariscus* Ewing, *op. cit.,* pp. 57-66; genotype: *Trombicula flui* Van Thiel, 1930, by original designation.
1944. *Eutrombicula* Ewing. Ewing, J. Parasit., *30,* no. 6, p. 346.
1944. *Acariscus* Ewing. Ewing, *op. cit.,* p. 347.
1945. *Eutrombicula* Ewing. Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, pp. 14, 58.
1945. *Acariscus* Ewing. Wharton, J. Parasit., *31,* no. 6, pp. 401-405.
1945. *Eutrombicula* —. Wharton, *op. cit.,* p. 401.
1946. *Eutrombicula* Ewing. Taylor, Comm. Aust. Serv. Publ. no. 6, p. 147.
1946. *Eutrombicula* Ewing. Michener, Ann. ent. Soc. Amer., *39,* no. 1, p. 104 (equals *Acariscus* Ewing, 1943, synonym).
1946. *Eutrombicula* —. Michener, Ann. ent. Soc. Amer., *39,* p. 432.
1946. *Eutrombicula* Ewing. Ewing, J. Parasit., *32,* no. 5, pp. 437, 439: redescription of the genus.
1946. *Acariscus* Ewing. Ewing, *op. cit.,* p. 439.

Species whose larvae appear to be related to the type of this genus are well represented in the Oudemans collection. The writer has thought it worthwile to attempt a preliminary revision of *Eutrombicula* Ewing, 1938, bearing in mind that there is no general agreement on which species should

be placed in it, and that the genus may eventually prove to be a synonym of *Trombicula* Berlese, 1905, *sensu stricto*, when the larva of *Trombicula minor* Berlese, 1905, is associated with its adult.

Ewing's original definition of *Eutrombicula*, based on larval characters, was satisfactory at that time, but it is now inadequate. In his key to genera (1938, pp. 290-291), it is separated from *Trombicula* by two characters: palpal claw divided into two prongs; dorsal abdominal setae usually less than thirty. (The form of the palpal claw is characteristic, but it needs amplification, as pointed out below; and the total number of dorsal setae is not considered to be of generic value). Ewing (1938, p. 294) listed the species to be included in his new genus and stated that some Old World species should be included, but that mounted specimens were not available for study.

Ewing (1943) restricted *Eutrombicula* solely on the basis of numbers and patterns of dorsal and ventral body setae. For those species with bifurcate palpal claws, not conforming to the restricted definition, he proposed the new genus, *Acariscus*, designating *Trombicula flui* Van Thiel, 1930, as genotype. This appeared to be a useful contribution, serving to remove certain elements of *Eutrombicula*. However, in studying larvae of the species assigned by Ewing to *Acariscus*, it is apparent that the genus is an unnatural assemblage of species whose only character in common is a bifurcate palpal claw. Furthermore, as pointed out by Michener (1946), the genotype is really related to that of *Eutrombicula*, so that *Acariscus* must fall as a synonym. In his key to genera, Ewing (1944, pp. 346, 347) separated *Eutrombicula* and *Acariscus* from each other on the same basis he had used in 1943. He also keyed two additional genera from *Trombicula* on the basis of having a bifurcate palpal claw: *Heaslipia* Ewing, 1944, and *Fonsecia* Radford, 1942. These two genera are easily distinguished from *Eutrombicula*, and further discussion of them is unnecessary at this time.

Wharton (1945) described two new species in the genus *Acariscus*. He pointed out that the line of demarcation between *Acariscus* and *Eutrombicula* was not too well defined, and that the taxonomic system of this whole family of mites was somewhat fluid, even at the generic level. (This is true at the present time of writing).

It remained for Michener (1946, p. 104) to provide positive evidence for synonymizing *Acariscus*. He noted that, in itself, the arrangement of dorsal setae is not tenable as a differential generic character, there being much greater differences among the species of *Acariscus* than between *Acariscus* and *Eutrombicula*. He found that the ventral abdominal setae are useless in separating these genera. His detailed study of the type species of *Acariscus* showed that it belongs in *Eutrombicula*. Michener (1946, p. 432) later ex-

pressed his opinion that probably *Eutrombicula* should be restricted to species having the two points of the palpal claw equal, or the outer (dorsal) prong the longer of the two. According to him, those species commonly included in *Eutrombicula,* in which the outer prong is slender and shorter than the main element, are merely species of *Trombicula* (*sensu lato*) in which one of the two small outer prongs has disappeared. Michener noted the presence of eyes in the known adults of *Eutrombicula,* and their absence in those of *Trombicula.*

Ewing (1946, p. 438) gave a redescription of *Eutrombicula,* based on larval characters. He emphasized his opinion that the most important character in this genus is not the number of dorsal abdominal setae (twenty-two), but their definite arrangement in the 2 — 6 — 6 — 4 — 2 — 2 pattern in the unengorged larva, or 2 — 6 — 6 — 2 — 4 — 2 in the most engorged larvae. He pointed out two correlated characters: the arrangement of the six ventral abdominal setae of row III (counting the sternals as rows I and II), and the particular type of scutum which he described.

The writer would define larvae of *Eutrombicula* as follows: tarsal claws normal; eyes present; scutum usually large, but never produced posteriorly to form an angle; five normal scutal setae present; dense stippling on scutum, tectum, palpi, coxae, and other leg segments; palpal claw bifurcate, the accessory prong being internal to the main element; chelicerae with a subapical recurved toothlet and sometimes a more proximal notch on the dorsal margin; ventral cheliceral margin with a recurved gouge-like or flap-like process; tarsus III always bearing one or more long, nude, whip-like setae; tibia III sometimes bearing two such setae.

It will be noted that this definition does not include a reference to dorsal or ventral body setae. It is quite true that several species have patterns similar or identical to that possessed by the genotype. But to restrict the genus on the basis of a character which is known to be variable would seem unsound, although this character may be helpful in recognising groups of species within the genus.

The following table includes larvae of Trombiculinae with five normal scutal setae, flagelliform pseudostigmatic organs, and described as having a bifurcate palpal claw. (In three instances the palpal claw was incorrectly described, being actually composed of three prongs). With one exception, those species whose generic assignment appears doubtful to the writer have not been seen by him. *T. rara* Walch, 1924, is atypical in the advanced forward position of the pseudostigmata, and in the fact that the small accessory prong of the palpal claw lies lateral to the main element. With the exception of *E. sulae* (Oudemans, 1910), those species referred by

the writer to *Eutrombicula* Ewing, 1938, have the typical palpal claw, large scutum, and one or more long, nude, whip-like setae on tarsus III. The atypical feature of *E. sulae* (Oudemans, 1910) is the palpal claw. The size of the scutum of *Eutrombicula* Ewing, 1938, is characteristic, as will be noted in the measurements given subsequently for the species represented in the Oudemans collection. The species referred to *Trombicula sensu lato* in this table lack the combination of characters shared by the genotype of *Eutrombicula* and its near relatives.

Species referable to *Trombicula* or *Eutrombicula*, described as having a bifurcate palpal claw.	Specimens studied by the writer.	Referred to *Eutrombicula* by Ewing (1938).	Referred to *Acariscus* by Ewing (1943).	Referred to *Trombicula sensu lato* by the writer.	Generic Assignment Doubtful.	Referred to *Eutrombicula* by the writer.
Thrombicula agamae André, 1929	×	—	—	×	...	...
Microthrombidium alfreddugèsi Oudemans, 1910	×	×	—	...	...	×
Acariscus anous Wharton, 1945	×	...	...	×	...	...
Acarus batatas Linnaeus, 1758	×	...	...	...	...	×
Syn.: *Trombicula flui* Van Thiel, 1930	×	×	×	...	...	×
Trombicula hominis Ewing, 1933	×	×	×	...	...	×
Trombicula brasiliensis Ewing, 1925	×	×	×	...	...	×
Microthrombidium bruyanti Oudemans, 1910	× [1]	×	×	×	...	...
Trombicula butantanensis Fonseca, 1932	—	×	×	...	...	×
Trombicula canis Floch & Abonnenc, 1941	×	...	...	...	×	...
Trombicula cavicola Ewing, 1931	—	×	...	...	×	...
Trombicula cynictia Radford, 1942	×	...	...	×	...	...
Eutrombicula defecta Ewing, 1946	×	...	...	...	...	×
Trombicula dunni Ewing, 1931	—	×	...	×	...	...
Microthrombidium gliricolens Hirst, 1915	—	...	...	× [2]	...	...
Microthrombidium göldii Oudemans, 1910	×	×	...	...	...	×
Trombicula gurneyi Ewing, 1937	×	×	×	×	...	...
Eutrombicula gymnodactyla Wom. & Kohls, 1947	—	...	...	×	...	...
Trombicula hamertoni Radford, 1942	×	...	...	×	...	...
Trombicula harperi Ewing, 1928	× [1]	×	...	×	...	...
Microthrombidium helleri Oudemans, 1911	×	×	...	...	...	×
Trombicula insularis Ewing, 1925	—	×	...	...	×	...
Trombicula isshikii Sugimoto, 1938	—	...	...	...	×	...
Trombicula kohlsi Womersley, 1944	×	...	...	×	...	...
Trombicula macropus Womersley, 1936	—	...	...	...	×	...
Acariscus masoni Ewing, 1943	×	...	×	...	...	×
Trombicula mastomyia Radford, 1942	×	...	...	×	...	...

1) Original description incorrect; palpal claw actually trifurcate.
2) Referred to *Acariscus* by Wharton (1945)

Species referable to *Trombicula* or *Eutrombicula*, described as having a bifurcate palpal claw.	Specimens studied by the writer.	Referred to *Eutrombicula* by Ewing (1938).	Referred to *Acariscus* by Ewing (1943).	Referred to *Trombicula sensu lato* by the writer.	Generic Assignment Doubtful.	Referred to *Eutrombicula* by the writer.
Microthrombidium minutissimum Oudms., 1910	×	...	...	×	...	...
Acariscus multisetosa Ewing, 1943	×	...	×	...	...	×
Trombicula munda Gater, 1932	×	...	...	×	...	...
Trombicula myotis Ewing, 1929	× [1]	×	×	×	...	...
Trombicula nissani Dumbleton, 1947	—	...	...	...	×	...
Trombicula ophidica Fonseca, 1932	—	×	...	...	×	...
Trombicula panamensis Ewing, 1925	×	×	×	×	...	...
Acariscus pluvius Wharton, 1945	×	...	...	×	...	...
Trombicula rara Walch, 1924	×	...	...	...	×	...
Trombicula rioi Gunther, 1939	×	...	...	...	...	×
Trombicula samboni Womersley, 1939	×	...	...	...	...	×
Trombicula sarcina Womersley, 1944	—	...	...	...	×	...
Trombicula scincoides Womersley, 1944	×	...	...	...	...	×
Trombicula spicea Gater, 1932	×	...	...	×	...	...
Microthrombidium sulae Oudemans, 1910	×	...	...	...	...	×
Microthrombidium tinami Oudemans, 1910	×	×	...	...	...	×
Trombicula irritans var. *tropica* Ewing, 1925	× [3]	×	...	...	...	×
Thrombicula irritans var. *uruguayensis* André, 1930	× [4]	...	...	...	...	×
Trombicula vanommereni Schierbeek, 1937	×	...	...	...	...	×
Trombicula (*Eutrombicula*) *vernalis* Willmann, 1942	—	...	...	...	×	...
Thrombidium wichmanni Oudemans, 1905	×	...	...	...	...	×
Trombicula lacertillae Boshell and Kerr, 1942	×	...	...	...	...	×

Finally, there are certain trombiculid larvae which the writer regards as species incertae sedis. Four of these were described from South America as attacking man. It is perhaps significant that the described species known to attack man in the Americas are referable to *Eutrombicula* Ewing, 1938, with the exception of *Euschöngastia nuñezi* (Hoffmann, 1944), new combination, described from Mexico. Since it is possible that the four South American species may belong to *Eutrombicula* Ewing, 1938, they are discussed briefly.

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1) Original description incorrect; palpal claw actually trifurcate.
3) *Eutrombicula alfreddugèsi* var. *tropica* (Ewing, 1925).
4) *Eutrombicula alfreddugèsi* var. *uruguayensis* (André, 1930).

Leptus irritans Lucas, 1847, was applied to a mite attacking man in the vicinity of Para, Brazil, and called "Mouquis". The description is quoted by Oudemans (1937, Kritisch Historisch Overzicht der Acarologie, III, D, pp. 1388-1389). Since the description includes mention of six legs, it refers to a larva. The probable identity of this mite depends upon the species found to attack man in Para. Data on this point are lacking at this time.

According to Brèthes (1909, An. Mus. Nac. B. Aires, *19* (Ser. 3 a, *12*), pp. 211-217), the name *Tetranychus molestissimus* Weyenbergh, 1876, was applied to a mite attacking man in Argentina. As the name stands, it is a nomen nudum, but the writer has not verified Weyenbergh's paper. According to a figure of the "Bicho colorado", published by Brèthes, this concerns a larval trombiculid mite. However, generic assignment is impossible on the basis of available information.

Leptus japa Ribeyro and Bambarén, 1922, was applied to a mite attacking man, and wild and domestic animals, in Peru. The published figures and descriptions suggest a larval trombiculid mite, but they do not permit generic assignment, although Ewing (1931) regarded it as belonging to *Trombicula.*

Microtrombidium Brumpti Lahille, 1927, was described as attacking man at Villa Ballaster, Argentina. This name is preoccupied by *Microtrombidium brumpti* Hirst, 1915, which is a synonym of *Trombicula akamushi* (Brumpt, 1910). Therefore it was rejected as a homonym, and *Microtrombidium lahillei* Sig Thor and Willmann, 1947, was proposed as a new name, to replace *M. brumpti* Lahille, 1927. According to André (1930, Ann. Parasit. hum. comp., *8,* nos 3-4, p. 355), the type was accidentally destroyed, and presumably no type material exists at present. This species was regarded by Van Thiel (1930) as a *Trombicula.* According to Lahille, the palpal claw is bifurcate, and his figures depict a larva whose scutum and dorsal and ventral setal patterns are reminiscent of *Eutrombicula* Ewing, 1938. However, he has figured normal humeral setae, with a much smaller seta on each side, between the humerals and the posterior lateral scutal setae. Possibly this is due to an error in observation, but the data available to the writer are insufficient to permit definite generic assignment.

The writer is unable to give a key to species at the time of writing.

Eutrombicula alfreddugèsi (Oudemans, 1910)

1873. *Leptus irritans* Riley, Amer. Naturalist, *7,* pp. 18-19; fig. 5 b (Homonym; preoccupied by Lucas, 1847).

1877. *Tetranychus tlalsahuate* Murray, Economic Entomology, Aptera, pp. 113-114 (Collected in France, therefore probably refers to a misidentified specimen, actually *Trombicula autumnalis* (Shaw, 1790).

1877. *Tetranychus irritans* (Riley). Murray, *op. cit.*, p. 116: treated as a species incertae sedis.
1880. "Thalsahuate" Mégnin, Paras. malad. paras., p. 317.
1887. *Leptus irritans* Riley. Riley, Extr. Ref. Handb. Med. Sci., *5,* pp. 745-746; fig. 2980.
1892. "El Tlalzahuate" (sic) Altamirano, El Estudio, Mexico, *4,* pp. 196-198; pl. X.
1892. "El Tlalzahuatl" (sic) Dugés, El Estudio, Mexico, *4,* pp. 198-199.
1892. "El Tlalzahuatl" (sic) Dugés, La Naturaleza (2), *2,* pp. 5, 6 (Separate); pl. 8, figs. 1-4.
1896. *Trombidium* (*Leptus*) *irritans* Riley. Hamilton, Ent. News, *7,* no. 1, pp. 2-3.
1896. *Leptus irritans* Riley. Osborn, U.S. Dept. Agric., Div. Ent., Bull. no. 5, New Ser., pp. 251-253; fig. 151.
1899. "Tlalsahuate" (sic) Huber, Bibl. klin. Ent., Heft 2, p. 11.
1906. *Leptus irritans* Riley. Chittenden, U.S. Dept. Agric., Bur. Ent. Cir. no. 77, pp. 1-6; fig. 2.
1907. *Leptus irritans* Riley. Banks, Proc. U.S. nat. Mus., *32,* no. 1553, p. 622.
1908. *Leptus irritans* —. Washburn, Twelfth Rep. State Ent. Minnesota, pp. 156-158; fig. 80.
1910. *Trombidium tlalsahuate* —. Brumpt, Précis de Parasitologie, 1st ed., p. 507; fig. 336.
1910. *Trombidium irritans* (Riley). Brumpt, *op. cit.,* p. 507.
1910. *Microthrombidium alfreddugèsi* Oudemans, Ent. Ber., *3,* no. 54, p. 84.
1911. *Microthrombidium tlalzahuatl* (Murray). Oudemans, Ent. Ber., *3,* no. 57, pp. 120-121 (equals *Microthrombidium alfreddugèsi* Oudemans, 1910, synonym).
1912. *Microthrombidium tlalzahuatl* (Murray). Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 18-24, 189, 201, 215; fig. D (equals *Microthrombidium alfreddugèsi* Oudemans, 1910, synonym).
1913. *Microtrombidium tlalsahuate* (sic) (Murray). Brumpt, Précis de Parasitologie, 2nd ed., p. 567.
1913. *Leptus irritans* Riley. Brumpt, *op. cit.,* p. 568.
1913. *Trombidium tlalsahuate* Moniez (sic). Galli-Valerio, Zbl. Bakt., 1 Abt. Ref., *56,* nos. 5/6, pp. 131, 134.
1913. *Trombidium irritans* (Riley). Galli-Valerio, *op. cit.,* pp. 131, 134.
1915. *Leptus irritans* Riley. Chittenden, U.S. Dept. Agric., Farm. Bull. no. 671, pp. 1-7; fig. 2.
1917. *Leptus irritans* Riley. Hirst, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 6, p. 25.
1918. *Microthrombidium tlalzahuatl* (sic) (Murray). Ewing and Hartzell, J. econ. Ent., *11,* no. 2, p. 261; fig. 10 C.
1920. *Trombicula cinnabaris* Ewing, Ann. ent. Soc. Amer., *13,* no. 4, pp. 387-389; fig. 3: adult.
1921. *Leptus* (*Trombicula* ?) *similis* (sic) Hirst, Ann. Mag. nat. Hist., ser. 9, *7,* p. 37.
1921. *Trombidium thalsahuate* (Lemaire) (sic). Toomey, Urol. cutan. Rev., *25,* p. 606.
1921. *Microtrombidium alfreddugese* (sic) Oudemans. Toomey, *op. cit.,* p. 606.
1921. *Leptus irritans* Riley. Ewing, U.S. Dept. Agric. Bull. no. 986, p. 2.
1922. *Microtrombidium tlalsahuate* (sic) (Murray). Brumpt, Précis de Parasitologie, 3rd ed., p. 733.
1922. *Leptus irritans* Riley. Brumpt, *op. cit.,* p. 734.
1922. *Microtrombidium tlalsahuate* (sic) —. Ribeyro and Bambarén, Arch. Asoc. Peruana Prog. Cien., *2,* no. 2, p. 115.
1922. *Microtrombidium tlalzahuatl* (sic) (Murray). Walch, Geneesk. Tijdschr. Ned. Ind., *62,* no. 5, p. 561.
1923. *Microtrombidium tlalzahuatl* (Murray). Walch, Kitasato Arch., *5,* no. 3, p. 76.
1923. *Trombicula tlalzahuatl* (Murray). Ewing, J. agric. Res., *26,* no. 9, pp. 401-403

(equals *Leptus* (*Trombicula*?) *similis* Hirst, 1921; and *Trombicula cinnabaris* Ewing, 1920, synonyms).

1923. *Leptus irritans* Riley. Ewing, *op. cit.*, pp. 401-403.
1924. *Trombicula cinnabaris* Ewing. Walch, Geneesk. Tijdschr. Ned. Ind., *64,* pp. 508-509.
1925. *Trombicula irritans* (Riley). Ewing, Proc. biol. Soc. Wash., *38,* pp. 17-20; fig. 1 (equals *Trombicula tlalzahuatl* (Murray, 1877); and *Trombicula cinnabaris* Ewing, 1920, synonyms).
1925. *Trombicula tlalzahuatl* (Murray). Miller, Science, *61,* no. 1578, pp. 345-346.
1925. *Trombicula irritans* (Riley). Ewing, Amer. J. trop. Med., *5,* no. 3, pp. 252-254; fig. 1: detailed synonymy.
1925. *Trombicula tlalzahuatl* (Murray). Miller, Ohio Agric. Exp. Sta., Bull. 386, pp. 118-119 (equals *Trombicula cinnabaris* Ewing, 1920, synonym).
1926. *Trombicula irritans* (Riley). Bequaert, Med. Rept. Hamilton Rice Seventh Exped. etc., Chapt. XIV, pp. 176, 177 (equals *Leptus tlalzahuatl* (Murray, 1877); and *Trombicula cinnabaris* Ewing, 1920, synonyms).
1926. *Trombicula irritans* (Riley). Ewing, Proc. biol. Soc. Wash., *39,* pp. 19-20.
1926. *Trombicula irritans* (Riley). Ewing, Ent. News, *37,* no. 4, pp. 111, 113.
1926. *Trombicula irritans* (Riley). Ewing, Ann. ent. Soc. Amer., *19,* no. 3, p. 266.
1927. *Trombicula irritans* (Riley). Stiles and Hassall, Hyg. Lab. Bull. no. 148, pp. 267, 269.
1927. *Trombicula tlalsahuate* Lemaire in Murray, 1877 (sic). Stiles and Hassall, *op. cit.*, pp. 269-270: detailed synonymy.
1927. *Microtrombidium tlalzahuatl* —. Oudemans, Tijdschr. Ent., *70,* p. LXXII.
1927. *Microtrombidium tlalzahuate* (Murray). Lahille, Bol. Inst. Clin. quir. B. Aires, *3,* p. 773.
1928. *Trombicula tlalzahuatl* (Murray). Methlagl, Denkschr. Akad. Wiss. Wien, *101,* pp. 216, 223, 248 (equals *Trombicula irritans* (Riley, 1873), synonym).
1928. *Trombicula irritans* (Riley). Ewing, Proc. ent. Soc. Wash., *30,* no. 5, p. 77.
1928. *Trombidium irritans* (Riley). Warburton, Parasitology, *20,* no. 2, p. 228.
1928. *Trombidium tlasahuate* (sic) Brumpt. Warburton, *op. cit.*, p. 228.
1928. *Leptus irritans* L. (sic). André, Bull. Soc. zool. Fr., *53,* no. 6, p. 370.
1928. *Trombicula irritans* (Riley). Ewing, Manual of External Parasites, pp. 24-25; figs. 11-13.
1929. *Trombicula irritans* —. Patton and Evans, Insects, Mites, etc., p. 658 (equals *telalsahuatae* (sic), synonym).
1929. *Trombicula irritans* (Riley). Ewing, Amer. Nat., *63,* pp. 94-95.
1929. *Thrombicula thalzahuatl* (sic) (Murray). André, Bull. Mus. Hist. nat. Paris, 2e sér., *1,* no. 6, pp. 401-402 (equals *Leptus irritans* Riley, 1873, synonym).
1929. *Trombicula irritans* (Riley). Vitzthum, Z. Parasitenk., *2,* Heft 2, pp. 229, 234; fig. 3.
1930. *Trombicula irritans* —. Van Thiel, Geneesk. Tijdschr. Ned. Ind. *70,* p. 49 (equals *Microthrombidium tlalzahuatl* —., synonym).
1930. *Thrombicula irritans* (Riley). André, Mém. Soc. zool. Fr., *29,* no. 2, p. 109 (equals *thalzahuatl* (sic) Murray; *Alfreddugesi* (sic) Oudemans; *cinnabaris* Ewing; *similis* Hirst, synonyms).
1930. *Trombicula tlalzahuatl* Ewing 1923 (sic). Van Thiel, Parasitology, *22,* no. 3, pp. 351-352.
1930. *Leptus irritans* Riley. Van Thiel, *op. cit.*, p. 352.
1930. *Thrombicula irritans* (Riley). André, Ann. Parasit. hum. comp., *8,* nos. 3-4, pp. 355-356 (equals *Microthrombidium tlalzahuatl* (Murray, 1877), synonym).
1931. *Trombicula irritans* (Riley). Ewing, Proc. U.S. nat. Mus., *80,* no. 2908, Art. 8, p. 8 (equals *Tetranychus tlalsahuate* (sic) of authors; *Microthrombidium alfreddu-*

gèsi Oudemans, 1910; *Trombicula cinnabaris* Ewing, 1920; *Leptus* (*Trombicula* ?) *similis* Hirst, 1921, synonyms).

1931. *Trombicula irritans* (Riley). Vitzthum, Kükenthal's Handbuch der Zoologie, *3,* 2nd half (9), p. 126.
1932. *Trombicula irritans* (*tlalzahuatl*) —. (sic) Fonseca, Mem. Inst. Butantan, *7,* p. 129.
1932. *Trombicula irritans* (Riley). Vitzthum, Zool. Jb., Abt. Syst., *63,* nos. 5/6, p. 688.
1933. *Trombicula irritans* (Riley). Ewing, Proc. U.S. nat. Mus., *82,* no. 2970, Art. 29, p. 1.
1933. *Trombicula irritans* —. Feng and Hoeppli, Chin. med. J., *47,* p. 1192.
1934. *Trombicula irritans* —. Stiles and Baker, Nat. Inst. Hlth. Bull. no. 163, p. 1012.
1934. *Trombicula tlalsahuate* —. Stiles and Baker, *op. cit.,* p. 1012.
1936. *Trombicula irritans* (Riley). Pearse, Carnegie Inst. Wash. Publ. no. 457, p. 54.
1936. *Trombicula irritans* (Riley). Sugimoto, J. Jap. Soc. vet. Sci., *15,* pp. 203-204.
1936. *Leptus* (*Trombicula?*) *similis* Hirst. Sugimoto, *op cit.,* p. 204.
1937. *Thrombicula cinnabaris* Ewing. André, Bull. Mus. Hist. nat. Paris, 2e sér., *9,* no. 6, p. 380.
1938. *Trombicula irritans* (Riley). Neveu-Lemaire, Traité d'Entomologie etc., pp. 486-487 (equals *Trombicula tlalzahuatl* (sic) (Murray), synonym).
1938. *Trombicula irritans* (Riley). Wharton, Carnegie Inst. Wash. Publ. no. 491, p. 137.
1938. *Trombicula irritans* (Riley). Brimley, Insects of North Carolina, p. 488.
1938. *Trombicula alfreddugèsi* (Oudemans). Ewing, Proc. helm. Soc. Wash., *5,* no. 1, pp. 26-27 (equals *Leptus irritans* Riley, 1873, preoccupied; *Tetranychus tlalsahuate* of authors; *Trombicula cinnabaris* Ewing, 1920; and *Leptus* (*Trombicula*) *similis* Hirst, 1921, synonyms).
1938. *Eutrombicula alfreddugèsi* (Oudemans). Ewing, J. Wash. Acad. Sci., *28,* no. 6, pp. 289, 294, 295; fig. 1: genotype.
1939. *Leptus rileyi* Oudemans, Zool. Anz., *127,* Heft 3/4, p. 80: nomen novum for *Leptus irritans* Riley, 1873, preoccupied by Lucas, 1847.
1940. *Trombicula irritans* —. Van Thiel and Van Ommeren, Geneesk. Tijdschr. Ned. Ind., *80,* no. 27, p. 1647.
1941. *Trombicula irritans* (Riley). Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 4, p. 527.
1941. *Trombidium alfredduges* —. (sic) Bunyea and Wehr, U.S. Dept. Agric. Farm. Bull. no. 1652, revised, pp. 79-80.
1942. *Trombicula irritans* (Riley). Radford, Parasitology, *34,* no. 1, p. 57.
1942. *Eutrombicula alfreddugesi* (Oudemans). Radford, *op. cit.,* p. 66.
1942. *Eutrombicula alfreddugèsi* (Oudemans). Ewing, J. Parasit., *28,* no. 6, pp. 485-486 (equals *Leptus rileyi* Oudemans, 1939, synonym).
1943. *Trombicula irritans* (Riley). Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, p. 98 (equals *Trombicula cinnabaris* Ewing, 1920, synonym).
1943. *Eutrombicula alfreddugesi* (Oudemans). Melvin, Smith and Graham, J. econ. Ent., *36,* no. 6, p. 940.
1944. *Eutrombicula alfreddugesi* (Oudemans). Smith and Gouck, J. econ. Ent., *37,* no. 1, pp. 131-132.
1944. *Eutrombicula alfreddugesi* (Oudemans). Madden, Lindquist and Knipling, J. econ. Ent., *37,* no. 2, p. 284.
1944. *Eutrombicula alfreddugesi* (Oudemans). Williams, Amer. J. trop. Med., *24,* no. 6, p. 357.
1944. *Eutrombicula alfreddugèsi* (Oudemans). Ewing, J. Parasit., *30,* no. 6, pp. 341-343, 348-350, 351, 353, 355-356, 358, 359; figs. 1 c, 2-4, 6, 7 C, 8.
1945. *Trombicula irritans* —. Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, p. 7; fig. 1.

1945. *Eutrombicula alfreddugesi* (Oudemans). Blake, Maxcy, Sadusk, Kohls and Bell, Amer. J. Hyg., *41,* no. 3, p. 292.
1945. *Otonyssus thalzahuath* (sic) (Murray). Buitendijk, Zool. Meded., *24,* p. 338.
1946. *Eutrombicula alfreddugesi* (Oudemans). Williams, Amer. J. trop. Med., *26,* no. 2, pp. 243-250.
1946. *Eutrombicula alfreddugèsi* (Oudemans). Michener, Ann. ent. Soc. Amer., *39,* no. 1, p. 101.
1946. *Eutrombicula alfreddugesi* —. Bushland, Amer. J. Hyg., *43,* no. 3, p. 219.
1946. *Eutrombicula alfreddugèsi* (Oudemans). Michener, Ann. ent. Soc. Amer., *39,* pp. 413, 414.
1946. *Eutrombicula alfreddugesi* —. Bushland, J. econ. Ent., *39,* no. 3, p. 344.
1946. *Eutrombicula alfreddugèsi* —. Wharton, Ecol. Monogr., *16,* no. 3, p. 154.
1946. *Eutrombicula alfreddugèsi* —. Wharton and Carver, Science, *104,* no. 2691, p. 76.
1946. *Eutrombicula alfreddugèsi* (Oudemans). Ewing, J. Parasit., *32,* no. 5, pp. 437, 439.
1947. *Eutrombicula alfreddugesi* (Oudemans). Fuller, Amer. J. Hyg., *45,* no. 3, p. 368.
1947. *Eutrombicula alfreddugesi* —. Jenkins, Ann. ent. Soc. Amer., *40,* no. 1, pp. 56-68; table I. (Life history and rearing methods).

The above list of references is incomplete. This species is represented in the Oudemans collection by two specimens mounted on a single slide, labelled in his handwriting: "*Microthrombidium tlalzahuatl* Murray, 1877. = tlalzahuatl veroorzaakt Otzolaapam. *Homo sapiens.* Temascaltepec, Mexico, Alfred Dugés, don. Trouessart". Neither specimen is in good condition for study, being shrunken and not satisfactorily cleared. The writer has also studied material from several localities in the United States.

DIAGNOSIS: The body of the uncleared larva is vermilion in color, rather short and rotund, with a slight lateral bulge at the level of the humeral setae in some specimens. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. On either side of the scutum, in close apposition to it, is a distinct ocular shield, bearing two subequal eyes. The anterior eye is at the level of the line of the pseudostigmata, and the posterior eye is at the level of the posteror corners. The cornea of the anterior eye is more convex and well developed. Oudemans' figure (1912, fig. D 1) of the outline of the scutum is rather schematic. The anterior lateral setae are located about seven micra behind the most anterior point of the anterior margin. The anterior margin is incurved and the lateral margins are irregular, forming a very gentle S line. The posterior margin is irregularly curved outward, but the writer has not seen specimens in which it was flattened medially or sinuate. The surface of the scutum bears numerous medium-sized stipples or "pits" of uniform size. The normal scutal setae bear numerous short barbs, arising from several sides of their shafts. About eight rather long, delicate cilia arise from a single side of the distal half of the pseudostigmatic organs in an undistorted specimen. Oudemans (*loc. cit.*) figured these cilia as arising from opposite sides of the shaft.

The palpal claw is uniformly bifurcate. The main element is rather long and slender, being pointed and curved gently inward in its distal portion. The ventral accessory element is about three fourths as long, and it is acutely curved inward at right angles to its long axis, near the tip. Each chelicera bears a dorsal, subapical, recurved toothlet, and a ventral, recurved, flap-like process.

The dorsal setae are similar in form to the posterior lateral scutal setae. Their arrangement in moderately engorged specimens is: 2 — 6 — 6 — 4 — 2 — 2, and their total number has been constant in the limited material examined by the writer. There are two plumose sternal setae between coxae I, and two between coxae III. The remainder of the ventral abdominal setae are arranged: 6 — 2 — 2 (flanking the anus). The para-anal setae are coarser and similar in form to the posterior dorsal setae.

The seta on palpal segment I bears about six delicate, lateral cilia. The seta on segment II bears several rather long cilia. The seta on segment III is variable on two sides of a single specimen, being nude, or bearing a single short cilia proximal to the mid-point. This applies to topotypic material, as well as to specimens from the United States. The dorsal and lateral setae on segment IV are uniformly nude, while the ventral seta bears three long, delicate cilia. Segment V bears a basal ventral, striated seta; a nude, curved, subapical, spine-like seta; plus five plumose setae of various forms. The writer's description of segment V is at variance with that of Oudemans (1912, p. 23), who described it: "... mit 3 Fiederchen und 2 Riechhaaren (soweit an den alten Exemplaren zu unterscheiden war)". His specimens were not satisfactory for study, particularly with regard to this detail.

Each coxa bears a single plumose seta, similar in form to the sternal setae. A long, nude, whip-like seta arises at the junction of the proximal and middle thirds of tarsus III. The vestiture of the remainder of the leg segments is not remarkable.

Measurements are recorded for: (1) the dorsal topotypic specimen; (2) a specimen from Kansas City, Missouri, 5 July 1946, on lawn, collected by H. K. Gouck, Bishopp no. 33282, and loaned by G. W. Wharton; (3) five specimens from Kissimmee, Florida, 6 January 1947, off cattle, collected by W. G. Bruce, Bishopp no. 24291, and loanend by G. W. Wharton.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
76	84	39	28	28	29	43	42	59	—	50	55
74	87	42	24	28	28	28	29	42	42	35	35
78	91	42	25	29	28	31	28	42	43	32	35
78	87	45	24	28	25	28	29	42	49	34	36

73	88	41	24	29	28	31	28	41	48	32	36
69	78	42	22	28	25	28	28	41	48	34	35
77	92	45	22	28	28	29	28	41	—	35	35

Tarsus III of the topotypic material is 91 micra in length, while the tarsi of the United States specimens examined are about 20 micra shorter. The significance of this observation remains to be evaluated.

TYPE MATERIAL AND SYNONYMY: *Leptus irritans* Riley, 1873, was proposed for the "Irritating Harvest mite" of the United States. Riley did not name a specific type locality, and no holotype was designated. Ewing (1923, p. 402) reported that only a portion of the mouth parts of Riley's specimen was in existence at that time. The name is preoccupied and it is therefore rejected as a homonym.

The name *Tetranychus tlalsahuate* was applied by Murray (1877) to a mite which had been removed by Lemaire (1867, C. R. Acad. Sci. Paris, *65*, p. 215) from the eye of a child living in France. The specimen was lost, and since Murray did not see it, he possessed no type material. Lemaire was of the opinion that the mite had been introduced from Mexico in the packing and contents of boxes received from that country by the child's parents. This was pure speculation on his part, and Ewing (1938, pp. 26-27) has pointed out the extreme unlikelihood of introducing trombiculid mite larvae by means of transoceanic traffic of this sort. The species commonly attacking man in France is *Trombicula autumnalis* (Shaw, 1790). Thus Murray's name is probably a synonym of that species. Various emendations of his original spelling of the specific name are to be found in the literature.

Microthrombidium alfreddugèsi Oudemans, 1910, was based on four specimens from Mexico, collected *circa* 1892, off man, by Alfred Dugés, and sent by Trouessart under the name "tlalzahuatl". According to Oudemans (1910, 1912), the type is in the Trouessart collection. However, careful search by Dr. Marc André failed to reveal type material of this species in the Muséum National d'Histoire Naturelle, Paris. Since the specimens in the Oudemans collection are obviously part of the same series, we now know the specific type locality. It is Temascaltepec, which is about twenty-two miles northeast of Tejupilco, in Mexico State, as shown on map no. 95 R in the Times Survey Atlas of the World, by J. G. Bartholomew, 1922.

Trombicula cinnabaris Ewing, 1920, was described from East Falls Church, Virginia, 21 August 1919. It was based on an adult taken from the soil of a blackberry patch which was heavily infested with larval "chiggers". Presumably the holotype is in the U.S. National Museum. Ewing also recorded it from North Beach, Maryland, in the same publication. Ewing (1923)

suggested its synonymy, and he (1925, pp. 17-20) definitely synonymized it on the basis of rearing a larva from an egg laid by an adult.

Leptus (*Trombicula* ?) *similis* Hirst, 1921, was described from "a few specimens" from Dallas, Texas, 24 July 1916, off a chicken, collected by H. P. Wood, no holotype designated. The writer did not find type material in the British Museum (Natural History), and there is no record of its accession. The writer has been unable to ascertain the present existence of type material. It was first synonymized by Ewing (1923).

The nomenclature of this species was revised by Ewing (1938, pp. 26-27), whose synonymy the writer has followed. Since *Leptus rileyi* Oudemans, 1939, was proposed as a new name for *Leptus irritans* Riley, 1873, preoccupied by Lucas, 1847, Oudemans' nomen novum falls into synonymy by application of the law of priority.

GEOGRAPHICAL DISTRIBUTION:

Mexico: Mexico State, Temascaltepec	Type locality
Puebla State: Matamoros	Ewing (1944)
Acatlan	Ewing (1944)
Yucatan: Chichen Itza	Pearse (1936)
Panama: Aguas Buenas	Ewing (1944)
Gatun Lake, Canal Zone	Ewing (1944)
Parito	Ewing (1944)
Venezuela: Chama River	Ewing (1944)
Bahama Islands	Ewing (1944)
Cuba: Cabo Cruz	Ewing (1944)
Haiti: San Michel	Ewing (1944)
United States:	
Arizona: Winslow	Ewing (1944)
California: Coachella	Ewing (1944)
Nice	Ewing (1944)
Delaware: Newark	Ewing (1944)
Florida: Orlando	Ewing (1923)
Royal Palm State Park	Ewing (1923)
Illinois: Yorkville	Ewing (1944)
Iowa: Keosauqua	Ewing (1923)
Kansas: Highland	Ewing (1923)
Winfield	Ewing (1944)
Louisiana: Tallulah	Ewing (1923)
Mound	Ewing (1923)
Maryland: North Beach	Ewing (1920)
Berwyn	Ewing (1923)
Glen Echo	Ewing (1923)
Chesapeake Bay	Ewing (1923)
Somerset	Ewing (1923)
Takoma Park	Ewing (1923)
Michigan: Camp Bryan, Cass County	Ewing (1938)
Minnesota: Enchantment Island, Lake Minnetonka	Washburn (1908)
Minneapolis	Ewing (1944)
Missouri	Ewing (1923)

New Jersey: Pemberton	Ewing (1923)
North Carolina	Brimley (1938)
Ohio: Nile Township	Ewing (1944)
Southern Ohio	Miller (1925)
Pennsylvania: Stone Valley	Ewing (1923)
Texas: Dallas	Hirst (1921)
Houston	Ewing (1923)
Duncanville	Ewing (1923)
Uvalde	Ewing (1944)
Central Texas	Melvin, *et al.* (1943)
Virginia: East Falls Church	Ewing (1920)
Great Falls	Ewing (1923)

RECORDED HOSTS:

Man, *Homo sapiens* Linnaeus	Type host
"Cat", *Felis catus*	Ewing (1923)
Canis familiaris	Stiles and Baker (1934)
Angora goat	Melvin, *et al.* (1943)
"Rat"	Ewing (1923)
"Squirrel"	Ewing (1923)
"Gray squirrel"	Melvin, *et al.* (1943)
Citellus sp.	Ewing (1923)
"Prairie dog" (*Cynomys* sp.)	Ewing (1923)
Microtus pennsylvanicus	Ewing (1944)
"Cottontail rabbit" (*Sylvilagus* sp.)	Ewing (1923)
Sylvilagus floridanus	Ewing (1944)
"Nest of rabbit"	Ewing (1923)
"Jack rabbit" (*Lepus* sp.)	Ewing (1923)
Dasypus novemcinctus Linnaeus	Melvin, *et al.* (1943)
Nasua narica panamensis	Ewing (1944)
Birds:	
"Chicken"	Hirst (1921)
"Hen"	Ewing (1944)
"Pheasant"	Ewing (1944)
"Dove"	Melvin, *et al.* (1943)
"Red-headed sapsucker"	Melvin, *et al.* (1943)
Butorides virescens virescens (Linnaeus)	Ewing (1944)
Geococcyx californianus (Lesson)	Ewing (1944)
Geothlypis trichas trichas (Linnaeus)	Ewing (1929)
Mniotilta varia (Linnaeus)	Ewing (1944)
Pipilo erythrophthalmus erythrophthalmus (Linnaeus)	Ewing (1929)
Polioptila caerulea caerulea (Linnaeus)	Ewing (1929)
Protonotoria citrea (Boddaert)	Ewing (1929)
Setophaga ruticilla (Linnaeus)	Ewing (1929)
Spizella pusilla pusilla (Wilson)	Ewing (1929)
Thryothorus ludovicianus ludovicianus (Latham)	Ewing (1929)
Reptiles:	
"Lizard"	Ewing (1944)
"Horned lizard" (*Phrynosoma* sp.)	Melvin, *et al.* (1943)
"Horned toads"	Ewing (1944)
Ameiva undulata undulata (Wiegmann)	Pearse (1936)
Anadia bitaeniata	Ewing (1944)

"Coach-whip snake"	Melvin, *et al.* (1943)
Coluber constrictor ssp.	Miller (1925)
Diadophis punctatus (Linnaeus)	Miller (1925)
Elaphe obsoleta obsoleta (Say)	Ewing (1938)
Elaphe quadrivittata (Holbrook)	Melvin, *et al.* (1943)
Heterodon contortrix (Linnaeus)	Miller (1925)
"Heterodon platyrhinus niger"	Miller (1925)
Lampropeltis sp.	Ewing (1923)
Spilotes pullatus	Ewing (1944)
Thamnophis sirtalis sirtalis (Linnaeus)	Miller (1925)
Terrapene carolina carolina (Linnaeus)	Ewing (1926)

MEDICAL IMPORTANCE: *Eutrombicula alfreddugèsi* (Oudemans, 1910) is the trombiculid mite commonly attacking man in certain parts of the United States, Central America, and the West Indies. Its distribution has been mapped by Ewing (1944, p. 349, fig. 6). He states (*op. cit.*, p. 348) that with the exception of certain areas made artificial by man, its distribution is almost continuous over all the Southern States, except for the northwestern part of Texas, and in addition over the Coastal Plain and Piedmont districts of the North Atlantic States, and the southern half of the Upper Austral life zone of Merriam, in the Mississippi Valley. Outside this area it occurs in scattered, local "ecological islands" in which conditions presumably favor its existence. (This fact is reminiscent of the spotty distribution of areas where cases of scrub typhus have been acquired in the Far East).

In the United States, these mites are commonly known as chiggers or red bugs. The origin of the term "chigger" is somewhat obscure. Murray wrote (1877, p. 116): "This is the Jigger of the Mississippi valleys...". Thus the common name for this mite is an unfortunate one, since it gives rise to confusion with the jigger-flea or chigoe, *Tunga penetrans* (Linnaeus, 1758). For this reason, the use of the term chigger might well be avoided in scientific literature, insofar as possible. Chittenden (1906, p. 1) conveyed his impression that the word chigger was actually a corruption of chigoe. Possibly Riley (1873) was the original authority for this idea, but the ultimate origin of the derivation is still not clear to the writer, and it may be a part of folk-lore.

In Mexico the mite is known as "el tlalzahuatl", a name which has also been rendered under several different spellings. According to Oudemans (1912, pp. 24, 229), the condition produced by its attack is known as "otzoloapan". (This explains the label on the slide in his collection).

There is a popular misconception that these mites burrow into the skin of their human hosts, but Ewing (1921) reported observations indicating that they do not enter bodily into pores or hair follicles. Most of the observations on the effects produced on human beings have been recorded by

Ewing, and they were summarized by him (1944, pp. 351-352). Of twenty-six attached individuals observed on his skin, five were attached inside the rim of hair follicles, but they did not penetrate the follicle. They are frequently found at pressure points, including the belt line, and the garter line. Ewing states that the insertion of the chelicerae is usually unnoticed, and it is only after the injection of a digestive fluid that itching is felt. Itching usually commences three to six hours after exposure, and it may persist for as long as two weeks. The lesion becomes a papule and may proceed to vesicle formation. The pathology and associated clinical course have been studied by Parkhurst (1937, Arch. Derm. Syph., *35*, no. 6, pp. 1011-1036), whose article the reader should consult for details. If the lesion is not excoriated, involution begins about the third day and is extremely slow. Owing to the intense itching, however, the lesion is frequently scratched open, becoming secondarily infected, with postule formation. This complication may be accompanied by systemic reaction. Whether massive infestation, uncomplicated by secondary bacterial infection, is accompanied by a systemic reaction, is not clear to the writer. From his conversations with numerous individuals, it would appear that it may be accompanied by a systemic reaction. Toomey (1921, p. 603) states that in the Ozark Mountains and other places where people go barefooted, some persons have lost toes as a result of secondary infection of chigger bites over toe joints. He did not find tetanus recorded as a complication.

There are published and unpublished references to individuals said to be immune to "chigger bites". The problems of individual immunity to attack, immunity to the *effects* of attack, and sensitization to the "bite", are worthy of critical investigation and experimental study.

The potentialities of *E. alfreddugèsi* (Oudemans, 1910) as a disease vector are likewise worthy of experimental investigation. It has been suggested that trombiculid mite larvae may play a role in the transmission of Bullis Fever. This infectious disease, presumably of rickettsial etiology, was first described from Camp Bullis, Texas, by Woodland, McDowell and Richards (1943, J. Amer. med. Assoc., *122*, no. 17, pp. 1156-1160). Livesay and Pollard (1943, Amer. J. trop. Med., *23*, no. 5, pp. 475-479) concluded, among other things, "That it may be associated with an arthropod vector, the tick or *Trombicula,* in the Camp Bullis area". (*E. alfreddugèsi* (Oudemans, 1910) is the species attacking man in this vicinity). Woodland, *et al.* (*op. cit.*) had stated that while chigger bites were a common experience to all commands, massive exposure to tick bites was peculiar to men who had been on duty in the maneuver area at Camp Bullis. Investigations reported by Anigstein and Bader (1943, Texas Reports Biol. Med., *1*, pp. 389-409) demon-

strated the possibility of the lone star tick, *Amblyomma americanum* (Linnaeus, 1758), as a vector of this disease. Experimental and epidemiological observations have not tended to incriminate trombiculid mite larvae as vectors of Bullis Fever.

Riley and Johannsen (1932, Medical Entomology, p. 45) state that there is a possibility that "the mild type of typhus which occurs in the southeastern United States" may be carried by trombiculid or related mites. They refer to endemic or murine typhus, carried by fleas, commonly *Xenopsylla cheopis* (Rothschild, 1903). The tropical rat mite, *Liponyssus bacoti* (Hirst, 1913) is an experimental vector. The possible role of trombiculid mites is unknown, but it has never been suspected to be an important one.

VETINARY IMPORTANCE: Although this species has been reported for domestic dogs and cats, the writer has found no record of its being an actual pest of these animals. Also it is frequently found on wild rabbits, but apparently has not been recorded as a pest of domestic rabbits. However, it may be a serious pest of domestic fowl. Ewing stated (1929, p. 25) that young chickens are frequently killed by it. Bunyea and Wehr (1941) state that young chickens and turkeys, having a free range, are likely to be attacked. Abscesses or ulcerated areas may be found where clusters of mites are attached, sometimes attaining a diameter of one-third of an inch. The young birds become droopy, refuse to eat, and may die from hunger and exhaustion. It is the immature fowl that are most seriously affected. These authors recommend hatching chickens early in the spring, so that by the time the mites are prevalent, the birds will be old enough to resist their attacks. Infestation can be prevented by keeping young fowl off the range in summer. The mites do not breed in chicken houses, or within the confines of the bare ground of the usual chicken coop.

REMARKS: The nomenclature of this species has been discussed. Oudemans (1912, pp. 19-21) gave extracts from the description by Dugés (1892), accompanied by critical comments. It is of particular interest that Dugés described the characteristic palpal claw, and Oudemans noted its similarity to that of *E. wichmanni* (Oudemans, 1905). The larvae of *E. alfreddugèsi* (Oudemans, 1910) are very close to those of certain other members of this genus, and further studies of all stages are necessary to evaluate their relationships and the matter of variation. The writer has not seen sufficient material to discuss these problems.

The adult stage was described and figured by Ewing (1925, pp. 17-20; fig. 1), based on a female captured in the field, from which five larvae were obtained in the laboratory. Ewing fed the adult mite upon fecal pellets of springtails (Collembola). He stated that he had kept many adults indefinitely

by feeding them upon fecal matter and decaying woody substances. This seems rather unusual in the light of subsequent observations on the feeding habits of the free-living stages of this and other species. Miller (1925) was apparently the first to rear nymphs from larvae of this species, although he regarded them erroneously as adults, claiming that the nymphal stage was absent. This matter has been discussed by Ewing (1944, p. 342).

Ewing (1924, pp. 19-20) reported the rearing of nymphs and adults from larvae collected off *Terrapene carolina carolina* (Linnaeus). The writer would point out that while these stages have been reared by Ewing and by several subsequent investigators, detailed descriptions and figures that would permit comparison with related species are apparently unpublished.

Jenkins (1947) reared this species (and two others) in mass quantities through its entire life cycle, and through several generations. Using various hosts in Florida, he found that common box turtles, *Terrapene carolina,* including three subspecies, were the best host and laboratory animals. His methods are described in detail, and they are apparently suitable for application by others workers. Jenkins tabulated the minimum lengths of time in days, required for each stage of this species, as follows: egg — 6; deutovum — 7; larva (unfed) — 1; larva (feeding on host) — 3; larva (fed) — 2; nymphochrysalis — 6; nymph — 11; imagochrysalis — 7; adult — 12. Thus fifty-five days represented the minimum period required to complete a single generation. He fed the nymphs and adults upon mosquito eggs, and cited the large quantities of these eggs required, as a disadvantage of his method. He noted that the nymphs and adults became cannibalistic and ate each other, if sufficient food was not provided. For further pertinent details, Jenkins' paper should be consulted.

Eutrombicula vanommereni (Schierbeek, 1937) (fig. 1 c)

1937. *Trombicula vanommereni* Schierbeek, Ann. Parasit. hum. comp., *15,* no. 4, pp. 326-329; figs. 1, 2.
1938. *Trombicula vanommereni* Schierbeek. Neveu-Lemaire, Traité d'Entomologie etc., p. 493; figs. 196, 197.
1940. *Trombicula vanommereni* Schierbeek. Van Thiel and Van Ommeren, Geneesk. Tijdschr. Ned. Ind., *80,* no. 27, pp. 1639, 1640, 1641.
1941. *Trombicula vanommereni* Schierbeek. Van Thiel and Van Ommeren, Acta Leidensia, *15-16,* pp. 290-293.
1941. *Trombicula vanommereni* Schierbeek. Floch and Abonnenc, Inst. Past. Guyane et Terr. de l'Inini, Publ. no. 20, pp. 2, 4-6; fig. 2.
1942. *Trombicula vanommereni* Schierbeek. Radford, Parasitology, *34,* no. 1, p. 60.
1942. *Trombicula vanommereni* Schierbeek. Floch and Abonnenc, Inst. Past. Guyane et Terr. de l'Inini, Publ. no. 40, p. 1.
1943. *Trombicula vanommereni* Schierbeek. Floch and Abonnenc, Inst. Past. Guyane et Terr. de l'Inini, Publ. no. 64, p. 2.

1946. *Eutrombicula vanommereni* (Schierbeek). Michener, Ann. ent. Soc. Amer., *39*, pp. 413-415, 416; fig. 6.

The Oudemans collection does not contain specimens labelled as this species. It is treated here because of its nearness to certain species described by Oudemans, and because there is topotypic material in the Rijksmuseum van Natuurlijke Historie. The writer has also studied topotypic specimens in the Instituut voor Hygiene en Tropische Geneeskunde, Leiden. Prof. P. H. van Thiel kindly presented the writer with one of these specimens. The specimen on which the following descriptive notes are based was collected at Duisburg, Surinam, 16 September 1930, off a school child.

DIAGNOSIS: The body of the partially engorged larva is ovoid in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. On either side of the scutum, in close apposition with it, is an ocular shield, bearing a rather well developed anterior eye, and a smaller posterior eye. The shape of the scutum is that depicted in the accompanying figure (fig. 1 c on page 89), drawn by Miss Sanina from the topotypic specimen in the writer's collection. It will be noted that Schierbeek's original figure of the scutum showed the anterior margin as emarginate, whereas it is actually curved inward. The five normal scutal setae are provided with short, delicate cilia. The distal half of each pseudostigmatic organ bears six or more delicate cilia, arising from the same side of the shaft in an undistorted specimen.

The palpal claw is bifurcate, and the inner accessory prong is only slightly shorter than the main element. This feature was emphasized by Michener (1946, p. 413, fig. 6), and it is a differential character in separating this species from *E. göldii* (Oudemans) and *E. helleri* (Oudemans), whose geographical distributions overlap that of this species. In the material from Surinam, the finer details of the chelicerae cannot be made out, as these structures are embedded in tissue. However, they can be seen to possess a dorsal, subapical, recurved toothlet, and a ventral, gouge-like or flap-like process. There is no notch on the dorsal margin, proximal to the subapical toothlet. These details are well visualized on Michener's specimens from Panama.

The dorsal setae are similar in form to the posterior lateral scutal setae, though shorter, and are arranged: 2 — 6 — 6 — 4 — 2, becoming slightly longer posteriorly. There are two plumose sternal setae between coxae I, and two between coxae III. Anterior to the anus, the remainder of the ventral setae are arranged 4 — 2 — 2; a seta is present on either side of the anus, and there is a pair of post-anal setae. These para- and post-anal setae are stouter and longer and they have shorter cilia than the pre-anal setae.

The seta on palpal segment I bears six delicate cilia. The seta on segment II bears four delicate cilia. The seta on segment III and the dorsal and lateral setae on segment IV are nude. The ventral seta on segment IV is provided with two or three delicate cilia, which arise from the proximal half of the shaft. This is another difference from *E. göldii* (Oudemans), and *E. helleri* (Oudemans), both of which have a uniformly nude ventral seta on palpal segment IV. Segment V bears a basal, striated seta; an apical, nude, spine-like seta; and six plumose setae of various forms, of which a dorsal one is stouter and more prominent than the others. The galeal seta is nude.

Each coxa bears a single plumose seta, similar in form to the sternal setae. Tarsus III bears a nude, whip-like seta, about 53 micra in length, arising from the proximal one-third of the shaft. The vestiture of the remainder of the leg segments is not remarkable.

Measurements are recorded for: (1) the topotypic specimen in the writer's collection, from which the scutum was drawn; and (2) five specimens collected in Panama by Dr. Charles D. Michener, and kindly loaned by him to the writer for study.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
80	95	44	24	31	27	31	35	42	49	32	35
91	104	48	28	32	31	39	39	48	59	39	45
88	98	45	25	29	28	36	36	46	57	39	45
81	97	43	29	31	28	39	39	48	56	42	43
87	98	45	28	34	28	34	36	46	—	36	42
88	98	46	25	28	28	—	39	49	—	39	45

Sufficient suitable material has not been measured to permit statistical analysis and comparison of data on specimens from Panama with those from Surinam.

TYPE MATERIAL: This species was described from Surinam, off lizards and human beings, no holotype designated. Topotypic specimens, collected from human beings, are deposited in the Rijksmuseum van Natuurlijke Historie, and the Instituut voor Hygiene en Tropische Geneeskunde, Leiden; and in the writer's personal collection.

GEOGRAPHICAL DISTRIBUTION:

Surinam (Dutch Guiana)	Type locality
French Guiana	Floch and Abonnenc (1941)
Panama: Panama Province, Colon Prov., Darien Prov., and Canal Zone	Michener (1946)

RECORDED HOSTS:

Man, *Homo sapiens* Linnaeus	Cotype host

Canis familiaris	Floch and Abonnenc (1941)
Dasyprocta aguti	Floch and Abonnenc (1941)
Pecari angulatus	Michener (1946)
Domestic goat	Michener (1946)
Dasyprocta punctata	Michener (1946)
Hydrochoerus isthmius	Michener (1946)
Sylvilagus gabbi	Michener (1946)
Rat, undetermined Panama species	Michener (1946)
Birds:	
Gallus gallus domesticus	Michener (1946)
Arremonops conirostris	Michener (1946)
Reptiles:	
"Lizards"	Cotype host
Ameiva praesignis	Michener (1946)
Drymarchon corais	Michener (1946)

MEDICAL IMPORTANCE: Since this species has been recorded for man, it is of potential medical importance, although its potentialities as a vector of pathogenic organisms have not been investigated. It is one of two species of trombiculid mites known to attack human beings in Surinam. From *E. batatas* (Linnaeus, 1758) it is easily distinguished by its larger scutum, and by the fact that *E. batatas* has three long, nude setae on tarsus III, whereas *E. vanommereni* (Schierbeek) has only one. Van Thiel and Van Ommeren found it to attack man much less frequently than did *E. batatas* (Linnaeus). During any month of the year, it never comprised more than 4.5 per cent of the trombiculid mites removed from school children in Surinam, the remainder being *E. batatas* (Linnaeus). It has also been recorded from human beings in French Guiana, by Floch and Abonnenc (1941). Apparently Michener (1946) did not find it on human beings in Panama, although he did collect it off boots. From the writer's perusal of the literature, it is not clear to him whether this species causes itching at the site of its attachment to the human skin.

REMARKS: Although Prof. Van Thiel loaned the writer a considerable number of specimens of this species, only one of them was suitable for measurements. His material agrees morphologically witch Michener's Panama series. According to Michener's records, this species accepts a wide variety of hosts, including mammals, birds and reptiles. In Surinam Schierbeek (1937) found that it comprised forty-nine of fifty-one trombiculid mites removed from lizards. Schierbeek did not find it on the domestic chicken, but Michener did.

The writer has examined some, but not all, of the specimens reported by Floch and Abonnenc from French Guiana, and referred by them to this species. He does not agree with their determination of the specimens seen by him. In this series the ventral seta on palpal segment IV is nude, and the

scutal measurements are at variance with those of topotypic *E. vanommereni* (Schierbeek, 1937). It is quite possible, however, that this species is represented in other collections from French Guiana, and its occurrence there will be discussed further in a subsequent paper.

The nymphal and adult stages have been described by Michener (1946, pp. 414-415; table I), based on material reared from larvae collected in Panama off lizards, *Ameiva praesignis*. He did not collect nymphs and adults of this species in the field. According to Michener, there are differences between the adults of this species and *E. alfreddugèsi* (Oudemans, 1910), but these differences have not been tabulated. The larvae are very similar morphologically, but those of *E. vanommereni* (Schierbeek, 1937) apparently attack man much less frequently. Additional studies are needed in order to clarify the relationships of these and other species.

Eutrombicula wichmanni (Oudemans, 1905) (figs. 1 d, 2)

1905. *Thrombidium wichmanni* Oudemans, Ent. Ber., *1,* no. 22, p. 217.
1906. *Allothrombidium wichmanni* (Oudemans). Oudemans, Ent. Ber., *2,* no. 28, pp. 58, 59.
1906. *Thrombidium Wichmanni* Oudemans. Oudemans, Nova Guinea, *5,* livr. I, pp. 106, 132-134; pl. III, figs. 67-78.
1908. *Thrombidium wichmanni* Oudemans. Oudemans, Tijdschr. Ent., *51,* no. 1, pp. 25-27.
1909. *Thrombidium wichmanni* Oudemans. Oudemans, Tijdschr. Ent., *52,* nos. 1/2, pp. 38-41, 55.
1909. *Trombidium (Heterotrombidium) Wichmanni* Oudemans. Verdun, C. R. Soc. Biol. Paris, *67,* p. 246.
1909. *Microthrombidium wichmanni* (Oudemans). Oudemans, Ent. Ber., *3,* no. 50, p. 20.
1910. *Trombidium Wichmanni* Oudemans. Brumpt, Précis de Parasitologie, 1e ed., p. 507.
1912. *Microthrombidium wichmanni* (Oudemans). Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 9-13, 188, 201.
1913. *Microtrombidium wichmanni* (Oudemans). Brumpt, Précis de Parasitologie, 2e ed., p. 567.
1913. *Trombidium Wichmanni* Oudemans. Galli-Valerio, Zbl. Bakt., Abt. 1, Ref., *56,* nos. 5/6, p. 132.
1917. *Microtrombidium wichmanni* (Oudemans). Hirst, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 6, p. 26.
1917. *Leptus autumnalis* (*not* of Shaw, 1790) Miyajima and Okumura, Saikingaku Zasshi, no. 266, pp. 893-908; pl. 2, figs. 1-8.
1918. *Microthrombidium wichmanni* (Oudemans). Ewing and Hartzell, J. econ. Ent., *11,* no. 2, pp. 259-260.
1919. *Trombicula pseudo-akamushi* Hatori, Ann. trop. Med. Parasit., *13,* no. 3, p. 244: nomen nudum.
1920. *Trombicula pseudo-akamushi* Hatori, Taiwan Igakkai Zasshi, no. 209, pp. 317, 332, 335, 337, 340, 347, 352; pl. II, fig. 1. (Description in Japanese, Latin names in Latin alphabet; specific name also spelled *Pseudo-akamushi* (pp. 317, 347), and *pseude-akamushi* (p. 332); specific name validated).
1921. *Trombicula pseudoakamushi* "(non Tanaka)" Hatori. Kawamura and Yamaguchi,

Kitasato Arch., *4,* no. 3, pp. 185, 186, 202; also spelled *pseuboakamushi* (sic, p. 185): lapsus.

1921. *Trombicula mediocris* ? (sic, *not* of Berlese) Kawamura and Yamaguchi, ***op. cit.,*** pp. 186-187, 202, 204-205; pl. IV, figs. 1-7; pl. V, figs. 1-7; pl. VI, figs. 1, 2.

1921. *Microtrombidium wichmanni* (Oudemans). Toomey, Urol. and Cutan. Rev., *25,* p. 606.

1922. *Microtrombidium Wichmanni* (Oudemans). Brumpt, Précis de Parasitologie, 3e ed., p. 733.

1922. *Trombicula pseudo-akamushi* var. *deliensis* Walch, Geneesk. Tijdschr. Ned. Ind., *62,* no. 5, pp. 543, 544, 553, 558-562, 565; tables I, II, III; figs. 10-13.

1922. *Trombidium Wichmanni* Oudemans. Walch, *op. cit.,* pp. 545, 561; tables II, III.

1922. *Microtrombidium wichmanni* (Oudemans). Oudemans, Ent. Ber., *6,* no. 128, p. 114.

1923. *Trombicula pseudoakamushi* "(non Tanaka)" Hatori. Walch, Kitasato Arch., *5,* no. 3, pp. 64, 65, 76.

1923. *Trombicula pseudoakamushi* var. *deliensis* Walch, *op. cit.,* pp. 75-76; tables I, II, III; pl. I, figs. 9-12.

1923. *Trombicula Wichmanni* (Oudemans). Walch, *op. cit.,* pp. 75-76; tables, I, II.

1924. *Trombicula pseudoakamushi* —. Walch and Keukenschrijver, Geneesk. Tijdschr. Ned. Ind., *64,* pp. 250, 251, 252, 253, 256, 258, 259, 261.

1924. *Trombicula pseudoakamushi* Hatori. Walch, Geneesk. Tijdschr. Ned. Ind., *64,* pp. 501, 502, 503, 508, 514.

1924. *Trombicula pseudoakamushi* var. *deliensis* —. Walch, *op. cit.,* pp. 517-520; tables I, II; figs. 10-12.

1924. *Trombicula Wichmanni* (Oudemans). Walch, *op. cit.,* p. 528.

1924. *Trombicula pseudo-akamushi* (Hatori). Walch, Trans. 5th Bienn. Congr. Far East. Assoc. trop. Med. (1923), pp. 584, 599, 601, 602, 603, 615; tables III, IV; fig. 16.

1924. *Trombicula pseudo-akamushi* var. *deliensis* Walch, *op. cit.,* pp. 618-621; figs. 28-30.

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1927. *Microtrombidium wichmanni* (Oudemans). Stiles and Hassall, *op. cit.,* p. 270.

1927. *Trombicula hirsti* Sambon, Ann. Mag. nat. Hist., *20,* 9th ser., no. 115, pp. 157-161; figs. 1-3.

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1927. *Microtrombidium Wichmannii* (sic) (Oudemans). Lahille, Bol. Inst. Clin. quir. B. Aires, *3,* p. 773.

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1928. *Trombicula hirsti* Sambon. Ewing, Proc. ent. Soc. Wash., *30,* no. 5, p. 77.

1928. *Trombicula hirsti* Sambon. Sambon, Ann. trop. Med. Parasit., *22,* no. 1, pp. 71-72; figs. 1, 2.

1928. *Trombicula wichmanni* (Oudemans). Sambon, *op. cit.,* pp. 72-73.

1928. *Microtrombidium wichmanni* (Oudemans). Warburton, Parasitology, *20,* no. 2, p. 228.

1928. *Trombicula pseudo-akamushi* —, Fletcher, Lesslar and Lewthwaite, Trans. R. Soc. trop. Med. Hyg., *22,* no. 2, pp. 166-168; fig. 2.
1929. *Trombicula pseudoakamushi* — Patton and Evans, Insects, Mites etc., pp. 649, 654; fig. 332.
1929. *Trombicula wichmanni* —. Patton and Evans, *op. cit.,* pp. 651, 658.
1929. *Trombicula hirsti* —. Patton and Evans, *op. cit.,* p. 659.
1929. *Trombicula wichmanni* (Oudemans). Stiles and Nolan, Hyg. Lab. Bull. no. 152, p. 485.
1929. *Trombicula hirsti* Sambon. Stiles and Nolan, *op. cit.,* p. 485.
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1929. *Trombicula Hirsti* Sambon. Vitzthum, *op. cit.,* p. 237.
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1931. *Trombicula hirsti* Sambon. Vitzthum, *op. cit.,* p. 127.
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1938. *Trombicula pseudo-akamushi* Hatori. Sugimoto, J. Jap. Soc. vet. Sci., *17,* pp. 59, 60.
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1939. *Trombicula hirsti* var. *buloloensis* Gunther, Proc. Linn. Soc. N. S. W., *64,* pts. 1-2, nos. 281-282, pp. 79-80; figs. 2, 3, 5 (equals *Trombicula hirsti* var. *morobensis* Gunther, 1938, synonym).
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1939. *Trombicula wichmanni* (Oudemans). Womersley, *op. cit.,* p. 153.
1940. *Trombicula pseudoakamushi* —. Van Thiel and Van Ommeren, Geneesk. Tijdschr. Ned. Ind., *80,* no. 27, pp. 1646-1647.
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1940. *Trombicula wichmanni* —. Gunther, *op. cit.*, p. 254.
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1941. *Trombicula hirsti* Sambon. Vitzthum, *op. cit.*, p. 624.
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1942. *Trombicula pseudo akamushi* (sic) Hatori. Radford, *op. cit.*, p. 58.
1942. *Trombicula hirsti* Sambon. Radford, *op. cit.*, p. 58; fig. 4.
1942. *Trombicula buloloensis* Gunther. Radford, *op. cit.*, p. 62; fig. 21.
1942. *Trombicula hirsti* Sambon. Ewing, J. Parasit., *28*, no. 6, p. 486.
1943. *Trombicula wichmanni* (Oudemans). Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67*, no. 1, pp. 75, 91, 92; pl. V, fig. 1.
1943. *Trombicula hatorii* Womersley and Heaslip, *op. cit.*, pp. 75, 92; pl. V, fig. 5: nomen novum for *Trombicula pseudoakamushi* Hatori, 1919, stated by Womersley and Heaslip to be preoccupied by Tanaka's earlier usage.
1943. *Trombicula minor* (*not* of Berlese) Womersley and Heaslip, *op. cit.*, pp. 75, 92-94; pl. V, fig. 2 (equals *Trombicula mediocris* Berlese; *Trombicula hirsti* Sambon, synonyms); p. 98 — adult.
1943. *Trombicula minor* var. *deliensis* Walch. Womersley and Heaslip, *op. cit.*, pp. 75, 94; pl. V, figs. 3, 4 (equals *Trombicula pseudoakamushi* var. *deliensis* Walch; *Trombicula hirsti* Gater (sic); *Trombicula hirsti* var. *morobensis* Gunther; *Trombicula hirsti* var. *buloloensis* Gunther, synonyms).
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1944. *Trombicula wichmanni* (Oudemans). Womersley, *op. cit.*, pp. 86, 93.
1944. *Trombicula minor* (*not* of Berlese) Womersley, *op. cit.*, pp. 92-94 (equals *Trombicula pseudoakamushi* var. *deliensis* Walch; *Trombicula hirsti* Sambon; *Trombicula hirsti* var. *morobensis* Gunther; *Trombicula hirsti* var. *buloloensis* Gunther; and *Trombicula minor* var. *deliensis* Womersley and Heaslip, synonyms).
1944. *Trombicula hatorii* Womersley and Heaslip. Womersley, *op. cit.*, p. 93.
1944. *Trombicula hirsti* var. *buloloensis* Gunther. Ewing, U.S. Nav. med. Bull. Wash., *43*, no. 4, pp. 837-838; fig. B: Demonstration that it is *distinct* from *Trombicula minor* Berlese.
1944. *Trombicula hirsti* Sambon. Ewing, *op. cit.*, p. 838: Distinct from *Trombicula minor* Berlese.

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1944. *Trombicula minor* (*not* of Berlese) McCulloch, Med. J. Aust., 31st year *2,* no. 21, p. 544.
1944. *Eutrombicula pseudoakamushi* (Hatori). Ewing, J. Parasit., *30,* no. 6, p. 342; fig. 3.
1944. *Trombicula hirsti* Sambon. Ewing, *op. cit.,* p. 355.
1945. *Trombicula minor* (*not* of Berlese) Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, pp. 11, 28, 33, 34, 62, 67-68; fig. 34 (equals *Trombicula hirsti* Sambon, synonym).
1945. *Trombicula hatorii* Womersley and Heaslip. Finnegan, *op. cit.,* p. 62.
1945. *Trombicula minor* var. *deliensis* Walch. Finnegan, *op. cit.,* p. 62.
1945. *Trombicula wichmanni* (Oudemans). Finnegan, *op. cit.,* pp. 34, 62, 68-69; fig. 35.
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1945. *Trombicula pseudo-akamushi* var. *deliensis* Walch. Blake, *et al., op. cit.,* p. 264.
1945. *Trombicula hirsti* Sambon. Blake, *et al., op. cit.,* p. 274.
1945. *Trombicula buloloensis* Gunther. Blake, *et al., op. cit.,* pp. 275, 294, 295, 299, 301-302 (equals *Trombicula minor* (*not* of Berlese) Gunther: homonym).
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1945. *Otonyssus pseudoakamushi* (Walch). Buitendijk, *op. cit.,* p. 338.
1945. *Otonyssus wichmanni* (Oudemans). Buitendijk, *op. cit.,* p. 339.
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1946. *Trombicula buloloensis* —. Bushland, Amer. J. Hyg., *43,* no. 3, pp. 221-222.
1946. *Trombicula wickmanni* (sic) (Oudemans). Bushland, *op. cit.,* p. 232: lapsus.
1946. *Trombicula minor* (*not* of Berlese) McCulloch, Med. J. Aust., 33rd year *1,* no. 21, pp. 718, 719, 722, 734, 735; figs. I, II.
1946. *Trombicula hatorii* —. McCulloch, *op. cit.,* p. 727.
1946. *Trombicula wichmanni* (Oudemans). McCulloch, *op. cit.,* pp. 733, 735.
1946. *Trombicula buloloensis* Gunther. McCulloch, *op. cit.,* p. 735.
1946. *Trombicula minor* var. *deliensis* Womersley and Heaslip. McCulloch, *op. cit.,* p. 735.
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1946. *Trombicula hirsti* Sambon. Taylor, *op. cit.,* pp. 166-168, 268.
1946. *Trombicula minor* (*not* of Berlese) Taylor, *op. cit.,* pp. 149, 150, 168-170, 268; pl. I, fig. 2 (equals *Trombicula hirsti* Sambon, synonym).
1946. *Trombicula buloloensis* Gunther. Taylor, *op. cit.,* pp. 170-172, 268; fig. 159.
1946. *Eutrombicula buloloensis* (Gunther). Wharton, Proc. ent. Soc. Wash., *48,* no. 7, pp. 175-176.
1946. *Trombicula* (*Eutrombicula*) *wichmanni* (Oudemans). Philip and Woodward, J. Parasit., *32,* no. 5, pp. 507-508, 509, 511.
1946. *Trombicula hatorii* —. Philip and Woodward, *op. cit.,* p. 511.

1946. *Trombicula hakei* Radford, Proc. zool. Soc. Lond., *116,* pt. II, p. 249; figs. 1, 2.
1947. *Eutrombicula wichmanni* (Oudemans). Fuller, Amer. J. Hyg., *45,* no. 3, pp. 368-369 (equals *Trombicula minor* (*not* of Berlese) of McCulloch; *Trombicula buloloensis* Gunther, of Kohls, *et. al.* (1945); and *Trombicula pseudoakamushi* of Fletcher, *et al.* (1928), synonyms).
1947. *Eutrombicula wichmanni* (Oudemans). Philip, Amer. J. Hyg., *46,* no. 1, pp. 63, 64 (equals *Trombicula hatorii* Womersley and Heaslip, 1943, synonym or variety).
1947. *Trombicula hirsti* Sambon. Dumbleton, Trans. Roy. Soc. N. Z., *76,* pt. 3, p. 413 (equals *Trombicula minor* "Berlese" (*not* of Berlese!); and *T. minor* var. *deliensis* Walch, synonyms. (N.B.: If this synonymy were accepted, it would be contrary to the law of priority, since Berlese's and Walch's publications antedate Sambon's. —H. S. F.)).

It is probable that the above list of references is incomplete. The complicated synonymy of this species is discussed under the heading "Remarks".

This species is represented in the Oudemans collection by several series as follows: (1) three specimens on one slide, from Tawarin, Dutch New Guinea, 20 June 1903, off *Goura* sp., none in perfect condition; (2) two specimens from Java, 29 July 1912, no host data, collected by Dr. A. J. Salm (remounted by the writer); (3) three slides (nos. 5, 6, 7) labelled "*Otonissus pseudoakamushi* Hatori", from Sumatra: Fort de Kock, 4 April 1932, off *Tapirus indicus,* collected by E. Jacobson; (4) three slides (nos. 1, 2, 3) of larvae, and one (no. 4) of nymphs, labelled "*Trombicula pseudoakamushi* Walch, 1923", from Medan, Deli, Sumatra, 1921, off *Sus indicus,* collected by Dr. E. W. Walch; and (5) one slide with three specimens, labelled "*Otonyssus hirsti* (Sambon)", from Sungei Buloh, Selangor, Federated Malay States, 12 November 1929, off *Rattus rattus diardi* (Jentink), determined by Prof. B. A. R. Gater.

The writer has also studied the type specimen of *Trombicula hirsti* Sambon, in the British Museum (Natural History), and the other material in that Museum from Malaya and New Guinea; specimens removed from human beings in Sumatra by Walch, and deposited in the Instituut voor Hygiene en Tropische Geneeskunde, Leiden; the type of *Trombicula hakei* Radford, in C. D. Radford's collection, and other topotypic specimens identified by him as that species; specimens determined by Gunther as *Trombicula minor* and as *Trombicula wichmanni*; specimens from Dobadura, New Guinea, collected and loaned by G. M. Kohls; specimens from Bagabag, Luzon, Philippine Islands, collected and loaned by C. B. Philip; specimens from Bougainville and Ponam Islands, collected and loaned by G. W. Wharton; and specimens from Burma, and Ledo, Assam, collected by the U.S.A. Typhus Commission.

The following descriptive remarks are based on the topotypic specimens from Tawarin, in the Oudemans collection. They are equally applicable to the other material examined by the writer.

DIAGNOSIS: The uncleared larva is vermilion or bright orange in color, and the body is round or ovoid, depending upon the degree of engorgement. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. On either side of the scutum is a well developed ocular plate, bearing two eyes, of which the anterior is the larger. Oudemans (1906, pl. III, fig. 72) depicted the diameter of each cornea as smaller than that of the pseudostigmata, but actually each cornea is of greater diameter than the pseudostigmata. The scutum is somewhat variable in shape, and this variability has been a contributory factor in the production of synonyms. The anterior corners project for varying distances beyond the anterior lateral setal pores. The posterior margin may be almost evenly curved, or flattened medially, or slightly sinuate. To illustrate these observations, the outlines of the scuta of the three specimens from Tawarin have been drawn by Miss Sanina (fig. 1 d on page 89). Similar variations have been observed in the other material examined by the writer, and variously determined as species which the writer regards as synonyms. The normal scutal setae bear short barbs. The pseudostigmatic organs bear seven cilia, which commence distal to the mid-point of the shaft. In an undistorted specimen, it is apparent that all of these cilia arise from a single side of the shaft.

The palpal claw is bifurcate, the inner accessory prong being ventral to the main element, and less than three-fourths as long as it. Each chelicera bears a terminal structure, to which the term "tricuspid" has been applied. There is a sharp, dorsal, subapical, recurved toothlet; and a more proximal, ventral, recurved, flap-like process, apparently arising from the medial margin of the blade. When the chelicera is viewed from the lateral aspect, it is seen to possess a notch or hump on the dorsal margin, proximal to the dorsal, subapical toothlet. Its appearance depends upon position, and may differ on the two chelicerae of a single specimen.

The arrangement of the dorsal setae has been the subject of much controversy. This is explained by changes in position with engorgement, as pointed out by Oudemans (1909, p. 39), and by Philip and Woodward (1946, p. 508). Two of the original specimens from Tawarin are suitable for study of the setal pattern. On the specimen mounted with the dorsum upward, the setae are arranged 2 — 6 — 6 — 4 — 2, plus two dorsal marginal setae, and two caudal setae; the ventral setae (exclusive of sternals): 6 — 2 — 2 (flanking the anus), plus two ventral marginals, making a total of twenty-four dorsal and twelve ventral setae. On the specimen mounted with the ventral surface upward, the dorsal setae are arranged: 2 — 6 — 6 — 4 — 2, plus two posterior marginal setae; the ventral setae (exclusive of sternals): 6 — 2 — 2 — 4, or twenty-two dorsal and fourteen ventral setae. The fol-

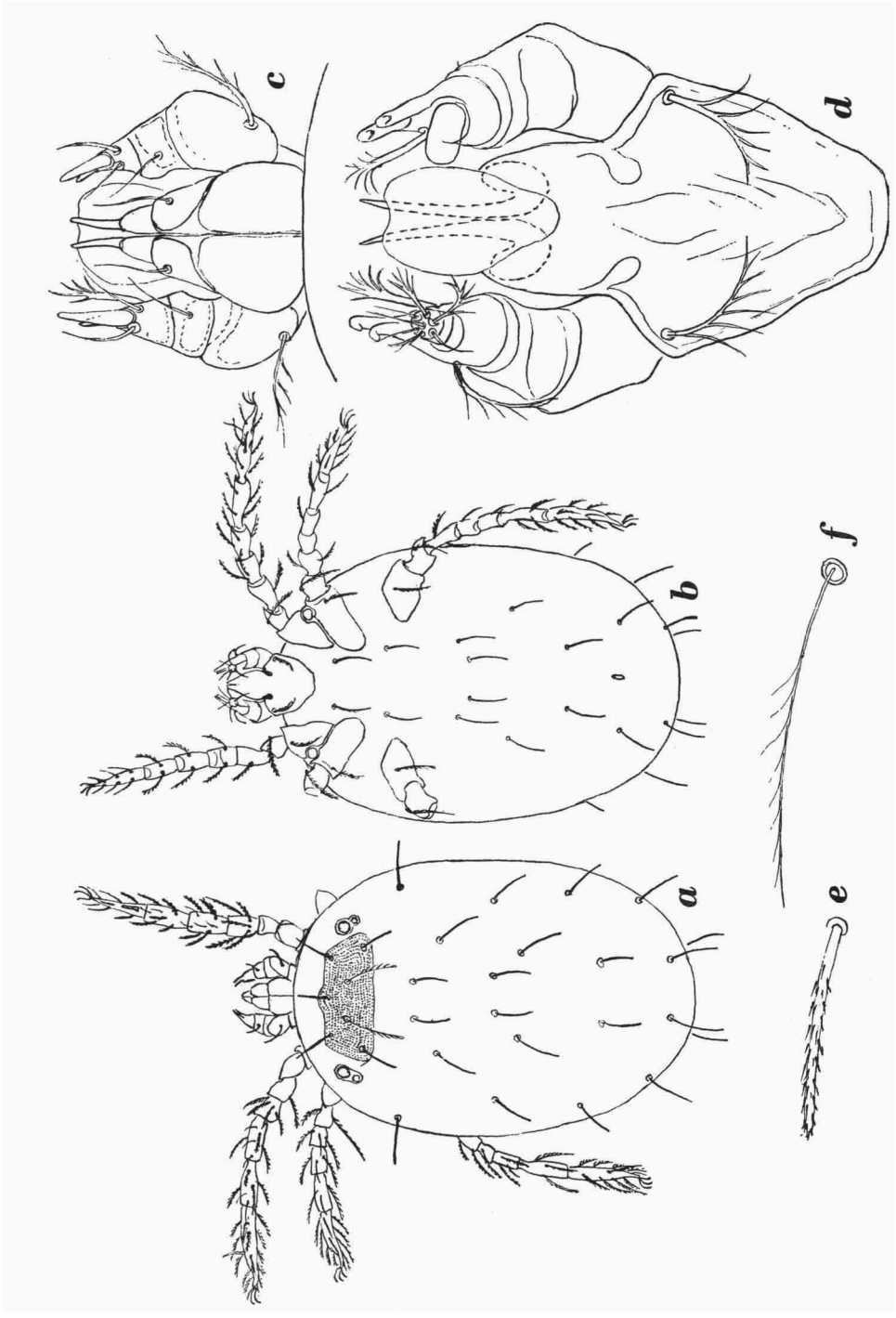

Fig. 2. *Eutrombicula wichmanni* (Oudemans, 1905); *a*, dorsum; *b*, venter; *c*, dorsal view of gnathosoma; *d*, ventral view of gnathosoma; *e*, dorsal seta; *f*, sensilla (Oudemans, original, unpublished).

Although the unpublished drawing is labelled as *wichmanni*, the number and pattern of body setae conform to *E. hirsti* (Sambon 1927) See Postscript for further comments.

lowing dorsal setal patterns are observed on specimens from New Guinea, nominally *Trombicula buloloensis* Gunther, on the type specimen of *Trombicula hirsti* Sambon, and on the Malayan specimens which are nominally *T. hirsti:* 2 — 6 — 6 — 2 — 2; and ventral setae: 6 — 2 — 2 — 4. This represents four less than the number of dorsal setae possessed by topotypic *E. wichmanni* (Oudemans, 1905). The writer fails to see the necessity for maintaining *T. hirsti* and *T. buloloensis* as separate named entities, in the absence of correlated characters.

There are two plumose sternal setae between coxae I, and two between coxae III.

The seta on palpal segment I is plumose, bearing long, delicate cilia. The seta on segment II bears five or more lateral barbs. The seta on segment III, and the dorsal and lateral setae on segment IV are nude. The long ventral seta on segment IV bears five unusually long cilia. Segment V bears a curved, basal, ventral, striated seta; a nude, subapical, pointed, spine-like seta, plus seven plumose setae of various forms, of which a dorsal, basal one is stout and prominent. The galeal seta is uniformly nude.

Each coxa bears a single plumose seta, provided with delicate cilia, similar in form to the sternal setae. From the dorsal aspect of tarsus III arises a single, long, nude, whip-like seta. The vestiture of the remainder of the leg segments is not remarkable.

Measurements are recorded for twenty-two specimens, as indicated in the following tabulation.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
Tawarin, New Guinea — topotypes											
77	90	41	29	29	32	42	53	56	62	53	52
78	88	42	29	33	36	46	52	55	56	46	42
77	92	42	28	32	32	43	50	59	56	—	—
Sumatra: Fort de Kock — "*Otonissus pseudoakamushi* Hatori"											
80	91	36	29	29	32	42	49	56	56	48	50
80	91	38	28	31	32	43	50	60	63	46	52
Sumatra: Medan, Deli — "*Trombicula pseudoakamushi* Walch, 1923"											
87	106	45	34	35	36	42	48	57	66	42	50
92	110	46	35	36	36	50	56	59	60	49	53
88	105	43	35	35	35	49	55	62	—	42	—
85	104	45	34	35	35	—	50	59	60	45	53
91	111	46	38	35	38	—	52	53	71	46	53
87	104	43	34	35	36	46	53	62	—	49	56
Malaya: "*Otonyssus hirsti* (Sambon)"											
81	98	38	29	32	34	45	45	56	53	42	49
83	98	39	31	34	32	43	48	53	56	45	49
89	106	45	34	34	36	48	52	59	59	42	49

Australia: *Trombicula hirsti* Sambon, type in British Museum (Natural History)											
78	93	42	30	39	36	—	45	56	—	42	48
Bougainville Island — determined as *Eutrombicula wichmanni* (Oudemans)											
97	106	52	31	35	38	43	52	49	62	42	42
Ponam Island — determined as *Eutrombicula buloloensis* (Gunther)											
98	109	50	29	?	36	46	46	50	—	43	42
Trombicula hakei Radford: type plus four topotypes											
88	104	42	30	33	32	—	50	60	—	54	54
86	104	42	33	32	32	45	45	51	—	46	48
84	102	39	32	33	32	45	45	56	60	46	51
86	102	40	32	32	32	46	48	56	—	50	51
87	104	42	33	33	33	48	48	51	63	48	54

TYPE MATERIAL: Oudemans described *Thrombidium wichmanni* from specimens, "Op den kop van *Goura* sp. (Ned. Nieuw-Guinea-Expeditie 1903) Tawarin, Juni; Jamoer, Augustus". He did not designate a holotype. Of his original material, the three specimens in the Rijksmuseum van Natuurlijke Historie are all that have been located. Oudemans mentioned that numerous specimens were found on the head of this *Goura* pigeon, but no trace of the particular host specimen was found by Miss Buitendijk.

Trombicula pseudoakamushi Hatori, 1920, was described from Yoshino and Kotobuki, Karenko Prefecture, Formosa, off *Centropus javanicus* Dumont, no holotype designated. According to Sugimoto (1936), the type and paratypes of another of Hatori's species, *Neoschöngastia gallinarum* (Hatori, 1920), are deposited in the Taihoku Imperial University Museum, Taihoku, Formosa. Thus it would seem reasonable to search for the type material of *T. pseudoakamushi* in the same museum.

Trombicula pseudo-akamushi var *deliensis* Walch, 1922, was described from Deli, Sumatra, off human beings, no holotype designated. According to a recent personal communication from Mrs. E. W. Walch, his original material is deposited in the Koningin Wilhelmina Instituut voor Hygiene en Bacteriologie, Batavia, Java. However, Prof. R. Gispen states (1947, *in litt.*) that none of the slides are labelled as types, and it seems likely to the writer that Walch did not designate types.

Trombicula hirsti Sambon, 1927, was described from three specimens, stated to have come from Townsville, North Queensland, Australia, collected off man by Frank H. Taylor. Although no holotype was designated in Sambon's publication, the slide in the British Museum (Natural History), no. 1927-6-20-1, bears the printed label, "Type". With regard to the type locality, Hirst states (1929, Trans. R. Soc. trop. Med. Hyg., *22*, no. 5, pp. 451-452): "Sambon gives Townsville as the type locality for this species, but the

original specimens came from Innisfail". Since Sambon, Hirst, and Taylor are now dead, the type locality may remain a matter of doubt, unless others have corroborative information not possessed by the writer.

Trombicula buloloensis Gunther, 1939, was described from many specimens off various hosts, including man, birds, and mammals. Apparently no holotype was designated in the original publication, although Gunther stated that type specimens of all new species described by him in that paper were at the School of Public Health and Tropical Medicine, University of Sydney, and paratypes in the Australian Museum, Sydney, Australia.

Trombicula hakei Radford, 1946, was described from several specimens from Imphal, Manipur State, India, off a copper-headed rat snake, *Coluber radiatus* Schlegel. No holotype was designated in print, but Radford kindly allowed the writer to examine a specimen in his personal collection, which he regards as the type. A paratype is in the U.S. National Museum, no. 1569, and Dr. Radford has kindly presented a specimen of the original series to the writer.

GEOGRAPHICAL DISTRIBUTION:

Dutch New Guinea: Tawarin, Jamoer (Jamur)	Type locality
Hollandia	Bushland (1946)
Ceram (questionable identity)	Oudemans (1906)
North Celebes	Oudemans (1905)
South Celebes	Walch (1927)
Formosa: Karenko Prefecture	Hatori (1920)
Sumatra: Deli	Walch (1922)
Tandjong Morawa	Walch (1923)
Lampong Districts	Walch (1927)
Fort de Kock	Buitendijk (1945)
Java	Oudemans (1922)
Australia: North Queensland	Sambon (1927)
Innisfail and Tully	Sambon (1928)
Lake Barrine, alt. 1,500 ft.	Womersley and Heaslip (1943)
AthertonTableland	McCulloch (1944)
Federated Malay States	Fletcher, Lesslar and Lewthwaite (1928)
Selangor: Sungei Buloh	Gater (1932)
Kuala Lumpur	Gater (1932)
British New Guinea: Bulolo Basin	Gunther (1939)
Watut River Valley	Gunther (1941)
Dobadura	Kohls, *et. al.* (1945)
Nissan Island (Green Island)	Dumbleton (1947)
British North Borneo: Bode River	Gunther (1940)
Balikpapan, Mangar Besar, Brunei	McCulloch (1946)
Philippine Islands:	
Luzon, Mindoro, Negros	Philip and Woodward (1946)
Ponam, Admiralty Islands	Wharton (1946)
Bougainville Island	Wharton (1946)

India: Imphal, Manipur State	Radford (1946)
Ledo, Assam	U.S.A. Typhus Comm. (unpublished)
Burma: Myitkyina	Fuller (1947)

RECORDED HOSTS:

Man, *Homo sapiens* Linnaeus	Oudemans (1905)
Buffalo	Kawamura and Yamaguchi (1921)
Pig	Walch (1922), and others
Cat, *Felis catus domesticus*	Walch and Keukenschrijver (1924)
Gibbon	Walch and Keukenschrijver (1924)
Goat	Walch and Keukenschrijver (1924)
"Rats"	Walch (1927)
Rattus rattus diardi (Jentink)	Gater (1932)
Rattus rattus jalorensis (Bonhote)	Gater (1932)
Tupaia glis ferruginea Raffles	Gater (1932)
Dog, *Canis familiaris*	McCulloch (1946)
Echymipera cockerelli	Gunther (1939)
Sus papuensis	Gunther (1939)
Tragulus borneanus	Gunther (1940)
Isoodon torosus	Womersley and Heaslip (1943)
Rattus gestri (?)	Blake, *et al.* (1945)
Wallaby	Blake, *et al.* (1945)
Guinea pig (experimental infestation)	Kohls, *et al.* (1945)
Rattus calcis	Philip and Woodward (1946)
Rattus mindanensis	Philip and Woodward (1946)
Muntiacus muntjak vaginalis Boddaert	Fuller (1947)
Birds:	
Goura sp.	Type host
Centropus javanicus Dumont	Hatori (1920)
Domestic chicken, *Gallus domesticus*	Walch (1922), and others
Excalfactorius chinensis	Walch and Keukenschrijver (1924)
Megapodidae	Sambon (1928)
Megapodius reinwardt Dumont	Gunther (1939)
Talegalla jobiensis Meyer	Gunther (1939)
Casuarius casuarius	Gunther (1939)
Amaurornis moluccanus nigrifrons	Gunther (1939)
Porphyrio melanotus	Gunther (1939)
Goura scheepmakeri Finsch	Gunther (1940)
Gallicolumba jobiensis (Meyer)	Gunther (1941)
Ailuroedus melanocephalus Ramsay	Gunther (1941)
Gallus gallus gallus Linnaeus	Fuller (1947)
Centropus benghalensis benghalensis (Gmelin)	Fuller (1947)
Reptiles:	
Platurus colubrinus	Vitzthum (1931)
Coluber radiatus Schlegel	Radford (1946)

MEDICAL IMPORTANCE: Under its various names, this species has been reported as attacking man in the following localities: North Celebes, by Oudemans (1905, p. 217; 1906, pp. 148-161); Ceram, by Oudemans, who attributed to this species the attacks recorded by Wallace, referring to an

undetermined species; Deli, Sumatra, by Walch (1922), and Walch and Keukenschrijver (1924); Queensland, Australia, by Hirst (1929), Sambon (1927), and McCulloch (1946); Lampong Districts, South Sumatra, by Walch (1927); Federated Malay States, by Fletcher, Lesslar and Lewthwaite (1928), Gater (1930), and Gater (1932); British New Guinea, by Gunther (1938, 1939, 1941), and Blake, *et al.* (1945); Java, by Vitzthum (1941); Dutch New Guinea, by Kohls, *et al.* (1945); Bagabag, Luzon, Philippine Islands, by Philip and Woodward (1946); Nissan Island (Green Island), Territory of New Guinea, by Dumbleton (1947). Vitzthum (1941) recorded it as attacking man in Formosa, but Hatori (1920) stated that his species, *T. pseudoakamushi,* did not attack human beings there.

Certain authors have recorded the common names applied by natives to this species. In Celebes, it is called "gonone" according to Oudemans (1905, p. 217); in Malaya it is called "tungau" according to Fletcher and Field (1927), and Fletcher, Lesslar and Lewthwaite (1928). Fletcher and Field state (1927, p. 15): "Malay children are frequently attacked by a mite called the *Tungau,* which burrows into the skin especially of the scrotum. We have examined a number of local rats and have found that a large proportion harbour clusters of trombiculae within their ears. The species of these mites has not been determined". In 1928, they reported the tungau as *Trombicula pseudoakamushi.* The writer has confirmed the identification of the species attacking man in Malaya by comparison of specimens labelled "Tungau" with the original series of *E. wichmanni* (Oudemans).

In New Guinea, the lesions produced in the human skin are called "Mokka-" bites, according to McCulloch (1946, p. 719). Gunther (1940, p. 251) recorded this species from man in company with *Schöngastia vandersandei* (Oudemans). Consequently, since their ranges overlap, the name "mokka" may apply to either species.

In North Queensland, Australia, the larva is known as the "scrub itch-mite", according to Sambon (1927), and subsequent authors. In other parts of Australia, a closely related species with more dorsal setae has been distinguished by Womersley. This is the "ti-tree itch" mite, *Eutrombicula samboni* (Womersley, 1936), of South Australia, described from Robe and recorded from other localities from Policeman's Point on the Coorong to Port McDonnell.

A few words about the origin of the term, scrub itch, may be appropriately included. Oudemans (1906, pp. 148-161; and 1908, pp. 25-27) has summarized the historical accounts of mites attacking man in New Guinea and nearby areas. He cites a reference which the writer has consulted: "Annual Report on British New Guinea from 1st July, 1897, to 30th June, 1898;

with Appendices. Queensland, 1898". This report contains extracts from diaries, and one, initialed "H N C" is of particular interest. It concerns the adventures of a group of people who departed from Port Moresby, New Guinea. On June 16, 1880, when about twenty miles from Mount Owen Stanley, there is the following entry: "We all suffered greatly with the scrub itch, which we felt here for the first time". Thus the term was apparently in use as early as 1880, and further research may reveal earlier references.

Walch and Keukenschrijver (1924, p. 629, table II) found varying numbers of this species on coolies from August to December, 1922, but they did not give detailed figures for their daily observations of the subsequent year, because they had no reason to consider it as a vector of scrub typhus. Gater (1930, p. 137, fig. II) published a graph showing the monthly percentages of rats infested with this species in Malaya, with peaks in June, September and November. Of forty-three Tamil coolies examined, five were found to be infested with this species.

That the attack of this mite causes itching is a well-known fact. However, the writer is unable to explain why the recorded distribution of scrub-itch is not co-extensive with that of this species. This matter has been discussed previously by the writer (1947). Obvious explanations suggest themselves, but none are supported by positive evidence. Concerning the local reaction, the production of a histosiphon in the skin (of a pig) is reported by Van Thiel and Van Ommeren (1940, pp. 1646-1647).

There is little factual information on the role of *Eutrombicula wichmanni* (Oudemans, 1905) as a disease vector, and no experimental attempts to transmit scrub typhus by this species have been recorded. The literature is replete with speculation. In his description of *Trombicula hirsti,* Sambon (1927, pp. 157-161) stated that it might prove to be a vector of Mossman fever, which we now regard as etiologically identical with scrub typhus. Sambon also stated: "Very likely the disease from which Wallace suffered in Amboyna was typhus contracted in Ceram through the agency of the local 'scrub itch-mite', *Trombicula wichmanni*". Although Sambon may have been correct, his statement is rank speculation, incapable of proof. Walch and Keukenschrijver (1923, 1924) did not consider this species to be a vector on epidemiological grounds. Hirst (1929, Proc. zool. Soc. Lond., p. 165) mentioned that Sambon's species "... might possibly convey 'Mossman Fever,' a local variety of typhus". Under the name, *Trombicula minor,* Gunther (1940, p. 569) discussed this species as the probable vector of "endemic typhus" in New Guinea. By endemic typhus, the reader must understand that Gunther referred to scrub typhus, *not* to the disease caused

by *Rickettsia prowazekii mooseri,* and transmitted by fleas. With regard to *E. wichmanni,* McCulloch (1946, p. 735) stated: "It was the only species found in the country near Balikpapan where scrub typhus infection existed, and so it must be suspected as a potential vector of the disease". Wharton (1946, pp. 175-176) reported it as the only species found on Ponam Island, three months after several cases of scrub typhus had occurred and control work had been extensive. Philip and Woodward (1946, p. 513) stated: "*Trombicula wichmanni* was taken on man in northern Luzon, and is considered by habits and wide distribution in the Archipelago to be a potential incidental vector of scrub typhus".

To summarize, this species is known to attack man, and to occur commonly in many areas where scrub typhus occurs. In order to incriminate it definitely as a vector, experimental evidence must include: (1) the recovery of strains of scrub typhus rickettsiae from specimens of this mite collected in nature; and (2) the demonstration that these organisms are transmitted during feeding, or by crushing an infected larva on the surface of the skin. The subject is worthy of investigation. In the meantime, this species can be regarded as a potential incidental vector of scrub typhus.

VETERINARY IMPORTANCE: The writer and others have observed large, ulcerated lesions on the skin of adult domestic fowl, caused by the attachment of larvae of this species. Although the writer has found no record of this species as an actual pest of young domestic fowl, it seems possible that it might be injurious to baby chicks, as is the case with certain species of trombiculid mites in the United States.

REMARKS: The writer's synonymy is based upon the findings of previous workers plus comparison of Oudemans' original material with the type of *T. hirsti* Sambon; paratypes of *T. buloloensis* Gunther; a paratype of *T. hakei* Radford; topotypic specimens of *T. pseudoakamushi* var. *deliensis* Walch; and specimens from British North Borneo, Ponam, Bougainville Island, Burma, Assam, Java, Malaya, Sumatra, Philippine Islands, and British and Dutch New Guinea. As far as he can determine, within reasonable limits of variation, they are indistinguishable. C. B. Philip (1947, *in litt.*) has informed the writer that the figures of *Trombicula pseudoakamushi,* and the scutal and setal dimensions derived therefrom, are similar to those of *E. wichmanni* (Oudemans, 1905). The writer has not seen Formosan specimens.

In discussing *T. hirsti* Sambon, under the name *T. minor,* Womersley (1944, p. 93) states: "The two closely allied species, *T. wichmanni* Oudms. and *T. hatorii* Wom. and Heasp. are not known from sufficient material but appear to be significantly different in the Standard Data, and in the ratio

of PW/SD which for *wichmanni* is 1.85 and for *hatorii* 1.57". It is of interest that the three authentic specimens of *E. wichmanni* in the Oudemans collection provide the following data for PW/SD: 1.52, 1.53 and 1.43. Separation of "species" and recognition of distinctions on these grounds alone does not appear justified to the writer, unless supported by correlated characters, including studies of the morphology of post-larval stages. Perhaps the subject could be approached by using the methods which Goldschmidt used in studying *Lymantria,* but one wonders whether the results would justify the effort.

With regard to post-larval stages, Hatori reported the rearing of the nymph of the Formosan species, and he gave a detailed description of it in Japanese. Walch (1923, p. 65) stated: "The prosopon of *T. pseudoakamushi* was dug out of the earth by Hatori in one of our mountain estates, where we found the larvae in the earth, this being the same place where the fowl carried so many trombiculae". The nymph was reared from Sumatran larvae by Walch (1924, Trans. 5th Bienn. Congr. Far East. Assoc. trop. Med. (1923), pp. 620-621; tables III, IV; figs. 28-30. 1924, Geneesk. Tijdschr. Ned. Ind., *64,* pp. 502, 517-520; tables I, II; figs. 10-12. 1925, Kitasato Arch., *6,* no. 3, pp. 248-250; tables III, IV; figs. 17-19). At Deli, he observed a period of ten to twelve days for the engorged larvae to metamorphose to nymphs.

Under the name *Trombicula minor,* Gunther described and figured nymphs reared from larvae determined as *T. hirsti* var. *buloloensis* (Gunther, 1939, Proc. Linn. Soc. N. S. W., *64,* pts. 5-6, nos. 285-286, pp. 466-470; figs. 2, 3). His association of his nymph with Berlese's species was due to the fact that Berlese's species had been incorrectly described and figured, as pointed out subsequently by Ewing. Womersley (1939, p. 153) wrote, "I have now received from Dr. W. G. Heaslip an adult female found at Innisfail in Queensland (December, 1939), which also corresponds to Berlese's species. As the only larval *Trombicula* known from Queensland is *T. hirsti* Sambon (the common itch-mite of that State), the above correlation is further confirmed". The conclusion in Womersley's second sentence is not critical, and it is without significance when one is attempting to correlate larval and post-larval stages.

The type material of *Trombicula minor* Berlese, 1905, was redescribed and figured by Willmann (1941, Zool. Anz., *133,* Heft 5/6, pp. 131-136; fig. 1 a & b). His illustrations show the area sensilligera and the dorsal aspect of the palpal tibia. The mite is a small adult, not a nymph. Ewing (1944, pp. 837-838) compared Gunther's and Willmann's figures and concluded that Gunther's species was distinct from *T. minor.* The present writer agrees with

this conclusion. Ewing (1944, p. 342, fig. 3) figured the crista, area sensilligera, and distal portion of the palpus of a nymph reared by Walch. His figures agree with the nymphs reared by Walch, and preserved in the Oudemans collection.

The writer has not found figures of the adult stage of this species, although he has examined authentic adults from New Guinea, associated with their larvae by G. M. Kohls.

Under the name *Trombicula minor*, McCulloch (1946, p. 722) recorded observations on the biology of this species. He placed some fifty to one hundred larvae in dry test tubes. In the jungle at 80° F and 60 % relative humidity, they showed no mortality at the end of three hours. When they were taken to a tent in which the temperature reached 87° F and relative humidity 36 %, about half of the larvae were dead in eight hours. The same investigator (p. 735) reported large numbers of larvae in the short grass at the edge of the jungle, smaller colonies along jungle tracks, and under heavier shade trees of savannah near jungle. There were few larvae on heavily shaded jungle floor. The larvae were always on the ground, never on stumps, etc. From these observations, it appears that a fringe habitat, as described by Audy (1947) provides suitable and perhaps optimal conditions for this species in nature.

Eutrombicula tinami (Oudemans, 1910)

1910. *Microthrombidium tinami* Oudemans, Ent. Ber., *3*, no. 54, p. 84.
1912. *Microthrombidium tinami* Oudemans. Oudemans, Zool. Jb., Suppl. *14*, Heft 1, pp. 24-26, 189, 201; fig. E.
1928. *Trombicula tinami* (Oudemans). Methlagl, Denkschr. Akad. Wiss. Wien, *101*, pp. 216, 223, 224.
1931. *Trombicula tinami* (Oudemans). Ewing, Proc. U. S. nat. Mus., *80*, no. 2908, Art. 8, p. 10.
1938. *Eutrombicula tinami* (Oudemans). Ewing, J. Wash. Acad. Sci., *28*, no. 6, p. 294.
1942. *Eutrombicula tinami* (Oudemans). Radford, Parasitology, *34*, no. 1, p. 67; fig. 45.
1945. *Otonyssus tinami* (Oudemans). Buitendijk, Zool. Meded., *24*, p. 338.

This species is represented in the Oudemans collection by a single specimen bearing the data of the original series, but not labelled as type. This specimen is broken, and certain details of the mouth parts and dorsal setal pattern cannot be made out. The writer has also studied the specimens in the Muséum National d'Histoire Naturelle, Paris. The following descriptive remarks are based on the Paris material, and they were confirmed by the writer's study of the specimen in the Oudemans collection.

DIAGNOSIS: The body of the fully engorged larva is rotund and ovoid in shape. The leg segmentation is characteristic of the subfamily, and the

tarsal claws are normal. On either side of the scutum, at a level midway between the anterior and posterior corners, is a distinct ocular shield, bearing a well developed anterior eye, and a smaller, poorly developed, indistinct, posterior eye. Although the scutum is perpendicular in both of the Paris specimens, in the Leiden specimen it is seen to be of the shape depicted by Oudemans (1912, fig. E 1). The normal scutal setae are all of equal calibre, with a delicate, gently tapered shaft, bearing rather fine lateral barbs. The pseudostigmatic organs bear six or seven cilia, arising from the distal half of the shaft.

The palpal claw is bifurcate, the outer main element being curved and sharply pointed, the inner accessory element being less than two-thirds as long, slightly curved, and pointed. Since the chelicerae could not be viewed from the lateral aspect, they cannot be described in detail. However, they can be seen to possess a dorsal, subapical, recurved toothlet, and a more proximal, vestigial, ventral toothlet.

The dorsal setae are similar in form to the normal scutal setae, and they are arranged: 2 — 6 — 6 — 2 — 4 — 2. The posterior setae are only slightly (3 micra) longer than the anterior ones. There are two plumose sternal setae between coxae I, and two between coxae III. The remainder of the ventral setae are arranged: 2 — 6 — 2 — 2 (flanking the anus) — 2. The para- and post-anal setae are somewhat longer and stouter than the pre-anal setae.

The seta on palpal segment I bears four delicate lateral cilia. The plumose setae on segments II and III are long, bearing relatively long lateral cilia. On segment IV, the dorsal and lateral setae are long and nude, while the ventral seta may be forked, or it may bear four delicate cilia. Segment V bears a basal, ventral, striated seta; an apical, nude, pointed, spur-like seta; and six plumose setae of various forms. The galeal seta is nude and rather long.

Each coxa bears a single plumose seta. Tarsus III bears a long, nude, whip-like seta. The vestiture of the remainder of the leg segments is not remarkable.

Measurements are recorded for one of the specimens in Paris, and for the one in Leiden.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
76	92	45	—	—	—	59	53	62	59	—	—
77	92	45	29	35	38	56	48	63	53	53	56

TYPE MATERIAL: Described from several specimens from Brazil, no specific locality, off *Crypturus noctivagus,* collected by E. A. Göldi. Two

cotypes, labelled as type in Oudemans' handwriting, are in the Trouessart collection in the Muséum National d'Histoire Naturelle, Paris.

REMARKS: This species is known only from the original material. It is the only trombiculid mite recorded from a Tinamou in Brazil.

Eutrombicula sulae (Oudemans, 1910)

1910. *Microthrombidium sulae* Oudemans, Ent. Ber., *3,* no. 54, p. 85.
1912. *Microthrombidium sulae* Oudemans. Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 7-9, 188, 201; fig. A.
1928. *Trombicula sulae* (Oudemans). Methlagl, Denkschr. Akad. Wiss. Wien, *101,* pp. 215, 216, 223, 224.
1929. *Microthrombidium sulae* Oudemans. André, Bull. Mus. Hist. nat. Paris, 2e sér., *1,* no. 6, p. 405.
1942. *Trombicula sulae* Oudemans). Radford, Parasitology, *34,* no. 1, p. 60; fig. 19.
1945. *Otonyssus sulae* (Oudemans). Buitendijk, Zool. Meded., *24,* p. 338.

This species is represented in the Oudemans collection by a single specimen, the holotype, labelled as type in Oudemans' handwriting. Although air has entered the preparation, obscuring many details, the writer deemed it unwise to attempt to remount the specimen.

DIAGNOSIS: The body of the engorged larva is ovoid in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. On either side of the scutum, at some distance from it, is a well developed ocular shield. The rather large, elliptical, anterior eye is located anterior to the level of the pseudostigmata, with its long axis in the transverse axis of the body of the mite. The smaller, poorly developed circular, posterior eye is located at a level behind the line of the posterior lateral setal pores. The scutum is large, and of the shape depicted by Oudemans (1912, fig. A 3). The five normal scutal setae bear short barbs. The pseudostigmatic organs bear numerous cilia (18 to 20) on the distal two-thirds of the shaft.

The palpal claw is bifurcate, the main element being curved inward and pointed. The dorsal, external, accessory element is straight and pointed. The form of the palpal claw constitutes an objection to placing this species in *Eutrombicula* Ewing, 1938. The chelicerae were described and figured by Oudemans as possessing no toothlet of any sort. The writer doubts this observation, but he was unable to visualize the chelicerae properly on the type specimen.

The dorsal setae are similar in form to the posterior lateral scutal setae, and they become shorter posteriorly. They are arranged: 2 — 8 — 16, not in rows, — 4 — 4 — 2, or a total of thirty-six. There are two plumose sternal setae between coxae I, and two between coxae III. The remainder of the ventral setae are thirty-eight in number, and their pattern cannot be

expressed as a formula, although Oudemans attempted to do so. The para- and post-anal setae are slightly stouter and longer than the pre-anal ones.

The seta on palpal segment I bears four delicate cilia. The plumose seta on segment II bears numerous cilia, giving rise to a bushy appearance. The long seta on segment III and the dorsal and lateral setae on segment IV are nude. The ventral seta on segment IV bears four cilia. Segment V bears a basal, ventral, striated seta; an apical, pointed, spine-like seta; and six plumose setae of various forms. The galeal seta is nude.

Each coxa bears a single plumose seta. Tarsus III bears a long, nude, whip-like seta. The vestiture of the remainder of the leg segments is not remarkable.

The following mesurements were made on the type: AW 94; PW 99; SB 39; ASB 35; PSB 20; AP 32; AM —; AL 42; PL 84; SENS 90; DSA 77; DSP 56.

TYPE MATERIAL: Described from a single specimen from West Africa, no specific locality, off *Sula capensis,* collected by Dybowski, and sent to Oudemans by Trouessart. The holotype is in the Rijksmuseum van Natuurlijke Historie.

REMARKS: This species is known only from the holotype. Its inclusion in *Eutrombicula* Ewing, 1938, may be incorrect; but in the size and shape of its scutum, the characteristic stippling, and the presence of a long, nude seta on tarsus III, it appears to share characters with the genotype. The palpal claw is atypical, however, and future studies may necessitate a different generic assignment.

Eutrombicula göldii (Oudemans, 1910)

1910. *Microthrombidium göldii* Oudemans, Ent. Ber., *3,* no. 54, p. 84.
1912. *Microthrombidium göldii* Oudemans. Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 13-15, 188, 201; fig. B.
1926. *Trombicula göldii* (Oudemans). Bequaert, Medical Report of the Hamilton Rice Seventh Expedition etc., chapt. XIV, p. 178.
1928. *Trombicula göldii* (Oudemans). Methlagl, Denkschr. Akad. Wiss. Wien, *101,* pp. 216, 223, 224.
1930. *Thrombicula Göldii* (sic) (Oudemans). André, Mém. Soc. zool., Fr., *29,* no. 2, p. 109.
1931. *Trombicula göldii* (Oudemans). Ewing, Proc. U. S. nat. Mus., *80,* no. 2908, Art. 8, p. 7.
1938. *Eutrombicula göldii* (Oudemans). Ewing, J. Wash. Acad. Sci., *28,* no. 6, p. 294.
1942. *Trombicula goldi* (sic) (Oudemans). Boshell and Kerr, Rev. Acad. Colomb. Ciencias etc., *5,* no. 17, reprt., pp. 4, 5, 6, 8, 9; pl. III, figs. 21, 22; pl. V, fig. 46; pl. VII, fig. 14.
1942. *Eutrombicula goldii* (sic) (Oudemans). Radford, Parasitology, *34,* no. 1, p. 66; fig. 43.
1943. *Eutrombicula göldii* (Oudemans). Fairchild, Amer. J. trop. Med., *23,* no. 6, p. 587.

1944. *Eutrombicula göldii* (Oudemans). Ewing, J. Parasit., *30,* no. 6, p. 344; fig. 5.
1945. *Otonyssus göldii* (Oudemans). Buitendijk, Zool. Meded., *24,* p. 338.
1946. *Eutrombicula göldii* (Oudemans). Michener, Ann. ent. Soc. Amer., *39,* no. 1, p. 101.
1946. *Eutrombicula göldii* (Oudemans). Michener, Ann. ent. Soc. Amer., *39,* p. 414.

This species is represented in the Oudemans collection by two specimens, mounted on a single slide, bearing the data of the original series, but not labelled as types. The writer has also studied the type material in the Muséum National d'Histoire Naturelle, Paris; and other specimens in the British Museum (Natural History), and the Museum of Comparative Zoölogy, Harvard College.

DIAGNOSIS: The body is ovoid in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. An ocular shield is located on either side of the scutum, bearing two eyes, of which the anterior one is larger, more distinct, and well developed. The scutum is of the shape depicted by Oudemans (1912, fig. B 1), with the exception that the anterior margin is concave, and the anterior lateral setal pores are actually situated farther behind the anterior corners than Oudemans has drawn them. The normal scutal setae bear short barbs, arising from several sides of the shaft at irregular intervals. The pseudostigmatic organs bear seven or eight prominent cilia, which commence proximal to the mid-point of the shaft, arising at regular intervals from a single side of the shaft. Thus they are typical of *Eutrombicula* Ewing, 1938.

The palpal claw is bifurcate. The main element is stout basally, and curved inward and pointed apically. The accessory prong lies ventral to the main element, is less than two-thirds as long, and is curved slightly inward. Each chelicera bears a dorsal, subapical, recurved toothlet (not figured by Oudemans, 1912), and a ventral, flap-like or gouge-like process.

The dorsal setae are similar in form to the posterior lateral scutal setae. They are arranged: 2 — 6 — 6 — 4 — 2 — 2, and in engorged specimens the posterior pair shifts caudally, so as to approach the ventral aspect of the body. The anterior and posterior dorsal abdominal setae are practically equal in length. There are two plumose sternal setae between coxae I and two between coxae III. The remainder of the ventral abdominal setae are arranged: 6 — 2 — 2 — 2, and the two middle setae of the "row" of six are behind those immediately on either side of them. The four setae posterior to the anus are stouter, longer, and have shorter barbs, than the pre-anal setae.

The setae on palpal segments I and II bear long lateral cilia. The seta on segment III, and the three setae on segment IV are nude. Of the setae

on segment IV, the ventral one is the longest. Segment V bears a basal, ventral, striated seta; an apical, nude seta; and six or seven plumose setae, of which a dorsal one is stouter and more prominent than the others. The galeal seta is uniformly nude.

The coxae are unisetose. Tarsus III bears a single long, nude, whip-like seta. The vestiture of the remainder of the leg segments is not remarkable. The numbers of pointed, spine-like setae on segments 5 and 6 of leg I may differ on two sides of a single specimen.

Measurements are recorded for two of the cotypes; the specimens in the Oudemans collection are not suitable for measurements.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
84	102	50	27	32	29	50	41	53	70	52	52
84	99	48	25	31	29	52	45	56	66	49	53

TYPE MATERIAL: Described from Brazil, no specific locality, off *Dasyprocta aguti,* collected by E. A. Göldi. Nine cotypes are mounted on one slide, labelled type in Oudemans' handwriting, in the Trouessart collection in the Muséum National d'Histoire Naturelle, Paris. Two specimens of the same series, not types, are in the Oudemans collection. The specimens collected by Boshell and Kerr, deposited in the British Museum (Natural History), nos. 1938-12-19-11, 12, 13, and 14, have been compared by the writer with the types in Paris, and they are indistinguishable.

GEOGRAPHICAL DISTRIBUTION:

Brazil, no particular locality specified	Type locality
Colombia: Restrepo, Dept. Meta	Boshell and Kerr (1942)
Villavicencio, Dept. Meta	Boshell and Kerr (1942)
Muzo, Dept. Boyaca	Boshell and Kerr (1942)
Bolivar, Dept. Santander del Sur	Boshell and Kerr (1942)
Panama: Barro Colorado Island	Fairchild (1943)

RECORDED HOSTS:

Dasyprocta aguti	Type host
Dasyprocta variegata	Boshell and Kerr (1942)
Cuniculus(Aguti) paca	Boshell and Kerr (1942)
Didelphis marsupialis	Boshell and Kerr (1942)
Metachirops nudicaudatus colombianus	Boshell and Kerr (1942)
Philander laniger	Boshell and Kerr (1942)
Nasua dorsalis	Boshell and Kerr (1942)
Icticyon venaticus	Boshell and Kerr (1942)
Cerdocyon sp.	Boshell and Kerr (1942)
Proechimys chrisaeolus	Boshell and Kerr (1942)
Macacus rhesus (experimental infestation)	Boshell and Kerr (1942)
Man, *Homo sapiens* Linnaeus	Boshell and Kerr (1942)

MEDICAL IMPORTANCE: It is noteworthy that Boshell and Kerr (1942, p. 6) recorded this species from man. They also found it frequently on boots and shoes in the field, a method of collection which has proved useful in the study of other species. They give no information regarding presence or absence of reaction at the site of attachment to human beings; thus we do not know whether this species causes itching. Its potentialities as a vector of pathogenic organisms have not been investigated.

REMARKS: The adult was described and figured by Boshell and Kerr (1942). Michener (1946, p. 414) states that there are differences between the adults of this species and *E. alfreddugèsi* (Oudemans, 1910), and *E. vanommereni* (Schierbeek, 1937), but he does not indicate what these differences are. With regard to the larvae of this species, *E. tropica* (Ewing, 1925), and others, he states: "Although these species are distinguished by only minute differences, the characters are constant in a large series of specimens from Panama".

In view of the variety of mammalian hosts accepted by this species, it is rather surprising that it has not been recorded from other classes of land inhabiting vertebrates.

According to the data of Boshell and Kerr (1942, p. 8), *E. göldii* (Oudemans, 1910) is found in Colombia at altitudes as high as 1,400 meters. It is one of the commonest species in Colombia.

Eutrombicula helleri (Oudemans, 1911)

1911. *Microthrombidium helleri* Oudemans, Ent. Ber., *3,* no. 57, p. 120.
1912. *Microthrombidium helleri* Oudemans. Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 15-18, 188, 201; fig. C.
1927. *Microthrombidium helleri* Oudemans. Oudemans, Tijdschr. Ent., *70* Verslag, pp. LXXII-LXXIII. (Regarded as a synonym of *Microthrombidium batatas* (Linnaeus, 1758), ex errore).
1928. *Trombicula helleri* (Oudemans). Methlagl, Denkschr. Akad. Wiss. Wien, *101,* pp. 216, 223, 224.
1930. *Microthrombidium helleri* Oudemans. Van Thiel, Geneesk. Tijdschr. Ned. Ind., *70,* p. 48.
1930. *Trombicula helleri* (Oudemans). Van Thiel, Parasitology, *22,* no. 3, pp. 346, 347, 351, 352.
1931. *Trombicula helleri* (Oudemans). Ewing, Proc. U. S. nat. Mus., *80,* no. 2908, Art. 8, p. 8.
1937. *Trombicula helleri* (Oudemans). Schierbeek, Ann. Parasit. hum. comp., *15,* no. 4, pp. 328-329.
1938. *Eutrombicula helleri* (Oudemans). Ewing, J. Wash. Acad. Sci., *28,* no. 6, p. 294.
1940. *Trombicula helleri* (Van Thiel, 1930) (sic). Van Thiel and Van Ommeren, Geneesk. Tijdschr. Ned. Ind., *80,* no. 27, pp. 1638, 1639.
1942. *Eutrombicula helleri* (Oudemans). Radford, Parasitology, *34,* no. 1, p. 66; fig. 44.
1946. *Eutrombicula helleri* (Oudemans). Michener, Ann. ent. Soc. Amer., *39,* pp. 411-412, 416; figs. 1-5.

In the Oudemans collection there are no specimens labelled by him as this species. However, on a slide labelled in his handwriting, "*Microtrombidium batatas* (L. 1758), Larvae dors. vent., met lange pooten, Missions Stat. Potriba a/d Oberen Commewijne, ö. v. Paramaribo, don. Mission C. Heller", are numerous specimens, some of which are very likely *E. helleri.* In view of the poor state of preservation of these specimens, they were not definitely determined by the writer, and they are unsuitable for measurement. The type specimen was not available to the writer; it is not in the Rijksmuseum van Natuurlijke Historie.

DIAGNOSIS: With the exception of the few characters mentioned below, this species is similar to *E. göldii* (Oudemans, 1910). Consequently repetition will be avoided. Measurements are recorded for two specimens of *E. helleri* (Oudemans, 1911) from Panama, collected and loaned by Dr. C. D. Michener.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
74	85	39	25	31	28	—	36	48	—	38	41
76	91	42	24	31	28	42	38	45	66	36	42

TYPE MATERIAL: *Microthrombidium helleri* Oudemans, 1911, was described from a single specimen from Paramaribo, Surinam, 21 July 1908, off *Passalus* sp. (Order: Coleoptera). According to Oudemans (1911, 1912), the holotype was in the Hamburg Museum at that time. The writer has not ascertained whether this specimen is in existence at the present time of writing. Oudemans pointed out that the type was collected from an accidental host, not a usual one.

GEOGRAPHICAL DISTRIBUTION:

Surinam: Paramaribo	Type locality
Panama: Panama Province	Michener (1946)
Colon Province	Michener (1946)
Herrera Province	Michener (1946)
Canal Zone	Michener (1946)

RECORDED HOSTS:

Passalus sp.	Type host
Undetermined mammal	Oudemans (1927)
Didelphis marsupialis	Michener (1946)
Dasyprocta punctata	Michener (1946)
Rat, undetermined Panama species	Michener (1946)
Sylvilagus gabbi	Michener (1946)
Felis pardalis	Michener (1946)
Man, *Homo sapiens* Linnaeus	Michener (1946)
Birds:	
Leptoptila verreauxi	Michener (1946)

Gallus gallus domesticus	Michener (1946)
Flycatcher, fam. Tyrannidae	Michener (1946)
Reptiles:	
Ameiva praesignis	Michener (1946)

MEDICAL IMPORTANCE: Michener's single record from a human being is of interest. He does not state whether or not this species causes itching at the site of attachment. He also collected this species off boots.

REMARKS: The writer's studies of *E. helleri* (Oudemans, 1911) are based on the assumption that Michener's specimens from Panama were correctly determined. The species is very close to *E. göldii* (Oudemans, 1910), and it is possible that further studies will reveal their identity. The characters given by Oudemans (1912, p. 188) are not of key value in separating them.

The adult of *E. helleri* (Oudemans, 1911) was correlated with the larva, and described and figured by Michener (1946, pp. 411-412; figs. 1-3). Boshell and Kerr (1942, pl. V, figs. 48 a-c) figured certain body setae of the adult of *E. göldii* (Oudemans, 1910). Their figure of a posterior body seta of the adult shows fewer cilia than figured by Michener for *E. helleri* (Oudemans, 1911); but Michener's figure is more applicable to their actual specimens, examined by the writer, than is their own figure. The writer is not in a position to distinguish *E. helleri* (Oudemans, 1911) from *E. göldii* (Oudemans, 1910) on the basis of adult characters. According to Michener, *E. helleri* (Oudemans, 1911) is the largest of the known adults of *Eutrombicula.*

Although Oudemans (1927) recorded this species from man, Van Thiel has cast doubt upon the authenticity of the host record, and the present writer agrees with Van Thiel. In addition to containing a rodent louse, Oudemans' material included more than one species of Trombiculid mite larvae. Thus he was not justified in determining it as *helleri* and synonymizing it under *batatas.* It is quite distinct from the mite which commonly attacks man in Surinam, as indicated in the key to species.

As this paper was going to press, Dr. Dale W. Jenkins informed the writer that adults and larvae from Colombia, determined by Boshell and Kerr as *göldii,* are indistinguishable from adults and larvae from Panama, collected by Michener and Jenkins, and determined as *helleri.* This further evidence strongly suggests the advisability of synonymizing the latter species, and the matter is being treated by Jenkins in a forthcoming paper.

Eutrombicula batatas (Linnaeus, 1758)

1758. *Acarus Batatas* Linnaeus, Systema Naturae, p. 617, Genus 235, species 22.
1805. *Gamasus batatas* (Linnaeus). Fabricius, Syst. Antliat., p. 362, no. 11. (Cited by

Oudemans, Kritisch Historisch Overzicht der Acarologie, 1937, III, D, p. 1385).
1815. *Acarus batatus* (sic) (Linnaeus). Oken, Lehrb. Naturg., *3* (1), p. 402. (Cited by Oudemans, *op. cit.*, p. 1386).
1847. ? *Leptus irritans* Lucas, Ann. Soc. ent. Fr., *2* sér., *5*, Bull. 2e Trim. p. xxxvi. (Cited by Oudemans, *op. cit.*, pp. 1388-1389).
1904. "Pattata-luis" Van Stockum, Tijdschr. Kon. Ned. Aardrijkskundig Genootschap, Versl. Saramacca-Expeditie, p. *22*.
1905. *Thrombidium batatas* (Linnaeus). Oudemans, Nova Guinea, *5*, Livr. I, p. 148.
1912. Gen.? *batatus* (sic) Linnaeus. Oudemans, Zool. Jb., Suppl. *14*, Heft 1, pp. 3-4, 201, 223-224.
1913. *Leptus batatas* (Linnaeus). Brumpt, Précis de Parasitologie, 2e ed., p. 568.
1917. *Acarus batatus* (sic) Linnaeus. Hirst, Brit. Mus. (Nat. Hist.) Econ. Ser. No. 6, p. 26.
1922. *Leptus batatas* (Linnaeus). Brumpt, Précis de Parasitologie, 3e ed., p. 734.
1926. *Acarus batatas* Linnaeus. Oudemans, Tijdschr. Ent., *69* Suppl., mite no. 43, pp. 129-130, 392, 402, 409 (?), 410, 413-414, 416, 442.
1927. *Microtrombidium batatas* (Linnaeus). Oudemans, Tijdschr. Ent., *70* Verslag, pp. LXXII-LXXIII (equals *Microthrombidium helleri* Oudemans, 1911, synonym (ex errore)).
1927. *Leptus batatas* (Linnaeus). Stiles and Hassall, Hyg. Lab. Bull. no. 148, p. 267 (Suggested synonymy with *Microtrombidium tlalzahuatl* (ex errore)).
1927. *Microtrombidium batatas* (Linnaeus). Stiles and Hassall, *op. cit.*, p. 270.
1928. *Acarus batatus* (sic) Linnaeus. Warburton, Parasitology, *20*, no. 2, p. 228.
1929. *Acarus batatas* Linnaeus. Oudemans, Tijdschr. Ent., *72* Suppl., mite no. 119, pp. 334-337, 916, 917, 924, 934, 935, 959, 960, 963-964, 972.
1929. *Acarus batatas* Linnaeus. Vitzthum, Z. Parasitenk., *2*, Heft 2, p. 235.
1930. *Acarus batatas* Linnaeus. André, Mém. Soc. zool. Fr., *29*, no. 2, p. 70.
1930. *Acarus batatas* Linnaeus. Van Thiel, Parasitology, *22*, no. 3, p. 346 (correction of synonymy proposed by Oudemans, 1927 (vide supra)).
1930. *Trombicula flui* Van Thiel, *op. cit.*, pp. 347-354; figs. 1, 2.
1930. *Acarus batatas* Linnaeus. Van Thiel, Geneesk. Tijdschr. Ned. Ind., *70*, p. 47.
1930. *Trombicula Fluï* (sic) Van Thiel, *op. cit.*, p. 50; figs. 1, 2.
1931. *Trombicula batatas* (Linnaeus). Ewing, Proc. U.S. Nat. Mus., *80*, no. 2908, Art. 8, pp. 6-7.
1931. *Trombicula flui* Van Thiel. Ewing, *op. cit.*, p. 7 (suggested synonymy with *Acarus batatas* Linnaeus).
1931. *Trombicula flui* Van Thiel. Vitzthum, Kükenthal's Handbuch der Zoologie, *3*, 2nd half (9), p. 127.
1933. *Trombicula hominis* Ewing, Proc. U.S. Nat. Mus., *82*, no. 2970, Art. 29, pp. 5-6; fig. 3.
1937. *Trombidium batatas* (Linnaeus). Oudemans, Kritisch Historisch Overzicht der Acarologie, III, D, mite no. 796, pp. 1384-1389 (*Otonyssus*).
1937. *Otonyssus batatas* (Linnaeus). Oudemans, *op. cit.*, p. 1995.
1937. *Otonyssus batatas* (Linnaeus). Oudemans, *op. cit.*, III, G, pp. 2934, 2936, 2974, 2975, 3070.
1937. *Trombicula flui* Van Thiel. Schierbeek, Ann. Parasit. hum. comp., *15*, no. 4, pp. 326-329.
1937. *Trombicula batatas* (Linnaeus). Schierbeek, *op. cit.*, p. 329 (equals *Trombicula flui* Van Thiel, 1930, synonym).
1938. *Trombicula flui* Van Thiel. Neveu-Lemaire, Traité d'Entomologie etc., p. 493.
1938. *Trombicula hominis* Ewing. Neveu-Lemaire, *op. cit.*, p. 493.
1938. *Leptus batatas* (Linnaeus). Neveu-Lemaire, *op. cit.*, p. 495.
1938. *Eutrombicula hominis* (Ewing). Ewing, J. Wash. Sci., *28*, no. 6, p. 294.

1938. *Eutrombicula flui* (Van Thiel). Ewing, *op. cit.*, p. 294.
1938. *Trombicula batatas* (Linnaeus). Schierbeek, Acta Leidensia, *12-13,* p. 269.
1940. *Trombicula batatas* (Linnaeus). Van Thiel and Van Ommeren, Geneesk. Tijdschr. Ned. Ind., *80,* no. 27, pp. 1638-1654; figs. 1-16 (equals *Trombicula flui* Van Thiel, 1930, synonym).
1941. *Trombicula flui* Van Thiel. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, *5,* Abt. IV, Buch 5, Lfg. 4, p. 623.
1941. *Trombicula batatas* (Linnaeus). Van Thiel and Van Ommeren, Acta Leidensia, *15-16,* 1940-1941, pp. 289-308 (equals *Trombicula flui* Van Thiel, 1930, synonym).
1941. *Trombicula flui* Van Thiel. Floch and Abonnenc, Inst. Pasteur Guiane et du Terr. de l'Inini, Publ. no. 20, pp. 2-4 (equals *Trombicula batatas* (Linnaeus, 1758), synonym).
1942. *Trombicula flui* Van Thiel. Floch and Abonnenc, *op. cit.,* Publ. no. 40, p. 1.
1942. *Trombicula pastorae* Boshell and Kerr, Rev. Acad. Colomb. Cien. Exact., Fisíco-Quim. y Nat., *5,* no. 17, separate, pp. 12-14; pl III, figs. 18, 19.
1942. *Eutrombicula hominis* (Ewing). Radford, Parasitology, *34,* no. 1, p. 66; fig. 38.
1942. *Eutrombicula flui* (Van Thiel). Radford, *op. cit.,* p. 66; fig. 39.
1942. *Trombicula batatus* (sic) (Linnaeus). Radford, *op. cit.,* p. 57.
1943. *Trombicula flui* Van Thiel. Floch and Abonnenc, Inst. Pasteur Guiane et du Terr. de l'Inini, Publ. no. 64, p. 2.
1943. *Acariscus flui* (Van Thiel). Ewing, Proc. ent. Soc. Wash, *45,* no. 3, pp. 57, 58, 64-65; 66: genotype.
1943. *Acariscus hominis* (Ewing). Ewing, *op. cit.,* pp. 63-64, 66.
1943. *Acariscus flui* (Van Thiel). Islas, Ann. Inst. Biol. Univ. Nac. Mexico, *14,* p. 441. (Cited by Michener, 1946, p. 102).
1943. *Eutrombicula hominis* (Ewing). Fairchild, Amer. J. trop. Med., *23,* no. 6, p. 587.
1945. *Otonyssus batatus* (sic) (Linnaeus). Buitendijk, Zool. Meded., *24,* p. 337.
1946. *Eutrombicula batatas* (Linnaeus). Michener, Ann. Rep. Gorgas Mem. Lab. for 1945, p. 23.
1946. *Eutrombicula batatas* (Linnaeus). Michener, Amer. J. trop. Med., *26,* no. 2, p. 251 (equals *Acariscus hominis* (Ewing, 1933), synonym).
1946. *Eutrombicula batatas* (Linnaeus). Michener, Ann. ent. Soc. Amer., *39,* no. 1, pp. 101-118; pl. I, figs. 1-4; pl. II, figs. 5-15; pl. III, figs. 17-27; pl. IV, figs. 28-32; pl. V, figs. 33, 34 (equals *Trombicula flui* Van Thiel, 1930; *Trombicula hominis* Ewing, 1933; and *Trombicula pastorae* Boshell and Kerr, 1942, synonyms).
1946. *Eutrombicula hominis* (Ewing). Melvin, Ann. ent. Soc. Amer., *39,* no. 1, p. 144.
1946. *Acariscus flui* (Van Thiel) Ewing, Proc. biol. Soc. Wash., *59,* pp. 22-23.
1946. *Acariscus hominis* (Ewing). Ewing, *op. cit.,* pp. 22-23.
1946. *Eutrombicula batatas* (Linnaeus). Michener, Ann. ent. Soc. Amer., *39,* pp. 415-417.
1946. *Eutrombicula batatas* —. Wharton, Ecol. Monogr., *16,* no. 3, p. 154.
1946. *Acariscus flui* (Van Thiel). Ewing, J. Parasit., *32,* no. 5, p. 439.
1947. *Eutrombicula batatas* —. Jenkins, Ann. ent. Soc. Amer., *40,* no. 1, pp. 56-58.
1947. *Eutrombicula batatas* (Linnaeus). Fuller, Amer. J. Hyg., *45,* no. 3, p. 368 (equals *Acariscus hominis* (Ewing, 1933), synonym).

This species is represented in the Oudemans collection by a series of specimens from Paramaribo, Surinam, April, 1923, Landbouw Proefstation, off *Gallus domesticus,* collected by A. Reyne. Another series from Paramaribo, collected by C. Heller, and labelled by Oudemans as "*Microtrombidium batatas* (L. 1758)" do not belong to this species. They are discussed in the present paper under *Eutrombicula helleri* (Oudemans, 1911). The

writer has also studied a topotypic specimen of *T. flui* Van Thiel, 1930, in the Rijksmuseum van Natuurlijke Historie, and other topotypic material in the Instituut voor Hygiene en Tropische Geneeskunde, Leiden; specimens from French Guiana, in the Institut Pasteur, Paris; paratypes of *T. pastorae* Boshell and Kerr, 1942, in the British Museum (Natural History); other type material in the Museum of Comparative Zoölogy, Harvard College; cotypes of this species and of *Trombicula hominis* Ewing, 1933, in the U.S. National Museum; and specimens from Panama, collected and determined by Dr. C. D. Michener, in the American Museum of Natural History, New York City. The following descriptive notes are based mainly on topotypic specimens from Surinam, and they apply equally to the other material seen by the writer.

DIAGNOSIS: The body of the engorged larva is rotund in shape, and red in color, with intensely red areas of pigment corresponding to eye spots. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. On either side of the scutum is a distinct ocular shield, bearing two eyes, of which the larger, anterior eye is at the level of the pseudostigmata, the smaller, posterior one being just behind the level of the posterior lateral setal pores. The scutum is of the shape depicted by Michener (1946, p. 103, pl. I, fig. 1), the anterior margin being biconcave, and the posterior margin broadly and evenly rounded. Its size is much smaller than that of *E. alfreddugèsi* (Oudemans, 1910), as indicated by the contrast in scutal measurements. It is ornamented with stippling, except in the region of the median setal pore. The normal scutal setae bear rather short barbs. The pseudostigmatic organs bear six delicate cilia, arising at regular intervals from the distal two-thirds of the shaft, the proximal one-third being completely nude.

The palpal claw is bifurcate, the inner accessory prong being about three-fourths the length of the main element, and situated ventral to it. Each chelicera bears a dorsal, subapical, sharp, recurved toothlet, and a ventral, recurved, blunt, flap-like process, apparently arising from the ventro-lateral aspect of the blade.

As discussed by Michener (1946, pp. 102, 104, 108), the dorsal abdominal setae vary in number and arrangement. There may be thirty-two to thirty-six dorsal setae, arranged 2 — 8 — 8 — 8 — etc., or 2 — 8 — 8 — 9 — etc., or 2 — 8 — 8 — 10 — etc., plus posterior and marginal setae which cannot always be patterned and assigned to rows. There is no constancy in relative lengths of anterior and posterior dorsal setae. Although there are consistently two plumose sternal setae between coxae I and two between coxae III, variations in the numbers, patterns, and symmetry of the remainder of the

ventral setae are observed. The pre-anal setae are shorter, with more delicate shaft and longer cilia; those flanking the anus and posterior to it are stouter, with short barbs, similar to the posterior dorsal setae. Exclusive of the sternals, there are about fourteen of these pre-anal setae, and ten (more or less) para- and post-anal setae.

The seta on palpal segment I bears long, delicate cilia. The seta on segment II is plumose, bearing numerous, long, delicate cilia which arise from both sides of its shaft. The seta on segment III is rather long, bearing two or three (variable) cilia, arising from the lateral aspect of its shaft. The dorsal and lateral setae on segment IV are uniformly nude, and the ventral seta bears two to five rather long, delicate cilia. Segment V is short and blunt apically, bearing a basal, ventral, striated seta; a curved, pointed, apical seta; and six plumose setae of various forms. The galeal seta is consistently nude.

The coxae are unisetose, each bearing a single plumose seta which is similar in form to the sternal setae. The setae on the terminal and pre-terminal segments of the third pair of legs are noteworthy. Tibia III bears two fine, nude, whip-like setae, and tarsus III bears three similar ones. These are characteristic. The vestiture of the remainder of the leg segments is not remarkable.

Measurements are recorded for eight specimens, as indicated in the following tabulation.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
Surinam: *T. flui* Van Thiel, 1930, in Rijksmuseum van Natuurlijke Historie											
63	69	28	24	24	21	38	35	49	52	41	42
Panama: in collection of Dr. C. D. Michener											
57	63	25	21	24	25	39	35	50	53	41	36
60	64	25	21	24	22	36	32	49	56	39	38
59	65	28	24	22	24	—	34	48	—	36	38
63	63	25	25	22	22	—	36	55	—	43	39
Panama: *Trombicula hominis* Ewing, 1933, cotype in U.S. National Museum											
63	71	28	26	26	25	—	37	59	—	47	44
Colombia: *Trombicula pastorae* Boshell and Kerr, 1942, paratypes											
60	66	25	24	24	24	36	32	46	62	38	39
60	67	27	24	25	24	36	33	52	62	39	—

TYPE MATERIAL: *Acarus batatas* Linnaeus, 1758, was described from Surinam, without specific locality, and without designating a type host. A careful search of the collections of the Linnean Society of London failed to reveal any trace of this species. It is doubtful that Linnaeus actually possessed type specimens of this mite.

Trombicula flui Van Thiel, 1930, was described from Surinam, off man, no holotype designated. Prof. Van Thiel has informed the writer in conversation that he did not have a particular specimen in mind when describing the species. Topotypic specimens, identified by Van Thiel, are in the Rijksmuseum van Natuurlijke Historie, and the Instituut voor Hygiene en Tropische Geneeskunde, Leiden.

Trombicula hominis Ewing, 1933, was described from five specimens from Aguabuenas, Republica de Panama, taken from the ear and scalp of a child by L. H. Dunn, no holotype designated. Cotypes are in the U. S. National Museum, no. 1065.

Trombicula pastorae Boshell and Kerr, 1942, was described from ten specimens from Landázuri, Municipio de Bolívar (Santander), Colombia, altitude 1,000 meters, off domestic chicken ("pollo domestico"). Three "cotypes" are deposited in the U. S. National Museum, no. 53016; two paratypes in the Museum of Comparative Zoölogy, Harvard College, no. 3002; and two paratypes in the British Museum (Natural History), nos. 1938-12-19-7 and 8.

The material on which Michener's studies and synonymy were based is deposited in the American Museum of Natural History, New York City; the U.S. National Museum; and the Gorgas Memorial Laboratory, Panama City, R. de P.

The material from French Guiana, recorded by Floch and Abonnenc as *Trombicula flui,* is in the Institut Pasteur, Paris.

GEOGRAPHICAL DISTRIBUTION:

Surinam	Type locality
Surinam: Paramaribo, Kwatta, Duisberg, Mattonshoop, Leiding, Uitvlugt, l'Hermitage	Van Thiel and Van Omneren (1940)
French Guiana: Cayenne; unspecified localities	Floch and Abonnenc (1941)
Colombia: Landázuri, Mun. Bolívar (Santander) Restrepo (Meta)	Boshell and Kerr (1942)
Panama: Aguabuenas	Ewing (1933)
Colon Province	Michener (1946)
Panama Province	Michener (1946)
Mexico: Puebla	Islas (1943)
Puerto Rico: Guaynabo, Mayaguez	Ewing (1943)
United States: Florida, Alabama	Ewing (1943)

Certain geographical records have been purposely omitted from the above list. Oudemans (1926) gives a quotation from Salmon, 1743, "Modern History: or, the Present State of all Nations &c.", London, vol. 3, pp. 419, 420, 487. Oudemans gives Salmon's references to "red-worms" attacking human beings in Virginia and New England and refers this red-worm to

Acarus batatas Linnaeus. Since the species commonly attacking man in Virginia is *E. alfreddugèsi* (Oudemans, 1910), and since authentic records for *E. batatas* are from only the extreme southeastern portion of the United States, the writer believes that the inclusion of Virginia and New England in the recorded distribution should await further field work. Furthermore, it must be realized that when Oudemans (1926, 1929, 1937) included the following localities in the distribution of this species, the basis was an assumption, for accurately determined specimens of this species have not yet been taken from human beings there: Barbados ("Potato-Louse"); Martinique ("Bête rouge"); Jamaica; Peru; Brazil ("Mucuim").

RECORDED HOSTS:

Man, *Homo sapiens* Linnaeus	Rolander (unpublished, see below)
Horse	Ewing (1933)
Goat	Michener (1946)
Dog	Michener (1946)
Rat	Michener (1946)
Donkey	Floch and Abonnenc (1941)
Domestic cattle	Michener (1946)
Forest rabbit, *Sylvilagus gabbi*	Michener (1946)
Birds:	
Domestic chicken, *Gallus domesticus*	Van Thiel and Van Ommeren (1940); Boshell and Kerr (1942); Michener (1946)
Undetermined bird, *Turdus* sp.?	Floch and Abonnenc (1941)
"Gallineta", *Numida meleagris* ssp.	Boshell and Kerr (1942)
Sturnella magna argutula	Ewing (1943)
Toxostoma rufum	Ewing (1943)
Chaemopelia rufipennis	Michener (1946)
Crotophaga ani	Michener (1946)
Tapera naevia	Michener (1946)
Aramides cajanea	Michener (1946)
Florida caerulea	Michener (1946)
Troglodytes musculus	Michener (1946)
Myiochanes cinereus	Michener (1946)
Tyrannus melancholicus	Michener (1946)
Reptiles:	
Lizard ("Hagedis")	Van Thiel and Van Ommeren (1940)

MEDICAL IMPORTANCE: This species has been identified as attacking human beings in Surinam (Dutch Guiana), French Guiana, Mexico, and various localities in Panama. Michener (1946, p. 107) noted that on children wearing only loose clothing, over eighty per cent of the larvae were attached in the groin and axillae. Van Thiel and Van Ommeren (1940) have devoted particular attention to this species in Surinam, where they found it and

T. vanommereni (Schierbeek, 1937) to be the two species attacking man. The latter constituted an average of 2.5 per cent and never more than five per cent of the larvae recovered from school children during more than one year of study. *E. batatas* (Linnaeus, 1758) was commonly found in open fields, where *Ipomoea batatas* and *Vigua sinensis* were cultivated. They were unable to explain its association with this biotope. Many worthwhile observations on rate of locomotion, site of attachment, symptoms, and clinical course of the lesions, are included in their paper.

As recorded for many other species of trombiculid mites, a "histosiphon" is produced in the skin. This is a product of host reaction, with coagulation necrosis of surrounding tissue, as indicated by the studies and conclusions of Van Thiel and Van Ommeren, not a structure extruded by the mite, as erroneously figured many years ago by Trouessart. Van Thiel and Van Ommeren figured objects in a photomicrograph of a section of the intestinal tract of a larva (fig. 16), which they interpreted as human erythrocytes. However, the writer is not convinced by their photomicrograph, for the possibility of artefact has not been excluded, and he believes that further studies are necessary before one can be certain that these mites actually suck blood. These authors reported finding the larvae actually under the skin of the prepuce. This remarkable finding is illustrated by a photomicrograph (fig. 11), and the observation is worthy of further study. It has not been reported for any other species of trombiculid mite.

The published suggestions that this mite acts as a vector of several human pathogens are without the support of positive experimental evidence. Its potentialites as a disease vector are unknown, and worthy of investigation.

REMARKS: Linnaeus described this species as follows: "Acarus sanguineus scabriusculus, pedibus anterioribus longitudine corporis. *Rolander. Habitat in Batatas* Surinami". The italics and capitals are those of Linnaeus. Oudemans (1912, p. 3) wrote: "Das Werk Rolander's kenne ich nicht." and subsequent accounts of the species have not elucidated this matter.

The writer is indebted to Dr. Bjørn Heilesen, of Copenhagen, Denmark, for the following pertinent information. Daniel Rolander's original diary is in the Botanical Library of Copenhagen University. The title is "Diarium Surinamicum, quod sub itinere exotico conscripsit". It is written in longhand with rather pale ink on yellow paper, comprising more than six hundred pages (folio). According to the diary, Rolander left Stockholm, Sweden, in October, 1754, and it contains his observations during his journey for the succeeding two years. In 1774, many corrections were made in the diary by C. F. Rottböll.

In December, 1755, Rolander recorded observations on scabies and on

the mite which Linnaeus named *Acarus batatas*. His notes on the latter (pp. 445-446) are quoted verbatim herewith:

"*Decembris* 8 nox et dies (cum) nubibus sparsis: pluvia parva ad meridiem. Therm. grad. 28½ supra punct. congelationis. *Acarus* sangvineus, vulgo Batat-luis, quia in Convolvolo batatas frequens invenitur, magnitudine et ratione vivendi cum Acaro crascras convenit; a quo tamen differt corpore scrabriusculo, sangvineo, pilis destituto, et pedibus anticis corporis longitudine, seu reliquis longioribus. Nigritis famulis inprimis odiosum est hoc Insectum; sub cutem enim eorum vivere, sangvinem sugere, vulneraque scabiei inducere solet. Circa hoc anni tempus vulgatissimum deprehenditur. Aciculis illud e carne, et cute, eximere promtissime norunt Nigritae. Femina Nigrita erat, quae hodie decem e brachio Nigritae puere eximebat. Alias occidi atque fugari solet vino Sacchari combusto, in quo pauxillum resinae Camphorae solutum est".

The writer has placed the word cum in parentheses to indicate its subsequent insertion by Röttboll. Probably "scrabriusculo" is an error for scabriusculo. Rolander's remark that this mite was especially common in December is of interest in view of the large number of this species collected during January in the series reported by Van Thiel and Van Ommeren (1940, table 1).

For many years the specific identity of Linnaeus' species remained a mystery and Vitzthum (1929, p. 235) wrote aptly: "Ein Zoologe hat ihn noch nicht untersucht". This statement was a succinct summary of the problem at that time. Van Thiel (1930) felt that the name *batatas* applied to a doubtful species, and he pointed out the incorrectness of the synonymy published by Oudemans (1927). Van Thiel (1930) described and figured a mite collected from human beings in Surinam by P. C. Flu, under the name, *Trombicula flui*. As pointed out by Michener (1946), Van Thiel's figures of his species were not altogether accurate, and the present writer has confirmed these inaccuracies in examining some of Van Thiel's specimens from Surinam. Ewing (1933), in figuring *Trombicula hominis,* did not show the long, nude setae on tibia and tarsus III. The identity of Van Thiel's and Linnaeus' species was first suggested by Schierbeek (1937, 1938), and later by Van Thiel and Van Ommeren (1940). Michener published detailed synonymy of this species (1946), but he did not have an opportunity to examine specimens from Surinam. Michener kindly loaned the writer some of his Panama specimens of *Eutrombicula batatas* (Linnaeus, 1758). These were compared by the writer with topotypic specimens of *T. flui* Van Thiel, 1930; with specimens from French Guiana identified as *T. flui* by Floch and Abonnenc (1941); with cotypes of *T. hominis*

Ewing, 1933, and with cotypes and paratypes of *T. pastorae* Boshell and Kerr, 1942. As far as one can observe, they are all indistinguishable. Hence the writer's studies merely confirm the conclusions of his predecessors.

In common with many other species that attack man, *E. batatas* (Linnaeus, 1758) accepts a wide variety of hosts in nature. Detailed information concerning sites of attachment to natural hosts is given by Michener (1946). It is of particular interest that he found the little blue heron, *Florida caerulea,* to be an important host, noting that some of the inviduals examined had nearly one thousand larvae on them. He stated his belief that this might be of importance in connection with an understanding of the survival of the species during the dry season in Panama. He thought it probable that *E. batatas* passed the dry season in damp, grassy areas along streams frequented by herons and other birds, becoming reestablished each wet season in the higher areas away from streams by movements of infested birds. The writer ventures the suggestion that an analogous line of thought may be applicable to some of the problems of local distribution of scrub typhus vectors in the Far East.

Detailed information on the life history, and figures and descriptions of the nymphal and adult stages, are to be found in the papers by Michener (1946).

The present writer's list of references is admittedly incomplete. For many additional earlier references, the reader is referred to Oudemans (1926, 1929, 1937).

Dr. Dale W. Jenkins has recently shown the writer that the type material of *E. brasiliensis* (Ewing, 1925) is indistinguishable from *E. batatas* (Linnaeus, 1758), and consequently Ewing's species must be regarded as a synonym.

Genus **Crotiscus** Ewing, 1944

Genotype: *Trombicula desdentata* Boshell and Kerr, 1942, by original designation.

1944. *Crotiscus* Ewing, Proc. biol. Soc. Wash., *57,* p. 102.
1944. *Crotiscus* Ewing. Ewing, J. Parasit., *30,* no. 6, p. 346.

When this genus was established, it was monotypic. Ewing stated: "It is most nearly related to *Trombicula* Berlese *sensustricto,* from which it differs in having the palpal claw simple and the number of dorsal setae less than 22". The writer regards the number of dorsal setae as having dubious generic value, but the distinctive palpal claw is noteworthy. The chelicerae

are reminiscent of *Eutrombicula*. The presence of a long, nude, whip-like seta on tarsus III is shared by the present genus and *Eutrombicula*.

The type species has been studied by the writer. It was described from nine specimens from Landázuri, Municipio de Bolívar (Santander), Colombia, altitude 1,000 meters, off *Proechimys chrisaeolus*. There are three "cotypes" in the United States National Museum, no. 53012; and two paratypes in the British Museum (Natural History), nos. 1938-12-19-3 and 4.

The species described by Oudemans as *Microthrombidium thomasi* is hereby included in *Crotiscus* for the first time. It is quite similar to the genotype, but it is easily distinguished by its much larger scutum and longer dorsal setae. The measurements recorded for *C. desdentata* (Boshell and Kerr, 1942), were made on a paratype in the British Museum (Natural History).

Key to the Described Species of the genus *Crotiscus* Ewing, 1944.

	C. desdentata	*C. thomasi*
AW	60	81-84
PW	78	104-112
SB	29	45-49
ASB	24	24-28
PSB	24	35-38
AP	25	29-36
AM	27	59-70
AL	35	42-50
PL	43	60-70
SENS	57	76-87
DSA	29	52-60
DSP	34	42-49

Crotiscus thomasi (Oudemans, 1910)

1910. *Microthrombidium thomasi* Oudemans, Ent. Ber., *3,* no. 54, p. 84.
1912. *Microthrombidium thomasi* Oudemans. Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 28-31, 189, 202; fig. G.
1921. *Microtrombidium* (sic) *thomasi* Oudemans. Toomey, Urol. Cut. Rev., *25,* p. 606.
1928. *Trombicula thomasi* (Oudemans). Methlagl, Denkschr. Akad. Wiss. Wien, *101,* pp. 216, 223, 224.
1928. *Trombicula thomasi* (Oudemans). Ewing, Proc. ent. Soc. Wash., *30,* no. 5, p. 77.
1929. *Microthrombidium Thomasi* Oudemans. André, Bull. Mus. Hist. nat. Paris, 2e sér., *1,* no. 6, p. 405.
1931. *Trombicula thomasi* (Oudemans). Ewing, Proc. U.S. nat. Mus., *80,* no. 2908, Art. 8, p. 10.
1942. *Trombicula thomasi* (Oudemans). Radford, Parasitology, *34,* no. 1, p. 57, fig. 2.
1945. *Otonyssus thomasi* (Oudemans). Buitendijk, Zool. Meded., *24,* p. 338.

This species is represented in the Oudemans collection by two specimens mounted on one slide, bearing the data of the original series. They are not

types. The writer has also studied the types in the Trouessart collection in the Muséum National d'Histoire Naturelle, Paris.

DIAGNOSIS: The body of these specimens is ovoid in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. A well developed ocular shield is situated on either side of the scutum, near the posterior corners. It bears well developed eyes, of which the anterior one is slightly larger. The scutum is of the shape depicted by Oudemans (1912, fig. G 1), except that he has shown the pseudostigmata located farther forward than they actually are. (See measurements). The posterior scutal margin is broadly rounded, not angulate, and its edge is uneven. The five normal scutal setae bear short cilia. The pseudostigmatic organs bear cilia on the distal two-thirds of their shafts.

The palpal claw is a simple, curved, pointed structure, without accessory prongs. Each chelicera bears a sharp, dorsal, subapical, recurved toothlet, and a ventral, mesial, gouge-like process.

The dorsal setae are similar in form to the posterior lateral scutal setae, although shorter. The anterior dorsal setae are longer than the posterior ones. They are arranged: 2 — 6 — 6 — 2 — 4 — 2, or 2 — 6 — 6 — 4 — 4, the total number being constant in the series studied. There are two sternal setae between coxae I and two between coxae III. The remainder of the ventral setae are arranged 6 — 4 — 2, becoming longer posteriorly.

The seta on palpal segment I bears five or six long, delicate cilia, which become shorter distally. The seta on segment II bears numerous cilia, and it is bushy in appearance. The seta on segment III bears three or four delicate lateral cilia. On segment IV, the dorsal and lateral setae are nude, while the ventral seta is coarser and bears three or four long branches. Segment V bears a basal, ventral, striated seta, an apical nude seta, and four or five plumose setae of various forms. The galeal seta is relatively long, with two rather short lateral branches, which arise proximal to the mid-point of the shaft.

The coxae are unisetose. Tarsus III requires special comment, for Oudemans figured it with a nude, subterminal, dorsal seta, which the writer was unable to find. However, it does possess a rather short, fine, nude, whip-like seta, located proximal to the mid-point of the tarsal segment. These observations were kindly confirmed by Dr. Marc André, when he and the writer examined the types in Paris, and they apply likewise to the specimens in Leiden. The vestiture of the remainder of the leg segments is not remarkable.

Measurements on eight specimens have been recorded by the writer. The first two represent the dorsal and ventral specimens on the cotype slide

and the next four refer to specimens in Paris. The last two sets of measurements refer to the specimens in the Oudemans collection.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
83	108	48	25	38	34	70	46	70	76	52	48
84	105	48	25	35	31	—	42	—	—	—	—
84	106	45	28	36	29	59	48	64	—	55	46
81	104	46	24	36	32	—	45	70	—	60	49
81	104	45	28	38	31	57	46	59	—	56	46
84	108	49	28	36	31	—	50	60	—	—	49
81	106	46	27	38	36	63	48	63	87	57	42
84	112	46	29	38	32	63	49	66	—	56	49

TYPE MATERIAL: Described from Peru, no specific locality, off *Akodon jelskii* O. Thomas. A slide bearing two cotypes, labelled as type in Oudemans' handwriting, is in the Trouessart collection, Muséum National d'Histoire Naturelle, Paris. Four additional specimens, not labelled as types, are in the same collection. Two specimens in the Oudemans collection have been noted above.

REMARKS: This species is known only from the original series, and it is easily separated from the genotype of *Crotiscus* by the scutal differences mentioned above.

Genus **Schöngastia** Oudemans, 1910

Genotype: *Thrombidium vandersandei* Oudemans, 1905, by original designation.

1910. *Schöngastia* Oudemans, Ent. Ber., *3,* no. 54, p. 86.
1912. *Schöngastia* Oudemans. Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp 45-67.
1921. *Schoengastia* (sic) Oudemans. Toomey, Urol. and Cutan. Rev., *25,* p. 606.
1925. *Schöngastia* Oudemans. Ewing, Amer. J. trop. Med., *5,* no. 3, pp. 260-262.
1927. *Schöngastia* Oudemans. Stiles and Hassall, Hyg. Lab. Bull. no. 148, p. 268.
1927. *Trombicula* (*Schöngastia*) —. Walch, Geneesk. Tijdschr. Ned. Ind., *67,* pp. 927-928 (reduced to subgeneric rank).
1928. *Schöngastia* Oudemans. Methlagl, Denkschr. Akad. Wiss. Wien, *101,* p. 214.
1929. *Schöngastia* —. Stiles and Nolan, Hyg. Lab. Bull. no. 152, pp. 484-485.
1929. *Schöngastia* Oudemans. Ewing, Manual of External Parasites, pp. 22, 27, 28, 188 (restricted).
1929. *Schöngastia* Oudemans. Hirst, Proc. zool. Soc. Lond., 1929, pp. 174-176.
1931. *Schöngastia* Oudemans. Vitzthum, Kükenthal's Handbuch der Zoologie, *3,* 2nd half (9), pp. 63, 146.
1931. *Schöngastia* Oudemans. Ewing, Proc. U.S. nat. Mus., *80,* no. 2908, Art. 8, p. 2.
1932. *Schöngastia* Oudemans. Gater, Parasitology, *24,* no. 2, pp. 153-156.
1934. *Schöngastia* Oudemans. Womersley, Rec. S. Aust. Mus., *5,* no. 2, p. 214-217.
1935. *Schöngastia* Oudemans. Sig Thor, Zool. Anz., *109,* nos. 5/6, p. 110.
1937. *Schöngastia* Oudemans. Womersley, Rec. S. Aust. Mus., *6,* no. 1, pp. 80, 81.

1938. *Schöngastia* Oudemans. Neveu-Lemaire, Traité d'Entomologie etc., pp. 479, 494.
1938. *Schöngastia* Oudemans. Ewing, J. Wash. Acad. Sci., *28*, no. 6, p. 290.
1939. *Schöngastia* Oudemans. Torres and Braga, Bol. Sec. Agr. Indust. Com., *4*, pp. 39, 42.
1939. *Schöngastia* Oudemans. Gunther, Proc. Linn. Soc. N. S. W., *64*, pts. 1-2, nos. 281-282, pp. 91-94.
1939. *Schöngastia* Oudemans. Womersley, Trans. roy. Soc. S. Aust., *63*, pt. 2, p. 166.
1940. *Schöngastia* Oudemans. Neave, Nomenclator Zoologicus, IV, p. 140.
1941. *Schöngastia* —. Vitzthum, Bronns Klassen und Ordnungen des Tierreiches, Bd. 5, Abt. IV, Buch 5, Lfg. 4, p. 624.
1942. *Schöngastia* Oudemans. Vitzthum, *op. cit.*, Lfg. 6, p. 829.
1942. *Schöngastia* Oudemans. Radford, Parasitology, *34*, no. 1, pp. 67-68, 78.
1943. *Schöngastia* Oudemans. Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67*, no. 1, pp. 102-106.
1944. *Schöngastia* Oudemans. Womersley, Trans. roy. Soc. S. Aust., *68*, no. 1, pp. 96-99.
1944. *Schöngastia* Oudemans. Ewing, J. Parasit., *30*, no. 6, p. 345.
1945. *Schöngastia* Oudemans. Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, pp. 14, 58, 69-72; fig. 36.
1946. *Schöngastia* Oudemans. Taylor, Comm. Aust. Serv. Publ. no. 6, pp. 147, 178-184.
1946. *Schöngastia* Oudemans. André, Bull. Mus. Hist. nat. Paris, 2e sér., *18*, no. 1, pp. 53-55.

In his original description of the genus, Oudemans separated a group of species with clavate ("kolfvormige") pseudostigmatic organs from those in which these structures are flagelliform. He stated that he knew five species with clavate pseudostigmatic organs, but specified only the genotype by name. In 1912 he included four species: *S. vandersandei* (Oudemans, 1905); *S. cercopitheci* (Trägårdh, 1904); *S. trouessarti* (Oudemans, 1910); and *S. berlesei* (Oudemans, 1909). At present *S. trouessarti* is assigned to the genus *Euschöngastia* Ewing, 1938. According to the figures published by Berlese, *S. berlesei* has clavate pseudostigmatic organs, but the scutum and chelicerae are inadequately figured and described to permit precise generic assignment, and the writer regards it as a species incertae sedis.

Ewing (1929) restricted *Schöngastia* to species with serrate chelicerae, clavate pseudostigmatic organs, and five normal scutal setae. He proposed *Neoschöngastia* for the species in which the chelicerae are not serrate.

The following characters are shared by the genotype and those species on which data are adequate to permit definite generic assignment: eyes present; pseudostigmatic organs clavate; dorsal margin of chelicerae bearing several teeth, i.e., serrate; tarsus III bearing a single long, nude, whip-like seta, in addition to the usual plumose setae. Of the various species which have been described or placed in this genus, the following ones can be definitely assigned to it:

Species	Remarks
S. cercopitheci (Trägårdh, 1904)	Seen
S. schüffneri (Walch, 1922)	Seen

Syn.: *S. pusilla* Womersley, 1944	Seen
S. minor U.S. Army Med. Dept., 1944: nomen nudum	
S. taylori Gunther, 1940	Seen
S. vandersandei (Oudemans, 1905)	Seen
Syn.: *S. yeomansi* Gunther, 1938: nomen nudum	
S. blestowei Gunther, 1939	Seen
S. vieta Gater, 1932	Seen
Syn.: *S. maldiviensis* Radford, 1946	Seen
S. katonis Womersley and Heaslip, 1943	Not seen
S. jamesi Gunther, 1939	Not seen
Syn.: *S. rotunda* Gunther, 1938: nomen nudum	
S. vandersandei var. *megapodius* Womersley and Heaslip, 1943	Not seen
S. philipi Womersley and Kohls, 1947	Not seen
S. pseudo-schüffneri (Walch, 1927)	Not seen

In addition to listing the above species, it is necessary to discuss the following. *S. oudemansi* (Walch, 1922) is made the type of a new genus elsewhere in this paper. *S. pillersi* Sambon, 1928, and *S. madagascariensis* Sambon, 1928, are hereby transferred to the genus *Endotrombicula* Ewing, 1931, based on the writer's comparison of specimens with examples of *E. penetrans* Ewing, 1931, the genotype. Since *S. lynni* Ewing, 1942, was described from a specimen in which the pseudostigmatic organs were missing, its generic assignment is doubtful. Finally, McCulloch (1946, Med. J. Aust., 33rd year *1*, no. 21, p. 727) mentioned *Schöngastia parva,* citing Womersley MS. As it stands, *Schöngastia parva* McCulloch, 1946, is a nomen nudum.

In attempting to make a key to species, the writer has included only those on which his information is adequate.

Key to the Described Species of the Genus *Schöngastia* Oudemans, 1910.

1. AL setae shorter than AM or PL setae (after Womersley and Heaslip, 1943) *S. jamesi* Gunther 1939
   AL setae not the shortest of the normal scutal setae 2
2(1). Total dorsal abdominal setae more than seventy in number . . . . . *S. taylori* Gunther, 1940
   Total dorsal abdominal setae fewer than sixty in number 3
3(2). Chelicerae 80-84 micra in length; AW 70; PW 100 . . . . . *S. vandersandei* (Oudemans, 1905)
   Chelicerae less than 60 micra in length; AW less than 60; PW less than 80 . 4
4(3). Chelicerae more than 50 micra in length, bearing about nine teeth, which commence 28 micra from the tip, and increase in size distally . . . . . *S. schüffneri* (Walch, 1922)
   Chelicerae less than 40 micra in length, bearing four to eight teeth of irregular sizes, commencing 16 micra from the tip . . . . *S. vieta* Gater, 1932

Schöngastia vandersandei (Oudemans, 1905) (fig. 3)

1905. *Thrombidium vandersandei* Oudemans, Ent. Ber., *1*, no. 22, pp. 216-217.
1906. *Allothrombidium vandersandei* (Oudemans). Oudemans, Ent. Ber., *2*, no. 28, pp. 56-58.

1906. *Thrombidium van der Sandei* Oudemans. Oudemans, Nova Guinea, Acari, *5,* pp. 106, 131-132; pl. III, figs. 59-66.
1908. *Thrombidium van der Sandei* Oudemans. Oudemans. Tijdschr. Ent., *51,* no. 1, pp. 25-27.
1909. *Thrombidium vandersandei* Oudemans. Oudemans, Tijdschr. Ent., *52,* nos. 1/2, pp. 50-52, 55.
1909. *Trombidium (Heterotrombidium) Vandersandei* Oudemans. Verdun, C. r. Soc. Biol. Paris, *67,* p. 246.
1909. *Microthrombidium vandersandei* (Oudemans). Oudemans, Ent. Ber., *3,* no. 50, p. 21.
1910. *Schöngastia vandersandei* (Oudemans). Oudemans, Ent. Ber., *3,* no. 54, p. 86.
1910. *Trombidium van der Sandei* Oudemans. Brumpt, Précis de Parasitologie, 1e ed., p. 507.
1912. *Schöngastia vandersandei* (Oudemans). Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 45-62, 190, 191, 202.
1913. *Schöngastia van der sandei* (Oudemans). Brumpt, Précis de Parasitologie, 2e ed., p. 567.
1913. *Trombidium vandersandei* Oudemans. Galli-Valerio, Zbl. Bakt., 1 Abt. Ref., *56,* nos. 5/6, p. 132.
1917. *Schöngastia vandersandei* (Oudemans). Hirst, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 6, p. 26.
1918. *Schöngastia vandersandei* (Oudemans). Ewing and Hartzell, J. econ. Ent., *11,* no. 2, p. 260.
1921. *Schoengastia* (sic) *vandersandei* (Oudemans). Toomey, Urol. and Cutan. Rev., *25,* p. 606.
1922. *Schöngastia Van der Sandei* (Oudemans). Brumpt, Précis de Parasitologie, 3e ed., p. 733.
1922. *Thrombidium van der Sandei* (Oudemans). Walch, Geneesk. Tijdschr. Ned. Ind., *62,* no. 5, pp. 546, 550; tables II, III.
1923. *Schöngastia van der Sandei* (Oudemans). Salm, Bull. Soc. Path. exot., *16,* no. 5, p. 339.
1923. *Trombicula van der Sandei* (Oudemans). Walch, Kitasato Arch., *5,* no. 3, pp. 66, 68.
1927. *Trombicula vandersandei* (Oudemans). Stiles and Hassall, Hyg. Lab. Bull. no. 148, pp. 268, 269.
1927. *Schöngastia Vandersandei* (Oudemans). Lahille, Bol. Inst. Clin. quir. B. Aires, *3,* p. 773.
1927. *Schöngastia vandersandei* (Oudemans). Sambon, Ann. Mag. nat. Hist., 9th ser., *20,* no. 115, p. 161.
1928. *Microtrombidium vandersandei* (Oudemans). Warburton, Parasitology, *20,* no. 2, p. 228.
1929. *Trombicula vandersandei* —. Patton and Evans, Insects, Mites, etc., pp. 651, 658.
1929. *Schöngastia vandersandei* (Oudemans). Vitzthum, Z. Parasitenk., *2,* Heft 2, p. 236.
1930. *Schöngastia Vandersandei* (Oudemans). André, Mém. Soc. zool. France, *29,* no. 2, p. 70.
1931. *Schöngastia vandersandei* (Oudemans). Vitzthum, Kükenthal's Handbuch der Zoologie, *3,* 2nd half (9), p. 127.
1934. *Trombicula vandersandei* —. Stiles and Baker, Nat. Inst. Hlth. Bull. no. 163, p. 1012.
1938. *Schöngastia van der Sandei* (Oudemans). Neveu-Lemaire, Traité d'Entomologie etc., p. 494.
1938. *Schöngastia yeomansi* Gunther, Med. J. Aust., 25th year *2,* no. 6, p. 204: nomen nudum.

1939. *Schöngastia blestowei* Gunther, Proc. Linn. Soc. N. S. W., *64,* pts. 1-2, nos. 281-282, pp. 92-94; figs. 31, 34, 37 (equals *Schöngastia yeomansi* Gunther, 1938: nomen nudum).
1939. *Schöngastia van der sandei* (Oudemans). Womersley, Trans. roy. Soc. S. Aust., *63,* pt. 2, p. 166.
1939. *Schöngastia blestowei* Gunther. Womersley, *op. cit.,* p. 166.
1940. *Schöngastia blestowei* —. Gunther, Proc. Linn. Soc. N. S. W., *65,* pts. 3-4, nos. 289-290, p. 251.
1940. *Schöngastia blestowei* Gunther. Gunther, Med. J. Aust., 27th year *2,* no. 22, p. 569.
1940. *Schöngastia vandersandei* (Oudemans). Gunther, *op. cit.,* p. 569.
1941. *Schöngastia blestowei* Gunther. Gunther, Proc. Linn. Soc. N. S. W., *66,* pts. 5-6, nos. 297-298, p. 391.
1941. *Schöngastia vandersandei* (Oudemans). Gunther, *op. cit.,* p. 394.
1941. *Schöngastia vandersandei* —. Floch and Abonnenc, Inst. Past. Guyane et du Terr. de l'Inini, Publ. no. 20, pp. 14, 16.
1941. *Schöngastia vandersandei* (Oudemans). Vitzthum, Bronns Klassen und Ordnungen der Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 4, p. 624.
1942. *Schöngastia blestowei* Gunther. Gunther, Proc. Sixth Pacific Sci. Congr. (1939), p. 718.
1942. *Schöngastia vandersandei* (Oudemans). Radford, Parasitology, *34,* no. 1, p. 67.
1942. *Schöngastia blestowei* Gunther. Radford, *op. cit.,* p. 68; fig. 61.
1943. *Schöngastia blestowei* Gunther. Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 103-104; pl. VI, fig. 4.
1943. *Schöngastia vandersandei* (Oudemans). Womersley and Heaslip, *op. cit.,* p. 106; pl. VI, fig. 8.
1944. *Schöngastia blestowei* Gunther. McCulloch, Med. J. Aust., 31st year *2,* no. 21, p. 545.
1944. *Schöngastia blestowei* Gunther. Womersley, Trans. roy. Soc. S. Aust., *68,* no. 1, pp. 97-98 (equals *Schöngastia yeomansi* Gunther, 1938: nomen nudum).
1945. *Schöngastia vandersandei* (Oudemans). Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, p. 69; fig. 37.
1945. *Schöngastia blestowei* Gunther. Finnegan, *op. cit.,* pp. 34, 70; fig. 40.
1945. *Schöngastia blestowei* Gunther. Blake, Maxcy, Sadusk, Kohls and Bell, Amer. J. Hyg., *41,* no. 3, pp. 275, 293, 294, 295, 299, 301-302.
1945. *Schöngastia blestowei* Gunther. Blake, Maxcy, Sadusk, Kohls and Bell, Science, *102,* no. 2638, pp. 61-64.
1945. *Schöngastia blestowei* —. Blake, Maxcy, Sadusk, Kohls and Bell, Amer. J. publ. Hlth., *35,* no. 11, p. 1127.
1945. *Schöngastia blestowei* Gunther. Kohls, Armbrust, Irons and Philip, Amer. J. Hyg., *41,* no. 3, pp. 380-381.
1945. *Schöngastia vandersandei* (Oudemans). Buitendijk, Zool. Meded., *24,* p. 336.
1946. *Schöngastia blestowei* Gunther. Taylor, Comm. Aust. Serv. Publ. no. 6, pp. 178, 180-181, 268; pl. II, fig. 4.
1946. *Schöngastia vandersandei* (Oudemans). Taylor, *op. cit.,* pp. 178, 182; pl. II, fig. 8.
1946. *Trombicula vandersandei* —. Taylor, *op. cit.,* p. 268.
1946. *Schöngastia Vandersandei* (Oudemans). André, Bull. Mus. Hist. nat. Paris, 2e sér., *18,* no. 1, p. 53.
1946. *Schöngastia blestowei* Gunther. Bushland, Amer. J. Hyg., *43,* no. 3, pp. 219, 231-232.
1946. *Schöngastia blestowei* Gunther. McCulloch, Med. J. Aust., 33rd year *1,* no. 21, pp. 719, 722, 736; figs. III, IV.
1946. *Schöngastia blestowei* Gunther. Bushland, J. econ. Ent., *39,* no. 3, pp. 344-347.
1946. *Schöngastia blestowei* Gunther. Wharton, Proc. ent. Soc. Wash., *48,* no. 7, p. 175.

1947. *Schöngastia blestowei* —. Mohr, Ecology, *28,* no. 2, pp. 194-199.
1947. *Schöngastia blestowei* Gunther. Fuller, Amer. J. Hyg., *45,* no. 3, p. 369.
1947. *Schöngastia vandersandei* (Oudemans). Dumbleton, Trans. roy. Soc. N. Z., *76,* pt. 3, p. 413 (equals *Schöngastia blestowei* Gunther, 1939, synonym).
1947. *Schöngastia blestowei* —. Southcott, Med. J. Aust., 34th year *2,* no. 15, p. 446.

This species is represented in the Oudemans collection by a slide, labelled type and bearing the following data in Oudemans' handwriting: "Ned. N.-Guinea Exped. 1903. Op de beenen van europeanen zoodra zij door de bosschen loopen". (On the legs of Europeans after walking through the woods). There are two specimens on this slide, one mounted with the dorsum facing the cover slip, and the other with the ventral surface facing the cover slip. Since these represent two different species, the writer hereby designates the ventral specimen as lectotype, as it conforms to Oudemans' description of this species. It is in good condition for study, except that the pseudostigmatic organs are missing. The other specimen (dorsal mount; pseudostigmatic organs present; chelicerae missing) is *S. schüffneri* (Walch, 1922), and it is discussed under that species. It is likely that confusion in this genus has resulted in part from the fact that Oudemans' original material was a composite. Since *S. vandersandei* is the genotype, it seems wise to place it on a firm basis by designating this lectotype.

The writer has also compared specimens, nominally *S. blestowei* Gunther, 1939, from Dobadura and Hollandia, New Guinea, with this lectotype. They were then compared with specimens from Dumpu and Lae, New Guinea (collected by McCulloch), and with paratypes of *S. blestowei* in the British Museum (Natural History). The writer's synonymy is based on these comparisons. The following remarks are based mainly on the lectotype in the Rijksmuseum van Natuurlijke Historie.

DIAGNOSIS: The slightly engorged larva is oval and flattened dorsoventrally. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. On either side of the scutum, in close apposition to it, is a well developed ocular shield, bearing two eyes which are close together. The anterior eye is larger and its cornea is more distinct; the posterior eye, located at the level of the posterior lateral setal pore, is smaller and less well developed. The outline of the scutum is that depicted by Oudemans (1906, pl. III, fig. 59). The actual degree of sinuation of the posterior margin is variable in the additional New Guinea specimens seen by the writer. On the lectotype, the ultimate points of attachment of the pseudostigmatic organs are in the line of the posterior lateral setal pores. In some other New Guinea specimens, they are very slightly behind this line, but this feature is variable within a series. There are "eyebrows" over the pseudostigmata, and in some

specimens, one sees a diagonal line behind each pseudostigma. The scutum is covered with stippling of uniform size. The normal scutal setae bear long cilia arising from several sides of the shaft. These cilia are easily broken, giving the shaft of the seta a serrated appearance. As mentioned previously, the lectotype has lost its pseudostigmatic organs. On other New Guinea specimens, these structures are broadly clavate, the length of the peduncle being equivalent to the transverse diameter of the head of the fully extended organ. There are minute setae on the head. In some mounts, these setules become invisible or almost so, giving the observer the false impression that the pseudostigmatic organs are nude. This error can be avoided by careful

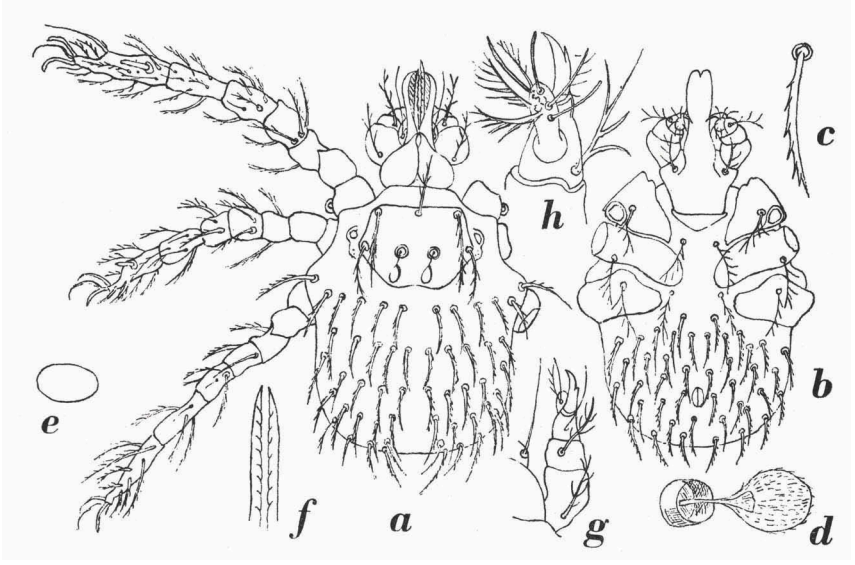

Fig. 3. *Schöngastia vandersandei* (Oudemans, 1905); *a*, dorsum; *b*, venter; *c*, dorsal seta; *d*, pseudostigmatic organ; *e*, apical view of pseudostigmatic organ; *f*, mandibles; *g* and *h*, palp (Oudemans, 1905, figs. 59-66).

observation under the oil immersion objective, and also with the aid of a phase contrast microscope.

The palpal claw is bifurcate, the main element being strongly curved inward and pointed apically. The accessory element is located lateral and ventral to the main element, being about three-fourths as long, straight, and sharply pointed. The chelicerae are distinctive in their length and dentition. On the lectotype, the distance from the posterior margin of the rounded basal portion of the movable blade to its apex is 84 micra. The length of this structure is of the same order of magnitude in other specimens examined. There are approximately fifteen teeth on the dorsal margin of each chelicera.

Those on the distal half of the blade are larger, sharp, recurved teeth, while those on the proximal half are smaller, some of them being mere notches. The blade of the chelicerae is truly reminiscent of a saw.

The dorsal setae are shorter than any of the scutal setae, and they bear fewer and shorter cilia. The dorsal setae decrease in length posteriorly. On the lectotype, they are arranged approximately: 2 — 11 — 10 — 2 — 10 — 10 — plus six posterior setae. This arrangement is variable in other New Guinea specimens, and it does not constitute a useful key character in distinguishing this species from others. There are two plumose sternal setae between coxae I and two between coxae III, each bearing long, delicate cilia that arise uniformly from a single side of the shaft. There are about twenty-two small pre-anal setae and eight stouter, longer, post-anal setae. The cilia on the pre-anal setae are long and delicate, while those on the post-anals are short and barb-like.

The seta on palpal segment I bears four or five very long, delicate cilia. Segment II is broadly rounded and plump, bearing a plumose seta whose cilia are much shorter. The seta on segment III bears two to four cilia. The dorsal and lateral setae on segment IV are nude, while the ventral seta bears three or four delicate cilia. Segment V bears a rather long, pointed, basal, ventral, striated seta; an apical, nude, pointed, spine-like seta; plus seven plumose setae of various forms. The galeal seta is nude and reaches beyond the tip of the chelicera.

Each coxa carries a single plumose seta, bearing long cilia. A long, nude, whip-like seta arises from the proximal one-fourth of tarsus III. This was neither mentioned nor figured by Oudemans (1906), although it is easily visible on the lectotype and on all other specimens examined. The vestiture of the remainder of the leg segments is not remarkable.

The following measurements concern: first, the lectotype, then four specimens from Hollandia, one from Dobadura, one from Lae, and one from Dumpu, in that order.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
70	91	22	34	31	31	—	76	55	—	39	28
74	98	26	36	32	35	—	75	56	34 × 18	46	36
72	100	26	38	33	34	42	80	60	34 × 18	45	36
70	100	26	36	32	33	38	84	63	36 × 18	45	—
74	99	28	40	30	34	38	78	58	34 × 17	42	—
74	99	26	34	31	32	—	81	60	38 × 18	42	34
78	102	27	39	34	33	40	84	64	—	42	36
72	102	27	36	32	36	40	82	63	44 × 16	46	36

A measurement for AM is not given for the lectotype because this seta is broken.

TYPE MATERIAL: Described from specimens from Dutch New Guinea, collected during 1903, off man, by G. A. J. van der Sande, who was physician to the Netherlands New Guinea Expedition. In his original description, Oudemans did not designate a holotype. In 1906 (page 131) he mentioned forty examples, but made no reference to a type in this or subsequent accounts of the species. Buitendijk (1945) recorded the presence of type material in the Oudemans collection. The lectotype, designated in the present paper, is in the Rijksmuseum van Natuurlijke Historie. The writer has not ascertained the present existence of the remainder of the original series.

Schöngastia blestowei Gunther, 1939, was described from British New Guinea, from "fifteen specimens collected from two men near the Suein River, Sepik District; eight specimens from abandoned colonies in the ears of two bush-fowl (*Megapodius duperreyi*) from the Bulolo River Basin, Morobe District; six specimens from a man at Bulolo". Gunther stated (1939, p. 78) that type specimens of all of the new species described by him in that paper were deposited in the School of Public Health and Tropical Medicine, University of Sydney, and paratypes of all except two species were in the Australian Museum, Sydney, Australia. He did not designate a holotype specimen for this species. Womersley and Heaslip (1943) reported their examination of the type slide. They state that this slide contained ten specimens of the series from Suein River, two of which were indicated as types. Therefore, in this instance, Gunther used what the writer regards as cotypes. The writer has examined four specimens on a slide from Bulolo, Territory of New Guinea, no host data, labelled paratypes, in the British Museum (Natural History), no. 1947-3-18-8.

GEOGRAPHICAL DISTRIBUTION:

	Type locality
Dutch New Guinea (no specific locality)	
Territory of New Guinea (British):	
Suein River, Aitape District	Gunther (1939)
Bulolo River Basin, Morobe District	Gunther (1939)
Bulolo, Morobe District	Gunther (1939)
Dobadura	McCulloch (1944)
	Blake, *et al.* (1945)
Buna Area	Womersley (1944)
Donabadu	McCulloch (1946)
Lae	McCulloch (1946)
Dumpu (Ramu Valley)	McCulloch (1944)
Dutch New Guinea:	
Sansapor	Mohr (1947)
Hollandia	Bushland (1946)
Finschhafen	McCulloch (1946)
Small Island off New Guinea	Kohls, *et al.*, (1945)
Admiralty Islands: Manus	Gunther (1941)

Bougainville Island: Cape Torokina	Wharton (1946)
Stirling Island, Treasury Group	Dumbleton (1947)

RECORDED HOSTS:

Man, *Homo sapiens* Linnaeus	Type host
Felis catus	Stiles and Baker (1934)
Canis familiaris	Stiles and Baker (1934)
Echymipera cockerelli	Blake, *et al.* (1945)
Rattus concolor browni	Kohls, *et al.* (1945)
"Rats"	McCulloch (1946)
Rattus ringens	Mohr (1947)
Rattus exulans	Mohr (1947)
Aves:	
Bush fowl, *Megapodius reinwardt reinwardt* Dumont	Gunther (1938, 1939)

MEDICAL IMPORTANCE: This species has been reported from human beings in several places in New Guinea and other Pacific islands. It is a common cause of "scrub itch" in the areas where it occurs. Historical references to this condition have been summarized by Oudemans (1906, 1908, 1912), but not all of them are attributable solely to this species, since its geographical distribution is overlapped by that of *S. schüffneri* (Walch, 1922) and *Eutrombicula wichmanni* (Oudemans, 1905).

The possibility that this species may play a role in the transmission of scrub typhus has been raised by several investigators. *S. vandersandei* occurs in some of the areas from which this disease has been reported, but its recorded distribution is much more limited than that of scrub typhus. McCulloch states (1944, p. 545): "At Dumpu (Ramu Valley), however, *Schöngastia blestowei* alone was more clearly indicated as the vector (as well as the cause of itch) than was any single other species elsewhere. It was found almost everywhere in the grass country of the valley, nearly always without other species; and in several camps with a history of typhus it alone was found after most careful searching". The subject is discussed by Blake, *et al.* (1945, p. 301), who thought it quite unlikely that this species served as a vector in New Guinea, in spite of its abundance and wide distribution. It continued to be present in considerable numbers in infected localities after the incidence of cases had become sporadic or ceased altogether. There was no correlation between the incidence of scrub itch and scrub typhus. Patients with scrub typhus gave no history of itching at the site of the primary lesion. The primary lesions were found on various parts of the body, while those of scrub itch were characteristically distributed on the ankles, legs, and to a lesser extent on the lower trunk. Finally, they believed it was significant that this species was found only in small numbers and infrequently on rats.

Bushland (1946, pp. 233-234) presented data showing that this species

prefers to attach to the legs and ankles, even when men are lying down during exposure. He stated that this observation added to the evidence that this species had not been an important vector of scrub typhus in the areas of New Guinea under consideration. His observations referred to this species and to *S. schüffneri* (Walch, 1922), and he used the specific names applied by his predecessors and which have been synonymized by the writer.

Returning to McCulloch's observations, he (1946) reiterated his suggestion that this species was incriminated as a vector in the Ramu Valley, New Guinea. This was based on the fact that it alone was found in one clearly defined camp with a history of scrub typhus infection in the middle of the main valley.

The writer believes that the evidence presented by Blake, *et al.*, and by Bushland strongly suggests that *S. vandersandei* is not a vector. The matter is controversial for lack of positive evidence of naturally infected mites, or transmission by mites during feeding. Since this species attacks rats and also human beings, it may be regarded as a potential incidental vector of scrub typhus.

REMARKS: The synonymy of *S. blestowei* Gunther, 1939, was suggested to the writer by G. M. Kohls, who kindly loaned specimens collected at Dobadura and Hollandia. Womersley (1947, *in litt.*) came to the same conclusion. In his description, Gunther (1939) stated that there was a strong resemblance between his species and *S. vandersandei* (Oudemans, 1905). The writer's comparisons, referred to previously, have confirmed the synonymy suggested by Kohls and by Womersley. It should be noted that the key characters given by Womersley and Heaslip (1943, p. 102) are useless in the separation of this species from its relatives.

The origin of the name, *Schöngastia yeomansi* Gunther, 1938, is the same as that of his other *nomina nuda.*

Womersley and Heaslip (1943, p. 104) recognized a variety which they named *S. blestowei* var. *megapodius.* This was based on three of Gunther's paratypes from *Megapodius,* which exhibited differences in the scutum. Womersley (1944) presented further evidence, based on these three specimens, concluding that they should be regarded as a distinct variety. Since the writer has not examined any material, he cannot express an opinion, and Womersley's conclusion is accepted regarding the validity of this variety. Since the specific name *blestowei* was proposed by Gunther for types which are synonymous with *vandersandei,* the variety should be now known as *Schöngastia vandersandei* var. *megapodius* Womersley and Heaslip, 1943.

Biological observations have been recorded for this species. McCulloch (1946, p. 722) found that when larvae were kept in moist earth in a test

tube, the majority were alive and fully active at the end of two weeks, and some individuals lived for forty-six days. Kohls, *et al.* (1945, p. 383) found this species in particular abundance in kunai grass adjacent to jungle, and within the jungle for a distance of a few yards. There was a tendency toward highly focalized distribution. They state that moving a distance of a yard or so from a spot where the mites were abundant was sometimes sufficient to place the observer in an apparently identical area in which few or no mites at all could be found. The writer believes that the ultimate explanation for this observation is to be found in a better understanding of the ecology and behavior of these mites. It is worthy of investigation and the writer hesitates to speculate on it at this stage.

The writer has not found descriptions or figures of the nymphal or adult stages of this mite. At the time of writing, it appears to be known only in the larval stage.

Schöngastia schüffneri (Walch, 1922)

1922. *Trombicula Schüffneri* Walch, Geneesk. Tijdschr. Ned. Ind., *62*, no. 5, pp. 546-552, 553, 554, 563; tables I, II, III; figs. 2-5.
1923. *Trombicula Schüffneri* Walch, Kitasato Arch., *5*, no. 3, pp. 64, 65, 66-69; tables I, II, III; pl. I, figs. 1-4.
1924. *Trombicula schüffneri* —. Walch, Trans. 5th Bienn. Congr. Far East. Assoc. trop. Med., (1923), pp. 584, 594, 595, 598, 600, 601, 612-614; tables I, II, III; figs. 12-15, 21-23.
1924. *Trombicula Schüffneri* —. Walch and Keukenschrijver, Geneesk. Tijdschr. Ned. Ind., *64*, pp. 250, 251, 252, 256, 257, 262-263, 274.
1924. *Trombicula Schüffneri* —. Walch, Geneesk. Tijdschr. Ned. Ind., *64*, pp. 499, 500, 502, 511-514, 523; tables I, II; figs. 3-5.
1925. *Trombicula Schüffneri* —. Walch, Kitasato Arch., *6*, no. 3, pp. 240, 242-244, 252; tables III, IV; pl. III, fig. 10;; pl. IV, figs. 11, 12.
1927. *Trombicula schüffneri* Walch. Stiles and Hassall, Hyg. Lab. Bull. no. 148, p. 269.
1927. *Trombicula schüffneri* —. Walch, Geneesk. Tijdschr. Ned. Ind., *67*, pp. 922, 925-926, 927, 931, 932.
1928. *Trombicula schüffneri* Walch. Warburton, Parasitology, *20*, no. 2, p. 228.
1928. *Trombicula schüffneri* —. Fletcher, Lesslar and Lewthwaite, Trans. R. Soc. trop. Med. Hyg., *22*, no. 2, p. 170.
1929. *Trombicula schüffneri* —. Patton and Evans, Insects, Mites, etc., pp. 648, 652-653; fig. 330.
1929. *Trombicula Schüffneri* Walch. Vitzthum, Z. Parasitenk., *2*, Heft 2, p. 236.
1929. *Schöngastia schüffneri* (Walch). Hirst, Proc. zool. Soc. Lond., 1929, p. 176.
1932. *Schöngastia schüffneri* —. Fonseca, Mem. Inst. Butantan, *7*, p. 129.
1938. *Trombicula schüffneri* Walch. Neveu-Lemaire, Traité d'Entomologie etc., p. 492.
1941. *Trombicula schüffneri* —. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 4, p. 623.
1941. *Schöngastia schüffneri* (Walch). Gunther, Proc. Linn. Soc. N. S. W., *66*, pts. 5-6, nos. 297-298, p. 394.
1942. *Neoschöngastia schuffneri* (sic, no ") (Walch). Radford, Parasitology, *34*, no. 1, p. 74; fig. 85.

1943. *Neoschöngastia schuffneri* (sic, no ") (Walch). Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 107, 117; pl. VIII, fig. 8.
1944. *Neoschongastia* (sic) *minor* Anonymous, Bull. U.S. Army Med. Dept., no. 76, p. 53; one figure: nomen nudum.
1944. *Schöngastia minor* Anonymous, U.S. War Dept. Technical Bulletin, T B Med 31, p. 3; fig. 2: nomen nudum.
1944. *Schöngastia schüffneri* (Walch). Williams, Amer. J. trop. Med., *24,* no. 6, p. 356.
1944. *Schöngastia pusilla* Womersley, Trans. roy. Soc. S. Aust., *68,* no. 1, p. 96; text-fig. 6.
1944. *Schöngastia pusilla* Womersley. McCulloch, Med. J. Aust., 31st year *2,* no. 21, p. 545.
1945. *Neoschöngastia schüffneri* (Walch). Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, pp. 31, 72, 74; fig. 44.
1945. *Schöngastia schüffneri* (Walch). Blake, Maxcy, Sadusk, Kohls and Bell, Amer. J. Hyg., *41,* no. 3, p. 264.
1945. *Schöngastia pusilla* Womersley. Blake, *et al., op. cit.,* pp. 293, 294, 295, 301-302; fig. 8.
1945. *Schöngastia pusilla* Womersley. Kohls, Armbrust, Irons and Philip, Amer. J. Hyg., *41,* no. 3, pp. 380, 381, 383.
1945. *Schöngastia pusilla* Womersley. Blake, *et al.,* Science, *102,* no. 2638, pp. 61-64.
1945. *Schöngastia pusilla* Womersley. Philip and Kohls, Amer. J. Hyg., *42,* no. 2, pp. 195-203.
1945. *Schöngastia pusilla* —. Blake, *et al.,* Amer. J. publ. Hlth., *35,* no. 11, p. 1127.
1945. *Otonyssus schüffneri* (Walch). Buitendijk, Zool. Meded., *24,* p. 338.
1946. *Schöngastia pusilla* Womersley. Taylor, Comm. Aust. Serv. Publ. no. 6, pp. 183-184, 268; fig. 162.
1946. *Neoschöngastia schüffneri* (Walch). Taylor, *op. cit.,* p. 185.
1946. *Neoschöngastia schüffneri* (Walch). Radford, Parasitology, *37,* nos. 1, 2, pp. 48, 51.
1946. *Schöngastia pusilla* —. Bushland, Amer. J. Hyg., *43,* n. 3, pp. 219, 221-222, 230, 231, 232, 233-234.
1946. *Schöngastia pusilla* Womersley. McCulloch, Med. J. Aust., 33rd year *1,* no. 21, pp. 719, 722, 736.
1946. *Schöngastia pusilla* Womersley. Bushland, J. econ. Ent., *39,* no. 3, pp. 344-347.
1946. *Schöngastia schüffneri* (Walch). Wharton, Proc. ent. Soc. Wash., *48,* no. 7, p. 176.
1947. *Schöngastia schüffneri* —. Mohr, Ecology, *28,* no. 2, pp. 194-199.
1947. *Schöngastia pusilla* —. Mohr, *op. cit.,* pp. 194-199.
1947. *Schöngastia pusilla* Womersley. Fuller, Amer. J. Hyg., *45,* no. 3, p. 369.

This species is represented in the Oudemans collection by a slide labelled *Trombicula schüffneri* Walch, "Medan, Deli, 1922, Dr. E. W. Walch", bearing one specimen. As mentioned previously, there is one specimen of this species on the slide which bears the lectotype of *S. vandersandei* (Oudemans, 1905). The writer has also studied topotypic material of *S. schüffneri* in the Instituut voor Hygiene en Tropische Geneeskunde, Leiden; a specimen from Lae, New Guinea, 30 January 1945, collected by R. N. McCulloch, in the Department of Entomology, London School of Hygiene and Tropical Medicine; and specimens from Hollandia, New Guinea, and Bat Island, off man, collected and loaned by G. M. Kohls. The following description is based

on the specimen in the Oudemans collection, and it is equally applicable to the other specimens studied.

DIAGNOSIS: The body of the partially engorged larva is orange to vermilion in color, and ovoid in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. On either side of the scutum, near the posterior corners, is a very distinct ocular shield, bearing two eyes. The anterior eye has a distinct, well developed cornea, while the posterior eye is smaller and very indistinct. The scutum is of the shape depicted by Walch. The figure by Womersley and Heaslip (1943, pl. VIII, fig. 8) is also applicable, except that the posterior margin is more rounded laterally than is indicated in their figure. The posterior margin may be flattened or slightly sinuate in its middle third. There are diagonal arcuate lines anterior and posterior to the pseudostigmata. The ultimate points of attachment of the pseudostigmatic organs lie in the line of the posterior lateral setal pores. Since the canal is inclined posteriorly, their point of exit from the scutum may lie slightly behind this line. The anterior median seta bears short cilia or barbs. The anterior and posterior lateral setae bear much longer cilia. Many of these cilia may be lost, giving the affected seta a serrated appearance. The pseudostigmatic organs are clavate, the length of the peduncle being approximately equivalent to the transverse diameter of the expanded portion. The expanded portion bears minute barbs which are easily overlooked, or which may become invisible, owing to the refractive index of the mountant.

The palpal claw is bifurcate. The main element is stout, long, strongly curved, and pointed apically. The accessory element is lateral to it, lying in the same plane, or slightly above the main element. It is straight and sharply pointed. In one of the specimens from Hollandia it appears to be absent from one side. The chelicerae are typical of the species, being 58 to 63 micra in length, and bearing eight to twelve prominent, slightly recurved, dorsal teeth. The more proximal teeth are smaller. In lateral view, the cheliceral blade resembles a saw.

The dorsal abdominal setae bear short barbs, similar in form to the anterior median scutal seta. A humeral seta is present on either side, and the number and arrangement of the remainder of the dorsal setae is variable. On the topotypic specimen in the Oudemans collection, the formula is 2 — 9 — 10 — 9 — 6 — 4 or 6. In other specimens, the arrangement may be 2 — 8 — 9 — etc., or 2 — 8 — 10 — etc. The arrangement given by Womersley (1944, p. 96) for *S. pusilla* is "2 — 8 — 2 (outer) — 8 — 8 — 6 — 2 — 2". Total counts appear to range from thirty-eight to forty-two. There are two plumose sternal setae between coxae I and two between coxae III. The

remainder of the ventral setae are often arranged: 6 — 6 — 2 — 2 (flanking the anus) — 4 — 2". The writer is unable to discern a pattern in the ventral setae on the specimen in the Oudemans collection.

The seta on palpal segment I bears several unusually long, delicate cilia. The seta on segment II bears several long cilia, and the one on segment III bears fewer such cilia. These are easily lost, giving rise to a serrated appearance. On segment IV, the dorsal and lateral setae are nude, while the ventral seta bears two or three long, delicate cilia. Segment V bears a rather long, pointed, basal, ventral, striated seta; an apical, curved, nude, spine-like seta; plus several (exact number?) plumose setae of various forms. The galeal seta is consistently long and nude.

Each coxa bears a single plumose seta, the one on coxa II being the shortest, and provided with the shortest cilia. Tarsus III bears a long, nude, whip-like seta, arising on the dorso-lateral aspect, a short distance beyond the articulation with the tibia. The vestiture of the remainder of the leg segments is not remarkable.

Measurements are recorded on several specimens in the following order: three topotypic specimens; the single specimen from New Guinea on the slide with the lectotype of *S. vandersandei* (Oudemans, 1905); three specimens from Hollandia; one from Lae; and one from Bat Island.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
55	73	22	27	25	22	35	63	53	29 × 14	36	27
55	74	18	27	24	24	—	62	49	30 × 15	—	25
56	77	22	28	27	25	—	—	53	30 × 15	35	—
51	70	18	25	25	21	29	70	52	25 × 14	35	28
58	75	21	30	27	24	28	63	46	32 × 15	32	27
54	75	20	32	26	24	28	63	45	32 × 16	34	26
58	75	21	33	27	26	—	60	46	— —	34	28
57	76	22	32	24	26	28	—	48	— —	32	27
57	76	23	26	26	24	22	57	45	36 × 16	30	30

TYPE MATERIAL: *Trombicula schüffneri* Walch, 1922, was described from Deli, Sumatra, off man, no holotype designated. According to a personal communication from Mrs. E. W. Walch, her husband's original specimens are in the Koningin Wilhelmina Instituut voor Hygiene en Bacteriologie, Batavia, Java. However, in a list of the species represented in their collection, it is not mentioned as present in a recent communication from Prof. R. Gispen. As mentioned above, some of Walch's original material of this species is in the Rijksmuseum van Natuurlijke Historie, and the Instituut voor Hygiene en Tropische Geneeskunde, Leiden.

Schöngastia pusilla Womersley, 1944, was described from numerous specimens from the Buna Area of British New Guinea, 1943, off boots, in kunai grass. No holotype was designated in the original publication. Presumably the material is in the South Australian Museum, Adelaide.

The names, *Neoschongastia minor* and *Schöngastia minor* appeared in 1944, in publications by the United States Army Medical Department. Although they were accompanied by illustrations, they are *nomina nuda*. Dr. G. W. Wharton has informed me that the illustrations were made from specimens which were nominally *S. pusilla* Womersley, 1944; consequently they are cited herewith in synonymy with *S. schüffneri* (Walch, 1922).

GEOGRAPHICAL DISTRIBUTION:

Sumatra: Deli	Type locality
Tandjong Morawa	Walch (1923)
British New Guinea: Buna Area	Womersley (1944)
Dobadura	Kohls, *et al.* (1945)
Dutch New Guinea: No specific locality	Netherlands New Guinea Exp. (Recorded herewith)
Hollandia	Bushland (1946)
Sansapor	Mohr (1947)
Bat Island, Purdy Group	Philip and Kohls (1945)

RECORDED HOSTS:

Man, *Homo sapiens* Linnaeus	Type host
Rattus exulans	Mohr (1947)
Rattus ringens	Mohr (1947)
Pogonomys mollipilosus	Mohr (1947)
Melomys sp	Mohr (1947)
"Boots"	Womersley (1944) and others

MEDICAL IMPORTANCE: The medical importance of this species is twofold: first, as one of the mites causing scrub itch, and secondly as a possible vector of scrub typhus. It has been found attacking man in the following localities: Deli and Tandjong Morawa, Sumatra; and the Buna area and Dobadura, British New Guinea. It has been collected frequently from boots and from the forest floor. It was originally described from man and subsequently Walch (1923) reported it from coolies on the estates of the Senembah Company at Tandjong Morawa, on the east coast of Sumatra. Walch and Keukenschrijver (1924, p. 257) reported that 213 of 221 mites removed from coolies working in the primitive forest belonged to this species. Their following observation is worthy of verbatim quotation: "Een koelie, waarop Keukenschrijver eene larve ervan aangetroffen had, kreeg eene week later een typischen aanval van pseudotyphus, waarbij wederom het primair affect geheel op dezelfde plaats gelegen was, waar de larve gebeten had". This

observation of development of a primary lesion of scrub typhus at the site of former attachment of a larva of this species strongly suggests that it may act as a vector. One must remember, however, that the man could have been bitten by an infected mite of another species, which had attached within a radius of a few millimeters, and which had detached or had been rubbed off before it could be found by the examining physician. In discussing *S. schüffneri* as a vector, Walch and Keukenschrijver pointed out that it is not a member of the "tsutsugasmushi group" from a morphological standpoint. In their summary in English, they state (*op. cit.*, p. 274): "Therefore since in the forest we found almost exclusively *T. Schüffneri* we believe that the role attributed to the forest in epidemiology of pseudotyphus has been overestimated. At least as far as we can see in the present epidemic the forest played no role". These observations, and the points mentioned in this paper under *S. vandersandei* (Oudemans, 1905), lead the writer to conclude that its role as a vector is probably a very minor one. It has been recorded only rarely from rats. However, it must be regarded as a potential incidental vector of scrub typhus.

REMARKS: According to personal communications from G. M. Kohls (1947) and H. Womersley (1947), these workers arrived at the conclusion that *S. schüffneri* and *S. pusilla* were synonymous before the writer's studies were made. Kohls kindly loaned the writer some authentic specimens of *S. pusilla* for comparison with the material in Leiden. The synonymy suggested by Kohls and by Womersley was thus confirmed.

The nymph of this species was reared, described and figured by Walch (1924, Trans. 5th Bienn. Congr. Far East. Assoc. Trop. Med., pp. 612-614; figs. 21-23. 1924, Geneesk. Tijdschr. Ned. Ind., *64*, pp. 511-514; tables I, II; figs. 3-5. 1925, Kitasato Arch., *6*, no. 3, pp. 242-244; tables III, IV; pl. III, fig. 10; pl. IV, figs. 11, 12).

In giving a check-list of the mite vectors of tsutsugamushi disease (scrub typhus), Williams (1944) has included this species. He lists it for Malaya, and in a footnote to Table I (p. 356), we read: "Thought to transmit the disease only from man to man". Presumably this "thought" was the product of Williams' imagination, for the writer has been unable to find it expressed elsewhere. It is ridiculous from an epidemiological standpoint. Williams does not explain under what circumstances a trombiculid mite larva would detach from one human being, reattach to the other, and transmit scrub typhus from the first to the second individual.

Finally, in listing this species from Malaya, Williams has cited Fletcher, Lesslar and Lewthwaite (1928). However, these authors state specifically

that this was *not* among the species found by them in Malaya. It would appear that Williams' interpretation of the literature is somewhat unreliable.

Schöngastia vieta Gater, 1932 (fig. 4 a)

1932. *Schöngastia vieta* Gater, Parasitology, *24,* no. 2, pp. 154-156; fig. 5.
1942. *Schöngastia vieta* Gater. Radford, Parasitology, *34,* no. 1, p. 68; fig. 63.
1943. *Schöngastia vieta* Gater. Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, p. 103; pl. VI, fig. 2.
1945. *Schöngastia vieta* Gater. Buitendijk, Zool. Meded., *24,* p. 336.
1946. *Schöngastia maldiviensis* Radford, Parasitology, *37,* nos. 1, 2, pp. 46, 48; figs. 9-12.

This species is represented in the Oudemans collection by a specimen (erroneously labelled "cotype" in Oudemans' handwriting), from Raub, Pahang, Federated Malay States, 5 May 1930, off *Rattus mülleri validus* (Miller). Specimens bearing these data were recorded by Gater (1932), but they were not listed by him as part of the type series. The writer has also studied the material in the British Museum (Natural History), the U.S. National Museum, and in the personal collection of Dr. C. D. Radford. The following notes, based on the type series of Gater's species, are equally applicable to *S. maldiviensis* Radford, 1946.

DIAGNOSIS: The specimens examined are nearly fully engorged, and the body is ovoid in shape. The color in life is vermilion. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. A distinct and well developed ocular shield is situated on either side of the scutum at the level of the posterior corners. It bears two distinct eyes, of which the anterior one is the larger. The scutum is of the general form depicted in the accompanying figure (fig. 4 a), drawn by Miss Sanina from a paratype in the British Museum (Natural History), no. 1932-7-18-8. Gater's drawing (1932, fig. 5) shows the posterior margin to be almost angulate medially. However, this is incorrect, and careful examination of the type series suggests to the writer that Gater was confused by folds of the dorsal integument. Actually the posterior margin is variable, being almost evenly rounded, or flattened medially, or slightly indented, in specimens of the type series. In this instance, therefore, the writer cannot regard it as a character of specific differential value or significance. Womersley, *in litt.,* has discussed the matter, and he does not agree with the writer's observations on the type series. Thus further study of the type series of *S. vieta* Gater, 1932, will be desirable. The five normal scutal setae bear numerous, rather long barbs, and the anterior laterals are longer than the posterior laterals, which in turn are longer than the anterior median seta. The pseudostigmata are situated anterior to the line of the posterior lateral setal pores. The pseudostigmatic

organs are clavate, and they bear many small barbs on the distal half of the expanded portion.

The palpal claw is trifurcate. The main element is curved inward distally. The dorsal accessory prong is almost straight, quite distinct from the main

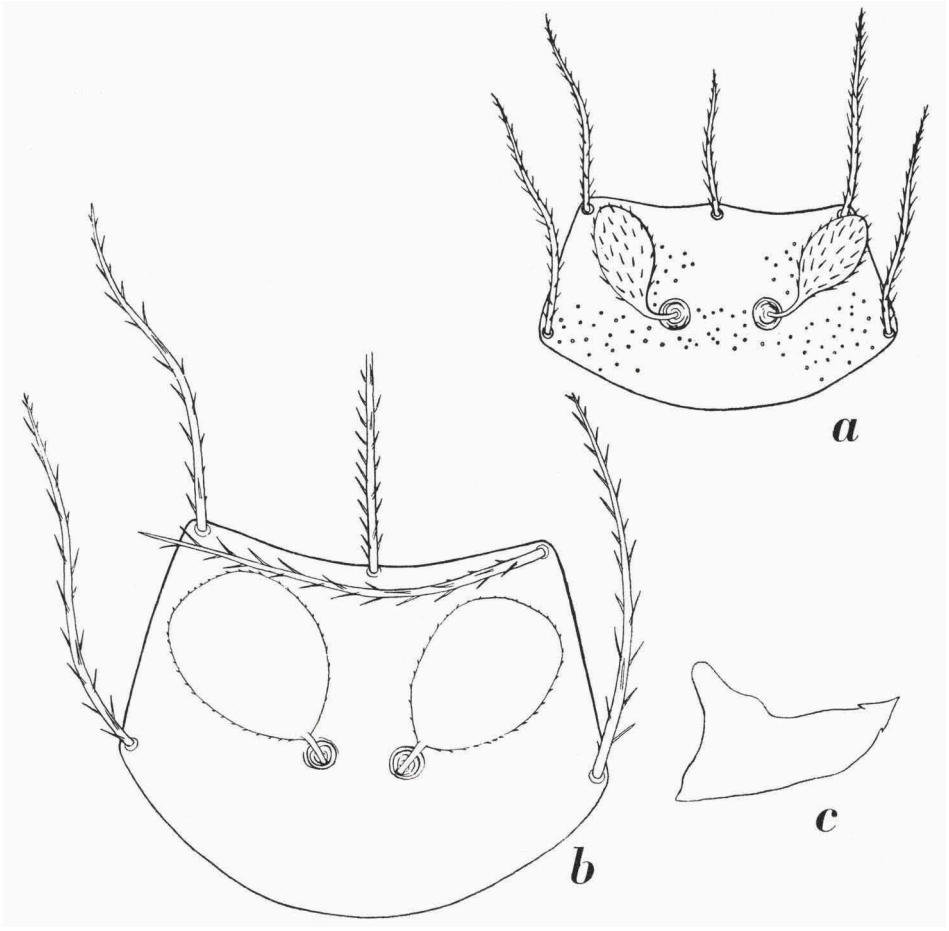

Fig. 4. *a, Schöngastia vieta* Gater, 1932, scutum; *b, c, Euschöngastia mutabilis* (Gater, 1932); *b,* scutum; *c,* chelicera. Original (Sanina).

element, and definitely shorter than it. The ventral accessory element is gently curved inward, and it is as long as, or longer than, the main element. Each chelicera bears six or more teeth on its dorsal margin. The three distal teeth are much larger and more prominent than the proximal ones. On the ventral margin, is a small, recurved, gouge-like process.

The dorsal abdominal setae are arranged approximately: 2 — 8 — 6 —

6 — 4 — 4 — 2, with minor variations. There are two plumose sternal setae between coxae I, and two between coxae III. The remainder of the ventral abdominal setae are somewhat variable in number and arrangement. As pointed out by Gater (1932, p. 155), the total body setae range in number from forty-eight to sixty-four. The pre-anal ventral setae are shorter and their barbs are more distinct and delicate, in contrast to the coarser, longer para- and post-anal setae.

Palpal segment I bears a plumose seta which is provided with long, delicate cilia. Segment II is broadly rounded, and its seta bears several inconspicuous, but nevertheless definite, rather long, delicate cilia. This seta was incorrectly figured as nude by Radford (1946, p. 49, fig. 11) for his species, as revealed by examination of the specimen regarded by him as the type. The seta on segment III may differ on two sides of a single specimen (e.g., the holotype of *S. vieta* Gater), being nude, or provided with a few delicate cilia. On segment IV, the dorsal seta is consistently nude. The lateral seta is usually nude, although on one paratype it is nude on one side and bears two cilia on the other. The ventral seta of this segment is consistently plumose, bearing six or more lateral cilia. Segment V bears a basal, ventral, striated seta, plus six plumose setae of various forms, one of which is prominent, having an unusually stout shaft. The galeal seta is uniformly nude.

Each coxa bears a single plumose seta, provided with numerous delicate cilia. The remainder of the leg segments are provided with plumose setae. Tarsus III bears on its lateral aspect a single, moderately long, nude, whip-like seta.

Measurements are recorded for several specimens in the following order: (1) *S. vieta,* the holotype and three paratypes in the British Museum (Natural History), two paratypes in the U.S. National Museum, and the specimen in the Oudemans collection; (2) *S. maldiviensis,* the holotype, two paratypes, and two topotypic specimens identified by Radford, in the London School of Hygiene and Tropical Medicine.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA
51	69	19	22	26	29	22	61	41	32 × 13	37
54	72	19	22	26	29	27	66	54	32 × 13	42
53	72	19	22	26	29	29	64	48	33 × 13	42
53	72	19	22	26	30	—	61	48	32 × 13	35
56	75	21	28	25	31	29	63	58	29 × 14	40
62	78	22	28	26	32	29	69	57	35 × 14	40
53	73	18	25	21	28	25	53	49	35 × 14	35
S. maldiviensis Radford										
56	75	18	24	32	30	29	60	48	30 × 16	30

57	76	21	26	21	29	31	57	50	32 × 17	35
54	74	19	26	22	27	29	62	47	31 × 16	37
57	75	18	26	28	30	—	74	51	32 × 17	34
57	78	18	28	27	30	33	60	46	30 × 18	33

The writer is unable to discern critical differences in measurements that might warrant recognition of *S. maldiviensis* as a distinct subspecies or geographical race.

TYPE MATERIAL: *Schöngastia vieta* Gater, 1932, was described from ten specimens from Kuala Lumpur, Selangor, Federated Malay States, 17 February 1930, off *Rattus rattus diardi* (Jentink). In the British Museum (Natural History) are the holotype, no. 1932-7-18-7, and three paratypes, nos. 1932-7-18-8, -9, and -10. There are two paratypes in the U.S. National Museum, no. 1052; paratypes are also in the Molteno Institute, Cambridge, England, and the King Edward VII College of Medicine, Singapore.

Schöngastia maldiviensis Radford, 1946, was described from Gan, Maradu, Fedu Islands, and Addu Atoll, off lizard, *Calotes versicolor*, and occasionally brown rat, *Rattus norvegicus norvegicus* Berkenhout, no holotype designated. A specimen regarded by Radford as the type was in his personal collection in January, 1947. There are two paratypes in the U.S. National Museum, no. 1574. Radford has kindly presented the writer with topotypic material.

GEOGRAPHICAL DISTRIBUTION:

Federated Malay States: Kuala Lumpur, Selangor	Type locality
Sungei Buloh, Selangor	Gater (1932)
Raub, Pahang	Gater (1932)
Maldive Islands: Gan, Maradu, and Fedu Islands	Radford (1946)
Addu Atoll	Radford (1946)

RECORDED HOSTS:

Rattus rattus diardi (Jentink)	Type host
Rattus rattus jalorensis (Bonhote)	Gater (1932)
Rattus mülleri validus (Miller)	Gater (1932)
Rattus norvegicus norvegicus Berkenhout	Radford (1946)
Lizard:	
Calotes versicolor	Radford (1946)

REMARKS: The writer's synonymy is based primarily on his comparison of the holotype and three paratypes of *S. vieta* Gater, 1932, with the specimen of *S. maldiviensis* Radford, 1946, kindly shown to him by C. D. Radford as the type. Comparisons of paratypes in the U.S. National Museum support the writer's impression that they are one species. Nymphs and adults are not available for study. Since the matter of synonymy will probably be controversial, it should be reconsidered when additional material becomes

available for study. Furthermore, since *S. vieta* Gater, 1932, is apparently close to *S. philipi* Womersley and Kohls, 1947, comparisons of types and other specimens will be desirable.

Schöngastia cercopitheci (Trägårdh, 1904)

1904. *Trombidium cercopitheci* Trägårdh, Results Swed. zool. Exp. White Nile, no. 20, pp.82-83; pl. 4, figs. 15-19.
1910. *Schöngastia cercopitheci* (Trägårdh). Oudemans, Ent. Ber., *3,* no. 54, p. 87.
1912. *Schöngastia cercopitheci* (Trägårdh). Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 62-64, 191, 203; fig. N.
1923. *Schöngastia cercopitheci* (Trägårdh). Salm, Bull. Soc. Path. exot., *16,* no. 5, p. 337.
1926. *Schöngastia cercopitheci* (Trägårdh). Hirst, Proc. zool. Soc. Lond., 1926, pt. 3, p. 828.
1929. *Schöngastia cercopitheci* (Trägårdh). Stiles and Nolan, Hyg. Lab. Bull. no. 152, pp. 484-485.
1942. *Schöngastia cercopitheci* (Trägårdh). Radford, Parasitology, *34,* no. 1, p. 67; fig. 52.
1945. *Schöngastia cercopitheci* (Trägårdh). Buitendijk, Zool. Meded., *24,* p. 336.

This species is represented in the Oudemans collection by two specimens mounted on one slide, bearing the data of the original series in Oudemans' handwriting. Gum chloral was added to the preparation by the writer, without disturbing the specimens, as air had entered, rendering examination impossible. Subsequently the specimens were in satisfactory condition for study.

DIAGNOSIS: The body of the engorged larva is ovoid in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. On either side of the scutum, at the level of the posterior corners, is a well developed ocular shield, bearing two eyes with distinct corneae. The anterior eye is the larger one, and the posterior eye is less well developed. The scutum is of the shape depicted by Oudemans (1912, figs. N 1 and N 3), with a well rounded posterior margin. However, in figure N 3, Oudemans has placed the pseudostigmata too far forward. They are actually located only slightly in advance of the line of the posterior lateral setal pores, as shown in his figure N 1. There are "eyebrows" over the pseudostigmata. The normal scutal setae bear numerous short barbs, arising from several sides of their shafts. The pseudostigmatic organs are globose, with a peduncle whose length is equivalent to the diameter of the head. These structures are adorned with minute barbs.

The palpal claw is trifurcate. Two of the elements are curved, pointed, and of equal length; a dorsal, external element is shorter, straight, and pointed. Each chelicera bears five or six small dorsal teeth of various sizes.

These were described by Oudemans (1912, p. 64), but he did not figure them. There is no apparent toothlet on the ventral margin.

There are thirty-four dorsal setae, similar in form to the posterior lateral scutal setae, arranged approximately: 2 — 6 — 8 — 6 — 2 — 4 — 4 — 2. On the specimens studied, these were not suitable for measurement. There are two plumose sternal setae between coxae I, and two between coxae III. The remainder of the ventral setae are arranged approximately: 2 — 6 — 4 (flanking the anus) — 2 (marginal) — 4 — 2.

The seta on palpal segment I bears six long, fine cilia. In Oudemans' figure (1912, fig. N 4) of this segment, he exaggerated the angulation of the posterior corners of the sclerite, which are actually rounded in the specimens studied. On segment II, the seta bears four delicate lateral cilia. The seta on segment III is apparently variable, either bearing one lateral cilia, or being nude. On segment IV, the dorsal and lateral setae are nude, and the ventral seta bears four or five rather long cilia. Segment V was not well visualized by the writer. According to Oudemans, it bears a basal, ventral, striated seta; an apical nude seta; and three plumose setae of various forms. The galeal seta is nude.

Each coxa bears a single plumose seta. Oudemans stated (1912, p. 64): "Am 3. Beine habe ich keine Sinneshaare gesehen". However, on the specimens examined by the writer, tarsus III bears a long, nude, whip-like seta, which is easily visible. The vestiture of the remainder of the leg segments is not remarkable.

The following measurements were taken from the specimen mounted with its dorsal surface facing the cover slip: AW 56; PW 88; SB 14; ASB 28; PSB 21; AP 28; AL 56; PL 57; SENS 25 × 12.5. The anterior median seta is perpendicular, and the dorsal abdominal setae are not suitable for measurements. It is probable that the antero-posterior measurements are slightly foreshortened, owing to the fact that the scutum is tipped forward.

TYPE MATERIAL: Described from several specimens from the White Nile, Egypt, March, 1901, behind the ears of *Cercopithecus griseus,* collected by Dr. Ivar Trägårdh. According to Oudemans, the type is in the Trägårdh collection, Stockholm, Sweden. The writer has been unable to ascertain the present existence or condition of the type.

REMARKS: This species is known only from the original specimens. It is the only trombiculid mite described from the Ethiopian region, which can be definitely assigned to this genus. It has been pointed out earlier in this paper that the two species described by Sambon (1928) in *Schöngastia* should be transferred to *Endotrombicula* Ewing, 1931.

Genus **Neoschöngastia** Ewing, 1929

Genotype: *Schöngastia americana* Hirst, 1921, by original designation.

1929. *Neoschöngastia* Ewing, Manual of External Parasites, pp. 22, 28, 187-188.
1931. *Neoschöngastia* Ewing. Ewing, Proc. U. S. nat. Mus., *80,* no. 2908, Art. 8, pp. 2, 5-6.
1932. *Neoschöngastia* Ewing. Gater, Parasitology, *24,* no. 2, pp. 156-161.
1935. *Neoschöngastia* Ewing. Sig Thor, Zool. Anz., *109,* nos. 5/6, p. 110.
1937. *Neoschöngastia* Ewing. Ewing, Proc. biol. Soc. Wash., *50,* p. 168.
1938. *Neoschöngastia* Ewing. Ewing, J. Wash. Acad. Sci., *28,* no. 6, p. 290.
1939. *Neoschöngastia* Ewing. Torres and Braga, Bol. Sec. Agr. Indust. Com., pp. 39, 42.
1939. *Neoschöngastia* Ewing. Gunther, Proc. Linn. Soc. N. S. W., *64,* pts. 1-2, nos. 281-282, pp. 81-91.
1939. *Paraschongastia* (sic, no ") Womersley, Trans. roy. Soc. S. Aust., *63,* pt. 2, pp. 165-166 (no type designated).
1940. *Neoschöngastia* Ewing. Neave, Nomenclator Zoologicus, III, p. 308.
1940. *Paraschöngastia* Womersley. Gunther, Proc. Linn. Soc. N. S. W., *65,* pts. 3-4, nos. 289-290, pp. 251-252.
1941. *Neoschöngastia* —. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 4, p. 624.
1942. *Neoschöngastia* Ewing. Vitzthum, *op. cit.,* Lfg. 6, p. 829 (as a subgenus of *Schöngastia* Oudemans, 1910).
1942. *Neoschöngastia* Ewing. Radford, Parasitology, *34,* no. 1, pp. 72-78.
1942. *Neoschöngastia* —. Ewing, J. Parasit., *28,* no. 6, p. 487.
1942. *Paraschöngastia* Womersley. Ewing, J. Parasit., *28,* no. 6, p. 487.
1943. *Paraschöngastia* Womersley. Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 72, 129-132 (Genotype designated: *Neoschöngastia yeomansi* Gunther, 1939).
1944. *Paraschöngastia* Womersley. Ewing, J. Parasit., *30,* no. 6, p. 345.
1945. *Paraschöngastia* Womersley. Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, p. 58.
1946. *Paraschöngastia* Womersley. Taylor, Comm. Aust. Serv. Publ. no. 6, pp. 147, 213-219.
1946. *Neoschöngastia* Ewing. Ewing, Proc. biol. Soc. Wash., *59,* pp. 70-71 (equals *Paraschöngastia* Womersley, 1939, synonym).
1946. *Neoschöngastia* Ewing. Wharton and Hardcastle, J. Parasit., *32,* no. 3, pp. 286-322.
1947. *Neoschöngastia* Ewing. Radford, Proc. zool. Soc. Lond., *116,* pt. III, pp. 593-601.

The history of this genus has been given in detail by Wharton and Hardcastle (1946). It was proposed by Ewing (1929) for those species of *Schöngastia* Oudemans, 1910, whose chelicerae lacked a row of teeth on the dorsal margin. Womersley (1939), recognizing two groups of species within Ewing's genus, proposed *Paraschöngastia* for those species with a ridge on the scutum, anterior to the pseudostigmata. Womersley and Heaslip (1943) designated *Neoschöngastia yeomansi* Gunther, 1939, as genotype of *Paraschöngastia.* Since this species is congeneric with *N. americana* (Hirst, 1921), *Paraschöngastia* becomes a synonym.

Wharton and Hardcastle emphasized the fact that in this genus the scutum

is at least partially submerged beneath the dorsal integument, and therefore the integumentary striations are visible over the surface of the scutum. These workers also noted several characters shared by the nymphs known to them. They gave an excellent discussion of the larvae and nymphs known from the Pacific area, adding several new species. They included a key to the species of that area, and the writer's key has been adapted from theirs.

The following characters are shared by the larvae studied by the writer: eyes present; scutum partially submerged beneath the dorsal integument; pseudostigmatic organs clavate or capitate; chelicerae with a dorsal, subapical, recurved toothlet, and a ventral process or gouge. The palpal claws are variable, as is the presence of a long, nude, whip-like seta on tarsus III. The known species are characteristically parasitic upon birds and none have been found to attack human beings or other mammals. *N. scelopori* Ewing, 1931, was described from a lizard, and it is possible that the type host was an accidental one. The apparent host preference of this genus is of probable phylogenetic significance, particularly when correlated with the distinctive morphological characters shared by the species.

Finally, it is noteworthy that certain species possess minute hairs on the concave side of each of the lateral tarsal claws. These are similar to the hairs on the tarsal claws of certain members of the Leeuwenhoekiinae. The writer has observed them on the following species of *Neoschöngastia*: *N. yeomansi* Gunther, 1939; *N. mirafra* Radford, 1942; and *N. thomasi* (Radford, 1946). It is quite likely that these hairs will be observed in other species as well. *Neoschöngastia* is the only genus of Trombiculinae in which the writer has found them.

The following species can be assigned to *Neoschöngastia* in the restricted sense of the genus:

	REMARKS
N. americana americana (Hirst, 1921)	Not seen
N. americana solomonis Wharton and Hardcastle, 1946	Seen
N. atollensis Wharton and Hardcastle, 1946	Seen
N. backhousei Gunther, 1939	Not seen
Syn.: *Neoschöngastia fournieri* Gunther, 1938: nomen nudum	
Paraschöngastia megapodius Womersley, 1939: lapsus	
N. bougainvillensis Wharton and Hardcastle, 1946	Seen
N. carveri Wharton and Hardcastle, 1946	Seen
N. dubia Gunther, 1939	Not seen
Syn.: *Neoschöngastia incerta* Gunther, 1938: nomen nudum	
N. egretta Wharton and Hardcastle, 1946	Seen
N. ewingi Wharton and Hardcastle, 1946	Seen
N. gallinarum (Hatori, 1920)	Not seen
N. mirafra Radford, 1942	Seen
N. monticola Wharton and Hardcastle, 1946	Seen
N. namrui Wharton and Hardcastle, 1946	Seen

N. pauensis Wharton and Hardcastle, 1946	Seen
N. posekanyi Wharton and Hardcastle, 1946	Seen
N. retrocincta Gunther, 1939	Seen
Syn.: *Neoschöngastia retrocoronata* Gunther, 1938: nomen nudum	
N. riversi Wharton and Hardcastle, 1946	Seen
N. salmi (Oudemans, 1922)	Not seen
N. scelopori Ewing, 1931	Not seen
N. strongi Wharton and Hardcastle, 1946	Not seen
N. thomasi (Radford, 1946)	Seen
N. yeomansi Gunther, 1939	Seen
Syn.: *Neoschöngastia jamesi* Gunther, 1938: nomen nudum	

No specimens belonging to this genus were found in the Oudemans collection, but his unpublished drawings of *N. salmi* (Oudemans, 1922) have been preserved. These figures enable one to assign this species with certainty to *Neoschöngastia.* Since it was described with three setae on coxa III, the writer has thought it useful to provide a key to the species which share this character. As pointed out by Wharton and Hardcastle (1946), the number of setae on coxa III is variable on the two sides of a single individual. This fact must be taken into consideration in using the key. Furthermore, the closeness of *N. thomasi* (Radford, 1946) and *N. americana* (Hirst, 1921) is apparent, and the former may eventually come to be regarded as a subspecies of the latter.

Key to Those Species of *Neoschöngastia* Ewing, 1929, which may have Three Setae on Coxa III.

1. Posterior body setae arising from tubercles . . *N. yeomansi* Gunther, 1939
   Posterior body setae not arising from tubercles 2
2(1). Dorsal body setae fewer than fifty 3
   Dorsal body setae more numerous than fifty 6
3(2). Posterior scutal margin deeply sinuate . . . *N. mirafra* Radford, 1942
   Posterior scutal margin not sinuate 4
4(3). Anterior dorsal setae 51 micra in length . . . *N. thomasi* (Radford, 1946)
   Anterior dorsal setae 68 micra in length 5
5(4). Scutal depth (SD) 37-48 micra . . *N. americana americana* (Hirst, 1921)
   Scutal depth (SD) 52-59 micra . . . . . .
   N. americana solomonis Wharton and Hardcastle, 1946
6(2). With as many as three humeral setae on each side . . . . . .
   N. pauensis Wharton and Hardcastle, 1946
   With a single pair of humeral setae 7
7(6). Lateral seta on palpal segment IV with a few delicate barbs; two striated setae on palpal segment V. . . . . *N. ewingi* Wharton and Hardcastle, 1946
   Lateral seta on palpal segment IV nude; a single striated seta on each palpal segment V 8
8(7). Anterior dorsal setae very long, becoming successively shorter posteriorly; long nude seta on tarsus III . . . . . *N. dubia* Gunther, 1939
   Anterior and posterior dorsal setae of nearly equal length; no long, nude, whip-like seta on tarsus III . . . . . *N. salmi* (Oudemans, 1922)

Neoschöngastia salmi (Oudemans, 1922) (figs. 5, 6)

1922. *Schöngastia salmi* Oudemans, Ent. Ber., *6,* no. 126, p. 81.
1922. *Schöngastia salmi* Oudemans. Oudemans, Ent. Ber., *6,* no. 128, p. 114.
1923. *Schöngastia salmi* Oudemans. Oudemans, Ent. Ber., *6,* no. 130, p. 155.
1923. *Schöngastia salmi* Oudemans. Salm, Bull. Soc. Path. exot., *16,* no. 5, pp. 336-340; figures.
1927. *Schöngastia salmi* Oudemans. Walch, Geneesk. Tijdschr. Ned. Ind., *67,* pp. 931-932; table I.
1941. *Neoschöngastia salmi* (Oudemans). Gunther, Proc. Linn. Soc. N. S. W., *66,* pts. 5-6, nos. 297-298, p. 394.
1941. *Schöngastia salmi* Oudemans. Floch and Abonnenc, Inst. Past. Guyane et Terr. de l'Inini, Publ. no. 20, p. 16.
1944. *Schöngastia salmi* Oudemans. Womersley, Trans. roy. Soc. S. Aust., *68,* no. 1, pp. 83, 98-99 (regarded as *incertae sedis*).
1945. *Schöngastia salmi* Oudemans. Buitendijk, Zool. Meded., *24,* p. 336.

This species is represented in the Oudemans collection only by drawings. These were made by Oudemans, but to the writer's knowledge, they were never published. The writer has not seen authentic specimens of this species, and the following remarks are based on the accompanying figures by Oudemans.

DIAGNOSIS: This species is apparently based on a nearly fully engorged specimen. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. The presence or absence of minute hairs on the paired lateral claws is not known. A well developed ocular shield is located on either side of the scutum, bearing two eyes, of which the anterior is definitely larger and more prominent. The shape of the scutum is depicted, emphasizing that it is partially submerged beneath whorled striae of the dorsal integument. The scutum bears stippling of nearly uniform size, and there are "eyebrows" over the pseudostigmata. The morphology of the pseudostigmatic organs and of the five normal scutal setae requires no comment.

The palpal claw is trifurcate, the accessory prongs being shorter than the main element. Each chelicera bears at least one toothlet, but its exact location is not clear to the writer.

The dorsal setae are of nearly uniform length, except that the humerals appear to be longer than the others. Exclusive of scutal setae, there are 124 dorsal abdominal setae. There are two sternal setae between coxae I, and two between coxae III. There are seventy-four additional ventral abdominal setae.

The seta on palpal segment I bears several delicate cilia. The seta on segment II bears seven to nine barbs or cilia, and that on segment III bears three or four delicate cilia. On segment IV, the dorsal and lateral setae are

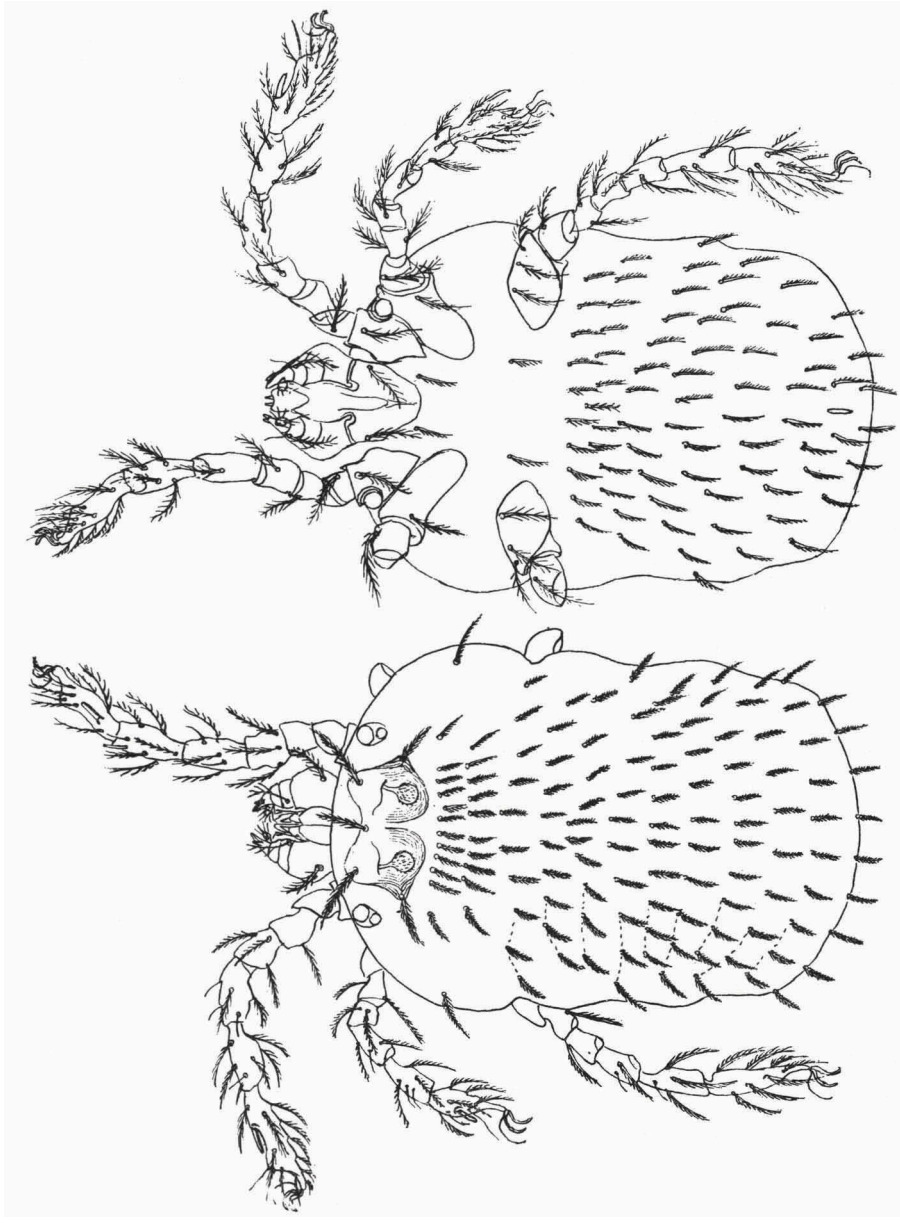

Fig. 5. *Neoschöngastia salmi* (Oudemans, 1922); left, dorsum; right, venter (Oudemans, original, unpublished).

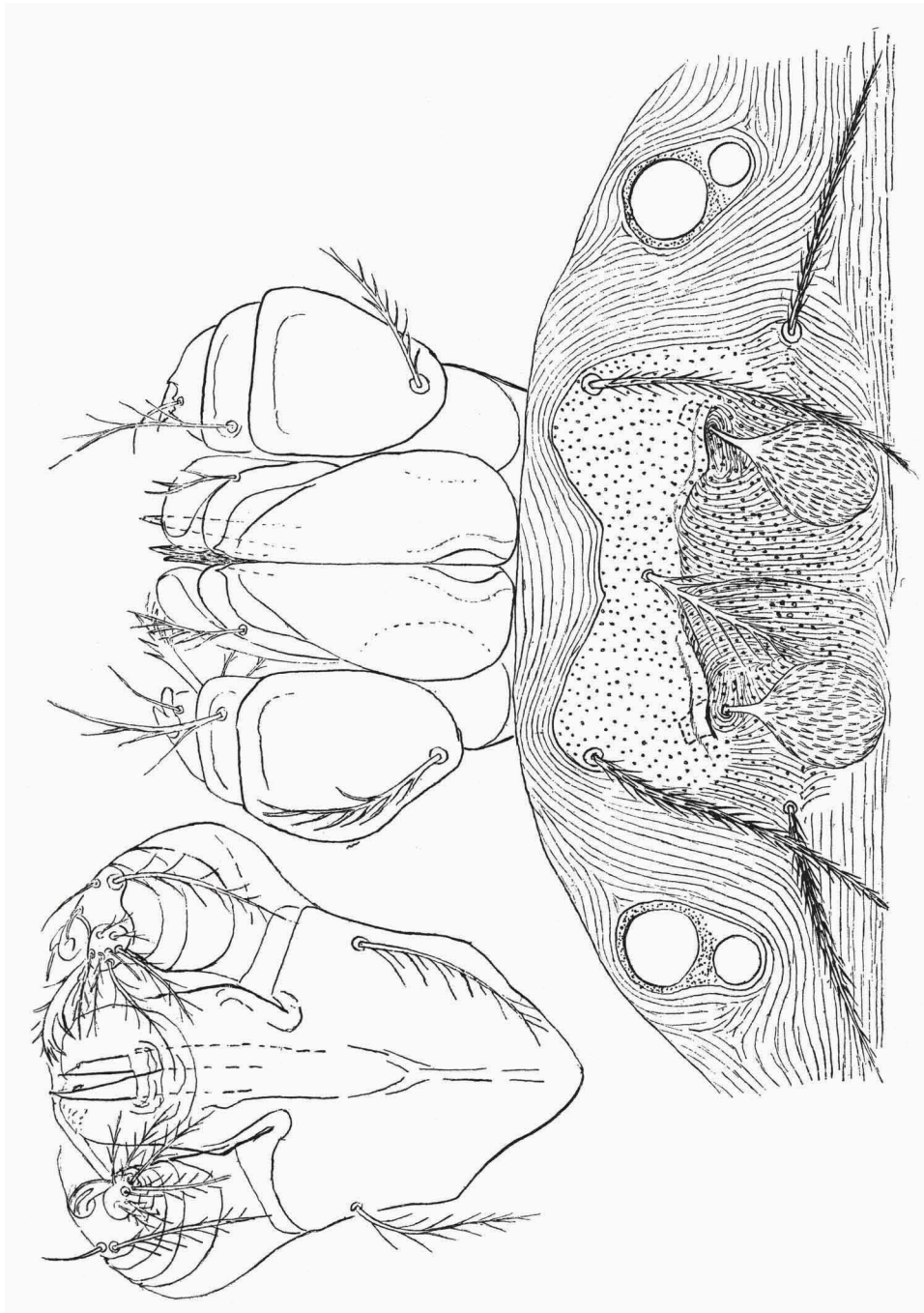

Fig. 6. *Neoschöngastia salmi* (Oudemans, 1922); left, ventral view of gnathosoma; right, dorsal view of gnathosoma, scutum and eyes (Oudemans, original, unpublished).

rather short and nude, while the ventral seta bears several delicate cilia. Segment V bears apparently seven plumose setae, of which a dorsal one has a prominent, stout shaft. Oudemans has also figured a blunt, peg-like seta, which is presumably striated. The galeal seta bears two to five cilia.

Each coxa III bears three plumose setae, but since this is a variable character in other species of this genus, one questions its constancy in a series of this species. The vestiture of the remainder of the leg segments is not remarkable, and it should be noted that Oudemans has figured no long, nude, whip-like seta on tarsus III.

TYPE MATERIAL: Described from a single specimen, collected and sent by Dr. A. J. Salm, at Magelang, Java, off grass, without host, September, 1916. The location of the type specimen is unknown to the writer. It was not found by Miss Buitendijk or by the writer in Oudemans' collection. At present, therefore, the species is known only from Oudemans' figures.

REMARKS: This species is closest to *N. dubia* Gunther, 1939, from which it is distinguished by the characters given in the key. Gunther's species was based on a single specimen, reported to be in the School of Public Health and Tropical Medicine, University of Sydney, Australia. Wharton and Hardcastle (1946, p. 294) were unable to locate it there.

The figures of this species published by Salm (1923) do not permit specific diagnosis, but his description of the scutum makes the generic assignment clear, and he mentions three setae on each coxa III. Womersley (1944) regarded it as a species incertae sedis, apparently having no access to Salm's description.

Genus **Euschöngastia** Ewing, 1938

Genotype: *Euschöngastia americana* Ewing, 1938, by original designation.

1938. *Euschöngastia* Ewing, J. Wash. Acad. Sci., *28,* no. 6, pp. 290, 293.
1942. *Euschöngastia* Ewing. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 6, p. 829: treated as a subgenus of *Schöngastia* Oudemans, 1910.
1944. *Euschöngastia* Ewing. Ewing, J. Parasit., *30,* no. 6, p. 345.
1946. *Euschöngastia* Ewing. Ewing, Proc. biol. Soc. Wash., *59,* pp. 21-22.

When this genus was established by Ewing, it was monotypic, being proposed for a species in which the palpal claw has five or seven prongs. The scutum is distinctive, being very wide transversely and short anteroposteriorly, with definite "eyebrows" over the pseudostigmata. The following species are very close to the genotype: *E. blarinae* (Ewing, 1931); *E. guntheri* (Radford, 1942); *E. samboni* (Radford, 1942); *E. hamiltoni* Brennan, 1947; *E. pipistrelli* Brennan, 1947; *E. sciuricola* (Ewing, 1925); and *E. ore-*

gonensis (Ewing, 1929). With the exception of Brennan's species, the preceding statement is based on the writer's examination of type material. It is quite possible that *E. sciuricola* and *E. americana* are synonymous. If further study of type material confirms this impression, the genotype will become *E. sciuricola* (Ewing, 1925).

In the present paper the writer has used *Euschöngastia* Ewing, 1938, for species which other workers have been assigning to *Ascoschöngastia* Ewing, 1946. In proposing *Ascoschöngastia,* Ewing intended that it should include those species formerly assigned to *Neoschöngastia sens. lat.,* and he restricted *Neoschöngastia* to a group in which the scutum is partially submerged beneath the dorsal integument. For the type of his new genus, however, he chose *N. malayensis* Gater, 1932. This species is distinctive in that the posterior lateral setae are off the scutum. This character is shared by only one other species with clavate pseudostigmatic organs, i.e., *Schöngastia aethiopica* Hirst, 1926. The writer believes that *Ascoschöngastia* should be restricted to these two species, the genotype, and *A. aethiopica* (Hirst, 1926). The remainder, possessing five normal scutal setae, would be assigned to *Euschöngastia,* as defined subsequently. For purposes of future reference, it appears useful to provide a synopsis of the species to be referred to *Euschöngastia.*

Species	Remarks
E. aethomyia (Radford, 1942)	Seen
E. americana Ewing, 1938	Seen
E. antipodianum (Hirst, 1929)	Not seen
E. blarinae (Ewing, 1931)	Seen
E. brasiliensis (Fonseca, 1935)	Not seen
E. brevipalpis (André, 1946)	Seen
E. brevipes (Ewing, 1931)	Not seen
E. bushlandi (Philip, 1947)	Seen
E. cairnsensis (Womersley and Heaslip, 1943)	Seen
E. cairnsensis var. *gateri* (Womersley and Heaslip, 1943)	Not seen
E. californica (Ewing, 1925)	Not seen
E. colombiae (Boshell and Kerr, 1942)	Seen
E. coorongense (Hirst, 1929)	Seen
E. dasycerci (Hirst, 1929)	Seen
E. dasyproctae (Ewing, 1937)	Not seen
E. debilis (Gater, 1932)	Seen
E. derricki (Womersley, 1939)	Not seen
E. echymipera (Womersley and Kohls, 1947)	Not seen
E. edwardsi (Gunther, 1939)	Not seen
E. foliata (Gunther, 1940)	Seen
E. globulare (Walch, 1927)	Not seen
E. guntheri (Radford, 1942)	Seen
E. lawrencei (Womersley, 1952), new name for *Neoschöngastia guntheri* Womersley and Heaslip, 1943, preoccupied by Radford, 1942	Not seen

Species	Remarks
E. guyanensis (Floch and Abonnenc, 1941)	Seen
E. hamiltoni Brennan, 1947	Not seen
E. heaslipi (Womersley and Heaslip, 1943)	Not seen
E. hirsti (Womersley and Heaslip, 1943)	Not seen
E. hirsuta (Boshell and Kerr, 1942)	Not seen
E. indica (Hirst, 1915)	Seen
Syn.: *Trombicula muris* Walch, 1922	
Neoschöngastia rattus Womersley and Heaslip, 1943	
Neoschöngastia cockingsi Radford, 1946	
E. innisfailensis (Womersley and Heaslip, 1943)	Seen
E. kohlsi (Philip and Woodward, 1946)	Seen
E. lacunosa (Gather, 1932)	Seen
E. lanius (Radford, 1946)	Seen
E. lorius (Gunther, 1939)	Not seen
E. mccullochi (Womersley, 1944)	Not seen
E. melomys (Womersley and Heaslip, 1943)	Seen
E. mutabilis (Gater, 1932)	Seen
E. nasuae (Boshell and Kerr, 1942)	Seen
E. nuñezi (Hoffmann, 1944)	Not seen
E. oregonensis (Ewing, 1929)	Seen
E. otomyia (Radford, 1942)	Seen
E. perameles (Womersley, 1939)	Seen
E. peromysci (Ewing, 1929)	Not seen
E. petrogale (Womersley, 1934)	Not seen
E. phascogale (Womersley and Heaslip, 1943)	Seen
E. philippensis (Philip and Woodward, 1946)	Seen
E. pipistrelli Brennan, 1947	Not seen
E. queenslandica (Womersley, 1939)	Not seen
E. samboni (Radford, 1942)	Seen
E. sciuricola (Ewing, 1925)	Seen
E. setosa (Ewing, 1937)	Seen
E. shieldsi (Gunther, 1941)	Not seen
E. signator (Ewing, 1931)	Not seen
E. similis (Womersley and Heaslip, 1943)	Not seen
E. smithi (Womersley, 1939)	Not seen
E. trichosuri (Womersley, 1939)	Not seen
E. trouessarti (Oudemans, 1910)	Seen
E. uromys (Womersley and Kohls, 1947)	Not seen
E. westraliense (Womersley, 1934)	Not seen
E. womersleyi (Gunther, 1940)	Seen
E. xerothermobia (Willmann, 1942)	Not seen

In addition to the characters of the subfamily, and those mentioned in the generic key, the following features are shared by members of this genus: pseudostigmatic organs expanded distally (clavate, capitate, or globose); palpal claw composed of two to seven prongs; chelicerae without a row of dorsal teeth; eyes usually present. In the species seen by the writer, there is no long, nude, whip-like seta on tarsus III. None of the species seen by the writer have minute hairs on the paired lateral tarsal claws.

It should be noted that Vitzthum (1942) treated this genus as a subgenus of *Schöngastia* Oudemans, 1910. The writer is unable to provide a key to *Euschöngastia* at this time. Four species are represented in the Oudemans collection: *E. indica* (Hirst, 1915); *E. lacunosa* (Gater, 1932); *E. mutabilis* (Gater, 1932); and *E. trouessarti* (Oudemans, 1910).

Euschöngastia indica (Hirst, 1915)

1915. *Schöngastia indica* Hirst, Bull. ent. Res., *6,* pt. *2,* pp. 187-188; figs. 5, 6.
1921. *Schoengastia* (sic) *indica* Hirst. Toomey, Urol. Cutan. Rev., *25,* p. 606.
1922. *Trombicula muris* Walch, Geneesk. Tijdschr. Ned. Ind., *62,* no. 5, pp. 562-563; tables II, III; figs. 14-17.
1923. *Trombicula muris* Walch, Kitasato Arch., *5,* no. 3, p. 77; tables I, II; pl. I, figs. 13-16.
1924. *Trombicula muris* —. Walch and Keukenschrijver, Geneesk. Tijdschr. Ned. Ind., *64,* p. 254.
1924. *Trombicula muris* —. Walch, Geneesk. Tijdschr. Ned. Ind., *64,* pp. 502, 513, 520-521, 522; tables I, II; figs. 13-15: larva only, *not* nymph.
1924. *Trombicula muris* Walch, Trans. 5th Bienn. Congr. Far East. Assoc. trop. Med. (1923), pp. 598, 599, 602, 608-610, 621-623; tables III, IV; figs. 18, 31, 32, 33: larva only, *not* nymph.
1925. *Trombicula muris* —. Walch, Kitasato Arch., *6,* no. 3, pp. 250-252; tables III, IV; figs. 20-22: larva only, *not* nymph.
1927. *Schöngastia indica* Hirst. Walch, Geneesk. Tijdschr. Ned. Ind., 67, pp. 924, 926, 928, 929, 931, 932, 933 (equals *Trombicula muris* Walch, 1922, synonym).
1928. *Trombicula muris* —. Fletcher, Lesslar and Lewthwaite, Trans. R. Soc. trop. Med. Hyg., *22,* no. 2, p. 168; fig. 3.
1929. *Trombicula indica* (*muris*) (sic) —. Patton and Evans, Insects, Mites, etc., pp. 650, 655, 656; fig. 333.
1932. *Neoschöngastia indica* (Hirst). Gater, Parasitology, *24,* no. 2, p. 156.
1937. *Trombicula indica* —. Mehta, Indian J. med. Res., *25,* no. 2, pp. 358, 359, 360.
1941. *Neoschöngastia indica* (Hirst). Gunther, Proc. Linn. Soc. N. S. W., *66,* pts. 5-6, nos. 297-298, p. 394 (equals *Trombicula muris* Walch, and *Trombicula indica* (*muris*) of Patton and Evans, synonyms).
1942. *Neoschöngastia muris* (Walch). Radford, Parasitology, *34,* no. 1, p. 74; fig. 83.
1942. *Neoschöngastia indica* (Hirst). Radford, *op. cit.,* p. 76; fig. 98.
1943. *Neoschöngastia indica* (Hirst). Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 108, 118; pl. IX, fig. 2 (equals *Trombicula muris* Walch, synonym).
1943. *Neoschöngastia rattus* Womersley and Heaslip, *op. cit.,* pp. 108, 118-120; text-fig. 11; pl. IX, fig. 5.
1945. *Neoschöngastia indica* (Hirst). Buitendijk, Zool. Meded., *24,* p. 336.
1945. *Neoschöngastia indica* (Hirst). Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, pp. 26, 72, 73; fig. 43.
1945. *Neoschöngastia indica* (Hirst). Blake, Maxcy, Sadusk, Kohls and Bell, Amer. J. Hyg., *41,* no. 3, pp. 295, 299.
1946. *Neoschöngastia indica* (Hirst). Taylor, Comm. Aust., Serv. Publ. no. 6, pp. 185, 198-199; pl. IV, fig. 2 (equals *Trombicula muris* Walch, synonym).
1946. *Neoschöngastia rattus* Womersley and Heaslip. Taylor, *op. cit.,* pp. 185, 201; fig. 169; pl. IV, fig. 5.
1946. *Neoschöngastia indica* (Hirst). Radford, Parasitology, *37,* nos. 1, 2, pp. 46, 48,

49, 51, 53; figs. 13-16, 26 a-e, 28 a-d, 29 (equals *Trombicula muris* Walch, synonym).
1946. *Neoschöngastia cockingsi* Radford, Proc. zool. Soc. Lond., *116,* pt. II, p. 262; figs. 25, 26.
1946. *Neoschöngastia indica* (Hirst). André, Bull. Mus. Hist. nat. Paris, 2e sér., *18,* no. 1, p. 53.
1946. *Neoschöngastia indica* —. Philip, Woodward and Sullivan, Amer. J. trop. Med., *26,* no. 2, p. 240.
1946. *Neoschöngastia indica* (Hirst). Wharton and Carver, Science, *104,* no. 2691, pp. 76-77.
1946. *Ascoschöngastia indica* (Hirst). Wharton, Ecol. Monogr., *16,* no. 3, pp. 151-184; figs. 1-24 (equals *Trombicula muris* Walch, synonym).
1946. *Ascoschöngastia indica* —. Philip and Woodward, J. Parasit., *32,* no. 5, pp. 509, 511.
1947. *Neoschöngastia indica.* —. Mohr, Ecology, *28,* no. 2, p. 198.
1947. *Neoschöngastia rattus* —. Mohr, *op. cit.,* p. 198.

This species is represented in the Oudemans collection by five specimens mounted on a single slide, from Sungei Buloh, Selangor, Federated Malay States, 16 October 1929, off *Rattus rattus jalorensis* (Bonhote), collected and presented by Prof. B. A. R. Gater. These specimens were compared by the writer with some of Hirst's original material in the British Museum (Natural History), and they are indistinguishable. The writer has also studied the material in the British Museum; specimens of *N. cockingsi* Radford, 1946; and numerous specimens from Assam and Burma at present in the collection of the U.S.A. Typhus Commission.

DIAGNOSIS: The body is ovoid in shape and cream to orange-white in color, with intensely red eyes in life. The leg segmentation is characteristic of the subfamily, the tarsi are abruptly tapered distally, and their claws are normal. Two eyes are situated on either side of the scutum, just behind the line of the pseudostigmata, and the anterior eye is slightly larger than the posterior one. The scutum is similar in shape to that depicted by Hirst (1915, fig. 5), by Wharton (1946, fig. 2), and others. The anterior margin projects beyond the anterior lateral setal pores (which are located posterior to the level of the anterior median setal pore), giving rise to scutal "shoulders". The five normal scutal setae bear several rather short barbs. The pseudostigmatic organs are clavate, and they are provided with small barbs. There are "eyebrows" over the pseudostigmata.

The palpal claw is bifurcate, the main element being curved inward distally, and the accessory element being definitely shorter, pointed, and almost straight. Each chelicera bears a single small, sharp, dorsal, subapical, recurved toothlet. Proximal to this toothlet there is a notch on the dorsal margin. A minute toothlet is present on the ventral margin.

The dorsal setae are similar in form to the posterior lateral scutal setae.

Their arrangement depends somewhat on the degree of engorgement, and the total number may vary, as pointed out by Gater (1932, p. 156). A frequent arrangement is 2 — 8 — 6 — 6 — 6 — 6 — 2. As pointed out by Wharton (1946, p. 158), two lateral setae may shift from the second to the first dorsal row, giving the appearance of two humeral setae on each side. The two medial setae of the second row are often slightly behind the level of the pair on either side of them, as depicted by Hirst (1915, fig. 5), and Radford (1946, fig. 25). There are two nude sternal setae between coxae I and two between coxae III. As stated by Wharton (1946, p. 158), the remainder of the ventral setae bear small barbs and they are arranged: 6 — 6 — 6 — 6 — 2, the anus being flanked by the two terminal setae. One observes variations in the numbers and arrangement of the ventral setae in a long series of specimens.

The seta on palpal segment I bears several delicate cilia. On segment II, the seta bears three to four short barbs, and on segment III the seta bears one or two short barbs. On segment IV, the dorsal seta bears two barbs, and the lateral and ventral setae are forked. Segment V bears a small, basal, ventral, striated seta, an apical, nude seta, and five plumose setae of various forms. The galeal seta is uniformly nude.

The coxae are unisetose, and the vestiture of the remainder of the leg segments is not remarkable.

Measurements are recorded herewith on six specimens from the type locality in the British Museum (Natural History), and on four of the specimens from Malaya in the Oudemans collection.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
36	56	20	18	20	28	21	15	30	30 × 10	26	20
34	56	20	19	18	26	—	—	28	— × 9	24	24
40	64	24	20	24	28	20	18	30	32 × 10	—	26
38	52	20	15	18	26	22	18	30	30 × 10	24	—
38	54	21	16	18	26	23	20	30	30 × 10	24	20
38	58	21	18	21	26	22	20	30	30 × 10	24	21
35	50	21	21	18	25	22	17	28	28 × 11	24	24
32	50	20	20	20	25	20	15	27	29 × 11	24	20
35	55	21	21	?	27	—	17	28	29 × 11	24	21
34	49	20	19	20	22	22	20	27	28 × 10	24	20

TYPE MATERIAL: Described from several specimens, no holotype designated, from Calcutta, India, 22 March 1915, off *Nesokia* (*Gunomys*) *bengalensis*, collected by C. Paiva. Three mounted specimens of this original material are in the British Museum (Natural History), bearing no accession

number. The writer regards them as cotypes. Additional specimens are preserved in alcohol, and four of these were removed and mounted by the writer.

Trombicula muris Walch, 1922, was described from Deli, Sumatra, off rats, no holotype designated. Prof. R. Gispen (*in litt.*, 1947) has informed the writer that larvae labelled as this species are in the collection of the Koningin Wilhelmina Instituut voor Hygiene en Bacteriologie, Batavia, Java, but none of the material is labelled as type. The location of the type, if it exists, is unknown.

Neoschöngastia rattus Womersley and Heaslip, 1943, was described from ten specimens, no holotype designated, from Imbil, and Brisbane, Queensland, Australia, off *Rattus assimilis*. Although the authors do not give the type depository, presumably type material is in the South Australian Museum, Adelaide. The writer has not examined specimens of this species, but, according to the figures and description, it falls within the range of variation observed in *E. indica* (Hirst, 1915). It is synonymized with some hesitation, therefore.

Neoschöngastia cockingsi Radford, 1946, was based on specimens from Kanglatongbi, near Imphal, Manipur State, India, 18 April 1945, off *Rattus rattus rufescens* (Gray). The extent of the series was not stated, and no holotype was designated. In January, 1947, the writer examined the specimen in the personal collection of Dr. C. D. Radford, regarded by him as the type. There is a paratype in the U.S. National Museum, no. 1567. The writer has compared these and other topotypic material with certain of Hirst's original specimens of *E. indica,* and they are indistinguishable. The present synonymy is given without hesitation.

GEOGRAPHICAL DISTRIBUTION:

India: Calcutta	Type locality
Kasauli, Sabathu (Simla Hills)	Metha (1937)
Kanglatongbi, Imphal, Manipur State	Radford (1946)
Ledo area, Assam	U. S. A. Typhus Commission (unpublished)
Sumatra: Deli	Walch (1922, *et seq.*)
South Sumatra	Walch (1922, *et seq.*)
Celebes: Makasser	Walch (1927)
Federated Malay States	Gater (1932)
Australia: Cairns, Imbil, Brisbane	Womersley and Heaslip (1943)
Java: Batavia	Womersley and Heaslip (1943)
Ceylon: Colombo and Embeliptiya	Radford (1945)
Maldive Islands: Addu Atoll	Radford (1946, p. 48)
Philippine Islands: Luzon	Philip and Woodward (1946)
Guam	Wharton (1946)
New Guinea: Dobadura	Blake, *et al.* (1945)
Burma: Myitkyina, Shingbwiyang, Shaduzup	U. S. A. Typhus Commission (unpublished)

RECORDED HOSTS:

Bandicota bengalensis	Type host
"Rats"	Walch (1922)
Rattus rattus diardi (Jentink)	Gater (1932)
Rattus concolor concolor (Blyth)	Gater (1932)
Rattus sabanus vociferans Miller	Gater (1932)
Rattus rattus jalorensis (Bonhote)	Gater (1932)
Rattus malaisia Kloss	Gater (1932)
Rattus praetor	Blake, *et al.* (1945)
Rattus rattus kandianus Kelaart	Radford (1946)
Rattus rattus rufescens (Gray)	Radford (1946)
Rattus norvegicus	Radford (1946)
Rattus canus	Wharton (1946)
Rattus mindanensis	Wharton (1946)
Rattus calcis	Philip and Woodward (1946)
Rattus alexandrinus	Philip and Woodward (1946)
Rattus ringens	Mohr (1947)
Rattus exulans	Mohr (1947)

REMARKS: This species is common and widespread in the Austro-Malayan and Indo-Malayan regions, where it accepts the local rats as hosts, surviving in a variety of habitats. It has never been recorded from birds or human beings. Nothing is known of its potential role as an inter-murine vector of pathogenic organisms, e.g., rickettsiae. In view of its frequent and widespread occurrence in areas where scrub typhus is found, its potentialities as an inter-murine vector might be worthy of investigation. From the zoogeographic, but not the epidemiologic standpoint, the Indo-Malayan region is the endemic area for this species, and for the genus *Rattus* as well. For detailed information concerning the morphology, life history, and ecology of this species, the reader is referred to Wharton (1946).

The writer's studies have elucidated the confusion surrounding Walch's figures and description of the nymph of this species. The mite which Walch regarded as the nymph of this species is actually another species, at present undetermined. (See Walch, 1924, Geneesk. Tijdschr. Ned. Ind., *64,* figs. 13-15; 1924, Trans. 5th Bienn. Congr. Far East. Assoc. trop. Med. (1923), figs. 31-33; 1925, Kitasato Arch, *6,* no. 3, pl. IV, figs. 20-22). However, careful study of Walch's figures of a nymph purported to be *Trombicula oudemansi* Walch, 1922, reveals striking similarity to the figures of the nymph of *E. indica* published by Wharton (1946, figs. 8-13). Now, in the Oudemans collection is a slide labelled *Trombicula oudemansi* Walch, bearing a single nymph sent by Walch, and said to have been reared from larvae off *Felis marmorata* at Medan, Deli, Sumatra, 1923. This nymph was borrowed by the writer for comparison with authentic nymphs of *E. indica* which had been reared in individual cells and associated with the larval exuviae to

avoid confusion. These authentic nymphs were kindly provided by Mr. Kenneth L. Cockings, formerly of the Scrub Typhus Research Laboratory, South East Asia Command; they had been reared by him. Walch's nymph is indistinguishable from these nymphs. Thus, the following figures, labelled as *Trombicula oudemansi* Walch, 1922, actually are figures of the nymph of *Euschöngastia indica* (Hirst, 1915): Walch, 1924, Geneesk. Tijdschr. Ned. Ind., *64*, figs. 16-19; 1924, Trans. 5th Bienn. Congr. Far East. Assoc. trop. Med. (1923), figs. 34-37; and 1925, Kitasato Arch., *6*, no. 3, pl. IV, figs. 23-26.

Walch's mistake may have had its origin in simple confusion in labelling slides. Or it may have had its origin in his method of rearing, described as follows (Walch, 1924, p. 602): "In most cases it is sufficient to determine a certain number of larvae, e.g., from the ear of a rat. When they all belong to one species it is most probable that the nymphae we get are those of that species. Generally I have chosen this method". However, it has been the experience of subsequent workers that mass rearing methods of this sort do not always provide satisfactory material for critical association of larvae with their corresponding nymphs.

Finally, if the confusion arose from inadvertent switching of slides in labelling, then the nymph with filiform pseudostigmatic organs, published as *E. indica* (under the synonym *Trombicula muris*), is probably the nymph of *Trombicula oudemansi* Walch, 1922. However, one must await further studies and association of individual larvae with their nymphs, before this matter can be decided.

Euschöngastia lacunosa (Gater, 1932)

1932. *Neoschöngastia lacunosa* Gater, Parisitology, *24*, no. 2, pp. 156-158; fig. 6.
1942. *Neoschöngastia lacunosa* Gater. Radford, Parasitology, *34*, no. 1, p. 76; fig. 95.
1943. *Neoschöngastia lacunosa* Gater. Womersley and Heaslip, Trans, roy. Soc. S. Aust., *67*, no. 1, pp. 107, 116; pl. VIII, fig. 6.
1945. *Neoschöngastia lacunata* (sic) Gater. Buitendijk, Zool. Meded., 24, p. 336: lapsus.
1946. *Neoschöngastia lacunosa* Gater. Taylor, Comm. Aust. Serv. Publ. no. 6, p. 185.

This species is represented in the Oudemans collection by a single paratype presented by Prof. B. A. R. Gater. The lapsus for the specific name, published by Buitendijk (1945), was caused by Oudemans' mistake in spelling the name when he labelled the slide. The writer has also studied the material in the British Museum (Natural History), and in the U.S. National Museum.

DIAGNOSIS: The specimens of the type series seen by the writer are fully engorged. As noted by Gater, there appears to be stippling on the body, fol-

lowing the lines of the integumentary striae. The leg segmentation is characteristic of the subfamily, but there is marked disparity between the paired lateral elements of the tarsal claws, reminiscent of certain species of Walchiinae. On each tarsus the anterior lateral claw is much longer than the posterior lateral claw, but both are apparently of the same calibre. The empodium is finer and longer than the anterior lateral claw. These features were not noted by Gater in his description.

A well developed ocular shield is present on either side of the scutum, near its posterior corners. The anterior eye is only slightly larger than the posterior eye, and each has a well developed cornea. The shape of the scutum is similar to that depicted by Gater (1932, fig. 6), except that he has exaggerated the acuteness of the indentation on the posterior margin. Also there are distinct "eyebrows" over the pseudostigmata, and the scutum is rather densely stippled. The five normal scutal setae bear small, short barbs, which are frequently missing, giving rise to a serrated appearance. This statement applies likewise to the dorsal and ventral abdominal setae. The pseudostigmatic organs are clavate and they are provided with small barbs.

The palpal claw is bifurcate. The main element is pointed and it curves inward distally. The accessory element is straight, sharply pointed, slightly shorter than the main element, and dorsal to it. Each chelicera bears a sharp, dorsal, recurved, subapical toothlet, and a ventral, mesial gouge-like process, similar to what is seen in *Eutrombicula* Ewing, 1938, *Trombicula autumnalis* (Shaw, 1790), etc. Proximal to this process is a minute tooth which is directed anteriorly and ventrally.

Gater pointed out that the dorsal and ventral setae are variable in number and arrangement. On the dorsum are forty-four to fifty-two, which cannot be arbitrarily classified in rows. There are two plumose sternal setae between coxae I, and two just posterior to the level of coxae III. The remainder of the ventral setae are plumose, and they become longer posteriorly.

The seta on palpal segment I bears several delicate cilia. Palpal segment II and III each bear a nude seta, that on segment III being the longer one. The dorsal seta on segment IV bears several very delicate cilia which are frequently lost. The lateral and ventral setae are variable, being either nude or provided with a few delicate cilia. Segment V was not well visualized by the writer, but it was seen to possess a basal, ventral, striated seta, plus five or six plumose setae of various forms, of which a subapical one is unusually long. The galeal seta is consistently nude.

Each coxa bears a single plumose seta. The setae of most of the other leg segments bear minute barbs which are easily lost. The fifth and sixth

segments of leg I each bear three rather short, pointed setae. There is no long, nude, whip-like seta on tarsus III.

The following measurements are based on the holotype and three paratypes in the British Museum, and the paratype in the Oudemans collection, respectively.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
70	78	38	32	30	48	48	39	30	57 × 9	48	40
71	78	39	33	28	46	51	39	30	58 × 8	52	44
64	78	41	30	24	46	50	36	28	51 × 10	46	39
64	82	39	33	24	50	45	36	27	50 × 10	48	44
59	73	34	32	25	42	48	35	21	46 × 9	48	38

TYPE MATERIAL: Described from twenty-three specimens from Sungei Buloh, Selangor, Federated Malay States, 9 June and 23 July 1930, off *Rattus sabanus vociferans* (Miller). The holotype, no. 1932-7-18-11, and three paratypes, nos. 1932-7-18-12, 13 and 14, are in the British Museum (Natural History). Paratypes have been deposited as follows: United States National Museum, two specimens, no. 1053; Molteno Institute, Cambridge, England; King Edward VII College of Medicine, Singapore; and Rijksmuseum van Natuurlijke Historie.

REMARKS: This species is known only from the original material. It is distinctive in the form of the scutum and the tarsal claws. The variability in numbers and arrangement of dorsal and ventral body setae, and in scutal measurements, is worthy of emphasis, since a mistaken impression might be gained if one referred solely to a figure of this species.

Euschöngastia mutabilis (Gater, 1932) (fig. 4 b, c)

1932. *Neoschöngastia mutabilis* Gater, Parasitology, *24,* no. 2, pp. 159-160.
1942. *Neoschöngastia mutabilis* Gater. Radford, Parasitology, *34,* no. 1, p. 76.
1943. *Neoschöngastia mutabilis* Gater. Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 107, 111-112; pl. VII, fig. 5.
1945. *Neoschöngastia mutabilis* Gater. Buitendijk, Zool. Meded., *24,* p. 336.
1946. *Neoschöngastia mutabilis* Gater. Taylor, Comm. Aust., Serv. Publ. no. 6, p. 184.
1947. *Ascoschöngastia mutabilis* (Gater). Audy, Nature, *159,* pp. 295-296. (Based on a misidentification by H. S. Fuller).

Thi species is represented in the Oudemans collection by one paratype from Sungei Buloh, Selangor, Federated Malay States, 23 July 1930, off *Rattus sabanus vociferans* (Miller), collected and presented by Prof. B. A. R. Gater. The writer has also studied the material in the British Museum (Natural History), and the U.S. National Museum.

DIAGNOSIS: The body of the nearly fully engorged larva is ovoid in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. A single eye is situated on either side of the scutum, anterior to the line of the posterior lateral setal pores. No trace of a posterior eye was seen and this confirms Gater's description. The scutum is of the shape depicted in the accompanying drawing by Miss Sanina (fig. 4 b on page 171). The five normal scutal setae bear moderately long barbs throughout the entire length of their shafts. The pseudostigmata are situated very close together, and the ultimate points of attachment of the pseudostigmatic organs are deep in the scutum, slightly behind the line of the posterior lateral setal pores. The canal itself is tilted anteriorly, so that the point of exit of the pseudostigmatic organs is somewhat anterior to this line. The pseudostigmatic organs are capitate, with a short peduncle, and although superficially they appear to be nude, on close examination they can be seen to possess several minute barbs on the head and peduncle.

The palpal claw is trifurcate, both accessory prongs being shorter than the main element, and the ventral being the shorter of the two accessories. Each chelicera bears a small dorsal, recurved, subapical toothlet, but no toothlet was seen on the ventral margin.

As stated by Gater (1932, p. 159), the dorsal and ventral body setae are variable in number, ranging in total numbers from eighty to ninety. There are forty to forty-two dorsal setae, arranged approximately: 2 — 8 — 6 — 6 — 8 — 2 — 4 — 2 — 2. This arrangement is not constant. The paratype in the U.S. National Museum appears to have two humeral setae on each side. There are two plumose sternal setae between coxae I, and two between coxae III. The remainder of the ventral abdominal setae are variable in number and irregular in pattern, becoming longer posteriorly.

The seta on palpal segment I bears several delicate cilia. Those on segments II and III each possess a few delicate cilia, which may be easily lost. On segment IV, the dorsal seta bears a few delicate cilia; the lateral seta is nude; and the rather unusually long ventral seta bears several long, delicate cilia. Segment V bears five plumose setae of various forms, in addition to the usual basal, ventral, striated seta. The galeal seta is uniformly nude.

Coxae I and II each possess a single seta bearing a few barbs which are easily lost. Coxae III bear three to five setae, the number varying on two sides of the same specimen, as pointed out by Gater (1932, p. 160). The holotype has five setae on the right coxa III, and four on the left. The paratype in the Oudemans collection, and one in the British Museum each have four setae on each coxa III. The paratype in the U.S. National Museum

has three setae on each coxa III. The vestiture of the remainder of the leg segments is not remarkable.

The following measurements are based on the holotype and a paratype in the British Museum (Natural History), and the paratype in the Oudemans collection respectively.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
45	71	10.5	30	14	33	—	60	56	30 × 18	34	38
50	70	10.5	33	12	30	34	60	52	35 × 18	34	34
48	71	13	28	14	34	39	49	50	25 × 16	29	40

The anterior median seta is broken on the holotype. Since the pseudostigmatic organs are almost perpendicular in the specimen in the Oudemans collection, the measurement for their length is probably incorrect, being too short.

TYPE MATERIAL: Described from ten specimens from Sungei Buloh, Selangor, Federated Malay States, 23 July 1930, off *Rattus sabanus vociferans* (Miller). Holotype, no. 1932-7-18-7, and paratype no. 1932-7-18-18, are deposited in the British Museum (Natural History); paratypes are in the United States National Museum (one specimen, no. 1055); Molteno Institute, Cambridge, England; King Edward VII College of Medicine, Singapore; and the Rijksmuseum van Natuurlijke Historie.

REMARKS: This species is known at present only from the type material. Based on an incorrect determination by the present writer, Audy (1947) recorded this species from Imphal, Manipur State, India, off *Rattus rattus* var. After examining this material, Womersley kindly called the matter to the writer's attention. The writer has reviewed the material and has found that in the Imphal specimens the galeal setae are consistently plumose, and there are differences in the form of the scutal setae and the position of the pseudostigmata. Although the numbers of setae on coxae III are variable on the two coxae of a single specimen, the other features do not lie within the range of variation observed in the type series of *E. mutabilis* (Gater, 1932). The writer's original determination, therefore, was due to carelessness.

Euschöngastia trouessarti (Oudemans, 1910)

1910. *Schöngastia trouessarti* Oudemans, Ent. Ber., *3,* no. 54, p. 87.
1912. *Schöngastia trouessarti* Oudemans. Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 65-67, 191, 203; fig. O.
1925. *Schöngastia trouessarti* Oudemans. Ewing, Amer. J. trop. Med., *5,* no. 3, p. 261.
1931. *Neoschöngastia trouessarti* (Oudemans). Ewing, Proc. U. S. nat. Mus., *80,* no. 2908, Art. 8, p. 6.
1942. *Schöngastia trouessarti* Oudemans. Radford, Parasitology, *34,* no. 1, p. 67; fig. 53.
1942. *Neoschöngastia trouessarti* (Oudemans). Radford, *op. cit.,* p. 74.
1945. *Schöngastia trouessarti* Oudemans. Buitendijk, Zool. Meded., *24,* p. 336.

This species is represented in the Oudemans collection by two specimens mounted on one slide, bearing the data of the original series in Oudemans' handwriting. The writer has also studied the two cotypes in the Muséum National d'Histoire Naturelle, Paris.

DIAGNOSIS: The moderately engorged larva is ovoid in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. An ocular shield is present on either side of the scutum at the level of the posterior corners, bearing a rather well developed anterior eye, and a smaller, obsolescent, posterior eye. The shape of the scutum is that depicted by Oudemans (1912, fig. O 3), and there are "eyebrows" over the pseudostigmata. The five normal scutal setae bear rather long cilia, giving rise to a bushy appearance. The pseudostigmatic organs are globose, with a short peduncle, and provided with numerous minute barbs.

The palpal claw is trifurcate, and both accessory prongs are shorter than the main element. Each chelicera has a single, small, dorsal, subapical, recurved toothlet, and a vestigial ventral toothlet.

The dorsal setae are numerous, bushy, and similar in form to the posterior lateral scutal setae. They are arranged approximately: 2 — 10 — 10 — 8 — 8 — 6 — 4, but it is difficult to resolve the three posterior rows into a strict pattern. There are two plumose sternal setae between coxae I, and two between coxae III. The remainder of the ventral abdominal setae are arranged approximately: 10 — 10 — 10 — 8 — 6 — 2, the more anterior rows containing setae which are 22 micra in length.

The seta on palpal segment I bears five delicate cilia. On segments II and III the setae are plumose. On segment IV, the dorsal and lateral setae bear short cilia, while the ventral seta has four relatively long branches. Segment V bears the usual basal, ventral, striated seta, a nude apical seta, and four or five plumose setae of various forms. The galeal seta is consistently nude.

The coxae are unisetose, and the vestiture of the remainder of the leg segments is not remarkable. There is no long, nude, whip-like seta on tarsus III.

The following measurements are based on the two cotypes in Paris and the dorsal mount on the slide in the Oudemans collection respectively.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
50	64	14	28	17	28	25	52	45	25 × 15	39	—
50	66	17	27	19	28	28	56	43	27 × 15	38	35
52	63	14	28	15	28	32	53	48	25 × 16	36	35

TYPE MATERIAL: Described from several specimens from southern Brazil, off *Didelphys opossum* Seba, collected by E. A. Göldi. Two speci-

mens labelled types in Oudemans' handwriting are mounted on a single slide which is in the Muséum National d'Histoire Naturelle, Paris. These are cotypes.

REMARKS: This species is known only from the type material. No apparently related species have been described from marsupials in Latin America.

Genus **Doloisia** Oudemans, 1910

Genotype: *Doloisia synoti* Oudemans, 1910, by original designation.

1910. *Doloisia* Oudemans, Ent. Ber., *3,* no. 54, p. 87.
1912. *Doloisia* Oudemans. Oudemans, Zool. Jb., Suppl., *14,* Heft 1, pp. 68-71.
1927. *Doloisia* Oudemans. Stiles and Hassall, Hyg. Lab. Bull. no. 148, p. 268.
1928. *Doloisia* Oudemans. Methlagl, Denkschr. Akad. Wiss. Wien., *101,* p. 214.
1931. *Doloisia* Oudemans. Vitzthum, Kükenthal's Handbuch der Zoologie, *3,* 2nd half (9), pp. 63, 146.
1935. *Doloisia* Oudemans. Sig Thor, Zool. Anz., *109,* nos. 5/6, p. 110.
1937. *Doloisia* Oudemans. Womersley, Rec. S. Aust. Mus., *6,* no. 1, p. 80.
1939. *Doloisia* Oudemans. Neave, Nomenclator Zoologicus, II, p. 141.
1941. *Doloisia* —. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 4, p. 624.
1942. *Doloisia* Oudemans. Vitzthum, *op. cit.,* Lfg. 6, p. 829.
1942. *Doloisia* Oudemans. Radford, Parasitology, *34,* no. 1, pp. 66, 78.
1944. *Doloisia* Oudemans. Ewing, J. Parasit., *30,* no. 6, p. 345.
1945. *Doloisia* Oudemans. Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, p. 58.
1946. *Doloisia* Oudemans. Taylor, Comm. Aust. Serv. Publ. no. 6, p. 147.

The generic characters emphasized by Oudemans (1912, p. 68) are: legs with divided femur and normal tarsal claws; coxae I and II in apposition to each other; scutum with five setae and two clavate pseudostigmatic organs; two eyes on each side; coxae with four to ten setae. He also mentioned the nature of the palpal claw and other features which, in this instance, are not distinctive. His genus was monotypic.

Radford (1946, Proc. zool. Soc. Lond., *116,* pt. II, p. 260; figs. 21, 22) described *Neoschöngastia manipurensis* from several specimens from Imphal, Manipur State, India, June 13, 1945, off *Rattus rattus rufescens* (Gray), no holotype designated. Through the kindness of Dr. Radford, the writer has been able to examine the specimen in his collection which he regards as the type. In view of the morphology of the scutum and chelicerae, and the numbers of setae on coxae II and III, the writer believes that Radford's species should be assigned to this genus in spite of the absence of eyes. It can be distinguished from *D. synoti* Oudemans, 1910, by the following characters:

	D. synoti	*D. manipurensis*
Eyes	Two plus two	Absent
Palpal claw	Bifurcate	Trifurcate
Chelicera	One dorsal hook	Two dorsal hooks, one mesial prong
Coxal Setae:		
I	4	1
II	7	3
III	10	6 or 7 (variable on type)

Doloisia synoti Oudemans, 1910

1910. *Doloisia synoti* Oudemans, Ent. Ber., *3,* no. 54, pp. 87-88.
1912. *Doloisia synoti* Oudemans. Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 68-71, 191, 203; fig. P.
1930. *Doloisia synoti* Oudemans. Stiles and Nolan, Nat. Inst. Hlth. Bull. no. 155(1), p. 639.
1941. *Doloisia synoti* Oudemans. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 4, p. 624.
1942. *Doloisia synoti* Oudemans. Radford, Parasitology, *34,* no. 1, p. 66; fig. 37.
1945. *Doloisia synoti* Oudemans. Buitendijk, Zool. Meded., *24,* p. 340.

This species is represented in the Oudemans collection only by drawings, and the writer has not examined specimens. The following remarks are based on information published by Oudemans (1912).

DIAGNOSIS: Oudemans depicted the body of an engorged larva as ovoid in shape. Leg I is shown to consist of seven segments, but the figures of legs II and III do not show the proximal segments. Since Oudemans stated that the femur was divided, one can assume that legs II and III are composed of seven segments. The tarsal claws are described and figured as normal. On either side of the scutum, at some distance from it, is a small ocular shield, bearing two eyes, of which the anterior is the larger. The scutum is roughly trapezoidal, with the anterior margin projecting forward to a blunt point, where the anterior median setal pore is located. The posterior margin is slightly sinuate, not projecting behind the line of the posterior lateral setal pores. The anterior lateral setae are short and nude. The anterior median and posterior lateral setae bear several short barbs. The pseudostigmatic organs are clavate, and covered with numerous short barbs. There are distinct "eyebrows" over the pseudostigmata.

The palpal claw is bifurcate. The main element is stout, curved, and pointed, and the shorter, curved, pointed, accessory element is located above and lateral to it. Each chelicera bears a large, dorsal, subapical, sharp, recurved tooth or hook.

Oudemans (1912, fig. P 1) depicted two humeral setae on each side, thus: 4 — 6 — 2 — 6 — 2 — 6 — 2 — 4, each unit of two representing a single marginal seta on either side of the body, interposed between the rows.

The dorsal setae are rather short and plumose. There are two sternal setae between coxae I and two between coxae III. There are thirty additional plumose ventral abdominal setae.

Palpal segment I bears a plumose seta with six or seven cilia. Segment II bears a plumose seta. Segment III bears a plumose seta which has three cilia. On segment IV, the dorsal seta is nude, the lateral seta bears one or two branches, and the ventral seta bears seven delicate cilia. Segment V bears a basal, ventral, striated seta, plus several plumose setae, of which the exact number is not clear from the description. The figures show a total of four plumose setae on this segment. The galeal seta is nude.

The vestiture of the coxae is distinctive of the genus. There are four plumose setae on coxa I, seven on coxa II, and ten on coxa III. These coxal setae are short, and they bear delicate cilia. According to the figures and description, the vestiture of the remainder of the leg segments is not remarkable.

Oudemans gives the width of the scutum as 72 and the length (SD) as 42. If one could be certain that his figure is mathematically precise, the remainder of the measurements could be calculated on the above basis.

TYPE MATERIAL: Described from a single specimen from Hamburg, Germany, off a bat, *Synotus barbastellus,* collected in 1904 by H. Fahrenholz. Oudemans did not state where this type specimen is deposited, and the writer has been unable to ascertain its locality, or to confirm its present existence.

REMARKS: This species is known only from the original figures and description. It has not been reported by subsequent European collectors, and topotypic material would be most valuable for study.

Genus **Riedlinia** Oudemans, 1914

Genotype: *Riedlinia coeca* Oudemans, 1914, by original designation.

1914. *Riedlinia* Oudemans, Ent. Ber., *4,* no. 77, p. 88.
1916. *Riedlinia* Oudemans. Oudemans, Tijdschr. Ent., *59,* nos. 1-2, p. 26.
1937. *Reidlinea* (sic) Oudemans. Womersley, Rec. S. Aust. Mus., *6,* no. 1, p. 80: lapsus.
1940. *Riedlinia* Oudemans. Neave, Nomenclator Zoologicus, IV, p. 74.
1941. *Riedlinia* —. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 4, p. 624.
1942. *Riedlinia* Oudemans. Vitzthum, *op. cit.,* Lfg. 6, p. 829.
1943. *Reidlinea* (sic) Oudemans. Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, p. 72: lapsus.
1944. *Riedlinia* Oudemans. Ewing, J. Parasit., *30,* no. 6, p. 345.
1945. *Reidlinia* (sic) Oudemans. Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, p. 58: lapsus.
1946. *Reidlinia* (sic) Oudemans. Taylor, Comm. Aust. Serv. Publ. no. 6, p. 147: lapsus.

This genus is monotypic for *R. coeca* Oudemans, 1914, and no other described species known to the writer can be assigned to it at present. It is characterized by the absence of eyes and by the form of the tarsal empodium. The latter is expanded distally, being spatulate or lanceolate. The species was described from specimens in which the pseudostigmatic organs were missing. In the key to genera given by Womersley and Heaslip (1943), we read: "Sensillae globose". The basis for this statement is not known to the writer; it may be an assumption. In a previous paper, Womersley (1937, p. 80) had keyed this genus in that part of a dichotomy which stated that these structures were "not clavate", as opposed to the alternative, "clavate". Their form is unknown to the writer.

Riedlinia coeca Oudemans, 1914 (fig. 7 a)

1914. *Riedlinia coeca* Oudemans, Ent. Ber., *4,* no. 77, pp. 88-89.
1916. *Riedlinia coeca* Oudemans. Oudemans, Tijdschr. Ent., *59,* nos. 1-2, pp. 26-29; figs. 17-27.
1930. *Riedlinia coeca* Oudemans. Stiles and Nolan, Nat. Inst. Hlth. Bull. no. 155 (1), p. 640.
1931. *Riedlinia coeca* Oudemans. Vitzthum, Z. Parasitenk., *4,* Heft 1, pp. 6-7.
1940. *Riedlinia coeca* Oudemans. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 2, p. 244.
1941. *Riedlinia coeca* Oudemans. Vitzthum, *op. cit.,* Lfg. 4, p. 624.
1945. *Riedlinia coeca* Oudemans. Buitendijk, Zool. Meded., *24,* p. 337.

This species is represented in the Oudemans collection by two specimens mounted on a single slide, bearing the type data in Oudemans' handwriting, but not labelled as types. They are almost fully engorged, and the pseudostigmatic organs are missing.

DIAGNOSIS: The body of the larva is ovoid in shape. The integument bears unusually coarse, widely spaced striae. The leg segmentation is characteristic of the subfamily. The noteworthy feature of this genus is the nature of the tarsal claws, the empodium being spatulate, and the paired lateral claws being rather stouter than in other genera. The absence of eyes was confirmed by examination of both specimens under a phase contrast microscope, and there is no trace or vestige of these structures. The shape of the scutum is that depicted by Oudemans (1916), except that one is unable to distinguish the posterior margin with certainty, owing to the degree to which the clearing process has progressed. The scutum bears sparse medium-sized stippling. The five normal setae are sparsely barbed. Between the pseudostigma and the posterior lateral setal pore on either side is an area which is apparently depressed and stippled. These areas may serve for the reception of the terminal portions of pseudostigmatic organs,

but this is a matter of speculation since the nature of these organs is unknown.

The palpal claw is bifurcate, the prongs being closely apposed and difficult to distinguish from one another. The chelicerae are involved in a mass of host tissue, and they cannot be studied satisfactorily.

The dorsal setae are arranged as depicted by Oudemans: 6 — 8 — 6 — 2 — 2, and humeral setae cannot be distinguished. The dorsal setae bear sparse cilia or delicate barbs. There are two sternal setae between coxae I and two between coxae III. Since the posterior portion of the appropriate specimen is broken, the ventral setae cannot be studied. Oudemans figured thirty of these setae, and they appear to be short and nude.

The first palpal segment bears a plumose seta. On segment II is a lateral tubercle, from which a rather uneven nude seta arises. It is possible that this seta once bore minute barbs that have been lost. Segment III bears a definitely nude seta. On segment IV, the dorsal and lateral setae are nude and rather long, while the ventral seta is forked distally. In Oudemans' drawings of the palp (1916, figs. 18, 20), the nature of these setae is apt to be confusing, particularly since no seta is shown on segment III. Segment V was not well visualized by the writer, but it bears a basal, ventral, striated seta, plus several additional setae, of which one is long, stout, plumose, and prominent, as figured by Oudemans. The galeal seta is nude.

The coxae are unisetose, and the vestiture of the remainder of the leg segments is not remarkable.

On the specimen mounted with the dorsum upward, the following measurements were made: AW 35; PW 45; SB 17; ASB 16; PSB ?; AP 25; AM ?; AL 25; PL 36; DSA 50; DSP 25. The line of the pseudostigmata is 12 micra anterior to the line of the posterior lateral setal pores. Since the anterior median seta is perpendicular, it cannot be measured.

TYPE MATERIAL: Described from several specimens, exact number not specified, from Khandala, Bombay Province, India, 25 October 1911, off *Rhinolophus* sp. Oudemans stated (1914, p. 29): "Type in meiner Sammlung". The slide in his collection does not bear a type label. The writer hereby designates as lectotype the specimen in the Oudemans collection mounted with its dorsal surface upward.

REMARKS: This species is known only from the type material. Since the form of the pseudostigmatic organs is unknown, it is unsatisfactory to speculate on its relationships. The absence of eyes and the morphology of the tarsal claws are distinctive features. In Oudemans' key (1912, p. 192), it can be interposed between *Typhlothrombium* Oudemans (a synonym of *Gahrliepia* Oudemans), and *Rohaultia* Oudemans, but this does not indicate a relationship with either genus.

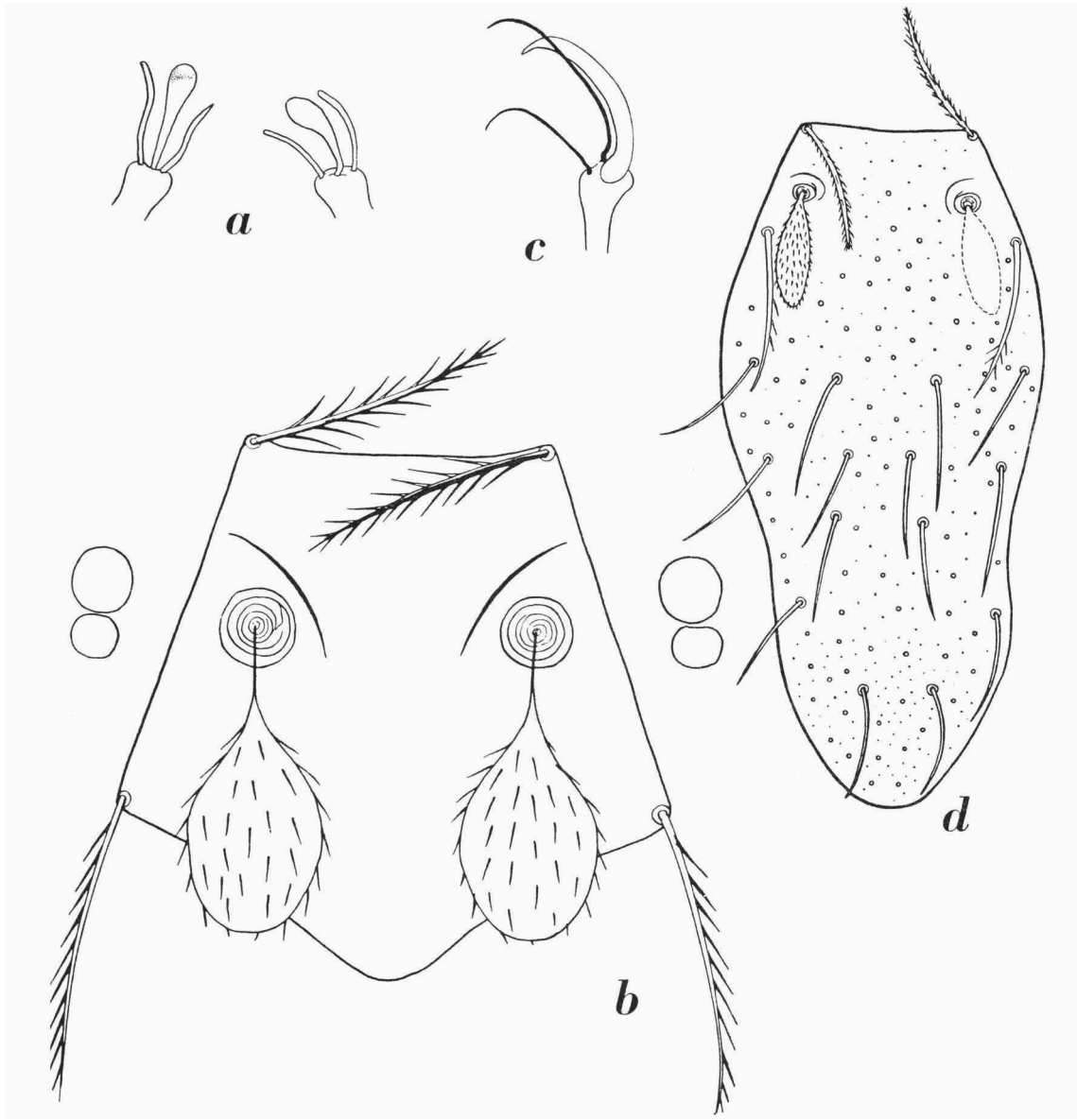

Fig. 7. *a, Riedlinia coeca* Oudemans, 1914, tarsus II; *b, c, Walchia disparunguis* (Oudemans, 1929): *b,* scutum; *c,* tarsal claws; *d, Gateria fletcheri* (Gater, 1932), scutum. Original (Sanina).

Subfamily WALCHIINAE Ewing, 1946

1946. Walchiinae Ewing, J. Parasit., *32*, no. 5, pp. 435-436.
1947. Walchiinae Ewing. Wharton, J. Parasit., *33*, no. 4, p. 381.

When Ewing proposed this subfamily, he included four genera: *Walchia* Ewing, 1931; *Gahrliepia* Oudemans, 1912; *Schöngastiella* Hirst, 1915; and *Gateria* Ewing, 1938. Wharton (1947) did not recommend any change in the list of genera included by Ewing. In the present paper, the writer has included a fifth genus, proposed as new, and monotypic for *Trombicula oudemansi* Walch, 1922.

The morphological characters of larvae of this subfamily are as follows: leg I composed of seven segments; legs II and III composed of six segments; at least two pairs of sternal setae; coxa I with only one seta, while more than one seta may be present on coxae II and/or III; pseudostigmatic organs clavate; tarsi bearing three claws, with frequent disparity in size between the two lateral claws; tarsal claws not provided with minute hairs. Frequently the eyes are reduced or absent. Spiracles and tracheae have not been observed in any of the known species. There is no long, nude, whip-like seta on any of the segments of leg III. In all except one genus, the scutum lacks an anterior median seta.

Many writers have regarded *Schöngastiella* Hirst, 1915, and *Gateria* Ewing, 1938, as synonyms of *Gahrliepia* Oudemans, 1912. Excellent reasons for doing so have been given by Womersley and Heaslip (1943, pp. 136, 138). These authors point out a transitional series, starting with *Gahrliepia rioi* Gunther, 1940, with four lateral scutal setae, in which the posterior prolongation of the scutum tends to include a number of median setae of one or more of the dorsal abdominal rows. This progression proceeds through *Schöngastiella* and *Gahrliepia,* reaching its culmination in *Gateria.* These points are brought out in the accompanying key.

The present writer has maintained these genera as distinct, admittedly for the sake of convenience in grouping species. From a phylogenetic standpoint, it is unlikely that they merit more than subgeneric standing. If the key is interpreted strictly, *G. rioi* Gunther, 1940, falls into *Walchia,* and the writer believes that a correct decision as to generic assignment must await further study. Unfortunately, the writer's treatment of this subfamily is more utilitarian than rational, owing to insufficient experience.

It is noteworthy that the described members of this subfamily have been recorded only from mammals, never from amphibians, reptiles, or birds. Most of the known species have been described from the Indo-Malayan and/or Austro-Malayan regions, where they appear to parasitize small mam-

mals by preference. They are very common on various species of rats and insectivores in the regions where they occur. Observations by Audy, *et. al.* (1947) indicate that certain species remain attached to their hosts for periods as long as six weeks.

At the time of writing, only the larval stages have been described, although the writer has seen nymphs reared from larvae of several species. As will be noted subsequently, the mite described and figured by Walch (1924) as the nymph of *Trombicula oudemansi* Walch, 1922, was in reality a nymph of *Euschöngastia indica* (Hirst, 1915).

Key to the Larval Genera of Walchiinae Ewing, 1946.

1.	Anterior median scutal seta present	New genus
	Anterior median scutal seta absent	2
2(1).	With four scutal setae	*Walchia* Ewing, 1931
	With more than four scutal setae	3
3(2).	With six scutal setae	*Schöngastiella* Hirst, 1915
	With more than six scutal setae	4
4(3).	Scutal setae all marginal	*Gahrliepia* Oudemans, 1912
	Scutal setae in part central	*Gateria* Ewing, 1938

Genus **Walchia** Ewing, 1931

Genotype: *Trombidium glabrum* Walch, 1927, by original designation.

1931. *Walchia* Ewing, Proc. U.S. nat. Mus., *80,* no. 2908, Art. 8, pp. 2, 10-11.
1932. *Walchia* Ewing. Gater, Parasitology, *24,* no. 2, pp. 169-173.
1935. *Walchia* Ewing. Sig Thor, Zool. Anz., *109,* nos. 5/6, p. 110.
1937. *Walchia* Ewing. Womersley, Rec. S. Aust. Mus., *6,* no. 1, p. 80.
1938. *Walchia* Ewing. Ewing, J. Wash. Acad. Sci., *28,* no. 6, p. 291.
1940. *Walchia* Ewing. Neave, Nomenclator Zoologicus, IV, p. 650.
1942. *Walchia* Ewing. Radford, Parasitology, *34,* no. 1, pp. 64, 79.
1942. *Walchia* Ewing. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 6, p. 829.
1943. *Walchia* Ewing. Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 71, 134-136.
1944. *Walchia* Ewing. Womersley, Trans. roy. Soc. S. Aust., *68,* no. 1, pp. 101-102.
1944. *Walchia* Ewing. Ewing, J. Parasit., *30,* no. 6, p. 348.
1945. *Walchia* Ewing. Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, p. 57.
1946. *Walchia* Ewing. Taylor, Comm. Aust. Serv. Publ. no. 6, pp. 147, 223-225.
1946. *Walchia* Ewing. Ewing, J. Parasit., *32,* no 5, p. 436.

Larvae of this genus are separated from other members of the subfamily by the fact that they have two pairs of lateral scutal setae, no anterior median scutal seta, and the chelicerae are not serrate. It is realized that *Gahrliepia rioi* Gunther, 1940, will fall in this genus on the basis of the writer's generic key. It can be distinguished from the species treated in the

following key by the fact that PSB is greater than 50 micra, the posterior scutal margin is broadly rounded, and the coxae are unisetose.

The construction of a key to the species of this genus is difficult, despite the fact that the writer has examined type material of each of the species included. In scrutinizing the following attempt, it will be apparent that specific distinctions based on larvae are in some instances quite arbitrary. The problem of speciation in this genus is obviously unsolved. This is particularly true in the case of *W. glabrum* (Walch, 1927), and *W. enode* Gater, 1932. The writer has been unable to find key characters to supplement those based on numbers of setae on coxae III. Womersley and Heaslip (1943) included characters which, in the writer's opinion, are not helpful, simply because they are relative in nature. For instance, these workers mentioned the shape of the pseudostigmatic organs, but since these structures are not always in the same position in mounted specimens, they are not comparable, and the character loses its usefulness in a key in this instance. A broadly clavate sensilla or pseudostigmatic organ may appear to be globose or capitate when its long axis is parallel to the observer's line of vision. They also mentioned the dorsal setal pattern, but this is almost impossible to distinguish in unengorged larvae, and furthermore it is subject to variation. This problem is discussed further under *W. enode* Gater, 1932.

In using the key, it is possible that variants of *W. glabrum* (Walch, 1927) may be encountered with two setae on each coxa III. On the basis of tarsal claws, these would key to *W. americana* Ewing, 1942. *W. americana* has fewer dorsal setae, and the scutum is much larger; furthermore its distribution is not known to overlap that of *W. glabrum,* although this point alone would be unreliable, for further collecting might reveal overlapping. Finally, it must be realized that this key is a preliminary attempt to provide a useful means for distinguishing larvae. As our species concepts acquire a more sound basis, this key will be subject to marked revision.

Key to the Described Species of the Genus *Walchia* Ewing, 1931.

1. Each coxa III with six setae . . . . . *W. lewthwaitei* Gater, 1932
   Each coxa III with fewer than six setae 2
2(1). Each coxa III with four setae; or four on one, five on the other; or four on one, three on the other . . . . . *W. enode* Gater, 1932
   Neither coxa III with four setae 3
3(2). Each coxa III with three setae; or three on one, two on the other . . . . *W. glabrum* (Walch, 1927) (=*W. pingue* Gater, 1932: syn.)
   Neither coxa III with three setae 4
4(3). Each coxa III with two setae 5
   Each coxa III with a single seta 6
5(4). Marked disparity in size of usual paired lateral tarsal claws, i.e., posterior lateral

claw of each tarsus of finer calibre than empodium, and shorter than anterior lateral claw . . . . . *W. disparunguis* (Oudemans, 1929)
Slight disparity in length of usual paired lateral tarsal claws, both being of stouter calibre than empodium . . . . . *W. americana* Ewing, 1942
6(4). SB only 18 to 20 micra . . . . . *W. morobensis* Gunther, 1939
SB greater than 30 micra 7
7(6). Chelicera with a sharp, recurved, dorsal toothlet . *W. rustica* (Gater, 1932)
Chelicera with a blunt, rounded hump on the dorsal margin . . . . . *W. turmalis* (Gater, 1932)

Two species are represented in the Oudemans collection by mounted specimens: *W. disparunguis* (Oudemans, 1929), and *W. enode* Gater, 1932.

Walchia enode Gater, 1932

1932. *Walchia enode* Gater, Parasitology, *24,* no. 2, pp. 169-170.
1942. *Walchia enode* Gater. Radford, Parasitology, *34,* no. 1, p. 64.
1943. *Walchia enodis* (sic) Gater. Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 134, 135-136; Pl. XII, fig. 4 (emendation).
1945. *Walchia enode* Gater. Buitendijk, Zool. Meded., *24,* p. 336.
1946. *Walchia enodis* (sic) Gater. Radford, Proc. zool. Soc. Lond., *116,* pt. II, p. 247.

This species is represented in the Oudemans collection by one paratype, presented by Gater, and taken at Sungei Buloh, Selangor, Federated Malay States, off *Rattus mülleri validus* (Miller).

DIAGNOSIS: The body of a fully engorged specimen is ovoid and elongate in shape. The leg segmentation is characteristic of the subfamily. On each tarsus, the anterior lateral claw is slightly stouter and longer than the posterior one, but there is no such striking disparity as is seen in *W. disparunguis* (Oudemans, 1929). Gater stated (1932, p. 169) that the ocular shield and eyes were apparently absent, and the writer has not found eyes on the type specimen or on paratypes. The scutum is longer than broad, the anterior margin concave, the posterior margin produced to form an acute angle, but quite variable in a series of specimens. The ordinary scutal setae bear delicate barbs. The pseudostigmatic organs appear to be capitate or clavate, depending upon the position in which they happen to be mounted. In comparing a series of this species with a series of *W. glabrum* (Walch, 1927), the writer has been unable to discern clear-cut differences in the scutum and its structures.

The palpal claw is trifurcate, the accessory prongs being fine, sharply pointed, shorter than the main element, and closely apposed to it. On the dorsal margin of each chelicera is a sharp, subapical, recurved, toothlet, and a more proximal, rounded hump. The ventral margin bears a recurved, gouge-like process.

As pointed out by Gater (1932, p. 169), the arrangement and number of

dorsal setae is variable within the type series, and this variation is particularly apparent in the posterior rows. Gater recorded thirty-two to thirty-eight dorsal setae, arranged approximately 2 — 6 — 6 — 6 — 6 — 4 — 4 — 2, and confirmed as variable by the writer's observations. The anterior and posterior dorsal setae are of equal lengths. There are two sternal setae between coxae I, and two between coxae III. The remainder of the ventral abdominal setae are variable in number, i.e., fifty to sixty, the more anterior ones being shorter and more delicate than those posterior to the anus.

The seta on palpal segment I is plumose, bearing several delicate cilia. Palpal segments II and III each bear a single nude seta. The dorsal, lateral and ventral setae on segment IV are nude. Segment V bears four plumose setae, in addition to the basal, ventral striated seta. The galeal seta is consistently nude.

The vestiture of coxa III requires detailed consideration, since it has been used as a key character for separation from *W. glabrum* (Walch, 1927). On the holotype, in the British Museum, the left coxa III bears four setae and the right one bears three. This observation was kindly confirmed for me by Dr. C. D. Radford, when we examined the material together. On the paratype in the Oudemans collection, and on the one in the U.S. National Museum, each coxa III bears four setae. With reference to this matter Gater stated (1932, p. 169): "In one specimen there are only three setae on one coxa and in one there are five on one coxa". The writer has examined a random series of twenty-five specimens, nominally *W. enode* Gater, 1932, from Mongjam and Kanglatongbi, both near Imphal, Manipur State, India, collected by the staff of the Scrub Typhus Research Laboratory, South East Asia Command; these were provided through the courtesy of Lt.-Col. J. R. Audy, R. A. M. C. Of this series, fifteen specimens have four setae on each coxa III; four have four on one side, three on the other; five have four setae on one side, five on the other; and one specimen has five setae on each coxa III. The writer has been unable to find correlating characters, and therefore he regards these as variants. Now in a series of specimens collected by the U.S.A. Typhus Commission near Myitkyina, Burma, which are nominally *W. glabrum* (Walch, 1927), one observes that the majority have three setae on each coxa III. However, in this Burmese material, there are variants with two setae on one side and three on the other, and some with three setae on one side and four on the other. In the absence of correlated characters, it would seem that the name to be applied to these specimens with three setae on one side and four on the other is purely arbitrary, as indicated in the writer's key. This situation is admittedly unsatisfactory, and the matter cannot be settled by the writer's studies of mounted larvae. A rational

solution would be aided by biological data, including correlation of larvae with nymphal and adult stages, and studies of their morphology. For the present, therefore, the writer has done no more than emphasize the matter of variation. It is quite possible that *W. enode* Gater, 1932, may eventually prove to be a race, or variant, of *W. glabrum* (Walch, 1927).

The following measurements are based on the holotype and paratype in the British Museum, and the paratype in the Oudemans collection.

AW	PW	SB	ASB	PSB	AP	AL	PL	SENS	DSA
30	54	27	21	?	39	28	28	33 × 15	34
30	50	24	22	?	38	26	30	33 × 14	34
28	53	22	22	36	36	24	28	28 × 13	28

The measurement for PSB on the specimens in the British Museum is omitted because the writer was unable to distinguish the outline of the posterior scutal margin.

TYPE MATERIAL: Described from nine specimens from Sungei Buloh, Selangor, Federated Malay States, 24 April 1930 and 8 August 1930, off *Rattus mülleri validus* (Miller), collected by Prof. B. A. R. Gater. In the British Museum (Natural History) are the holotype, no. 1932-7-18-31, and a paratype, no. 1932-7-18-32; in the U.S. National Museum is a single paratype, no. 1061. Paratypes are also deposited in the Molteno Institute, Cambridge, England; King Edward VII College of Medicine, Singapore; and Rijksmuseum van Natuurlijke Historie, Leiden.

GEOGRAPHICAL DISTRIBUTION:

Federated Malay States: Sungei Buloh, Selangor	Type locality
India: Imphal, Manipur State	Radford (1946)
Kanglatongbi and Mongjam	Audy (1947, personal communication)

RECORDED HOSTS:

Rattus mülleri validus (Miller)	Type host
Rattus rufescens	Radford (unpublished)

REMARKS: This species is a common ectoparasite of the genus *Rattus* in Assam and Burma. Its nearness to *W. glabrum* (Walch, 1927) should be appreciated. Series of larvae, nymphs, and adults should be studied throughout the range of each species, in an attempt to clarify the matter of synonymy or specific distinction.

Walchia disparunguis (Oudemans, 1929) (figs. 7 b, c, 8)

1929. *Schöngastiella disparunguis* Oudemans, Ent. Ber., *7*, no. 165, pp. 398-399.
1944. *Walchia disparunguis* (Oudemans). Womersley, Trans. roy. Soc. S. Aust., *68*, no. 1, pp. 83, 101-102.

1945. *Walchia disparunguis* (Oudemans). Kohls, Armbrust, Irons and Philip, Amer. J. Hyg., *41,* no. 3, p. 381.
1945. *Schöngastia* (sic) *disparunguis* Oudemans. Buitendijk; Zool. Meded., *24,* p. 336.
1947. *Walchia disparunguis* —. Mohr, Ecology, *28,* no. 2, pp. 194-199.

This species is represented in the Oudemans collection by a single slide, on which four cotype specimens are mounted.

DIAGNOSIS: The body of the partially engorged larva is ovoid in shape. The leg segmentation is characteristic of the subfamily. The nature of the tarsal claws is distinctive, in that the posterior lateral claw of each tarsus is finer, more delicate, and shorter than the empodium. The anterior lateral claw is stouter and shorter than the empodium, but longer than the posterior lateral claw. This disparity in size between the anterior and posterior elements of the usually paired lateral tarsal claws is carried to a greater degree in this species than in any other referable to *Walchia.*

A pair of eyes is present on each side of the scutum. The anterior eye has a well developed, very convex cornea, located at the level of the pseudostigmata. The posterior eye is almost equal in diameter, but it is much less distinct, and not so well developed. The shape of the scutum is shown in the accompanying figure (fig. 7 b on page 201), traced by the writer, and finished by Miss Sanina. There are eyebrows over the pseudostigmata. The normal scutal setae bear several rather delicate cilia, and the clavate pseudostigmatic organs bear short barbs.

On a specimen with the ventral surface facing upward, it is apparent that the palpal claw is trifurcate. The accessory prongs are sharp, delicate, subequal in length to each other, and both shorter than the main element. This character is not distinguishable in all specimens, however, its visibility depending upon the position in which the palpal claw is viewed. Each chelicera bears a dorsal, subapical, recurved toothlet. Owing to the position of the chelicerae, the writer was unable to be certain of the structure of the ventral margin.

Since the specimens examined are not engorged, it is difficult to discern a dorsal or ventral setal pattern. There is one humeral seta on each side, and there are six dorsal abdominal setae in the next row, followed by approximately twenty-six (or more) dorsal setae, of which the posterior ones are shorter. They are similar in form to the posterior lateral scutal setae. There are two plumose sternal setae between coxae I and two between coxae III. The remainder of the ventral surface bears approximately thirty-six plumose setae, of which twenty-two to twenty-four are pre-anal.

The palpi are rounded, not angulate. Segment I bears a plumose seta with long, delicate cilia. The setae on segments II, III, and IV are all nude.

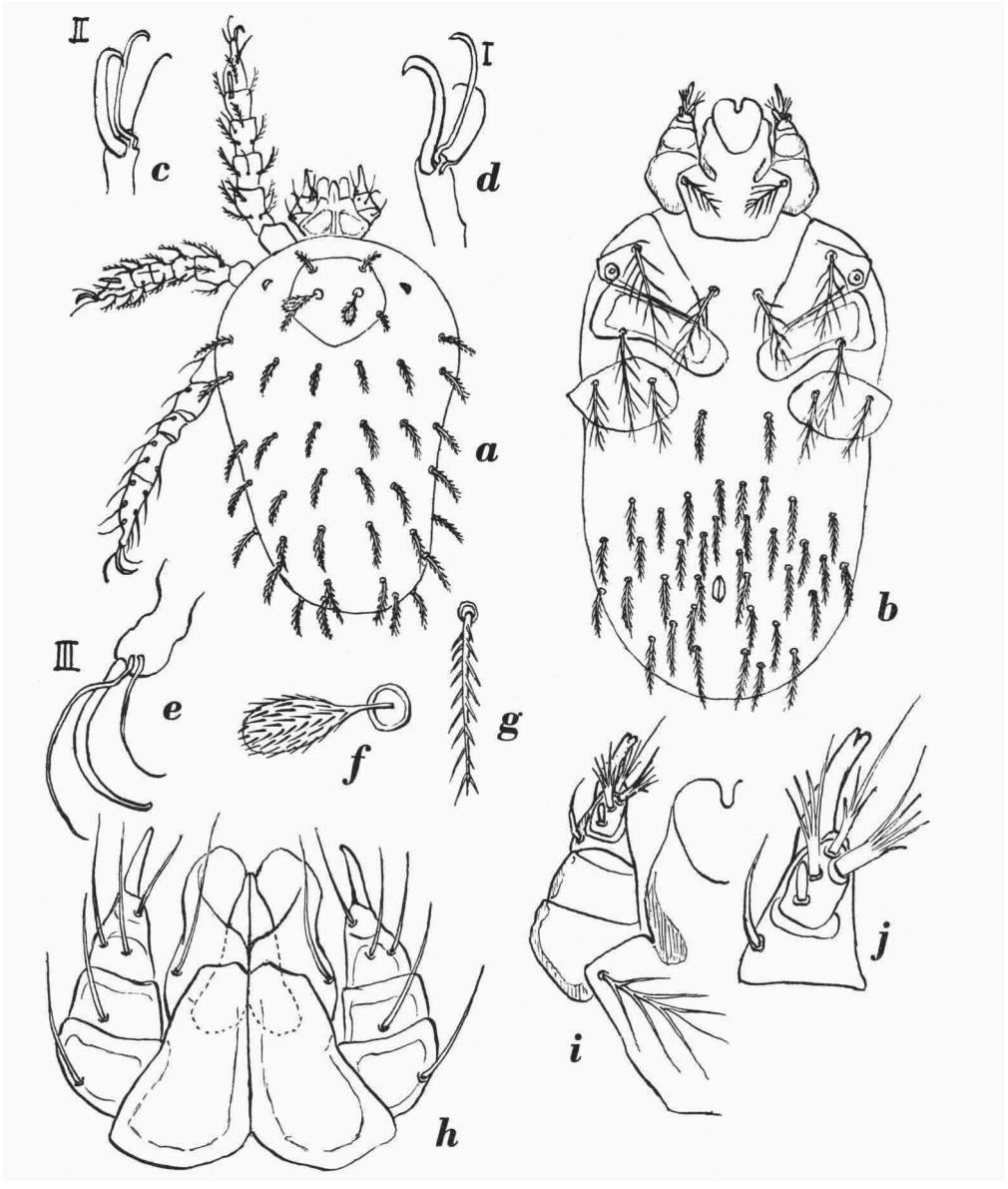

Fig. 8. *Walchia disparunguis* (Oudemans, 1929); *a*, dorsum; *b*, venter; *c*, distal part of right tarsus II; *d*, idem of right tarsus I; *e*, idem of left tarsus III; *f*, pseudostigmatic organ; *g*, dorsal seta; *h*, dorsal view of gnathosoma; *i*, ventral view of gnathosoma; *j*, ventral view of tibia and tarsus of right palp (Oudemans, original, unpublished).

Segment V bears a basal, ventral, peg-like, striated seta, plus four plumose setae of various forms. One of these plumose setae is long, slender, and delicate; another is much shorter and stouter; while the other two are not remarkable. The galeal seta is nude.

Coxae I and II each bear a single plumose seta, and coxa III bears two such setae. The vestiture of the remainder of the leg segments is not remarkable.

The following measurements are taken from these four cotypes.

AW	PW	SB	ASB	PSB	AP	AL	PL	SENS	DSA	DSP
27	46	25	18	32	35	27	28	28 × 14	28	—
28	46	25	18	34	34	25	28	29 × 12	31	22
28	45	24	20	35	34	24	28	29 × 12	28	24
28	48	24	20	36	35	25	27	28 × 12	27	25

TYPE MATERIAL: There is one slide, labelled as type in Oudemans' handwriting, in his collection, bearing four cotypes, with the following data: Garoet, West Java, August 1928, off *Rattus rattus* ssp., sent by W. C. van Heurn. These are mounted in Faure's solution, and they are in excellent condition for study.

GEOGRAPHICAL DISTRIBUTION:

West Java: Garoet	Type locality
Dutch New Guinea	Kohls, *et al.* (1945)
Dutch New Guinea: Sansapor	Mohr (1947)

RECORDED HOSTS:

Rattus rattus ssp.	Type host
Rattus concolor browni	Kohls, *et al.* (1945)
Rattus ringens	Mohr (1947)
Rattus exulans	Mohr (1947)

REMARKS: The distinctive tarsal claws, together with the two setae on coxa III, should serve to distinguish this species from other members of the genus. It may be noted that the writer's interpretation of the tarsal claws is not in agreement with that given by Womersley (1944, p. 102); possibly this is due to misunderstanding of Oudemans' description by the latter.

Genus **Schöngastiella** Hirst, 1915

Genotype: *Schöngastiella bengalensis* Hirst, 1915, by monotypy.

1915. *Schöngastiella* Hirst, Bull. ent. Res., *6*, pt. 2, p. 188.
1927. *Schöngastiella* —. Walch, Geneesk. Tijdschr. Ned. Ind., *67*, p. 927.
1929. *Schöngastiella* Hirst. Oudemans, Ent. Ber., *7*, no. 165, pp. 398-399.
1931. *Schöngastiella* Hirst. Vitzthum, Kükenthal's Handbuch der Zoologie, *3*, 2nd half (9), p. 146.

1931. *Schöngastiella* Hirst. Ewing, Proc. U.S. nat. Mus., *80,* no. 2908, Art. 8, p. 2.
1935. *Schöngastiella* Hirst. Sig Thor, Zool. Anz., *109,* nos. 5/6, p. 110.
1937. *Schöngastiella* Hirst. Womersley, Rec. S. Aust. Mus., *6,* no. 1, p. 79.
1938. *Schöngastiella* Hirst. Ewing, J. Wash. Acad. Sci., *28,* no. 6, pp. 291, 295.
1939. *Schöngastiella* Hirst. Abdussalam, Ind. J. Ent., *1,* pt. 3, p. 85.
1940. *Schöngastiella* Hirst. Neave, Nomenclator Zoologicus, IV, p. 140.
1941. *Schöngastiella* Hirst. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 4, p. 624.
1942. *Schöngastiella* Hirst. Vitzthum, *op. cit.,* Lfg. 6, p. 829.
1942. *Schöngastiella* Hirst. Radford, Parasitology, *34,* no. 1, p. 68.
1944. *Schöngastiella* Hirst. Ewing, J. Parasit., *30,* no. 6, p. 348.
1946. *Schöngastiella* Hirst. Radford, Proc. zool. Soc. Lond., *116,* pt. II, p. 247.
1946. *Schöngastiella* Hirst. Ewing, J. Parasit., *32,* no. 5, p. 436.

The necessity for maintaining this genus as distinct from *Gahrliepia* Oudemans, 1912, is a controversial matter, which has been discussed elsewhere. The writer has arbitrarily followed Ewing in retaining it. The species are easily separated from other members of this subfamily by the possession of only three pairs of marginal scutal setae. Thus the genus lies between *Walchia* Ewing, 1931, and *Gahrliepia* Oudemans, 1912. The described species are rather common parasites of rats, and thus far they have been recorded only from the Indo-Malayan region.

Although no species of this genus are represented in the Oudemans collection, the writer has provided a key, for the sake of completeness in the consideration of this subfamily. He has examined type material of all except *S. homunguis* (Abdussalam, 1939), which was originally described in the genus *Gahrliepia.* The similarity of this species and *S. ligula* Radford, 1946, will be noted, and the possibility of synonymy must be borne in mind.

Key to the Described Species of the Genus *Schöngastiella* Hirst, 1915.

1. Coxa III with two setae 2
   Coxa III with a single seta 3
2(1). PSB measuring approximately 78 micra . . . . *S. brevis* Radford, 1946
   PSB measuring approximately 114 micra . . . *S. punctata* Radford, 1946
3(1). Scutal margins not incurved posterior to the posterior lateral setal pores . . *S. bengalensis* Hirst, 1915
   Scutal margins definitely incurved posterior to the posterior lateral setal pores 4
4(3). Dorsal setae arranged 4 — 4 — etc., or 2 — 6 — etc. (total of eight in first two rows); total dorsal setae forty-six; palpal claw definitely trifurcate . . . *S. ligula* Radford, 1946
   Dorsal setae arranged 2 — 4 — etc. (total of six in first two rows); (total dorsal setae not recorded); palpal claw described as bifurcate . . . . . *S. homunguis* (Abdussalam, 1939)

As noted previously, this genus is not represented in the Oudemans collection, and it is discussed for the sake of completeness in the treatment of the Walchiinae.

Genus **Gahrliepia** Oudemans, 1912

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

1910. *Typhlothrombium* Oudemans, Ent. Ber., *3,* no. 56, p. 105.
1912. *Typhlothrombium* Oudemans. Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 83-86.
1912. *Typhlothrombium* Oudemans. Berlese, Redia, *8,* p. 281 (preoccupied by *Typhlothrombium* Berlese, 8 July 1910).
1912. *Gahrliepia* Oudemans, Ent. Ber., *3,* no. 67, p. 273: nomen novum for *Typhlothrombium* Oudemans, 1 November 1910, preoccupied.
1928. *Typhlothrombium* Oudemans. Methlagl, Denkschr. Akad. Wiss. Wien, *101,* p. 214.
1928. *Typhlotrombidium* Oudemans, Treubia, *8* suppl., p. 91: nomen novum for *Typhlothrombium* Oudemans, 1 November 1910, preoccupied.
1931. *Gahrliepia* Oudemans. Vitzthum, Kükenthal's Handbuch der Zoologie, *3,* 2nd half (9), pp. 48, 63, 146.
1932. *Gahrliepia* Oudemans. Gater, Parasitology, *24,* no. 2, p. 161 (equals *Typhlothrombium* Oudemans, 1910, and *Schöngastiella* Hirst, 1915, synonyms).
1935. *Gahrliepia* Oudemans. Sig Thor, Zool. Anz., *109,* nos. 5/6, p. 110.
1937. *Gahrliepia* Oudemans. Womersley, Rec. S. Aust. Mus., *6,* no. 1, p. 79.
1938. *Gahrliepia* Oudemans. Ewing. J. Wash. Acad. Sci., *28,* no. 6, pp. 291, 292, 295.
1939. *Gahrliepia* Oudemans. Neave, Nomenclator Zoologicus, II, pp. 431.
1939. *Gahrliepia* Oudemans. Abdussalam, Indian, J. Ent., *1,* pt. 3, pp. 84-85.
1940. *Typhlothrombium* Oudemans. Neave, Nomenclator Zoologicus, IV, p. 602 (preoccupied; synonym of *Gahrliepia* Oudemans, 1912).
1940. *Gahrliepia* Oudemans. Gunther, Proc. Linn. Soc. N.S.W., *65,* parts 5-6, nos. 291-292, p. 481 (equals *Typhlothrombium* Oudemans, 1910, and *Schöngastiella* Hirst, 1915, synonyms).
1941. *Gahrliepia* —. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 4, p. 624.
1942. *Gahrliepia* Oudemans. Vitzthum, *op. cit.,* Lfg. 6, p. 829 (equals *Typhlothrombium* Oudemans, 1910, preoccupied).
1942. *Gahrliepia* Oudemans. Radford, Parasitology, *34,* no. 1, pp. 64, 79.
1943. *Gahrliepia* Oudemans. Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 72, 136-141 (equals *Typhlothrombium* Oudemans, 1910; *Schöngastiella* Hirst, 1915; and *Gateria* Ewing, 1938, synonyms).
1944. *Gahrliepia* Oudemans. Ewing, J. Parasit., *30,* no. 6, p. 348.
1945. *Gahrliepia* Oudemans. Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, pp. 14, 57, 75 (equals *Schöngastiella* Hirst, 1915, and *Gateria* Ewing, 1938, synonyms).
1946. *Gahrliepia* Oudemans. Taylor, Comm. Aust. Serv. Publ. no. 6, p. 147 (equals *Schöngastiella* Hirst, 1915, and *Gateria* Ewing, 1938, synonyms).
1946. *Gahrliepia* Oudemans. Ewing, J. Parasit., *32,* no. 5, p. 436.
1946. *Gahrliepia* Oudemans. Radford, Proc. zool. Soc. Lond., *116,* pt. II, p. 247.

On November 1, 1910, Oudemans proposed the genus *Typhlothrombium,* designating *T. nanus* Oudemans, 1910, as the type species. No other species were included. However, the name had been published on July 8, 1910, by Berlese, who used it for a different mite (Redia, *6,* fasc. 2, p. 358), with *Trombidium histricinum* Leonardi, 1901, as genotype. Upon learning of Berlese's earlier publication, Oudemans proposed the new name *Gahrliepia* in 1912. In 1928, apparently having overlooked or forgotten his earlier

proposal of a new name, Oudemans proposed *Typhlotrombidium* to replace his preoccupied genus. This becomes a synonym of *Gahrliepia* by simple application of the law of priority.

Gater (1932) regarded *Schöngastiella* Hirst, 1915, as a synonym of *Gahrliepia,* and Gunther (1940) followed him. Womersley and Heaslip (1943) did likewise and regarded *Gateria* Ewing, 1938, as an additional synonym, giving valid reasons for doing so. The writer has, however, decided to follow Ewing and others in recognizing these genera, realizing that this procedure may be illogical and open to criticism.

Members of the genus *Gahrliepia* Oudemans, 1912, are characterized by the possession of four or more pairs of marginal scutal setae. Ewing (1938) restricted the genus to those species in which the setae are marginal. In other respects, the species of *Gahrliepia* share the characters of the subfamily. The two species conforming to Ewing's definition of the genus can be separated by the following key, based on the writer's examination of specimens.

Key to the Described Species of the Genus *Gahrliepia* Oudemans, 1912.

Scutal length 192 micra; scutal width 96 micra; dorsal setae 42-32 micra in length
G. cetrata Gater, 1932

Scutal length 112 micra; scutal width 77 micra; dorsal setae 20-15 micra in length
G. nanus (Oudemans, 1910)

Gahrliepia nanus (Oudemans, 1910)

1910. *Typhlothrombium nanus* Oudemans, Ent. Ber., *3,* no. 56, p. 105.
1911. *Typhlothrombium nanus* Oudemans. Oudemans, Ent. Ber., *3,* no. 57, p. 122.
1912. *Typhlothrombium nanus* Oudemans. Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 83-86, 192, 203; fig. U.
1930. *Typhlothrombium nanus* Oudemans. Stiles and Nolan, Nat. Inst. Hlth. Bull. no. 155 (1), p. 640.
1931. *Gahrliepia nana* (Oudemans). Vitzthum, Z. Parasitenk., *4,* Heft, 1, p. 7.
1938. *Gahrliepia nanus* (Oudemans). Ewing, J. Wash. Acad. Sci., *28,* no. 6, pp. 291-292.
1939. *Gahrliepia nanus* (Oudemans). Abdussalam, Indian J. Ent., *1,* pt. 3, pp. 84-85.
1940. *Gahrliepia nanus* —. Gunther, Proc. Linn. Soc. N. S. W., *65,* pts. 5-6, nos. 291-292, p. 481.
1942. *Gahrliepia nanus* (Oudemans). Radford, Parasitology, *34,* no. 1, p. 64; fig. 33.
1943. *Gahrliepia nanus* (Oudemans). Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 136, 138.
1945. *Gahrliepia nana* (Oudemans). Buitendijk, Zool. Meded., *24,* p. 337.

This species is represented in the Oudemans collection by a slide bearing a single specimen, with the data of the original series in Oudemans' handwriting. It is in excellent condition for study, except that it has been cleared to too great a degree.

DIAGNOSIS: The body of the partially engorged larva is ovoid in shape. The leg segmentation is characteristic of the subfamily, and the paired lateral tarsal claws show no disparity in size. The empodium is likewise normal. At the level of the second pair of lateral scutal setae, on either side of the scutum, there is a suggestion of paired eyes. Owing to the degree to which clearing has taken place, the writer is uncertain about these structures. Oudemans stated (1912, p. 84): "Augenschildchen und Augen fehlen". The scutum was correctly described and figured by Oudemans (1912, *loc. cit.*, fig. U).

The palpal claw is trifurcate, the two accessory prongs being shorter than the main element, and closely apposed to it. All three prongs are sharply pointed. Each chelicera bears a dorsal, subapical, recurved toothlet. On the ventral margin there is only a suggestion of a vestigial toothlet, and for practical purposes it can be regarded as absent. The arrangement of the dorsal setae is that depicted by Oudemans, i.e., exclusive of the scutal setae: 2 — 2 — 4 — 6 — 4 — 4 — 2. There are two sternal setae between coxae I and two between coxae III. There are thirty-eight additional ventral setae, which bear a few minute barbs. According to Oudemans (1912, p. 85), they are arranged: 10 — 8 — 8 — 6 (three on either side of the anus) — 4 — 2. The post-anal setae resemble the posterior dorsal setae.

Palpal segment II possesses a lateral angle, or tubercle, as figured by Oudemans. The seta on segment I bears several delicate cilia. Segments II and III each bear a single nude seta. The dorsal, lateral, and ventral setae on segment IV are nude. Segment V is difficult to visualize, but it bears at least four plumose setae, in addition to the usual, basal, ventral, striated seta. The galeal seta is nude.

Each coxa bears a single seta, similar in form to the sternal setae. These sternal and coxal setae are described and figured by Oudemans as nude. Although they were not too well visualized by the writer, it seems possible that their apparent nudeness is actually due to loss of delicate cilia, owing to trauma. The vestiture of the remainder of the leg segments is not remarkable.

The measurements on this single specimen are as follows: AW 43; PW 73; SB 41; ASB 14; PSB 91; AP 35; AL 27; PL 22; SENS 28 × 5.6; DSA 20; DSP 15.

TYPE MATERIAL: Described from three specimens taken at Durban, Africa, during January, 1905, by Dr. Ivar Trägårdh. One was taken off *Hipposideros caffer* Sundevall, and two off *Georhychus hottentottus* Lesson; one off the latter host is in the Oudemans collection. Oudemans stated (1912, p. 86) that the type was in the collection of Dr. Trägårdh, Stockholm,

Sweden, but he did not specify from which host the type was described. The writer has been unable to ascertain whether or not the type is still in existence. Since the specimen now in the Oudemans collection was before him when the description was written, it can be regarded as a paratype.

REMARKS: This species is known only from the original material. It is the only member of the subfamily recorded from bats, and also the only one recorded from the African continent. Since little intensive collecting of these mites has been done in Africa, however, an attempt to discuss the possible significance of these facts would be premature at this time.

Gahrliepia cetrata Gater, 1932

1932. *Gahrliepia cetrata* Gater, Parasitology, *24,* no. 2, pp. 165-167; fig. 12.
1942. *Gahrliepia cetrata* Gater. Radford, Parasitology, *34,* no. 1, p. 64; fig. 35.
1943. *Gahrliepia cetrata* Gater. Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 138, 140; Pl. XIII, fig. 1.
1945. *Gahrliepia cetrata* Gater. Buitendijk, Zool. Meded., *24,* p. 336.

This species is represented in the Oudemans collection by a paratype, bearing the data of the original series, and presented by Prof. B. A. R. Gater. The writer has also studied the holotype and two paratypes in the British Museum (Natural History).

DIAGNOSIS: The body of the engorged larva is ovoid in shape. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. Two markedly reduced eyes are just barely visible on either side of the scutum at the level of the pseudostigmata. The anterior eye is the larger. The scutum is of the shape depicted by Gater (1932, p. 166, fig. 12), except that the two posterior pairs of lateral scutal setae are actually removed further mesially from the scutal margin. However, this character is variable. The normal scutal setae bear short barbs, and the clavate pseudostigmatic organs bear short cilia.

The palpal claw is obviously trifurcate in this specimen, but this feature cannot be observed on the specimens in the British Museum, owing to their position. Each chelicera bears a blunt, dorsal hump, and a sharp, recurved, ventral, gouge-like process.

The dorsal abdominal setae are similar in form to the normal scutal setae, and they are arranged: 2 — 4 — 4 — 6 — 6 — 4 — 4 — 2. The posterior dorsal setae are shorter than the anterior ones. There are two plumose sternal setae between coxae I, and two between coxae III. There are fifty to fifty-six additional ventral abdominal setae, of which the pre-anal ones are shorter and more delicate than those located posterior to the anus.

Palpal segment I bears a plumose seta. The seta on segment II bears a

few short barbs. In the specimens examined by the writer, the seta on segment III is nude, although Gater (1932, p. 166) states that rarely it possesses a few barbs. The dorsal and lateral setae on segment IV are nude, while the ventral seta may be nude on one palp and barbed on the other palp of a single specimen. Segment V bears four plumose setae, in addition to a rather long, basal, ventral, striated seta. The galeal seta is nude.

Each coxa bears a single plumose seta, and the vestiture of the remainder of the leg segments is not remarkable.

The following measurements were made from the type and two paratypes in the British Museum, and the paratype in the Oudemans collection, respectively.

AW	PW	SB	ASB	PSB	AP	AL	PL	SENS	DSA	DSP
51	77	48	24	18	40	32	42	38 × 11	42	35
51	77	48	22	18	38	35	38	—	40	32
51	80	49	22	19	42	35	45	—	38	35
53	80	49	24	17	42	35	43	—	39	—

In the material examined, the maximum width of the scutum varies from 96 to 105 micra, this width being attained shortly behind the line of the posterior lateral setal pores. The maximum length is more variable: 147 to 192 micra. In the above table, PSB is not used in the ordinary sense, but here it denotes the distance between the line of the pseudostigmata and the line of the posterior lateral setal pores. The distance between the two setae of the third scutal pair is 53 to 59 micra; while the distance between the two setae of the fourth pair is 35 to 40 micra.

TYPE MATERIAL: Described from thirteen specimens from Fraser's Hill, altitude 4,500 feet, Pahang, Federated Malay States, off *Rattus edwardsi ciliatus* (Bonhote). The mites were removed from the region of the ears and the anus of the type host, stated by Gater to be found only in the hills. The holotype, no. 1932-7-18-19, and two paratypes, nos. 1932-7-18-20 and 21, are in the British Museum (Natural History). Paratypes are deposited also in the United States National Museum, no. 1058; the Molteno Institute, Cambridge, England; King Edward VII College of Medicine, Singapore; and the Rijksmuseum van Natuurlijke Historie, Leiden.

REMARKS: This species is known at present only from the type material. Its distinctive scutum should serve to separate it from other described members of the subfamily.

Genus **Gateria** Ewing, 1938

Genotype: *Gahrliepia fletcheri* Gater, 1932, by original designation.

1938. *Gateria* Ewing. J. Wash. Acad. Sci., *28*, no. 6, pp. 291, 295.

1942. *Gateria* Ewing. Radford, Parasitology, *34,* no. 1, p. 67.
1942. *Gateria* Ewing. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 6, p. 829.
1944. *Gateria* Ewing. Ewing, J. Parasit., *30,* no. 6, p. 348.
1946. *Gateria* Ewing. Ewing, J. Parasit., *32,* no. 5, p. 436.
1946. *Gateria* Ewing. Radford, Proc. zool. Soc. Lond., *116,* pt. II, p. 247.

This genus was established for species of *Gahrliepia* Oudemans, 1912, in which some of the normal scutal setae are not marginal. The writer has been unable to find any additional character for separation. Ewing stated (1938, p. 295): "... the important point about the setae on the dorsal plate is not their number, but the fact that some of them are not marginal". Womersley and Heaslip (1943, pp. 136, 138) gave adequate and sound reasons for considering *Gateria* a synonym of *Gahrliepia.* However, Ewing, Radford, and Wharton have continued to regard *Gateria* as a distinct and valid genus. The writer has arbitrarily followed them in so doing at the present time, realizing that this procedure is open to criticism.

The following key to species is based on the writer's study of type specimens of each species. It will be noted (couplet 7) that no character has been found for the separation of two of Radford's species. One of these, *G. crocidura* Radford, 1946, was based on imperfect specimens in which the pseudostigmatic organs were missing. The possibility of synonymy must be borne in mind, but the writer has deferred definitive action in the absence of perfect specimens.

Key to the Described Species of the Genus *Gateria* Ewing, 1938.

1. Scutum bearing two setae on each anterior corner (posterior laterals have moved forward) . . . . . *G. hirsuta* Radford, 1946
   Scutum bearing one seta on each anterior corner 2
2(1). Scutum with large and small "pits", the larger ones resembling oil droplets . . *G. fletcheri* (Gater, 1932)
   Scutum with fine or medium stippling of uniform size 3
3(2). Scutum less than 125 micra in length (depth) 4
   Scutum more than 140 micra in length (depth) 5
4(3). Scutal and dorsal abdominal setae all greater than 45 micra in length; scutum almost pointed posteriorly . . . . . *G. longipili* Radford, 1946
   Scutal and dorsal setae all less than 20 micra in length; scutum blunt and rounded posteriorly . . . . . *G. rutila* (Gater, 1932)
5(3). Scutum bearing ten to twelve setae, in addition to the anterior and posterior laterals 6
   Scutum bearing six setae, in addition to the anterior and posterior laterals . 7
6(5). All scutal setae marginal except for a pair behind the posterior laterals; total scutal setae fourteen in number; total dorsal setae (exclusive of scutal setae) thirty-two in number . . . . . *G. ciliata* (Gater, 1932)
   More than two setae located on central portion of scutum; total scutal setae

sixteen; total dorsal setae (exclusive of scutal setae) twenty-six . *G. spinulosa* Radford, 1946

7(5). *G. crocidura* Radford, 1946, and *G. lancearia* Radford, 1946.

Only the genotype species is represented in the Oudemans collection.

Gateria fletcheri (Gater, 1932) (fig. 7 d)

1932. *Gahrliepia fletcheri* Gater, Parasitology, *24,* no. 2, pp. 161-163; fig. 9.
1938. *Gateria fletcheri* (Gater). Ewing, J. Wash. Acad. Sci., *28,* no. 6, p. 295.
1942. *Gateria fletcheri* (Gater). Radford, Parasitology, *34,* no. 1, p. 67; fig. 48.
1943. *Gahrliepia fletcheri* Gater. Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 138, 140; pl. XIII, fig. 3.
1945. *Gahrliepia fletscheri* (sic) Gater. Buitendijk, Zool. Meded., *24,* p. 337: lapsus.
1947. *Gahrliepia fletcheri* Gater. Audy, Nature, Lond., *159,* pp. 295-296.

This species is represented in the Oudemans collection by five specimens mounted on a single slide, bearing the data of the type series. These are labelled as cotypes in Oudemans' handwriting, but they are paratypes in the meaning of the word as used elsewhere in the present paper. The writer has also studied the material in the British Museum (Natural History), and in the United States National Museum.

DIAGNOSIS: The specimens of the type series are ovoid in shape, being nearly fully engorged. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. The ocular shields are small, being located on either side of the scutum at the level of the pseudostigmata. The eyes are poorly developed, and the anterior one is slightly larger. The shape of the scutum is that depicted in the accompanying drawing (fig. 7 d on page 201), made by Miss Sanina from the type specimen. Gater's figure (1932, fig. 9), was too schematic, as pointed out by him (*loc. cit.*, p. 162). The number of scutal setae, exclusive of pseudostigmatic organs, varies from fourteen to twenty. There are eighteen scutal setae on the holotype in the British Museum. Of the three specimens in the Oudemans collection on which the scutal setae can be counted, two have sixteen and one has seventeen. The anterior and posterior lateral setae are stouter than the remainder of the scutal setae. The setae behind the posterior laterals are not symmetrically arranged on all specimens. The scutum bears two types of ornamentation: uniformly distributed fine stippling, and scattered larger areas of differential refractility, which may or may not be "pits". The writer has seen a similar type of ornamentation in an undescribed species of this genus, collected in Burma. The pseudostigmatic organs are clavate, and they bear fine, short barbs. There are "eyebrows" over the pseudostigmata.

The palpal claw is trifurcate, the accessory elements being fine, sharply pointed, shorter than the main element, and closely apposed to it. Each

chelicera bears a blunt dorsal hump, distal to which there is a minute, sharp, recurved toothlet. On the ventral margin there is a recurved gouge-like process.

The dorsal setae are arranged as stated by Gater: 1, 2, 2 on each side of the scutum, then 6 — 6 — 4 — 4 — 2 across the posterior portion of the body. There are two sternal setae between coxae I and two between coxae III. The remainder of the ventral abdominal setae are variable in number, i.e., fifty to sixty, those anterior to the anus shorter and more delicate than the post-anal setae.

The seta on palpal segment I bears several delicate cilia. Segment II is provided with a minute lateral tubercle, and its seta bears several short cilia on the proximal portion of the shaft. The seta on segment III may vary on two sides of an individual specimen, being nude, or provided with one or two cilia. Segment IV bears three uniformly nude setae, of which the dorsal one is the longest. Segment V bears a basal, ventral, striated seta, in addition to four plumose setae of various forms. The galeal seta is nude.

The coxae are uniformly unisetose, and the vestiture of the remainder of the leg segments is not remarkable.

The material in the Oudemans collection was not measured. The following measurements are based on the type and two paratypes in the British Museum (Natural History).

AW	PW	SB	ASB	PSB	AP	AL	PL	SENS	DSA	SD	SCUTAL WIDTH
53	78	48	22	18	42	35	38	38 × 13	35	182	96
51	77	45	19	18	38	34	35	38 × 12	35	182	96
51	75	46	22	16	38	35	37	—	38	185	96

The measurements for PSB in this instance denote the distance between the line of the pseudostigmata and the line of the posterior lateral setal pores; it will be noted, therefore, that the sum of ASB and PSB is not equal to SD.

TYPE MATERIAL: Described from "numerous specimens" (number not specified) from Kuala Lumpur, Selangor, Federated Malay States, off *Rattus diardi diardi* (Jentink). 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.

Gater gave additional records as noted below.

GEOGRAPHICAL DISTRIBUTION:

Federated Malay States: Kuala Lumpur, Selangor	Type locality
Sungei Buloh, Selangor	Gater (1932)

RECORDED HOSTS:

Rattus rattus diardi (Jentink)	Type host
Rattus sabanus vociferans Miller	Gater (1932)
Sciurus caniceps concolor Blyth	Gater (1932)
Tupaia glis ferruginea Raffles	Gater (1932)
Rhinosciurus tupaiodes laticaudatus (Blyth)	Gater (1932)

REMARKS: Gater collected this species during March, April, May, June, July, August, and November. He found it to be more prevalent on rats from the town than those from the country. It is not clear whether this observation is to be explained on the basis of host preference, or on the basis of environmental factors favorable to the mites themselves, or possibly a combination of these. Gater noted that these larvae tended to remain attached to a host for twelve or more hours after the death of the host. Similar unpublished observations on duration of attachment after death of the host have been made on undescribed species of this genus studied in Burma and Assam by the U.S.A. Typhus Commission.

The variability of this species should be appreciated, particularly by workers in the field who may collect apparently new species, and who may not have access to museum material.

Genus **Walchiella** new genus

Genotype: *Trombicula oudemansi* Walch, 1922.

DIAGNOSIS: The larva is a trombiculid mite in general facies. Spiracles and tracheae are absent. The leg segmentation is characteristic of the subfamily Walchiinae. In the genotype, the tarsal claws are normal. Paired eyes are present on either side of the scutum. The scutum is roughly rectangular in shape, not being produced posteriorly. There are five normal scutal setae: two anterior laterals, two posterior laterals, and a single anterior median. The pseudostigmatic organs are clavate. The palpal claw is trifurcate. The chelicerae are characteristic, bearing about four teeth on the dorsal margin, in addition to the usual subapical recurved toothlet, and a ventral, gouge-like process. The dorsal and ventral abdominal setae are unusually short. Coxae I and II are closely apposed to each other (as in other Trombiculidae), and coxa III is only slightly removed from coxa II. The chaetotaxy of the palpi and legs is not remarkable. There is no long, nude, whip-like, sensory seta on tarsus III.

At present this genus is monotypic, and the writer knows of no other described species that should be included.

Walchiella is easily separated from other members of the subfamily by the possession of an anterior median seta. This suggests a relationship with the Trombiculinae. Although the scutum is not produced posteriorly, its posterior margin is sinuate, and the scutal outline is somewhat reminiscent of that of *Euschöngastia lacunosa* (Gater, 1932). The ocular shield and eyes are much more developed than those of other Walchiinae. The chelicerae are not typical of the Walchiinae, in possessing several dorsal teeth. However, certain species of *Walchia* possess a tooth or hump on the dorsal cheliceral margin, in addition to the subapical toothlet. The leg segmentation is considered to suggest relationship with the other genera included in the Walchiinae. The significance of this character is admittedly controversial, but the writer agrees with Wharton (1947) on its basic value in grouping genera into subfamilies. A minor character which this genus shares with some other Walchiinae is the nearness of coxae III to coxae II.

The genotype is hereby placed in the Walchiinae for the first time. Although it has frequently been referred to *Schöngastia* and *Neoschöngastia,* it is abundantly distinct from any of the other species included in those genera.

The nymphal and adult characters are not known with certainty, since a mite described by Walch as the nymph has been shown to have been incorrectly determined.

Walchiella oudemansi (Walch, 1922)

1922. *Trombicula Oudemansi* Walch, Geneesk. Tijdschr. Ned. Ind., *62,* no. 5, pp. 563-564; tables II, III; figs. 18-21.
1923. *Trombicula Oudemansi* Walch, Kitasato Arch., *5,* no. 3, pp. 77-78; tables I, II; pl. II, figs. 17-20.
1924. *Trombicula oudemansi* —. Walch, Trans. 5th Bienn. Congr. Far East. Assoc. Trop. Med. (1923), pp. 584, 598, 600, 601, 607, 608-610, 623-626; tables III, IV; figs. 17, 34-37: larva only, but *not* nymph.
1924. *Trombicula Oudemansi* —. Walch and Keukenschrijver, Geneesk. Tijdschr. Ned. Ind., *64,* pp. 254, 261.
1924. *Trombicula Oudemansi* —. Walch, Geneesk. Tijdschr. Ned. Ind., *64,* pp. 499, 502, 508, 513, 521-523; tables I, II; figs. 16-19: larva only, but *not* nymph.
1925. *Trombicula Oudemansi* —. Walch, Kitasato Arch., *6,* no. 3, pp. 240, 242, 251-252; tables III, IV; pl. IV, figs. 23-26: larva only, but *not* nymph.
1927. *Trombicula oudemansi* Walch. Stiles and Hassall, Hyg. Lab. Bull. no. 148, p. 269.
1927. *Trombicula oudemansi* —. Walch, Geneesk. Tijdschr. Ned. Ind., *67,* pp. 924, 926, 927, 932.
1928. *Trombicula oudemansi* —. Fletcher, Lesslar and Lewthwaite, Trans. R. Soc. trop. Med. Hyg., *22,* no. 2, p. 169: fig. 4.

1929. *Trombicula oudemansi* —. Patton and Evans, Insects, Mites etc., pp. 650, 655, 656; fig. 334.
1929. *Trombicula oudemansi* Walch. Hirst, Proc. zool. Soc. Lond., 1929, p. 174.
1932. *Schöngastia oudemansi* (Walch). Gater, Parasitology, *24,* no. 2, p. 154.
1937. *Trombicula oudemansi* —. Mehta, Indian J. med. Res., *25,* no. 2, pp. 358-360.
1938. *Neoschöngastia clauda* Gunther, Med. J. Aust., 25th year *2,* no. 6, p. 204: nomen nudum.
1939. *Neoschöngastia impar* Gunther, Proc. Linn. Soc. N. S. W., *64,* pts. 1-2, nos. 281-282, pp. 85-86; figs. 11, 16, 24 (equals *Neoschöngastia clauda* Gunther, 1938, synonym).
1939. *Neoschöngastia impar* Gunther. Womersley, Trans. roy. Soc. S. Aust., *63,* pt. 2, p. 165.
1940. *Neoschöngastia impar* —. Gunther, Proc. Linn. Soc. N. S. W., *65,* pts. 3-4, nos. 289-290, p. 251.
1940. *Neoschöngastia bodensis* Gunther, Proc. Linn. Soc. N. S. W., *65,* pts. 5-6, nos. 291-292, pp. 482-483; figs. 10-12.
1940. *Neoschöngastia impar* Gunther. Gunther, Med. J. Aust., 27th year *2,* no. 22, p. 569.
1941. *Neoschöngastia impar* Gunther. Gunther, Proc. Linn. Soc. N. S. W., *66,* pts. 5-6, nos. 297-298, p. 391.
1941. *Schöngastia oudemansi* (Walch). Gunther, *op. cit.,* p. 394.
1942. *Neoschöngastia impar* Gunther. Gunther, Proc. Sixth Pacific Sci. Congr. 1939, p. 718.
1942. *Neoschöngastia oudemansi* (Walch). Radford, Parasitology, *34,* no. 1, p. 74; fig. 82.
1942. *Neoschöngastia impar* Gunther. Radford, *op. cit.,* p. 74; fig. 88.
1943 *Schöngastia oudemansi* (Walch). Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 102-103; pl. VI, fig. 1.
1943. *Neoschöngastia impar* Gunther. Womersley and Heaslip, *op. cit.,* pp. 107, 116-117; pl. VIII, fig. 7 (equals *Neoschöngastia bodensis* Gunther, 1940, synonym).
1944. *Neoschöngastia impar* Gunther. Womersley, Trans. roy. Soc. S. Aust., *68,* no. 1, p. 87.
1945. *Schöngastia oudemansi* (Walch). Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, pp. 27, 70; fig. 38.
1945. *Neoschöngastia impar* Gunther. Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, pp. 34, 74; fig. 46.
1945. *Schöngastia oudemansi* (Walch). Blake, Maxcy, Sadusk, Kohls and Bell, Amer. J. Hyg., *41,* no. 3, p. 264.
1945. *Neoschöngastia impar* Gunther. Blake, *et al., op. cit.,* pp. 295, 299.
1945. *Neoschöngastia impar* Gunther. Kohls, Armbrust, Irons and Philip, Amer. J. Hyg., *41,* no. 3, p. 381.
1945. *Schöngastia oudemansi* (Walch). Buitendijk, Zool. Meded., *24,* p. 336.
1945. *Otonyssus oudemansi* (Walch). Buitendijk, *op. cit.,* p. 338.
1946. *Neoschöngastia impar* Gunther. Taylor, Comm. Aust. Serv. Publ. no. 6, pp. 185, 196-197; fig. 168 (equals *Neoschöngastia bodensis* Gunther, 1940, synonym).
1946. *Trombicula oudemansi* Walch. Taylor, *op. cit.,* p. 204.
1947. *Neoschöngastia impar* —. Mohr, Ecology, *28,* no. 2, pp. 194-199.

This species is represented in the Oudemans collection by the following material: four slides labelled *"Trombicula oudemansi",* bearing larvae from Medan, Deli, Sumatra, 1923, off *Felis marmorata,* collected by Dr. E. W. Walch; and a single specimen from Sungei Buloh, Selangor, Federated

Malay States, 2 March 1929, off *Rattus rattus jalorensis* (Bonhote), collected and presented by Prof. B. A. R. Gater.

The writer has also studied a topotypic larva in the Instituut voor Hygiene en Tropische Geneeskunde, Leiden. He has seen paratypes of *Neoschöngastia impar* Gunther, 1939, and of *N. bodensis* Gunther, 1940, in the British Museum (Natural History). He has seen specimens from Burma and Assam, collected by the U.S.A. Typhus Commission. He was loaned a series of specimens from New Guinea, kindly provided by G. M. Kohls.

The following descriptive remarks are based on topotypic material from Sumatra, and they apply equally to the other specimens examined by the writer.

DIAGNOSIS: The body of the engorged larva is pinkish white in color, with brillant red eye spots, rotund in shape, without any noticeable constriction. The integumentary striations are widely spaced and coarse. The leg segmentation is characteristic of the subfamily. The tarsal claws are normal, the paired lateral claws being of equal size, while the empodium is longer and of finer calibre. On either side of the scutum is an ocular shield, bearing two eyes, of which the anterior one is the larger, and located at the level of the line of the pseudostigmata. The scutum is of the shape depicted by Walch, and subsequently by Gunther. The anterior margin is biconcave, and the anterior lateral setal pores are located at the anterior corners. The lateral margins are irregularly incurved, and the posterior margin is distinctly sinuate. There are "eyebrows" over the pseudostigmata, and a curved line behind each pseudostigma. The scutum is covered with small, dense stippling. The five normal scutal setae bear very short barbs, arising from several sides of the shafts. These are lost from the majority of specimens examined, giving rise to a serrated appearance. The anterior median seta is the longest, and the posterior lateral setae are the shortest. The pseudostigmatic organs are clavate, becoming gradually expanded shortly beyond the base, and pointed apically. They bear sparse, very delicate barbs, which are easily lost.

The palpal claw is trifurcate. The main element is pointed and curved. The rather stout, dorsal, accessory element is lateral to the main element. The minute, ventral, accessory prong is closely apposed to the main element, and is easily overlooked. Each chelicera bears a dorsal, subapical, recurved toothlet, and three to five more proximal dorsal toothlets. The latter are easily overlooked unless the chelicera is viewed from the lateral aspect. The ventral margin bears a recurved, gouge-like process, similar to other genera of Walchiinae.

The dorsal abdominal setae are similar in form to the anterior lateral

scutal setae. Their arrangement seems to be fairly consistent, i.e.: 2 — 6 — 6 — 6 — 4 — 4 — 2. In the specimen from Malaya, they are arranged: 2 — 7 — 5 — etc. There are two short, plumose, sternal setae between coxae I, and two between coxae III. There are thirty-six to forty additional short, ventral, abdominal setae. Most of these appear to be serrate, owing to the loss of their short, delicate barbs.

The seta on palpal segment I bears nine or more delicate cilia, which are easily lost. The seta on segment II is nude. The seta on segment III is apparently variable. It may be nude, or it may bear one to three delicate, lateral cilia. The writer is not certain whether the nude appearance is real, or whether it is due to loss of cilia. The dorsal and lateral setae on segment IV are variable, being either nude, or provided with three or four delicate cilia. The ventral seta on this segment is nude or bears one or two cilia. Segment V bears a basal, ventral, striated seta; an apical, curved, spine-like seta; plus five or six plumose setae of various forms. The galeal seta is uniformly nude.

Coxa III is only slightly removed from coxa II. Each coxa has a single plumose seta, bearing delicate cilia which are easily lost. The vestiture of the remainder of the leg segments is not remarkable. Walch thought that the presence of a nude, pointed seta on "telofemur III" was unusual. A similar one is present on tibia III.

Measurements are recorded herewith for: (1) a topotypic specimen from Sumatra; (2) the specimen from Malaya in the Oudemans collection; (3) four paratypes of *Neoschöngastia bodensis* Gunther, 1940, in the British Museum (Natural History); and (4) four specimens from Dobadura, New Guinea, 22 July 1944, off *Melomys* sp., collected by G. M. Kohls, and part of the series loaned by him to the writer.

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	SENS	DSA	DSP
53	63	32	22	22	34	35	24	18	39 × 10	32	18
53	63	31	31	21	35	36	28	15	40 × 10	27	20
52	68	33	26	24	38	36	26	18	—	32	22
57	66	33	26	27	39	38	24	16	—	30	22
56	68	32	24	26	38	38	24	16	—	32	22
57	66	33	26	26	34	38	27	20	44 × 12	32	24
53	63	28	25	24	35	39	24	17	43 × 10	28	18
56	69	31	27	21	35	35	22	15	41 × 9	24	14
53	69	31	28	21	38	35	22	14	—	24	14
56	70	32	25	22	35	38	24	17	—	27	17

TYPE MATERIAL: *Trombicula oudemansi* Walch, 1922, was described from Deli, Sumatra, off "rats", collected by Dr. E. W. Walch, no holotype

designated. According to Mrs. Walch, his original material is in the Koningin Wilhelmina Instituut voor Hygiene en Bacteriologie, Batavia, Java. However, in a recent communication, Prof. Dr. R. Gispen does not list this among the species represented in their collection. There are topotypic specimens in the Oudemans collection, and in the Instituut voor Hygiene en Tropische Geneeskunde, Leiden.

Neoschöngastia impar Gunther, 1939, was described from "sixty specimens from seven bandicoots (six *Echymipera cockerelli* and one *Peroryctes raffrayana*), many from two Monckton's melomys (*Melomys moncktoni*), one Stalker's melomys (*Melomys stalkeri*), one Rufous melomys (*Melomys rubex*) and thirteen Brown bush-rats (*Rattus ringens*)". In his description of this species, Gunther (1939, pp. 85-86) did not specify a type locality, but he stated earlier in his paper that the collections were made in the main Lower Bulolo basin, in the Morobe District, British New Guinea. He stated (p. 78) that type specimens were in the School of Public Health and Tropical Medicine, Sydney, and paratypes in the Australian Museum, Sydney. In reporting a study of type material, Womersley and Heaslip (1943, p. 117) give measurements for two "type" specimens. Thus one assumes that Gunther had cotypes and paratypes. There are many paratypes on a slide in the British Museum (Natural History), no. 1947-3-13-5.

Neoschöngastia bodensis Gunther, 1940, was described from Bode River, British North Borneo, September 1939, off mouse deer, *Tragulus borneanus* Miller. There were colonies on the legs of the type host. The type material is in the School of Public Health and Tropical Medicine, Sydney. Womersley and Heaslip (1943, p. 117) record measurements for three "type" specimens, which are presumably cotypes. Four paratypes are in the British Museum (Natural History), no. 1947-3-13-4.

GEOGRAPHICAL DISTRIBUTION:

Sumatra:	Deli	Type locality
	Lampong Districts	Walch (1927)
Federated Malay States		Fletcher, Lesslar and Lewthwaite (1928)
	Sungei Buloh, Selangor	Gater (1932)
	Fraser's Hill (4,500 ft.), Pahang	Gater (1932)
India:	Simla Hills — Kasauli and Sabathu	Mehta (1937)
	Ledo, Assam	U.S.A. Typhus Comm. (unpublished)
British New Guinea:		
	Budolo Basin	Gunther (1939)
	Milne Bay	Womersley (1944)
	Dobadura	Blake, *et al.* (1945)
British North Borneo:	Bode River	Gunther (1940)

Dutch New Guinea: Sansapor	Mohr (1947)
Burma: Myitkyina	U.S.A. Typhus Comm. (unpublished)

RECORDED HOSTS:

"Rats"	Type host
House rats, field rats, concolor rats	Walch and Keukenschrijver (1924)
Tiger cat, *Felis marmorata*	Walch and Keukenschrijver (1924)
Man, *Homo sapiens* Linnaeus	Walch and Keukenschrijver (1924); Walch (1925)
Rattus rattus diardi (Jentink)	Gater (1932)
Rattus rattus jalorensis (Bonhote)	Gater (1932)
Rattus mülleri validus (Miller)	Gater (1932)
Trichys fasciculata fasciculata (Shaw)	Gater (1932)
Sciurus notatus miniatus Miller	Gater (1932)
Rhinosciurus laticaudatus tupaiodes (Blyth)	Gater (1932)
Tupaia glis ferruginea Raffles	Gater (1932)
Tragulus kanchil fulviventer Gray	Gater (1932)
Rattus edwardsi ciliatus (Bonhote)	Gater (1932)
"Rats"	Mehta (1937)
Echymipera cockerelli	Gunther (1939)
Peroryctes raffrayana	Gunther (1939)
Melomys moncktoni	Gunther (1939)
Melomys stalkeri	Gunther (1939)
Melomys rubex	Gunther (1939)
Rattus ringens	Gunther (1939)
Rattus browni Alston	Gunther (1940)
Tragulus borneanus Miller	Gunther (1940)
Rattus praetor (?)	Blake, *et al.* (1945)
Rattus flavipectus yunnanensis (Anderson)	U.S.A. Typhus Comm. unpubl.
Suncus murinus fulvo-cinerea Anderson	U.S.A. Typhus Comm. unpubl.
Crocidura vorax Allen	U.S.A. Typhus Comm. unpubl.

MEDICAL IMPORTANCE: This species was recorded once for man in Sumatra by Walch and Keukenschrijver (1924, p. 261). Walch (1925, p. 240) commented that this species "... be it only once, has been found on man too". Gater and others did not collect it from human beings in Malaya. Apparently it seldom attacks man, and it can be regarded as of practically no potential medical importance.

REMARKS: Womersley and Heaslip (1943, pp. 116-117) suppressed *N. bodensis* Gunther, 1940, as a synonym of *N. impar* Gunther, 1939, presenting adequate evidence for this action. Until the writer's studies, however, *N. impar* was regarded as distinct from *Walchiella oudemansi.* This was due in part to the fact that the cheliceral teeth are often difficult to see, as they may be invisible unless the cheliceral blade is in an appropriate position. The writer recently communicated his findings to Mr. H. Womersley, who studied the matter and expressed his agreement.

Walch figured a nymph which he referred to this species. As discussed elsewhere in this paper, this is not *Walchiella oudemansi* (Walch, 1922), but it is the nymph of *Euschöngastia indica* (Hirst, 1915). It is possible that the nymph of *W. oudemansi* is the mite with nude pseudostigmatic organs, which Walch ascribed to his species, *Trombicula muris,* a synonym of *E. indica* (Hirst, 1915). In other words, the slides may have been inadvertently switched. However, a decision on this matter must await critical association of larvae with nymphs in individual rearing containers.

The wide variety of hosts accepted by this species is of interest, but it will be noted that birds are not included. *Walchiella oudemansi* is common and widespread in the Indo-Malayan and Austro-Malayan regions. Its systematic relationships have been discussed.

Subfamily LEEUWENHOEKIINAE Womersley, 1944

1944. Leeuwenhoekiinae Womersley, Trans. roy. Soc. S. Aust., *68,* no. 1, pp. 102-103.
1945. Leeuwenhoekiidae Womersley, Trans. roy. Soc. S. Aust., *69,* no. 1, pp. 96-113.
1946. Leeuwenhoekiinae Womersley. Taylor, Comm. Aust. Serv. Publ. no. 6, p. 225.
1946. Leeuwenhoekiinae Womersley. Ewing, J. Parasit., *32,* no. 5, p. 435.
1946. Leeuwenhoekidae (sic) —. Radford, Proc. zool. Soc. Lond., *116,* pt. II, p. 247.
1947. Leeuwenhoekiidae Womersley. Dumbleton, Trans. roy. Soc. N. Z., *76,* pt. 3, pp. 409-411.
1947. Leeuwenhoekiinae Womersley. Wharton, J. Parasit., *33,* no. 4, p. 381.

André (1943) first reported the presence of a respiratory spiracle, or true stigma, situated in front of the first coxae, on either side of the gnathosoma, from which tracheal tubes radiate. This was noted for *Leeuwenhoekia paradoxa* André, 1943. Similar findings were reported by Womersley (1944) for five species from New Guinea and Australia, at that time included in the genus *Leeuwenhoekia* Oudemans, 1911, and later referred to *Acomatacarus* Ewing, 1942. Womersley proposed the new subfamily Leeuwenhoekiinae, but in 1944 he was able to place only the type genus in it. In 1945, Womersley elevated his subfamily to full familial rank, and included the following additional genera: *Hannemannia* (sic) Oudemans, 1911; *Apolonia* Torres and Braga, 1939; *Comatacarus* Ewing, 1942; and *Acomatacarus* Ewing, 1942. Referring to the presence of spiracles and tracheae in the larvae, Womersley stated (1945, p. 96): "I am now convinced that such a fundamental character justifies raising the group to familial rank..." This is a matter of opinion, on which there is no agreement, and the writer has followed the more conservative views of Ewing and Wharton in maintaining the group at the level of a subfamily. Womersley mentioned additional larval characters, but none of them, even the scutal

ones, are constant within the subfamily. He did not emphasize the segmentation of the legs, as has been done by subsequent writers. Womersley included also the adult genus *Neotrombidium* Leonardi, 1901, on the basis of the similarity of its crista to the same structure of the nymphs and adults of *Acomatacarus* Ewing, 1942. The writer prefers to await the discovery of the larvae of *Neotrombidium,* before including this genus in the subfamily.

Ewing (1946) gave a key to subfamilies, including in the Leeuwenhoekiinae six genera in which there is a pair of submedian setae on the anterior margin of the scutum. He referred to his previously published key to genera (1944), thus including: *Comatacarus* Ewing, 1942; *Acomatacarus* Ewing, 1942; *Leeuwenhoekia* Oudemans, 1911; *Apolonia* Torres and Braga, 1939; *Whartonia* Ewing, 1944; and *Hannemania* Oudemans, 1911. He redescribed *Odontacarus* Ewing, 1929, reporting the presence of spiracles and tracheae. However, in his key to subfamilies, it would fall into Trombiculinae Ewing, 1929, on the basis of scutal characters.

The writer has accepted the definition of the subfamily given by Wharton (1947), as being a natural grouping of genera, as well as a useful one. The following larval characters are diagnostic: all legs composed of six segments; coxa I bearing two setae; pseudostigmatic organs flagelliform. Spiracles and tracheae have been noted by others or confirmed by the writer for all except *Chatia* Brennan, 1946, and *Comatacarus* Ewing, 1942. Excepting *Odontacarus* Ewing, 1929, the scutum bears two anterior median setae. Minute hairs have been observed by the writer on the tarsal claws of certain species of *Hannemania* Oudemans, 1911, and *Acomatacarus* Ewing, 1942. They have not been observed in *Chatia* Brennan, 1946, and the remainder of the genera have not been studied sufficiently.

The following key will separate the larval genera recognized by Wharton (1947) as belonging to this subfamily.

1. One anterior median scutal seta . . . . . *Odontacarus* Ewing, 1929
   Two anterior submedian scutal setae 2
2(1). Posterior lateral scutal setae unusually stout; dorsal setae arising from tubercles *Leeuwenhoekia* Oudemans, 1911
   Posterior lateral scutal setae normal, or foliate; dorsal setae not arising from tubercles 3
3(2). Each tarsus bearing only two equal claws (empodium lacking on all tarsi); palpal claw bearing seven or more terminal prongs; chelicera without toothlets; scutum without anterior median extension; coxa III bearing five to seven setae; spiracles and tracheae absent . . . . . *Chatia* Brennan, 1946
   Without this combination of characters 4
4(3). Chelicerae with numerous, rather stout, recurved teeth, reminiscent of a larval Ixodid tick; no anterior median extension of scutum . . . . . *Whartonia* Ewing, 1944

Without this combination of characters 5

5(4). Chelicerae with a single dorsal tooth; anterior median extension of scutum present or absent . . . . . *Comatacarus* Ewing, 1942

Chelicerae with a series of dorsal teeth; anterior median extension of scutum consistently present 6

6(5). Chelicerae blade-like, with a series of dorsal teeth and upturned ventral teeth *Acomatacarus* Ewing, 1942

Chelicerae expanded distally, resembling a spearhead, with a series of teeth on the expanded portion . . . . . *Hannemania* Oudemans, 1911

Three genera are represented in the Oudemans collection: *Leeuwenhoekia* Oudemans, 1911; *Acomatacarus* Ewing, 1942; and *Hannemania* Oudemans, 1911. It is the writer's opinion that our generic concepts in this subfamily are unsound regarding these three genera, and therefore he regards the above key as arbitrary and preliminary. This matter is given further consideration below.

Genus **Acomatacarus** Ewing, 1942

Genotype: *Acomatacarus arizonensis* Ewing, 1942, by original designation.

1942. *Acomatacarus* Ewing, J. Parasit., *28,* no. 6, p. 490.
1944. *Acomatacarus* Ewing. Ewing, J. Parasit., *30,* no. 6, p. 347.
1945. *Acomatacarus* Ewing. Womersley, Trans. roy. Soc. S. Aust., *69,* no. 1, pp. 96-98, 110, 111.
1946. *Acomatacarus* Ewing. Taylor, Comm. Aust. Serv. Publ. no. 6, pp. 225-234.
1946. *Acomatacarus* Ewing. Ewing, Proc. biol. Soc. Wash., *59,* pp. 24, 26.
1946. *Acomatacarus* Ewing. Ewing, J. Parasit., *32,* no. 5, p. 436.
1946. *Acomatacarus* Ewing. Radford, Proc. zool. Soc. Lond., *116,* pt. II, p. 247.
1947. *Acomatacarus* Ewing. Radford, Proc. zool. Soc. Lond., *116,* pt. III, pp. 579, 580-583.

Ewing described this genus as related to *Comatacarus* Ewing, 1942, but differing as follows: each chelicera with a row of teeth on the dorsal margin, instead of a single tooth, and with nude setae on palpal segments II and III, instead of one or both setae being plumose or barbed. The cheliceral character applies to the four species included by Ewing (1942), whereas the palpal setal character applies to the genotype, but not to the three Old World species included by Ewing. The writer is able to resolve this inconsistency only by ignoring the palpal setal character. Also in some, but not all, of the species on which data are adequate, there is a long, nude, whip-like seta on tarsus III. The presence of minute hairs on the lateral tarsal claws of some species has been referred to previously. The following species whose larvae are known can be included tentatively in *Acomatacarus*:

A. adelaideae (Womersley, 1944)	Not seen
A. arizonensis Ewing, 1942	Not seen
A. athertonensis Womersley, 1945	Not seen
A. audyi Radford, 1946	Seen
A. australiensis (Hirst, 1925)	Seen
A. barrinensis Womersley, 1945	Not seen
A. echidnus Womersley, 1945	Not seen
A. galli Ewing, 1946	Not seen
A. gateri (Radford, 1942)	Seen
A hirsti (Womersley, 1944)	Not seen
A. jaegerskioeldi (Oudemans, 1911)	Seen
A. longipes Womersley, 1945	Not seen
A. lygosomae Dumbleton, 1947	Not seen
A. mccullochi (Womersley, 1944)	Not seen
A. nova-guinea (Womersley, 1944)	Not seen
A. polydiscum (Oudemans, 1910)	Not seen
A. southcotti (Womersley, 1944)	Not seen
A. thallomyia Radford, 1947	Seen
A. theileri Radford, 1947	Seen

The following species were included in *Acomatacarus* by Womersley (1945), but they are not known as larvae: *A. attolus* (Banks, 1916); *A. dromus* (Womersley, 1939); *A. patrius* Womersley, 1945; and *A. retentus* (Banks, 1916). It is convenient to assume that their larvae possess the characters of this genus, but the writer believes that the more conservative policy is to await the actual discovery of their larvae, rather than to include them on the basis of similarities among free-living stages.

No host preferences are noted in this genus. Two species have been recorded for man: *A. australiensis* (Hirst, 1925), and *A. barrinensis* Womersley, 1945. Species have been described from the United States, Africa, Egypt, India, and the Pacific region. In view of the writer's inadequate study of material, a key to species is not provided.

Acomatacarus jaegerskioeldi (Oudemans, 1911)

1911. *Leeuwenhoekia jaegerskioeldi* Oudemans, Ent. Ber., *3,* no. 58, p. 138.
1912. *Leeuwenhoekia jaegerskioeldi* Oudemans. Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 79-82, 192, 203; fig. T.
1925. *Leeuwenhoekia jaegerskioeldi* Oudemans. Hirst, Trans. R. Soc. trop. Med. Hyg., *19,* no. 3, p. 150.
1942. *Leeuwenhoekia jaegerskioeldi* Oudemans. Radford, Parasitology, *34,* no. 1, p. 70; fig. 67.
1942. *Acomatacarus jaegerskioeldi* (Oudemans). Ewing, J. Parasit., *28,* no. 6, p. 490.
1943. *Leeuwenhoekia jaegerskioeldi* Oudemans. André, Bull. Mus. Hist. nat. Paris, 2e sér., *15,* no. 5, p. 294.
1945. *Leeuwenhoekia jaegerskioeldi* Oudemans. Buitendijk, Zool. Meded., *24,* p. 336.

This species is represented in the Oudemans collection by fragments of a specimen, mounted on a slide bearing the data of the original series in

Oudemans' handwriting. The scutum and anterior portion of the body are present, minus capitulum and legs. Therefore the following remarks are based mainly on the description and figures by Oudemans (1912).

DIAGNOSIS: The partially engorged larva is broadly ovate in shape. In the specimen examined, on either side anterior to coxa I, is a spiracle, from which tracheal tubes can be traced on either side as far back as coxae III. These spiracles and tracheae were neither described nor figured by Oudemans. According to Oudemans (1912, p. 82), the leg segmentation is characteristic of the subfamily, and the tarsal claws are normal. Since the writer dit not find tarsal claws in the fragments examined, he can make no statement regarding the presence or absence of minute hairs upon them, but such hairs were neither mentioned nor figured by Oudemans. On either side of the scutum, near the posterior corners, is an ocular shield, bearing a well developed anterior eye, and a smaller, poorly developed, posterior eye. The scutum is of the form depicted by Oudemans (1912, fig. T 1, but not fig. T 4). In fig. T 4, he has placed the pseudostigmata too far in advance of the line of the posterior lateral setal pores, whereas they are actually only slightly in advance of this line. There are "eyebrows" over the pseudostigmata. The normal scutal setae are figured as bearing short cilia; and the pseudostigmatic organs bear nine short cilia, arising from the distal half of the shaft. The palpal claw is described and figured as bifurcate, the inner main element being pointed and very slightly curved, the accessory element being shorter, straight, pointed, and located above and lateral to the main element. The chelicerae are described and figured as bearing six dorsal teeth.

The dorsal setae bear short barbs, arising from several sides of the shaft. There is a single humeral seta on each side, and a total of sixty-two dorsal setae. Oudemans' formula for their arrangement is 2 — 10 — 4 — 12 — 14 — 10 — 6 — 4, but the writer finds it difficult to discern such a precise pattern on Oudemans' figure of this species. There are no sternal setae between coxae I, and two between coxae III. Between coxae II and III, on either side, are three setae, which may represent a ventral extension of a dorsal row. The remainder of the ventral setae are thirty-eight in number, increasing in size posteriorly, but their pattern cannot be expressed as a formula.

The seta on palpal segment I bears four long, delicate cilia. The setae on segments II and III bear numerous short, delicate, lateral cilia. On segment IV, the dorsal seta bears very short cilia, the lateral seta is nude, and the ventral seta bears three delicate cilia. Segment V bears a basal, ventral striated seta, plus six plumose setae bearing delicate cilia, according

to Oudemans (1912, p. 82). The galeal seta bears several short cilia or barbs.

The arrangement of coxal setae is characteristic of the subfamily. Oudemans *(loc. cit.)* described tarsus III, "mit 1 kurzen Sinneshaar", but he did not mention a "Tasthaar", or long, nude, whip-like seta. Among the fragments studied by the writer, the legs were not found, but according to Oudemans' figures, their vestiture is not remarkable.

It was possible to make only a few measurements on the material examined: AW 62; PW 77; SB 28; ASB 31; PSB 17; AP 25.

TYPE MATERIAL: Described from four specimens from Heluan, near Cairo, Egypt, May 1901, under stones, not on a host, collected by Dr. Ivar Trägårdh. According to Oudemans *(loc. cit.)*, the type is in Dr. Trägårdh's collection, Stockholm, Sweden, but the writer has been unable to ascertain or confirm its present existence.

REMARKS: This species is known only from the original specimens and description. In proposing the genus *Acomatacarus,* Ewing (1942) included this species without stating reasons. The chelicerae conform to the generic description. With regard to the palpi, however, the setae on segments II and III are both barbed, and this feature does not conform to Ewing's definition. Because of the inadequacy of his own studies, the writer is unable to express an opinion of value concerning the generic relationships of this species. For this reason, placing emphasis on cheliceral morphology rather than palpal setae in this instance, he has arbitrarily followed Ewing's generic assignment of this species.

Acomatacarus polydiscum (Oudemans, 1910)

1910. *Heterothrombidium polydiscum* Oudemans, Ent. Ber., *3,* no. 56, p. 105.
1911. *Leeuwenhoekia polydiscum* (Oudemans). Oudemans, Ent. Ber., *3,* no. 58, p. 138.
1912. *Leeuwenhoekia polydiscum* (Oudemans). Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 77-79, 192, 203; fig. S.
1925. *Leeuwenhoekia polydiscum* (Oudemans). Hirst, Trans. R. Soc. trop. Med. Hyg., *19,* no. 3, p. 150.
1930. *Leeuwenhoekia polydiscum* (Oudemans). Stiles and Nolan, Nat. Inst. Hlth. Bull. no. 155 (1), pp. 639-640.
1942. *Leeuwenhoekia polydiscum* (Oudemans). Radford, Parasitology, *34,* no. 1, p. 68; fig. 66.
1942. *Acomatacarus polydiscum* (Oudemans). Ewing, J. Parasit., *28,* no. 6, p. 490.
1945. *Leeuwenhoekia polydiscum* (Oudemans). Buitendijk, Zool. Meded., *24,* p. 336.

This species is represented in the Oudemans collection by drawings only. Since the writer has not examined any specimens, the following remarks are based on information published by Oudemans (1912).

DIAGNOSIS: The body of the fully engorged larva is described as rotund,

almost spherical in shape, only slightly oval, and constricted toward the middle. The leg segmentation is characteristic of the subfamily and the tarsal claws are normal. The presence or absence of minute hairs on the tarsal claws is not mentioned by Oudemans. On either side of the scutum, at the level of the posterior lateral setal pores, is a small ocular shield, bearing two eyes of approximately equal size. The maximum width (PW) of the scutum is 97 micra, and its length (SD), exclusive of the anterior median projection, is 23 micra. The anterior margin is strongly incurved, and the posterior margin is strongly sinuate. The relative lengths of the normal scutal setae are: PL longer than AL, which are longer than AM. These setae are short and stout, bearing numerous barbs arising from several sides of the shafts. The pseudostigmata are located in the posterior half of the scutum, with their anterior margins behind the line of the posterior lateral setal pores. The pseudostigmatic organs are distinctive, being long, tapered, and nude.

The palpal claw is described and figured as consisting of a single, thick, long, terminally rounded element, without accessory prongs. The chelicerae possess numerous relatively large ventral recurved toothlets, which Oudemans (1912, p. 79) compares to those of Ixodidae.

The dorsal setae are similar to the posterior lateral scutal setae, being short, stout, and provided with numerous, very short barbs, arising from several sides of the shaft. In Oudemans' figure (1912, fig. S 1), a single humeral seta can be distinguished on either side. The remainder of the dorsal setae are arranged approximately 12—12 or 14—4. Oudemans figured a total of 31 dorsal setae, including the humerals. The posterior half of the dorsum is covered by numerous circular discs, which Oudemans called "scheibenförmigen Haaren", arranged in convex rows, with approximately fourteen in the first row. These extend around the sides of the body, and they cover the ventral aspect, posterior to the anus. There are no setae between coxae I, but there are two sternal setae between coxae III. The remainder of the ventral setae are similar in form to the dorsal setae, becoming shorter posteriorly, numbering thirty. According to Oudemans, there are thirty small discs on the ventral aspect, posterior to the anus. There are no ordinary setae posterior to the anus.

The seta on palpal segment I bears four rather long, delicate cilia. The seta on segment II is rather short, bearing numerous delicate cilia. The seta on segment III is longer than the one on II, and it is nude. Of the three setae on segment IV, the dorsal is the longest, bearing numerous, short, delicate cilia. The lateral seta is nude, while the short ventral seta bears seven delicate cilia. Segment V is figured as bearing a basal, ventral,

striated seta; a pointed, spine-like seta, located at the mid-point of the shaft; three long, nude setae, and three plumose setae of various forms. Segment V itself is short and rounded. The galeal seta is long and nude.

The coxal vestiture is characteristic of the genus. The distal (lateral) seta on coxa I bears definite cilia, whereas the remainder of the coxal setae bear short barbs. Oudemans' description of the remainder of the leg segments is not remarkable. There is no mention of a long, nude, whip-like seta on tarsus III.

Since no specimens have been examined by the writer, no measurements are given.

TYPE MATERIAL: Described from a single specimen from Durban, Africa, January 1905, off *Hipposideros caffer* Sundevall, collected by Dr. Ivar Trägårdh. According to Oudemans (1912, p. 79), the holotype is in the collection of Dr. Trägårdh, Stockholm, Sweden. The writer has been unable to ascertain the present existence of this specimen.

REMARKS: This species is known only from the original specimen and descriptions. In proposing the genus *Acomatacarus,* Ewing (1942) included this species. In this regard, it should be noted that the seta on palpal segment II is plumose, while that on segment III is nude. Therefore it does not conform to Ewing's definition of the genus. The description of the chelicerae is reminiscent of *Whartonia* Ewing, 1944, a genus parasitic upon bats. However, *Whartonia* has no anterior median projection on the anterior margin of the scutum.

The writer believes that the present generic assignment is purely arbitrary, but he is unable to offer a better suggestion. The species is distinctive, being the only described member of the subfamily possessing disc-like structures on the posterior surface of the integument. These are reminiscent of similar structures on *Neoschöngastia retrocincta* Gunther, 1939, and *Euschöngastia heaslipi* (Womersley and Heaslip, 1943), both members of the subfamily Trombiculinae.

Genus **Leeuwenhoekia** Oudemans, 1911

Genotype: *Heterothrombidium verduni* Oudemans, 1910, by original designation.

1911. *Leeuwenhoekia* Oudemans, Ent. Ber., *3,* no. 58, pp. 137-138.
1912. *Leeuwenhoekia* Oudemans. Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 74-82.
1927. *Leeuwenhoekia* Oudemans. Stiles and Hassall, Hyg. Lab. Bull. no. 148, p. 268.
1928. *Leeuwenhoekia* Oudemans. Methlagl, Denkschr. Akad. Wiss. Wien, *101,* p. 214.
1931. *Leeuwenhoekia* Oudemans. Vitzthum, Kükenthal's Handbuch der Zoologie, *3,* 2nd half (9), p. 146.

1931. *Leeuwenhoekia* Oudemans. Ewing, Proc. U.S. nat. Mus., *80,* no. 2908, Art. 8, pp. 2, 5.
1934. *Leuwenhoekia* (sic) Oudemans. Womersley, Rec. S. Aust. Mus., *5,* no. 2, p. 217: lapsus.
1935. *Leeuwenhoekia* Oudemans. Sig Thor, Zool. Anz., *109,* nos. 5/6, p. 110.
1937. *Leeuwenhoekia* Oudemans. Womersley, Rec. S. Aust. Mus., *6,* no. 1, pp. 79, 82.
1938. *Leeuwenhoekia* Oudemans. Neveu-Lemaire, Traité d'Entomologie etc., pp. 479, 494.
1938. *Leeuwenhoekia* Oudemans. Ewing, J. Wash. Acad. Sci., *28,* no. 6, p. 291.
1939. *Leeuwenhoekia* Oudemans. Neave, Nomenclator Zoologicus, II, p. 884.
1939. *Leeuwenhoekia* Oudemans. Torres and Braga, Bol. Sec. Agr. Indust. Com., *4,* pp. 39, 42.
1941. *Leeuwenhoekia* —. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 4, p. 624.
1942. *Leeuwenhoekia* Oudemans. Vitzthum, *op. cit.,* Lfg. 6, p. 829.
1942. *Leeuwenhoekia* Oudemans. Radford, Parasitology, *34,* no. 1, pp. 68, 70.
1942. *Leeuwenhoekia* Oudemans. Ewing, J. Parasit., *28,* no. 6, pp. 487, 490: (restricted).
1943. *Leeuwenhoekia* Oudemans. Womersley and Heaslip, Trans. roy. Soc. S. Aust., *67,* no. 1, pp. 72, 141.
1944. *Leeuwenhoekia* Oudemans. Womersley, Trans. roy. Soc. S. Aust., *68,* no. 1, pp. 103-112.
1944. *Leeuwenhoekia* Oudemans. Ewing, J. Parasit., *30,* no. 6, p. 347.
1945. *Leeuwenhoekia* Oudemans. Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, pp. 14, 57, 75.
1945. *Leeuwenhoekia* Oudemans. Womersley, Trans. roy. Soc. S. Aust., *69,* no. 1, pp. 96-98.
1946. *Leeuwenhoekia* Oudemans. Taylor, Comm. Aust. Serv. Publ. no. 6, pp. 147, 225.
1946. *Leeuwenhoekia* Oudemans. Ewing, J. Parasit., *32,* no. 5, p. 435.
1946. *Leeuwenhoekia* Oudemans. Radford, Proc. zool. Soc. Lond., *116,* part II, p. 247.
1947. *Leeuwenhoekia* Oudemans. Radford, Proc. zool. Soc. Lond., *116,* part III, p. 579.

When this genus was originally proposed, it contained *L. polydiscum* (Oudemans, 1910) and *L. jaegerskioeldi* (Oudemans, 1911), in addition to the genotype. The following species have been described in or referred to *Leeuwenhoekia: L. adelaideae* Womersley, 1944; *L. australiensis* Hirst, 1925; *L. gateri* Radford, 1942; *L. hirsti* Womersley, 1944; *L. mccullochi* Womersley, 1944; *L. nova-guinea* Womersley, 1944; *L. paradoxa* André, 1943; and *L. southcotti* Womersley, 1944. With the exception of André's species, they have been referred by subsequent authors to *Acomatacarus* Ewing, 1942. If one adheres to the restriction which Ewing placed on *Leeuwenhoekia* when he separated *Comatacarus* and *Acomatacarus,* then the species mentioned above can be placed in the latter genus, providing one ignores palpal setal characters. The writer has been purely arbitrary in his key to genera, and he believes that if a clear line of demarcation exists in the case of *Leeuwenhoekia* and *Acomatacarus,* it must await further study. According to Ewing's restriction, *Leeuwenhoekia* can contain only the genotype, based on the fact that the dorsal setae arise from tubercles. To the writer, it would seem just as logical to propose a new genus for *A. polydiscum* (Oudemans, 1910), with its distinctive discs, as to restrict

Leeuwenhoekia in the present manner. Without proposing to settle the matter at present, therefore, the writer would point out the possibility that future studies may conceivably necessitate synonymizing *Acomatacarus* Ewing, 1942.

The single species discussed below can be separated from other members of the subfamily by the characters given in the key to genera.

Leeuwenhoekia verduni (Oudemans, 1910)

1910. *Heterothrombidium verduni* Oudemans, Ent. Ber., *3,* no. 54, p. 88.
1911. *Leeuwenhoekia verduni* (Oudemans). Oudemans, Ent. Ber., *3,* no. 58, p. 138: genotype.
1912. *Leeuwenhoekia verduni* (Oudemans). Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 74-77, 191, 203; fig. R.
1925. *Leeuwenhoekia verduni* (Oudlemans). Hirst, Trans. R. Soc. trop. Med. Hyg., *19,* no. 3, p. 150.
1927. *Leeuwenhoekia verduni* —. Stiles and Hassall, Hyg. Lab. Bull. no. 148, p. 268.
1931. *Leeuwenhoekia verduni* (Oudemans). Ewing, Proc. U.S. Nat. Mus., *80,* no. 2908, Art. 8, p. 5.
1938. *Leeuwenhoekia verduni* (Oudemans). Neveu-Lemaire, Traité d'Entomologie etc., p. 494.
1942. *Leeuwenhoekia verduni* (Oudemans). Radford, Parasitology, *34,* no. 1, p. 68; fig. 65.
1945. *Leeuwenhoekia verduni* (Oudemans). Womersley, Trans. roy. Soc. S. Aust., *69,* no. 1, p. 97.
1945. *Leeuwenhoekia verduni* (Oudemans). Buitendijk, Zool. Meded., *24,* p. 336.

This species is represented in the Oudemans collection by the holotype, labelled as type in Oudemans' handwriting. The specimen is mounted with the dorsal surface upward. Since the scutum is tipped forward, the pseudostigmatic organs are missing, and the chelicerae difficult to see, the specimen is not entirely satisfactory for study.

DIAGNOSIS: The body of the partially engorged larva is ovoid in shape. On either side of the capitulum, between this structure and coxae I, is a well defined spiracle. The writer was unable to trace tracheal trunks from these spiracles, and he did not have the opportunity to examine the specimen under a phase contrast microscope. Presumably they are present, although neither spiracles nor tracheae were mentioned by Oudemans. The leg segmentation is characteristic of the subfamily, and the tarsal claws are normal in size. No minute hairs were seen on the lateral claws. The ocular shields are removed from the scutum, and each bears two eyes with well developed convex corneae. Owing to their position, the size relationship between anterior and posterior eyes cannot be stated. The scutum is of the shape depicted by Oudemans (1912, fig. R 3), and an anterior median projection is present on the anterior margin. However, Oudemans exaggerated the

terminal portion of the posterior lateral scutal setae, giving rise to the impression that these setae were clavate. Actually the shaft is quite stout, but it is tapered distally, and not broadly rounded. The six normal scutal setae bear numerous fine cilia. As mentioned above, the pseudostigmatic organs are missing. By analogy with allied genera, it is probable that they are flagelliform; but the presence or absence of cilia on them is a matter of useless speculation.

Oudemans (1912, p. 76) described the palpal claw as composed of five prongs (i.e., "fünfspitzig"), when viewed from below. To the writer it appears to be trifurcate. As mentioned previously, the chelicerae are difficult to visualize. They definitely do not have a row of dorsal teeth, nor do they have a "spearhead conformation". There is only a suggestion of a dorsal, subapical, recurved toothlet, and no toothlet is seen on the ventral margin.

As depicted by Oudemans (1912, fig. R 1), the dorsal setae arise from small tubercles. Their shafts are rather stout, bearing numerous, short, fine cilia, and the anterior dorsal setae are much longer than the posterior ones. There are two setae which can be regarded as humerals. Immediately behind the scutum are two rows of four setae each, and behind the humeral setae are two marginal setae. The remainder are arranged 4 — 4 — 2. It is difficult to express this arrangement as a formula. There are no sternal setae between coxae I, but there are two plumose setae between coxae III. The remainder of the fine, short, plumose, ventral setae are arranged: 10 — 10 — 2 — 2 (flanking the anus) — 4, and on the posterior margin are four setae similar in form to the dorsal setae, and likewise arising from tubercles.

The seta on palpal segment I bears numerous fine cilia. On segments II and III, the setae are rather short, stout, and bushy in appearance, being adorned with fine cilia. On segment IV, the dorsal seta bears a single cilia, arising from the proximal portion of the shaft, while the lateral and ventral setae are nude. Segment V bears a basal, ventral, striated seta, an apical, nude, pointed seta, plus five plumose setae of various forms. Oudemans figured the galeal seta with a single cilia. Actually this seta is stout basally, quickly tapering, and bearing three relatively short cilia.

The coxal setae are plumose and their arrangement is characteristic of the subfamily. There is no long, nude, whip-like seta on tarsus III, and the vestiture of the remainder of the leg segments is not remarkable.

Owing to the fact that the scutum is tipped, longitudinal measurements cannot be made. Since the anterior median and lateral scutal setae are perpendicular, they cannot be measured. The following measurements were made on the holotype: AW 60; PW 84; SB 36; PL 84; DSA 90; DSP 57.

TYPE MATERIAL: Described from a single specimen from southern Brazil,

no specific locality, off *Didelphys opossum* Seba, collected by E. A. Göldi, and sent to Oudemans by Trouessart. The holotype is in the Rijksmuseum van Natuurlijke Historie, Leiden.

REMARKS: This species is known only from the holotype. The collection and study of additional topotypic material is essential to a proper understanding of the species. Its occurrence on a marsupial is of particular interest, but nothing further is known of its distribution or host preferences.

Genus **Hannemania** Oudemans, 1911

Genotype: *Heterothrombidium hylodeus* Oudemans, 1910, by original designation.

1911. *Hannemania* Oudemans, Ent. Ber., *3,* no. 58, p. 137.
1912. *Hannemannia* (sic) Oudemans, Ent. Ber., *3,* no. 64, p. 234: emendation.
1912. *Hannemania* Oudemans. Oudemans, Zool. Jb., Suppl. *14,* Heft 1, pp. 71-74.
1927. *Hannemania* Oudemans. Stiles and Hassall, Hyg. Lab. Bull. no. 148, p. 268 (equals *Hannemannia* Oudemans, 1912: emendation, synonym).
1929. *Hannemania* Oudemans. Ewing, Manual of External Parasites, pp. 22, 26-27.
1931. *Hannemannia* (sic) Oudemans. Vitzthum, Kükenthal's Handbuch der Zoologie, *3,* 2nd half (9), p. 146.
1931. *Hannemania* Oudemans. Ewing, Proc. U.S. Nat. Mus., *80,* no. 2908, Art. 8, pp. 2, 3-4.
1935. *Hannemania* Oudemans. Sig Thor, Zool. Anz., *109,* nos. 5/6, p. 110.
1937. *Hannemania* Oudemans. Womersley, Rec. S. Aust. Mus., *6,* no. 1, p. 79.
1938. *Hannemania* Oudemans. Ewing, J. Wash. Acad. Sci., *28,* no. 6, p. 291.
1939. *Hannemania* Oudemans. Neave, Nomenclator Zoologicus, II, p. 562.
1939. *Hannemannia* (sic) Oudemans. Neave, *op. cit.,* p. 562.
1939. *Hannemania* Oudemans. Torres and Braga, Bol. Sec. Agr. Indust. Com., *4,* pp. 39, 42.
1941. *Hannemannia* (sic) —. Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 4, pp. 622, 624.
1942. *Hannemannia* (sic) Oudemans. Vitzthum, *op. cit.,* Lfg. 6, p. 829.
1942. *Hannemania* Oudemans. Radford, Parasitology, *34,* no. 1, pp. 70, 72.
1944. *Hannemannia* (sic) —. Womersley, Trans. roy. Soc. S. Aust., *68,* no. 1, pp. 83, 103.
1944. *Hannemania* Oudemans. Ewing., J. Parasit., *30,* no. 6, p. 347.
1945. *Hannemania* Oudemans. Finnegan, Brit. Mus. (Nat. Hist.) Econ. Ser. no. 16, p. 57.
1945. *Hannemannia* (sic) Oudemans. Womersley, Trans. roy. Soc. S. Aust., *69,* no. 1, pp. 96, 97.
1946. *Hannemannia* (sic) Oudemans. Taylor, Comm. Aust. Serv. Publ. no. 6, p. 147.
1947. *Hannemania* Oudemans. Dumbleton, Trans. roy. Soc. N. Z., *76,* pt. 3, pp. 409-410.

In proposing the emendation *Hannemannia,* Oudemans did not give any reasons for the change, and the writer has followed Stiles and Hassall (1927) and others in adhering to the original orthography.

When this genus was proposed, it was monotypic, but in 1917 Oudemans described *H. rouxi,* host unknown, from New Caledonia or the Loyalty Islands. Several species from amphibia and mammals have been placed in

this genus by subsequent authors. Until recently it has been thought that *Hannemania* lacked an anterior median process on the anterior margin of the scutum. The writer has examined type material of each of the following species, and in every case the presence of this structure has been demonstrated: *H. hylodeus* (Oudemans, 1910); *H. rouxi* Oudemans, 1917; *H. hylae* (Ewing, 1925); *H. edwardsi* Sambon, 1928; *H. hobdayi* Sambon, 1928; *H. newsteadi* Sambon, 1928; *H. pattoni* Sambon, 1928; *H. stephensi* Sambon, 1928; *H. penetrans* Ewing, 1931; and *H. samboni* Ewing, 1931 (equals *H. argentina* Sambon, 1928, preoccupied). Consequently the absence of an anterior median scutal projection should no longer be used as a key character in defining this genus. The writer has not located the original specimens of *H. dunni* Sambon, 1928, nor *H. eltoni* Sambon, 1928. He has not seen specimens of *H. argentina* Lahille, 1927, or *H. hepatica* Fonseca, 1935. Comparison of the figures and descriptions published by Lahille and Fonseca respectively suggests great similarity between the two species, and since both were described from the same type host, *Leptodactylus ocellatus,* the possibility of synonymy should be investigated.

Several species that have been studied by the writer do not appear to be related to the genotype of *Hannemania. H. ochotrona* Radford, 1942 (emended to *ochotona* by Radford, 1947), and *H. hirsuta* Ewing, 1931, appear to be closely related to the genotype of *Comatacarus* Ewing, 1942. *H. nudosetosa* Wharton, 1938, is the genotype of *Whartonia* Ewing, 1944. Two species also collected from bats have been described in the genus *Hannemania: H. perplexa* Brennan, 1947 (Montana, U.S.A.); and *H. vellae* Dumbleton, 1947 (British Solomon Islands). After studying the figures and descriptions of these two species from bats, the writer believes that they are probably related to *Whartonia* Ewing, 1944. However, these opinions are preliminary, and subject to revision.

In summary, the writer's studies suggest that the following species are definitely related to *H. hylodeus* (Oudemans,1910), and he would therefore include them in a preliminary synopsis of the genus: *H. argentina* Lahille, 1927; *H. dunni* Sambon, 1928; *H. edwardsi* Sambon, 1928; *H. eltoni* Sambon, 1928; *H. hepatica* Fonseca, 1935; *H. hobdayi* Sambon, 1928; *H. hylae* (Ewing, 1925); *H. newsteadi* Sambon, 1928; *H. pattoni* Sambon, 1928; *H. penetrans* Ewing, 1931; *H. rouxi* Oudemans, 1917; *H. samboni* Ewing, 1931 (equals *H. argentina* Sambon, 1928, preoccupied); and *H. stephensi* Sambon, 1928. The detailed reasons for the inclusion of each of the above species must await a subsequent paper. Furthermore, in view of the unsatisfactory nature of figures and descriptions, it is not possible to give a key to these species at this time.

The generic characters originally given by Oudemans (1911, p. 137) would not be considered distinctive in the light of subsequent studies: "Larva. Schildje breeder dan lang, min of meer 5-hoekig, met spits naar achter; maxillicoxaalharen achter de palpen; type *Heterothrombidium hylodeus* Oudms." In his later characterization of the genus, Oudemans (1912, p. 71) included many more points, of which the writer would emphasize the following as of subfamilial value: "Beine mit 2 dicken und 1 mittleren dünneren Kralle" (i.e., normal tarsal claws); "Schildchen mit 8 Haaren" (including the pseudostigmatic organs); "Femur der Beine einfach" (i.e., legs composed of six segments); "Coxae I je mit 2 Haaren; keine Haare zwischen den Coxae I; 1 Paar zwischen den Coxae III". Oudemans did not mention the presence of true spiracles and tracheae. According to the writer's observations, the following morphological characters are common to the species which should be included in *Hannemania* Oudemans, 1911:

GENERIC DIAGNOSIS: True spiracles and tracheae present. Legs composed of six segments. Tarsal claws normal in size, with two rows of minute hairs on the concave aspect of the paired lateral claws; empodium present. Eyes present. Scutum pentagonal, with an anterior median projection on the anterior margin, and a pair of submedian setae, a pair each of anterior and posterior lateral setae, and flagelliform pseudostigmatic organs. Chelicerae with an expanded apical process, bearing teeth, somewhat reminiscent of a spearhead. No sternal setae between coxae I, two between coxae III. Coxa I bisetose, coxae II and III unisetose. No long, nude, whip-like seta on tarsus III.

Correlation of the above morphological characters with the host preference and mode of life of the larvae, encysted within the skin of Amphibia, serves to characterize a distinctive group. The fact of host preference is of probable phylogenetic significance, but its proper evaluation must await further studies. Finally, the physiology of these larvae is worthy of investigation, with particular reference to the mode of respiration, and the method whereby they escape from the skin of the host when they are ready to undergo metamorphosis.

The two species described by Oudemans are represented in his collection by specimens.

Hannemania hylodeus (Oudemans, 1910) (fig. 9a)

1910. *Heterothrombidium hylodeus* Oudemans, Ent. Ber., *3*, no. 54, p. 88.
1911. *Hannemania hylodeus* (Oudemans). Oudemans, Ent. Ber., *3*, no. 58, p. 137: genotype.
1912. *Hannemania hylodeus* (Oudemans). Oudemans, Zool. Jb., Suppl. *14*, Heft 1, pp. 71-74, 191, 203; fig. Q.

1923. *Hannemannia* (sic) *hylodeus* (Oudemans). Oudemans, Nova Caledonia, *3,* livr. I, pp. 128-131.
1927. *Hannemania hylodeus* (Oudemans). Lahille, Bol. Inst. Clin. quir. B. Aires, *3,* p. 778.
1931. *Hannemania hylodeus* (Oudemans). Ewing, Proc. U.S. nat. Mus., *80,* no. 2908, Art. 8, p. 4.
1941. *Hannemannia* (sic) *hylodeus* (Oudemans). Vitzthum, Bronns Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 5, Lfg. 4, p. 624.
1942. *Hannemania hylodeus* (Oudemans). Radford, Parasitology, *34,* no. 1, p. 72; fig. 75.
1945. *Hannemannia* (sic) *hylodeus* (Oudemans). Buitendijk, Zool. Meded., *24,* p. 336.
1945. *Hannemannia* (sic) *hylodeus* (Oudemans). Womersley, Trans. roy. Soc. S. Aust., *69,* no. 1, p.97.

This species is represented in the Oudemans collection by two specimens, mounted on one slide, bearing the data of the original series in Oudemans' handwriting, but not labelled as types. One is mounted with the dorsal surface facing the cover slip, and the other with the ventral surface upward. Since these specimens were askew, the preparation was warmed and moistened and manipulated, without removal of the cover slip, so as to bring them into a more satisfactory position for examination.

DIAGNOSIS: The body of these engorged larvae is broadly ovoid in shape. The leg segmentation is characteristic of the subfamily, and the paired lateral tarsal claws are equal in size, bearing two rows of minute hairs on their concave side. These minute hairs were neither mentioned nor figured by Oudemans for this species. They are similar to those seen in *H. rouxi* Oudemans, 1917. A poorly defined spiracle is present on either side of the capitulum, anterior to coxa I, and portions of tracheal trunks can be distinguished within the body. Owing to the fact that the clearing process has been unsatisfactory, these structures are best visualized with the aid of a phase contrast microscope. They are easily overlooked and were not mentioned by Oudemans.

On either side of the scutum, at the level of the posterior corners, is an ocular plate, bearing a well developed anterior eye, and a smaller, less distinct, posterior eye, as figured by Oudemans (1912, fig. Q 1). The scutum is of the general form depicted by Oudemans (*loc. cit.*), except that there is an anterior median projection on its anterior margin. Oudemans described the anterior margin as "vorn in der Mitte etwas vorspringend", but he did not figure this projection. The anterior median setae appear nude, and the anterior and posterior lateral setae bear short barbs. The pseudostigmata are situated behind the line of the posterior lateral setal pores. The pseudostigmatic organs bear six cilia, arising from the distal half of the shaft. Oudemans described and figured a median longitudinal crista

between the pseudostigmata, but the writer was unable to demonstrate it with certainty.

The palpal claw is distinctly trifurcate, the main element being pointed, and only gently curved; the dorsal and ventral accessory elements being shorter, straight, and pointed. Oudemans' figures of the chelicerae are schematic (1912, figs. Q 3 & 4). Their structure is complicated, consisting

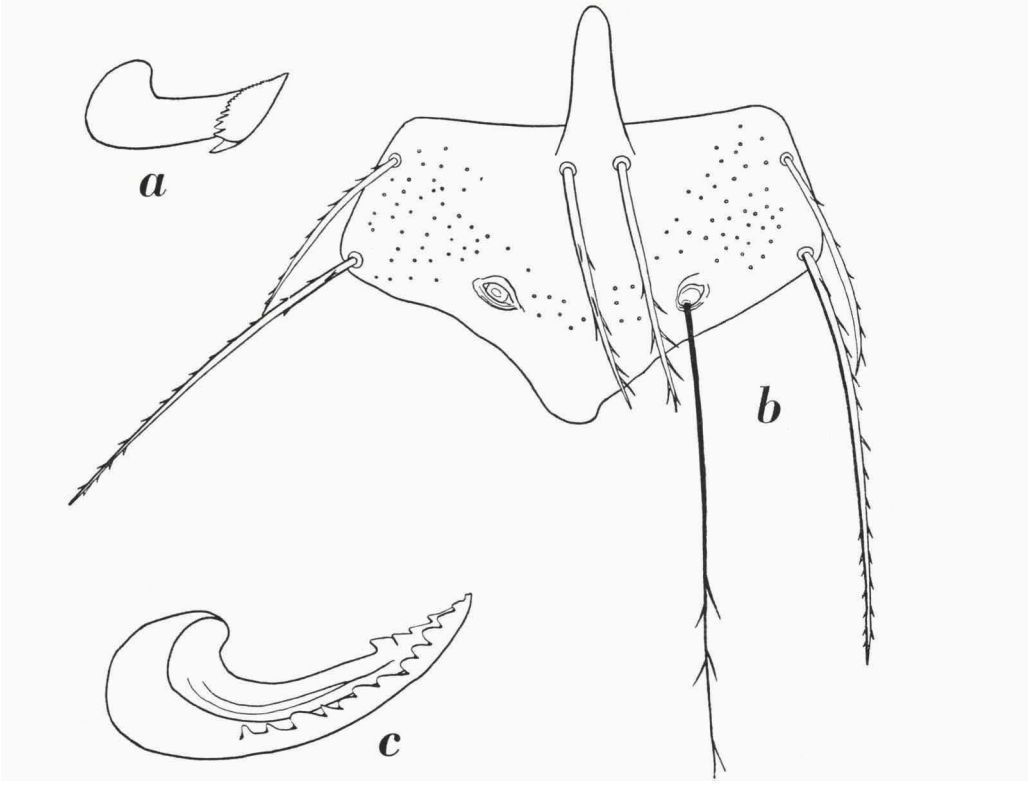

Fig. 9. *a, Hannemania hylodeus* (Oudemans, 1910), chelicera; *b, c, Hannemania rouxi* Oudemans, 1917: *b,* scutum; *c,* chelicera. Original (Sanina).

of an expanded process, bearing several teeth, and shown in the accompanying figure drawn by Miss Sanina (fig. 9 a). This process is in the nature of a recurved, dentate gouge.

The dorsal setae bear short barbs. Their pattern does not permit distinction of humeral setae. There is a total of thirty dorsal setae. There are no sternal setae between coxae I, but there are two between coxae III. The remainder of the ventral setae bear short barbs, and they are arranged: 4 — 4 — 4 —4.

The seta on palpal segment I bears four short cilia or barbs. The seta on segment II bears numerous short barbs. The seta on segment III is shorter, bearing fewer and smaller barbs. On segment IV, the dorsal and lateral setae are nude, while the ventral seta bears two or three delicate lateral cilia. Segment V was poorly visualized in the material studied. According to Oudemans (1912), it bears a long, curved, basal, ventral, striated seta (confirmed by the writer); plus five plumose setae of various forms. The galeal seta is nude.

Coxa I bears two plumose setae, while coxae II and III each bear a single plumose seta. The vestiture of the remainder of the leg segments is not remarkable, and tarsus III does not bear a long, nude, whip-like seta.

TYPE MATERIAL: Described from several specimens (number not stated) from Brazil (no specific locality), off a tree frog, *Hylodes* sp., collected by E. A. Göldi, and sent to Oudemans by Trouessart. Oudemans did not designate a holotype. The cotypes are in the Trouessart collection in the Muséum National d'Histoire Naturelle, Paris. There are thirteen specimens mounted on a single slide. Five of these are encysted in a piece of skin, and eight are mounted separately under the same cover glass. The clearing process has been carried too far, making these specimens quite unsatisfactory for detailed study.

REMARKS: This species is known only from the original material. Sambon's species from South America appear to be distinct, but a precise key must await further studies.

Buitendijk (1945, p. 343) lists this species as a synonym of "*Johnstoniana hylodeus* (Oudms., 1910)", referring to drawings only. This is evidently a lapsus, for on page 336, *H. hylodeus* Oudemans, 1910 is listed as a valid species, and the symbol beside the name denotes a reference to drawings and preparations as well. It should be noted that *Hannemania* is actually quite distinct from *Johnstoniana* George, 1909 (genotype: *Johnstoniana errans* George, 1909), which Sig Thor (1935) made the type genus of a separate subfamily.

Hannemania rouxi Oudemans, 1917 (figs. 9 b, c, 10)

1917. *Hannemannia* (sic) *rouxi* Oudemans, Ent. Ber., *4*, no. 93, pp. 342-343.
1923. *Hannemannia* (sic) *rouxi* Oudemans. Oudemans, Nova Caledonia, *3*, livr. I, pp. 127-131; figs. 1-10.
1945. *Hannemannia* (sic) *rouxi* Oudemans. Buitendijk, Zool. Meded., *24*, p. 336.

This species is represented in the Oudemans collection by a single specimen, labelled in his handwriting as this species, and bearing the data of the original series. The specimen is broken and the integument has been

spread out so as to reveal both the dorsal and ventral surfaces. Its appearance suggests that it has been treated with a strong alkali, such as potassium hydroxide. In fact Oudemans states (1923, pp. 127-128): "Après avoir traité un individu à la potasse caustique..." Examination of this specimen has enabled the writer to correct Oudemans' description, as indicated below.

DIAGNOSIS: Oudemans (1923, figs. 1 & 2) figured the body of an engorged larva as elongate and ovoid in shape. The integument is ornamented with a mosaic of pits of irregular size, shape, and distribution. The writer was unable to discern integumentary striae. On either side of the capitulum, near coxae I, is a definite, well developed spiracle, from which tracheal tubes arise and eventually ramify; these structures were neither figured nor mentioned by Oudemans. Each leg is composed of a total of six segments, characteristic of the subfamily. There are two rows of minute hairs on the concave aspect of each of the paired lateral tarsal claws, as figured by Oudemans (1923, figs. 9, 10 & 11). The lateral claws are equal in size, and the empodium is normal.

The ocular shields are rather poorly developed. One is situated on either side of the scutum at some distance from it, behind the level of the pseudostigmata, bearing an anterior eye with a well developed cornea, and a smaller, poorly developed, indistinct, posterior eye. Oudemans' figure of the scutum (1923, fig. 6) is incorrect, probably owing to the fact that the anterior margin had been destroyed in the specimen from which it was drawn. The present figure (fig. 9 b on page 242) was drawn by Miss Sanina, from the specimen in the Oudemans collection, and its details are correct. It should be noted that an anterior median projection is present, and the anterior scutal margin is not jagged.

The palpal claw is actually trifurcate. The main element is large, stout, and curved; the accessory elements being small, shorter, straight, pointed and inconspicuous. In this specimen it would be easy to overlook the dorsal prong, whence the claw would be erroneously described as bifurcate. Each chelicera bears dorsal and ventral teeth, as shown in the accompanying figure by Miss Sanina (fig. 9 c on page 242).

In the material examined by the writer, it was not possible to discern dorsal and ventral setal patterns, owing to the fact that the integument had been split and spread out. Oudemans (1923, fig. 1) figured forty-eight dorsal abdominal setae, and he did not show distinct humerals. His figure shows a symmetrical arrangement, but it would be difficult to express the pattern as a formula. There are no sternal setae between coxae I, and the two sternal setae between coxae III are nude. Oudemans (1923, fig. 2) figured fifty-two additional ventral setae. The dorsal and ventral setae bear short

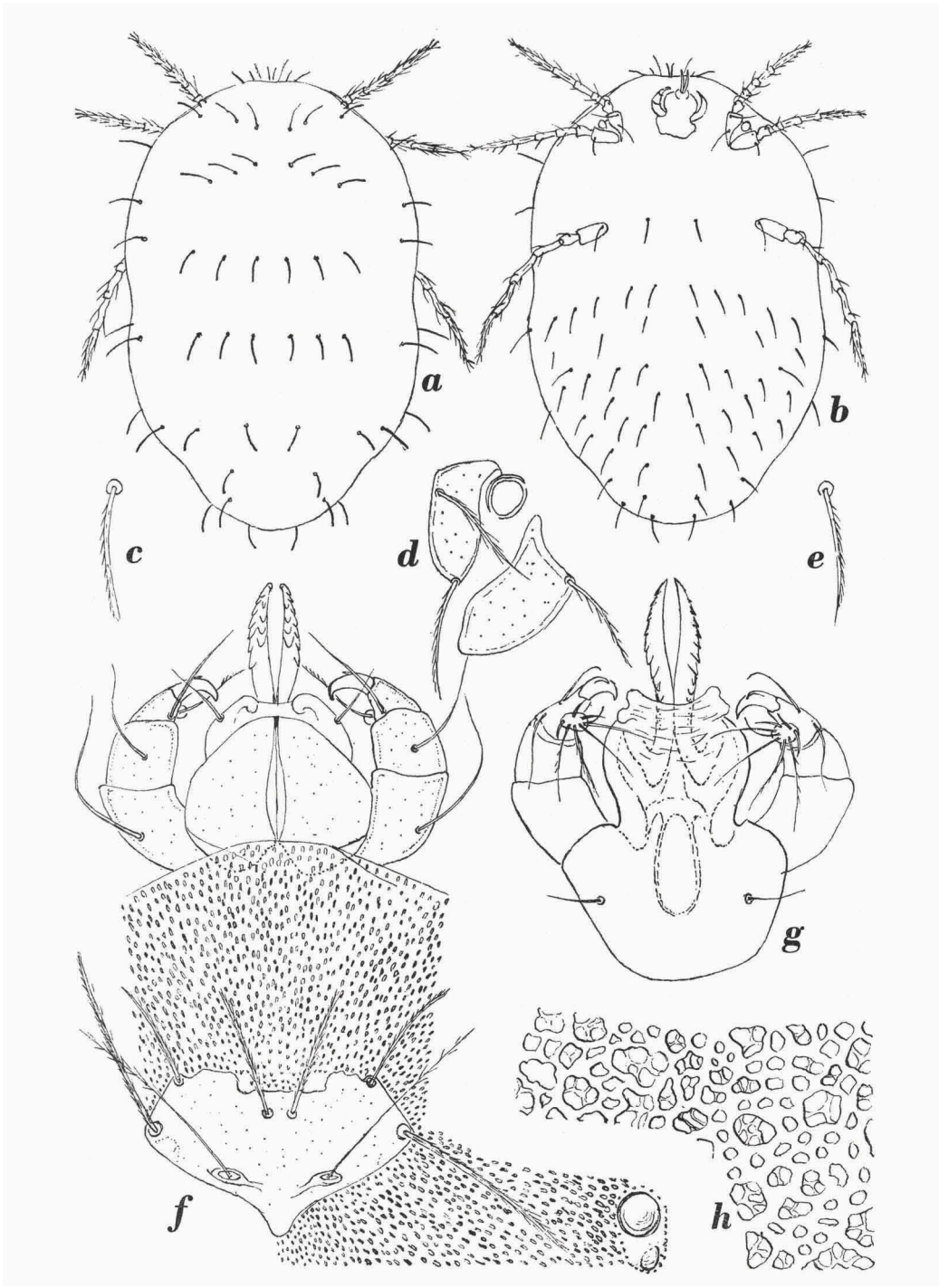

Fig. 10. *Hannemania rouxi* Oudemans, 1917; *a,* dorsum; *b,* venter; *c,* dorsal seta; *d,* ventral view of left coxae I and II; *e,* ventral seta; *f,* dorsal view of gnathosoma and scutum; *g,* ventral view of gnathosoma; *h,* structure of cuticle (Oudemans, 1923, figs. 1-8).

barbs, which are easily lost, and possibly this explains the nude appearance of the sternal setae in this instance.

The seta on palpal segment I has been lost from the specimen studied, but Oudemans (1923, fig. 7) figured it as nude. The setae on segments II and III, and the dorsal, lateral, and ventral setae on segment IV are nude. Segment V bears the usual basal, ventral, striated seta, plus seven plumose setae of various forms. The galeal seta is nude.

Coxa I bears two plumose setae, characteristic of the subfamily. Coxae II and III each bear a single plumose seta. The vestiture of the remainder of the leg segments is not remarkable. Tarsus III does not bear a long, nude, whip-like seta, although Oudemans described and figured it as possessing three short, spine-like setae.

Measurements on this single specimen are as follows: AW 81; PW 94; SB 36; ASB 35; PSB 27; AP 21; AM 53; AL 52; PL 83; SENS 85; DSA 60.

TYPE MATERIAL: This species was described from seven specimens, sent to Oudemans by Dr. G. Neumann at Toulouse. These were collected by Sarasin and Roux in New Caledonia or the Loyalty Islands, but the exact data were lost, and the type host is unknown. Oudemans did not designate a holotype, and the specimen in his collection is not labelled as type. The writer hereby designates the single specimen in the Oudemans Collection, Rijksmuseum van Natuurlijke Historie, Leiden, as lectotype.

REMARKS: This species is known only from the original material. Inasmuch as the other related species parasitize Amphibia, it is probable that this species does likewise. As pointed out to the writer by Dr. L. D. Brongersma, the only amphibian collected by Roux was *Hyla aurea* (Lesson), an Australian species introduced into New Caledonia. (See Roux, 1913, Les Reptiles de la Nouvelle-Calédonie et des Iles Loyalty. Nova Caledonia, Zoologie, vol. I, livr. II, p. 146). The writer examined several specimens of this frog in the Rijksmuseum van Natuurlijke Historie, but no mites were found.

POSTSCRIPT

The following discussion of Trombiculidae concerns certain of the many important contributions to our knowledge of these mites which have been published since May, 1948, when the manuscript of the present paper was closed. A concise account of the terminology and classification of larvae and adults has been presented by Wharton, *et al.* (1951). A comprehensive treatment of the group, including a catalogue of the species of the world, has been published by Wharton and Fuller (1952). A monograph by Womersley (1952) and a check list by Gunther (1952) concern Trombiculidae of Asia and islands of the Pacific Ocean. A general account of the family, together with a synopsis of subfamilies, genera, and subgenera, is presented by Baker and Wharton (1952). These and other contributions to our knowledge of Trombiculidae are discussed below with reference to taxonomy, biology, and medical importance.

TAXONOMY

The four subfamilies mentioned in the writer's key (page 13) are recognized by American workers, while Womersley (1952) continues to separate the Leeuwenhoekiinae as a distinct family. The keys of Wharton, *et al.* (1951, 1952) distinguish Apoloniinae from Trombiculinae on the basis of scutal characters: the Apoloniinae possess paired, submedian, anterior scutal setae, and/or an anterior median scutal projection, whereas the Trombiculinae possess neither of these characters. This is a useful key character, since the tracheae mentioned in the writer's key are often difficult to see in cleared preparations. It should be realized, however, that one may encounter anomalous specimens of various species of Trombiculinae which possess two anterior median scutal setae, and these might be referred incorrectly to Apoloniinae by an uninitiated person.

TROMBICULINAE

Within the genus *Trombicula,* many workers now recognize groups of species with characters in common which are believed to entitle these groups to subgeneric rank. The remaining species are sometimes placed in a collective subgenus *Trombicula,* although the writer prefers to refer them to the collective genus *Trombicula* and to omit the use of a subgeneric name, because of its implication of a relationship which is not intended when one states clearly that he is using a genus in a broad collective sense. The currently recognized subgenera of *Trombicula* are: *Blankaartia* Oudemans, 1911; *Crotiscella* Wharton, 1952; *Eutrombicula* Ewing, 1938; *Fonsecia*

Radford, 1942; *Leptotrombidium* Nagayo, *et al.*, 1916; *Neotrombicula* Hirst, 1925; and *Trombiculindus* Radford, 1948. Keys for their recognition are given by Wharton, *et al.* (1951, 1952). *Trombiculindus* and *Fonsecia* are not represented in the Oudemans collection.

Subgenus *Blankaartia* Oudemans, 1911. Type: *Trombidium niloticum* Trägårdh, 1904, based on an adult mite. Synonyms: *Trägårdhula* Berlese, 1912; *Pentagonella* Thor, 1936; and *Megatrombicula* Michener, 1946, proposed as a subgenus. The application of the generic name has been discussed by Fuller and Wharton (1951). It will be noted that Womersley (1952) prefers *Trägårdhula.* Species belonging to *Blankaartia* must be distinguished from *Neotrombicula,* since the larvae of both groups possess a more or less pentagonal scutum, as well as one or more long, nude, whip-like setae on leg III. In *Blankaartia* the larvae have no whip-like setae on the femur or tibia of leg III, and the adults have eyes, whereas in *Neotrombicula* the larvae have whip-like setae or delicate, elongated feathered setae on the femur and/or tibia of leg III, and the adults are without eyes. Two species are represented in the Oudemans collection: *Trombicula* (*Blankaartia*) *acuscutellaris* Walch, 1922, and *T.* (*B.*) *ardeae* (Trägårdh, 1904).

Subgenus *Crotiscella* Wharton, 1952. Type: *Microthrombidium thomasi* Oudemans, 1910. Wharton (1952) has found that the genotype of *Crotiscus,* namely, *Trombicula desdentata* Boshell and Kerr, 1942, was incorrectly described, and that the palpal claw is actually composed of three prongs; this fact necessitates its transfer to *Trombicula sens. lat.,* and for this reason Wharton has proposed the new subgenus, which is monotypic. It is represented in the Oudemans collection by *T.* (*C.*) *thomasi* (Oudemans, 1910).

Subgenus *Eutrombicula* Ewing, 1938. Type: *Microthrombidium alfreddugèsi* Oudemans, 1910. Synonym: *Acariscus* Ewing, 1938. This subgenus contains species whose larvae have the palpal claw composed of two prongs of typical form, as well as other correlated characters. The writer's table (pages 99-100), representing an attempt to classify species described as having the palpal claw composed of two prongs, must be modified in the light of studies by several workers. Thus four additional species are assigned to the subgenus *Eutrombicula*: *T.* (*E.*) *isshikii* Sugimoto, 1938; *T.* (*E.*) *kohlsi* Womersley, 1944; *T.* (*E.*) *macropus* Womersley, 1936; and *T.* (*E.*) *sarcina* Womersley, 1944. Two species are assigned to the subgenus *Leptotrombidium*: *T.* (*L.*) *myotis* Ewing, 1929; and *T.* (*L.*) *panamensis* Ewing, 1925. Two species are assigned to the subgenus *Neotrombicula*: *T.* (*N.*) *cavicola* Ewing, 1931; and *T.* (*N.*) *harperi* Ewing, 1928. Eight species are

assigned to *Trombicula sensu lato*: *T. canis* Floch and Abonnenc, 1941; *T. insularis* Ewing, 1925; *T. nissani* Dumbleton, 1947; *T. ophidica* Fonseca, 1932; *T. rara* Walch, 1924; *T. scincoides* Womersley, 1944; *T. sulae* (Oudemans, 1910); and *T. vernalis* Willmann, 1942.

Several of the species referred to *Eutrombicula* in the table have been synonymized subsequently. Thus *E. defecta* Ewing, 1946, and *E. helleri* (Oudemans, 1911) are synonyms of *T.* (*E.*) *göldii* (Oudemans, 1910). *Acariscus masoni* Ewing, 1943, is a synonym of *T.* (*E.*) *splendens* Ewing, 1913. Five forms listed in the table are synonyms of *T.* (*E.*) *alfreddugèsi* (Oudemans, 1910): *Trombicula butantanensis* Fonseca, 1932; *T. irritans* var. *tropica* Ewing, 1925; *T. irritans* var. *uruguayensis* André, 1930; *T. lacertillae* Boshell and Kerr, 1942; and *T. vanommereni* Schierbeek, 1937. It should be noted that two species to which the writer gave separate treatment in the text have been synonymized as noted above: *E. helleri* (Oudemans) is a synonym of *T.* (*E.*) *göldii* (Oudemans), and *E. vanommereni* (Schierbeek) is a synonym of *T.* (*E.*) *alfreddugèsi* (Oudemans).

Since *T.* (*E.*) *wichmanni* (Oudemans, 1905), and *T.* (*E.*) *hirsti* Sambon, 1927, are now regarded as separate species, several questions concerning them require detailed consideration. With reference to their differentiation, it is important to note that Jenkins (1948, 1949) has made thorough studies of the morphology and bionomics of the larvae and adults of two American species which are closely related to one another: *T.* (*E.*) *alfreddugèsi* (Oudemans, 1910), and *T.* (*E.*) *splendens* Ewing, 1913. His observations have provided sound evidence for regarding them as separate entities, and consideration of this fact is essential to an evaluation of the problem of *T.* (*E.*) *hirsti* and *T.* (*E.*) *wichmanni*. The writer has noted that on the type specimen of *T.* (*E.*) *hirsti*, the total number of body setae is four less than the number possessed by *T.* (*E.*) *wichmanni*, and in this instance, the character is believed to differentiate the larvae of these two species. Further studies of bionomics and of the morphology of post-larval stages are indicated. According to Wharton (1952), *T. pseudoakamushi* Hatori, 1920, probably represents a complex of these two species, and *T.* (*E.*) *wichmanni* has no synonyms other than a portion of this complex. On the other hand, *T.* (*E.*) *hirsti* has a number of synonyms, many of which have been listed by the writer under *T.* (*E.*) *wichmanni*.

It is necessary to consider Oudemans' drawings in relation to the problem of *T.* (*E.*) *wichmanni* and *T.* (*E.*) *hirsti*. Reference to his previously unpublished drawing, here reproduced on page 124 as figure 2, in relation to the topotypic specimens in his collection, leads to three comments: (1) the scutum is quite schematic; (2) the long nude seta on tarsus III has been

omitted; and (3) the setal pattern does not conform to the actual specimens of *T.* (*E.*) *wichmanni*, but rather to specimens of *T.* (*E.*) *hirsti*. It seems likely to the writer that the drawings for fig. 2 were made from a series of specimens, for it is unusual to find a single mounted specimen in which all of the details are satisfactorily displayed. It seems probable that Oudemans had a mixture of the two species before him when he drew fig. 2, or else that he was unaware that his drawings did not agree in important respects with those which he actually published in Nova Guinea (1906). It is also possible that he, himself, was confused and perhaps he hesitated to publish fig. 2 for fear of introducing further confusion. Whatever the case may have been, students of Trombiculidae are now in a position to appreciate the difficulty of the problem and to resolve it in the light of newer knowledge. The specimens from which fig. 2 were drawn were probably *T.* (*E.*) *hirsti*. The figures of *T.* (*E.*) *wichmanni* published in Nova Guinea (1906) are truly representative of the type specimens, with two slight exceptions: (1) the details of the setae of palpal segment V (figs. 73-75) are somewhat confusing, and (2) the scutum is accurately depicted in fig. 72, whereas in fig. 70 it is not.

At present the writer would identify the specimens in the Oudemans collection as follows: *T.* (*E.*) *wichmanni*—only the three topotypic specimens; *T.* (*E.*) *hirsti*—three slides from Fort de Kock and three from Medan, Deli, Sumatra, and one slide from Sungei Buloh, Selangor, Federated Malay States. On the basis of his notes, the writer is unable to comment further on the specimens from Java.

As matters now stand, therefore, the following members of the subgenus *Eutrombicula* are represented in the Oudemans collection: *T.* (*E.*) *alfreddugèsi* (Oudemans, 1910); *T.* (*E.*) *batatas* (Linnaeus, 1758); *T.* (*E.*) *göldii* (Oudemans, 1910); *T.* (*E.*) *hirsti* Sambon, 1927; *T.* (*E.*) *tinami* (Oudemans, 1910); and *T.* (*E.*) *wichmanni* (Oudemans, 1905). The adults of the first three species have been described by Jenkins (1949), while the nymph and adult of *T.* (*E.*) *wichmanni* have been described by Womersley (1952).

Subgenus *Leptotrombidium* Nagayo, Miyagawa, Mitamura and Imamura, 1916. Type: *Trombidium akamushi* Brumpt, 1910, by monotypy. Synonym: *Kedania* Kishida, 1917. This subgenus is represented in the Oudemans collection by four species: *T.* (*L.*) *akamushi* (Brumpt, 1910); *T.* (*L.*) *deliensis* Walch, 1922, which is now accorded full status as a species by Womersley (1952) and by Wharton (1952); *T.* (*L.*) *muscae* (Oudemans, 1906); and *T.* (*L.*) *russicum* (Oudemans, 1902). Although *T.* (*L.*) *myotis* Ewing, 1929, has been discussed in this paper as a variety of *T.* (*L.*) *russicum* (Oudemans), it is regarded as a distinct species by Wharton (1952). Although

Wharton (1952) lists *Trombicula fulleri* Ewing, 1945, as a synonym of *T.* (*L.*) *deliensis* Walch, the writer believes that they are distinct, that Ewing's drawing was inaccurate, that his cotype series was a composite of the two species, and that a lectotype designation and a redescription might clarify the problem. The medical importance of certain members of this group is discussed below.

Subgenus *Neotrombicula* Hirst, 1925. Type: *Acarus autumnalis* Shaw, 1790. Four species are represented in the Oudemans collection: *T.* (*N.*) *autumnalis* (Shaw, 1790); *T.* (*N.*) *fahrenholzi* (Oudemans, 1910), represented by drawings, but not by specimens; *T.* (*N.*) *muris* (Oudemans, 1910); and *T.* (*N.*) *trägårdhi* (Oudemans, 1910). Although many workers have treated *Trombidium inopinatum* Oudemans, 1909, as a synonym of *T.* (*N.*) *autumnalis* (Shaw), Womersley (1952) regards them as distinct species. Observations pertinent to this question are contained in the studies of variation in *T.* (*N.*) *autumnalis* (Shaw) in Great Britain, published by Richards (1950) and Jones (1950). Nearctic species of *Neotrombicula* have been treated by Brennan and Wharton (1950), while certain Oriental species were discussed by Philip and Fuller (1950).

Trombicula sensu lato. The Oudemans collection contains five species which the writer is unable to assign with certainty to an existing subgenus: *T. bruyanti* (Oudemans, 1910); *T. minutissimum* (Oudemans, 1910); *T. munda* Gater, 1932; *T. schmitzi* (Oudemans, 1914); and *T. sulae* (Oudemans, 1910). Four of these species require additional consideration.

Trombicula minutissimum (Oudemans) was made the type of *Microtrombicula* Ewing, 1950, proposed as a subgenus of *Eutrombicula.* Wharton (1952) has assigned this species to the subgenus *Eutrombicula,* but it is not related to the genotype according to the writer's observations. The writer would forego a conclusion until further information on its relationships is available.

T. munda Gater has been referred tentatively to *Neotrombicula* Hirst by Womersley (1952). His basis apparently consists of the following facts: (1) there is a strong similarity between the larvae of this species and *T. spicea* Gater, 1932; and (2) the nymph of *T. spicea* Gater will be placed in *Neotrombicula* when one applies the key to nymphal and adult stages given by Womersley (1952). The writer would point out that, although Womersley's key is workable in this respect, it does not necessarily express fundamental relationships. Thus, although he does not question the observations, he believes that the conclusion is premature in the absence of correlated morphologic characters. Hence the writer does not assign *T. munda* Gater to any particular subgenus.

T. schmitzi (Oudemans) has been considered by Womersley (1952), who has calculated a series of measurements on the basis of Oudemans' drawings. It should be noted that these calculated values are in very close agreement with those made by the writer from the specimen in the collection. This strongly suggests that Oudemans' drawing was a precise one, and furthermore, that no distortion has occurred during the years since he studied the specimen. These points are of obvious interest to acarologists.

T. sulae (Oudemans) was referred by the writer to *Eutrombicula* Ewing. The writer now agrees with Wharton (1952) in regarding the evidence as being insufficient to permit this assignment.

The remainder of the genera of Trombiculinae which require discussion possess expanded sensillae which are clavate or globose in shape. The writer's key is still adequate for the separation of their larvae.

Genus *Schöngastia* Oudemans, 1910. The new species described by Radford (1948) and Lawrence (1949) from Africa, and by André (1949) from Madagascar, are treated by Wharton (1952), while additional new species have been described by Womersley (1952) from the Pacific region.

S. vandersandei (Oudemans, 1905). Wharton and the writer are in agreement regarding the synonyms of this species. On the other hand, Womersley (1952) gives a key to the genus, containing a couplet which separates certain species on the basis of the palpal claw being bifurcate as opposed to trifurcate. The writer has observed that certain structures of the palpi may exhibit considerable variation in species of this genus. Consequently he reserves acceptance of Womersley's conclusion that *S. blestowei* Gunther, 1939, is a distinct species, pending the discovery of associated differential characters.

S. schüffneri (Walch, 1922). Although Womersley (1952) regards *S. katonis* Womersley and Heaslip, 1943, as a synonym, Wharton (1952) has treated it as a distinct species. The writer, lacking additional evidence, is unable to contribute to the problem of the standing of *S. katonis*.

S. vieta Gater, 1932. Although Wharton (1952) and the writer agree in regarding *S. maldiviensis* Radford, 1946, as a synonym, Womersley (1952) separates them in his key on the basis of the shape of the scutum. Thus *S. vieta* Gater is assigned to a group of two species which are stated to have a pentagonal scutum, while *S. maldiviensis* Radford belongs to a group of several species stated not to have a pentagonal scutum. As the matter now stands, Womersley and the writer are not in agreement regarding what they see on examination of Gater's type series. The matter has been discussed in correspondence, and it is unfortunate that there was no opportunity for Womersley and the writer to study the specimens together. Thus it will be

worth-while to have the observations of additional workers. Specimens of nymphs of both named species should be compared, particularly in view of the fact that they have been reared and described.

Genus *Neoschöngastia* Ewing, 1929. Since the writer's list was compiled, *N. scelopori* Ewing, 1931, has been suppressed as a synonym of *N. americana americana* (Hirst, 1921) by Brennan (1951), who has also given a key to the adequately described species of the world.

Genus *Euschöngastia* Ewing, 1938. In view of the fact that *E. americana* (Ewing, 1938) is a synonym of *E. sciuricola* (Ewing, 1925), the citation of the genotype species is thus changed. Although Womersley (1952) treats *Euschöngastia* as a subgenus of *Schöngastia* Oudemans, Wharton (1952) and the writer concur in according it full generic rank. American authors use *Euschöngastia* in the rather broad sense in which the writer has used it in this paper. Womersley (1952), however, includes the majority of these same species in *Ascoschöngastia* Ewing, regardless of whether they possess three or five normal scutal setae, and his key applies *Euschöngastia* in a restricted sense to species with the palpal claw composed of five or more prongs, and with five normal scutal setae. An appreciation of these differences in interpretation is necessary if one attempts to coordinate the work of various authors.

Certain changes in the writer's list of species of *Euschöngastia* are indicated: *E. americana* Ewing, 1938, is suppressed as a synonym of *E. sciuricola* (Ewing, 1925); *E. brevipes* (Ewing, 1938), and *E. signator* (Ewing, 1931) are synonyms of *E. peromysci* (Ewing, 1929); *E. lawrencei* (Womersley, 1952) is a new name for *Neoschöngastia guntheri* Womersley and Heaslip, 1943, preoccupied by Radford, 1942; *E. cairnsensis* var. *gateri* (Womersley and Heaslip, 1943) is suppressed by Wharton (1952) as a synonym of *E. cairnsensis* (Womersley and Heaslip, 1943), although Womersley (1952) continues to regard them as distinct; and *E. brasiliensis* (Fonseca, 1935) is tranferred to *Doloisia* Oudemans by Wharton (1952). It should be noted that the generic assignment of *E. debilis* (Gater, 1932) is no longer in doubt, since the writer's specimens from Burma possess typical expanded sensillae. For many additions to the writer's list, one must consult Wharton (1952) and Womersley (1952). Of the four species in the Oudemans collection referred to *Euschöngastia,* two require discussion.

E. indica (Hirst, 1915). The limits of this species are not clear. Thus Womersley (1952) and the writer agree in regarding *Neoschöngastia cockingsi* Radford, 1946, as a synonym, while Wharton (1952) treats it as a distinct species. Wharton (1952) and the writer agree in regarding *N. rattus* Womersley and Heaslip, 1943, as a synonym of *E. indica,* while

Womersley (1952) treats them as distinct entities. An apparently close relative of *E. indica* (Hirst), namely, *E. soekaboemiensis* (Takekawa, 1945) described from Java, has been carefully studied and redescribed by Womersley (1952) on the basis of material from southern Burma. This group of closely related mites provides interesting material for further studies in variation. The potential medical importance of *E. indica* (Hirst) is discussed below.

E. mutabilis (Gater, 1932). The nymph has been described by Womersley (1952), who has noted that Audy's record of larvae from Imphal, India, actually concerned a composite mixture of *E. lanius* (Radford, 1946), and *E. kohlsi* (Philip and Woodward, 1946). The record was based on incorrect identifications made by the writer.

Genus *Doloisia* Oudemans, 1910. In addition to the two species which the writer has referred to this genus, Wharton (1952) includes *Doloisia brasiliensis* (Fonseca, 1935).

Genus *Riedlinia* Oudemans, 1914. The writer has examined specimens of an undetermined species of this genus from an African bat, and he can now state that the sensillae are expanded distally, being clavate in form. The cheliceral blade is short and stout and bears a minute dorsal subapical toothlet. A recently described genus, *Mackiena* Traub and Evans, 1950, might be confused with *Riedlinia* in a key. In *Mackiena,* however, the expanded empodium is actually pulvilliform, and the scutum possesses concentric striations over its posterior portion, reminiscent of the scutum of *Neoschöngastia,* thus being quite easily distinguished from *Riedlinia.*

WALCHIINAE

Womersley (1952) regards *Gahrliepia* Oudemans, 1912, as the only group entitled to full generic standing, and he treats *Walchia* Ewing, 1931, *Schöngastiella* Hirst, 1915, and *Gateria* Ewing, 1938, as subgenera. Thus, according to Womersley, the subfamily is known as Gahrliepiinae. Wharton, *et al.* (1951, 1952) recognize all four genera as entitled to full generic standing, as well as *Pseudoschöngastia* Lipovsky, 1951, and *Walchiella* Fuller, 1952. Certain of the genera and species represented in the Oudemans collection require comment.

Genus *Walchia* Ewing, 1931. Type: *Walchia pingue* Gater, 1932 (synonyms: *Trombidium glabrum* Walch, 1927; and *Trombidium ewingi* Fuller, 1949, new name for *Trombidium glabrum* Walch, 1927, preoccupied by Dugés, 1834). Fuller's proposal of a new name was unnecessary, since he should have realized that Gater's name was available. The changes in nomen-

clature are summarized by Wharton (1952). Womersley (1952) has described the nymphs of *W. enode* Gater, 1932, and *W. disparunguis* (Oudemans, 1929), the two species which are represented in the Oudemans collection by larvae.

Genus *Gateria* Ewing, 1938. In the writer's key to species, couplet 7, he was unable to state characters for the separation of *G. crocidura* Radford, 1946, from *G. lancearia* Radford, 1946. Womersley (1952) states in his key that the sensillae are lanceolate in *G. lancearia,* but clavate in *G. crocidura.* According to the writer's observations of Radford's specimens, the appearance of the sensillae depends upon their position, and he is unable to separate these two nominally different species. Neither is represented in the Oudemans collection.

Genus *Walchiella* Fuller, 1952. A concise description in the Manual by Wharton aided by Fuller (1952) probably antedates the more lengthy description in the present paper, but the authorship is clearly attributed to the writer. Womersley (1952) has described the nymph of *W. oudemansi* (Walch, 1922). He has thus shown that the nymphs which Walch described as *Trombicula muris* are actually *W. oudemansi* (Walch), a point which has been discussed in the present paper. The nymph does not possess a projection on the dorsum of tarsus I, a character shared by and found upon nymphs of the other species of Walchiinae studied by Womersley. Womersley does not believe that the leg segmentation of the larva merits generic separation in the light of present knowledge, and he places *Trombicula oudemansi* Walch in the genus *Schöngastia* Oudemans. He also describes the larva of a new species from Manipur State, India, *Schöngastia lewthwaitei* Womersley, 1952, which has similar leg segmentation and finely serrate chelicerae. The new species has a distinctly larger scutum and much longer posterior lateral scutal setae. The sensillae are missing from his series of four specimens. The writer would provisionally refer this new species to *Walchiella.* Further studies of the post-larval stages of *Walchiella* may clarify the relationships of this interesting genus whose larvae share characters of the subfamilies Walchiinae and Trombiculinae.

LEEUWENHOEKIINAE

Acomatacarus Ewing, 1942, is considered by Wharton, *et al.* (1951, 1952) to consist of several subgenera. Of the species listed by the writer as belonging to *Acomatacarus,* all are to be referred to the subgenus *Acomatacarus,* with one exception: the species described by Oudemans from an African bat is now known as *Acomatacarus* (*Austracarus*) *polydiscum* (Oudemans, 1910).

Leeuwenhoekia Oudemans, 1911, is considered by Wharton, *et al.* (1951, 1952) to consist of two subgenera: *Leeuwenhoekia* Oudemans, 1911, and *Comatacarus* Ewing, 1942, each containing a single species.

Hannemania Oudemans, 1911. The species definitely included by the writer in his preliminary synopsis of this genus have not been changed in subsequent publications. Species which the writer believed were not related to the genotype of *Hannemania* Oudemans are assigned by Wharton (1952) as follows: *Chatia ochotona* (Radford, 1942); *Acomatacarus* (*Acomatacarus*) *hirsuta* (Ewing, 1931); *Whartonia perplexa* (Brennan, 1947); and *Whartonia vellae* (Dumbleton, 1947).

BIOLOGY

Fundamental studies of several aspects of the biology of Trombiculidae have been made during recent years in Great Britain, the Americas, and Malaya. Although these contributions have been well treated by Wharton (1952), they are noted here for purposes of reference because they concern species discussed in the present paper.

Trombicula (*Neotrombicula*) *autumnalis* (Shaw, 1790) has been studied in Great Britain by Jones (1950, 1951) and by Richards (1950).

The well coordinated papers of Jenkins (1948, 1949) provide important information on the bionomics of members of the subgenus *Eutrombicula* in the Americas. Wharton (1952) has presented many of his own previously unpublished observations on the biology of certain species in the United States.

The activities of two groups of investigators in Malaya have included studies of the biology of Trombiculidae, with particular reference to the species which are vectors of scrub typhus. Some of the observations of the British workers are mentioned by Audy and Harrison (1951), and further details will doubtless appear in subsequent publications. American investigators have recorded observations made in connection with voluntary exposure of human beings to infestation with larval mites under field conditions. These are described by Philip, *et al.* (1949), and by Traub and Frick (1950).

MEDICAL IMPORTANCE

Several additions to the list of species known to attack man are given by Wharton (1952). In this postscript, the writer has noted changes in nomenclature affecting several of these species which are represented in the Oudemans collection.

An authoritative account of scrub typhus is presented by Smadel (1950),

who has given the established facts concerning the bionomics of the vector species in relation to the epidemiology and control of the disease, together with pertinent references to the literature. Many details are presented and summarized by Audy (1949).

A recent finding of Traub, Frick and Diercks (1950) is of particular interest with reference to *Euschöngastia indica* (Hirst, 1915). They have reported the first instance of natural infection of this species with the causative rickettsiae of scrub typhus. The rickettsiae were recovered from two pools of larval mites removed from individual tree squirrels captured in a region of primary jungle near Kuala Lumpur, Malaya. Some of the implications of this type of finding are discussed in the body of the writer's paper.

Traub (1949) has summarized evidence which strongly suggests the existence of an important biological difference between two species whose larval morphology exhibits close similarity. Thus, on the basis of epidemiological observations, it appeared that, in a situation where *Trombicula deliensis* Walch, 1922, was acting as an effective vector of scrub typhus to man, *T. fulleri* Ewing, 1945, although also present in abundance, was not a vector.

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SUMMARY

1. The following members of the mite family Trombiculidae Ewing, 1944, have been discussed in detail:

Subfamily Trombiculinae Ewing, 1929

Genus *Trombicula* Berlese, 1905

Subgenus *Blankaartia* Oudemans, 1911: *T.* (*B.*) *acuscutellaris* Walch, 1922; *T.* (*B.*) *ardeae* (Trägårdh, 1904)

Subgenus *Crotiscella* Wharton, 1952: *T.* (*C.*) *thomasi* (Oudemans, 1910)

Subgenus *Eutrombicula* Ewing, 1938: *T.* (*E.*) *alfreddugèsi* (Oudemans, 1910), including *Eutrombicula vanommereni* (Schierbeek, 1937); *T.* (*E.*) *batatas* (Linnaeus, 1758); *T.* (*E.*) *göldii* (Oudemans, 1910), including *Eutrombicula helleri* (Oudemans, 1911); *T.* (*E.*) *hirsti* Sambon, 1927, including *Eutrombicula wichmanni* (Oudemans, 1905), in part, as treated in this paper; *T.* (*E.*) *tinami* (Oudemans, 1910); *T.* (*E.*) *wichmanni* (Oudemans, 1905)

Subgenus *Leptotrombidium* Nagayo, Miyagawa, Mitamura and Imamura, 1916: *T.* (*L.*) *akamushi* (Brumpt, 1910); *T.* (*L.*) *deliensis* Walch, 1922; *T.* (*L.*) *muscae* (Oudemans, 1906); *T.* (*L.*) *russicum* (Oudemans, 1902)

Subgenus *Neotrombicula* Hirst, 1925: *T.* (*N.*) *autumnalis* (Shaw, 1790); *T.* (*N.*) *fahrenholzi* (Oudemans, 1910); *T.* (*N.*) *muris* (Oudemans, 1910); *T.* (*N.*) *trägårdhi* (Oudemans, 1910)

Trombicula sensu lato: *T. bruyanti* (Oudemans, 1910); *T. minutissimum* (Oudemans, 1910); *T. munda* Gater, 1932; *T. schmitzi* (Oudemans, 1914); *T. sulae* (Oudemans, 1910)

Genus *Schöngastia* Oudemans, 1910: *S. vandersandei* (Oudemans, 1905); *S. schüffneri* (Walch, 1922); *S. vieta* Gater, 1932; *S. cercopitheci* (Trägårdh, 1904)

Genus *Neoschöngastia* Ewing, 1929: *N. salmi* (Oudemans, 1922)

Genus *Euschöngastia* Ewing, 1938: *E. indica* (Hirst, 1915); *E. lacunosa* (Gater, 1932); *E. mutabilis* (Gater, 1932); *E. trouessarti* (Oudemans, 1910)

Genus *Doloisia* Oudemans, 1910: *D. synoti* Oudemans, 1910

Genus *Riedlinia* Oudemans, 1914: *R. coeca* Oudemans, 1914

Subfamily Walchiinae Ewing, 1946

Genus *Walchia* Ewing, 1931: *W. enode* Gater, 1932; *W. disparunguis* (Oudemans, 1929)

Genus *Schöngastiella* Hirst, 1915

Genus *Gahrliepia* Oudemans, 1912: *G. nanus* (Oudemans, 1910); *G. cetrata* Gater, 1932

Genus *Gateria* Ewing, 1938: *G. fletcheri* (Gater, 1932)
Genus *Walchiella* Fuller, 1952: *W. oudemansi* (Walch, 1922)

Subfamily Leeuwenhoekiinae Womersley, 1944

Genus *Acomatacarus* Ewing, 1942
Subgenus *Acomatacarus* Ewing, 1942: *A.* (*A.*) *jaegerskioeldi* (Oudemans, 1911)
Subgenus *Austracarus* Lawrence, 1949: *A.* (*A.*) *polydiscum* (Oudemans, 1910)
Genus *Leeuwenhoekia* Oudemans, 1911
Subgenus *Leeuwenhoekia* Oudemans, 1911: *L.* (*L.*) *verduni* (Oudemans, 1910)
Genus *Hannemania* Oudemans, 1911: *H. hylodeus* (Oudemans, 1910); *H. rouxi* Oudemans, 1917

2. Keys to certain species of the following genera are provided: *Schöngastia* Oudemans, 1910; *Neoschöngastia* Ewing, 1929; *Doloisia* Oudemans, 1910; *Walchia* Ewing, 1931; *Schöngastiella* Hirst, 1915; *Gahrliepia* Oudemans, 1912; and *Gateria* Ewing, 1938.

3. Synoptic lists give the species tentatively assigned to each of the following categories: *Eutrombicula* Ewing, 1938 (a subgenus of *Trombicula* Berlese, 1905); *Schöngastia* Oudemans, 1910; *Neoschöngastia* Ewing, 1929; *Euschöngastia* Ewing, 1938; *Acomatacarus* Ewing, 1942; and *Hannemania* Oudemans, 1911. These lists are intended to serve as preliminary bases for revisional studies.

4. The new genus, *Walchiella* Fuller, 1952, is described on the basis of larval characters. It is referred to the subfamily Walchiinae.

5. A lectotype specimen is designated for each of four species: *Trombicula schmitzi* (Oudemans, 1914); *Schöngastia vandersandei* (Oudemans, 1905); *Riedlinia coeca* Oudemans, 1914; and *Hannemania rouxi* Oudemans, 1917. These lectotypes are preserved in the Rijksmuseum van Natuurlijke Historie, Leiden.

6. Several species of medical importance are discussed. *Trombicula* (*Leptotrombidium*) *akamushi* (Brumpt, 1910) and *T.* (*L.*) *deliensis* Walch, 1922, are vectors of the rickettsial disease, scrub typhus (tsutsugamushi disease, mijtekoorts, mite-borne typhus); the rickettsiae which cause this

disease have also been recovered from *Euschöngastia indica* (Hirst, 1915), a species which has never been recorded for man, but which may play a role in the natural maintenance of the rickettsiae.

Certain species whose attack may cause irritating lesions of the human skin are discussed: *Trombicula* (*Eutrombicula*) *alfreddugèsi* (Oudemans, 1910); *T.* (*E.*) *batatas* (Linnaeus, 1758); *T.* (*E.*) *göldii* (Oudemans, 1910); *T.* (*E.*) *hirsti* Sambon, 1927; *T.* (*E.*) *wichmanni* (Oudemans, 1905); *Schöngastia vandersandei* (Oudemans, 1905); and *S. schüffneri* (Walch, 1922).

7. The Trombiculidae give rise to many problems in speciation, outstanding examples being those forms which are of medical importance. The larvae are worthy of further study with respect to the numerous aspects of host-parasite relationships. The free-living nymphs and adults, with their apparently precise requirements as members of the microbiota of the soil, are in need of further investigation from the ecological standpoint. Thus the members of the family Trombiculidae offer many valuable opportunities to the inquisitive and critical biologist.