

A REVIEW OF THE GENUS *NEOPODOCINUM*  
OUDEMANS 1902 (ACARINA : MACROCHELIDAE)

BY

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INTRODUCTION.

OUDEMANS (1902) erected the genus *Neopodocinum* to contain *Laelaps jaspersi* Oudemans, 1900, and placed it in the subfamily Laelaptinae of the family Parasitidae. Separation of *Neopodocinum* from other genera in the Laelaptinae was on the basis of the lack of ambulacra on legs I of *Neopodocinum* (*Podocinum* Berlese) also lacks ambulacra on legs I but was separated from *Neopodocinum* by differences in general body shape and comparative lengths of legs I). OUDEMANS included the genus in the Laelaptinae primarily because of the tectal shape (fig. 37), which is similar to that found in the family Eviphididae, the latter group also having been considered a part of the Laelaptinae. Later (1904), OUDEMANS revised his opinion on the suprageneric position of *Neopodocinum* and, on the basis of the presence of spurs on legs II of the males, attached it to the Parasitinae. VITZTHUM (1926) intimated a relationship of *Neopodocinum* to the genus *Macrocheles* Latreille in his description of *N. coprophilum*, and later (1930) included *Neopodocinum* as a genus in his family Macrochelidae.

*N. jaspersi*, the type species of the genus *Neopodocinum*, was reported by OUDEMANS (1902) to have been collected in Amsterdam, but was believed to be "a creature of warmer regions, being accidentally brought to our country [Holland]". Additional collections of *N. jaspersi* from Java (ex *Copris molossus* L., Berlese collection, Florence, Italy) gave credence to OUDEMAN'S belief as to the tropical origin of this species. VITZTHUM (1926) concurred with this assumption and, indeed, many subsequently described species in the genus have proven to be tropical or semi-tropical in their distribution.

KRANTZ (1962) described *Neopodocinum* as follows : "Dorsal shield broad, covering most of the dorsum ; with twenty-eight pairs of setae, most of which are smooth, setae D<sub>1</sub> and M<sub>1</sub> commonly ornamented. Sternal shield transversely

narrowed medially, with three pairs of setae; metasternal shields free. With simple anal shield. Tectum unipartite. Lateral elements of pretarsi short, broad and distally acuminate. Other characters as in *Macrocheles* Latr." In addition, mention was made of the unpaired posterior dorsocentral seta found in the genus.

Recent examination of specimens of the genus *Coprolaelaps* Berlese (1908) has led to the conclusion that this genus, currently placed in the family Pachylaelaptidae, is congeneric with *Neopodocinum*, despite differences in various structures heretofore considered constant within the Macrochelidae. These differences include the presence of ambulacra on tarsi I and the absence of a peritremal loop as described for *Neopodocinum* and other members of the family. Comparisons of tecta, chelicerae, setation and shield conformation in *Coprolaelaps* and *Neopodocinum*, however, leave little doubt that an extremely close relationship exists. The fact that the two assemblages have been placed in different families is indicative of the problems inherent in the classification of closely related taxa which tend to include extreme morphological forms. Close adherence to a more or less arbitrary familial character, or group of characters, in these cases often leads to divisions within natural groups which, on the basis of other sets of characters, might not be possible. The inclusion of *Coprolaelaps* in the genus *Neopodocinum* certainly satisfies the broad generic concept of the latter group (see diagnosis below), but makes necessary a revised interpretation of the family Macrochelidae. While this revision affects some rather classic diagnostic characters (i. e. peritrematal shape and condition of tarsus I), it does not break down the separation between the Macrochelidae and related parasitoid assemblages.

#### BIOLOGY.

Species of the genus *Neopodocinum* inhabit tropical, subtropical and temperate regions of Asia, Africa and Europe where they are found in association with coprophilous beetles of the family Scarabaeidae. The mites generally attach by their chelicerae to the ventral portion of the beetle "host", either between the mandibles and under the labrum (KRANTZ 1962), or around coxae I, or the ventral pelage (COSTA 1963). The association between the mite and the beetle apparently is a purely phoretic one, and the mites may leave the beetle in the dung substrate to feed on small arthropods. Only adults and nymphs are found on the beetles, the larvae apparently remaining in the substrate until the first molt.

It may be assumed that specimens found between the mandibles of the host beetle are in close contact with the food material being utilized by the beetle, and are perhaps feeding on the same substances. It also is conceivable that the very presence of numbers of *Neopodocinum* in the feeding apparatus of the beetle may significantly reduce the availability of food for the beetle, primarily because of the physical barrier produced. Specimens of *Neopodocinum* may attain a length

of 1000-2000  $\mu$ , and have been found in such numbers as to virtually block the passage of food into the oral cavity of the beetle carrier.

A certain degree of specificity is seen in the relationships of beetles and the mites which attach to them. For example, specimens of *N. benoiti* n. sp. (page 165) have been collected only from species of the scarabaeid genus *Catharsius*. The implications of this phenomenon will be discussed in a later paper (KRANTZ, in preparation).

Further information on the biology of *Neopodocinum* will be found in a paper soon to be published by COSTA (in press).

## EXTERNAL MORPHOLOGY

### ADULTS.

#### *Dorsal shield.*

Members of the genus *Neopodocinum* have an ovate weakly punctate or punctate-reticulate shield which occasionally is narrowed posteriorly. Many of the 28-31 pairs of dorsal setae may be broad and pectinate, as in *N. setosum*, or they may be virtually smooth, or minute as in *N. tshambi* (figs. 53, 62). An additional unpaired seta ( $D_x$ ) is inserted posterodorsally (fig. 12) in most species. At least one species has a series of extramarginal setae (*N. emodi*, fig. 28), so that the number of dorsal shield setae may well exceed 31 pairs. Setal insertions, particularly in the anterior portion of the shield, often are connected by strong ridges (fig. 35 ; rdg) or bordered by shorter clefts (fig. 35 ; cl). Setae  $D_1$  are distinctly separated, and may be smooth or pectinate. The dorsal shield also has a series of "pores", as are found in other members of the family (EVANS and BROWNING, 1956). Muscle insertion patterns also may be seen (fig. 38 ; mi).

The dorsal shield setae of the genus have been named according to the system used by EVANS and BROWNING (1956), a scheme which, although arbitrary, is less confusing and certainly no less indicative of phylogenetic origins than that used by HIRSCHMANN (1957), EVANS and HYATT (1963) and others. It was found that *Neopodocinum benoiti*, a new species described in this review, possesses a total of 30 pairs of dorsal shield setae (occasionally 31 pairs) plus an unpaired seta inserted posterodorsally. These setae are as follows (fig. 12) : nine (occasionally eight) pairs of dorsocentral (D) setae, five (often four) pairs of median (M) setae, six pairs of lateral (L) setae, and ten pairs of marginal (Mg) setae (an extra pair of setae may be inserted on the margin of the shield between  $Mg_9$  and  $Mg_{10}$ . Often, only one seta of the pair is on the shield, the other being in the adjacent integument). The unpaired posterodorsal seta ( $D_x$ ) is inserted between setae  $D_7$  ( $D_6$  of MICHERDZINSKI 1964) or posterior to them.  $D_x$  may be absent in some specimens, with a pair of setae (presumably  $D_7$ ) occupying the position usually taken by  $D_x$  and  $D_7$  (fig. 15). Setae  $M_3$  are present in these specimens, while setae  $D_8$  may or may

not be present. This variation has not been seen in other species. The remaining species of the genus have 28-29 pairs of dorsal shield setae, with the posterior median setae ( $M_5$ ), and  $D_7$  and/or  $D_8$ , often absent. The numbering of setae has been kept constant, despite the absence of various setae; i. e.  $D_9$  of *N. jaspersi* Berl. is the same seta as  $D_9$  in *N. benoiti*, despite the fact that various intervening setae are absent in *jaspersi* (fig. 35). The problem of distinguishing between setae  $D_8$  and  $M_5$  in species where only one of the two pairs of setae is present has been resolved by assuming, on the basis of setal and pore positions in the various stadia of species examined, that  $D_8$  is retained and  $M_5$  is lost. An exception to this assumption will be found in *N. vanderhammeni* n. sp. (and, possibly, *N. maius*), where the position of opisthosomal setae points to the presence of  $M_5$  and the absence of  $D_8$  (fig. 68).

The numbering of the Mg series of dorsal setae is somewhat unfortunate due to the invaginated position of  $Mg_3$  (fig. 12). While the author feels that a system in which  $Mg_3$  could be placed into the L series (with a concomitant adjustment in the M series) might be justified, it is unlikely that such a change would enhance our understanding of setal homologies. A scheme based on transverse, rather than vertical, relationships between dorsal setae, might better satisfy this goal.

#### *Venter.*

The tritosternum is well-developed, with two plumose laciniae attached to a slightly broadened tritosternal base (fig. 2). The primary ventral shields of the female consist of sternal, epigynial and anal shields, a pair of metasternal and a pair of peritrematal shields. Metapodal shields are absent, although sclerotized pores may be present in the metapodal area. Parapodal sclerites generally are confined to a narrow strip adjacent to the posterolateral aspect of coxae IV, although expansion of these sclerites does occur (Pl. IV; 30).

The sternal shield is rectangular, distinctly wider than long, and may be deeply excavated posteriorly, as in *N. jaspersi* (Pl. IV; 36). The shield usually is without distinct ornamentation (*N. wenzeli* has a punctate pattern), but a partial or complete *linea media transversa*, or l. m. t., often is present (Pl. VI; 49). The l. m. t. has its origins at the insertions of sternal setae II. Well-developed *linea obliqua anterior*, or l. o. a., usually are seen. Three pairs of sternal setae are present, in addition to two pairs of pores. The sternal setae generally are smooth and spinose, although they are distally plumose in *N. bartkei* (Pl. II; 11). The metasternal shields are small, anteriorly rounded structures with a pore on the anterior angle, and a metasternal seta inserted posteriorly on each shield. While free in all members of the genus, the metasternals may appear fused to the endopodals in some species (i. e. *N. emodi*), or absent, as in *N. verschureni* (Pl. VII; 64). The epigynial shield is broad, gently rounded or truncate posteriorly, and provides insertions for a pair of epigynial setae on the posterolateral angles. A pair of posterior pores also may be seen in some species (*N. afrum* and *N. vanstraeleni*, for example).

The shield is typically unornamented, although a distinctive punctate pattern is present on the epigynial shield of *N. wenzeli* (Pl. VII ; 66). Members of the genus *Neopodocinum* possess an anal rather than a ventrianal shield, on which are inserted a pair of adanal setae and a single postanal seta, all of which are smooth or nearly so. The anal opening, and associated setae, are located in the posterior half of the shield (Pl. VI ; 49). The postanal seta often is inserted in an unsclerotized "crescent" which may be present behind the anal opening (Pl. II ; 13). At least two species (*N. magna* and *N. maius*) have an anterolateral expansion of the shield (Pl. V ; 43). A pair of preanal setae is inserted on the expanded portions of the shield in *N. magna*. The integument surrounding the anal shield provides insertion loci for the ventral integumental, or perianal, setae. These may be smooth or pectinate, with most species having some of each type (Pl. IV ; 36). The perianal setae of *N. tshambi* (Pl. VI ; 50) are minute, while those of *N. verschureni* (Pl. VII ; 64) are very long. The peritrematal shields are long and narrow, accomodating the peritremes but without broad lateral or posterior extensions. The proximal portion of the peritreme may be looped so as to join the stigma posteriorly, or it may be only curved or straight proximally (Pl. VII ; 67). The peritreme extends anteriorly and dorsally, terminating somewhat below and laterad of setae  $M_1$ .

Ventrally, the male has a fused sternitigenital shield and a separate anal shield, the former having five pairs of setae, three pairs of pores, and an anteromedian genital opening (Pl. VI ; 54). As in the female, these setae are smooth, except in *N. bartkei*. The anal and peritrematal shields are essentially like those of the female.

### *Gnathosoma.*

The tectum of *Neopodocinum* is unipartite, strongly spined, and apparently capable of partial extrusion or withdrawal through a telescoping of the basal portion (fig. 37). The base of the tectum may or may not be strongly spined. The palpi have five free segments, the tarsus having a three-tined palpal claw on the proximal internal angle. The proximal tooth often is only weakly developed (Pl. II ; 18). The chelicerae are heavily sclerotized, with each digit having one strong tooth medially, in addition to the distal eminences (Pl. V ; 45). A short pilus dentilis is present on the fixed digit, and the dorsal cheliceral seta is simple. A pair of cheliceral brushes is inserted adjacent to the base of the movable digit, the internal brush being considerably longer than the outer. A short, blunt spermatophore transfer organ is found on the median internal aspect of the digitus mobilis of the male (fig. 58 ; sp). The epipharynx is strongly spiculate, and somewhat similar to the distal portion of the tectum (fig. 1). A pair of strong salivary styli is present as is a pair of plumose hypopharyngeal styli, the latter being found mediad of the salivary styli (figs. 1,2). A median smooth labral organ (fig. 1) is found ventrad of the tectum. The hypostomal and deutosternal setae usually are smooth (fig. 2), but setae II and III, and the deutosternals, are plumose in

*N. bartkei*. Hypostomal setae II may be shorter or longer than setae III. There are usually five rows of deutosternal teeth throughout the genus (fig. 2), although species may be found with four or six rows. The corniculi are broad basally and bluntly pointed distally (fig. 1).

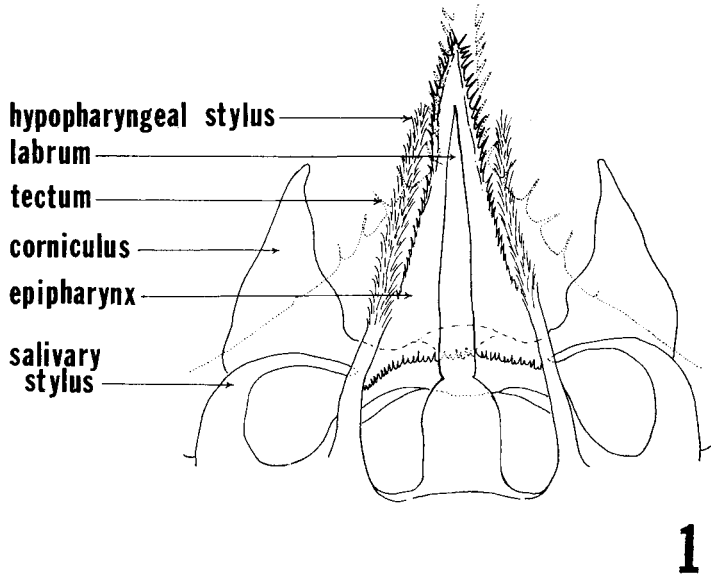


FIG. 1. — Dorsum of gnathosoma of *Neopodocinum jaspersi* (Oudemans) with tectum removed.

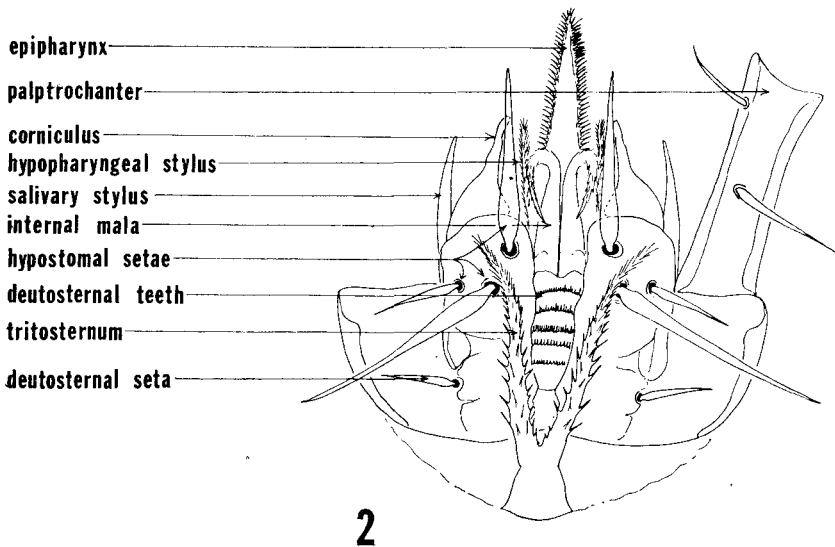


FIG. 2. — Venter of gnathosoma of *Neopodocinum vanstraeleni* n. sp.

*Legs.*

Tarsus I (Pl. V ; 47) may or may not have a distal ambulacrum. Claws are not present on tarsus I. The setation of the legs is fairly typical of the general macrochelid type (EVANS and HYATT 1963 ; MICHERDZINSKI 1964), except for genu IV and trochanter III. The number of setae on genu IV of a female may be seven (as in *N. caputmedusae*) or eight (as in *N. verschureni*). *N. afrum* may have seven or eight setae (figs. 6, 7). Differences in size and condition of various setae on genu IV provide some useful characters for species determination in *Neopodocinum* (see key to females). Contrary to the setal formulae for leg chaetotaxy of *Macrocheles* set forth by EVANS and HYATT (1963), and for the Macrochelidae by EVANS (1963), trochanter III of *Neopodocinum* has only four setae, rather than five (fig. 27). Trochanter II possesses five setae (MICHERDZINSKI refers to only four setae on trochanter II of *N. bartkei*, but examination of specimens of *bartkei* by the present writer reveals the presence of five setae (fig. 10)). Leg II often is distinctly heavier than leg I (always in the male), and tarsus II often is adorned with a series of massive spines (Pl. I ; 6) which are reminiscent of the genus *Pachylaelaps* Berlese (family Pachylaelaptidae). Tarsi II-IV are equipped with ambulacra and claws, with a well-developed pretarsus being found on tarsi III-IV. The laterodistal pretarsal elements are short, broad and usually acuminate distally. Femur II of the male has a large spur internally (fig. 63), and other spurs of various types may occur on the genu and tibia of leg II, and anterior to seta  $pv_2$  on tarsus IV. Genu and tarsus IV, as well as other leg segments, show considerable interspecific variation in length and plumosity of certain setae (figs. 72, 73). The setal nomenclature devised by EVANS (1963) for his review of leg chaetotaxy of free-living Gamasina, has been used in describing this variation. Differences between male and female setation of tarsus IV often is considerable, primarily because of differences in basic tarsal structure.

DEUTONYMPH.

*Dorsum.*

The dorsal shield of the deutonymph may be laterally incised or entire, but is never separated into two shields (fig. 4). Seta  $D_x$  may be absent (as in *N. caputmedusae*) or present (as in *N. bartkei*). The dorsal setae may be less developed in the deutonymph, both in length and in ornamentation (as in *N. caputmedusae*) or the setae may be longer and more well developed than in the adult (as in *N. afrum*). Ornamentation on the dorsal shield, aside from *N. wenzeli*, is either weak or absent. Some species (i. e. *N. oudemansi* and *N. magna*) may have distinct dorsal ridges and clefts.

### *Venter.*

The tritosternum is well-developed. A peltate or heart-shaped sternal shield, and an anal shield, are found on the venter of the deutonymph. The sternal shield usually is distinctly reticulate, and has four pairs of setae (*N. bartkei* has only three pairs (Pl. II ; 10)) and three pairs of pores (Pl. II ; 16). The anal shield and the perianal setae are similar to those of the adult. The peritreme is essentially without a surrounding shield, the peritreme itself being much like that of the adult. Free endopodal platelets often may be found mediad of the coxae. The gnathosoma, and gnathosomal appendages, are similar to those of the adults.

### *Legs.*

In those species where the adult has a well-developed ambulacrum on tarsus I, the deutonymph possesses a small but distinct claw. Tarsi II-IV are equipped with claws and ambulacra similar to those found on the adults. Leg chaetotaxy in the deutonymph is essentially the same as that of the adult. Differences in setal number are minor, and appear to be confined to tarsal setae. Trochanter III has only four setae as had been noted for the adults.

## PROTONYMPH <sup>1</sup>.

### *Dorsum.*

The dorsal shield is divided into an anterior and posterior portion, both portions commonly being strongly ornamented. The anterior dorsal shield has from 11-14 pairs of setae (those protonymphs available for study by the author have 11-12 pairs), and the posterior shield has 8-10 pairs (the presence of setae  $L_4$  in *N. caput-medusae* gives this species nine pairs of posterior dorsal shield setae). The shield division occurs just posterior to setae  $D_6$ . Setae  $D_7$  and seta  $D_x$  are absent in the protonymphal stage, which tends to indicate that, as with the loss of claws, the addition of dorsal setae during ontogenetic development is a sign of an advanced evolutionary condition.

1. OUDEMANS (1914) described *Neopodocinum rhinolophi* from a specimen which, on the basis of peritreme length, he considered to be a protonymph. In a later paper (1915), he mentioned that the specimen resembled a deutonymph in other respects. In point of fact, the specimen in question has, among others, the following deutonymphal characteristics :

- a. Four pairs of sternal setae
- b. An incised dorsal shield
- c. Two setae on the palptrochanter

A search through Oudemans's types in Leiden by the author failed to locate *N. rhinolophi*, so that it is impossible at present to further clarify this problem (see also page 205).



### *Venter.*

The tritosternum is well-developed, being quite similar to that of the later stages. The sternal shield (Pl. IV ; 34) is weakly ornamented and provided with three pairs of setae. The anal shield is essentially the same as that of the deutonymph and adult, as are the perianal setae. The peritreme is greatly reduced (Pl. III ; 20), being little more than a stigmal spur. The gnathosoma is similar to later stages, except for a slight difference in pedipalpal setal number. The setal formulae for protonymphs as compared to deutonymphs and adults for the first three free segments of the palp (trochanter, femur and genu) are as follows : P.-I, 4, 5 ; D. and Ad.-2, 5, 6.

### *Legs.*

As in the deutonymph, tarsus I of the protonymph may or may not be equipped with an ambulacrum and a small pair of claws. When claws are present in the deutonymphal stage, they also are found in the protonymph. Various tarsal setae are absent in the protonymph, a condition also seen in the deutonymph. For example, tarsus III of the protonymph of *N. magna* has 15 setae, while tarsus III of the adult has 16. Trochanter III has four setae, and genu IV apparently has only five. Tarsi II-IV each have an ambulacrum and a pair of claws.

### LARVA.

While nymphs and adults of *Neopodocinum* may be found in great numbers on coprophilous scarabs, larvae have not been similarly obtainable. Apparently the larval stage is not phoretic as are the later stages, and is present only in the habitat of the beetle carrier rather than on the beetle itself. Artificial rearing of *N. caputmedusae* by Dr. Michael COSTA of Israel has resulted in the collection of a number of larval specimens, some of which Dr. COSTA has been kind enough to send. The following descriptive material, therefore, concerns only *N. caputmedusae* larvae, since the larval stage of other members of the genus *Neopodocinum* is unknown<sup>1</sup>.

It is likely that the larval stage occupies a very brief period in the ontogeny of *N. caputmedusae*, since the specimens examined contain a well-developed protonymph. Observation of larval setal insertions, shields, leg chaetotaxy and mouthparts were incomplete, due to the superimposition of larval and protonymphal structures. The weak sclerotization of the larva makes difficult the separation of these structures. Only those features which are obviously larval are included herein. A more detailed review of larval morphology of *N. caputmedusae* will be given by COSTA (in press).

1. OUDEMANS' unpublished drawings (page 164) include illustrations of a larva of *N. jaspersi*, but these are either incomplete or of limited diagnostic use.

*Dorsum.*

There is no apparent dorsal shield on the larva of *N. caputmedusae*, and the number of setae is less than in succeeding stages. There appear to be fourteen pairs of smooth setae ( $D_1$ ,  $D_3$ - $D_6$ ,  $M_2$ - $M_3$ ,  $L_1$ ,  $L_4$ - $L_6$ ,  $Mg_1$ ,  $Mg_8$  (?), and  $Mg_{10}$ ) of which setae  $D_4$  and  $D_5$  are quite short.  $D_1$  is longer than  $D_4$ - $D_6$ , but appears weak and hair-like. The other setae are fairly strong. A diagrammatic representation of the larval dorsum, taken from several specimens, is given in fig. 24.

*Venter.*

A tritosternum with two pectinate laciniae is present. While it was not entirely clear, it appears that no ventral shields are present in *N. caputmedusae* larvae. Three pairs of sternal setae are present. No peritreme was seen, although the protonymphal homologue may have overshadowed the larval structure. A larval anal opening was observed, but no anal shield was found.

*Gnathosoma.*

The tectum, although unipartite as in later stages, is considerably less spiculate than that of the protonymph. The chelicerae (Pl. III ; 23) are blunt, and the teeth are only weakly developed. Cheliceral brushes are very weak or absent. The palptarsal claw is three-tined, the proximal tine being quite weak. The palptrochanter has no setae (one in the protonymph).

*Legs.*

The larva has three pairs of legs but, since the larval stadium is apparently extremely brief, the fourth pair of legs found in the protonymph may be seen developing within the larva. Tarsi I have well-developed claws and ambulacra, as do legs II-III. (It is assumed that claws and ambulacra on tarsi I occur only in those species where such structures also occur in later stages). The distal portion of tarsus II is of particular interest, in that the large dorsal spine which is found in all succeeding stages is acuminate and curved in the larva, overhanging the claws and ambulacrum. It is possible that this spine serves the function of an extra claw in the larval stage. The chaetotaxy of the leg segments is complicated by the developing protonymphal leg segments within them. Thus it was felt inadvisable to attempt larval leg chaetotaxy with the specimens now available.

CLASSIFICATION.

The genus *Neopodocinum* Oudemans, as originally formulated, included macrochelids with a unipartite tectum and an anal shield, by which features separation

from other macrochelid genera has been easily accomplished (OUDEMANS 1931; KRANTZ 1962). The finding of a congeneric relationship between *Neopodocinum* and BERLESE's *Coprolaelaps* (see INTRODUCTION) makes this separation no more difficult, but rather makes necessary an expansion of the familial diagnosis. The congenerity mentioned above has been illustrated by MICHERDZINSKI (1964) whose description of *Neopodocinum bartkei* more correctly fits into the BERLESE concept of *Coprolaelaps* (see description on page 158). COSTA (in press) places *Coprolaelaps caputmedusae* into the genus *Neopodocinum* and, in fact, concurs in the synonymy which is presented below.

The following diagnosis of the family Macrochelidae is taken in part from KRANTZ (1962), and modified so as to include species formerly assigned to *Coprolaelaps*.

#### MACHROCHELIDAE Vitzthum.

VITZTHUM, H. G. (1930). *Zool. Jahr. Syst.* Bd. 59 : 300.

Dorsal shield entire, variously ornamented and with twenty-eight to thirty-one pairs of setae (dorsal neotrichy may occur in some species); sternal shield with three pairs of setae; metasternal shields free, absent, or fused to sternal-endopodal complex. Peritremes often looped posteriorly so as to join the stigmata posteriorly (sometimes not looped in *Neopodocinum*). Epigynial shield with a pair of lateral accessory sclerites; with a ventrianal or anal shield. Male with a separate ventrianal or anal shield, or with a holoventral shield; genital orifice at the anterior edge of the sternitigenital or holoventral shield. Gnathosoma well-developed; with salivary styli and sclerotized corniculi; tectum tripartite or unipartite; palpi with five free segments, palpal claw three-tined. Chelicerae chelate-dentate and with one or two setal brushes at the base of the digitus mobilis; male with strong spermatophoral process. Legs I without claws in males and females, but sometimes with ambulacra (claws may be found on tarsi I of immature stages); legs II-IV with claws and pulvilli; legs II and, in many species, legs IV of the male distinctly spurred (legs II of the female may rarely have spurs also). Genu IV of adults with 6, 7 or 8 setae. Laterodistal elements of pretarsi membranous, broad basally, and divided or acuminate distally. Free-living in soil or vegetable debris, or found as paraphages of insects.

#### Genus *Neopodocinum* Oudemans.

*Neopodocinum* OUDEMANS, A. C. (1902). *Tijds. v. Ent.* 45 : 24.  
*Coprolaelaps* BERLESE, A. (1908). *Redia* 5 : 13. *New synonymy*.

Tectum unipartite; with an anal shield (rarely with a laterally expanded anal shield on which a single pair of preanal setae may or may not be inserted); often with ambulacra on tarsi I; peritreme looped or straight posteriorly; genu IV

with seven or eight setae, trochanter III with four setae; with an unpaired seta on the posteromedial portion of the dorsal shield. Paraphagic on coprophagous scarab beetles.

Type species — *Laelaps jaspersi* Oudemans.

The following keys to the species to *Neopodocinum* utilize characters which may or may not be of phylogenetic importance. The format should be considered an arbitrary one, with major indices of separation (i. e. presence or absence of claws on tarsi I) being less arbitrary than others. The key to males is incomplete, since males are unknown for some species. Immature stages, where known, will be treated in the species diagnoses which follow the keys.

# KEY TO THE SPECIES OF NEOPODOCINUM.

## FEMALES.

1. With well-developed ambulacra on tarsi I; peritreme with at most a slight curve posteriorly, never joining the stigma posteriorly; with seven setae on genu IV. . . . . 2
- Ambulacra and claws on legs I absent in all stages; peritreme often curved so as to meet the stigma posteriorly; genu IV with seven or eight setae. . . . . 10
2. Sternal shield with distinctive punctate pattern (Pl. VII; 66); small species (ca. 1200  $\mu$ ); Turkestan. . . . . *wenzeli* n. sp.
- Sternal shield without punctate pattern as above. . . . . 3
3. Sternal shield with complete, well-developed l. m. t. . . . . 4
- Sternal shield unornamented, or with partial l. m. t. developed on the lateral portions of the shield. . . . . 6
4. Hypostomal setae II-III club-shaped, distally blunt; all setae of tarsus IV smooth, small species (ca. 1050  $\mu$ ); China and North Viet Nam. . . . . *vanderhammeni* n. sp.
- Hypostomal setae II shorter and broader than setae III, acuminate distally; idiosoma more than 1150  $\mu$  in length. . . . . 5
5. Setae Mg<sub>2</sub>-Mg<sub>10</sub> long, equal in length to setae Mg<sub>1</sub>, D<sub>2</sub>-D<sub>3</sub>, M<sub>2</sub> and L<sub>1</sub>; setae ad<sub>2</sub>, pd<sub>2</sub> and md of tarsus IV distally plumose; Central Africa. . . . . *benoitii* n. sp.
- Setae Mg<sub>2</sub>-Mg<sub>10</sub> short, approximately half the length of Mg<sub>1</sub>, D<sub>2</sub>-D<sub>3</sub>, M<sub>2</sub> and L<sub>1</sub>; Java. *spinirostris* (Berlese)
6. Sternal, metasternal and epigynial setae strongly plumose distally; posterior hypostomal and deutosternal setae also distally plumose; seta pl<sub>3</sub> of pretarsus IV longer than seta mv; North Viet Nam. . . . . *bartkei* Micherdzinski
- Sternal, metasternal and epigynial setae smooth; hypostomal and deutosternal setae simple; seta pl<sub>3</sub> not as above. . . . . 7
7. Setae D<sub>1</sub> and D<sub>2</sub> approximately equal in length; perianal setae numbering less than 50 pairs. . . . . 8
- Setae D<sub>2</sub> over three times longer than setae D<sub>1</sub>; venter with well over 50 pairs of smooth perianal setae; southern Europe, North Africa and Israel. . . . . *caputmedusae* (Berlese)

8. Sternal shield deeply excavated posteriorly ; with less than twenty pairs of perianal setae ; less than 1000  $\mu$  in length ; Ionic Islands..... *meridionalis* (Sellnick)
- Sternal shield normally concave ; with considerably more than twenty pairs of perianal setae ; more than 1200  $\mu$  in length ; Asia..... 9
9. Parapodal shields expanded, extending anteriorly to the anterior aspect of coxae III ; with six rows of deutosternal teeth ; sternal shield without lateral portions of l. m. t. ; seta  $ad_2$  of tarsus IV smooth distally ; setae  $ad_{1-2}$  and  $pd_{1-2}$  of genu IV short, smooth ; Nepal..... *emodi* n. sp.
- Parapodal shields narrow, confined to posterolateral borders of coxae IV ; with five rows of deutosternal teeth ; sternal shield with lateral portions of l. m. t. well-developed ; seta  $ad_2$  of tarsus IV plumose distally ;  $ad_{1-2}$  and  $pd_{1-2}$  of genu IV distally plumose ; Tibet..... *emodioides* n. sp.
10. Anal shield oblong-ovate or round..... 11
- Anal shield expanded laterally, either subtriangular or scutellate, not ovate.... 17
11. Dorsocentral and perianal setae minute, hair-like ; dorsal shield narrowed posteriorly ; Central Africa..... *tshambi* n. sp.
- Dorsocentral and perianal setae not minute, often pectinate ; dorsal shield not narrowed posteriorly ; hypostomal setae II over twice the length of setae III..... 12
12. Dorsal marginal (Mg) and lateral (L) setae long, extending to or beyond the insertions of the setae behind them ; setae of genu and tarsus IV smooth ; India..... *setosum* n. sp.
- Dorsal and lateral setae shorter, not reaching the insertions of the setae behind them ; some setae of genu and tarsus IV often pectinate or plumose..... 13
13. With less than 50 pairs of perianal setae ; l. m. t. represented by lateral remnants ; seta  $pd_2$  of genu IV strongly plumose throughout its length, distinctly longer than  $pd_1$  ; Africa ..... 15
- With considerably more than 50 pairs of perianal setae ; l. m. t. either complete or broken medially for less than a third of its length ; seta  $pd_2$  of genu IV short, broad and distally plumose, subequal in length to seta  $pd_1$  ; Asia..... 14
14. With four rows of deutosternal teeth ; setae  $D_4$  surpass insertions of  $D_5$  ; lateral portions of l. m. t. nearly joined medially ; Java..... *javensis* n. sp.
- With five rows of deutosternal teeth ; setae  $D_4$  not long enough to reach insertions of  $D_5$  ; lateral portions of l. m. t. distinctly separated medially ; India and Java.. *jaspersi* (Oudemans)
15. Sternal shield without posterior excavation, smoothly concave ; seta  $pd_2$  of tarsus IV long and pectinate, reaching insertions of distal setal complex, seta  $ad_2$  short and spinose, slightly plumose distally ; perianal setae very long, easily surpassing insertions of setae behind them ; genu IV with eight setae ; Congo Republic..... *verschureni* n. sp.
- Sternal shield with posterior excavation ; setae  $pd_2$  and  $ad_2$  not as above ; perianal setae not excessively long, few surpassing insertions of the setae behind them ; genu IV with seven or eight setae..... 16
16. Setae  $ad_2$  and  $pd_2$  of tarsus IV long and pectinate, nearly reaching insertion of seta md ; setae  $D_3$  nearly smooth ; genu IV with eight setae ; Congo Republic..... *vanstraeleni* n. sp.
- Setae  $ad_2$  and  $pd_2$  of tarsus IV more or less subequal and lightly pectinate ( $pd_2$  plumose distally), not approaching insertion of seta md ; setae  $D_3$  broadly pectinate ; genu IV with seven or eight setae ; Congo, British East Africa..... *afrum* Berlese

17. Anal shield subtriangular (fig. 47) ; l. m. t. complete ; Sumatra.... *maius* Berlese  
 — Anal shield scutellate (Pl. V ; 43) ; l. m. t. broken medially ; Central Africa.....  
*magna* n. sp.

# MALES.

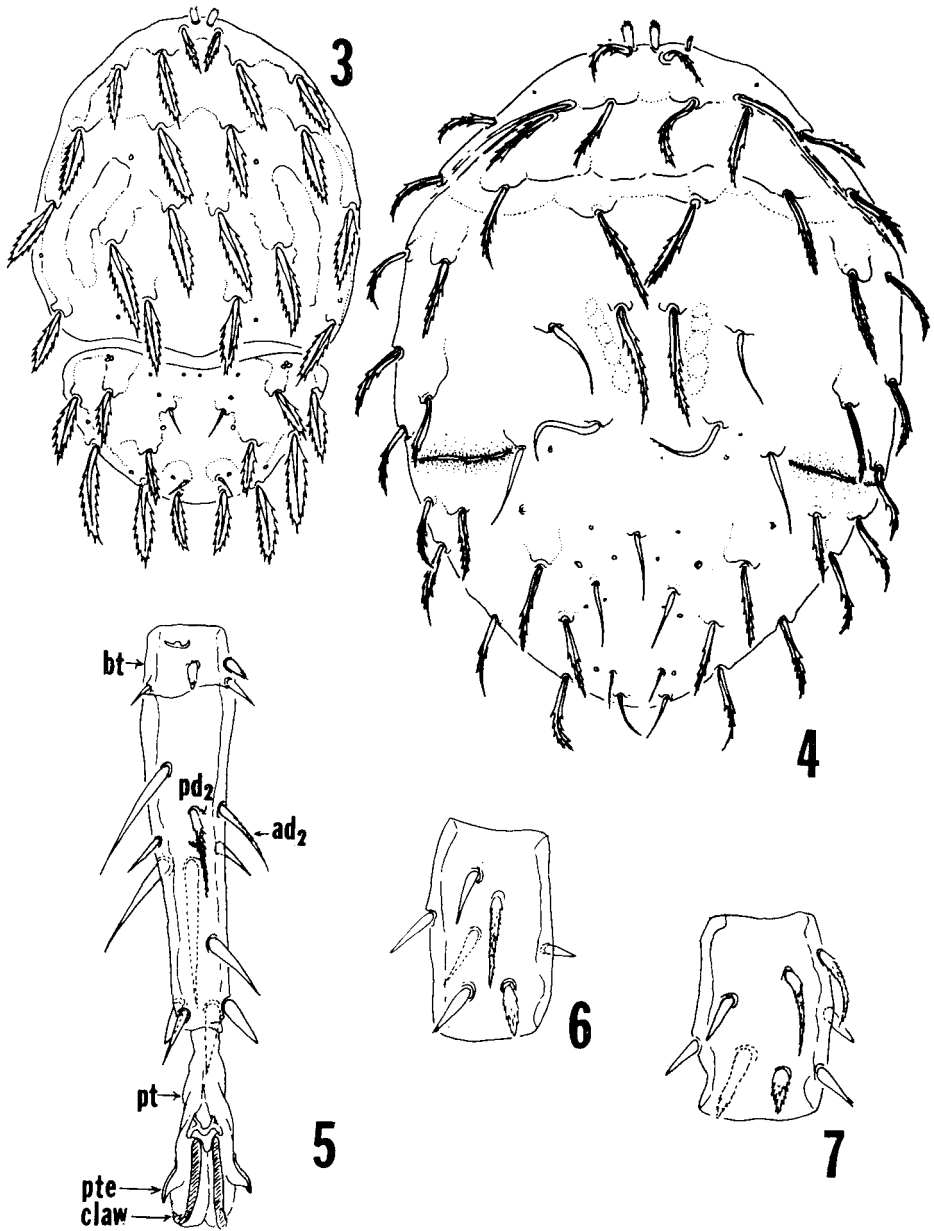
1. With ambulacra on tarsi I..... 2
- Without ambulacra on tarsi I..... 7
2. Setae of sternitigenital shield, posterior hypostomal and deutosternal setae plumose distally ; without l. m. t. ; North Viet Nam..... *bartkei* n. sp.
- Sternitigenital, hypostomal and deutosternal setae smooth ; l. m. t., or portions of l. m. t., may be present..... 3
3. With complete l. m. t. ; hypostomal setae II-III club-shaped, short ; China and North Viet Nam..... *vanderhammeni* n. sp.
- With lateral portions of l. m. t., or l. m. t. absent ; hypostomal setae not as above. 4
4. With strong lateral remnants of l. m. t. (may be complete in *spinirostris* (Berl.)). 5
- Without indications of l. m. t..... 6
5. Line l. m. t. represented by lateral remnants ; peritreme strongly curved medially just anterior to the stigma ; Central Africa..... *benoiti* n. sp.
- Line l. m. t. apparently complete ; peritreme virtually straight anterior to the stigma ; Java..... *spinirostris* (Berlese)
6. Sternitigenital shield and preanal integumental setae short, in no case long enough to approach the setal insertions posterior to them ; small species (ca. 800  $\mu$ ) ; Ionic Islands..... *meridionalis* (Sellnick)
- Sternitigenital and preanal integumental setae quite long, in many instances extending to or beyond the setal insertions posterior to them ; larger species (over 1000  $\mu$  in length) ; southern Europe, North Africa and Israel..... *capulmedusae* (Berlese)
7. Perianal setae mostly minute ; line l. m. t. absent ; sternal setae IV less than 1/3 the length of sternal setae III ; Central Africa..... *tshambi* n. sp.
- Perianal setae distinct, never minute ; lateral portions of l. m. t. present ; sternal setae IV of a length similar to that of sternals III..... 8
8. With more than 40 pairs of perianal setae ; Asia..... 9
- With less than 40 pairs of perianal setae ; Africa..... 10
9. With four rows of deutosternal teeth ; posterior portion of sternitigenital shield with loose punctate pattern ; Java..... *javensis* n. sp.
- With five rows of deutosternal teeth ; posterior portion of sternitigenital shield with dense uniform punctate pattern ; India and Java..... *jaspersi* (Oudemans)
10. Tarsus IV with a large spur on the medioventral portion ; robust species (ca. 1750  $\mu$ ) ; Central Africa..... *magna* n. sp.
- Tarsus IV with at most a small protuberance medioventrally ; smaller species.. 11
11. Seta  $pd_2$  of tarsus IV long and pectinate, at least half again as long as seta  $ad_2$  (fig. 76) ; seta  $ad_2$  spinose and distally plumose ; dorsal setae  $D_2$ - $D_3$  smooth or very nearly so ; with eight setae on genu IV ; small species (ca. 925  $\mu$ ) ; Congo Republic.....  
*verschurenii* n. sp.
- Setae  $pd_2$  and  $ad_2$  of tarsus IV approximately equal in length, both lightly pectinate ; dorsal setae  $D_2$ - $D_3$  plumose throughout most of their length ; with seven or eight setae on genu IV ; larger species (ca. 12-1300  $\mu$ ) ; Congo, Central Africa, British East Africa..... *afrum* Berlese

*Neopodocinum afrum* Berlese.

*Neopodocinum afrum* BERLESE, A. (1917). *Redia* 12 : 153; VITZTHUM, H. G. (1926). *Treubia* 8 (1-2) : 52.

Examination of the BERLESE type material at Florence, Italy revealed only a nymph (probably a deutonymph) of *N. afrum* (slide 214/13), although the original description was based on a female. A drawing of the female was found in BERLESE's unpublished manuscript, "Familia Gamasidae. Tribus Macrochelini," page 272. Specimens of *afrum* in the author's collection were determined with the aid of this drawing. It must be presumed that the holotype is lost or has been misplaced.

FEMALE (Pl. I ; 2, 5, 6 : figs. 5, 6, 8). Length of idiosoma averages 1238  $\mu$ , with a range of 1160-1320  $\mu$ ; width of idiosoma at level of coxae II averages 871  $\mu$ , with a range of 800-930  $\mu$ . *Dorsal shield* punctate and weakly reticulate; with 28 pairs of smooth or pectinate setae, and an unpaired seta ( $D_x$ );  $D_1$  thickened and plumose (fig. 8), approximately twice the length of  $M_1$ ; setae  $D_2$ - $D_3$ ,  $M_1$  $M_2$ ,  $L_1$ - $L_2$  and  $Mg_1$ - $Mg_3$  distinctly pectinate or plumose, other dorsal setae smooth or virtually so;  $Mg_2$  and  $Mg_3$  inserted in a nearly parallel line; anterior dorsal setae generally longer than posterior setae, but not so long as to reach the insertions of the setae behind them; seta  $D_x$  inserted between dorsocentral pores, well behind setae  $D_6$ ; setae  $D_7$  absent. *Sternal shield* (Pl. I ; 2) punctate, narrowed centrally, with lateral portions of line l. m. t. well-developed, and with three pairs of smooth spinose setae; sternal setae I inserted mediad of pores I, somewhat shorter than sternals II, which are inserted anterior to pores II. *Metasternal shields* ovoid, adjacent to endopodal sclerites; each with a long spinose seta and an anterior pore. *Epigynial shield* punctate, convex posteriorly, and with a pair of epigynial pores mediad of the setae. Integumental setae anterior to anal shield short, smooth; setae laterad and posterior to anal shield pectinate or plumose (some of the more posterior setae may be smooth), considerably less than 50 pairs *in toto*. *Anal shield* ovate or obovate, punctate, and with a pair of adanal setae and a single postanal seta; anal opening and setae in posterior half of shield; adanal setae inserted somewhat anterior to the anterior edge of the anal opening; postanal seta smooth, approximately 1/4 the length of the adanals. *Stigmata* opening between coxae III-IV; peritremes looped, joining the stigmata posteriorly, each extending anterior and dorsal to a point distinctly laterad of  $M_1$  (fig. 8). *Tectum* typical for genus; hypostomal setae smooth, spinose, with setae II broader and approximately three times as long as setae III; with five rows of small deutosternal teeth, the more posterior rows often having more teeth (ca. 14-22), deutosternal setae smooth. *Chelicera* (Pl. I ; 5) and palpi typical for genus; internal chelicerai brush at least three times the length of the external brush. Legs I equal



FIGS. 3-7. — *Neopodocinum afrum* Berlese.

Fig. 3. — Dorsum of protonymph ; Fig. 4. — Dorsum of deutonymph ; Fig. 5. — Tarsus IV of female (bt = basitarsus ; pt = pretarsus ; pte = pretarsal element) ; Fig. 6. — Genu IV of female with seven setae ; Fig. 7. — Genu IV of deutonymph with eight setae.



in length to legs II, but without ambulacra or claws ; legs II-IV with well-developed claws, ambulacra and pretarsi ; genu IV (figs. 6, 7) with seven or eight setae ; setae  $ad_2$  and  $pd_2$  of tarsus IV (fig. 5) both fairly short ;  $ad_2$  slightly pectinate,  $pd_2$  plumose distally. Setae  $ad_3$  and  $pd_3$  of pretarsus IV short, broad and weakly plumose distally.

MALE (Pl. I ; 3, 4, 7). Length of idiosoma averages  $1158\ \mu$  with a range of  $1100-1220\ \mu$  ; width of idiosoma at level of coxae II averages  $813\ \mu$ , with a range of  $770-850\ \mu$ . *Dorsal shield* essentially similar to that of the female. *Sternitigenital shield* (Pl. I ; 3) with five pairs of smooth spinose setae, of which setae I are the shortest ; with three pairs of pores which correspond to those of the female ; with distinct lateral portions of line l. m. t. between sternal setae II. Integumental setae posterior to sternitigenital shield somewhat longer than those of female, smooth or pectinate. *Anal* and *peritrematal shields* similar to those of female (Pl. I ; 2). *Tectum*, hypostome and palpi as in female ; movable digit of *chelicera* (Pl. I ; 4) with a short broad spermatophore transfer organ. *Legs* similar to those of the female except for the following : femur II with a large somewhat blunted protuberance on the medioventral portion, genu and tibia II each with a small medioventral protuberance ; tarsus IV with a small medioventral spur anterior to seta  $pv_2$  ; setae  $ad_2$  and  $pd_2$  of tarsus IV somewhat longer than in female.

DEUTONYMPH (Pl. I ; 1 : figs. 4, 7). Length of idiosoma averages  $805\ \mu$ , with a range of  $800-810\ \mu$  ; width of idiosoma at level of coxae II averages  $615\ \mu$ , with a range of  $610-620\ \mu$ . *Dorsal shield* (fig. 4) incised laterally behind setae  $Mg_5$  ; anterior portion with a total of eighteen pairs of setae, all of which are plumose or pectinate ( $D_6$ ,  $M_3$  and  $M_4$  may appear smooth in some specimens) ; average length and breadth of setae greater than that for adults, with many reaching to, or beyond, the insertions of setae behind them. Posterior portion of shield somewhat obscure, but apparently with nine pairs of setae and seta  $D_x$  ; setae  $D_8-D_9$  smooth or at most weakly pectinate. Anteriormost portion of shield with a series of transverse lines which break up into shorter ridges around the setal insertions. *Sternal shield* (Pl. I ; 1) peltate, weakly reticulate and with four pairs of smooth lateral setae. Perianal integument with smooth and pectinate setae, greater in length and in number than the adults. *Anal shield* oval, similar to that of succeeding stages. *Stigmata* between coxae III-IV ; peritremes joining stigmata posterolaterally, forming an "open" loop, each extending anteriorly and dorsally to a point posterior to the insertion of setae  $M_1$ . *Gnathosoma* similar to that of female, as are the *legs*.

PROTONYMPH (fig. 3). Length of idiosoma =  $700\ \mu$  ; width of idiosoma at level of coxae II =  $500\ \mu$ . *Dorsal shield* (fig. 3) divided into two portions, the division occurring just posterior to setae  $D_6$  ; with eleven pairs of broad, pectinate setae on the podonotal portion, and eight pairs of setae on the opisthosomal portion ;  $D_7$  absent, setae  $D_8-D_9$  smooth, other opisthosomal setae broad and pectinate.

Dorsolateral integument exposed ; setae strongly pectinate. *Sternal shield* weak, with three pairs of small smooth setae ; integument behind sternal and around anal shield with less than 15 pairs of smooth and pectinate setae (sternals IV very short). *Anal shield* somewhat elongate, with distinct anal pores ; generally similar to that found in later stages. *Stigmata* between coxae III-IV ; peritremes join stigmata laterally, curve anteromediad, and terminate near the points of origin. *Gnathosoma* similar to that of the adult except for the following : palptrochanter with one seta, palpal femur with four setae (five in succeeding stages), and palpal genu with five setae (six in later stages) ; teeth of digitus mobilis of *chelicera* undeveloped, knob-like ; external cheliceral brush extremely short. Tarsi I without claws or ambulacra ; tarsi II-IV with both claws and ambulacra. Genu IV with only five setae ; various tarsal setae also may be lacking.

#### LARVA.

Unknown.

#### HABITAT AND LOCALITY.

The holotype female described by BERLESE (1917) was from " Lesammise Rendilé, in Africa orientali Anglica ", [British East Africa] collected by Cl. ROTHSCCHILD. The following collections also have been examined by the author : five females and three males from " savane herbeuse " ; Garamba National Park, Congo ; 8 October, 1951 ; with coprophagic beetles ; H. DE SAEGER, coll. (Mission H. DE SAEGER, Coll. No. 2533) : two additional males from coprophagic beetles in Garamba Park collected by H. DE SAEGER on 24 May, 1952 (Coll. No. 3565) and 6 June, 1952 (Coll. No. 3672) : two females from Madibira, D.O.A. [Dutch East Africa ?] ; ex *Heliocopris andersoni* Bates ; Ertl, coll. (Central African Museum Coll. No. 120192) : one female, two deutonymphs and a protonymph from Koarnouth, Congo ; June, 1921 ; ex *Heliocopris antenor* Ol. ; H. SHOUTEDEN, coll. (Central African Museum Coll. No. 120365) : one female from Ngorongoro, Tanganyika (2500 m.) ; 6 June, 1957 ; ex *Heliocopris hunteri* Waterh. ; P. BASILEWSKY and N. LELEUP, coll. (Central African Museum Coll. No. 120209) : two females, one male and three deutonymphs from Mukesa, D.O.A. ; ex *Heliocopris dilloni* Guér. ; NAGEL, coll. (Central African Museum Coll. No. 120171) : two females, two males, and two deutonymphs from British East Africa ; September, 1909 ; ex *Heliocopris haroldi* Kol. (U. S. National Museum Collection).

The variation in numbers of setae on genu IV in the Macrochelidae has been reported earlier (EVANS and HYATT 1963). This segment is unique in the leg chaetotaxy of the family, being one of the only segments which exhibits intra- and intergeneric variation in number (*Neopodocinum* has only four setae on trochanter III, as contrasted to five on other genera). Some genera (i. e. *Holoce-laeno*) are found to have seven setae on genu IV, while others (i. e. *Macrocheles* s. str.)

have only six. The constancy of this character within genera or within so-called species groups is such that it may be used as a primary supraspecific character. The genus *Neopodocinum* has been considered to have seven setae on genu IV, inasmuch as none has been found with less than seven setae. The discovery of specimens possessing eight setae on genu IV as in *N. afrum*, might lead to speculation on the value of the genual character as a primary supraspecific character. Two new species of *Neopodocinum* which are described later in this paper also have eight setae on genu IV. The possibility that these two species, along with those specimens of *afrum* which have eight setae on genu IV, constitute a species group within the genus, has been considered. The fact that those specimens of *afrum* with eight genual setae were from a single collection of *Heliocopris haroldi*, and those with seven were from Central Africa on other species of *Heliocopris*, might indicate a specific difference. This point of view is made even stronger when the strength of the genual setal character is considered. However, the total lack of variation between specimens of *afrum* with seven and with eight genual setae, and the closely related habitats of the two assemblages, argue in favor of conspecificity.

The author prefers, at this time, to consider the two assemblages both as *afrum* based on the following points :

1. While the constancy of the genual setal character has been demonstrated in the Macrochelidae, the variation has been confined to that between six and seven setae. The presence of eight setae is unknown elsewhere in the family and cannot, at present, be thought of as anything more than an intraspecific variable which expresses itself somewhat differently in populations inhabiting different parts of the geographical or host range. The presence of eight setae on genu IV of the two new species to be described must be interpreted in a similar way, since few specimens have been seen. The fact that an intraspecific variation between six and seven genual setae has not been observed in the Macrochelidae may show that the addition of genual setae (seven or more) is an advanced character which is not yet stabilized as to number, but which has occurred as a result of evolution from the primitive type. Thus, the primitive genera consistently have six setae on genu IV, while the more highly evolved types may have seven, eight, or more setae on the same segment.

2. The two assemblages of *afrum* are identical in every respect, aside from the genual setal character. Based on observations of primary and secondary characters in *Neopodocinum*, such a similarity between different species would have to be considered as most unusual.

3. Assuming the two populations to be *afrum*, then the range of the collected specimens would include that of BERLESE's holotype ("Africa orientali Anglica").

*Neopodocinum bartkei* Micherdzinski.

*Neopodocinum bartkei* MICHERDZINSKI, W. (1964). *Acarologia* 6 (2) : 229.

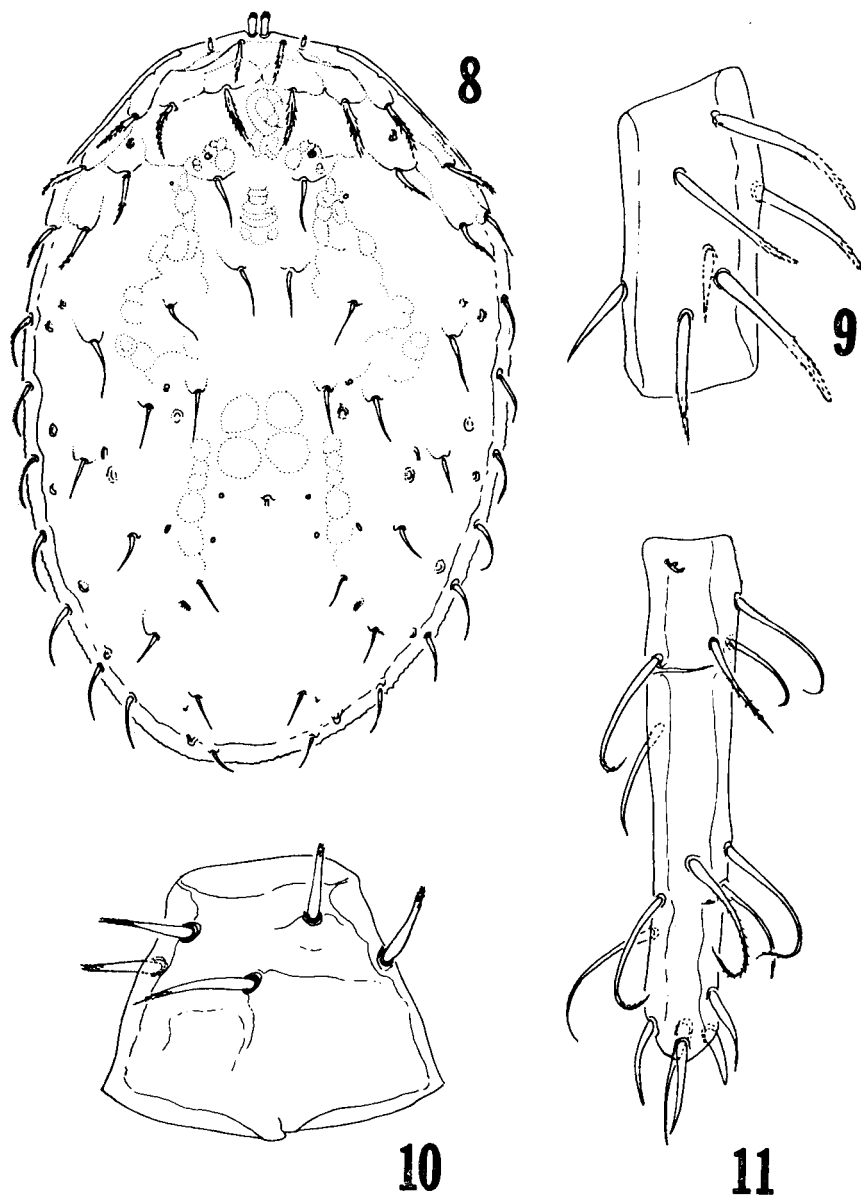
The morphology of *N. bartkei* has been adequately described and figured by MICHERDZINSKI (1964). The following, therefore, constitutes only a brief diagnosis of features based on the original description, or observed by the writer from specimens of *N. bartkei* which Dr. Micherdzinski was kind enough to send.

FEMALE (Pl. I ; 8 : Pl. II ; 11, 13 : figs. 9, 11). Length of idiosoma averages 2268  $\mu$ , while the width averages 1817  $\mu$ . *Dorsum* without ornamentation, and with 29 pairs of setae, plus an unpaired seta  $D_x$ ;  $D$  setae posterior to  $D_3$  ( $D_2$  of MICHERDZINSKI) short, smooth;  $M_3$ ,  $M_4$  and  $L_6$  also short and smooth, other setae pectinate and longer;  $Mg$  setae long enough to surpass insertions of setae behind them; apparently with eleven pairs of marginals. *Sternal shield* unornamented, with three pairs of plumose setae; metasternal and epigynial setae also plumose; anal setae smooth. *Peritreme* joins stigma anterolaterally, curves anterolaterad and mediad, proceeding anteriorly and dorsally. Hypostomal setae II-III, and deutosternal setae, plumose distally; in other respects *gnathosoma* typical for genus; with five rows of deutosternal teeth (20-28 teeth/row). Tarsus I with a well-developed ambulacrum; genu IV with seven setae of which only  $av_1$  and  $pl_1$  are smooth (fig. 9);  $ad_2$  and  $pd_2$  of tarsus IV approximately equal in length,  $ad_2$  lightly pectinate distally,  $pd_2$  pectinate for most of its length. Seta  $pl_3$  of pretarsus IV extremely long, surpassing seta  $mv$  in length (fig. 11); other tarsal setae long, many curved.

MALE (Pl. II ; 12, 13). Length of idiosoma averages 2012  $\mu$ , and the width averages 1574  $\mu$ . *Dorsum* as in female. *Sternitigenital shield* unornamented, with five pairs of distally plumose setae; remainder of the venter similar to that of female; digitus mobilis of *chelicera* with a blunt spermatophore transfer organ. Femur II with large medioventral spur; genu and tibia II with smaller medioventral protuberances.

DEUTONYMPH (Pl. I ; 9 : Pl. II ; 10). Length and width average 1552  $\mu$  by 1269  $\mu$ , according to the original description. *Dorsum* similar to female in setation; lateral incisions absent. *Sternal shield* peltate, with only three pairs of plumose sternal setae (setae IV are smooth and inserted in the integument behind the lateral angles of the shield); other ventral integumental setae plumose. *Gnathosoma* similar to that of female. Tarsus I with an ambulacrum and a small pair of claws (Pl. I ; 9).

PROTONYMPH. Length and width average 1201  $\mu$  by 1009  $\mu$ . *Dorsal shield* divided; anterior portion apparently with 14 pairs of setae, rather than the more



FIGS. 8-11. — *Neopodocinum barthei* Micherdzinski.

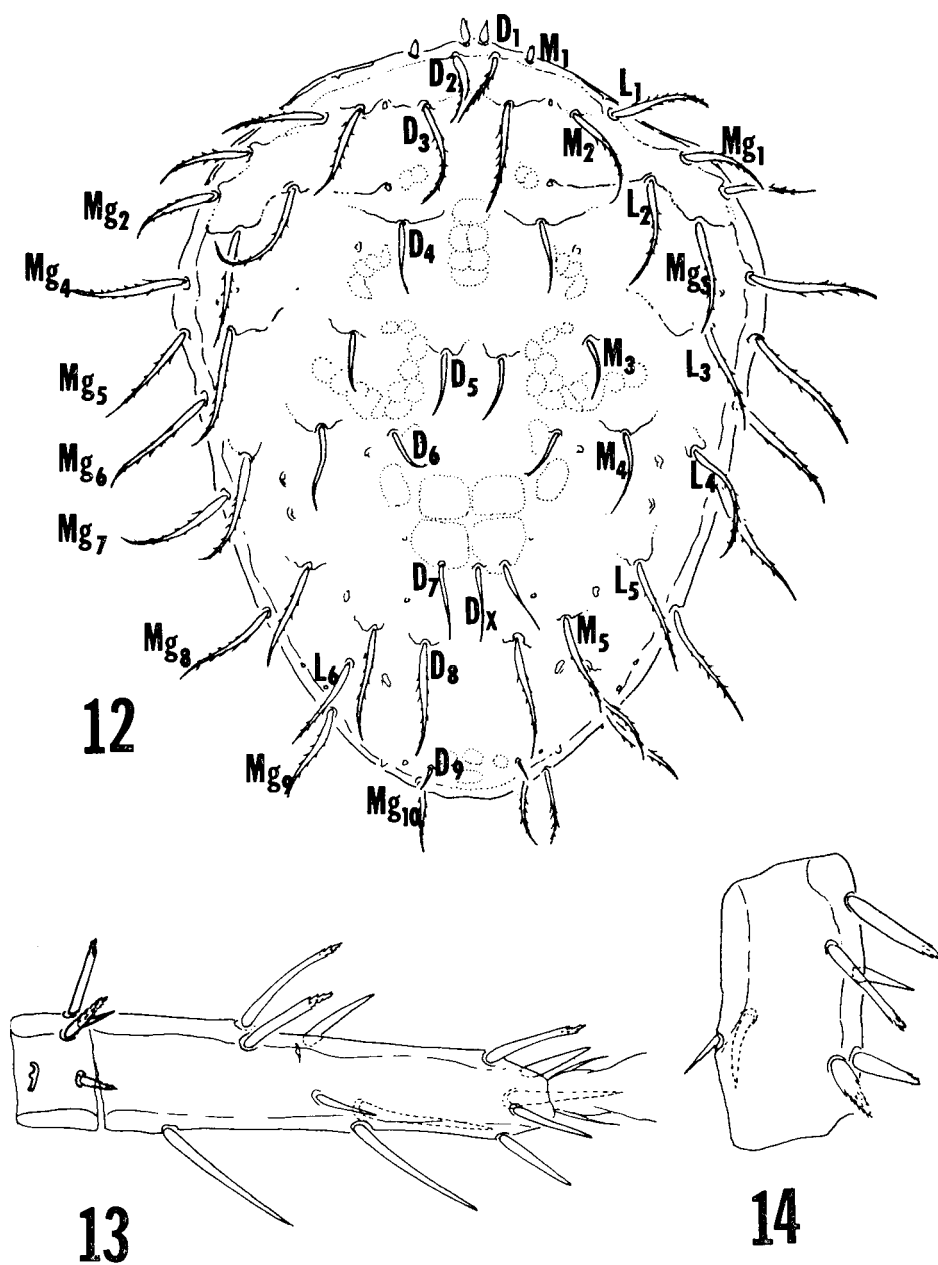
Fig. 8. — Dorsum of female ; Fig. 9. — Genu IV of female ;  
Fig. 10. — Trochanter II of female ; Fig. 11. — Tarsus IV of female.

typical 11; posterior portion with 8 pairs. *Sternal shield* with three pairs of distally plumose setae; less than 30 pairs of perianal integumental setae. Hypostomal setae I and III (and often the deutosternal setae) are smooth, setae II plumose. Tarsus I with claws, as in deutonymph.

LOCALITY AND HABITAT. Forty-seven specimens on beetles of the genus *Copris*; Cha-Pa, North Viet Nam; 2-19 March, 1961; A. BARTKE, coll.

***Neopodocinum benoiti* n. sp.**

FEMALE (Pl. II; 14, 19: figs. 12-15). Length of idiosoma averages 1198  $\mu$ , with a range of 1100-1310  $\mu$ ; width of idiosoma at level of coxae II averages 900  $\mu$ , with a range of 750-950  $\mu$ . *Dorsal shield* (fig. 12, 15) lightly punctate; apparently with 29-31 pairs of smooth and pectinate setae, and an unpaired seta  $D_x$  (difference in setal number depends, in part, on insertions of posteromarginal setae); setae  $D_1$  inserted nearly adjacent to one another, broad basally, narrowed and weakly plumose distally; setae  $M_1$  more than half the length of  $D_1$ , smooth distally, or nearly so; setae  $D_4$ - $D_7$ ,  $D_x$ ,  $D_9$ ,  $M_3$ - $M_4$  smooth or nearly so, other setae pectinate throughout most of their length; anterior, marginal and posterior setae long, many extending beyond the setal insertions of those behind them; seta  $D_x$  either between setae  $D_7$  (fig. 12), or absent (in the latter case,  $D_8$  may be present or absent, as shown in fig. 15).  $Mg_3$  inserted posterior to  $Mg_2$ . *Sternal shield* (Pl. II; 14) narrow, uniformly punctate, and with a complete transverse l. m. t. between sternal setae II; sternal setae spinose, long enough to reach the insertions behind them; with two pairs of sternal pores. *Metasternal shields* ovate, lying adjacent to the edopodal platelets and each bearing a stout seta and an anterior pore. *Epigynial shield* uniformly punctate as sternal shield; epigynial setae spinose, inserted posterolaterally behind short strong ridges which usually are distinct; shield convex behind. Integumental setae inserted lateral and posterior to the anal shield numbering over 40 pairs, smooth or weakly pectinate, long enough to surpass the insertions of setae behind them. *Anal shield* elongate-oval, with anal opening and accompanying setae in posterior half; uniformly punctate. *Stigmata* between coxae III-IV; each peritreme joins stigma anterolaterally, curves anterolaterad and mediad, proceeds anteriorly and dorsally to a point anterior to the insertion of seta  $M_2$  (fig. 12). *Tectum* and *palpi* typical for genus; *chelicera* also typical but the internal cheliceral brush is short, barely extending half the length of the digitus mobilis (Pl. II; 19); hypostome with the usual three pairs of setae; setae II somewhat shorter and broader than setae III; deutosternum with five rows of small, sometimes irregular teeth, numbering ca. 25-30/row, deutosternal setae smooth, considerably smaller than any of the hypostomal setae. *Legs* of approximately equal length; leg II not greatly thickened, little stouter than legs I; tarsi I with well-developed membranous ambulacra which are ventrodistally inserted, tarsi II-IV with claws and ambulacra; spines



FIGS. 12-14. — *Neopodocinum benoiti* n. sp.

Fig. 12. — Dorsum of female with full complement of setae;  
 Fig. 13. — Tarsus IV of female; Fig. 14. — Genu IV of female.

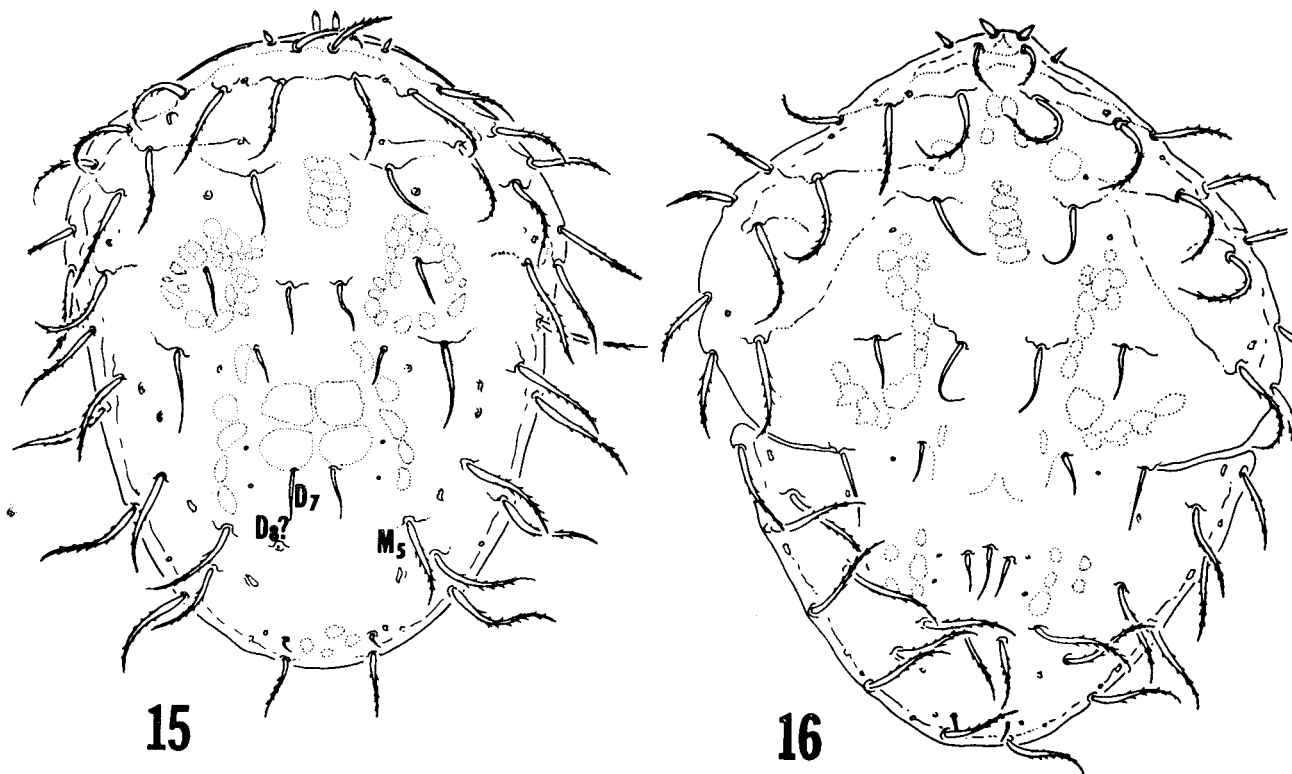
on tarsus II weakly developed, little different from tarsus III ; genu IV (fig. 14) with seven setae, of which  $al_1$ ,  $av_1$  and  $pl_1$  are smooth,  $pd_1$  plumose ; setae  $ad_2$  and  $pd_2$  of tarsus IV (fig. 13) considerably longer than those of *N. afrum* (fig. 5) ;  $ad_2$  somewhat longer than  $pd_2$ , both distally plumose ; seta  $md$  also plumose distally.

MALE (Pl. II ; 15, 17 : Pl. III ; 21). Length of idiosoma averages 1320  $\mu$  (two specimens of equal length) ; width of idiosoma at level of coxae II averages 915  $\mu$ , with a range from 890-940  $\mu$ . *Dorsal shield* similar to that of female except that setae  $D_1$  appear smooth distally (many of the central and posterior setae were not observed, so comparisons cannot be made at this time). *Sternitigenital shield* (Pl. II ; 15) with five pairs of smooth spinose setae, setae I being the shortest ; lateral portions of l. m. t. present, with three pairs of pores. *Anal shield* and integumental setae surrounding it are similar to those found in the female (Pl. II ; 14) ; peritremes and stigmata also similar to female counterparts. *Gnathosoma* essentially like that of the female except for the following : variation in number of deutosternal teeth is greater than in female (ca. 22-40) ; digitus mobilis of *chelicera* (Pl. III ; 21) with a distally swollen spermatophore transfer organ. Legs similar to those of female, except that legs II and IV are stouter than legs I and III ; femur II with a stout spur on the medioventral portion ; genu and tibia II with smaller protuberances in the same location ; tarsus II without the complement of large spurs commonly found in males of this group ;  $ad_2$  of tarsus IV somewhat longer than  $pd_2$ , both lightly pectinate and longer than those of female ; tarsus IV with a small medioventral protuberance anterior to setae  $pv_2$  ; with a broad spur posteroventrally.

DEUTONYMPH (Pl. II ; 16 : fig. 16). Length of idiosoma averages 892  $\mu$ , with a range of 850-950  $\mu$  ; width of idiosoma at coxae II averages 725  $\mu$ , with a range of 670-760  $\mu$ . *Dorsal shield* (fig. 16) laterally incised behind setae  $M_5$  ; anterior portion with a series of lateral grooves, ridges and punctations ; with eighteen pairs of setae, of which  $D_1$ ,  $D_4$ - $D_6$ ,  $M_1$ ,  $M_3$  and  $M_4$  are smooth or nearly so ; others distinctly pectinate ; most pectinate setae long and curved. Posterior portion of shield with thirteen pairs of setae and an unpaired  $D_x$  inserted between setae  $D_7$  ; similar in length, position and ornamentation to those of female. *Sternal shield* (Pl. II ; 16) heart-shaped, distinctly reticulate and with lateral portions of l. m. t. present ; with four pairs of smooth setae and three pairs of pores. Perianal setae long, smooth or weakly pectinate and similar in number to that found in the female ; *anal shield* also similar to that of adults. *Peritreme* extending to a point just mediad of the insertion of setae  $M_2$ . *Gnathosoma* and legs similar to those of female.

PROTONYMPH (Pl. II ; 18 : Pl. III ; 20 : fig. 17). Length of idiosoma averages 653  $\mu$ , with a range of 650-660  $\mu$  ; width of idiosoma at level of coxae II averages 526  $\mu$ , with a range of 500-550  $\mu$ . *Dorsal shield* (fig. 17) divided into two portions, the split occurring just behind setae  $D_6$  ; anterior podonotal portion with eleven





FIGS. 15-16. — *Neopodocinum benoiti* n. sp.

Fig. 15. — Dorsum of female with setae  $D_8$  and seta  $D_x$  absent ;

Fig. 16. — Dorsum of deutonymph.

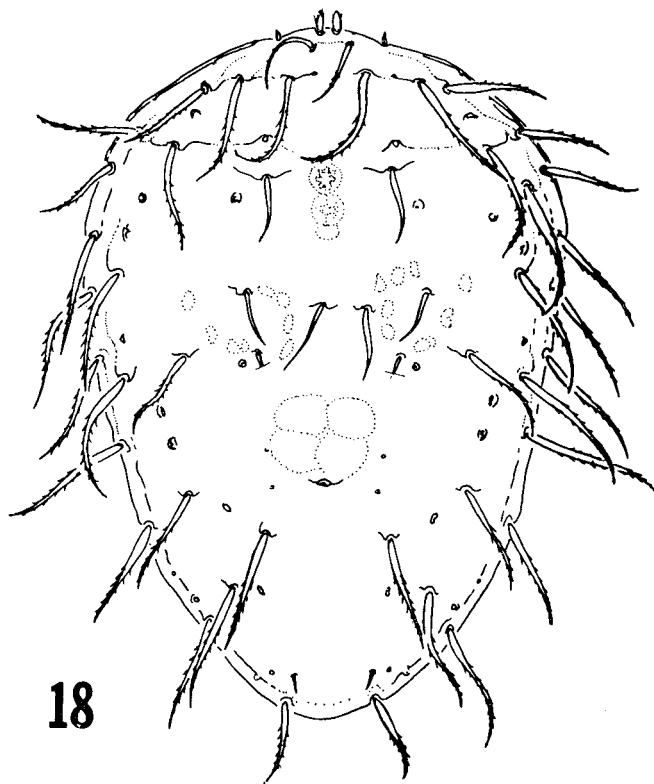


FIG. 17. — Dorsum of protonymph of *Neopodocinum benoiti* n. sp.  
 FIG. 18. — Dorsum of *Neopodocinum benoiti ectopothrix* n. var.

pairs of smooth (or nearly smooth) setae, shield with a series of lateral ridges and punctations; posterior shield with a weak punctate pattern and with eight pairs of setae,  $Mg_{8-10}$  being distinctly pectinate; setae  $D_7$  and seta  $D_x$  absent, among others;  $D_8$  present. *Sternal shield* lightly reticulate, with three pairs of smooth setae and two pairs of pores. Integument surrounding anal shield with more than 30 pairs of setae, of which most are pectinate. *Anal shield* punctate, similar to that of succeeding stages. Stigmata more or less laterad of coxae III; peritremes join stigmata anterolaterally, extend in a straight anterolateral direction and terminate near the points of origin (Pl. III; 20-pt). Palpal trochanter, genu and tibia with the typical 1-4-5 setal formula; cheliceral teeth well-developed (Pl. II; 18). Tarsi I each with a pair of small but well-developed claws and ambulacrum; tarsi II-IV similarly armed; genu IV with five setae.

#### LARVA.

Unknown.

#### HABITAT and LOCALITY.

A total of 21 collections from the Central African Museum, with data as follows: one female from Uele Nepoko; 1931; ex *Catharsius dux* Har.; T. VRYDAGH, coll. (Coll. No. 117538): one female from Leierville; 1928; ex *Catharsius dux*; M<sup>me</sup> TENANT, coll. (Coll. No. 117539): one protonymph from Leopoldville, Congo; 12 July, 1912; ex *Catharsius dux*; Dr. A. DUBOIS, coll. (Coll. No. 117541): one male and one female from Kwamouth; ex *Catharsius dux*; Dr. MAES, coll. (Coll. No. 117542): two protonymphs and two deutonymphs from Barqueta; 14 Sept., 1912, ex *Catharsius dux*; Dr. CHRISTY, coll. (Coll. No. 117544): one female and one deutonymph from Eala; 13 October, 1931; ex *Catharsius dux*; H. T. BREDO, coll. (Coll. No. 117547): one protonymph from Kisantu; 15 Dec., 1920; ex *Catharsius dux*; Dr. H. SCHOUTEDEN, coll. (Coll. No. 117554): two females from Barumbu; January, 1921; ex *Catharsius dux*; L. GHESQUIERE, coll. (Coll. No. 118077): one female from Mahungu; 10 February, 1912; ex *Catharsius dux*; R. VERSCHUREN, coll. (Coll. No. 118078): one protonymph from Kapanga, Congo; January, 1933; ex *Catharsius alpheus*; G. F. OVERLAET, coll. (Coll. No. 120286): one female from Batembas; January, 1926; ex *Catharsius dux*; Ch. SEYDEL, coll. (Coll. No. 118089): one female, one male and one deutonymph from Coquilhatville; ex *Catharsius dux*; THESQUENS, coll. (Coll. No. 118090): two females and a deutonymph from Kasai Kondue; ex *Catharsius dux*; LEOHARD, coll. (Coll. No. 118091): two females from Congo da Luuba; 1913; ex *Catharsius dux*; R. MAYNE, coll. (Coll. No. 118092): one female from Bumba; ex *Catharsius dux*; DUEHIENE, coll. (Coll. No. 118093): one female from Kwamouth; June, 1921; ex *Catharsius dux*; LEBRUN, coll. (Coll. No. 118096): three deutonymphs from Eala; 1924; ex *Catharsius dux*; A. CORBISIER, coll. (Coll. No. 118098): two females and two deutonymphs from Lusambo; January, 1926; ex *Catharsius dux*; Ch. SEYDEL, coll. (Coll. No.

118099) : three females and a deutonymph from Sankuru, Congo ; March, 1925 ; ex *Catharsius satyrus* Kolbe ; L. GHESQUIERE, coll. (Coll. 120282) : one female from Eala ; February, 1935 ; ex *Catharsius gorilla* Thoms. ; L. GHESQUIERE, coll. (Coll. No. 120290) : one female from Eala Bokatola ; October, 1930 ; ex *Catharsius dux* ; Dr. P. STANER, coll. (no collection number given). The holotype female, allotype male, and deutonymph and protonymph specimens will be deposited in the collection of the Central African Museum, Tervuren, Belgium. Paratypes will also be placed in the collections of the U. S. National Museum, Washington, D. C., Oregon State University, Corvallis, Oregon, British Museum (Natural History), London, Institute of National Parks of the Congo and Ruanda-Urundi, Brussels, and the Zoological Museum, Leningrad, U.S.S.R.

*N. benoiti* is unique in that adults and deutonymphs may have 29-31 pairs of dorsal setae, and that the number may vary between specimens. Details on this phenomenon are given under the section entitled "EXTERNAL MORPHOLOGY" (page 141).

***Neopodocinum benoiti* var. *ectopothrix* n. var.**

FEMALE (fig. 18). Length of idiosoma averages 1311  $\mu$ , with a range of 1280-1343  $\mu$  ; width of idiosoma at level of coxae II averages 821  $\mu$ , with a range of 814-830  $\mu$ . Dorsal shield similar to that of *benoiti* except for the following : with only 28 pairs of setae ; setae  $D_7$  and  $D_8$  absent ;  $D_5$  nearly half again as long as  $M_3$ ,  $M_4$  weakly pectinate ;  $M_5$ ,  $L_6$  and  $Mg_9$  noticeably more robust than in *benoiti*. Venter, gnathosoma and legs similar to those of *benoiti* (Pl. II ; 14, 19).

DEUTONYMPH. Length of idiosoma = 879  $\mu$  ; width of idiosoma at level of coxae II = 553  $\mu$ . Dorsal shield similar to that of *benoiti* (fig. 16), except for the following : with only 28 pairs of setae ; setae  $D_2$  long, extending well beyond the insertions of  $D_3$ ,  $D_4$  and  $M_4$  pectinate ;  $D_7$  and  $D_8$  absent, setae  $M_5$ ,  $L_6$  and  $Mg_9$  long and robust, as in adult (fig. 18) ; venter, gnathosoma and legs essentially the same as in *benoiti*.

MALE, PROTONYMPH and LARVA.

Unknown.

HABITAT and LOCALITY.

Two females and a deutonymph from "Belgian Congo" ; ex *Catharsius dux* ; GIBSON, coll. (Coll. No. 117548, Central African Museum). The holotype female and paratype deutonymph will be deposited in the collection of the Central African Museum, Tervuren, Belgium. The paratype female will be placed in the collection of the U. S. National Museum, Washington, D. C.

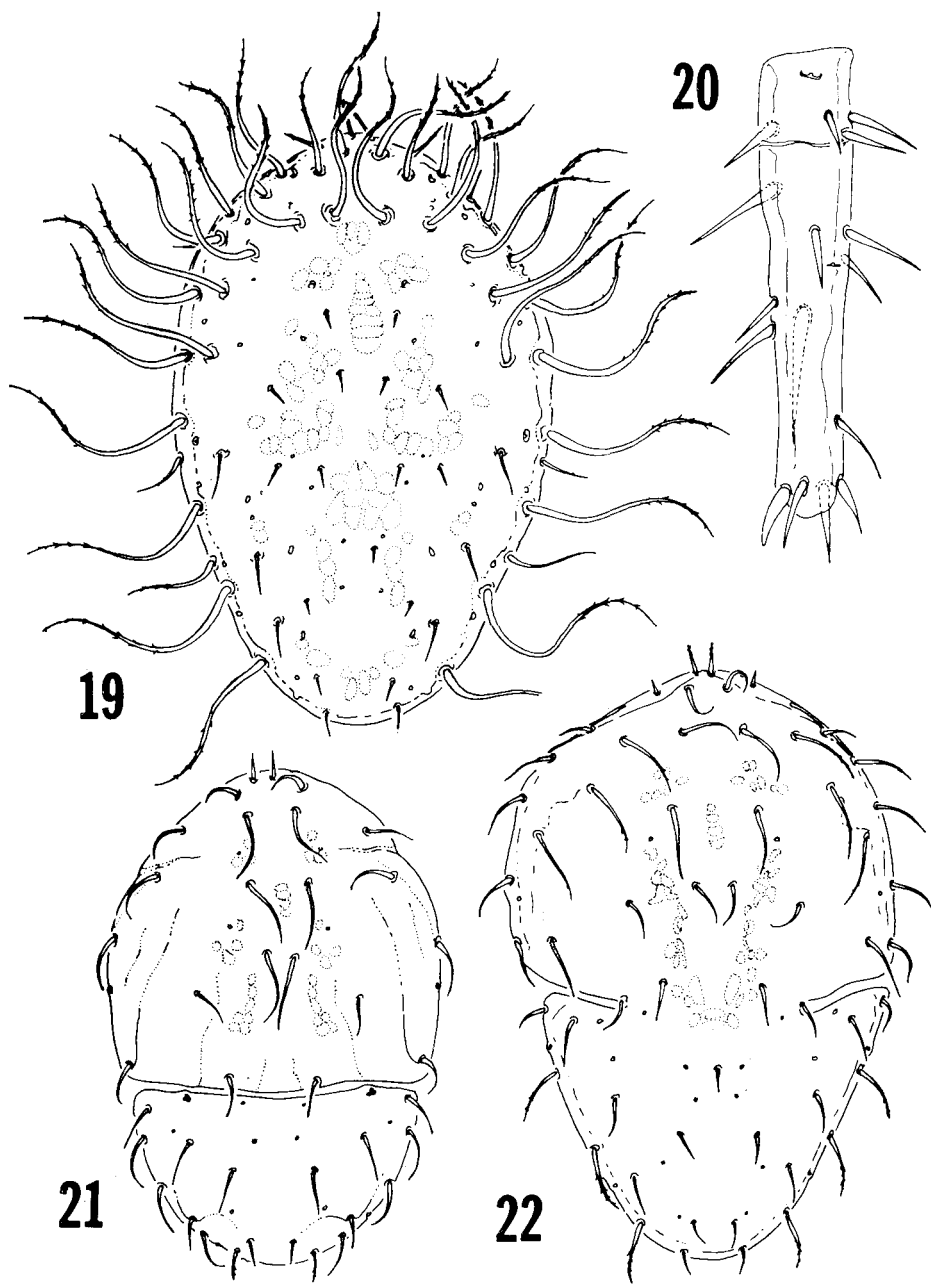
The erection of a varietal category for *ectopothrix* is felt to be necessary because of the striking differences noted between the dorsal setation of *ectopothrix* and *N. benoiti* s. str. While *N. benoiti* shows distinct inconsistencies in the region of  $D_x$  (figs. 12, 15), these are not considered to be unusual in *Neopodocinum*. The disappearance of  $D_x$  and the concomitant appearance of setae  $D_7$ , for example, is seen in occasional specimens of other species (i. e. *N. wenzeli*). The rather widespread occurrence of such specimens in field collections, and the fact that they are generally found in populations of "normal" specimens, leads one to conclude that such variations should not be thought of as differentiating taxonomic characters. The variations noted in *ectopothrix*, however, include not only the loss of setae  $D_7$  and  $M_5$ , but a rearrangement of opisthosomal setae. Obvious differences in setal lengths and degree of pectination of setae also have been found. The extent of variation between *ectopothrix* and *benoiti* s. str. is even greater in the deutonymphal stage than in the adult stage. Although the extent of these dissimilarities appears to be more than that which is normally encountered, and the specimens of *ectopothrix* came from a single beetle host on which no typical *benoiti* were found, the former was taken in a sequential series of collections of *benoiti* s. str. from *Catharsius dux*. This, coupled with the essential similarity of venter, gnathosoma and legs of *ectopothrix* and *benoiti* s. str., indicates that the former should not be considered a distinct species, or a subspecies. It is therefore assigned varietal rank.

*Neopodocinum caputmedusae* (Berlese).

*Coprolaelaps caputmedusae* BERLESE, A. (1908). *Redia* 5 : 14; BERLESE, A. (1913). *Redia* 9 : 82; COSTA, M. (1963). *J. Linn. Soc. (Zool.)* 45 (303) : 35.  
*Neopodocinum caputmedusae*, (Berlese). COSTA (in press) (*New combination*).

COSTA (in press) has described all stages of *N. caputmedusae*. The following brief diagnosis is presented merely to indicate some useful characters for separation from other species of the genus.

FEMALE (Pl. III ; 25, 26 : figs. 19, 20, 23). The holotype female of *N. caputmedusae* in the BERLESE collection at Florence (slide 106/45) was found to measure 1050  $\mu$  in length and approximately 625  $\mu$  at the level of coxae II. The range of nine other specimens was 970-1140  $\mu$ , with an average of 1065  $\mu$ . The width averaged 645  $\mu$ , with a range of 620-660  $\mu$ . *Dorsal shield* (fig. 19) with several extra pairs of anterior marginal setae inserted on the shield; many marginals lightly pectinate distally;  $D_1$ - $D_3$  distally pectinate, more posterior D setae short and smooth; setae  $M_3$ - $M_4$ ,  $L_4$ - $L_6$ ,  $D_x$  and  $Mg_{10}$  also short and without pectination;  $M_1$  smooth or nearly so, almost as long as setae  $D_1$ ; setae  $D_7$ - $D_8$  absent. Dorsal integumental setae longer than the distance between insertions, smooth or weakly pectinate. *Sternal shield* (Pl. III ; 26) uniformly punctate, unornamented, with three pairs of long smooth setae; *epigynial shield* similarly punctate, with a pair



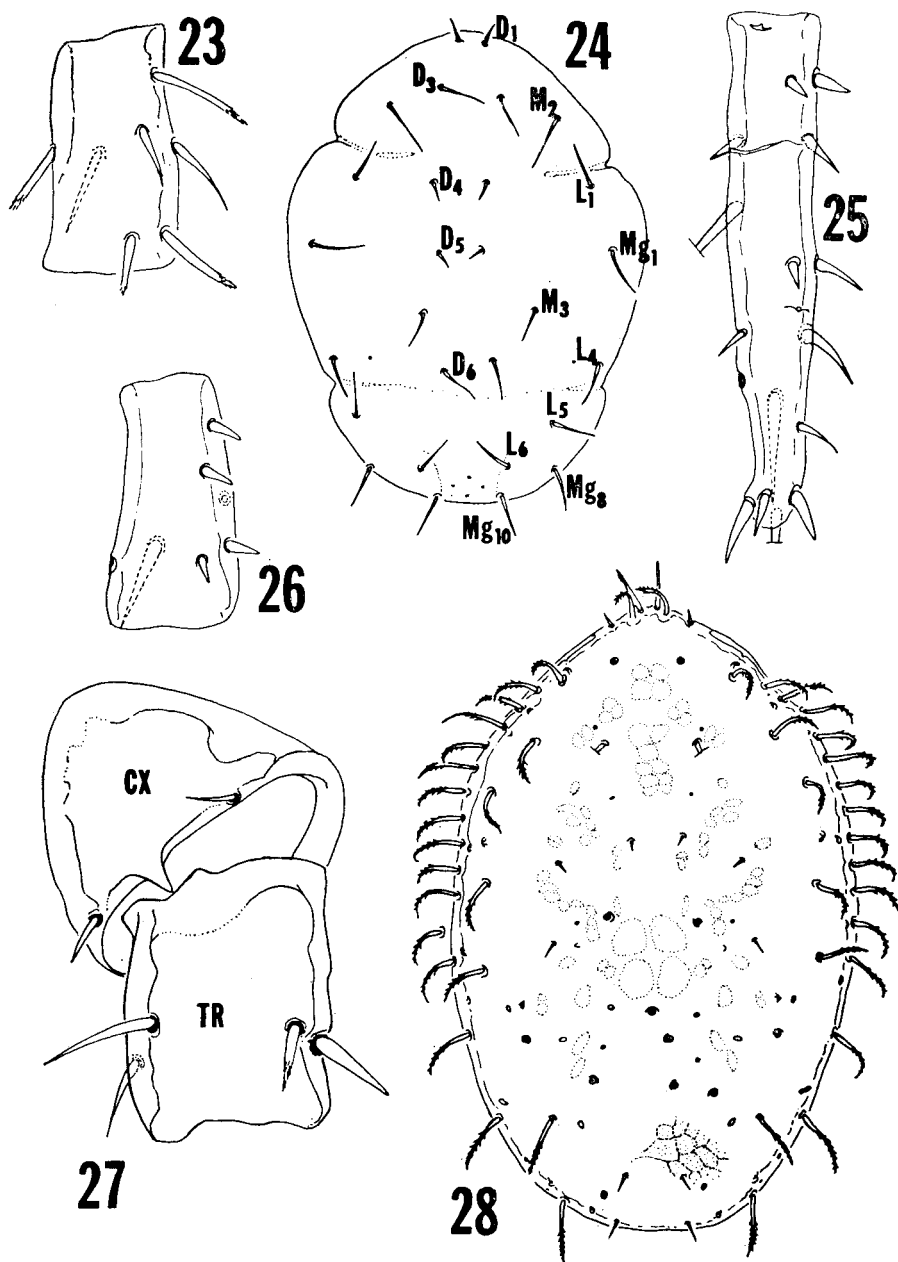
FIGS. 19-22. — *Neopodocinum caputmedusae* (Berlese).

Fig. 19. — Dorsum of female ; Fig. 20. — Tarsus IV of female ;  
Fig. 21. — Dorsum of protonymph ; Fig. 22. — Dorsum of deutonymph.

of long smooth posterolateral setae; metasternal setae somewhat shorter than either the sternal or epigynial setae; with a pair of epigynial pores posterior to the setae and on the shield border. With well over 50 pairs of long perianal integumental setae, some of which are lightly pectinate distally. Peritreme meeting stigma anterolaterally; without loop; each peritreme extends anteriorly and dorsally to a point laterad of seta  $M_1$  (fig. 19). Hypostomal setae smooth; setae II longer than setae I or III; deutosternals smooth, equal in length to hypostomals II; with five rows of small deutosternal teeth (ca. 30-35 teeth/row). Tarsi I with well-developed membranous ambulacra (Pl. III; 25); genu IV with seven setae, of which  $al_1$ ,  $av_1$  and  $pd_2$  are smooth distally (fig. 23); setae  $ad_2$  and  $pd_2$  of tarsus IV apparently smooth;  $ad_2$  only slightly longer than  $pd_2$  (fig. 20).

MALE (Pl. III; 27, 28). Length of idiosoma averages  $1337\ \mu$  in available "normal" specimens (see following discussion), with a range of  $1020$ - $1060\ \mu$ ; width of idiosoma at level of coxae II averages  $650\ \mu$ , with a range of  $640$ - $660\ \mu$ . *Dorsal shield* and setae similar to those of female. *Sternitigenital shield* (Pl. III; 27) deeply incised behind sternal setae III, l. m. t. absent; metasternal shields free in the integument between the sternitigenital and endopodal shields, each with a seta and pore; "epigynial" portion of sternitigenital shield similar to that of female, but fused anteriorly to "sternal" portion; sternitigenital and metasternal setae smooth. Perianal setae smooth or weakly pectinate, numbering well over 50 pairs, and of a length similar to those of female (Pl. III; 26). *Peritreme* extends to a position laterad of seta  $M_1$ , as in female. *Gnathosoma* similar to that of female; digitus mobilis of *chelicera* (Pl. III; 28) with a distally hooked spermatophore transfer organ; cheliceral brushes short, the internal brush being considerably less than half the length of the digitus mobilis. Ambulacra present on tarsi I; femur, genu and tibia II with medioventral spurs, the femoral protuberance being large and distinct; tarsus IV also with a small medioventral spur well anterior to seta  $pv_2$ ; without posteroventral spur.

DEUTONYMPH (Pl. III; 22, 24 : fig. 22). Length of idiosoma of available specimens averages  $725\ \mu$ , with a range of  $670$ - $780\ \mu$ ; width of idiosoma at level of coxae II averages  $473\ \mu$ , with a range of  $450$ - $500\ \mu$ . *Dorsal shield* (fig. 22) incised laterally behind  $Mg_5$ ; anterior portion with a total of eighteen pairs of setae, all of which appear to be smooth ( $D_1$  may be weakly plumose distally, as may  $L_1$ - $L_2$ ); setae  $M_1$  subequal in length to  $D_1$ ; marginal and lateral setae little longer than dorsocentrals, the former being barely long enough to reach the insertions of the setae behind them. Posterior portion of shield with ten pairs of setae and an unpaired dorsal seta,  $D_x$ ;  $Mg_{7-9}$  distally pectinate, but others smooth,  $D_7$  absent. *Sternal shield* (Pl. III; 24) convex anteriorly, with lateral portions of line l. m. t. weakly developed, and with four pairs of smooth sternal setae (setae IV may be off the shield when the posterior sclerotization of the shield is weak); setae quite short, each barely attaining the insertion of the seta immediately behind it. Perianal setae smooth, numbering less than 30 pairs; *anal shield* similar to that of adults.



FIGS. 23-24. — *Neopodocinum caputmedusae* (Berlese).

Fig. 23. — Genu IV of female; Fig. 24. — Dorsum of larva.

FIGS. 25-28. — *Neopodocinum emodi* n. sp.

Fig. 25. — Tarsus IV of female; Fig. 26. — Genu IV of female;  
Fig. 27. — Coxa and trochanter III of female; Fig. 28. — Dorsum of female.



*Peritremes* without loop anterior to stigmata ; peritremes extend anteriorly and dorsally to a point between  $M_1$  and  $M_2$ . *Gnathosoma* similar to that of female, except that deutosternal setae are distinctly shorter than hypostomals II. Tarsi I with a well-developed pair of claws, in addition to the ambulacrum found in succeeding stages.

PROTONYMPH (fig. 21). Length of idiosoma of the single available specimen =  $450\ \mu$  ; width of idiosoma =  $300\ \mu$ . *Dorsal shield* (fig. 21) with a series of punctate lines ; divided into two portions, the division occurring behind setae  $D_6$  ; with eleven pairs of smooth setae, of which setae  $D_3$ - $D_5$  are the longest ; with eight pairs of posterior dorsal shield setae, none of which are distinctly pectinate ; setae  $D_7$  and seta  $D_x$  absent. *Sternal shield* punctate, concave anteriorly and convex posteriorly, with three pairs of smooth setae ; with less than 15 pairs of smooth and pectinate perianal setae. *Anal shield* elongate. *Stigmata* between coxae III-IV ; peritremes join stigmata anteriorly, and extend anterolaterally for a distance less than that of the width of coxa III. *Gnathosoma* similar to that of female except for the palptrochanter-genu-tibia setal formula (1-4-5) in the protonymph, and the virtually undeveloped cheliceral brushes. Tarsi I-IV with claws and ambulacra ; genu IV with only five setae.

LARVA (Pl. III ; 23 : fig. 24). Length of idiosoma of the single undamaged larval specimen available for study =  $430\ \mu$ , width at level of coxae II =  $280\ \mu$ . The larval stage has been described earlier in the section entitled "EXTERNAL MORPHOLOGY" (page 147).

#### HABITAT and LOCALITY.

The holotype of *N. caputmedusae* was described from *Copris hispanus* (L.) in the commune of Pisa (BERLESE 1908), and virtually all of the subsequent collections have been from the same host. COSTA (1963) lists a total of 694 specimens of *N. caputmedusae* from *Copris hispanus* at Mishmar Haemek, Israel. This author has seen, in addition, the following : one female and one nymph from Sardinia ; ex *Copris hispanus* ; KRAUSSE, coll. (USNM Coll.) ; one female from Turkestan ; ex *Homalocopris tmolus* Fisch (Chicago Museum Collection). Several additional laboratory-reared specimens have been donated by Dr. COSTA.

COSTA (in press) reports the presence, in laboratory cultures, of three morphologically distinct types of males. These differ in a variety of ways, including extent of sclerotization, shape of sternitigenital shield (Pl. III ; 27), and length of sternitigenital and dorsal setae. COSTA has postulated that the differences noted may be dependent on the degree of exposure during preimaginal development, with those individuals lacking the protection of an enclosed "brood pill" attaining the highest degree of sclerotization. COSTA recovered several deutonymphs from these brood pills which were weakly sclerotized (appearing white rather than brown) and globular (deutonymphs found on the beetle carrier are nearly as heavily sclerotized as the adults, and are more or less ovoid and flattened). The deu-

tonymphs from the brood pills molted into normal females (Pl. III ; 26), heteromorphic males, and into a third type of male intermediate between the heteromorphic and the so-called "normal" male found attached to beetles in the field. Inasmuch as heteromorphic males have not been found in field collections, it may be assumed that their occurrence is as a result of unusual environmental conditions during preimaginal development which would rarely, if ever, prevail in the field. On the other hand, the occurrence of heteromorphic males in *N. caputmedusae*, even under artificial rearing conditions, indicates that morphologically diverse individuals may also occur in other species of the genus under unusual or abnormal conditions. It is of more than passing interest to note that abnormal female deutonymphs developed into typical females, rather than exhibiting the polymorphism seen in the males. This phenomenon is similar to that seen in other acarids (NESBITT 1945 ; HUGHES 1959) where males of various morphological types are produced, apparently for environmental reasons, but females remain unchanged under all conditions. (Heteromorphic males of the latter types may occur, in varying percentages, in the same brood with "normal" males. This is not the case with heteromorphic males of *N. caputmedusae*, where heteromorphism is total under high stress conditions).

***Neopodocinum emodi* n. sp.**

FEMALE (Pl. IV ; 29-31 : figs. 25-28). Length of idiosoma = 1450  $\mu$  ; width of idiosoma at level of coxae II = 850  $\mu$ . *Dorsal shield* (fig. 28) weakly punctate-reticulate, with considerably more than 28 pairs of setae (lateral portion between  $Mg_2$ - $Mg_6$  with a series of five or six identical extramarginal hairs) ; setae  $M_5$  and  $D_7$  absent,  $D_x$  seta present ; setae  $D_1$  long, stout and distally plumose, as long as setae  $D_2$  and over four times the length of setae  $M_1$  ; setae  $D_5$ ,  $D_9$ ,  $Mg_{10}$ ,  $M_3$ - $M_4$  very short, smooth, remaining dorsal setae pectinate and longer, or absent on available specimen. Dorsal integument strongly striated, with several long distally pectinate setae. *Sternal shield* (Pl. IV ; 29) lightly reticulate, broader than long, and with three pairs of smooth setae and two pairs of pores ; with a pair of elongate presternal sclerites anterior to the anterolateral angles of the sternal shield. *Metasternal shields* appearing fused to the endopodals ; each with a pore and a smooth seta which is shorter and weaker than sternal setae III. *Epigynial shield* weakly reticulate as sternal shield, slightly convex posteriorly and with a pair of posterolateral setae of a length nearly that of sternals III, epigynial pores off the shield ; with more than 20 pairs of perianal setae, of which only the first pair behind the epigynial shield appears to be smooth ; *anal shield* typical for genus. Sclerotized *parapodal* remnant, confined in other known species of the genus to a position posterolaterad of and adjacent to coxa IV (Pl. IV ; 33), greatly expanded, extending anteriorly to a point laterad of the anterior angles of coxa III (Pl. IV ; 30). *Stigmata* laterad of expanded parapodals, between coxae III-IV, and joining the peritremes on their anterolateral aspect ; peritremes each extending anteriorly

and dorsally to a point laterad of setae  $M_1$ . *Tectum* with an expanded membranous base bordered with small subequal spines; hypostomal setae smooth, setae II being over twice the length of setae III; deutosternal setae shorter than setae III; with six rows of small deutosternal teeth, each row averaging 32-38 teeth. *Chelicerae* typical for genus. *Tarsi I* each with a membranous ambulacrum on the ventrodistal aspect; coxae I each with a small rounded "extrusion" on the proximoventral aspect (Pl. IV; 29); legs II little heavier than legs I, tarsus II with the usual complex of heavy spines; genu IV with seven setae;  $ad_{1-2}$  and  $pd_{1-2}$  short and smooth,  $av_1$  long, also smooth, setae  $al_1$  and  $pl_1$  not seen. Setae  $ad_2$  and  $pd_2$  of tarsus IV smooth;  $ad_2$  longer than  $pd_2$  but only long enough to barely surpass the median tarsal pore (fig. 25).

MALE.

Unknown.

HABITAT and LOCALITY.

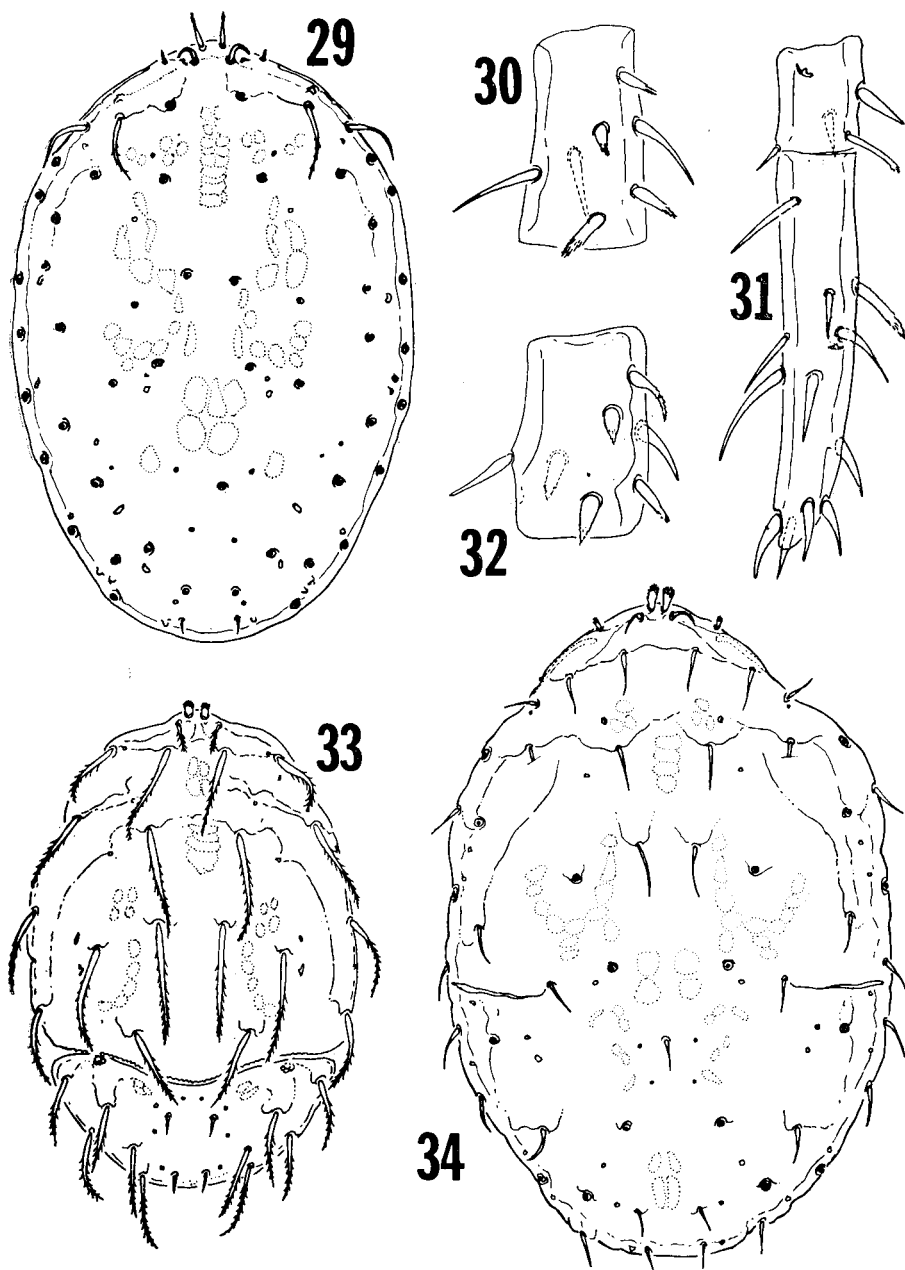
A single female with the following data: Nepal, Nangoon; 14, 100' elevation; Oct. 7, 1960; ex venter of *Geotrupes* sp.; L. SWAN, coll. The holotype female will be deposited in the collection of the U. S. National Museum, Washington, D. C.

*N. emodi* is of particular interest in that it was collected at a high altitude in an area which is distinctly non-tropical. It can be assumed, therefore, that the genus may be expected to be found in other temperate localities as well, the only restriction to distribution being the limitations of the beetle "hosts".

The species which is described below appears to be closely related to *emodi* and, in fact, was collected in the same portion of Asia, from a beetle of the same genus as that associated with *N. emodi* (*Geotrupes*).

***Neopodocinum emodioides* n. sp.**

FEMALE (Pl. IV; 32, 33: figs. 29-31). Length of idiosoma = 1450  $\mu$ ; width of idiosoma = 860  $\mu$ . *Dorsal shield* punctate, weakly reticulate, apparently with 29 pairs of setae (most of the setae of the only available female specimen are missing):  $D_1$  long, similar to that of *emodi* (figs. 28, 29);  $M_1$  short, smooth;  $M_g$  setae inserted on sclerotized peripheral "shelf" of dorsal shield, without adjacent extra-marginal setae; insertion for setae  $D_x$  present,  $D_7$  and  $M_g$  absent. *Sternal shield* (Pl. IV; 32) punctate, somewhat narrowed medially, and with well-developed lateral portions of l. m. t. and l. o. a.; sternal setae long and smooth, attaining the insertions of the setae behind them. Metasternal shields oblong, adjacent to endopodals; each with a pore, and a smooth seta equal in length to the sternals. *Epigynial shield* punctate, convex posteriorly, and with a pair of long smooth posterolateral setae; epigynial pores off the shield. With somewhat more than 20 pairs of perianal setae, of which most of the pre- and adanals are smooth; others distally pecti-



FIGS. 29-31. — *Neopodocinum emodioides* n. sp.

Fig. 29. — Dorsum of female ; Fig. 30. — Genu IV of female ; Fig. 31. — Tarsus IV of female.

FIGS. 32-34. — *Neopodocinum jaspersi* (Oudemans).

Fig. 32. — Genu IV of female ; Fig. 33. — Dorsum of protonymph ;

Fig. 34. — Dorsum of deutonymph.

nate; *anal shield* typical for genus. Sclerotized parapodal shields each confined to strip adjacent to the posterolateral aspect of coxae IV. *Peritremes* joining stigmata at their anterolateral angles, each extending anteriorly and dorsally to a point well laterad of setae  $M_1$ . *Tectum* with pyramidal base, bordered by large subequal spines; hypostomal setae smooth, setae II being three times the length of setae III; deutosternal setae approximately equal in length to setae III; with five rows of small deutosternal teeth. *Chelicerae* typical for genus; internal brush over half the length of the digitus mobilis. *Tarsi I* each with a well-developed ventrodiscal membranous ambulacrum; legs II little stronger than legs I, with the usual strong spines on tarsus II; genu IV with seven setae, of which  $ad_{1-2}$  and  $pd_{1-2}$  are short and distally plumose; others long and smooth (fig. 30); seta  $ad_2$  of tarsus IV distally pectinate, equal in length to  $al_2$ ;  $pd_2$  short and nearly smooth distally (fig. 31).

#### MALE.

Unknown.

DEUTONYMPH. Length of idiosoma =  $920\ \mu$ ; width of idiosoma at level of coxae II =  $610\ \mu$ . *Dorsal shield* without distinct lateral incisions, uniformly punctate and with 29 pairs of setae, plus an unpaired seta  $D_x$ ; setae  $D_1$  well separated, long and stout, and distally divided, somewhat longer than the distally pectinate  $M_1$ ;  $D_2$ - $D_3$ ,  $M_2$ ,  $L_1$ - $L_4$ , and  $Mg_{1-9}$  lightly or distinctly pectinate distally, of a length equal to or greater than the distances between their insertions; dorso-central and posterior lateral setae shorter, smooth;  $D_x$  present,  $D_7$  and  $M_5$  absent. *Sternal shield* punctate, concave anteriorly and narrowed posteriorly, and with distinct lateral portions of l. m. t.; with four pairs of smooth sternal setae, of which setae IV appear to be longest. With more than 20 pairs of long perianal setae, of which only some of the more posterior are pectinate; anal shield elongate. *Peritreme* joins the stigma anterolaterally, curves mediad and continues anterior and dorsal to a point anterior to seta  $M_2$ . *Gnathosoma* generally similar to that of female. *Tarsi I* with a pair of claws and with ambulacra; tarsi II-IV also with claws and ambulacra; terminal spines on tarsi II acuminate, leg II little heavier than leg I; seta  $ad_2$  of tarsus IV stout, plumose distally, and longer than seta  $pd_2$  as in female (fig. 31).

#### HABITAT and LOCALITY.

One female and one deutonymph from Tibet (1500 m. elev.); 1923; ex *Geotrupes genestieri* Bouc. (U. S. National Museum Collection). The holotype female and paratype deutonymph will be deposited in the collection of the U. S. National Museum, Washington, D. C.

*Neopodocinum jaspersi* (Oudemans).

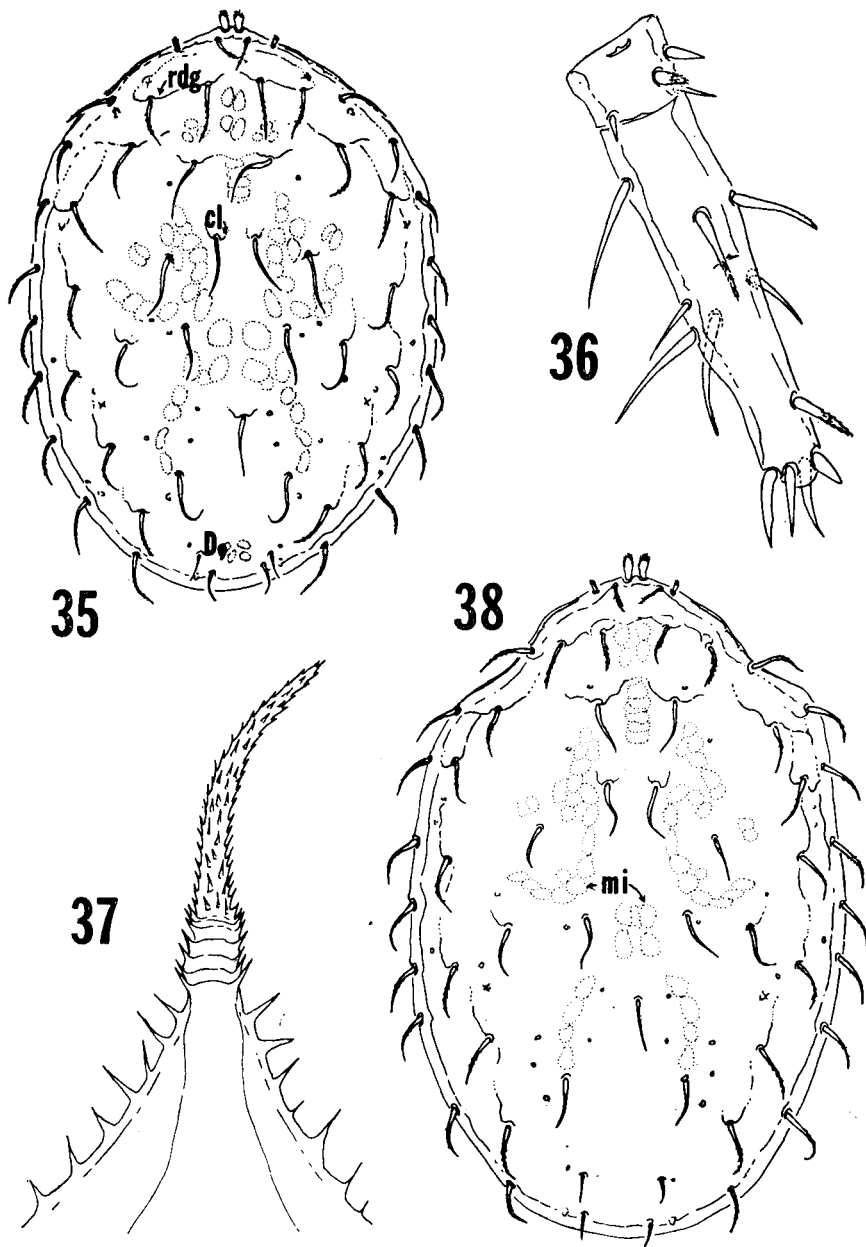
*Laelaps jaspersi* OUDEMANS, A. C. (1900). *Tijdschr. v. Ent.* 43 : 72.

*Neopodocinum jaspersi*, OUDEMANS, A. C. (1903). *Tijdschr. v. Ent.* 45 : 25 ; OUDEMANS, A. C. (1904). *Tijdschr. v. Ent.* 47 : 119 ; BERLESE, A. (1911). *Redia* 7 : 431 ; BERLESE, A. (1917). *Redia* 12 : 153 ; VITZTHUM, H. G. (1926). *Treubia* 8 : 41 ; KRANTZ, G. W. (1962). *Acarologia* 4 : 159 ; MICHERDZINSKI, W. (1964). *Acarologia* 6 : 239.

*N. jaspersi*, the type species for the genus *Neopodocinum*, has been figured by OUDEMANS (1903) as having short dorsal setae and a paired  $D_x$ . Specimens subsequently identified as *jaspersi* possess somewhat longer setae on the dorsal shield (fig. 35) and an unpaired  $D_x$ . Twelve collections in the Berlese Collection in Florence contain males, females and nymphs of a species identified by BERLESE as *N. jaspersi*. These were collected in Java and "Asia" on *Copris molossus* L. The writer has identified a series of specimens of *N. jaspersi* through comparisons with BERLESE's examples, the latter being as illustrated earlier by KRANTZ (1962). Two specimens from Java (a male and a female) show a strong resemblance to *jaspersi*, both morphological and habitual (both were collected from species of *Helio-copris*), but are being described herein as separate species on the basis of dorsal setal and sternal characters. A more complete series of *jaspersi* may conceivably include both forms, but a conspecific treatment is not considered advisable at this time.

The following description of *N. jaspersi* emends and enlarges that presented earlier by Oudemans.

FEMALE (Pl. IV ; 36 : Pl. V ; 39 : figs. 32, 35, 36). Length of idiosoma averages 1273  $\mu$ , with a range of 1220-1330  $\mu$  ; width of idiosoma at level of coxae II averages 827  $\mu$ , with a range of 780-850  $\mu$ . *Dorsal shield* (fig. 35) punctate-reticulate, with lateral ridges and short cuticular "flaps" over most of the setal insertions ; with 28 pairs of dorsal setae, none of which is long enough to surpass the setal insertion behind it ; setae  $D_2$ - $D_3$ ,  $M_2$ , and  $L_2$ - $L_6$  distinctly pectinate ;  $Mg$  setae may or may not be weakly pectinate ;  $D_1$  and  $M_1$  broad, rounded and plumose distally, with  $D_1$  being twice the length and breadth of  $M_1$  ;  $D_7$  absent, unpaired  $D_x$  present ;  $Mg_3$  pectinate, inserted slightly posterior or in a line with  $Mg_2$ . *Sternal shield* (Pl. IV ; 36 narrowed medially, punctate, with well-developed l. o. a. ; lateral portions of l. m. t. extend medially to a point mediad of the insertions of sternal setae I ; with three pairs of smooth sternal setae and two pairs of pores ; metasternal setae equal in length to sternals, on distinct metasternal shields. *Epigynial shield* unornamented, uniformly punctate ; with a pair of smooth posterolateral setae and a pair of pores posterior to the epigynial setal insertions. With more than 50 pairs of perianal setae inserted in the heavily striated integument laterad of and posterior to the anal shield ; setae both smooth and plumose, with many of the plumose hairs being somewhat broadened medially (Pl. IV ; 36). *Anal shield* typical for genus.



FIGS. 35-38. — *Neopodocinum jaspersi* (Oudemans).

Fig. 35. — Dorsum of female (rdg = ridge ; cl = cleft) ; Fig. 36. — Tarsus IV of female ;  
Fig. 37. — Tectum ; Fig. 38. — Dorsum of male (mi = muscle insertion).

*Peritremes* join stigmata posteriorly at a point laterad of coxae III-IV, each loops anterolaterally and continues anteriorly and dorsally to a point laterad of seta  $M_1$ . *Tectum* (fig. 37) and palpi typical for genus; proximal claw of palpal tined claw well-developed. *Chelicera* (Pl. V; 39) with an external brush as long as the movable digit itself. Hypostomal setae smooth; setae II approximately three times the length of setae III; deutosternal setae equal to setae III in length. With five rows of deutosternal teeth, each row containing from 13-25 teeth. *Tarsi I* without claws or ambulacra; tarsi II-IV with both ambulacra and claws; leg II considerably heavier than leg I. Genu IV with seven short setae;  $al_1$  and  $pl_1$  smooth,  $ad_2$  distally narrowed and plumose (fig. 32). Setae  $ad_2$  and  $pd_2$  of tarsus IV subequal, neither being long enough to attain the distal setal complex;  $pd_2$  plumose throughout most of its length;  $ad_2$  distally plumose; seta  $ad_3$  of pretarsus IV smooth, seta  $md$  plumose distally (fig. 36).

MALE (Pl. IV; 37: Pl. V; 38: fig. 38). Length of idiosoma averages 1245  $\mu$ , with a range of 1110-1380  $\mu$ ; width of idiosoma at level of coxae II averages 755  $\mu$  with a range of 700-810  $\mu$ . *Dorsal shield* with 28 pairs of setae which are similar to those of the female, with various anterior setae appearing shorter than in the female (fig. 38);  $L_1$  distinctly pectinate. *Sternitigenital shield* (Pl. IV; 37) with l. o. a. and strongly developed l. m. t., punctate throughout and with five pairs of smooth setae; setae IV-V distinctly longer than setae I-III. With more than 40 pairs of setae inserted in the strongly striated integument behind the sternitigenital shield, many of which are long and smooth, or distally pectinate. *Stigmata* and peritremes as in female. *Tectum*, hypostome and palpi similar to those of female. *Chelicera* (Pl. V; 38) with a short slightly hooked spermatophore transfer organ on the medial portion of the digitus mobilis; external cheliceral brush as long as the digit. Legs similar to those of female, except that femur, genu and tibia II, and tarsus IV, each have a medioventral protuberance or spur, the protuberance on femur II being quite large.

DEUTONYMPH (Pl. IV; 35: fig. 34). Length of idiosoma averages 870  $\mu$ , with a range of 830-890  $\mu$ ; width of idiosoma at level of coxae II averages 564  $\mu$ , with a range of 540-580  $\mu$ . *Dorsal shield* (fig. 34) unusual in that lateral incisions of the type ordinarily found on deutonymphal dorsal shields (fig. 16) are not present; instead, with a pair of narrow lateral unsclerotized slits within the dorsal shield, at the normal position of lateral incisions; with 28 pairs of dorsal setae, of which  $D_1$  and  $M_1$  are broad and plumose as in adult, and the remainder apparently are smooth (setae  $D_6$ ,  $D_8$ ,  $M_3$ ,  $L_2$ ,  $L_4$ ,  $L_6$ ,  $Mg_1$ ,  $Mg_{3-4}$ , and  $Mg_8$  absent on available specimens). *Sternal shield* (Pl. IV; 35) peltate, lightly reticulate, with four pairs of smooth setae, the fourth pair being longest. With approximately 40 pairs of perianal setae, many of which are broadened medially and pectinate; others smooth; anal shield typical. *Stigmata* join peritremes laterally rather than posteriorly and form only a strong curve as they turn anteriorly; peritremes each



extend dorsally to a point posterior to setae  $M_1$ . *Gnathosoma* similar to that of later stages; salivary styli often curved medially. *Legs* similar to those of female.

**PROTONYMPH** (Pl. IV; 34: fig. 33). Length of idiosoma averages  $535\ \mu$ , with a range of  $500\text{--}570\ \mu$ ; width of idiosoma at coxae II averages  $335\ \mu$ , with a range of  $330\text{--}340\ \mu$ . *Dorsal shield* (fig. 33) with strong anterior transverse and lateral ridges; divided behind setae  $D_6$ , the posterior edge of the pronotal shield being strongly serrate; pronotal shield with eleven pairs of setae, of which all but setae  $D_1\text{--}D_2$  are extremely long, broad and heavily pectinate;  $D_1$  short and plumose as in succeeding stages,  $D_2$  pectinate and considerably shorter than  $D_3$ ;  $M_1$  absent. Posterior dorsal shield with eight pairs of setae, of which  $D_8\text{--}D_9$  are short and smooth; remaining setae long and pectinate as on anterior shield; setae  $D_7$  and  $D_x$  absent. *Sternal shield* heart-shaped, weakly reticulate and with three pairs of smooth setae, none of which are long enough to attain the insertions of the setae behind them; integument behind sternal shield with less than 15 pairs of smooth and pectinate setae, most of which are quite long (Pl. IV; 34); *anal shield* typical for genus. *Stigmata* between coxae III-IV; peritremes join stigmata laterally, curve anteromediad, and terminate near the points of origin. *Gnathosoma* similar to that of female except that the palp trochanter-genu-tibia setal formula is 1-4-5, rather than 2-5-6 as in later stages. *Chelicerae* well-developed. *Tarsus I* without claws; genu IV with only five setae; various tarsal setae also may be lacking.

#### LARVA.

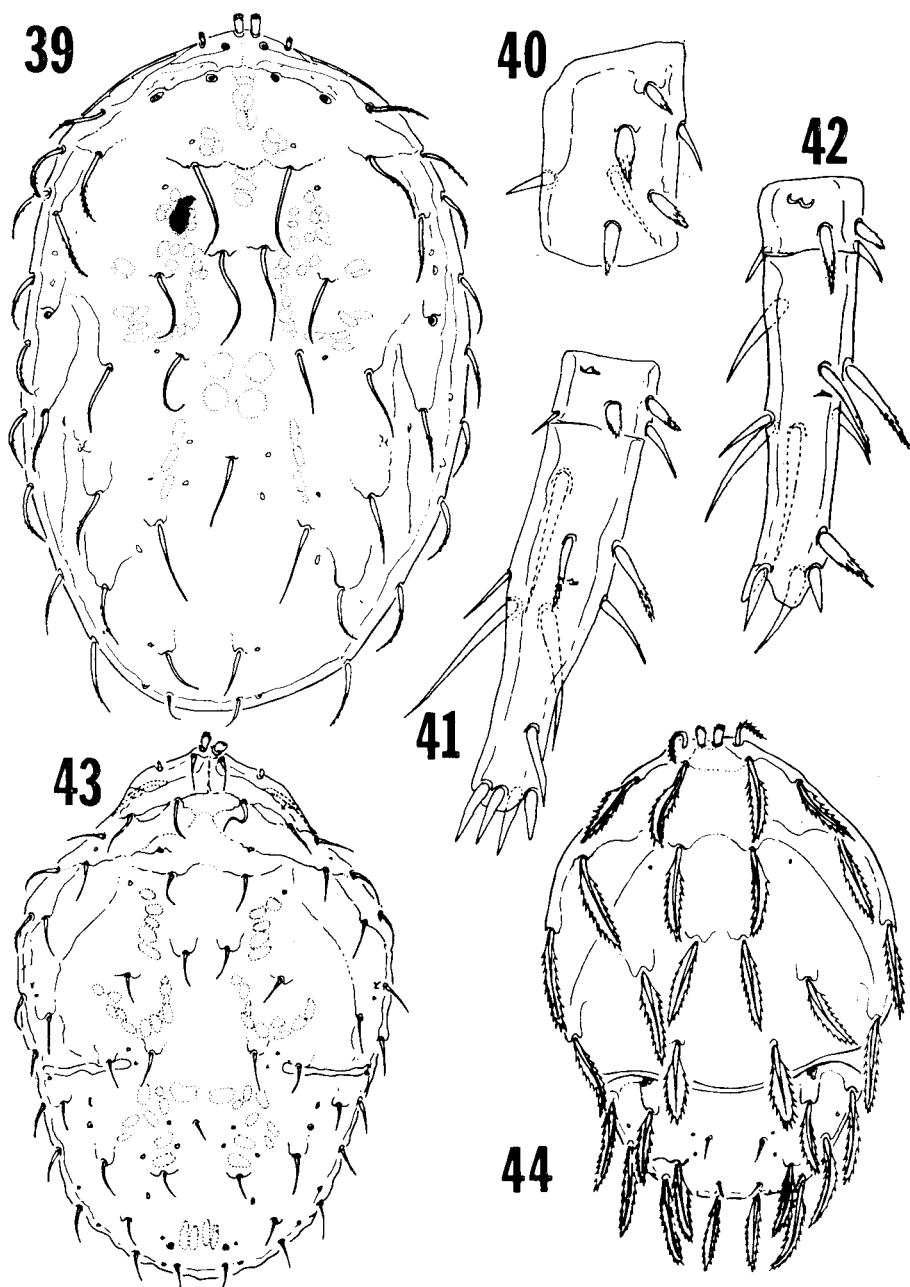
Unknown.

#### HABITAT and LOCALITY.

Five females, two males, six deutonymphs and two protonymphs from Jabalpur, Central India (1600' elev.); September, 1957; ex *Heliocopriss* sp.; P. NATHAN, coll. The holotype of *N. jaspersi* was, as mentioned in the introduction, collected in Amsterdam. Berlese's collections are from "Asia" and "Giava" (12 collections) on *Copris molossus*.

#### ***Neopodocinum javensis* n. sp.**

**FEMALE** (Pl. V; 40: figs. 39-41). Length of idiosoma =  $1400\ \mu$ ; width of idiosoma at level of coxae II =  $850\ \mu$ . *Dorsal shield* (fig. 39) punctate-reticulate, similar to that of *N. jaspersi*, except for dorsal setal length; setae  $D_4$  attain or surpass the insertions of setae  $D_5$ ; setae  $D_1$  and  $M_1$  short, broad and plumose as in *jaspersi*;  $Mg_3$  long enough to attain the insertion of  $Mg_4$ ;  $D_x$  present; setae  $D_2\text{--}D_3$ ,  $M_2$  and  $L_3$  not seen. *Sternal shield* (Pl. V; 40) punctate, weakly reticulate centrally, and with well-developed l. m. t. and l. o. a.; lateral elements of line l. m. t. extending medially so that they virtually meet, with a sclerotized band surrounding



FIGS. 39-41. — *Neopodocinum javensis* n. sp.

Fig. 39. — Dorsum of female; Fig. 40. — Genu IV of female;

Fig. 41. — Tarsus IV of female.

FIGS. 42-44. — *Neopodocinum magna* n. sp.

Fig. 42. — Tarsus IV of female; Fig. 43. — Dorsum of deutonymph;

Fig. 44. — Dorsum of protonymph.

line l. m. t. ; sternal setae smooth. *Metasternal shields* oblong, adjacent to endopods, and each with a strong smooth seta and a pore. *Epigynial shield* with a loose, even punctate pattern rather than the solid pattern seen in *jaspersi* ; with a pair of posterolateral setae and a pair of more posterior pores. With more than 50 pairs of perianal setae, most of which are pectinate ; with several setae which are greatly broadened basally (Pl. V ; 40) ; anal shield uniformly punctate, typical for genus. *Peritremes* and stigmata similar to those of *jaspersi*. *Gnathosoma* similar to that of *N. jaspersi* (fig. 1) except that *N. javensis* has only four rows of deutosternal teeth on the hypostome, instead of five as in *jaspersi* ; with a few disassociated teeth between rows I-II ; with an average of 20-26 teeth per row. *Tarsi I* without claws or ambulacra ; genu IV with seven setae, of which  $av_1$  is long and smooth (fig. 40) ; setae  $ad_2$  and  $pd_2$  of tarsus IV as in *jaspersi*, except that  $ad_2$  is more strongly plumose (fig. 41) ; seta  $md$  smooth ; seta  $ad_3$  of pretarsus IV distally plumose.

MALE (Pl. V ; 41). Length of idiosoma =  $1350\ \mu$  ; width of idiosoma at level of coxae II =  $850\ \mu$ . *Dorsal shield* similar to that of female. *Sternitigenital shield* (Pl. V ; 41) with well-developed l. o. a. ; l. m. t. portions not meeting medially ; posterior portion of shield with a loose punctate pattern as seen in female ; with five pairs of smooth sternitigenital setae. With at least 40 pairs of smooth and pectinate perianal setae, many of which are greatly broadened basally ; anal shield typical for genus. *Peritremes* and stigmata similar to those of female. *Gnathosoma* similar to that of the male of *N. jaspersi*, except that *N. javensis* possesses only four rows of deutosternal teeth (20-28 teeth/row). *Chelicerae* and legs essentially as in *N. jaspersi* ; with a medioventral spur just anterior to  $pv_2$  ; seta  $pd_2$  strongly pectinate throughout its length, rather than being distally ornamented as in female ; seta  $md$  plumose.

#### IMMATURE STAGES.

Unknown.

#### HABITAT and LOCALITY.

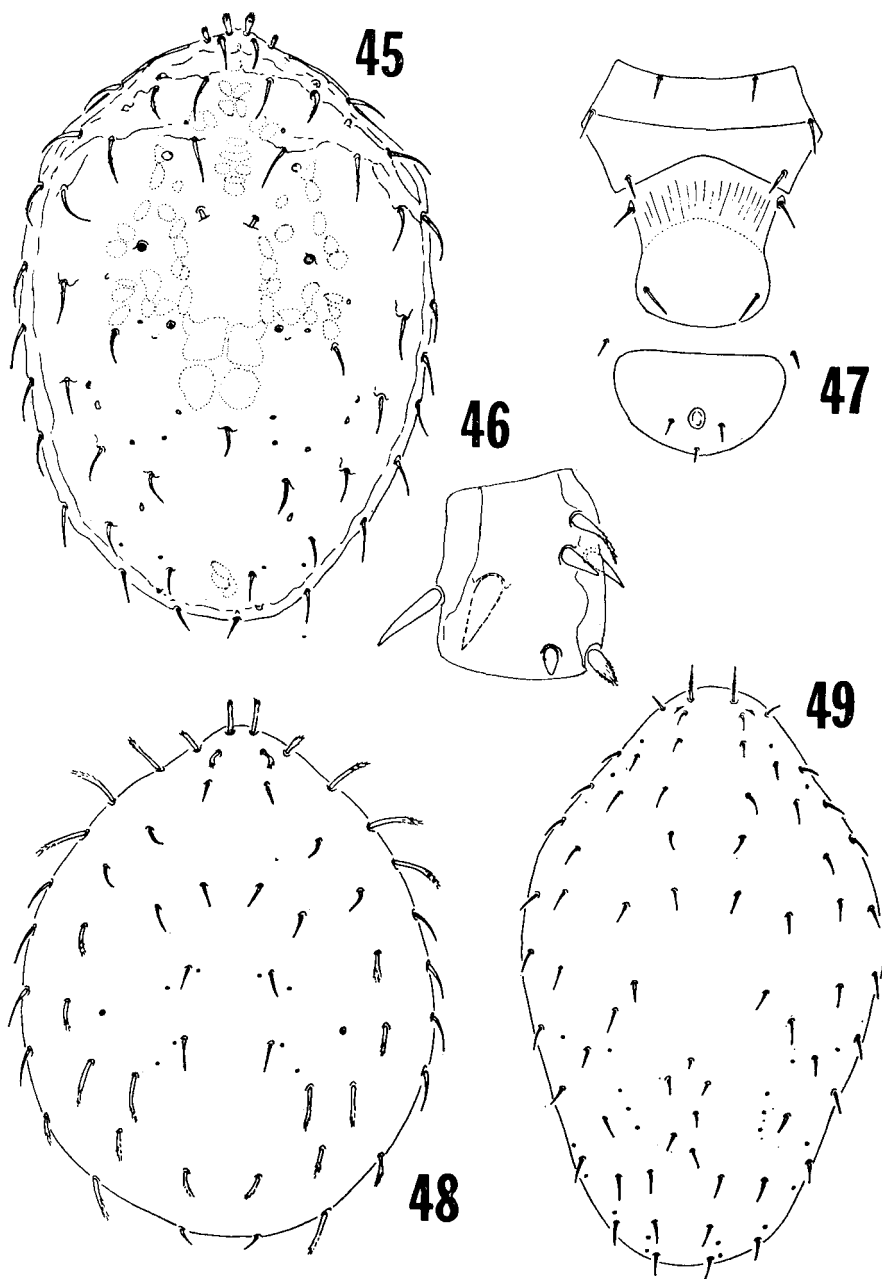
One female and one male from Buitenzorg, Java ; 1909 ; ex *Heliocopris bucephalus* Fabr. ; BRYANT and PALMER, coll. The holotype female and allotype male will be deposited in the collection of the U. S. National Museum, Washington D. C.

#### ***Neopodocinum magna* n. sp.**

FEMALE (Pl. V ; 43-45, 47 : figs. 42, 45, 46). Length of idiosoma averages  $1562\ \mu$ , with a range of  $1500-1650\ \mu$  ; width of idiosoma at level of coxae II =  $1024\ \mu$ , with a range of  $870-1160\ \mu$ . *Dorsal shield* (fig. 45) strongly punctate, with anterior ridges and clefts around setal insertions ; with 28 pairs of setae and an unpaired

seta  $D_x$ , of which all but setae  $D_1$  and  $M_1$  are smooth, or nearly so ( $L_2$ ,  $M_2$ );  $D_1$  and  $M_1$  short, broad and plumose, other dorsal setae longer but none is long enough to attain the insertion of the seta behind it. *Sternal shield* (Pl. V; 44) punctate, weakly reticulate medially, and with strong l. o. a. and lateral portions of l. m. t.; sternal setae smooth. *Metasternal shields* each with a smooth seta and an anterior pore. *Epigynial shield* (Pl. V; 43) typically truncate posteriorly, with a loose punctate pattern; posterolateral corners each with a smooth seta and a more posteromedial pore; often with a series of four narrow platelets behind the shield. *Anal shield* (Pl. V; 43) expanded laterally to form a scutellate "ventrianal" shield on which a single pair of anterolateral preanal setae is inserted; anal portion of shield with a demarcating suture or groove, with the usual three setae; entire shield ornamented with a strong punctate-reticulate pattern which is unlike that found on the sternal or epigynial shields; with approximately 20 pairs of smooth or lightly pectinate setae inserted in the integument laterad of, and posterior to, the ventrianal shield. *Stigmata* between coxae III-IV; peritreme joining stigma posterolaterally and looping anteriorly; peritremes each extend dorsally to a point just laterad of seta  $M_1$ . *Tectum* and palpi typical for genus; hypostomal setae II approximately  $2\frac{1}{2}$  times the length of setae III; deutosternal setae subequal to setae III in length; with five rows of deutosternal teeth, averaging 25-30 teeth/row. *Digitus mobilis* of *chelicera* (Pl. V; 45) with a distinctly grooved medial tooth; internal cheliceral brush not quite extending as far as the distal end of the digit. *Legs* II considerably heavier than legs I, approximately equal in length; tarsi I without claws or ambulacra, tarsi II-IV with both ambulacra and claws; genu IV (fig. 46) with seven broad setae of which only  $ad_{1-2}$  are distinctly plumose; setae  $ad_2$  and  $pd_2$  of tarsus IV subequal, pectinate, neither being long enough to attain the distal setal complex; seta  $md$  distally plumose (fig. 42).

MALE (Pl. V; 42, 46). Length of idiosoma averages  $1466\ \mu$ , with a range of  $1400$ - $1600\ \mu$ ; width of idiosoma at level of coxae II averages  $1000\ \mu$ , with a range of  $950$ - $1050\ \mu$ . *Dorsal shield* essentially the same as in female (fig. 45). *Sternitigenital shield* (Pl. V; 42) uniformly punctate, with strong lateral portions of l. m. t. which tend to arch anteriorly; with five pairs of smooth sternal setae, of which setae IV appear to be the longest. With at least 20 pairs of perianal setae, all of which appear to be lightly pectinate; anal shield with reticulate pattern similar to that of female, but without lateral expansion; occasionally with a pair of small platelets anterolaterad of anal shield, as well as pair of weak postepigynial sclerites (Pl. V; 46). *Peritremes* and *stigmata* as in female. *Gnathosoma* also similar to that of the female except for the presence, on the *digitus mobilis* of the *chelicera*, of a distally notched spermatophore transfer organ. *Tarsi* I without claws or ambulacra; femur, genu and tibia II each with a medioventral spur, the femoral spur being distally hooked and larger than the others; tarsus IV with a distinct medioventral spur just anterior to seta  $pv_2$ ; seta  $md$  considerably longer than in female; genu IV with seven setae; setae  $ad_2$  and  $pd_2$  subequal, distinctly pectinate.



FIGS. 45-46. — *Neopodocinum magna* n. sp.

Fig. 45. — Dorsum of female ; Fig. 46. — Genu IV of female.

FIGS. 47-48. — *Neopodocinum maius* Berlese.

Fig. 47. — Sternal, epigynial and anal shields of female (after Vitzthum 1926) ;

Fig. 48. — Dorsum of female (after Vitzthum 1926).

FIG. 49. — *Neopodocinum meridionalis* (Sellnick).

Dorsum of deutonymph (after Götz and Hirschmann 1957).

DEUTONYMPH (fig. 43). Length of idiosoma averages 958  $\mu$ , with a range of 860-1000  $\mu$ ; width of idiosoma at level of coxae II averages 686  $\mu$ , with a range of 620-710  $\mu$ . *Dorsal shield* (fig. 43) without typical lateral incisions behind  $Mg_5$ ; with at most a pair of grooves which terminate before the edge of the shield is reached; with anterior transverse ridges and setal clefts; with 28 pairs of setae and an unpaired  $D_x$ , of which all but setae  $D_1$  and  $M_1$  appear smooth and of a length similar to that of the adults. *Sternal shield* short and broad, distinctly reticulate and with four pairs of smooth setae. With over 15 pairs of long pectinate perianal setae; anal shield punctate, typical for genus. *Stigmata* between coxae III-IV; peritremes join stigmata laterally, curve anteromedially and continue laterally and dorsally, terminating posterior to setae  $M_1$ . *Gnathosoma* similar to that of female, as are legs.

PROTONYMPH (fig. 44). Length of idiosoma averages 596  $\mu$ , with a range of 590-600  $\mu$ ; width of idiosoma at coxae II averages 483  $\mu$ , with a range of 470-500  $\mu$ . *Dorsal shield* (fig. 44) divided behind setae  $D_6$ , both portions strongly ornamented with ridges and punctations; anterior shield with eleven pairs of setae, of which all but setae  $D_1$  and  $D_2$  are long, broad and strongly pectinate;  $D_1$  short, broad and plumose;  $D_2$  over twice as long as  $D_1$ , narrow and pectinate. Posterior shield with eight pairs of setae, of which all but setae  $D_8$  and  $D_9$  are long, broad and pectinate; setae  $D_8$ - $D_9$  short and smooth, setae  $D_x$  and  $D_7$  absent. Integument bordering dorsal shields with a series of very long setae, most of which are smooth or nearly so. *Sternal shield* reticulate, broad, concave anteriorly and somewhat produced posteriorly; with three pairs of smooth setae. Perianal setae posterior to elongate anal shield are strongly pectinate; more anterior perianal setae smooth. *Stigmata* between coxae III-IV; peritremes each join stigmata laterally, curve anteriorly and terminate near the point of origin. Palpal trochanter, genu and tibia with typical 1-4-5 setal formula. Tarsi I without claws or ambulacra; genu IV with five setae.

#### LARVA.

Unknown.

#### HABITAT and LOCALITY.

A total of nine collections from the Central African Museum, with data as follows: two females, one male, two deutonymphs and a protonymph from Bambesa, Central Africa; July, 1938; ex *Heliocopris haroldi* Kol.; J. VRYDAGH (Coll. No. 118074): four females and a deutonymph from Bambesa; September, 1937; ex *Heliocopris haroldi*; J. VRYDAGH, coll. (Coll. No. 118107): one female, one male and a deutonymph from Territory of Gemena (Karewa), Central Africa; 5 December, 1938; ex *Heliocopris haroldi*; LEONTOVITCH, coll. (Coll. No. 118063): one male and one female from Kalina; 25 December, 1933; ex *Heliocopris* sp.; A. FINANT, coll. (Coll. No. 71161-71170): one female from Elisabethville, Congo; ex *Heliocopris haroldi*; Dr. BEQUAERT, coll. (Coll. No. 118785): one female and

one deutonymph from Bambesa ; 3 June, 1938 ; ex *Heliocopris haroldi* ; J. VRYDAGH, coll. (Coll. No. 118067) : one male from Bambesa ; October, 1937 ; ex *Heliocopris haroldi* ; J. VRYDAGH, coll. (Coll. No. 118795) : one female from Barumbu ; January, 1921 ; ex *Heliocopris haroldi* ; L. GHESQUIERE, coll. (Coll. No. 118775) : one female from Bambesa ; 11 October, 1937 ; ex *Onitis artuosus* Gillet (synonym of *O. vethi* Lansb.) ; J. VRYDAGH, coll. (Coll. No. 116727). An additional two collections from the Congo were made from the scarab collection at the Chicago Natural History Museum, one being a protonymph from *Onitis monstrosus* Felsche, and the other from *Heliocopris haroldi*. The holotype female, allotype male, and deutonymph and protonymph specimens will be deposited in the collection of the U. S. National Museum, Washington, D. C. Paratypes will be deposited in the collections of Oregon State University, Corvallis, Oregon, Central African Museum, Tervuren, Belgium, Chicago Natural History Museum, Chicago, Illinois, British Museum (Natural History), London, and the Zoological Museum, Lenin-grad, U.S.S.R.

*Neopodocinum maius* Berlese.

*Neopodocinum maius* BERLESE, A. (1911). *Redia* 7 : 431.

*Neopodocinum coprophilum* VITZTHUM, H. G. (1926). *Treubia* 8 : 40 ; VITZTHUM, H. G. (1925). *Suppl. Ent.* 11 : 20. (? *New synonymy*)<sup>1</sup>.

The holotype of *N. maius* (slide 132/45, Berlese Collection, Florence) is a male specimen from Sumatra, the female and immature stages having been unknown. Examination of the holotype male was hindered by the poor condition of the slide. Dorsal setation is obscure, as are most of the gnathosomal and ventral structures. However, one interesting feature was noted ; the anal shield is considerably wider than long, appearing subtriangular. VITZTHUM (1926) described the female and two nymphal stages of *N. coprophilum* from a *Heliocopris* sp. collected in Sumatra. The female is noteworthy in that the anal shield is expanded laterally, giving the shield a subtriangular appearance. On the basis of this unusual modification in both the male of *N. maius* and in the female of *N. coprophilum*, and on the identical geographical habitat of both collections (Sumatra), the author has tentatively placed *N. coprophilum* into synonymy with *N. maius*. A tentative synonymy is preferable at this point, inasmuch as the male and female have not yet been recorded from the same collection. It should be remembered that, although the female of *N. magna* n. sp. has a laterally expanded anal shield (Pl. V ; 43), the male does not. Thus it cannot be said with certainty that the basis of the above synonymy is an altogether valid one<sup>2</sup>.

1. VITZTHUM (1925) cited *N. coprophilum* as having been described in 1924 (*Treubia* 6) rather than in 1926 (*Treubia* 8), presumably because of an unanticipated delay in publication of the original description.

2. VITZTHUM (1925) discussed a unique male specimen collected from *Catharsius molossus* (? Sumatra) which he believed to be *N. coprophilum*. The present author cannot concur in this opinion.

The author has not seen females or immature forms of *maius*. The following brief descriptions are derived from VITZTHUM (1926).

FEMALE (figs. 47-48). Length of idiosoma averages 1735-1755  $\mu$ , with the greatest width averaging 1450-1515  $\mu$ . *Dorsal shield* (fig. 48) smooth, with at least 28 pairs of setae, none of which is long enough to surpass the insertions of the setae behind it;  $D_1$  plumose distally, as are  $M_1$  and  $D_2$ ;  $L_1$ ,  $L_3$ - $L_6$ ,  $M_5$  ( $D_8$  ?),  $Mg_{1-2}$ ,  $Mg_8$ - $Mg_9$  distally plumose; others appearing smooth; setae  $D_7$  apparently present,  $D_x$  absent (neither  $M_2$  nor  $D_4$  were included in VITZTHUM's drawing, but are assumed to be present). *Sternal shield* (fig. 47) somewhat broader than long, with complete l. m. t. and three pairs of smooth setae. *Metasternal shields* each with a seta (pore ?); *epigynial shield* with a pair of smooth setae. *Anal shield* expanded laterally, subtriangular, without preanal setae; perianal setae pectinate or smooth. *Stigmata* between coxae III-IV; peritreme apparently joining stigma anteriorly and continuing laterally and, presumably, dorsally. *Gnathosoma* without clear-cut specific characters; more or less typical for family. *Legs* II broader than legs I; tarsus I without ambulacra or claws.

MALE. Length of idiosoma = 2020  $\mu$  (1900  $\mu$ , according to BERLESE's description); width of idiosoma = 1600  $\mu$  (1550  $\mu$  in BERLESE's description). The description of the male in the original account (BERLESE 1911) is vague and non-specific, nor is there an illustration of the holotype. As mentioned earlier, the holotype slide is inadequate for formulation of a comprehensive description. The form of the anal shield must be considered definitive for the present time.

DEUTONYMPH. Length of idiosoma averages 1240-1280  $\mu$ ; greatest width averages 930-965  $\mu$ . According to VITZTHUM, the *dorsal shield* is without lateral incisions such as commonly found in this stage; dorsal shield setae  $L_6$  are considerably longer than in the adult; setae  $D_7$  present,  $D_x$  absent. *Sternal shield* elongate, strongly reticulate and with four pairs of smooth setae. *Anal shield* rounded, not expanded as in adults; with at least 20 pairs of perianal setae. *Stigmata* and peritremes as in female. *Gnathosoma* typical for genus; *legs* as in female.

PROTONYMPH. Length of idiosoma = 1060  $\mu$ ; greatest width = 680  $\mu$ . *Dorsal shield* divided behind setae  $D_6$ ; pronotal shield with eleven pairs of short narrow setae (setae  $D_2$  are not in the original description but are assumed to be present); posterior shield with eight pairs;  $D_7$  and  $D_x$  absent. *Sternal shield* peltate, with three pairs of short smooth setae; perianal setae sparse; anal shield oblong. *Stigmata* between coxae III-IV; peritremes very short. *Gnathosoma* indistinct. *Tarsi* I without claws or ambulacra.

LARVA.

Unknown.



#### HABITAT and LOCALITY.

One protonymph from Tandjoeng Karang, South Sumatra ; 9 November, 1921 ; ex *Copris*-like beetle ; Dr. KARNY, coll. ; one male from Sumatra ; A. FAHRENHOLZ, coll. ; females and deutonymphs from Toba-Sea, Sumatra ; 22 March 1922 ; ex *Heliocopris* sp. ; Dr. DAMMERMAN, coll.

#### *Neopodocinum meridionalis* (Sellnick) new combination.

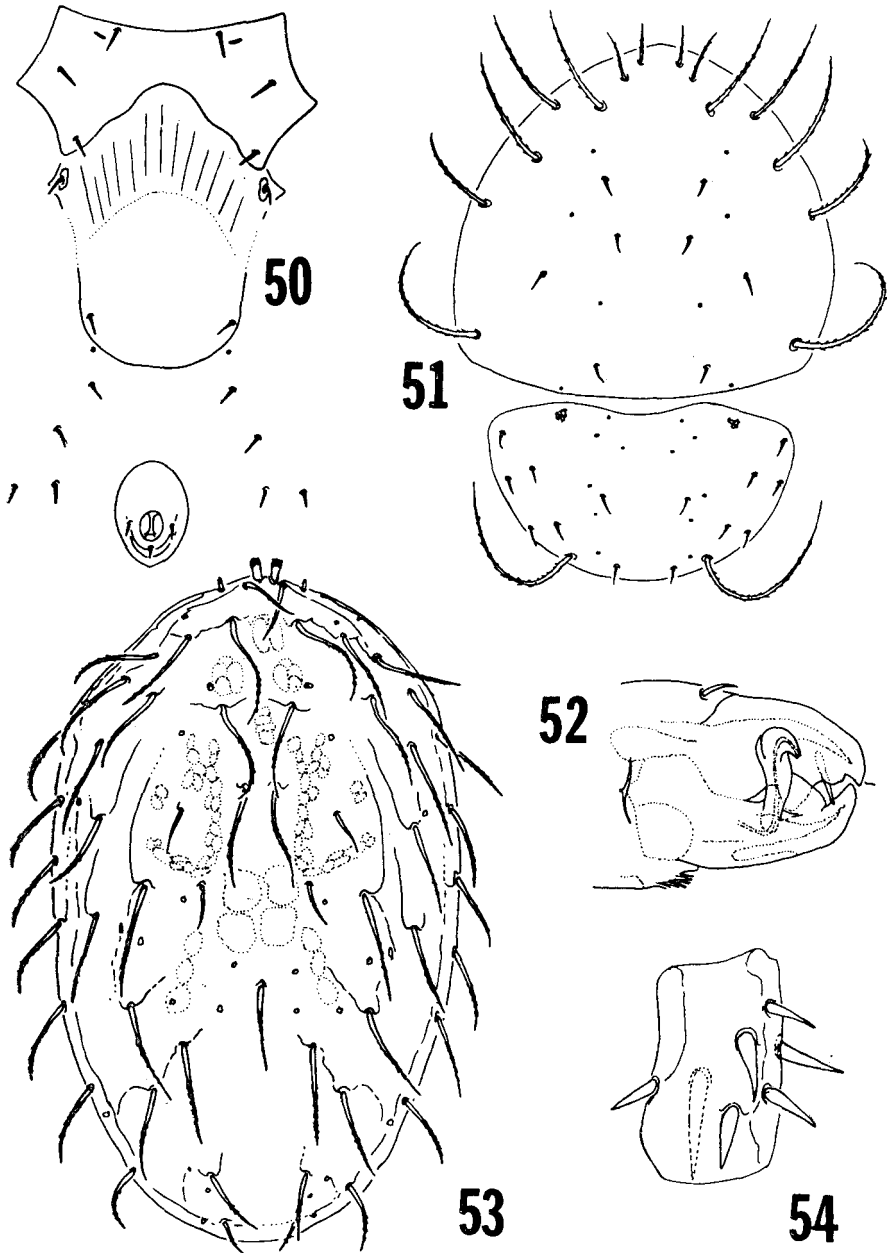
*Coprolaelaps* (?) *meridionalis* SELLNICK, M. (1931). *Sitzung mathem.-naturw. Kl.*, abt. 1, 9, u. 10, Hft. 140 : 767.

*Coprolaelaps meridionalis*, GÖTZ, H. and W. HIRSCHMANN (1957). *Mikrokosmos* 46 : 115.

SELLNICK (1931) described the male and female stages of *N. meridionalis* from the Ionic Islands of southern Europe. Despite the presence of ambulacra on tarsi I of the new species, SELLNICK mentioned the obvious similarities between it and *N. jaspersi* Berlese, particularly in the structure and shape of ventral shields. He also pointed out that the male of *meridionalis* is quite similar to the male of BERLESE'S *Megalolaelaps spinirostris*, the chelicerae and second pair of legs of both species being nearly identical in their modifications. The latter species has been placed into the genus *Neopodocinum* in this paper (see page 191). GÖTZ and HIRSCHMANN (1957) presented illustrations of the protonymph and deutonymph of *meridionalis*, which may have been described earlier in an unpublished thesis by GÖTZ (Erlangen, 1952). The larva has not been found, but is thought to live free in dung inhabited by the " host " beetle, *Geotrupes silvaticus* Pan. Males and females also were observed by GÖTZ and HIRSCHMANN, presumably in collections from which immature forms also were taken. The immature stages, therefore, are considered to be conspecific with SELLNICK'S adult specimens described in 1931.

The author has not seen specimens of *meridionalis*, the following descriptions having been derived from SELLNICK, and from GÖTZ and HIRSCHMANN.

FEMALE (fig. 50). Length of female (average of three specimens) = 836  $\mu$  ; width = 600  $\mu$ . There is no figure of the female dorsal shield, but SELLNICK notes that the male shield is similar to that of the female. His figure of the dorsal shield of the male gives no indication of setal number, although it appears that there are least 29 pairs ;  $Mg_6$ ,  $Mg_8$ - $Mg_9$ , and  $L_3$ , among others, are considerably longer than the D setae, and are pectinate ;  $D_1$  are well separated, short and apparently smooth ; setae  $D_7$  are present, as is an unpaired seta  $D_x$ , which is illustrated as being inserted somewhat behind  $D_7$ . *Sternal shield* (fig. 50) deeply concave posteriorly, punctate, without l. m. t. ; sternal setae short and smooth, as are metasternal and epigynial setae ; metasternal shields oblong, adjacent to endopodals ; epigynial shield punctate. Perianal setae apparently sparse and smooth. *Stigmata* between coxae III-IV ; peritremes join stigmata anteriorly and each continues



FIGS. 50-52. — *Neopodocinum meridionalis* (Sellnick).

Fig. 49. — Dorsum of deutonymph (after Götz and Hirschmann 1957) ; Fig. 50. — Sternal, epigynal and anal shields of female (after Sellnick 1931) ; Fig. 51. — Dorsum of protonymph (after Götz and Hirschmann 1957) ; Fig. 52. — Chelicera of male (after Sellnick 1931).

FIGS. 53-54. — *Neopodocinum setosum* n. sp.

Fig. 53. — Dorsum of female ; Fig. 54. — Genu IV of female.

anteriorly beyond coxa I, presumably to some point near dorsal seta  $M_1$ . Hyposomal setae II over twice as long as setae III; deutosternal setae approximately the same length as setae III. *Tectum* and *chelicerae* typical for genus; internal cheliceral brush not extending to the terminus of the digitus mobilis. *Tarsus I* with a membranous ambulacrum; tarsi II-IV with ambulacra and claws.

MALE (fig. 52). Length of idiosoma of the single male allotype =  $770\ \mu$ ; width =  $638\ \mu$ . *Dorsal shield* similar to that of female. *Sternitigenital shield* without lateral portions of l. m. t.; with five pairs of short smooth setae. Integument behind sternitigenital shield with at least ten pairs of perianal setae, of which the most posterior are the longest; anal shield similar to that of female, as are *peritremes* and *stigmata*. *Gnathosoma* as in female except that the digitus mobilis of *chelicera* has a median internal spermatophore transfer organ (fig. 52) which is terminally hooked. *Tarsus I* with ambulacrum, tarsi II-IV with ambulacra and claws; femur, genu and tibia II, and femur IV, each with a medioventral spur; femoral spur large and hooked.

DEUTONYMPH (fig. 49). Length and width unknown. *Dorsal shield* (fig. 49) apparently without lateral incisions and, according to GÖTZ and HIRSCHMANN, with more than the usual complement of setae; with an extra pair of D setae between  $D_4$ - $D_5$ , and an extra pair between  $L_2$ - $L_3$ ;  $D_7$  and  $M_5$  present, as in *benoiti* (fig. 12); in addition, with an unpaired  $D_x$  and three assymmetrically inserted setae mediad of  $M_5$ , two of which may be  $D_8$ ; all dorsal setae short and smooth except for  $D_1$ , which is pectinate. *Sternal shield* punctate, with four pairs of short laterally inserted setae. Perianal setae also short; anal shield typical. *Peritreme* meets *stigmata* on the anterior aspect of the latter, proceeding anteriorly for some distance. *Gnathosoma* and *legs* not seen.

PROTONYMPH (fig. 51). Length and width of idiosoma unknown. *Dorsal shield* (fig. 51) divided behind setae  $D_6$ ; with the usual eleven pairs of anterior shield setae, of which  $D_4$ - $D_6$  and  $M_3$  are short and smooth;  $D_1$ - $D_2$  spinose and pectinate, and the remaining setae quite long and pectinate ( $D_3$ ,  $M_2$ ,  $L_1$ ,  $L_3$ ,  $Mg_1$ ). Posterior shield with eight pairs of setae, of which only  $Mg_{10}$  are long and pectinate; others short and smooth;  $D_x$  absent. *Sternal shield* with three pairs of smooth setae. Perianal area with less than ten pairs of setae, all of which are short. *Stigmata* with anteriorly attached peritremes which extend over a distance less than the width of coxae III. *Gnathosoma* and *legs* not seen.

#### LARVA.

Unknown.

#### HABITAT and LOCALITY.

Three females and one male from Greece; 1929: an indeterminant number of males, females, deutonymphs and protonymphs from Europe (GÖTZ and HIRSCHMANN).

**Neopodocnum setosum** n. sp.

FEMALE (Pl. V ; 48 : Pl. VI ; 49 : figs. 53, 54, 56). Length of idiosoma averages 1128  $\mu$ , with a range of 1080-1180  $\mu$  ; width of idiosoma at coxae II averages 703  $\mu$ , with a range of 700-710  $\mu$ . *Dorsal shield* (fig. 53) punctate-reticulate, with strong anterior and lateral ridges and clefts ; with 28 pairs of setae and an unpaired weakly pectinate  $D_x$  ; setae  $D_1$  and  $M_1$  short and plumose, with  $D_1$  being at least twice the size of  $M_1$  ;  $M_3$  and  $D_6$  smooth, of moderate length, not extending beyond insertions of setae posterior to them ; remaining dorsal setae long and lightly pectinate distally ( $Mg_{10}$  shorter, similar to  $M_3$ , but lightly pectinate) ;  $Mg$  setae reaching insertions of setae behind them ;  $D_3$  extending well beyond insertions of  $D_4$ . *Sternal shield* (Pl. VI ; 49) without deep posterior excavation, uniformly punctate and with lateral portions of l. m. t. extending mediad of insertions of sternal setae I ; l. o. a. also well-developed ; sternal setae long and smooth, as are *metasternal* setae. *Epigynial shield* (Pl. VI ; 49) punctate, with a pair of long smooth setae which exceed the length of the sternal and metasternal setae ; shield with a pair of posterior pores. With well over 50 pairs of perianal setae, most of which are pectinate ; *anal shield* typical for genus. *Peritremes* each joining stigmata posterolaterally, forming a loop and continuing anteriorly and dorsally to a point posteromedial of seta  $M_1$ . *Tectum* and palps typical for genus. Hypostomal setae II over twice the length of setae III ; deutosternal setae longer than setae III ; with five rows of deutosternal teeth (16-22 teeth/row). *Chelicerae* (Pl. V ; 48) typical for genus ; internal brush extending nearly to the end of the digitus mobilis. *Tarsi I* without ambulacra or claws ; *tarsi II-IV* with both ambulacra and claws ; legs II distinctly stouter than legs I, tarsal spines blunt ; genu IV (fig. 54) with seven smooth setae, of which  $av_1$  is the longest ; setae  $ad_2$  and  $pd_2$  of tarsus IV short ;  $pd_2$  slightly pectinate ; other tarsal setae smooth (fig. 56).

MALE.

Unknown.

DEUTONYMPH (fig. 55). A single deutonymphal specimen without associated adult forms has been assigned to this species, primarily because the setal condition of the dorsum (fig. 55) and the habitat (India, on a species of *Catharsius*) appear to fit the diagnosis of *N. setosum*.

Length of idiosoma = 840  $\mu$  ; width of idiosoma at level of coxae II = 550  $\mu$ . *Dorsal shield* (fig. 55) punctate-reticulate, and with anterior and lateral ridges and clefts ; with lateral incisions behind  $Mg_5$  ; with 28 pairs of setae,  $D_1$ ,  $M_3$  and  $D_6$  being similar to those of adult ;  $M_1$  apparently smooth, setae  $D_2$  moderately long and pectinate,  $L_{1-3}$ ,  $M_2$ , and  $Mg_{1-6, 9}$  pectinate, other setae smooth, or nearly so (setae  $Mg_{7-8}$  and  $L_6$  not seen) ;  $D_x$  present. *Sternal shield* reticulate, heart-shaped,

with four pairs of setae, of which the most posterior pair is the longest. With at least 30 pairs of perianal setae, the posterior pairs being pectinate. *Peritremes* join stigmata posterolaterally, form a broad loop and extend anteriorly beyond coxae I. *Gnathosoma* and *legs* similar to those of female.

PROTONYMPH and LARVA.

Unknown.

HABITAT and LOCALITY.

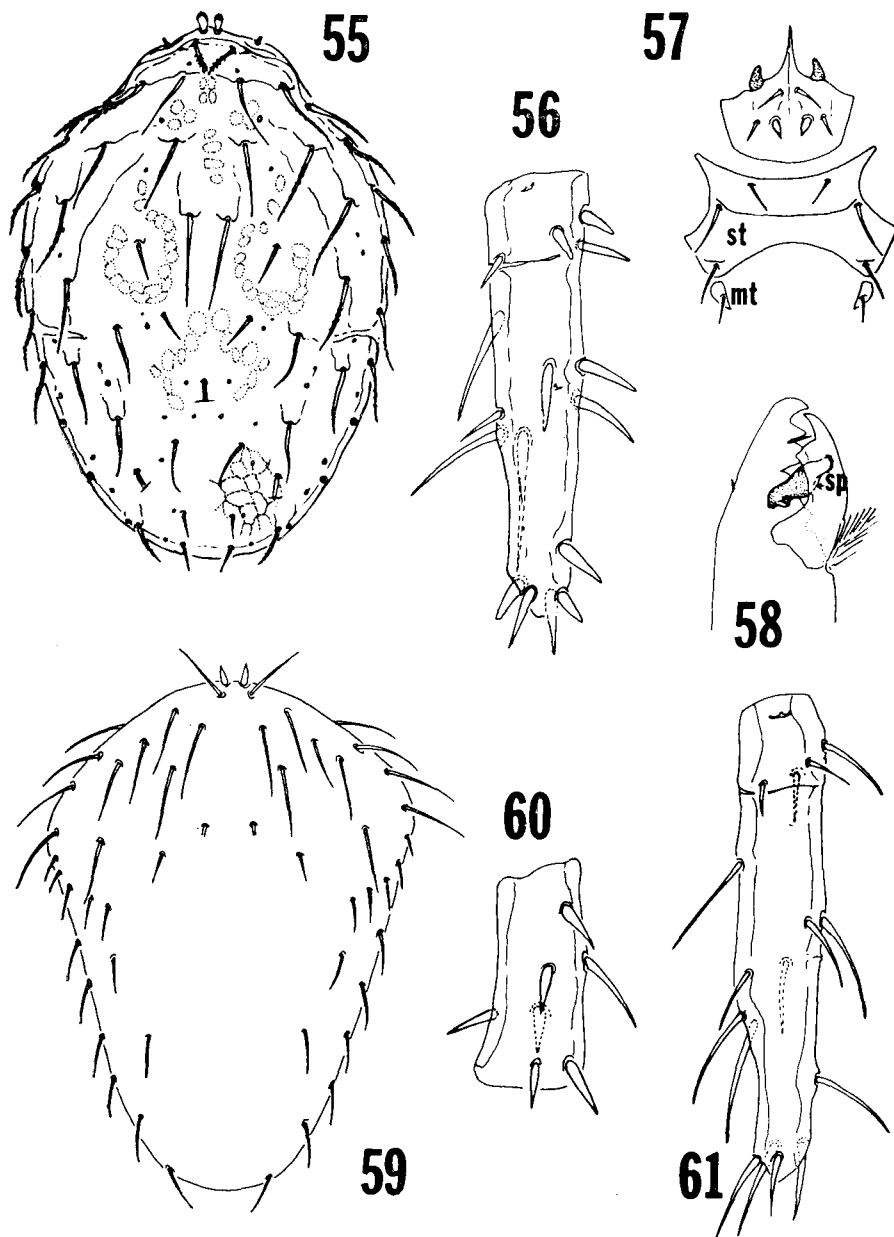
Three females from India ; ex *Catharsius capucinus* F. (Chicago Natural History Museum Collection) : one female from Shimoga-Mysore, India (1865' elev.) ; ex *Catharsius capucinus* F. ; P. NATHAN, coll. (U. S. National Museum Collection) : one deutonymph from South India ; ex *Catharsius pithecius* F. (Chicago Natural History Museum Collection). The holotype female and deutonymph will be deposited in the collection of the U. S. National Museum, Washington, D. C. Paratype females will be deposited in the following institutions ; Chicago Natural History Museum, Chicago, Illinois, Oregon State University, Corvallis, Oregon and the British Museum (Natural History), London, England.

*Neopodocinum spinirostris* (Berlese) new combination.

*Megalolaelaps spinirostris* BERLESE, A. (1910). *Redia* 6 : 258 ; BERLESE, A. (1913). *Redia* 9 : 82 ; SELLNICK, M. (1931). *Sitz. mathem.-naturw. Kl., Abt. I*, 9, u. 10, Hft. 140 : 768.

BERLESE assigned *spinirostris* to his genus *Megalolaelaps* (BERLESE 1892), probably because of the presence of large spurs on tarsus II. *Megalolaelaps*, a genus in the Pachylaelaptidae, does appear to have a number of characters in common with *Neopodocinum*, but differs in the shape and development of the sternal and parapodal shields, as well as in dorsal setation, cheliceral structure and leg chaetotaxy. The writer has not seen the type specimen of *spinirostris* nor have any specimens in the writer's collection been assigned to this species. BERLESE (1913) illustrated the female and male of *spinirostris*, from which is derived the brief description presented below.

FEMALE (figs. 57, 59). Length of idiosoma, according to BERLESE = 1250  $\mu$  ; width = 900  $\mu$ . *Dorsal shield* (fig. 59) somewhat attenuated posteriorly, anterior dorsal setae long ( $D_1$  is quite short), as in *setosum* (fig. 53),  $D_2$ - $D_4$  easily surpass the insertions of the setae behind them ; posterior dorsal setae not seen ; Mg setae barely long enough to attain insertions of setae behind them ; with a series of anterolateral marginal setae which may be misplaced on BERLESE's drawing ; all setae appear smooth on the original drawing, but some may be pectinate or plumose. *Sternal shield* (fig. 57) without deep posterior excavation ; line l. m. t.



FIGS. 55-56. — *Neopodocinum setosum* n. sp.

Fig. 55. — Dorsum of deutonymph; Fig. 56. — Tarsus IV of female.

FIGS. 57-59. — *Neopodocinum spinirostris* (Berlese).

Fig. 57. — Hypostomal and sternal region of female (after Berlese 1913) (st = sternal shield; mt = metasternal shield); Fig. 58. — Chelicera of male (after Berlese 1913) (sp = spermatophore transfer organ); Fig. 59. — Dorsum of female (after Berlese 1913).

FIGS. 60-61. — *Neopodocinum tshambi* n. sp.

Fig. 60. — Genu IV of female; Fig. 61. — Tarsus IV of female.

apparently complete; sternal setae smooth, as are *metasternals*. *Epigynial* setae equal in length to sternals. Perianal region with at least 30 pairs of setae; *anal shield* typical for genus. *Peritreme* meeting stigma on anterior aspect, continuing anterior and dorsal. Hypostomal setae II short, thick, spine-like, subequal in length to setae III. *Tarsi I* with membranous ambulacra, tarsi II-IV with ambulacra and claws.

MALE (fig. 58). Dimensions unknown. *Dorsal shield* as described for female. *Sternitigenital shield* with five pairs of smooth setae (setae I were not included on BERLESE'S drawing, but are presumed to be present); line l. m. t. complete. With over 40 pairs of perianal seta. *Peritremes* and stigmata similar to those of female. *Digitus mobilis* of *chelicera* (fig. 58) with a median internal spermatophore transfer organ with a distal cleft. *Tarsus I* with ambulacra, as in female. Femur, genu and tibia II each with a medioventral spur, the femoral spur being the largest; tarsus IV also with a small spur medioventrally.

#### IMMATURE STAGES.

Unknown.

#### HABITAT and LOCALITY.

Holotype female from Java; ex *Copris* sp.; JACOBSON, coll.

Examination of the illustrations of *N. spinirostris* presented by BERLESE (figs. 57-59) confirms the similarity between it and *N. vanderhammeni* n. sp. (Pl. VI; 53-58). Although many of the dorsal setae are missing in BERLESE'S drawing (fig. 59), the length and placement of podonotal and marginal setae, as well as the attenuation of the dorsal shield, are strongly like those of *vanderhammeni*. The series of marginal and lateral hairs inserted diagonally on each side of the dorsal shield of *spinirostris* apparently are homologous to the diagonally inserted  $Mg_{5-6}$ ,  $L_4$ ,  $M_4$  and  $D_6$  of *vanderhammeni* (fig. 68). The short broad hypostomal setae II of *spinirostris* (fig. 57) are identical to those of *vanderhammeni*, as is the short spermatophore transfer organ on the *digitus mobilis* of the male *chelicera* (fig. 58). Line l. m. t. of the female sternal shield is complete in both species. Differences in gnathosomal structures, in addition to that of distribution, prompts the separation of the two species.

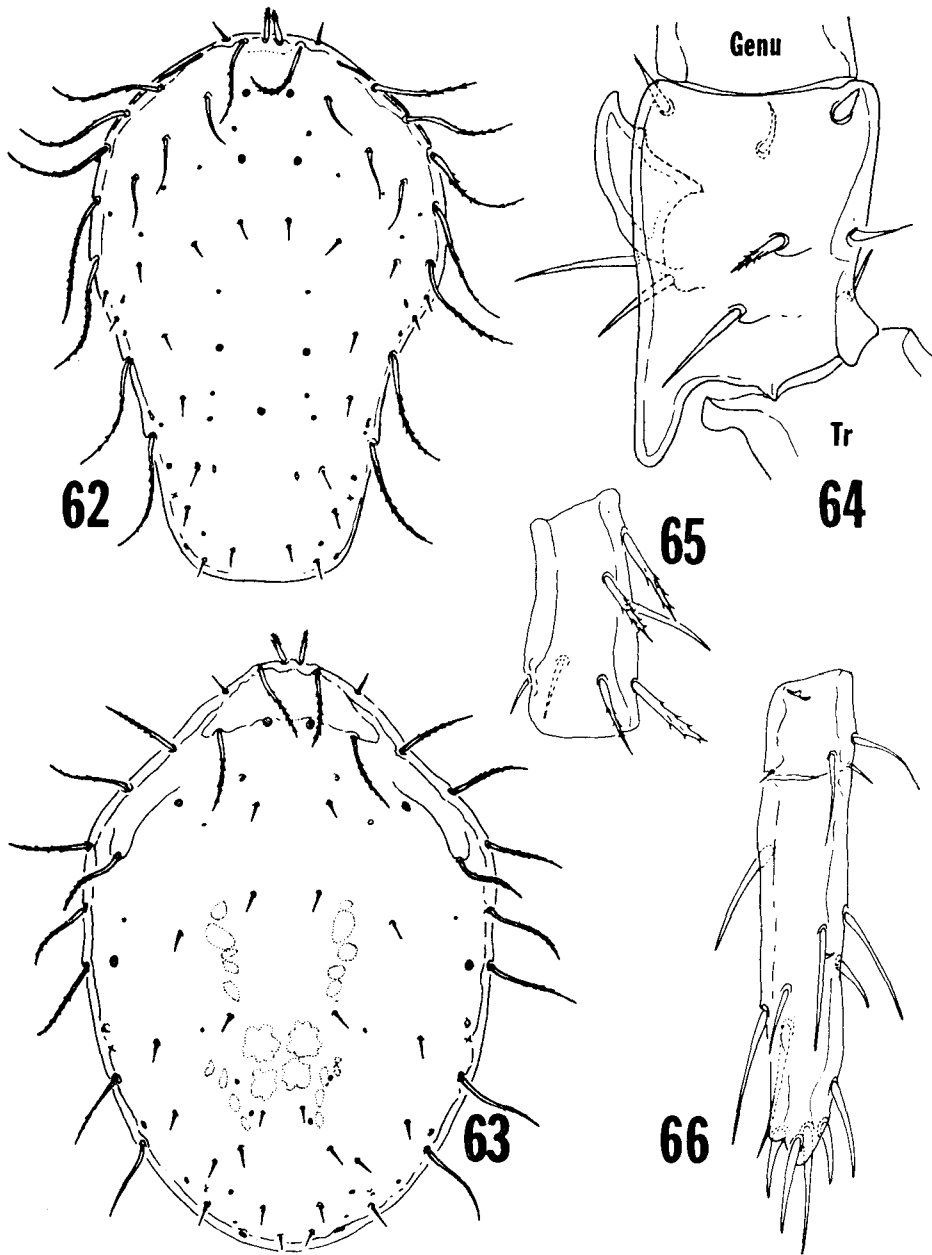
#### ***Neopodocinum tshambi* n. sp.**

FEMALE (Pl. VI; 50: figs. 60-62). Length of idiosoma averages 1180  $\mu$ , with a range of 1100-1250  $\mu$ ; width of idiosoma at level of coxae II averages 708  $\mu$ , with a range of 680-750  $\mu$ . *Dorsal shield* (fig. 62) uniformly punctate, weakly reticulate, opisthosomal region constricted laterally; with at least 27 pairs of setae ( $Mg_9$  not seen) plus an unpaired  $D_x$ ; many setae inserted in odd positions,

probably because of opisthosomal constriction. Setae  $D_1$  long, well separated and distally plumose;  $D_2$  inserted laterad of  $D_1$ , approximately four times the length of  $D_1$ , lightly pectinate;  $M_1$  smooth, shorter than  $D_1$ , and inserted in a nearly straight transverse line with both  $D_1$  and  $D_2$ ; setae  $L_1$ ,  $Mg_{1-2}$ ,  $Mg_{4-5}$ , and  $Mg_{7-8}$  very long and pectinate, similar to  $D_2$ ; setae  $M_2$ ,  $L_2$ , and  $Mg_3$  somewhat more than half the length of  $D_2$ , appearing smooth;  $D_5$ ,  $M_3$ - $M_4$ , and all of the remaining opisthosomal setae short to minute, smooth (setae  $D_3$ - $D_4$ ,  $D_6$  and  $D_x$  not seen); with two minute setae in position of  $Mg_6$ , the more posterior of which is assumed to be  $Mg_6$ ; anterior seta is assumed to be  $L_4$ , inasmuch as the adjacent typical insertion position of  $L_4$  is lost; integumental setae laterad of opisthosomal portion are minute and hair-like. *Sternal shield* (Pl. VI; 50) greatly narrowed medially, weakly reticulate and with lateral portions of l. m. t. strongly developed; sternal setae smooth, long. *Metasternal shields* oval, adjacent to endopodals and each with a short smooth seta which is  $1/4$  the length of sternals III. *Epigynial shield* punctate, with a pair of short smooth setae in the posterolateral portions; with a pair of pores directly behind the setae and on the posterior edge of the shield. With over 30 pairs of tiny, hair-like perianal setae; adanal setae of anal shield longer than in most species. *Peritremes* join stigmata posteriorly, each loop anteriorly and continue anterior and dorsal to a point laterad of seta  $M_1$ . *Tectum* typical for genus, as are palps. Hypostomal setae smooth; setae II at least twice the length of setae III; deutosternal setae approximately equal to or somewhat longer than setae III; with five rows of deutosternal teeth, with a range of 8-16 teeth/row. Internal brush at base of digitus mobilis of *chelicera* with compact pectination, nearly reaching distal end of digit. Tarsus I without ambulacra; tarsi II-IV with claws and ambulacra; legs II distinctly stouter than legs I. Genu IV (fig. 60) with seven smooth setae; setae  $ad_2$  and  $pd_2$  of tarsus IV smooth,  $ad_2$  half again as long as  $pd_2$ ; other tarsal setae smooth (fig. 61).

MALE (Pl. VI; 51, 52 : fig. 63). Length of idiosoma averages 1205  $\mu$ , with a range of 1170-1240  $\mu$ ; width of idiosoma at level of coxae II averages 740  $\mu$ . *Dorsal shield* differing from that of female as follows: opisthosomal region is not constricted laterally;  $Mg_9$  present;  $Mg_{10}$  inserted posteromedial of  $D_9$ , rather than posterolaterad as in female;  $Mg_8$  smooth, or nearly so;  $Mg_3$  pectinate; setae  $Mg_6$  and  $L_4$  (?  $M_4$ ) absent;  $D_7$  present and  $D_x$  absent. *Sternitigenital shield* (Pl. VI; 51) broad, without l. m. t.; with five pairs of smooth setae, of which the first three pairs are long and the two posterior pairs are short (approximately  $1/4$  the length of setae III). With one pair of setae inserted behind the sternitigenital shield which is somewhat longer than setae IV-V of the shield; with over 30 pairs of tiny hair-like perianal setae; adanal setae of *anal shield* considerably longer than postanal seta. *Stigmata* and peritremes as in female. *Gnathosoma* also similar to that of female except for the presence of a spermatophore transfer organ on the internal medial aspect of the digitus mobilis (shape not clear). Femur, genu and tibia II with medioventral spurs; with a large protuberance also on the medio-





FIGS. 62-63. — *Neopodocinum tshambi* n. sp.

Fig. 62. — Dorsum of female ; Fig. 63. — Dorsum of male.

FIGS. 64-66. — *Neopodocinum vanderhammeni* n. sp.

Fig. 64. — Femur II of male, showing ventral spur and proximoventral enlargement ;

Fig. 65. — Genu IV of female ; Fig. 66. — Tarsus IV of female.

ventral aspect of tarsus IV (Pl. VI ; 52) ; setae  $ad_{1-2}$  and  $pd_{1-2}$  may be weakly pectinate distally.

#### IMMATURE STAGES.

Unknown.

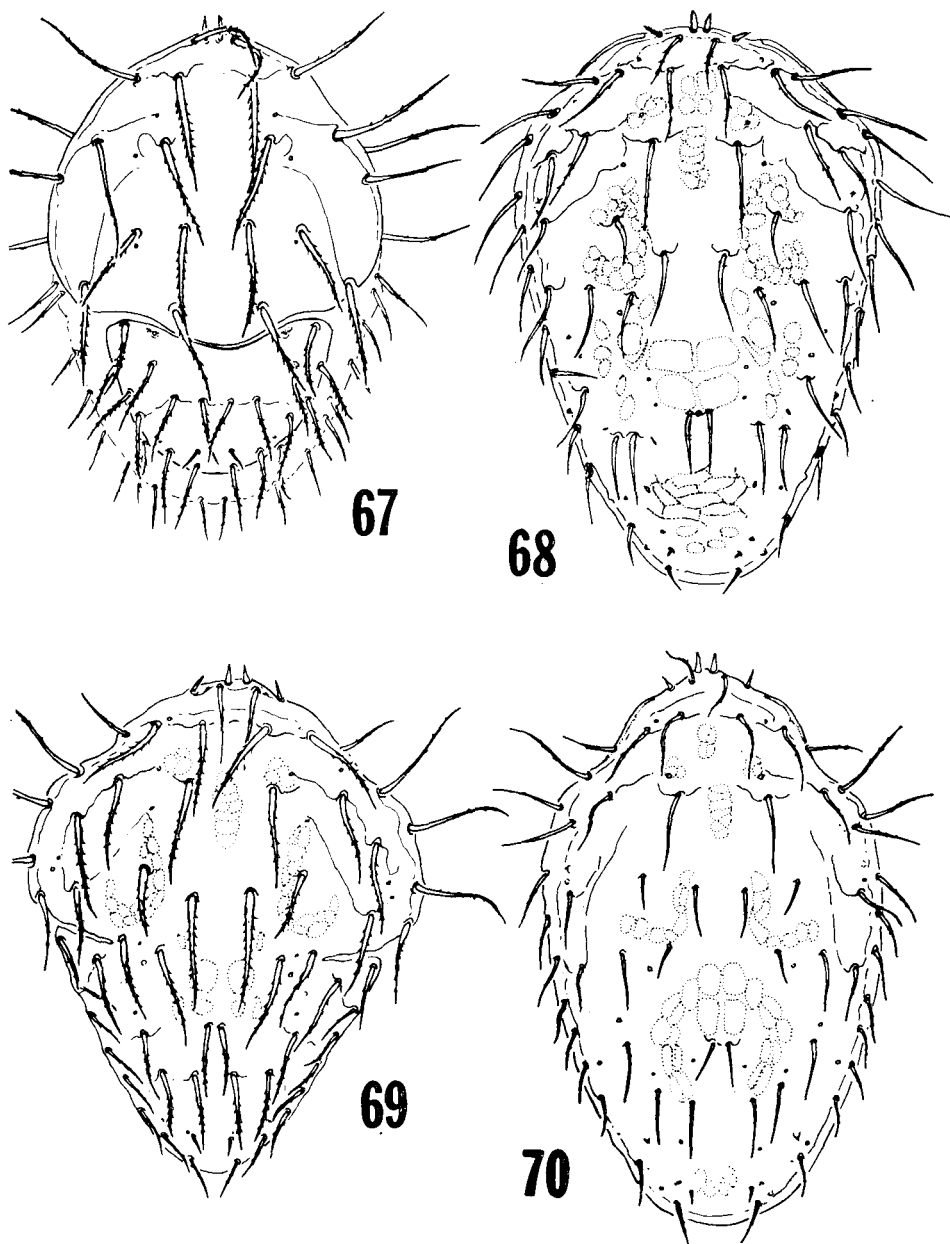
#### HABITAT and LOCALITY.

Four collections from the Central African Museum as follows : two females from Lake Albert (Kasenyi) ; May, 1935 ; ex *Scarabaeus gangeticus* Cast. ; H. J. BREDO, coll. (Collection No. 118243) : one female from Tshambi, Kabasha ; October, 1933 ; ex *Scarabaeus gangeticus* ; G. F. DE WITTE, coll. (Collection No. 118232) : one male from Lonami, Kambaye ; September, 1950 ; ex *Scarabaeus gangeticus* ; P. QUARRE, coll. (Collection No. 118281) : one male from Ruanda, Kibungu (1500 m.) ; ex *Scarabaeus gangeticus* ; P. BASILEWSKY, coll. (Collection No. 118247). A single collection from the Chicago Natural History Museum as follows : one female from Africa ; ex *Scarabaeus gangeticus*. The holotype female and allotype male will be deposited in the collection of the U. S. National Museum, Washington, D. C. Paratypes will be placed in the collections of the Chicago Natural History Museum, Chicago, Illinois, Central African Museum, Tervuren, Belgium, and Oregon State University, Corvallis, Oregon.

The extent of sexual dimorphism seen in *N. tshambi* is unknown elsewhere in the genus *Neopodocinum*. The dorsal shield constriction of the female makes difficult any attempt at setal homologies between male and female, and between females of *tshambi* and of other species.

#### ***Neopodocinum vanderhammeni* n. sp.**

FEMALE (Pl. VI ; 53, 56, 57 : figs. 65, 66, 68). Length of idiosoma averages 1013  $\mu$ , with a range of 1000-1020  $\mu$  ; width of idiosoma at level of coxae II averages 667  $\mu$ , with a range of 660-680  $\mu$ . *Dorsal shield* (fig. 68) punctate, gradually narrowed posteriorly, and with anterior and lateral ridges and clefts ; with 31 pairs of setae and often with an unpaired  $D_x$  ;  $D_1$  smooth, spinose,  $M_1$  somewhat pectinate distally ;  $D_2$  considerably longer than  $D_1$ , with strong even pectinations ; setae  $D_3$ ,  $M_2$ ,  $L_1$ - $L_2$  and  $Mg_1$  pectinate, other dorsal setae smooth or nearly so ; anterior  $Mg$  setae ( $Mg_3$ - $Mg_6$ ) long, smooth, easily surpassing the setae behind them, more posterior  $Mg$  setae shorter, or not seen ; setae  $D_7$  flanking  $D_x$  ;  $D_6$  inserted nearer to  $D_5$  than is usual in the genus,  $L_4$  anterior to  $M_4$  ;  $D_9$  represented by a pair of minute protuberances anterior to setae  $Mg_{10}$  ;  $D_8$  present, inserted slightly mediad, rather than anteromedial of  $L_6$  as in other species ; with two extra pairs of  $Mg$  setae between  $Mg_7$  and  $Mg_9$ . Integument laterad and posterior to shield with smooth or weakly pectinate setae. *Sternal shield* (Pl. VI ; 53) punctate, weakly reticulate, with a strong complete l. m. t. as well as l. o. a. ; sternal setae smooth, spinose.



FIGS. 67-70. — *Neopodocinum vanderhammeni* n. sp.  
Fig. 67. — Dorsum of protonymph ; Fig. 68. — Dorsum of female ;  
Fig. 69. — Dorsum of deutonymph ; Fig. 70. — Dorsum of male.

*Metasternal* shields ovate, each with a pore and a long seta. *Epigynial shield* punctate, truncate posteriorly and with a pair of setae on the posterolateral corners; epigynial pores in the integument. With more than 40 pairs of smooth or weakly pectinate perianal setae, most of which are long enough to surpass the setal insertions behind them; *anal shield* typical for genus. Parapodal remnants laterad to coxae IV fairly strong and broad, but not extending anterior to coxae IV. *Stigmata* between coxae III-IV; peritremes join stigmata anterolaterally, curve slightly anteriorly and each continues laterally and dorsally to a point laterad of seta  $M_1$ . *Tectum* with spines smaller than usual. Hypostomal setae I long and spinose; setae II-III short, broad and rounded distally, of approximately equal dimensions (Pl. VI; 56); deutosternal setae normal, shorter than setae I. With five rows of deutosternal teeth, averaging 14-22 teeth/row. Tarsi I with membranous ambulacra; tarsi II-IV with ambulacra and claws. Legs II little broader than legs I; tarsi II with spines poorly developed; genu IV (fig. 65) with seven setae;  $ad_{1-2}$  and  $pd_{1-2}$  distally pectinate, other genual setae spinose and smooth. Setae  $ad_2$  and  $pd_2$  of tarsus IV long and smooth (fig. 66); other tarsal setae also smooth.

MALE (Pl. VI; 54, 58: figs. 64, 70). Length of idiosoma averages 1157  $\mu$ , with a range of 1090-1200  $\mu$ ; width of idiosoma at level of coxae II averages 780  $\mu$ , with a range of 690-850  $\mu$ . *Dorsal shield* (fig. 70) similar to that of female in shape and ornamentation; with 31 pairs of setae which differ from those of the female as follows:  $D_{4-5}$ ,  $M_1$  and  $M_3$  smooth or nearly so,  $Mg$  setae often weakly pectinate; insertion for  $D_x$  not observed; relationship of  $D_6$  to  $D_5$  normal for genus,  $L_4$  and  $M_4$  on a nearly parallel line,  $M_4$  weakly pectinate;  $D_9$  minute, but setate in appearance; setae  $D_8$  inserted posteromedial of setae  $L_6$ ; dorsal, median and lateral setae generally shorter and less expanded than those of female. *Sternitigenital shield* (Pl. VI; 54) with strong complete l. m. t.; with five pairs of smooth setae, of which setae IV-V are by far the longest; with at least 40 pairs of smooth and weakly pectinate perianal setae, most of which are long enough to surpass the setal insertions behind them. *Anal shield*, stigmata and peritremes as in female. *Digitus mobilis* of *chelicera* (Pl. VI; 58) with a short blunt spermatophore transfer organ on the internal medial aspect. *Femur*, genu and tibia II with medioventral spurs; proximoventral aspect of femur II produced so as to form a shelf-like protuberance (fig. 64); with a small protuberance on the medioventral aspect of tarsus IV, in addition to a small ventrodistal spur; setae  $ad_2$  and  $pd_2$  of tarsus IV slightly pectinate distally; seta  $ad_3$  of pretarsus IV longer than in female, weakly pectinate distally.

DEUTONYMPH (Pl. VI; 55: fig. 69). Length of idiosoma averages 743  $\mu$ , with a range of 710-770  $\mu$ ; width of idiosoma at level of coxae II averages 580  $\mu$ , with a range of 560-620  $\mu$ . *Dorsal shield* (fig. 69) strongly attenuated posteriorly, pear-shaped, with strong lateral and anterior ridges and clefts, and strong lateral incisions posterior to  $Mg_5$ ; with 31 pairs of setae, almost all of which are strongly pectinate ( $D_1$ ,  $M_1$ ,  $L_1$ ,  $Mg_{1-2}$ ,  $Mg_1$ , and  $D_9$  are smooth or nearly so);  $D_2$  little longer

than  $D_1$ ,  $D_8$  and  $L_6$  inserted in a manner similar to that of the female (fig. 68),  $D_x$  absent. *Sternal shield* (P. VI ; 55) with lateral ornamentation ; lateral portions of l. m. t. distinct ; with four pairs of smooth long sternal setae. With well over 30 pairs of smooth and pectinate perianal setae ; anal shield typical for genus. *Stigmata*, peritremes, and *gnathosoma* as in female. Tarsi I with strong ambulacra and a pair of claws ; other legs essentially similar to those of female.

PROTONYMPH (fig. 67). Length of idiosoma averages  $576\ \mu$ , with a range of  $550$ - $620\ \mu$  ; width of idiosoma averages  $434\ \mu$ , with a range of  $420$ - $470\ \mu$ . *Dorsal shield* (fig. 67) divided behind setae  $D_6$  ; pronotal portion with strong ridges and clefts, with eleven pairs of setae of which all but  $D_1$  are extremely long ; marginal setae weakly pectinate, dorsal (except  $D_1$ ), median and lateral setae strongly pectinate ; posterior portion of dorsal shield with ten pairs of setae, rather than the more usual eight pairs found in other species ;  $D_7$  present ;  $D_9$  smooth, short, other setae strongly pectinate. *Sternal shield* broad, reticulate, with three pairs of long smooth setae. With at least 20 pairs of long pectinate perianal setae. *Stigmata* between coxae III-IV ; peritremes very short, terminating on a level with coxae III. Hypostomal setae as in female ; claws and ambulacra present on tarsi I.

#### LARVA.

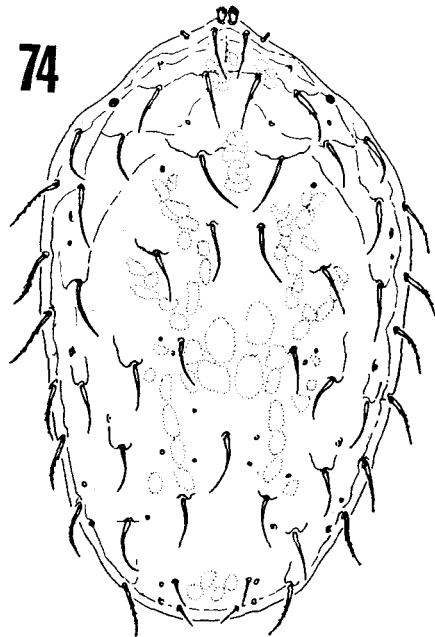
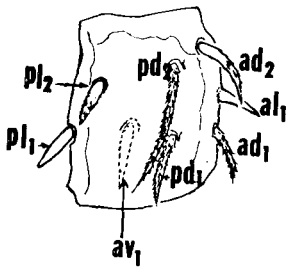
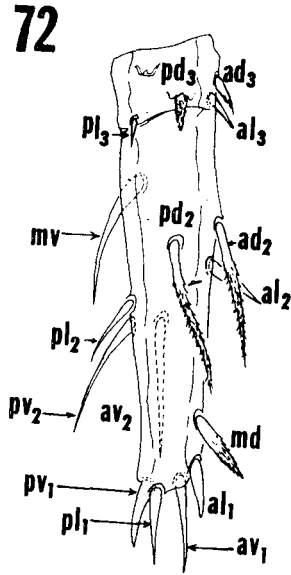
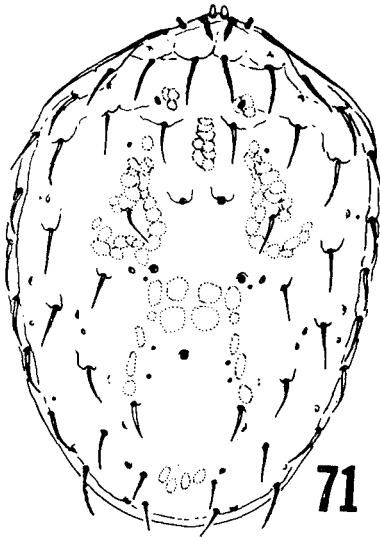
Unknown.

#### HABITAT and LOCALITY.

One female from Futsjan, Province of Fokien, China ; 1905 ; G. SIEMSEN, coll. (Leiden Museum Collection No. 723) : five females, three males, five deutonymphs and ten protonymphs from Cha-Pa, North Viet Nam, around Geophysical Station ; 27 October, 1960 ; ex *Copris* sp. ; A. BARTKE, coll. The holotype female, allotype male and paratype protonymph and deutonymph will be placed in the collection of the Rijksmuseum van Natuurlijke Historie, Leiden, Holland. Paratype males and females also will be placed in the collections of the U. S. National Museum, Washington, D. C., Oregon State University, Corvallis, Oregon, Jagiellonian University, Krakow, Poland, and the British Museum (Natural History), London, England.

#### ***Neopodocinum vanstraeleni* n. sp.**

FEMALE (Pl. VII ; 59, 60 : figs. 71-73). Length of idiosoma =  $1160\ \mu$  ; width of idiosoma at level of coxae II =  $800\ \mu$ . *Dorsal shield* (fig. 71) oval, punctate and weakly reticulate, and with a series of anterior and lateral clefts associated with setal insertions ; with 28 pairs of setae and an unpaired  $D_x$  ;  $D_1$  and  $M_1$  short and broad,  $M_1$  being pectinate ;  $D_2$  longer than  $D_1$ , distinctly pectinate, other dorsal setae of moderate length, generally smooth ( $D_3$ ,  $M_2$ ,  $L_1$ ,  $Mg_1$ ,  $Mg_3$  and  $Mg_8$  , weakly pectinate) ;  $Mg$  setae do not reach the insertions of the setae behind them ; seta  $Mg_3$  inserted virtually parallel to seta  $Mg_2$  ; setae  $D_7$  and  $M_5$  absent. *Sternal shield*



FIGS. 71-73. — *Neopodocinum vanstraeleni* n. sp.

Fig. 71. — Dorsum of female ; Fig. 72. — Tarsus IV of female ;  
Fig. 73. — Genu IV of female.

FIG. 74. — *Neopodocinum verschureni* n. sp.

Dorsum of female.

(Pl. VII ; 59) punctate, weakly reticulate and deeply excavated posteriorly ; lateral portions of l. m. t. well-developed ; sternal setae spinose. *Metasternal shields* oblong, each with a posterior smooth seta and an anterior pore. *Epigynial shield* with a loose punctate pattern ; epigynial setae long, inserted well ahead of the posterolateral borders ; epigynial pores in the shield, behind and mediad of the setal insertions. With approximately 30 pairs of perianal setae, of which the more anterior pairs are smooth and the posterior pairs evenly pectinate throughout their length ; *anal shield* punctate. *Peritremes* join stigmata posterolaterally, each curves anteriorly and extends laterally and dorsally to a point laterad of seta  $M_1$ . *Tectum* and palps typical for genus. Hypostomal setae smooth ; seta II approximately twice the length of setae III, broadened basally ; setae I somewhat longer than setae III ; deutosternal setae subequal to setae III. With five rows of small deutosternal teeth, which average from 14-26 teeth/row ; *chelicerae* (Pl. VII ; 60) with typical dentition ; internal cheliceral brush very short, extending less than half the length of the digitus mobilis. *Tarsus I* without claws or ambulacra ; leg II distinctly broader than leg I, with stout tarsal spines ; genu IV (fig. 73) with eight setae ;  $al_1$ ,  $av_1$  and  $pl_1$  smooth or nearly so ;  $pd_1$  strongly plumose, extending well beyond insertion of strongly plumose  $pd_1$  ;  $ad_{1-2}$  and  $pd_2$  (the additional seta) plumose ;  $ad_2$  and  $pd_2$  of tarsus IV subequal, strongly pectinate and nearly extending to the distal setal complex (fig. 72) ; seta *md* plumose distally.

#### MALE and IMMATURES.

Unknown.

#### HABITAT and LOCALITY.

One female from the Congo ; 22 August, 1951 ; H. DE SAEGER, coll. (? host) (Congo Collection No. 2287). The holotype female will be placed in the collection of the Institute of National Parks, Congo and Ruanda-Urundi, Brussels, Belgium.

There can be little doubt that *N. vanstraeleni* n. sp. is closely related to BERLESE's *N. afrum*. One can separate the two species primarily on the basis of the length and type of setae  $ad_2$  and  $pd_2$  of tarsus IV, and on the dorsal shield setation. The presence of eight setae on genu IV (fig. 73), and the type of setae noted there, presents a picture very similar to that found in those specimens of *afrum* possessing eight genual setae. It certainly is possible that *N. vanstraeleni* occupies still another morphological locus in the *afrum* "complex" and is, in fact, conspecific with it. The author prefers to refer to it as a distinct species at this time, on the basis of the morphological features noted above.

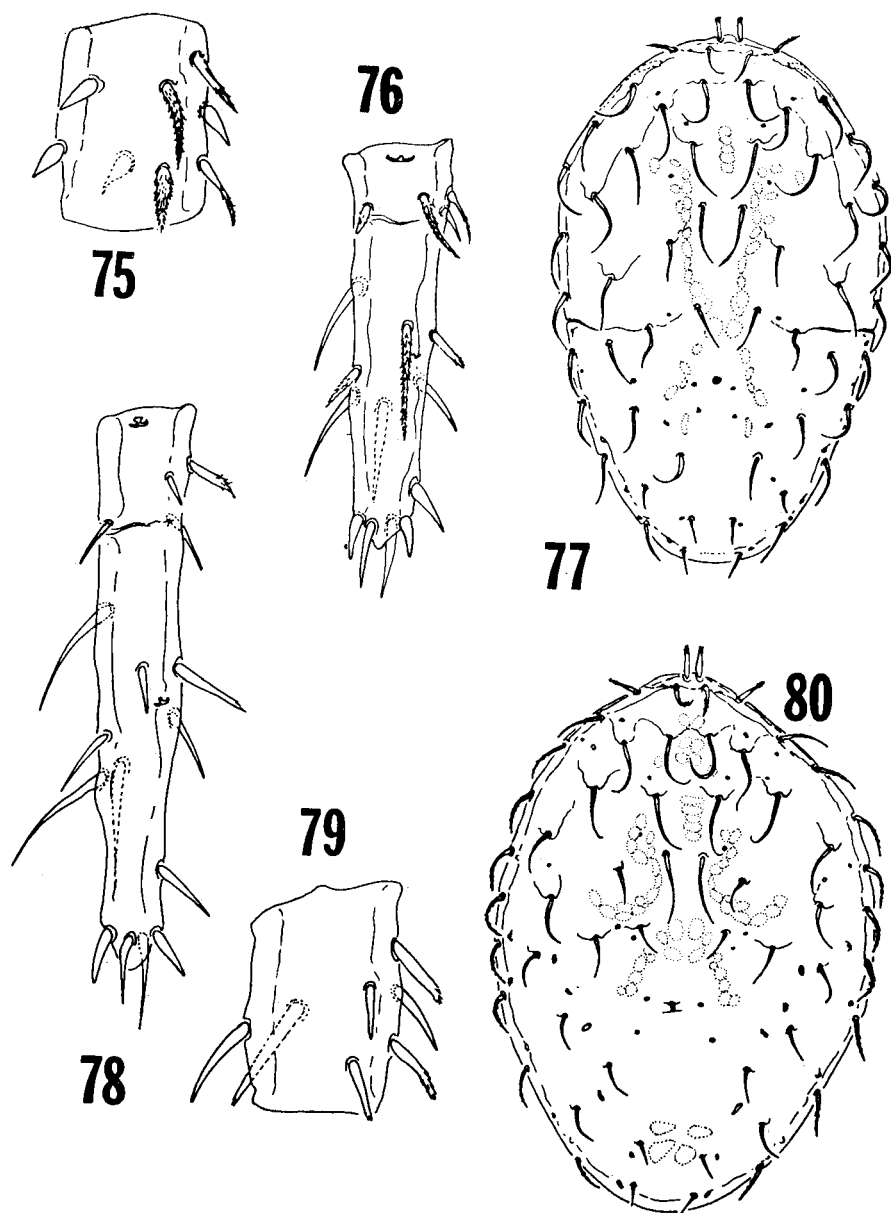
#### ***Neopodocinum verschureni* n. sp.**

FEMALE (Pl. VII ; 61, 63, 64 : figs. 74-76). Length of idiosoma averages 1530  $\mu$ , with a range of 1500-1560  $\mu$  ; width of idiosoma at coxae II averages 915  $\mu$ , with

a range of 900-930  $\mu$ . *Dorsal shield* (fig. 74) punctate, with anterior and lateral ridges and clefts; with 28 pairs of setae and an unpaired  $D_x$ ;  $D_1$  short, plumose, rounded, with  $M_1$  being about half its size; setae  $D_2$ - $D_3$  and  $M_2$  very weakly pectinate; other observed dorsal D setae smooth;  $Mg_2$ ,  $Mg_{4-9}$  weakly pectinate, usually not quite attaining the insertions of the setae behind them; setae  $L_1$  not observed. *Sternal shield* (Pl. VII; 64) not excavated posteriorly, strongly punctate and with lateral portions of l. m. t. well developed (one side of the paratype female has no l. m. t. while the other is well developed); with strong sclerotized clefts above insertions of sternals III; sternal setae smooth. *Metasternal shields* absent, or nearly so; metasternal setae shorter than sternals, pores anterior to setae. *Epigynial shield* uniformly punctate, convex posteriorly, and with a pair of smooth setae posterolaterally; epigynial setae subequal in length to sternals; pores in the integument behind shield. With at least 30 pairs of perianal setae in the closely striated integument, of which only the more anterior pairs are smooth; others are lightly pectinate and very long, easily surpassing the setal insertions behind them. *Peritremes* meeting stigmata posteriorly, each looping anteriorly and proceeding anterolaterally and dorsally to a point slightly laterad of setae  $M_1$ . Basal spines of *tectum* small to minute; more anterior spines well developed. Hypostomal setae I-II broad basally; setae II longer than setae I; setae III short, spinose, less than  $1/3$  the length of setae II; deutosternal setae similarly short and spinose. With five rows of deutosternal teeth, which average from 12-18 small (often blunt) teeth/row. *Chelicera* (Pl. VII; 61) with typical dentition; internal cheliceral brush short, extending only half the length of the digitus mobilis. *Tarsus I* without claws or ambulacra; tarsi II-IV with both of the above; leg II considerably stouter than leg I; tarsal spines large and well-developed; genu IV (fig. 75) with eight setae, of which  $ad_{1-2}$  and  $pd_{1-2}$  are plumose, other setae, including  $pl_2$ , are short, broad and smooth. Seta  $pd_2$  of tarsus IV long and strongly plumose,  $ad_2$  half as long as  $pd_2$ , spinose, slightly plumose distally (fig. 76); setae  $pl_{2-3}$  of pretarsus and tarsus IV plumose; seta  $md$  smooth.

MALE (Pl. VII; 62, 63). Length of idiosoma = 1110  $\mu$ ; width of idiosoma at level of coxae II = 690  $\mu$ . *Dorsal shield* similar to that of female; setae of male compare closely with those setae which are present on available female specimens; dorsal setae smooth, or nearly so (except for  $D_1$  and  $M_1$ ), never surpassing insertions of setae behind them. *Sternitigenital shield* (Pl. VII; 62) punctate, truncate posteriorly and with well developed lateral portions of l. m. t., and clefts above insertions of setae III; with five pairs of smooth spinose setae. Perianal setae mostly long and pectinate as in female. Anal shield, peritremes and stigmata as in female. *Gnathosoma* as in female, except for the presence, on the digitus mobilis of the *chelicera* (Pl. VII; 63), of a rounded sperm transfer organ which is only slightly hooked distally; internal cheliceral brush short and quite weakly plumose. With a strong medioventral femoral spur on leg II; much smaller protuberances present on genu and tibia II; tarsus IV without well defined medioventral spur; genu IV





FIGS. 75-76. — *Neopodocinum verschurenii* n. sp.

Fig. 75. — Genu IV of female ; Fig. 76. Tarsus IV of female.

FIGS. 77-80. — *Neopodocinum wenzeli* n. sp.

Fig. 77. — Dorsum of deutonymph ; Fig. 78. — Tarsus IV of female ;

Fig. 79 — Genu IV of female ; Fig. 80. — Dorsum of female.

with eight setae; setae  $pd_2$  and  $ad_2$  of tarsus IV as in female; medioventral spur small; seta  $pd_2$  of genu IV appears longer than that of female.

#### IMMATURE STAGES.

Unknown.

#### LOCALITY and HABITAT.

Two females and one male from the Congo Republic; "ex savane herbeuse; avec coprophage;" J. VERSCHUREN, coll. (Congo Collection No. 1994). The holotype female and allotype male will be deposited in the collection of the Institute of the National Parks of the Congo and Ruanda-Urundi, Brussels, Belgium. The paratype female will be placed in the collection of the U. S. National Museum, Washington, D. C.

#### **Neopodocinum wenzeli** n. sp.

FEMALE (Pl. VII; 65-67: figs. 78-80). Length of idiosoma averages 1245  $\mu$ , with a range of 116-1350  $\mu$ ; width of idiosoma at level of coxae II averages 813  $\mu$ , with a range of 750-870  $\mu$ . *Dorsal shield* strongly punctate and reticulate (fig. 80), with 28 pairs of setae;  $D_1$  stout, quite long, and pectinate distally;  $M_1$  also long and distally pectinate; setae  $D_2$  pectinate, as are most of the Mg setae ( $Mg_3$  and  $Mg_{10}$  are smooth); others are smooth or nearly so;  $M_2$  distinctly posterior to line between  $D_3$  and  $L_1$ ;  $D_3$ ,  $M_2$ ,  $L_1$  and other anterior setae commonly looped distally; none of the opisthosomal setae long enough to reach insertions of setae behind it;  $D_x$  not seen. *Sternal shield* (Pl. VII; 66) punctate-reticulate, broad medially, without deep posterior excavation; with lateral portions of l. m. t.; sternal setae long, thin and smooth, as are metasternals. *Epigynial shield* with punctate pattern, with a pair of long smooth setae laterally; epigynial pores off shield. With less than 30 pairs of pectinate and smooth perianal setae, most of which do not surpass the setal insertions behind them; *anal shield* punctate, anal opening more anterior than most other species of the genus. *Stigmata* between coxae III-IV; peritremes join stigma anterolaterally, and each continue anteriorly and dorsally to a point laterad of setae  $M_1$ . *Tectum* with strong basal spines; hypostomal setae II long, spinose, over twice the length of setae III; setae I nearly as long as setae II; deutosternal setae smooth, somewhat longer than setae III. With five rows of small to minute deutosternal teeth, averaging from 22-34 teeth/row. Median tooth of digitus mobilis of *chelicera* (Pl. VII; 65) with a cleft distally; internal cheliceral brush strongly plumose, extending little more than half the length of the digitus mobilis. *Tarsus I* with a membranous ambulacrum, but without claws; leg II distinctly stouter than leg I, with well-developed spines on tarsus II; with seven smooth or weakly plumose setae on genu IV (fig. 79);  $ad_2$  of tarsus IV (fig. 78) nearly twice the length of  $pd_2$ ;  $ad_2$  weakly plumose distally;  $pd_2$  smooth, or nearly so.

DEUTONYMPH (Pl. VII ; 68 : fig. 77). Length of idiosoma = 860  $\mu$  ; width of idiosoma at level of coxae II = 510  $\mu$ . *Dorsal shield* (fig. 77) punctate and weakly reticulate, with narrow lateral incisions behind setae  $Mg_5$  ; dorsum with 28 pairs of setae, of which all but  $D_1$  and  $M_1$  are smooth or nearly so ; setal placement and condition similar to that of female ;  $D_x$  not seen. *Sternal shield* (Pl. VII ; 68) punctate-reticulate ; lateral portions of l. m. t. well developed, and connected medially by a punctate line ; with four pairs of smooth subequal setae. With considerably less than 30 pairs of smooth or pectinate perianal setae ; anal shield typical for genus. *Peritremes* with origins similar to that of female, each extending anteriorly and dorsally to a point posterolaterad of setae  $M_1$ . Tarsi I with well-developed ambulacra and a pair of distinct claws ; other legs as in female.

MALE, PROTONYMPH and LARVA.

Unknown.

HABITAT and LOCALITY.

Four females and a deutonymph from Turkestan ; ex *Homalocopris tmolus* Fisch (Chicago Natural History Museum Collection). The holotype female and deutonymph will be deposited in the collection of the U. S. National Museum, Washington D. C. Paratypes will be placed in the collections of the Chicago Natural History Museum, Chicago, Illinois, Oregon State University, Corvallis, Oregon, and the British Museum (Natural History), London.

#### SPECIES INCERTAE SEDIS.

##### *Neopodocinum rhinolophi* Oudemans.

*Neopodocinum rhinolophi* (? deutonymph) OUDEMANS, A. C. (1914). *Ent. Ber.* (Nederland) 4 : 67 ; OUDEMANS, A. C. (1915). *Archiv. für Naturg. Berlin* 81 : 122 ; VITZTHUM, H. G. (1926). *Treubia* 8 : 41.

The confusion connected with the original and subsequent descriptions of *N. rhinolophi* by OUDEMANS (1914, 1915) was discussed in a footnote earlier in this paper (page 146). The author has seen no immature specimens which could be referred to this species. *N. rhinolophi* was collected from a beetle species of the genus *Rhinolophus* in Khandala, Bombay, India.

##### *Neopodocinum nederveeni* Oudemans.

*Neopodocinum nederveeni* (♂) OUDEMANS, A. C. (1903). *Ent. Ber.* (Nederland) 14 n. s. : 100 ; OUDEMANS, A. C. (1904). *Tijdschr. v. Ent.* 47 : 118 ; VITZTHUM, H. G. (1926). *Treubia* 8 : 41.

*N. nederveeni* cannot be identified satisfactorily on the basis of only male characters, and thus has not been assigned valid status in the genus. The presence of claws on legs I, and the arrangement of dorsal setae, preclude conspecificity with *N. jaspersi*, which it seems to resemble in various other ways. It is of particular interest that *N. nederveeni* and *N. vosi* (see below) were collected from the same habitat and locality (Sumatra, on *Catharsius* [? *Copris*] *molossus*), and by the same collector. Furthermore, the two species were described from two different stages — *N. vosi* from the protonymph, and *N. nederveeni* from the male. The implication here appears obvious : — that *vosi* and *nederveeni* are different stages of the same species. The protonymph of *vosi*, however, was described as having no ambulacra on legs I, while the male of *nederveeni* was purported to have distinct ambulacral structures. Inasmuch as the presence of ambulacra in the adults of *Neopodocinum* appears to be coupled with the presence of claws in the protonymphal stage, the implication does not apply easily in this situation. It is possible that OUDEMANS had an imperfect protonymphal specimen, and that claws and ambulacra were overlooked. It also is conceivable, however, that the two forms collected from *Catharsius molossus* were indeed two different species, although observations on host and locality data for other species argue against it. Examination of OUDEMANS's collection in Leiden by the author failed to reveal the type specimens of either form.

*Neopodocinum vosi* Oudemans.

*Neopodocinum vosi* (protonymph) OUDEMANS, A. C. (1903). *Ent. Ber.* (Nederland) 14 n. s. : 100 ; OUDEMANS, A. C. (1904). *Tijdschr. v. Ent.* 47 : 117 ; OUDEMANS, A. C. (1915). *Archiv. für Naturg. Berlin* 81 : 124 ; VITZTHUM, H. G. (1926). *Treubia* 8 : 41.

As mentioned above, *N. vosi* was collected from *Catharsius molossus* in Sumatra. It cannot be further identified in relation to the species described in this review.

*Cosmiphis bosschai* (Oudemans).

*Emeus bosschai* OUDEMANS, A. C. (1901). *Tijdschr. Nederl. Dierkund Vereeniging* 7 (2) : 290.

*Cosmiphis bosschai*, VITZTHUM, H. G. (1926). *Treubia* 8 : 88.

This species was described originally from a nymph (probably a deutonymph), and later expanded by VITZTHUM to include the description of the female. Although the female is figured as having over 35 pairs of dorsal setae, and claws are present on tarsi I, the general similarity of this species to members of the genus *Neopodocinum* is striking. *C. bosschai* possesses a narrow unipartite tectum, and a ventral aspect strongly suggestive of *Neopodocinum*. Specimens were not available, however, making impossible a critical evaluation of this species.

*C. bosschai* was collected from Borneo on "a *Copris*-like beetle".

# PHYLOGENETIC POSITION OF NEOPODOCINUM.

Mention was made in an earlier paper (KRANTZ 1960) of the apparent close relationship between the Macrochelidae and the family Parholaspididae. This relationship was shown to be almost completely morphological, the typical behavior patterns of one group being quite unlike those of the other. For example, most of the Macrochelidae are phoretic on insects (the genus *Geholaspis* and species of *Macrocheles* are exceptions) while the Parholaspididae are exclusively nonphoretic. The Neoparasitidae (or Rhodacaridae of various authors) also was felt to be closely related to the Macrochelidae, but again for morphological, rather than behavioral, reasons. It was postulated that a *Gamasellus*-like acarine was ancestral to both the Macrochelidae and the Parholaspididae. No mention was made in that paper of the family Pachylaelaptidae, which shares with the Macrochelidae a number of characteristics, both morphological and behavioral. The Pachylaelaptidae exhibit the habit of phoresy as well as a number of morphological characters which also are found in the Macrochelidae. It is in fact a likely assumption that the Pachylaelaptidae, along with the Macrochelidae and Parholaspididae, were derived from common neoparasitid-rhodacarid stock. The close relationship between the Macrochelidae and the Pachylaelaptidae is made all the more apparent in the study of representatives of the genus *Neopodocinum*.

The apparent affinity of *Neopodocinum* for the Pachylaelaptidae could indicate either that *Neopodocinum* is an intermediate form between the Pachylaelaptidae

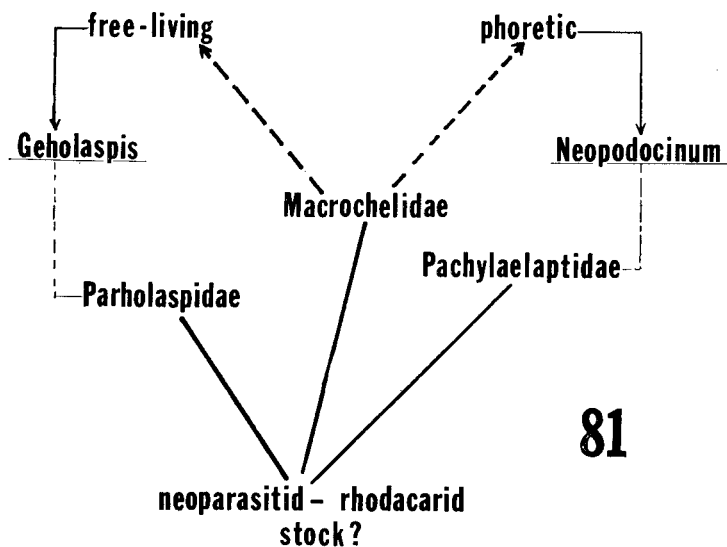


FIG. 81. — A dendrogram showing possible relationships between *Neopodocinum* and related taxa.

and the Macrochelidae, or that similar morphological characters have evolved independently in the Pachylaelaptidae and in *Neopodocinum*, the convergence being as a result of similar behavioral and habitat patterns. The author favors the latter theory over the former on the basis of the following assumptions :

1. If *Neopodocinum* is an intermediate group between the Pachylaelaptidae and the Macrochelidae, then the Macrochelidae would probably have evolved from the Pachylaelaptidae (absence of claws and/or ambulacra on legs I in most Macrochelidae, an advanced character) ; then :
2. *Neopodocinum* would have to be considered as highly developed pachylaelaptids, or as primitive macrochelids. The absence of claws and of ambulacra, and the presence of a peritremetal loop in many species of *Neopodocinum*, in addition to the presence of cheliceral brushes in all species, would tend to place the genus in the Macrochelidae rather than in the Pachylaelaptidae. Then :
3. Considering *Neopodocinum* to be a macrochelid genus and, by the above definition, a primitive group, the derivation of free-living macrochelids such as *Geholaspis* would be difficult to trace, inasmuch as this group exhibits many primitive morphological and behavioral characters. Such a theory might, therefore, necessitate adherence to the belief of a polyphyletic origin for the Macrochelidae. As stated in the paper referred to earlier (Krantz 1962) the Macrochelidae is a well-defined, well-integrated group which does not lend itself easily to the polyphyletic theory.

If the theory of convergence is followed for *Neopodocinum* and Pachylaelaptidae, then it is necessary also to relate the several other phoretic macrochelid genera to the same convergence. This creates a dichotomy in the Macrochelidae, one part of which comprises the comparatively small group of free-living, non-phoretic macrochelids exemplified by *Geholaspis*, and the other consisting of *Neopodocinum* and related phoretic genera. The position of the genus *Geholaspis* might then be considered isomeric to that of *Neopodocinum*, occupying a position between the free-living Parholaspididae and the free-living Macrochelidae (fig. 81). Thus, the basic and important behavioral divergence resulting in phoresy is intrafamilial in the Macrochelidae, but the apparent relationship of *Neopodocinum* to phoretic groups other than the Macrochelidae is due to morphological convergence between families, or portions of families, exhibiting similar phoretic behavior.

#### SUMMARY.

The genus *Neopodocinum* is expanded so as to include *Coprolaelaps* Berlese, and the diagnosis of the family Macrochelidae is emended. Descriptions of the following new species are given :

*Neopodocinum benoiti*, *emodi*, *emodioides*, *javensis*, *magna*, *setosum*, *tshambi*, *vanderhammeni vanstraeleni*, *verschureni*, and *wenzeli* n. spp. The variety *benoiti ectopothrix* also is described.

The following new combinations and synonymies are proposed :

*Neopodoconum caputmedusae* (Berlese), new combination for *Coprolaelaps caputmedusae* Berlese.

*Neopodocinum coprophilum* Vitzthum, synonym of *Neopodocinum maius* Berlese.

*Neopodocinum meridionalis* (Sellnick), new combination for *Coprolaelaps* (?) *meridionalis* Sellnick.

*Neopodocinum spinirostris* (Berlese), new combination for *Megalolaelaps spinirostris* Berlese.

Keys to females and known males are presented.

#### ACKNOWLEDGEMENTS.

The author would like to express his thanks to the following persons for making material available for study ; Dr. E. W. BAKER, U. S. National Museum, Washington, D. C. ; Dr. R. E. WENZEL, Chicago Museum of Natural History, Chicago, Illinois ; the late Dr. Antonio MELIS, Stazione di Entomologia Agraria, Florence, Italy ; Dr. P. L. G. BENOIT, Musée Royal de l'Afrique Centrale, Tervuren, Belgium ; the late Dr. V. VAN STRAELEN, Institut des Parcs Nationaux, Congo et Ruanda, Brussels, Belgium ; Dr. L. VAN DER HAMMEN, Rijksmuseum van Natuurlijke Historie, Leiden, Holland ; Dr. W. MICHERDZINSKI, Jagiellonian University, Krakow, Poland. The research and publication costs involved in this review have been provided by the National Science Foundation (Research Grant GB 2323), the U. S. Public Health Service (Research Grant No. AI-04693), the Institute of National Parks of the Congo and Ruanda-Urundi, Brussels, Belgium, and Oregon State University Agricultural Experiment Station (Technical Paper 1908).





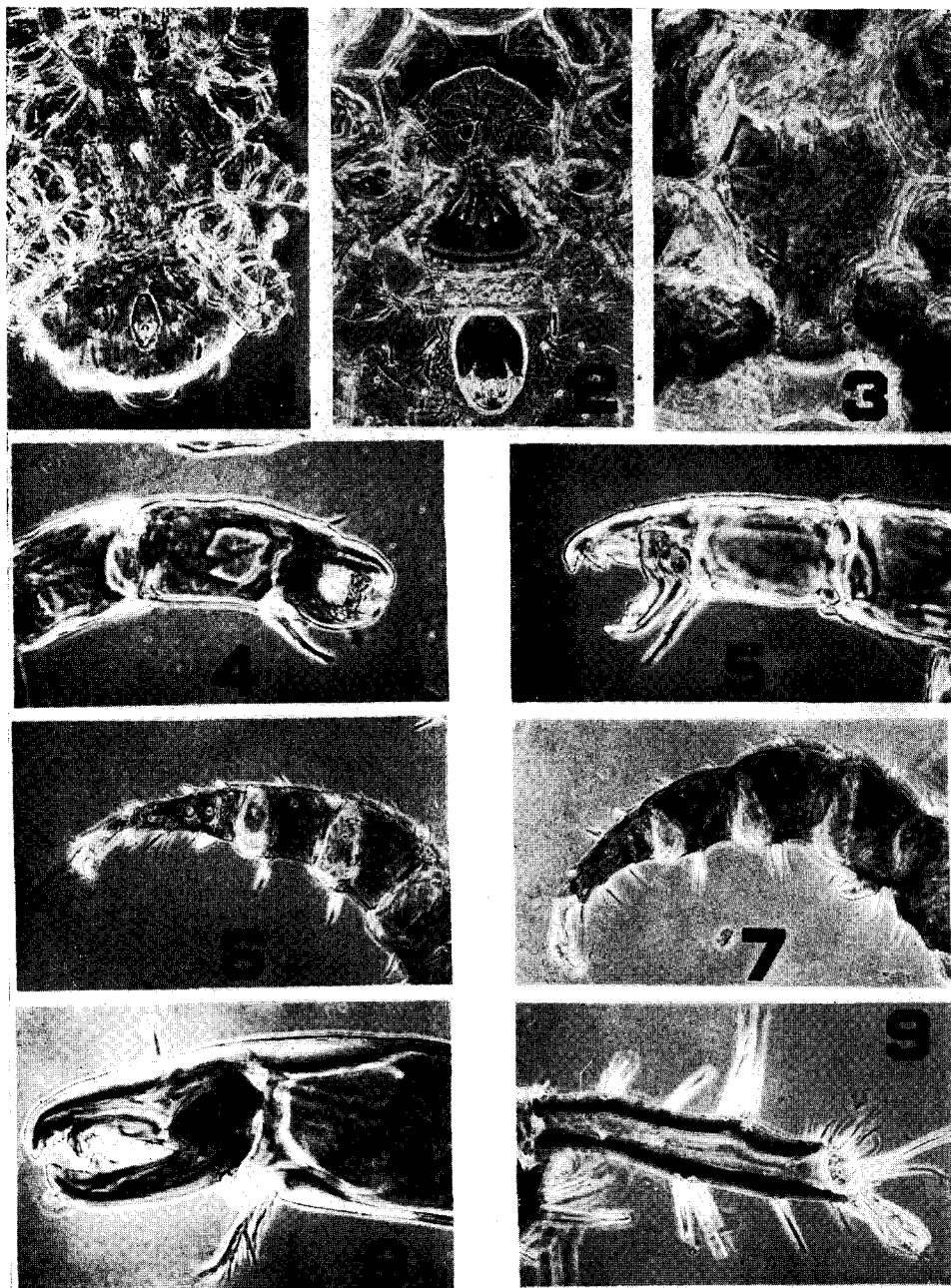


PLATE I.

Nos. 1-7. — *Neopodocinum afrum* Berlese.

1. Venter of deutonymph ; 2. Venter of female ; 3. Sternitigenital shield of male ; 4. Chelicera of male ; 5. Chelicera of female ; 6. Leg II of female, showing tarsal spines ; 7. Leg II of male, showing femoral spur.

Nos. 8-9. — *Neopodocinum bartkei* Micherdzinski.

8. Chelicera of female ;
9. Tarsus I of deutonymph, showing well-developed ambulacrum and claws.



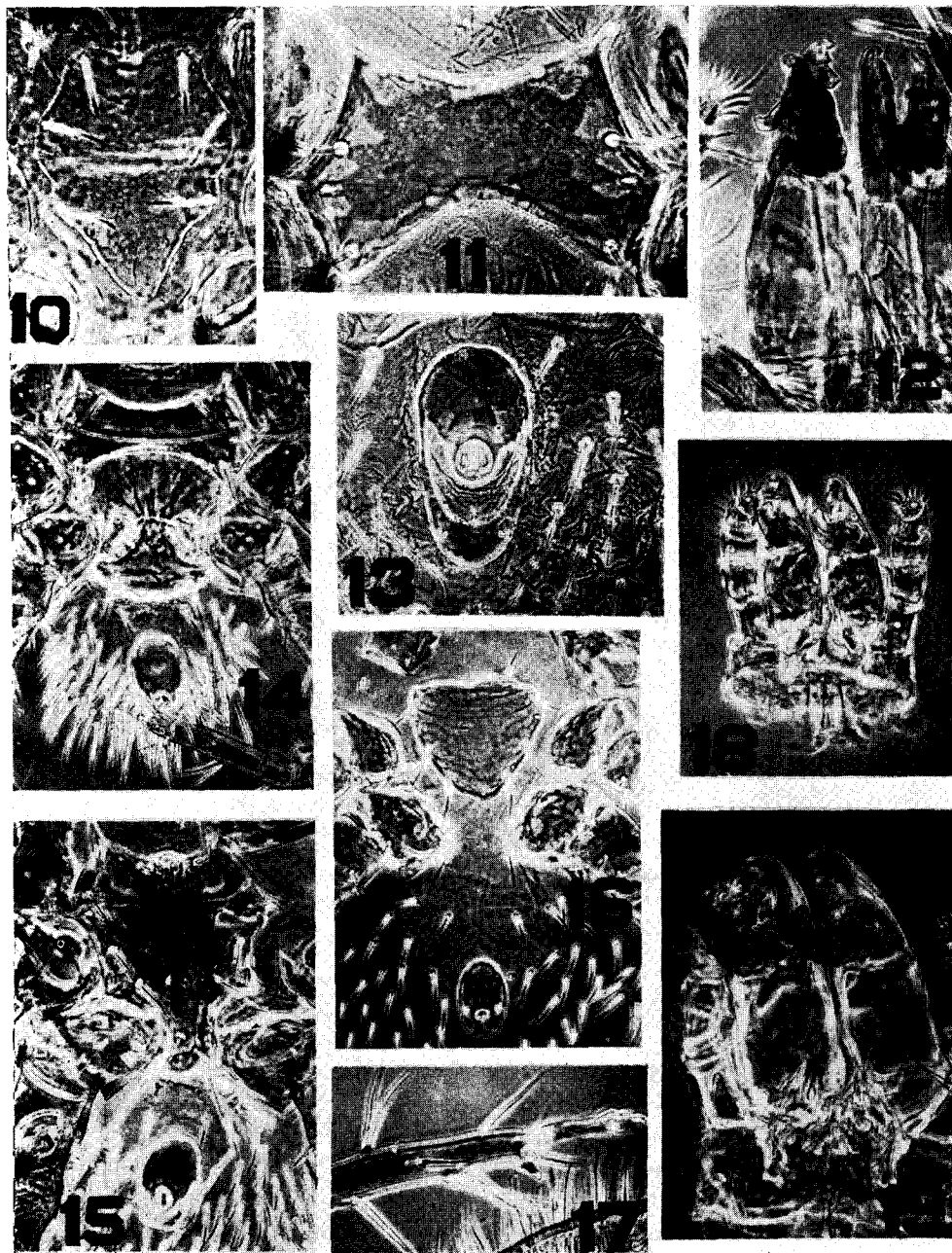


PLATE II.

Nos. 10-13. — *Neopodocinum barthei* Micherdzinski.

10. Sternal shield of deutonymph; 11. Sternal shield of female;  
12. Chelicerae of male; 13. Anal shield of female.

Nos. 14-19. — *Neopodocinum benoiti* n. sp.

14. Venter of female; 15. Venter of male; 16. Venter of deutonymph; 17. Tarsus IV of male, showing medioventral and distal spurs; 18. Gnathosoma of protonymph; 19. Gnathosoma of female.



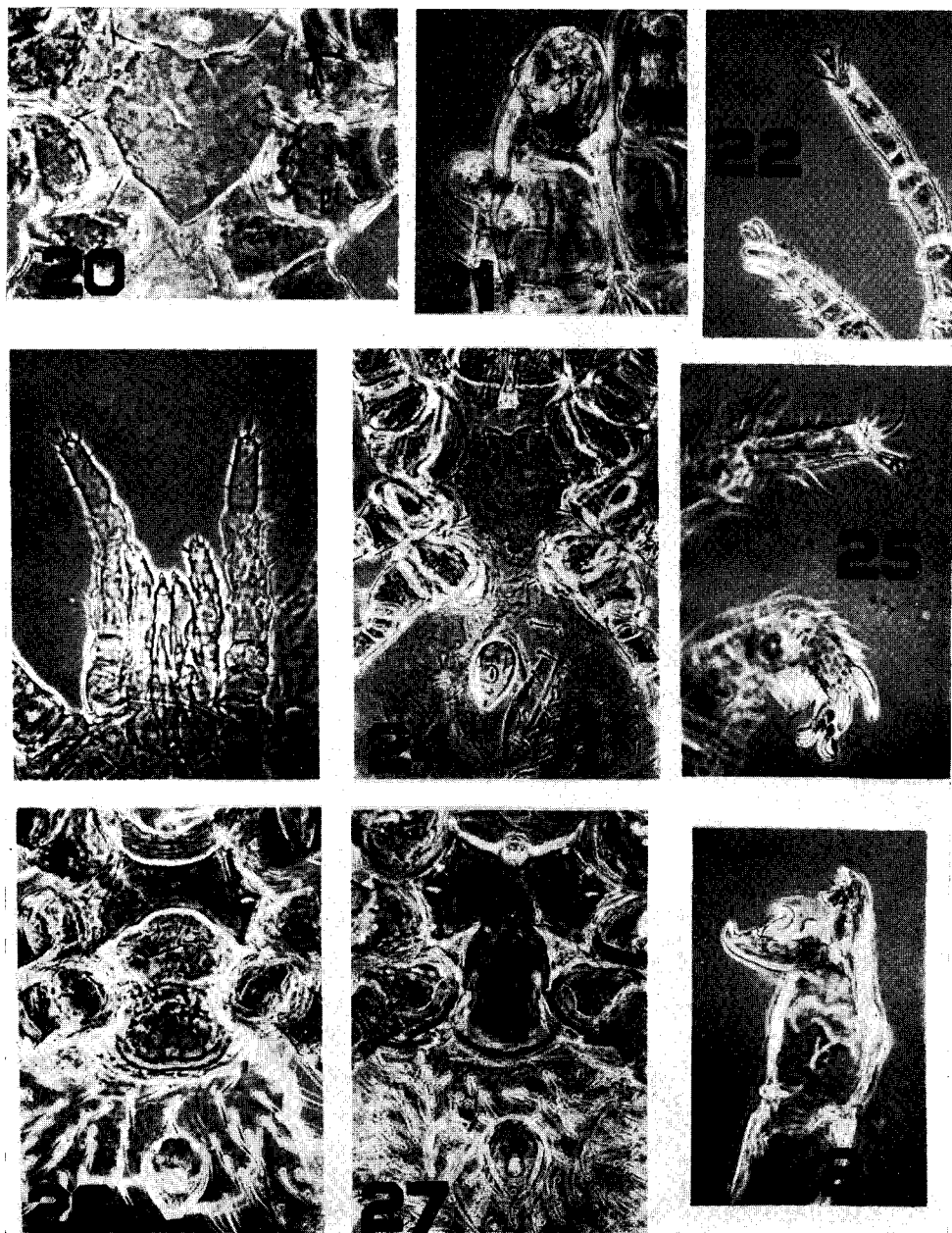


PLATE III.

Nos. 20-21. — *Neopodocinum benoiti* n. sp.

20. Sternal area of protonymph (pt = peritreme) ;  
21. Chelicera of male (sp = spermatophore transfer organ).

Nos. 22-28. — *Neopodocinum caputmedusae* (Berlese).

22. Tarsi I-II of deutonymph, showing distal tarsal spines of tarsus II and the ambulacrum and claws of tarsus I (anterior) ; 23. Gnathosoma and legs I of larva (developing deutonymphal members may be seen in the larval palps and in legs I) ; 24. Venter of deutonymph ; 25. Tarsi I-II of female ; 26. Venter of female ; 27. Venter of « normal » male ; 28. Chelicera of male.



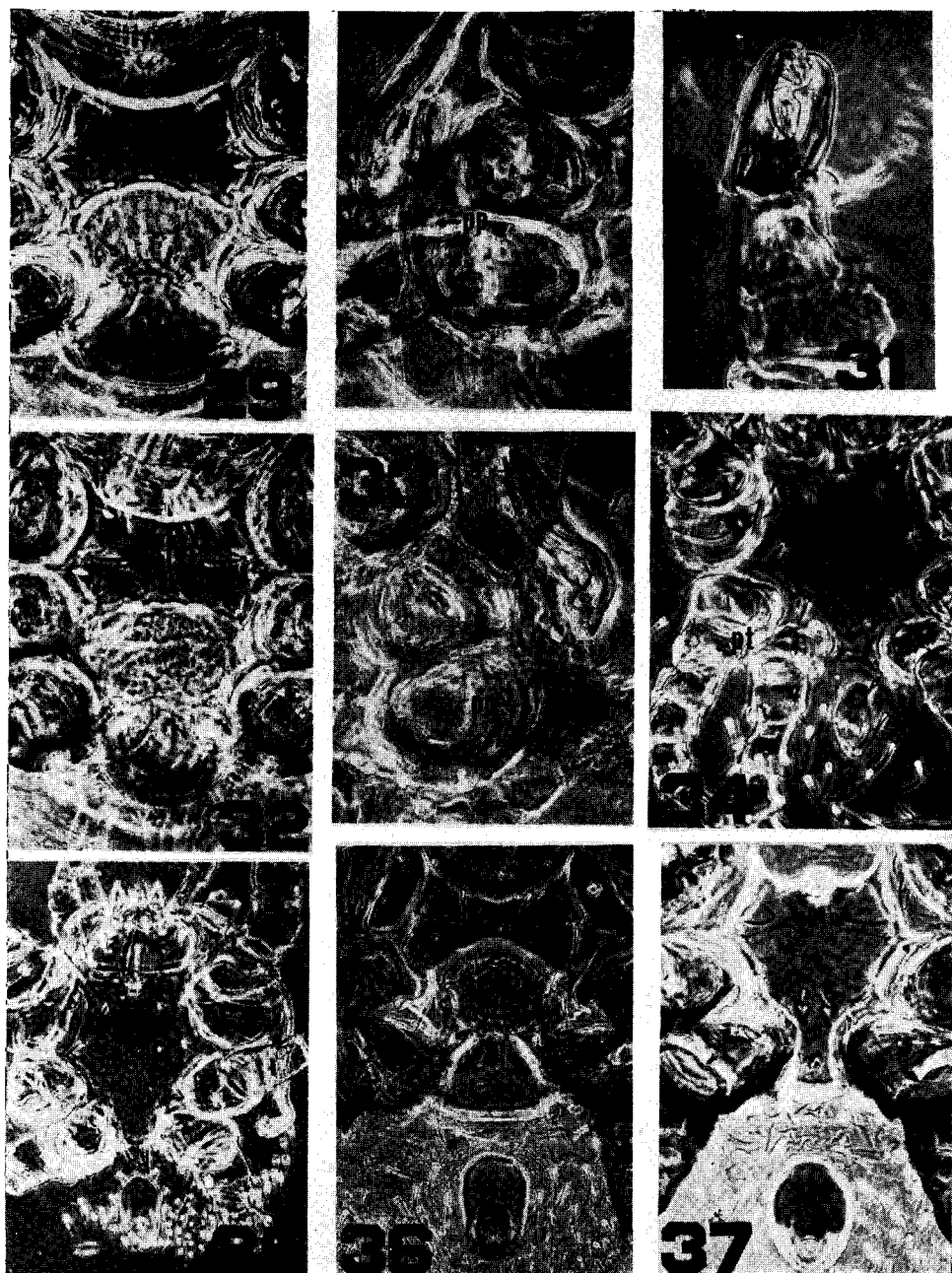


PLATE IV.

Nos. 29-31. — *Neopodocinum emodi* n. sp.

29. Venter of female ; 30. Parapodal-peritrematal region of female, showing extensive development of parapodal around coxae III-IV (pp = parapodal) ; 31. Chelicera of female.

Nos. 32-33. — *Neopodocinum emodioides* n. sp.

32. Venter of female ; 33. Parapodal-peritrematal region of female, showing limited parapodal development (pp = parapodal).

Nos. 34-37. — *Neopodocinum jaspersi* (Oudemans).

34. Venter of protonymph (pt = peritreme) ; 35. Venter of deutonymph ;  
36. Venter of female ; 37. Venter of male.





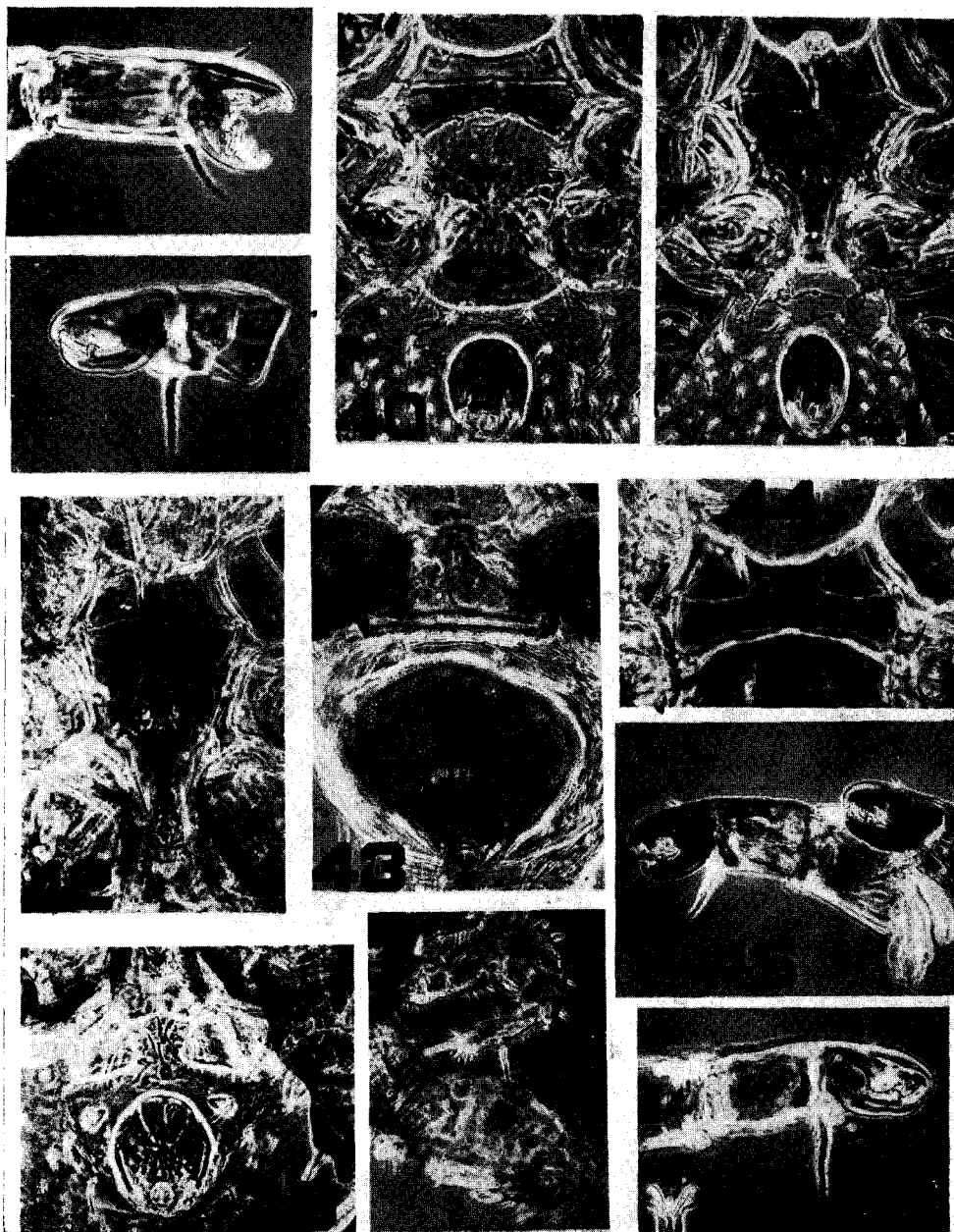


PLATE V.

Nos. 38-39. — *Neopodocinum jaspersi* (Oudemans).

38. Chelicera of male ; 39. Chelicera of female.

Nos. 40-41. — *Neopodocinum javensis* n. sp.

40. Venter of female ; 41. Venter of male.

Nos. 42-47. — *Neopodocinum magna* n. sp.

42. Sternitigenital region of male ; 43. Epigynial-anal region of female ; 44. Sternal shield of female ; 45. Chelicerae of female ; 46. Anal region of male, showing preanal platelets and post-epigynial sclerites ; 47. Tarsi I-II of female.

No. 48. — *Neopodocinum setosum* n. sp.

Chelicera of female.



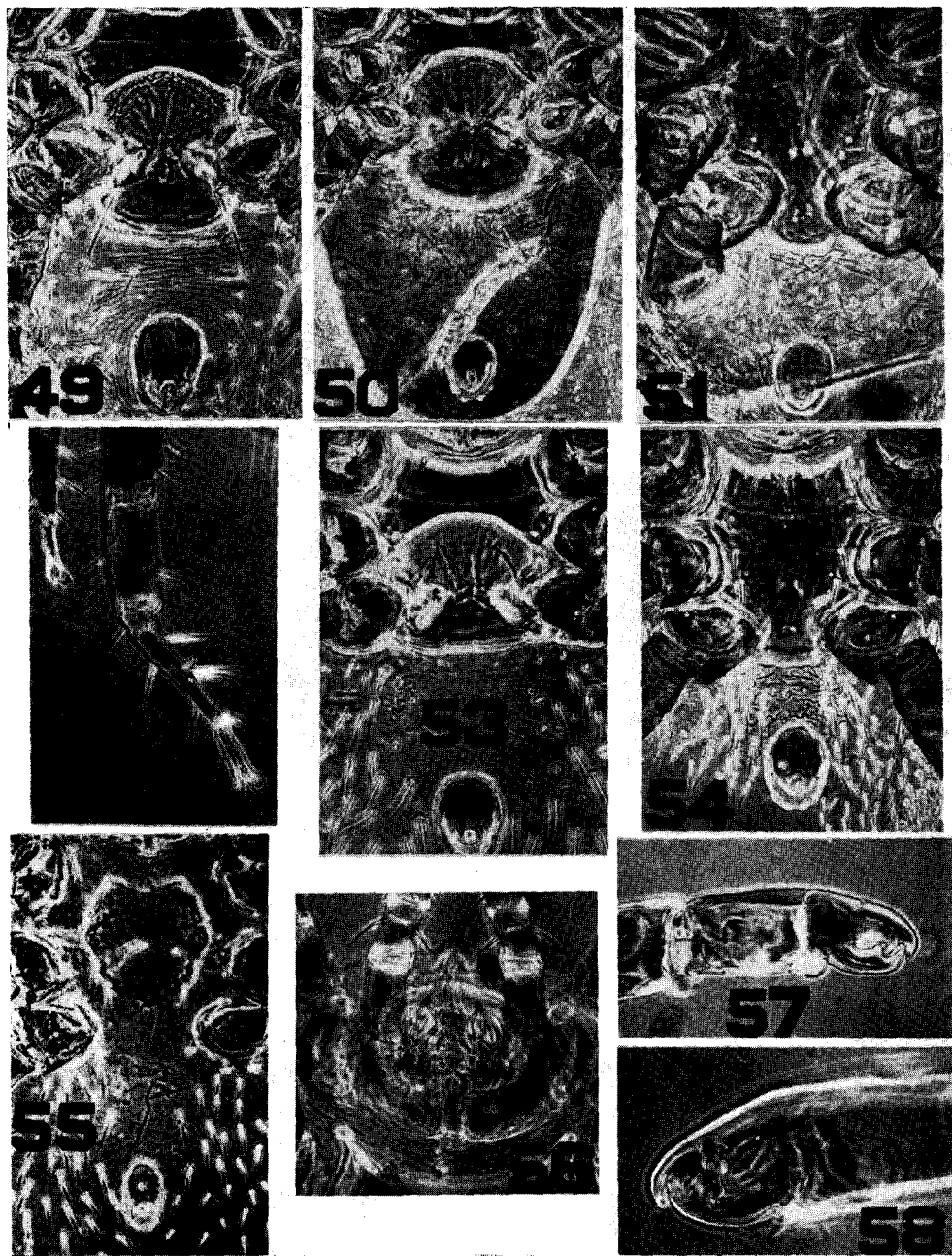


PLATE VI.

No. 49. — *Neopodocinum setosum* n. sp.  
Venter of female.

Nos. 50-52. — *Neopodocinum tshambi* n. sp.  
50. Venter of female ; 51. Venter of male ;  
52. Genu, tibia and tarsus IV of male.

Nos. 53-58. — *Neopodocinum vanderhammeni* n. sp.  
53. Venter of female ; 54. Venter of male ; 55. Venter of deutonymph ; 56. Venter of gnathosoma of female, showing blunt hypostomal setae II-III ; 57. Chelicera of female ; 58. Chelicera of male.



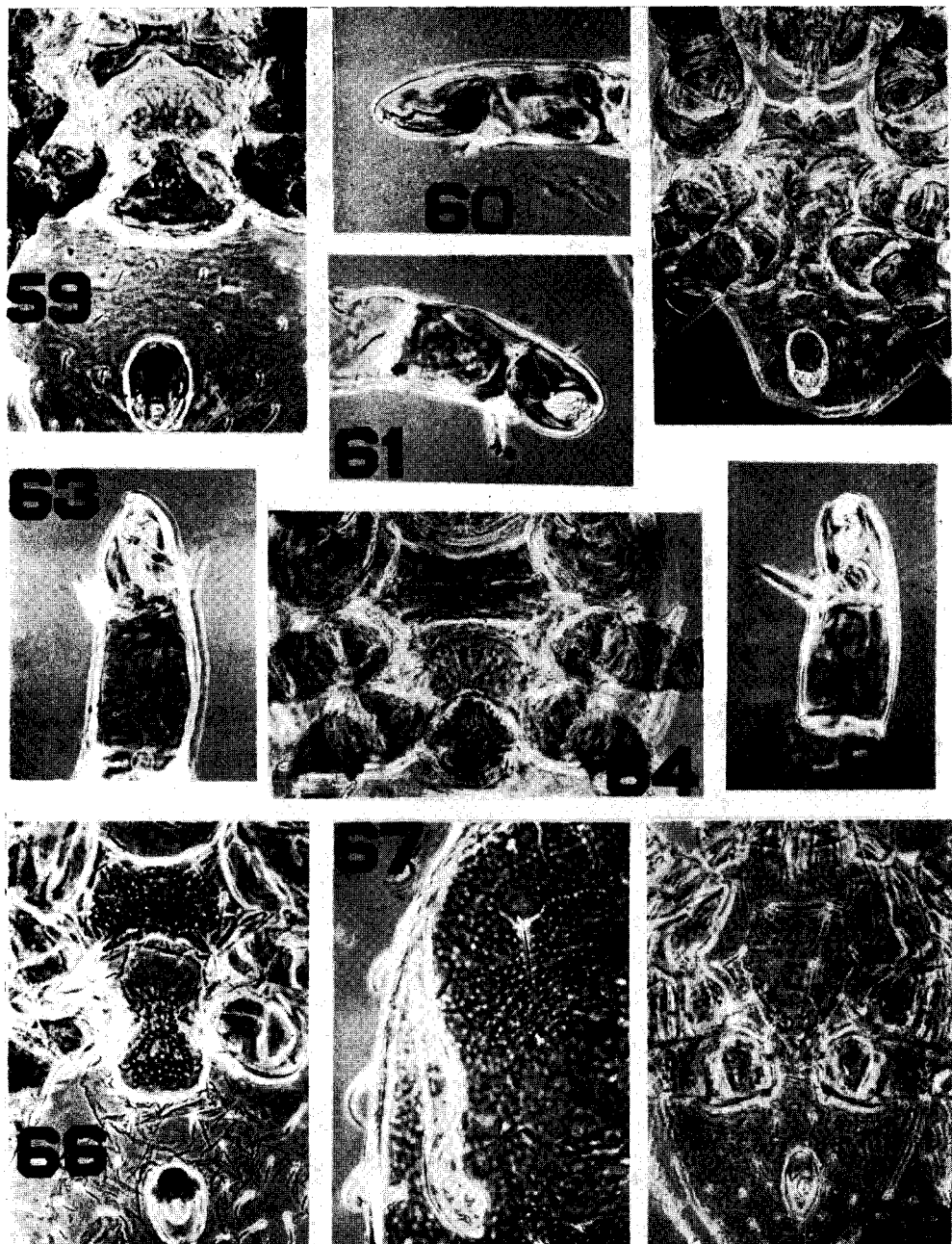


PLATE VII.

Nos. 59-60. — *Neopodocinum vanstraeleni* n. sp.  
59. Venter of female ; 60. Chelicera of female.

Nos. 61-64. — *Neopodocinum verschurenii* n. sp.  
61. Chelicera of female ; 62. Venter of male ;  
63. Chelicera of male ; 64. Venter of female.

Nos. 65-68. — *Neopodocinum wenzeli* n. sp.  
65. Chelicera of female ; 66. Venter of female ;  
67. Sculpturing of female dorsal shield ; 68. Venter of deutonymph.



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ERRATA

G. W. KRANTZ. A review of the genus *Neopodocinum* Oudemans 1902 (Macrochelidae). *Acarologia*, 7 (2) : 139-226, 1965.

The holotype and allotype specimens of *Neopodocinum magna* Krantz (p. 181) and *N. tshambi* Krantz (p. 193) will be sent to the Central African Museum, Tervuren, Belgium. Paratypes of both species will be deposited in the collection of the U. S. National Museum, Washington, D. C. (*G. W. Krantz*).

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Achevé d'imprimer le 1<sup>er</sup> Juillet 1965.

*Le Directeur Gérant* : Marc ANDRÉ.