NEOTROMBIDIUM LEONARDI (ACARINA : TROMBIDIOIDEA) PART 1 : REVISION OF THE GENUS, WITH DESCRIPTION OF TWO NEW SPECIES

BY

G. SINGER [1].

ABSTRACT.

Studies of the genus *Neotrombidium* are reviewed and discussed. The genus is redefined on the basis of larval and post-larval morphology, and *N. andrei* and *N. beeri* are described as new species. Taxonomic characters are discussed and illustrations of pertinent morphology are included.

INTRODUCTION.

Neotrombidium species show morphological affinities with the families Trombidiidae Leach, Leeuwenhoekiidae Womersley, and Trombiculidae Ewing. The systematic position of these species, and conflicting data on their morphology, suggested a need for a critical revision.

The family Trombidiidae is generally studied from the post-larval stages, while the Leeuwenhoekiidae and Trombiculidae are best known from their larval stages. The drastic heteromorphic nature of these two life categories generally prevents an understanding of one through a study of the other. The availability and rearing of live *Neotrombidium* material (SINGER, in press), has presented an opportunity for a study and description of the life stages of one species, supplied data for a statistical analysis of taxonomic characters (SINGER, in preparation), and a description of the larval idiosomal musculature (SINGER, in preparation).

This paper, the first of a series of 4, presents a review and detailed taxonomic description of the genus in order that its relationship to other trombidioid genera may be more clearly interpreted.

MATERIALS AND METHODS.

Specimens were mounted in a gum chloral fluid (SINGER, 1967), on standard glass slides. Dissection and remounting of specimens was carried out, where necessary, to more clearly interpret given structures. Measurements were made with a fixed, calibrated ocular micrometer.

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Illustrations were made with the aid of a microprojector, and details were then checked and corrected under phase contrast microscopy, prior to inking.

In addition to specimens representing two new species, type material of *N. tricuspidum* (including Homotype males and females), *indosinensis* (adult male), *elongatum* (one female), *armatum* (one female), and *Monunguis streblida* (larvae) were also studied. Museum specimens of host beetles were softened on the pin by placing in boiling water for up to one minute. The free elytron was raised and the parasitic mites could be easily removed. This procedure (P. O. RITCHER, Dept. Entomology, Oregon State University, personal communication, 1964) does not harm pinned beetle specimens.

Setal nomenclature follows SINGER (in press), being a modification of the terminology employed by F. GRANDJEAN and others :

Trichodea (= sensilla trichodea, scobalae, vrais poils, tactile setae, tactala, etc.)
Basiconica (= category including *Solenidea* and *Eupathidea*)
Solenidea (= thin-walled sensilla basiconica, ampullacea, coeloconica ; tarsala, solenidia, etc.)
Crassiconica (= thick-walled sensilla basiconica).
Microcrassiconica (= thick-walled sensilla basiconica, microsetae, famuli, poils vestigieux in some cases, etc.)
Trichobothria (= *Trichodea*, pseudostigmatic organs and pseudostigmatum, poil bothrionique and etc., sensillae, etc.)

ACKNOWLEDGEMENTS.

The substance of this study would have been considerably reduced were it not for the encouragement and fine bibliographical and technical facilities afforded me by Dr. R. E. BEER, Chairman, Department of Entomology, University of Kansas, Lawrence, Kansas. Paratypes and homotypes of *N. tricuspidum*, as well as specimens of *N. andrei* n. sp. were kindly lent me by Dr. BEER.

I am deeply indebted to the late Dr. M. ANDRÉ, past Director of Acarologia, for his interest and for his gracious loan of types of *N. elongatum*, *armatum*, and *indosinensis*. His time, effort, and kindness have been warmly received.

I was able to obtain a loan of a paratype of *N. elongatum* through the kindness of Dr. A. DE BARROS MACHADO, Director of the Dundo Museum, Dundo, Lunda, Angola.

Dr. E. W. BAKER, U.S.D.A., Entomology Research Division, Washington, D. C., U.S.A. took the time to try to locate EWING's type of *N. tridentifer* and kindly loaned me a type series of *Monunguis streblida*.

I acknowledge my debt to Dr. G. W. KRANTZ and Dr. P. O. RITCHER, Department of Entomology, Oregon State University, Corvallis, Oregon, and finally, to Dr. D. K. McE. KEVAN, Chairman, Department of Entomology, Macdonald College of McGill University, Quebec, Canada. It was through their personal interest in me and my work that this study reached fruition.

AFFINITIES OF NEOTROMBIDIUM.

The genus *Neotrombidium* was erected as a subgenus of *Trombidium* Fabricius, 1775, in the family Trombidiidae Leach, 1815, by LEONARDI (1901). BERLESE (1912) elevated *Neotrombidium* to generic status. THOR (1935 *a*) included *Neotrombidium* in his Ottoniinae, but (THOR, 1935 *b*) substituted the name Microtrombidiinae for Ottoniinae, which was preoccupied. THOR and WILLMANN (1947) retained THOR's concept, although earlier, WOMERSLEY (1945 *a*), calling attention to the close relationship between *Neotrombidium* adults and adults of *Leeuwenhoekia*, removed *Neotrombidium* from the Microtrombidiinae. WOMERSLEY (1945 *b*) redefined the genus *Neotrombidium*, using the adult of *N. barringunense* Hirst to typify the genus, and assigned it to the newly proposed Leeuwenhoekiidae Womersley.

BAKER and WHARTON (1952) again listed *Neotrombidium* in the Microtrombidiinae, although, on the basis of their key (p. 174), *Neotrombidium* species would be included in the Trombiculidae. The observations of CROSSLEY (1960 : 163) indicated that the post-larval *Neotrombidium* scutum aligns it with the Leeuwenhoekiinae rather than the Microtrombidiinae.

WHARTON (1938) described the larval *Monunguis streblida*, but later, (WHARTON, 1947) synonymized the genus *Monunguis* with *Neotrombidium* because *M. streblida* resembled specimens of trombidioid larvae collected in association with *Neotrombidium* adults. This erroneous observations by WHARTON apparently prompted WOMERSLEY (1954) and AUDY (1954) to place the larval *Neotrombidium* (represented by *Monunguis streblida*) in the Apoloniinae (Leeuwenhoekiidae of WOMERSLEY, Trombiculidae of others). It should be noted again, that the data presented for the larval *Neotrombidium* represents *Monunguis streblida*, and not the larva of a *Neotrombidium* species. The importance of this fact will be shown below (see *N. samsinaki*). VERCAMMEN-GRANDJEAN and KOLEBINOVA (1968) excluded *Neotrombidium* from the Apoloniinae, placing it in the Trombidiidae.

SOUTHCOTT (1954) was the first to correlate the larva with the adult for a *Neotrombidium* species, *N. barringunense*, through actual rearing. The larval *N. barringunense* was placed in the Leeuwenhoekiidae. In a later paper, SOUTHCOTT (1957) reviewed the genus and discussed some of its affinities with the Trombidioidea, placing it tentatively in the Leeuwenhoekiidae, a family concept which SOUTHCOTT did not accept. In SOUTHCOTT (1961 : 412) *Neotrombidium* was included in the Trombiculidae.

FEIDER (1955) placed the genus *Neotrombidium* in a monotypic subfamily in his Stigmotrombidiidae.

BORLAND (1956) correlated the larva and adult for *N. tricuspidum*, but left the genus unassigned, " until the taxonomy of related genera becomes better known, and until family levels are drawn, along more definite lines ".

CROSSLEY (1956) stated, " these mites appear taxonomically intermediate between the families Trombidiidae and Trombiculidae, although at least generically distinct from members of both families ".

The familial concept of WOMERSLEY's Leewenhoekiidae is still in a state of flux. BAKER and WHARTON (1952), AUDY (1954), SOUTHCOTT (1957), CROSSLEY (1960), ZUMPT (1961), and others, did not accept WORMERSLEY's concepts. ANDRÉ (1958), COOREMAN (1960), VERCAMMEN-GRANDJEAN (1965), and others, found the concept useful.

Studies by the present author indicate that a fragmentation of trombidioid forms into the various currently employed family categories is unwarranted. Only the family Trombidiidae, as characterized by BERLESE (1912) appears acceptable, but the many subfamilies proposed by THOR (1935 *a*), THOR and WILLMAN (1947), FEIDER (1955) and others, are viewed with distress and are not recognized. *Neotrombidium* is regarded as a valid genus, distinct from other trombidioid genera, and assigned to the family Trombidiidae.

Neotrombidium Leonardi.

Trombidium (*Neotrombidium*) Leonardi, 1901, Zool. Anz., **25** : 17.
Cockingsia Womersley, 1954, Stud. Inst. Med. Res., Federated Malaya States, **26** : 115-117.

Type species : *Trombidium* (*Neotrombidium*) *furcigerum* Leonardi, 1901.

Post-larval stages : Idiosoma characteristically bearing trifurcated trichodea (Pl. 14). Two pairs of genital discs (acetabula) internal to centrovalves in nymphs and adults. Crista (scutum)

narrow, extending anteriorily into sclerotized nasus. Nasus projecting beyond propodosoma, bearing two (rarely 1 or 3) anteriorly-directed uniramous spiculated trichodea. Dorsal propodosomal trichobothria attenuated, arising from bases set near caudal extreme of crista (Pl. 22). Idiosoma characteristically elongated, constricted at level coxae IV, into " figure-eight " shape (Pl. 14) due to muscle insertions into this region (mounted preparations may obscure this constriction). Two pairs of genital sclerites present, bearing uniramous spiculated trichodea, occasional bifurcated examples present on epivalves (Pls. 6 B, 7, 8). Anal valves with uniramous spiculated trichodea and occasional bifurcated and trifurcated examples (Pl. 6 A, C). Ventral hypostome basally

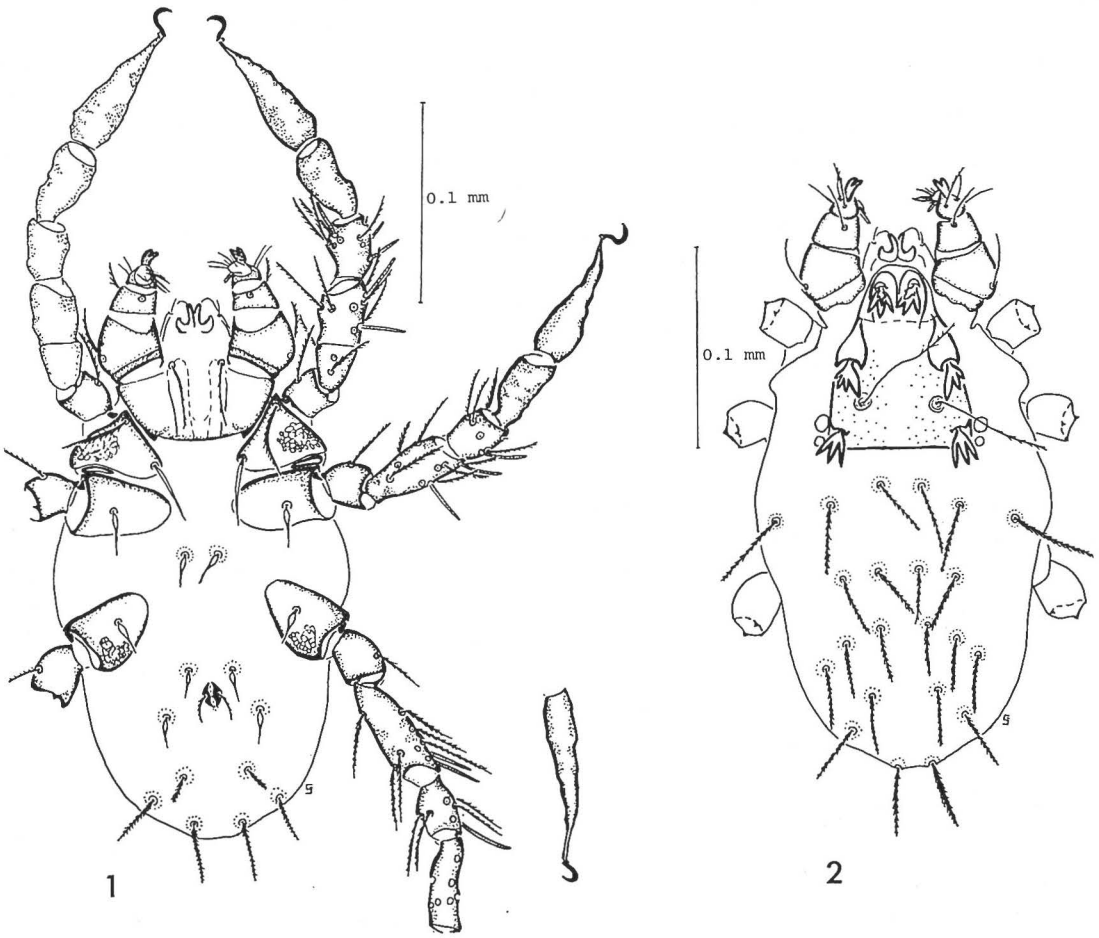

FIG. 1-2 : *N. beeri*, larva (morphotype).
1. — Ventral aspect. 2. — Dorsal aspect.

with uniramous spiculated trichodea, distally with four simple pairs (Pl. 5 B). Usually one pair eye lenses distinct, dorsal to coxae I (second pair may be distinct, reduced or absent). Spiracular and tracheal system absent (salivary ducts may be confused with tracheae). Palp tibia usually with external whip-like trichodea at base of tibial claw and accessory spines (Pl. 5 B). Leg claws asymetrical, one member of each pair longer than other (usually by 2-3 μ).

Adult Female : Centrovalves simple, with setae set medially in one or two rows. Internal sclerotized apparatus absent (Pl. 7).

Adult Male : Centrovalves widened caudally, tapering anteriorly, with setae set posteriorly in more than one row (Pl. 8). Internal sclerotized apparatus present, apparently of characteristic morphology (Pl. 9, 10).

Nymph : As in female, except with about half as many setae on epivalves and anal valves (Pl. 6 A, B). Sexes apparently indistinguishable in nymphal instar.

Larva : Leg tarsi terminating in one claw (Pl. 3, 17, 21). Leg segmentation 7 : 6 : 6. Scutum with an antero-median projection extending over chelicerae (Pl. 2), bearing two setae. Scutal trichobothrial filaments thin, attenuated. Idiosomal neotrichy absent, with 16 pairs of setae (Pl. 2), set in orderly rows (apparently only 14 pairs in *N. barringunense* and *tenuipes*). One pair of setae anteromedial to coxae III (Pl. 1). One pair of setae associated with anal valves (Pl. 1), or setae and valves absent (Pl. 15, 19). Coxa II and III each with one seta (Pl. 1). Coxa I with two setae (mesal seta may be set in integument of sternum) (Pl. 1, 15, 19). Basifemur I with two trichodea (Pl. 15). Two pairs of eyes present, flanking caudal margins of scutum (Pl. 4, 18, 20). Tracheal system absent. Palp tarsus with six trichodea and one basal inner solenideum (Pl. 4 A, 18 B, 20 C). Palp tibial claw bifurcated. Idiosoma constricted posterior to coxae III (due to muscle insertions in that region (Singer, in press, b). Urstigma present, associated with coxa I (Pl. 1, 15, 19). Parasitic on the abdomen, under the elytra of Coleoptera.

Neotrombidium beeri n. sp.

Holotype Female (measurements *taken* prior to dissection) : Length from base of nasus 1,729 μ, width sejugal area 879 μ, width at level coxae III 803 μ. Scutum with nasus slightly wider than trichobothrial socket rims (Pl. 22 A). Crista length from trichobothria to posterior of nasus 187 μ, central width 19 μ. Crista prolonged posteriorly from nototrichobothria by 58 μ. Scutal trichobothria thin, basally spiculated and distally setulated, 96 μ long. Idiosomal trichodea characteristically trifurcated, with additional lateral rami ; 20 to 24 μ long anterior to scutal trichobothria and 26 μ long posterior to trichobothria, 26 μ long at caudal margin idiosoma, 26 μ long anterior to genital aperture (Pl. 14 A). Epivalves 215 μ long, each with about 50 spiculated setae (Pl. 7). Centrovalves with 7 to 9 uniramous spiculated setae set in single row. Anal valves 69 μ long, each with about 13 spiculated setae (Pl. 6 C). Tarsus I 204 μ long, 64 μ wide. Tibia I 136 μ long, 50 and 72 μ wide. One pair eye lenses dorsal to coxae I. Tarsus I with claws about 26 μ long, other tarsal claws 34 to 37 μ long, faintly rayed (Pls. 11 A, 12, 13). Palp tibia with one accessory spine dorsal to tibial claw (Pl. 5 B). Hypostome with about 34 pr. spiculated setae (Pl. 5 B).

Allotype Male : Similar to holotype female. Length 1,285 μ, sejugal width 740 μ, width level coxae III 708 μ. Crista length from trichobothria to base of nasus 161 μ, width 17 μ. Epivalves 150 μ long, each with about 70 spiculated setae (Pl. 8). Centrovalves each with about 34 spiculated setae set in single, double, and triple rows. Internal sclerotized genital apparatus present (Pl. 9, 10). Tarsus I 177 μ long, 63 μ wide. Tibia I 108 μ long, 56 μ wide. Tarsus I claws about 29 μ long, others 38 to 43 μ long.

Morphotype Nymph : Similar to holotype female. Length 992 μ, sejugal width 567 μ, width level coxae III 538 μ. Crista length from trichobothria to nasus 105 μ. Epivalves 139 μ long, each with about 22 spiculated setae (Pl. 6 B). Centrovalves each with 3 to 6 spiculated setae in single rows. Anal valves 47 μ long, each with 5 or 6 spiculated setae (Pl. 6 A). Tarsus I 122 μ

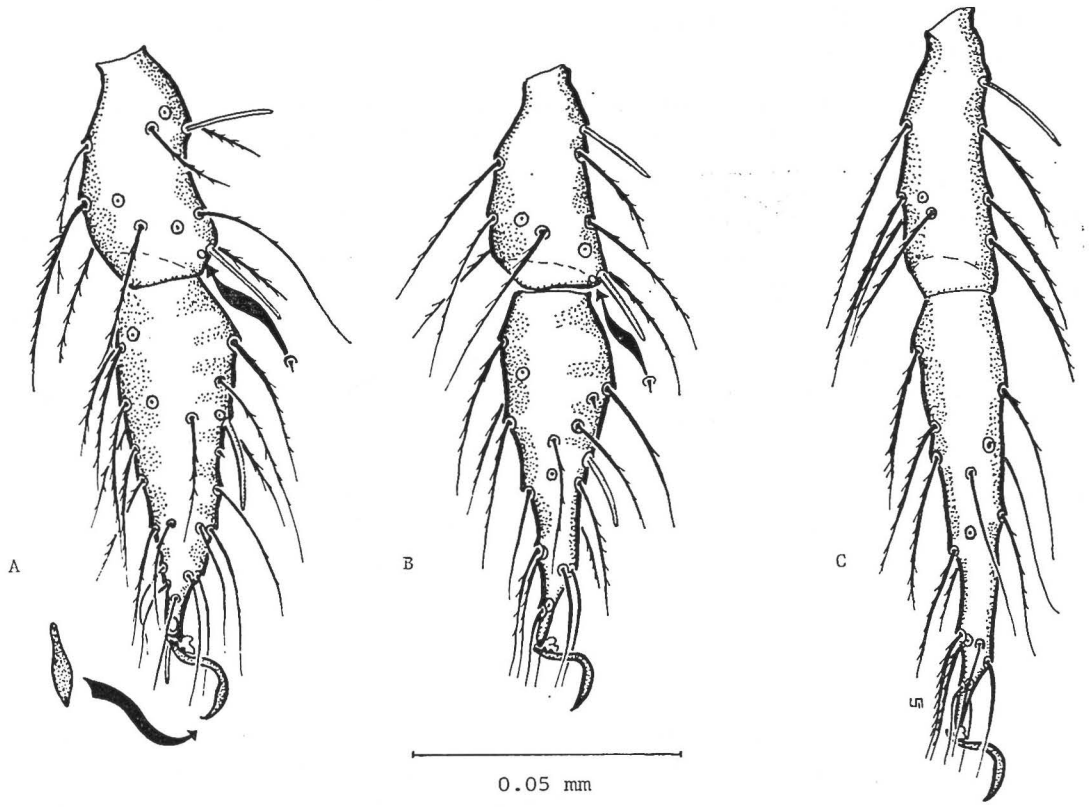

FIG. 3 : *N. beeri*, larva (morphotype).
A — Tarsus and tibia I. B. — Tarsus and tibia II. C. — Tarsus and tibia III.

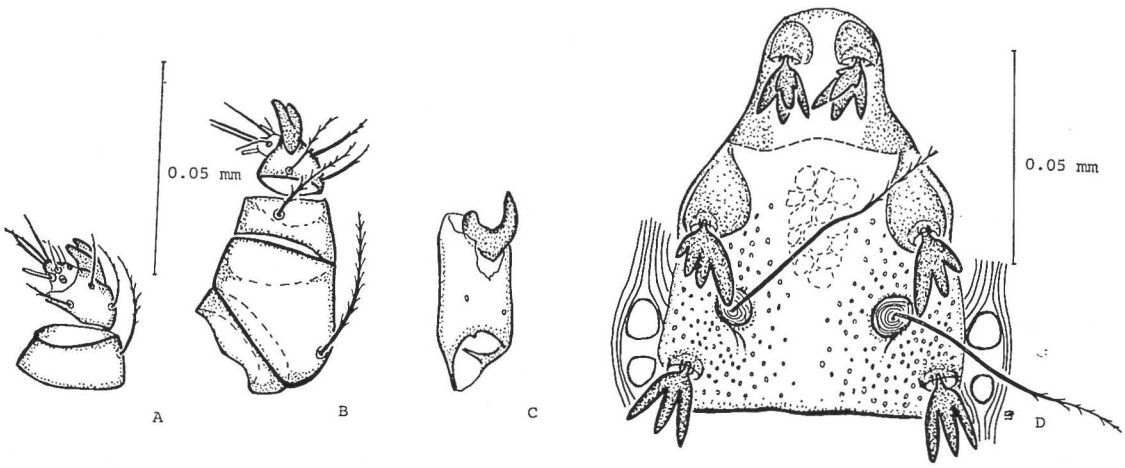

FIG. 4 : *N. beeri* larva.
A. — External aspect of palp. B. — Dorsal aspect of palp. C. — Chela. D. — Scutum (morphotype).

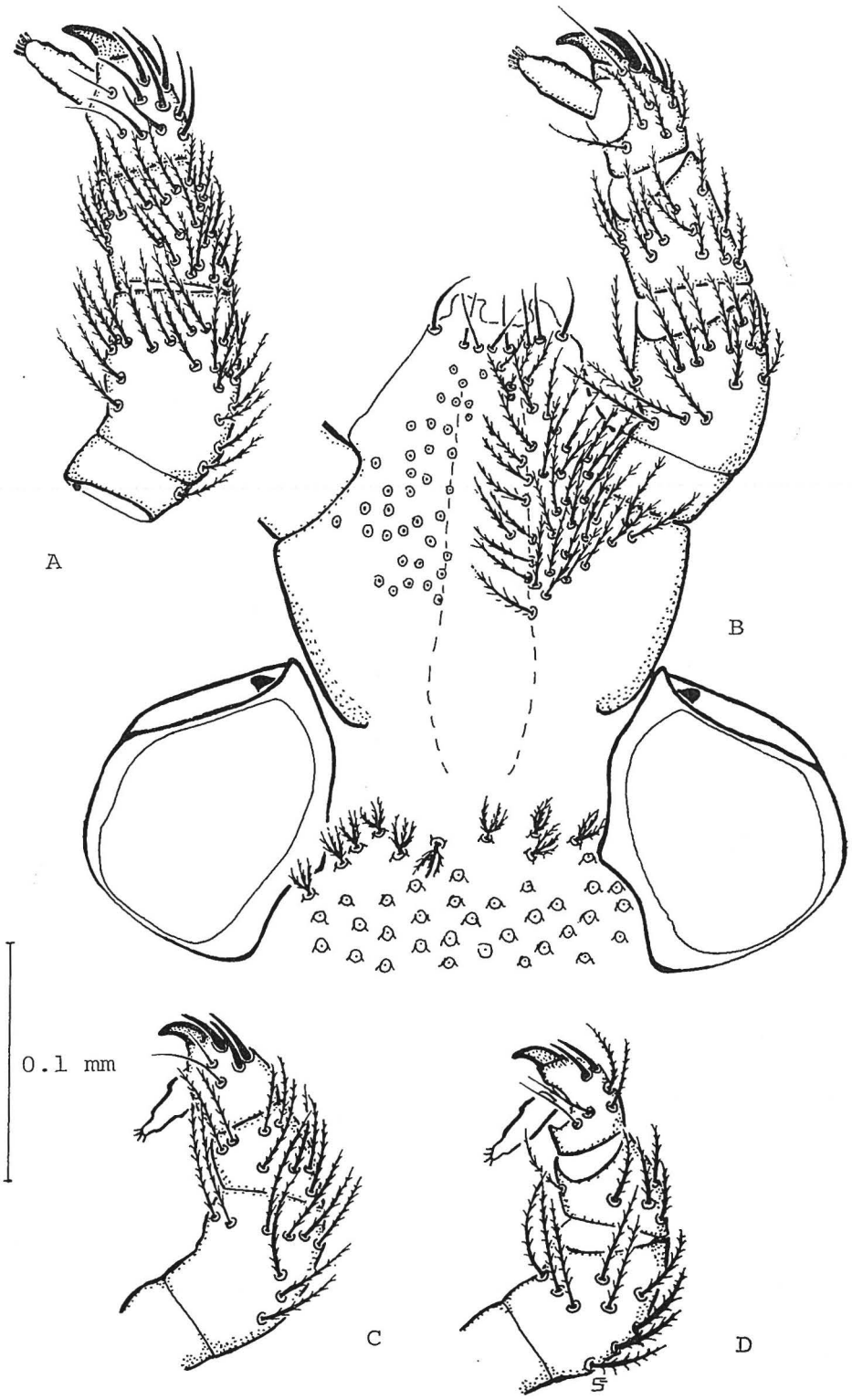

FIG. 5 : *N. beeri.*

A. — Internal aspect of adult female palp. B. — Ventral hypostome and external aspect of adult female palp. C. — Internal aspect of nymphal palp. D. — External aspect of nymphal palp. (Note : palp tarsal trichodea not illustrated).

long, 45 μ wide. Tibia I 74 μ long, 40 μ wide. Claws of tarsus I about 22 μ long, other tarsal claws 26 to 35 μ long. Hypostome with about 12 pr. spiculated trichodea.

Morphotype Larva : Unengorged length from tip of nasus 256 μ, sejugal width 151 μ, width level coxae III 128 μ (Pls. 1, 2). (Engorged specimens measured to 1,000 μ long, 625 μ wide). Scutum with anterior nasus containing two unusually branched trichodea (Pl. 4 D). Lateral scutal setae typically trifurcated (morphotype specimen with one antero-lateral seta branched four times). Scutum punctuated and areolated as figured. Scutal trichobothrial filaments attenuated, 61 μ long, and distally setulated. Idiosomal setae (Pl. 1) in small " platelets ", in distinct convex rows ; humerals 42 μ and caudals 38 μ long ; dorsal hysterosomals and postanals spiculated, perianals and sternals smooth and medially dialated. Coxae I with mesal setae on coxal scleroma ; smooth, medially dialated, longer than sternals or perianals. Other coxal setae similar to, but slightly longer than sternals and perianals. Anal valves present, with one pair curved, spiculated setae. Palp and chela (flattened) as figured (Pl. 4 A, C). Tarsal claws spatulated, 12 μ long (Pl. 3). Tarsus I 69 μ long, 23 μ wide. Tibia I 38 μ long, 22 μ wide. Leg chaetotaxy as figured (Pls. 1, 3), with microcrassiconica on tarsi, tibiae, and genuae I and II. Microcrassiconicum on tarsus I placed distal to solenideum. Tarsus I with apical-ventral crassiconicum projecting under claw (Pl. 3 A).

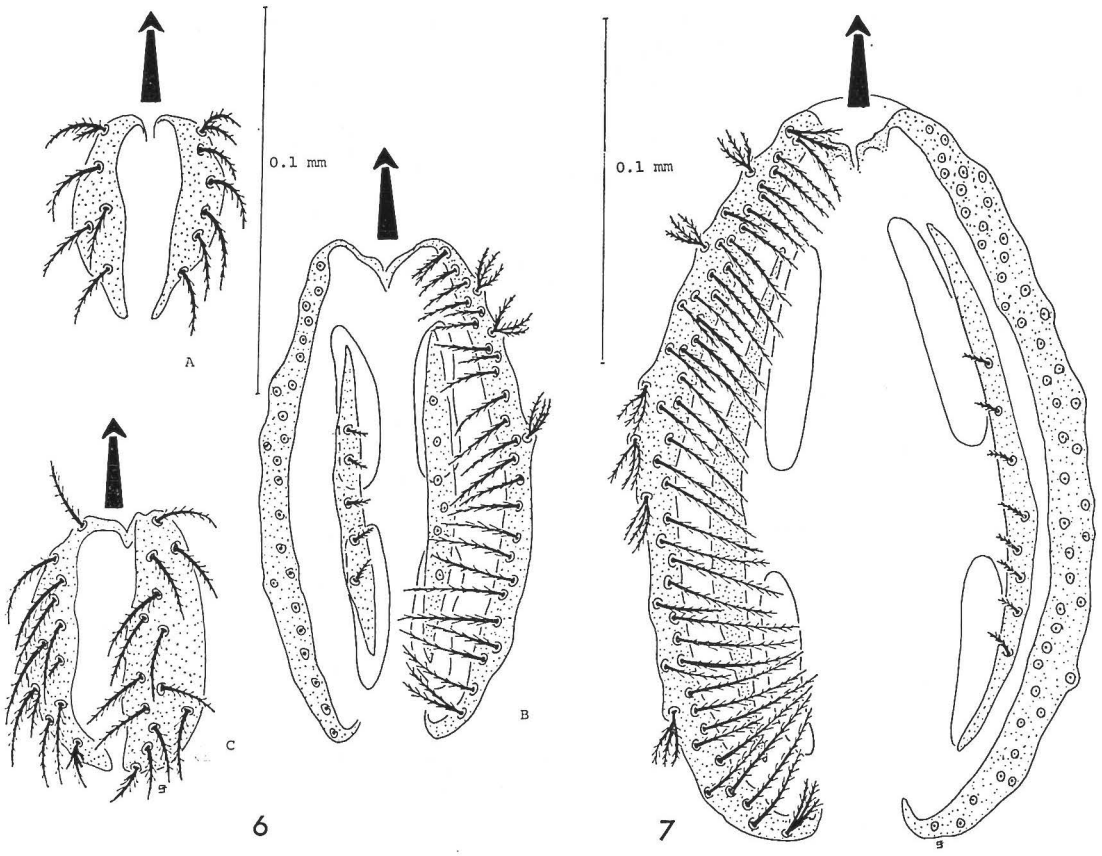

FIG. 6 : *N. beeri*. A. — Anus of nymph. B. — Genital aperture of nymph. C. — Anus of adult female.
FIG. 7 : *N. beeri* adult female, genital aperture.

Type Data : Montgomery County State Park, seven miles south of Independence, Kansas, U.S.A. Eighteen live engorged larvae collected from under the elytra of one live *Alobates pennsylvanica* (DEGEER) (Coleoptera : Tenebrionidae), found under the bark of an elm log, October 14, 1961. The Holotype female and Allotype male were reared from these larvae, producing an F_1 generation from which the Morphotype nymph and larva, and other Paratype specimens were subsequently reared (SINGER, in press, a).

The type series comprised 11 adult females, 9 adult males, 18 nymphal exuvia, 8 nymphs, 40 unengorged F_1 larvae, and assorted field-collected engorged larvae removed from host beetles from several localities in the United States of America and from Quebec, Canada.

A statistical analysis of taxonomic characters involving this type series is covered in a separate study (SINGER, in preparation, a).

Location of types : Holotype, Allotype, Morphotype, and Paratype specimens will be deposited in the Acarological Collection, Snow Entomological Museum, University of Kansas, Lawrence, Kansas, U.S.A.

Paratypes will also be donated to the following : National Museum, Washington, D. C. ; Institute of Acarology, Ohio State University, Columbus, Ohio ; Bernice P. Bishop Museum, Honolulu, Hawaii ; Lyman Entomological Museum, Macdonald College, Quebec, Canada ; Cana-

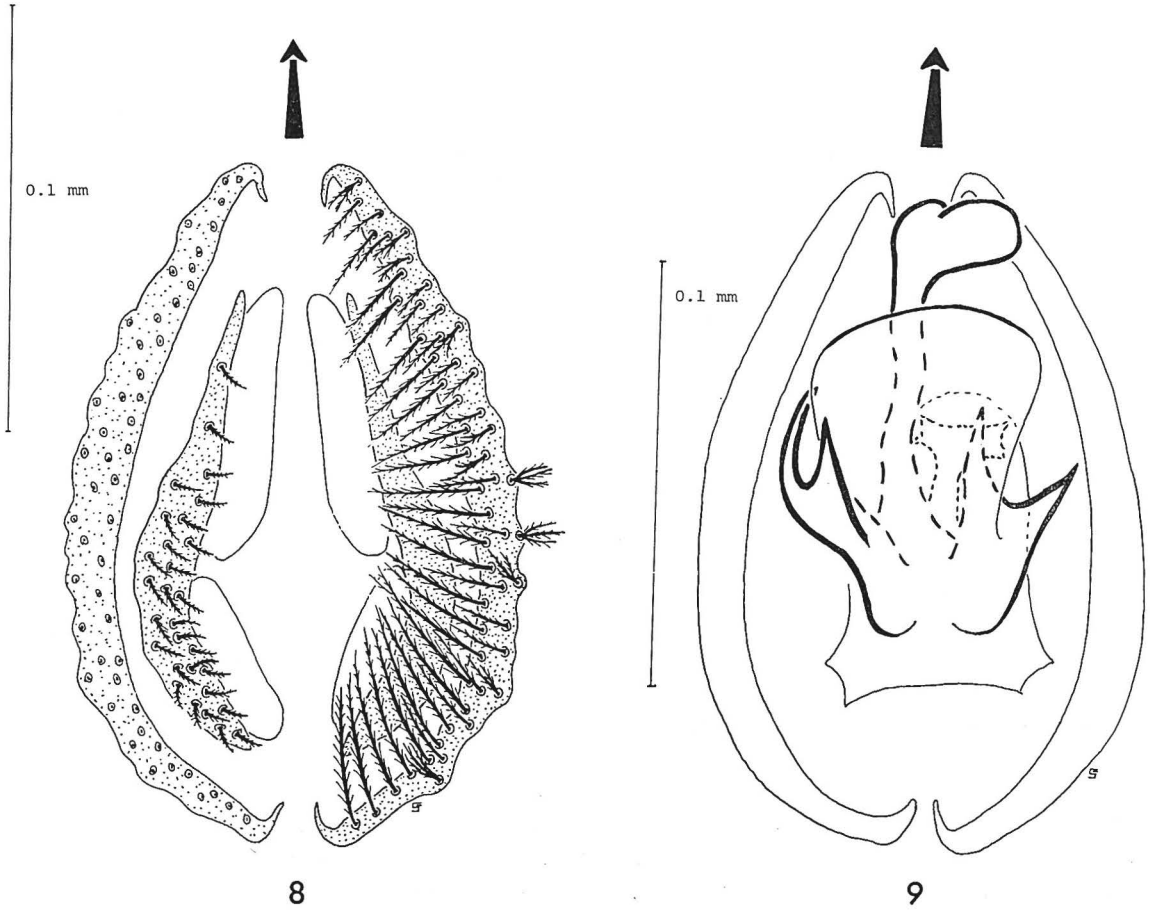

FIG. 8-9 : *N. beeri* adult male.
8. — External aspect of genital aperture ; 9. — Internal aspect of genital aperture.

dian National Collection, Ottawa, Ontario, Canada ; British Museum (Nat. Hist.), London, England ; Institut Royal des Sciences Naturelles de Belgique, Bruxelles, Belgium ; Muséum National d'Histoire naturelle, Paris, France ; South Australian Museum, Adelaide, Australia ; Natal Museum, Pietermaritzburg, Union of South Africa ; Zoological Institute of the Academy of Sciences of the U.S.S.R., Leningrad, U.S.S.R. ; Entomological Museum, Oregon State University, Corvallis, Oregon ; Dundo Museum, Dundo, Lunda, Angola ; Dr. BRENNAN, Rocky Mountain Laboratory, Hamilton, Montana ; J. S. ROSAS COSTA, José Luis Cantilo 3722, Buenos Aires 19, Argentina ; M. DANIEL, Inst. Parasitology, Czechoslovak Academy of Sciences, Flemingovo

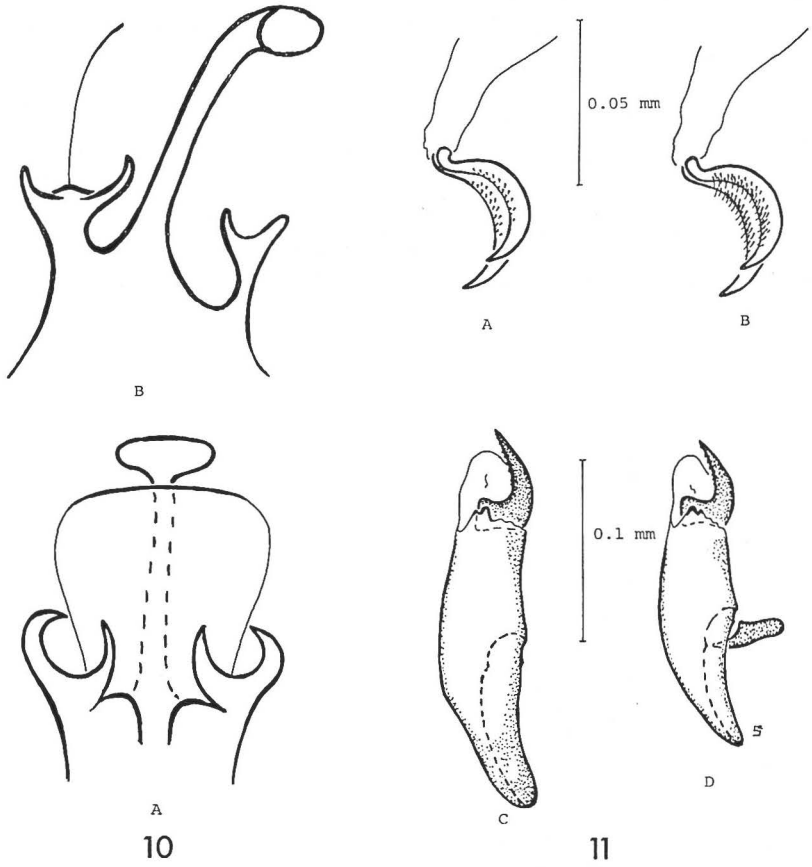

FIG. 10 : *N. beeri*, adult male.
A. — Posterior aspect of male organ. B. — Lateral aspect of male organ. (Not to scale, schematic).

FIG. 11 : A. — Claws on tarsus IV of adult female *N. beeri*. B. — Claws on tarsus IV of adult female *N tricuspidum*. C. — Chela of adult *N. beeri*. D. — Chela of nymphal *N. beeri*.

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Remarks : *Neotrombidium beeri* larvae were recovered from *A. pennsylvanica* collected in Quebec, Canada and New York, Pennsylvania, Iowa, Arkansas, and Kansas, U.S.A.

Three beetle specimens at the Oregon State University Entomological Museum, Corvallis, Oregon, were collected near Tangent, Oregon, suggesting a coast-to-coast distribution for the beetles. The northern distribution of these hosts extends to the Canadian border. A survey of the host beetle throughout its range from September to January (at which time the beetles harbor the mites and the beetles congregate under dead bark) should given an index of the range of *N. beeri.*

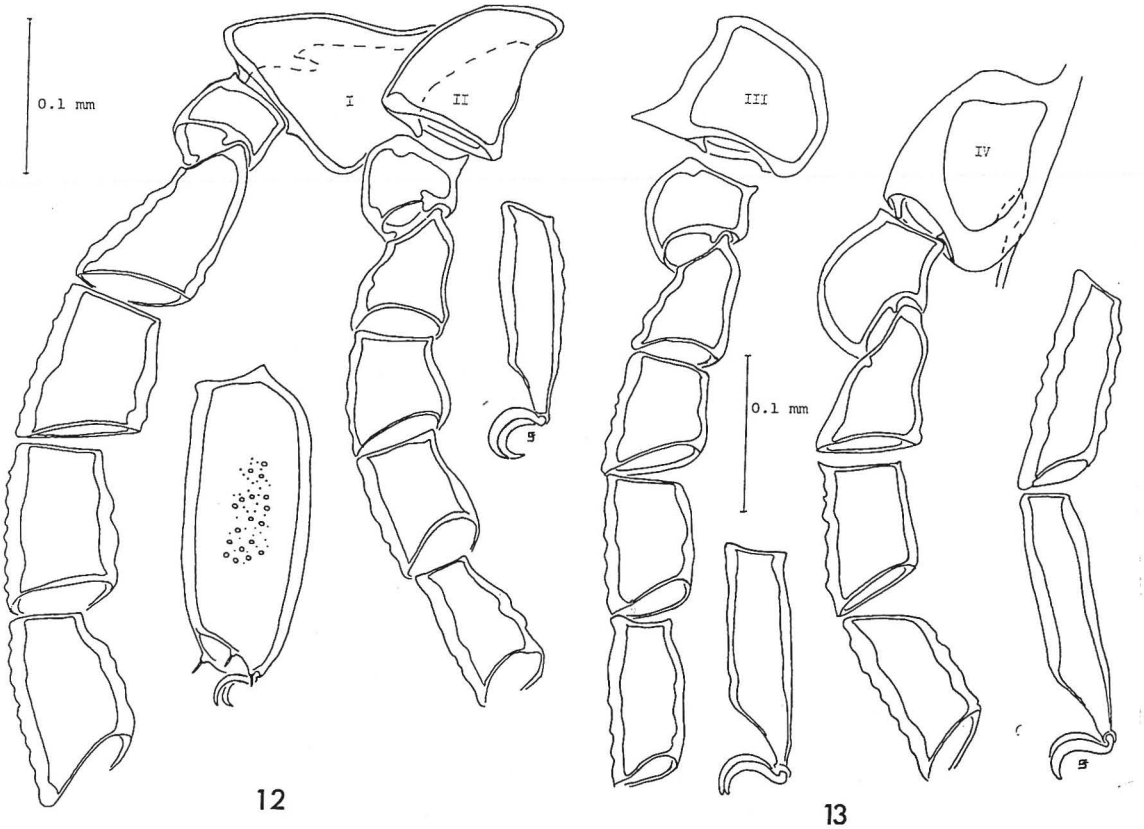


FIG. 12-13 : *N. beeri,* adult male.
12. — Legs I and II ; 13. — Legs III and IV.

Although adults of *N. tricuspidum* were commonly collected from under bark in the vicinity of Lawrence, Kansas, and *N. beeri* larvae were commonly collected on the host beetle under bark in the same general locality, no post-larval instars of *N. beeri* appear to have been recorded in field collections.

This species is named in honor of Dr. R. E. BEER, Chairman, Department of Entomology, University of Kansas, Lawrence, Kansas, whose research work and example have been an inspiration to his students.

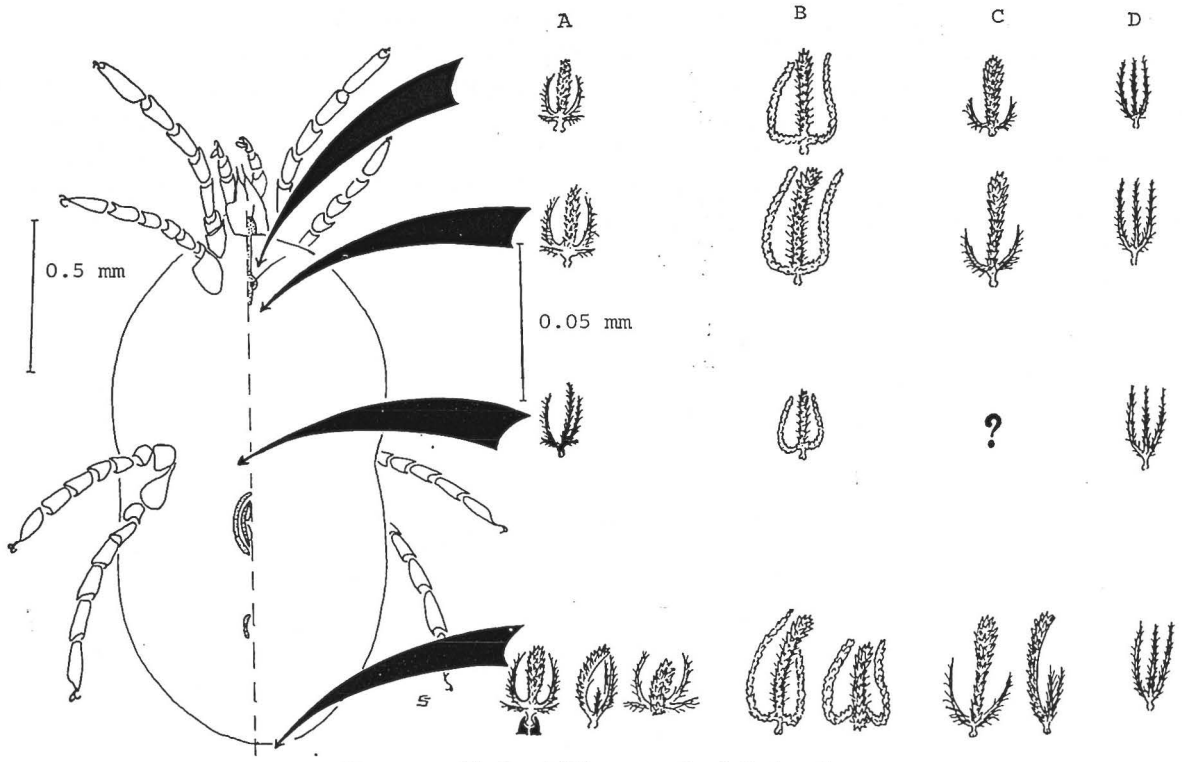


FIG. 14 : *N. beeri* idiosoma of adult female.
A. — Idiosomal setae of *N. beeri* ; B. — *N. indosinensis* ; C. — *N. elongatum* ; D. — *N. tricuspidum*.

Neotrombidium andrei n. sp.

Holotype Larva : Engorged and extremely flattened (Pls. 15, 16), length 831 μ, sejugal width 539 μ, width coxae III 444 μ. Scutum with lateral trichodea similar to dorsal hysterosomals. Scutum punctated and aerolated as figured, with nasus projecting over gnathosoma. Trichobothrial filaments attenuated, simple, 65 μ long (Pl. 18 C). Ventral idiosomal trichodea longer and finer than ventrocaudals and dorsals ; humerals and caudals 32 μ long. Coxa I with mesal seta in sternal membrane. Coxal trichodea similar to sternals. Anal valves and anal setae absent. Palp and chelae as figured (Pl. 18 A, B). Leg tarsus I 64 μ long, 25 μ wide ; tibia I 41 μ long, 25 μ wide. Leg chaetotaxy as figured (Pls. 15, 16, 17). Microcrassiconicum on tarsus I posterior to solenideum, and microcrassiconicum on tibia II apparently absent. Claws 23 to 26 μ long.

Type Data : Brown's Canyon, Baboquivari Mountains, Arizona, U.S.A., July 18, 1949. Two engorged larval specimens collected from *Cymatodera peninsularis* Schffr. (Coleoptera : Cleridae), by WERNER and NUTTING. Originally mounted in Polyvinyl-alcohol-lacto-phenol, paratype remounted in gum chloral medium.

Location of Types : The holotype and paratype specimens will be deposited in the Acarological Collection, Snow Entomological Museum, University of Kansas, Lawrence, Kansas.

The name *Neotrombidium andréi* is given in honor of the late Dr. Marc ANDRÉ, whose unselfish dedication and many basic contributions to Acarology stand as a monument to a great scientist.

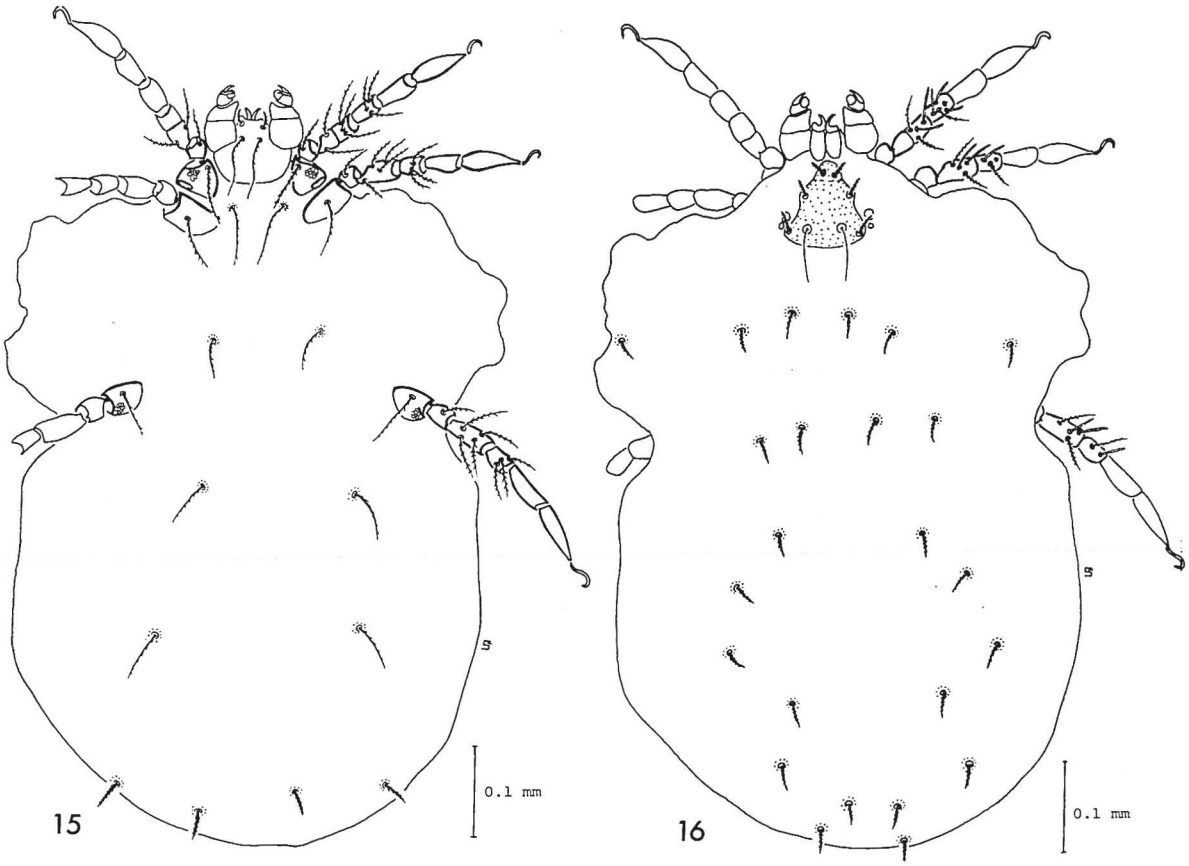


FIG. 15-16 : *N. andrei* larva (Holotype).
15. — Ventral aspect ; 16. — Dorsal aspect.

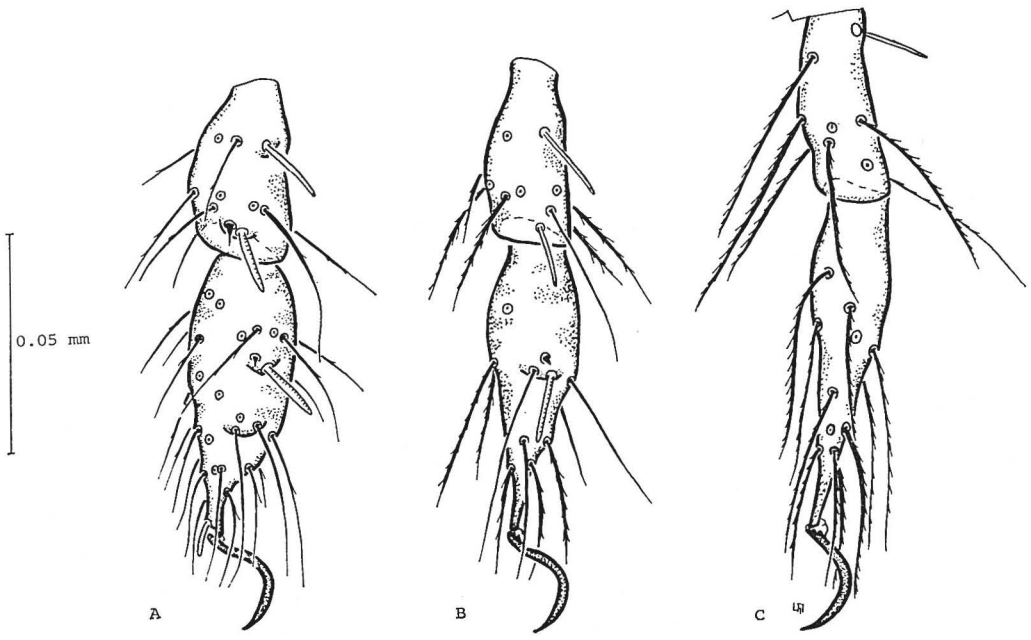


FIG. 17 : *N. andrei* larva (Holotype). A. — Tarsus and tibia I. B. — Tarsus and tibia II.
C. — Tarsus and tibia III.

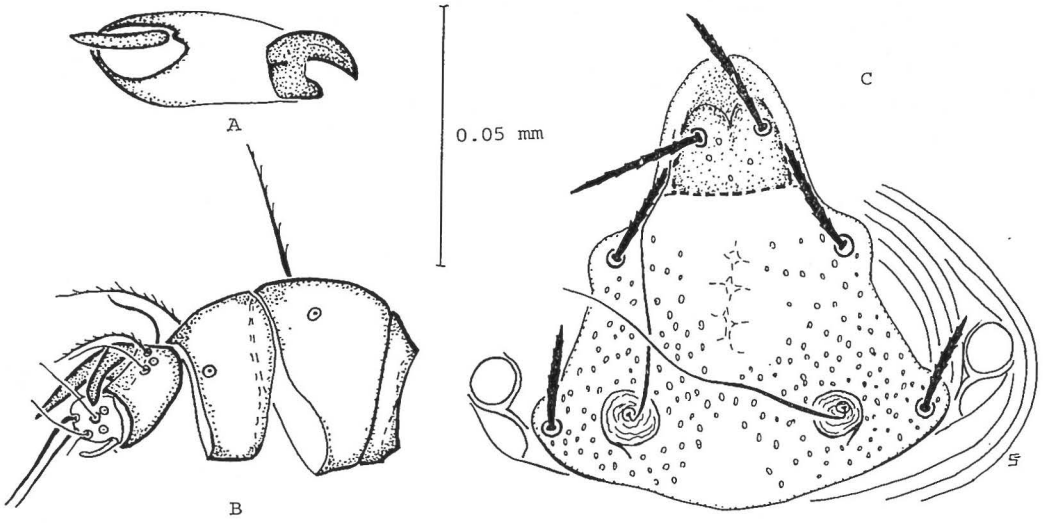


Fig. 18 : *N. andrei* larva (Holotype). A. — Chela. B. — Palp. C. — Scutum.

Neotrombidium ophthalmicum (Berlese).

Trombidium opthalmicum Berlese, 1888, Boll. Soc. Ent. Italiana, 20 : 179.

Remarks : The description for *N. ophthalmicum* was drawn from one unique Paraguayan specimen (see *N. furcigerum*).

Neotrombidium furcigerum Leonardi.

Trombidium (*Neotrombidium*) *furcigerum* Leonardi, 1901, Zool. Anz., 25 : 17.

Remarks : LEONARDI described *N. furcigerum* from an Argentinian adult specimen, including it in a new subgenus of *Trombidium* ; the original description follows :

" 43° *Trombidium furcigerum* Leon. n. sp. — miniaceum (?), et cutulis ; abdomine toto pilis in furcan lange triramosam defermatis induto, cephalothorace crista metopica destituto pilisque breviter cylindricis desevestuto ; oculo in quoque latere unico ; palporum unguibus apice tribus.

Propter oculos tantum binos, cephalothorace crista metopica nulla, aliisque characteribus in subgenere *Neotrombidium* species mihi videtum inserinda.

Ad : 1,900 long.

Habitat : Unicum vidi exemplu ad St. Pedro de Colalao collectum. "

The triramous configuration of the idiosomal setae in adult trombidioids was considered by BERLESE to have generic value and, in BERLESE (1912), *Neotrombidium* was elevated to generic rank. *Neotrombidium ophthalmicum* (Berlese) was redescribed, and additional data were presented by which *ophtalmicum* and *furcigerum* could be distinguished. These data were incorporated in the keys of THOR and WILLMAN (1947) and WOMERSLEY (1963 *c*).

Neotrombidium barringunense Hirst

N. barringunense Hirst, 1928, Ann. Mag. Nat. Hist., 1 : 563-4.

Remarks : HIRST (1928) described, but did not illustrate *N. barringunense* from an adult Australian specimen. In HIRST (1929) the adult *N. barringunense* was illustrated and mention was made of its abundance in Australia. *Neotrombidium barringunense* was later mentioned briefly by WOMERSLEY (1936). WOMERSLEY (1945 *b*) critically redescribed the adult *barringunense*, and included a list of Australian localities from which the species was known. The larva of *barringunense* was carefully described and illustrated by SOUTHCOTT (1954).

Neotrombidium tenuipes (Womersley).

Cockingsia tenuipes Womersley, 1954, Stud. Inst. Med. Res., Federated Malaya States, 26 : 115-7.

Remarks : The genus *Cockingsia* was proposed for the larval *N. tenuipes* by WOMERSLEY (1954). SOUTHCOTT (1957) synonymized *Cockingsia* with *Neotrombidium* on rather conclusive evidence and WOMERSLEY (1963 *c*) accepted this synonymy.

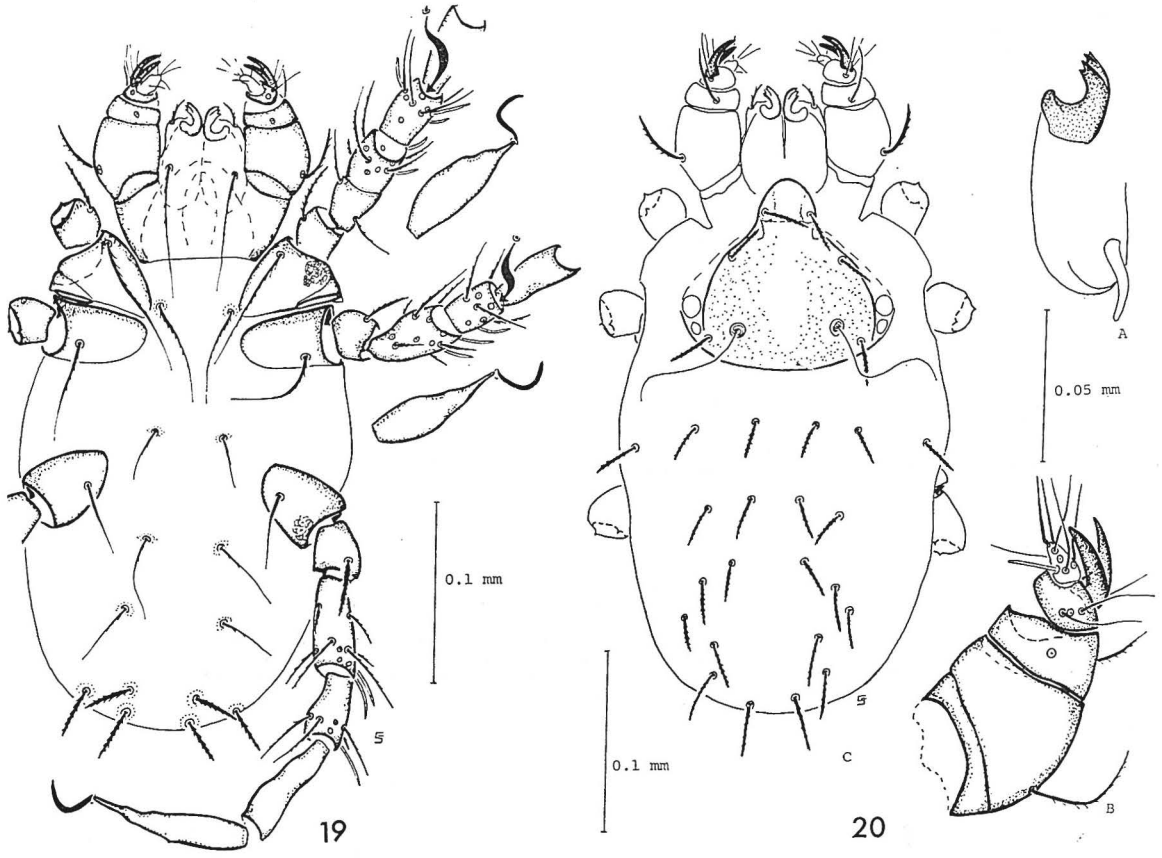
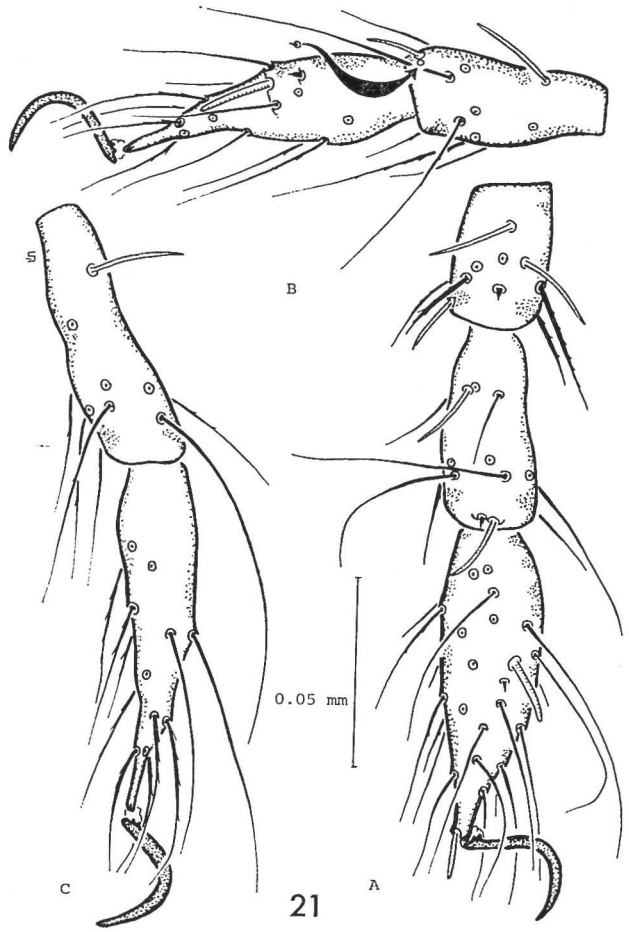


Fig. 19 : *N. tricuspidum* larva (paratype), ventral aspect.
FIG. 20 : *N. tricuspidum* larva (paratype). A. — Dorsal aspect. B. Chela. C. — Palp.

Neotrombidium tricuspidum Borland.

N. tricuspidum Borland, 1956, J. Kansas Ent. Soc. 29 : 29-35.

Remarks : Borland (1956) described the larva and adult of *N. tricuspidum* from Kansas and North Carolina, U.S.A. Southcott (personal communication, 1963) suggested that *tricuspidum* may be a synonymy of Ewing's *tridentifer*. Borland's *N. tricuspidum* is re-illustrated here (Pls. 14 D, 19, 20, 21), in an attempt at supplying additional comparative data.



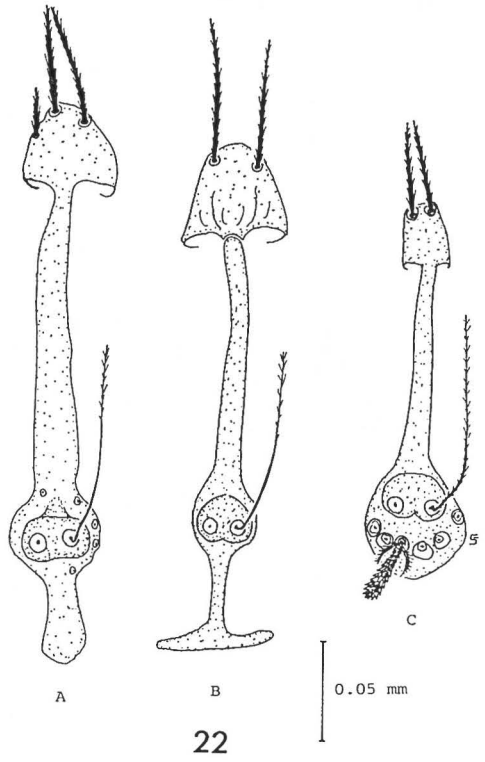


Fig. 21 : *N. tricuspidum* larva (paratype).

A. — Tarsus, tibia and genu I. B. — Tarsus and tibia II. C. — Tarsus and tibia III.

Fig. 22 : Scuta. A. — *N. beeri* adult female (Holotype). B. — *N. tricuspidum* adult female. C. — *N. elongatum* adult female (paratype).

Neotrombidium elongatum André.

N. elongatum André, 1958, Publ. Cult. Companhia Diamantes, Angola, Mus. Dundo, **35** : 112-4.

Remarks : André described the species from 2 adults collected in Angola.

Neotrombidium armatum André.

N. armatum André, 1958, Pub. cult. Companhia Diamantes, Angola, Mus. Dundo, 35 : 115.

Remarks : This species is known from one adult female specimen collected in Angola.

Neotrombidium indosinensis André.

N. indosinensis André, 1960, Acarologia, 2 : 324-6.
N. helladicum Cooreman, 1960, Bull. Ann. Soc. Roy. Ent. Belgique, 96 : 195-204.

Remarks : André (1960) described *N. indosinensis* from 21 specimens collected in Indochina. Cooreman (1960) described *N. helladicum* from one adult specimen collected in Greece, and included an excellent review of the genus *Neotrombidium*. Cooreman's *N. helladicum* is here considered a synonym of André's *indosinensis*. A study of André's paratype of *indosinensis* showed that the idiosomal setae (Pl. 14 B) appear indistinguishable from those illustrated for *helladicum* (contrary to André's illustration). The shape and measurements of tarsus I, as well as a comparison of the description and illustrations of *helladicum* with a paratype of *indosinensis*, indicates that the two are conspecific.

Neotrombidium neptunium Southcott.

N. tridentifer (*Nom. Praeocc.*) Southcott, 1957, Tans. Roy. Soc. S. Australia, 80 : 157-164.
N. neptunium Southcott, 1961, Australian J. Zool., 9 : 412.

Remarks : Southcott (1957) described *N. neptunium* from adults collected in association with *N. barringunense* adults in Australia.

Neotrombidium gracilare Womersley.

N. gracilare Womersley, 1963, Trans. Roy. Soc. S. Australia, 86 : 150-2.

Remarks : Womersley (1963 *c*) described *N. gracilare* from 10 post-larval specimens collected from bat caves in Australia. Womersley was able to distinguish between nymphs, females and males, but did not present much data by which these different forms may be characterized. A short incomplete review and a key to some of the adult forms of *Neotrombidium* were also included.

Neotrombidium samsinaki (Daniel).

Cockingsia samsinaki Daniel, 1963, Acarologia, 4 : 576-581.

Remarks : Daniel (1963) described this species from the larva, a parasite of cerambycid beetles. Daniel was apparently misinformed, following Audy (1954) and Womersley (1954), in his statements that *Neotrombidium* larvae bear a 7 : 7 : 7 leg segmentation and that *N. tenuipes* shows spiracles and tracheae. Southcott (1957) correctly indicated that *Neotrombidium* larvae have a 7 : 6 : 6 leg segmentation and lack spiracles and tracheae.

Neotrombidium tridentifer (Ewing) (*nomen dubium*).

Rhyncholophus tridentifer Ewing, 1909, Trans. Acad. Sci. St. Louis, **18** : 56.

Remarks : Ewing (1909) described *N. tridentifer* from the adult, collected in Illinois, U.S.A. Ewing's description and illustration are useless below the generic level and, regrettably, the type material has been misplaced and lost (Dr. E. W. Baker, personal communication, 1963). This species was transferred from *Rhyncholophus* Dugès, 1934, by Southcott (1961 : 412).

Species Incorrectly Assigned to Neotrombidium.

Neotrombidium vietsi, described by Oudemans (1929), is a synonym for *Valgothrombium valgum* (George) (Thor and Willman, 1947).

Monunguis streblida Wharton, 1938, was synonymized with *Neotrombidium* by Wharton (1947). Borland (1956) and Cooreman (1960) suggested that *Monunguis* represents a genus distinct from *Neotrombidium*. Later, Womersley (1963 *a*) reviewed the taxonomic position of *Monunguis streblida*, recognizing *Monunguis* as a genus distinct from *Neotrombidium*. Singer (in preparation) reviewed and redescribed *M. streblida*, also considering it to represent a genus distinct from *Neotrombidium* on the basis of its 7 : 7 : 7 leg segmentation and idiosomal neotrichy. In addition, the hosts for *M. streblida* (Diptera) differ from those of known Neotrombidium species (Coleoptera).

Neotrombidium gracilipes was described by Womersley (1963 *b*) from one unique larval specimen from an Australian bat cave. He was impressed by the fact that the post-larval instars of *N. gracilare* and the larval *gracilipes* were collected from similar habitats. This suggested that they might be conspecific. The lack of substantiating correlative data prompted Womersley to describe the larval *gracilipes* as a species distinct from *gracilare*. Womersley's *N. gracilipes* is considered to belong in a genus distinct from *Neotrombidium* on the basis of its idiosomal neotrichy and palp tarsal chaetotaxy. Womersley's specimen apparently requires re-examination in order to determine its true generic affinities.

Discussion of morphological characters.

Idiosomal Setae : Setal length and fine structure often varies, depending on the location of each given seta on a given specimen (e. g., see Pl. 14 A). The more detailed a comparison is made between setae, the more important the exact location of each seta becomes. In the post-larval instars of *Neotrombidium* species, setal measurements and illustrations are given for setae anterior and posterior to the propodosomal sensillary region, on the posterior idiosomal margin, and immediately anterior to the genital aperture (Pl. 14). Although some species of *Neotrombidium* may be identified by the size and structure of the post-larval idiosomal setae (*N. beeri* Pl. 14 A), these characters are often difficult to measure and interpret. Other, more obvious, morphological differences must also be looked for in differentiating between species.

Numbering of the larval idiosomal setal rows and designating given series as ventrals or dorsals are practices of dubious value. Dorsal idiosomal setae in *Neotrombidium* larvae, and in many trombidioid larvae, are set in characteristically convex rows. This convex pattern is

usually modified as the starved larva reaches full engorgement, resulting in some confusion when comparing setal row counts. By way of example, SOUTHCOTT (1954) described a 6 : 4 : 4 : 2 : 4 row pattern of idiosomal setae in *N. barringunense*, while WOMERSLEY (1954) arrived at a pattern of 2 : 4 : 4 : 4 : 2 for *N. tenuipes*. BORLAND (1956) indicated a pattern of 6 : 4 : 6 : 2 : 2 : 2 for *N. tricuspidum*, while DANIEL (1963) recorded *N. samsinaki* as having a 2 : 4 : 4 : 6 : 6 pattern. An examination of the illustrations of these specimens indicates an identical setal row pattern between *N. barringunense* and *tenuipes*, and *N. tricuspidum* and *samsinaki*, the differences being found only in the interpretations of the different authors.

Slide preparations of fully engorged larval *Neotrombidium* species frequently produce specimens that show some of the posterior dorsal setae located on the ventral idiosomal region. Adherence to rigid dorsal and ventral counts would result in a distorted interpretation in such cases. Adding to this problem is the fact that the ventral post-anal larval setae in *Neotrombidium* larvae appear identical to those characteristically found on the dorsum, while the perianal sternal setae are morphologically distinct from the dorsals.

Larval trombidioid idiosomal setal patterns are extremely variable throughout the Trombidioidea, including many instances of neotrichy (e. g. MITCHELL and NADCHATRAM, 1966 ; TRAUB and NADCHATRAM, 1965). Under these circumstances, it appears dubious whether a standardized system of idiosomal setal row counts, such as used in the Tetranychidae (PRITCHARD and BAKER, 1955), for example, would be feasible or useful. Complete and detailed illustrations of larval instars should accompany each new species description, so that setal arrangement and numbers would be made more useful in species comparisons.

AUDY (1954 : 148-9) discussed what he referred to as " organizer fields " (using this term in the embryological sense), which influence the larval idiosomal setation. He suggested that several " fields " exists which are influenced, each by a different " organizer ", thereby ascribing taxonomic importance to the differences between the different " fields ". These " fields " include the following setal groups : median scutals (AM), anterolateral cutals (AL), posterolateral scutals (PL), dorsal hysterosomals (DS), humerals (HS), post anals (PS), and the ventrals (VS). This appears to be a useful concept, calling attention to characters which may otherwise be overlooked in some species. In *Neotrombidium* species studied, the DS and the PS have been found to be similar morphologically. The ventrals are considered to represent the sternals and the perianals. The anal valve setae, when present, are considered to represent a different " field " from that of the ventral series, since their morphology appears distinct from that of the ventrals (Pl. 1). The median coxal I and the coxal II and III setae appear to share close morphological similarities with the sternals and perianals, this is obvious in *N. beeri* (Pl. I). In *N. andrei* and *tricuspidum* there appears to be no appreciable difference between the median and lateral scutal setae and the other dorsal hysterosomals, while in *N. beeri* the median and lateral scutals show a difference in morphology and the scutals are distinct from the other dorsal setae (Pl. 2).

Larval Appendicular Setae : The presence of one or two setae on coxa I has been used by VERCAMMEN-GRANDJEAN and KOLEBINOVA (1968) to separate Leeuwenhoekiinae from Apoloniinae species. In some species of *Neotrombidium*, this median coxal seta (= anterior sternal seta of other authors) may be located in the sternal membrane or on the coxal scleroma. In *N. tricuspidum*, this character may be difficult to interpret. BORLAND's description of *N. tricuspidum* states, " Coxa I with two setae, the inner long, whiplike, located on innermost coxal rim and possibly on the venter in some specimens ". BORLAND's illustration shows this mesal seta situated on coxa I. A re-examination of two of BORLAND's larval types showed the mesal seta to be loca-

ted on the membrane adjacent to the coxal rim (Pl. 19). Engorged specimens may show this seta to be further from the coxal rim, than would be the case with starved specimens. In *N. beeri* the mesal coxa seta sits on the scleroma (Pl. 1), while in *N. barringunense, samsinaki,* and *tenuipes,* this seta appears to be included on or contiguous with the coxal rim. *Neotrombidium andrei* has the inner coxal seta set on the sternal membrane (Pl. 15). The positioning of the inner coxal I seta, with respect to the coxal rim, must be considered with caution if it is to be used as a taxonomic character.

The presence, shape, and number of appendicular setae, especially solenidea, trichobothria, and microcrassiconica, have been used extensively in the larval trombiculid classification. Detailed illustrations and descriptions of these appendicular setae are in many cases indispensable for characterizing given species of larval trombiculids. The literature, however, does not allow for detailed comparative studies of all larval appendicular setae in *Neotrombidium* species. Observations were therefore limited to the material at hand, *N. tricuspidum, andrei,* and *beeri,* with additional information from the literature, where available.

Characterizing appendicular trichobothria, or so-called " masti-setae ", is useful only when these setae are considerably modified from other adjoining setae. In *Neotrombidium* larvae, there appears to be a gradation between these trichobothria and the adjoining trichodea. No purpose would be served, therefore, by distinguishing between these setal types. The numbers of trichodea on the appendicular tarsi and tibiae indicate specific differences as listed in the following chart :

	Tricuspidum	*andrei*	*beeri*
Tarsus I	18	20	20
Tibia I	7	8	8
Tarsus II	10	9	15
Tibia II	6	6	7
Tarsus III	10	10	15
Tibia III	6	6	7

The location of appendicular microcrassiconica in *Neotrombidium* larvae, although sometimes difficult to locate, are of taxonomic value, usually located dorso-distally on tarsi, tibiae, and genuae I and II. The genual microcrassiconica are not associated with a solenideum, as they are in the tarsal and tibial segments. In *N. andrei* the tarsal I microcrassiconicum is located posteriad to the dorsal solenideum (Pl. 17 A), while in *N. beeri, tricuspidum, samsinaki,* and *barringunense,* it is distad to the dorsal solenideum (Pl. 3 A, 21 A). I was unable to detect a microcrassiconicum on tibia II in *N. andrei* (Pl. 17 B), but it is present in the other species studied.

Tarsal Claws : The larval appendicular tarsal segments in *Neotrombidium* species characteristically bear one claw. This character, however, is not in itself diagnostic for the genus, since it is shared by *Audyana* Womersley (1954), *Mackerrasiella* Womersley (1954), *Monunguis* Wharton (1938), and others. In *N. beeri* the tarsal claws are spatulate in the larva (Pl. 3) and simple in the other larvae studied.

The post-larval *N. beeri* and *elongatum* show the claws to be finely haired (Pl. 11 A). In *N. tricuspidum* (Pl. 11 B) the claws are more strongly rayed, while *indosinensis* showed smooth claws. The outer member of each pair of tarsal claws was found to be slightly larger than the

inner member. Some specific differences were found when adult claw measurements were taken. However, differences between *elongatum, tricuspidum,* and *beeri* are not considered as significant.

	armatum	*tricuspidum*	*elongatum*	*indosinensis*	*beeri*
Claws I	13/17 μ	27/28 μ	24/26 μ	10/13 μ	25/27 μ
Claws II		33/37 μ	33/38 μ	21/25 μ	37/39 μ
Claws III		37/39 μ	33/38 μ	23/28 μ	38/40 μ
Claws IV		39/42 μ	33/38 μ	25/28 μ	38/40 μ

Anus : Presence or absence of an anus (excretary pore), anal valves, and anal setae appear to be valuable specific larval characters that have been given little consideration. In *N. beeri* (Pl. 1), *barringunense,* and *tenuipes,* anal valves and associated anal trichodea are present. In *N. tricuspidum* (Pl. 19) and *andrei* (Pl. 15), the anal opening, valves, and setae are absent. DANIEL's *N. samsinaki* is illustrated showing an anal opening but no valves or setae. Such an obvious series of species characters deserves more attention.

In post-larval stages, the nymphs characteristically show fewer trichodea on the valves than do their respective adults (Pl. 6 A, C).

Neotrombidium indosinensis ♂ showed 6-8 uniramous spiculated setae per valve and *N. tricuspidum* showed 8-10 setae, compared with 11-13 for *N. beeri* adults.

Palps : Palpal chaetotaxy and measurement has been used extensively to characterize trombidiid species (e. g., in BERLESE, 1912 and ANDRÉ, 1958) and descriptions of several adult *Neotrombidium* species weigh heavily upon this one character (e. g. ANDRÉ, 1958 and 1960). Specific characters presented by palps of *Neotrombidium* species include the following : 1) Accessory tibial spines (= stout trichodea) grading into simple trichodea (*N. indosinensis* and *armatum*), or only one accessory tibial spine distinct from the other tibial trichodea (*N. elongatum, beeri,* and *tricuspidum*) ; 2) One tibial spine set at internal base of tibial claw (*N. indosinensis* and *armatum*), or absent (*N. beeri, tricuspidum,* and *elongatum*).

An examination of a series of *N. beeri* post-larvae indicated that the numbers of accessory tibial spines, smooth trichodea, as well as the numbers of femoral and genual trichodea were occasionally variable from one specimen to the next, and from nymph to adult of the same individual. Plate 5 represents the palp of one adult female and of her nymphal exuvium. The nymphal palp tibia is abnormal, with several accessory spines and no external whip-like trichodea (mastala), while the palp of the resulting adult represents the more normal condition. Cases of several accessory tibial spines grading into the simple trichodea were also noted in one adult male specimen.

The palpal smooth trichodea tend to grade imperceptably into spiculated trichodea. ANDRÉ (1960) described the palp tibial trichodea in *N. indosinensis* as being smooth, while an oil-immersion examination of one of his types showed these setae to be slightly spiculated. The dorsal trichodea on the palp and leg segments are usually stouter and of different shape from those found ventrally on these same segments. However, these setae tend to grade into one another along the lateral margins of these segments.

Taxonomic characters found on the palps of post-larval *Neotrombidium* species, and most other trombidioid species, must be weighed with caution, because of the variability of these structures and the subjectivity involved in their interpretation. It may be found that excep-

tional trombidioid species show subtle taxonomic traits on the palps (e. g., CROSSLEY, 1960 : 153-162). However, the palps of *Neotrombidium* species and, in general, other trombidioid post-larval forms are not, by themselves, sufficiently diagnostic for species determination.

Larval *Neotrombidium* species bear palps which appear to be almost identical, with respect to the types, numbers, and placement of setae, varying only with respect to the degree of filament plumosity (Pl. 4 A, B, 18 B, 20 B).

Genitalia : The paired sclerites surrounding the genital apertures of adult trombidioids have been named by NEWELL (1957) and FEIDER (1959). The inner sclerites are referred to as " genital sclerites " (NEWELL) or " centrovalves " (FEIDER), and the outer valves as " paragenital sclerites " (NEWELL)or " epivalves " (FEIDER). MOSS (1962) used a combination of these two terminologies, " genital valves " for the inner sclerites, and " paragenital valves " for the outer sclerites.

The terms " genital valves ", or " genital sclerites ", if applied loosely refer to both the inner and outer sclerites. Attempting to give these terms the restricted meaning as proposed by NEWELL and Moss will no doubt lead to confusion. Therefore, the terminology proposed by FEIDER is considered to be the more practical of the terminologies proposed, and the term " genital valves " is applied to the total valve complex associated with the genital aperture.

In *Neotrombidium*, the genital aperture is flanked by centrovalves and epivalves. Two pairs of genital " discs " are located internal to the centrovalves in both nymphs and adults. JOHNSTON and WACKER (1968) suggested that the number of genital " discs " in the ontogeny of trombidioids is of significance (usually 2 pair in nymphs and 3 pair in adults, while the quiescent stage preceding the Nymph was shown to have 1 pair). The phylogenetic significance of genital discs is debatable.

In males, the centrovalves are characteristically shaped (Pl. 8), and there is present an internal sclerotized structure (Pls. 9, 10). Females show more simplified centrovalves (Pl. 7), and lack an internal sclerotized structure.

The trichodea of the adult centrovalves show sexual, as well as specific differences. In *N. tricuspidum*, males haves 16 to 18 spiculated trichodea on each centrovalve, set in single, double and triple rows. Females of *tricuspidum* have 12 to 17 spiculated trichodea set in 2 tows. In *N. beeri*, males have 20 to 30 spiculated trichodea on each centrovalve, set in single, double, and triple rows (Pl. 8), while females have 7 to 9 trichodea, set in one single row, (Pl. 7). The one male paratype specimen of *N. indosinensis* studied had 7 and 8 trichodea on each respective centrovalve, set in single and double rows.

Nymphs of *N. beeri* show a reduction in the number of genital valve setae (Pl. 6 B). This was found to be an aid in characterizing mounted specimens of nymphs from females of the same species.

Propodosomal Trichobothria : The ornamentation of the nototrichobothrial filaments in larval and post-larval instars show subtle specific differences. Larvae of *N. tricuspidum* show filaments which appear almost smooth (Pl. 20 C), while post-larvae show distinct distal setulation (Pl. 22 B). Larvae (Pl. 4 D) and post-larvae of *N. beeri* (Pl. 22 C) show distal setulation, adults of *elongatum* show setulation full-length (Pl. 22 C), while apparently smooth filaments are found in adults of *N. indosinensis* and in the larval *N. andrei* (Pl. 18 C).

Scutum : The dorsal propodosomal scutum of trombidioids has been given considerable taxonomic and phylogenetic weight. NEWELL (1958) discussed the relationship of the crista metopica to the rest of the scutum, calling attention to the fact that the crista is only a strengthening part of the scutum, to which muscles insert (confirmed by MITCHELL, 1962, Fig. 3). NEWELL suggested that the portions of the scutum periferal to the crista may illustrate valuable taxono-

mic differences. This is evidenced in post-larval *Neotrombidium* species, where diagnostic specific characters are available in the shape and size of the nasus and the shape of a posteriorly inflected prolongation of the trichobothrial region. Both these structures deserve attention in species comparison.

In *N. beeri, tricuspidum,* and *elongatum* (Pl. 22), the posterior scutal prolongations present clear specific differences. The nasus shape, size and morphology is a helpful species character, if used with caution, since thin preparations tend to flatten these structures. The chaetotaxy of the nasus is subject to frequent variation, from the normal two uniramous spiculated trichodea to one or three.

Eyes : All larvae studied possess 2 pairs of eye lenses. Post-larval *N. beeri, indosinensis,* and *elongatum* have 1 pair of eye lenses, while *N. tricuspidum* have 2 pairs. The viewing and correct interpretation of these structures is not always possible in single post-larval specimens. Presence or absence of eye lenses is probably not an indication of photosensory ability (Crossley 1960 : 176).

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