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Description of six species of nothroid mites from Nigeria and Brazil (Acari: Oribatida: Nothroidea)

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ABSTRACT. Three new species of *Nothrus, N. lasebikani, N. incavatus* and *N. ifensis* from Nigeria, as well as one species, *N. seropedicalensis* from Brazil are described. A new genus, *Parallonothrus* comprising of two new species, *P. nigeriensis* and *P. braziliensis* were also described and the genus was assigned to a new Family Parallonothridae. A justification was made for the creation of this new Family to which the genus *Allonothrus* has been assigned. *Allonothrus tuxlasensis* was considered a synonym of *A. ghanaensis* and the creation of the genus *Parallonothrus* is considered inevitable pending the re-description of many species of *Allonothrus* and a re-definition of the genus so as to remove all doubts on the actual number of notogatral setae and the organisation of the notogaster as well as the morphology of the infracapitulum. All the new species were compared with related species in literature and each was found to display a unique combination of nothroid characters which other known species do not possess. The species also display a combination of characters of lower and higher oribatid taxa which led to the conclusion that the body of Nothroidea represents a transitional grade of organisation between lower and higher oribatid mites. Exploration of many more locations in the Ethiopian and Neotropical regions for more nothroid species followed by a comprehensive revision of the Superfamily Nothroidea were suggested as exercises which are long overdue.

Key words: acarology, taxonomy, new species, Oribatida, Nothroidea, Nigeria, Brazil

INTRODUCTION

Nothroid mites are cosmopolitan and their taxonomic diversity is very high. About 54 nominal species of *Nothrus* alone have been described (NORTON and PALMER 1991) and all of them are thelytokous. The Nothroidea *sensu stricto*

(NORTON and KETHLEY 1994) are a very important superfamily of Oribatida in the tropical rainforest floor as well as agroecosystems in Nigeria (BADEJO 1999). This superfamily, like many others in the western Ethiopian region has been poorly studied. The few known records of Nothroidea for example include three species of *Allonothrus* from Ghana (WALLWORK 1961), and recently, *Nothrus senegalensis* from Senegal (MAHUNKA 1992). The first indication of the occurrence of Nothroidea in Nigeria was given by LASEBIKAN (1974) and up till now, there is no detailed taxonomic investigation of this group from Nigeria. This study will be the first extensive diagnosis of nothroid mites from Nigeria and it is part of a series of taxonomic investigations embarked upon to describe other species of oribatid mites from Nigeria and Brazil.

Superfamily Nothroidea GRANDJEAN, 1954
Family Nothridae BERLESE, 1896
Genus *Nothrus* EWING, 1917

Nothrus lasebikani n. sp.
(figs 1-13)

ETYMOLOGY

Named after Prof. B. Adebayo LASEBIKAN, a pioneer oribatodologist in Nigeria.

MATERIAL EXAMINED

28 adults (females) and 8 juveniles collected from forest soil and litter in Ile-Ife (24 adults, 6 juveniles), and from *Pueraria phaseoloides* plot (4 adults (females), 2 juveniles) in International Institute of Agriculture (IITA), Ibadan in Nigeria.

Holotype: female from Ile-Ife, Nigeria. M.A. BADEJO col., June 2000, (specimen dissected for the description) deposited in the Museum of Natural History (MNH) at Obafemi Awolowo University, Ile-Ife, Nigeria.

Paratypes: 15 females and 4 juveniles from Ile-Ife, Nigeria 4 females and 2 juveniles from Ibadan, Nigeria. all deposited in MNH. 8 females and 2 juveniles from Ile-Ife deposited at Staatliches Museum für Naturkunde, Karlsruhe (SMNK), Germany.

DIAGNOSIS AND REMARKS

The unique features of Nothroidea possessed by *N. lasebikani* include the following: presence of lyrifissure *ian*, nine setae on the tarsus of the pedipalp and coupling of dorsal seta to solenidia on tibia I (GRANDJEAN 1954). The traits of Nothridae possesed by *N. lasebikani* are: 16 pairs of notogastral setae, the absence of the postero-antiaxial setae (or_3), and epimeral neotrichy (GRANDJEAN 1954, BALOGH and MAHUNKA 1983). It is remarkable, however, that the insertion points of

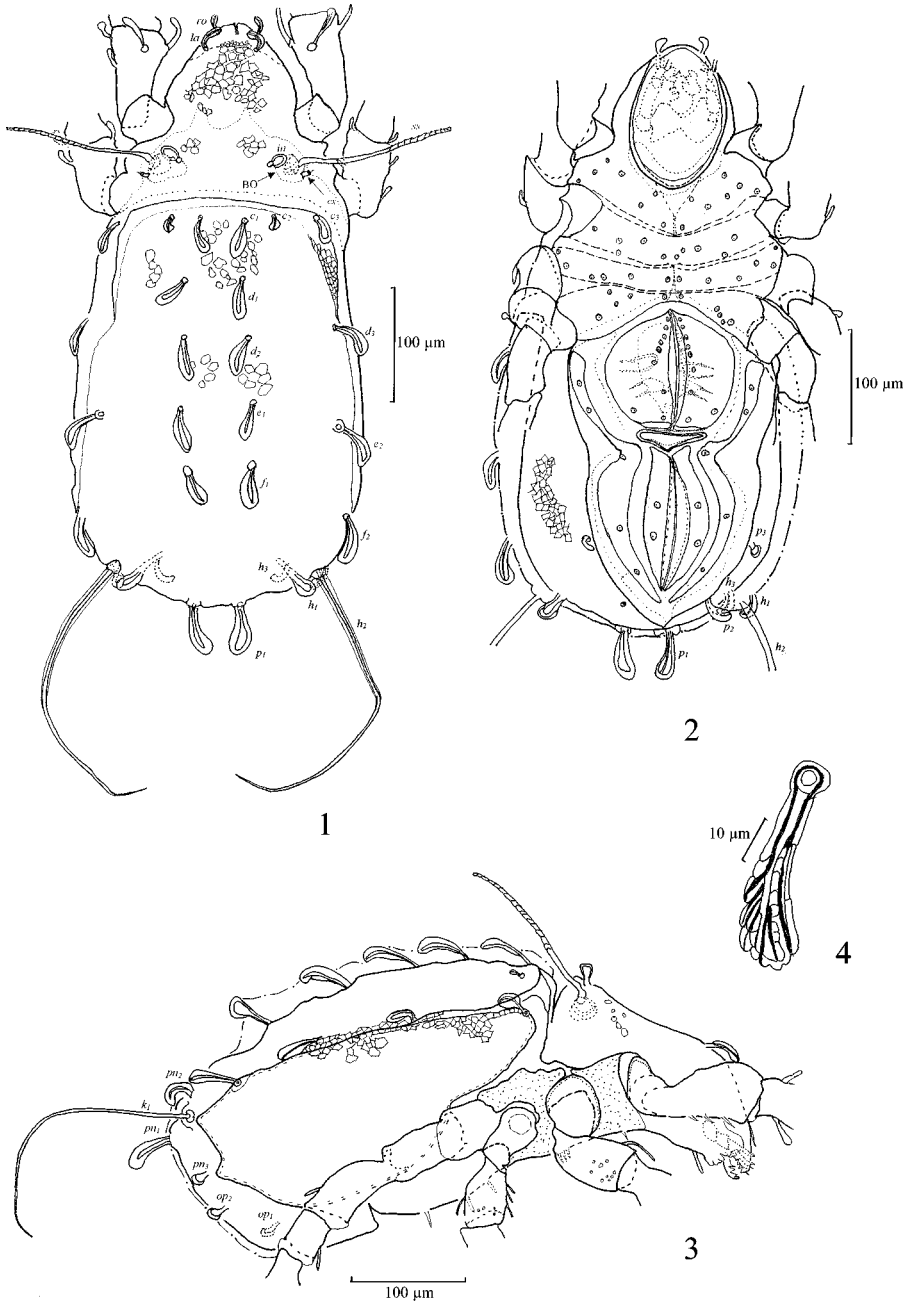
two pairs of aggenital setae were seen in all the specimens of *N. lasebikani* examined. This is not a known trait of Nothridae but a trait of *Heminothrus* and *Camisia* of the family Camisiidae as well as *Crotonia* and *Holonothrus* of the family Crotoniidae (Table 1), where epimeral neotrichy does not exist.

The popular definition of *Nothrus*, i.e.“ ... rostrum with median incision.....“ (BALOGH and BALOGH 1992), is also true for *N. lasebikani,* but the absence of aggenital setae in all known *Nothrus* could only make *N. lasebikani* an exception rather than putting it in another genus. This certainly is an indication that long standing definitions of taxonomic groups might eventually change when more specimens are collected from more locations in the world. When the diagnostic features of *Nothrus* was given by EWING in 1917 and GRANDJEAN in 1954, there was no known *Nothrus* from the Ethiopian region. *N. lasebikani* possesses a unique combination of characters which are found in many *Nothrus* species. Such traits include the following: very long seta k_1 (found in *N. espinarensis, N. palustris, N. mystax* and *N. senegalensis*,*;* relative sizes and position of c_2 in relation to c_1 (found in *N. senegalensis, N. pratensis, N. borussicus* and *N. mystax*) areolate prodorsum and notogaster as well as monodactylous tarsi (as in *N. senegalensis*). However, *N. lasebikani* differs from each of these species in many respects. These differences which include shape and construction of notogaster, shape and form of prodorsal setae, relative length and shape of sensillus, epimeral chaetotaxy, shape and form of notogastral setae most especially length of k_1 (Table 2) involve taxonomic features that are even sometimes diagnostic for some species. The solenidiotaxy of the legs of *N. silvestris*, an European species investigated by GRANDJEAN (1964) for example is (1-2-3), II (1-1-1), III (1-1-0), IV (1-1-0). *N. lasebikani* has less solenidia on its legs. This is one of the characters which in combination with others has given *N. lasebikani* the status of a new species in the family Nothridae. Lack of information on the leg solenidiotaxy of other species of Nothridae makes it impossible to make more detailed comparisons of this new species with other related species. There is, however, enough evidence from the description provided above that *N. lasebikani* belongs to the *´palustris*‘ group which has been discussed by MAHUNKA (1978).

DESCRIPTION

Measurements: length: 514-623 µm; width: 169-250 µm.

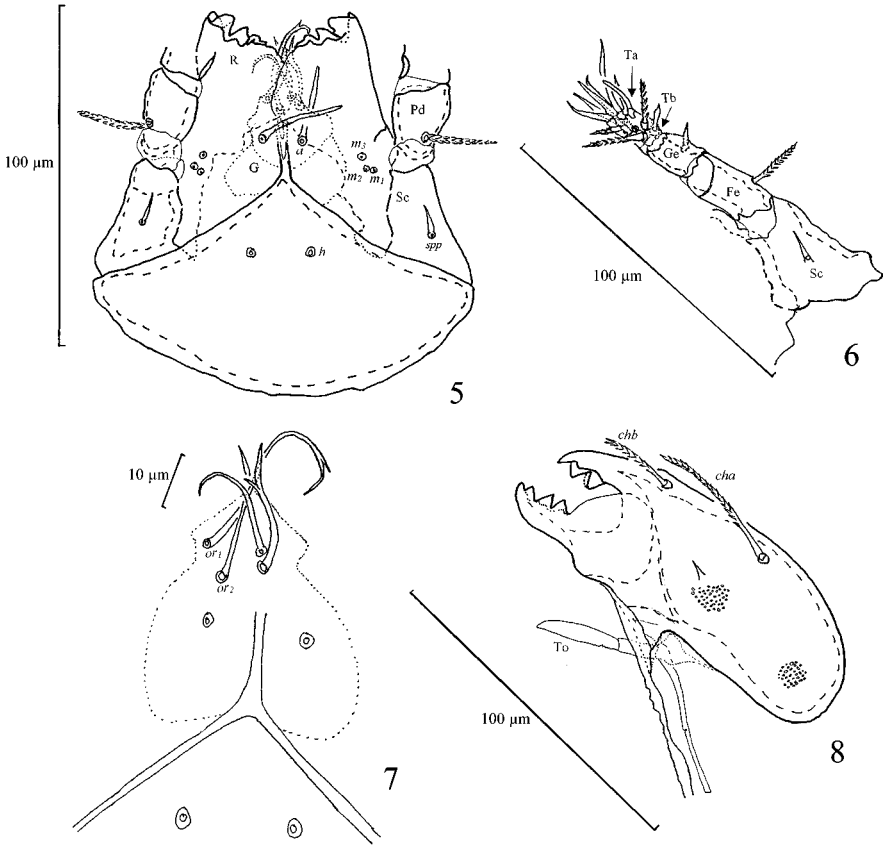
Integument: Brownish. The body is covered all over with cerotegument and adherent debris which occur in large patches on the entire dorsal and ventral surfaces. Virtually all specimens observed carry a heap of adherent debris on the notogaster in the area of and almost concealing the dorsal f_1 setae. Areas not covered with debris reveal a polygonal reticulate body surface comprising of alveoli of varying shapes and sizes. This pattern changes gradually to a pustulate body surface at the lateral edges of the notogaster and it gradually becomes reticulate again towards the ventral side (Figs. 1-3).



1-4. *Nothrus lasebikani* n. sp.: 1 - dorsal view, 2 - ventral view, 3- lateral view, 4 - notogastral seta

Prodorsum

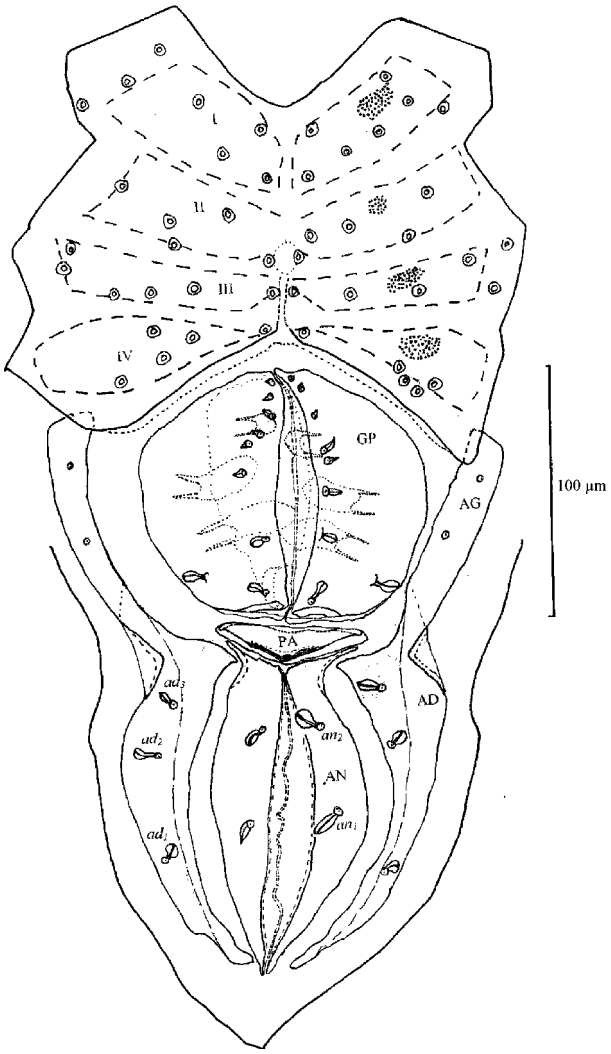
The rostrum has a conspicuous median incision (Fig. 1). The rostral (*ro*), lamellar (*la*) and interlamellar (*in*) setae are spatulate. Both the *ro* and *la* are arcuate but *la* is not only longer and bigger than *ro,* it also appears to be borne on an inner ridge which extends across the notogaster. This ridge which is seen through the integument forms a demarcation between posterior bigger foveoles and anterior smaller foveoles on the prodorsum. The *in* is somewhat squat in appearance. The sensillus (*ss*) is filliform and longer than the distance between the two bothridia (BO). It is spinose with the spines occurring alternately along the length of the seta. A tiny spiniform exobothridial seta (*ex*) is present right on the edge of the bothridia.



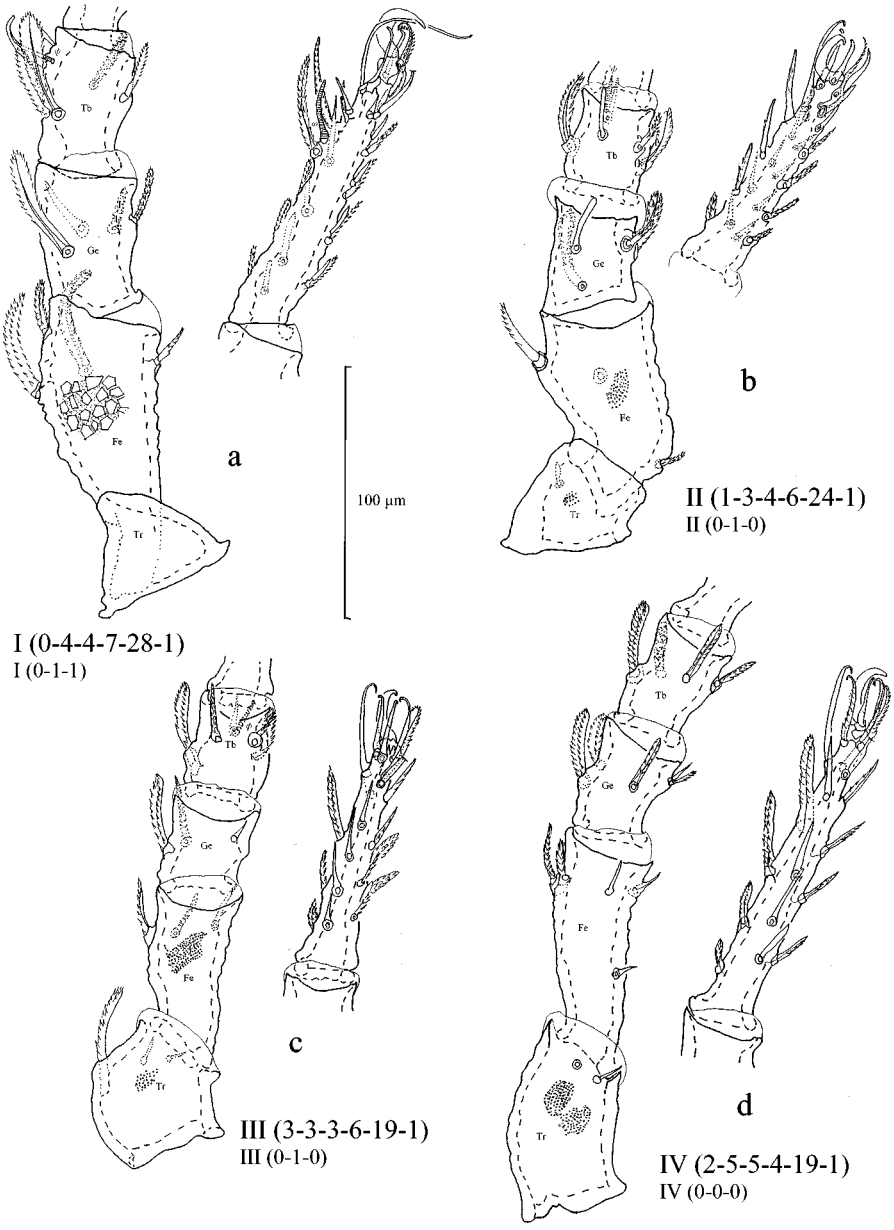
5-8. *Nothrus lasebikani* n. sp.- mouthparts: 5 - infracapitulum, 6 - pedipalp, 7 - adoral setae, 8 - chelicera

Notogaster

When viewed from above, the notogaster is pentagonal in shape. The anterior edge is straight while the posterior edge is convex. The lateral sides are more or less parallel to each other as each slants slightly inwards towards the anterior end (Fig. 1). There are 16 pairs of notogastral setae, 13 of which can be seen without much difficulty from the dorsal view. All setae except k_1 are spatulate with blunt conical ends. The lower one-third of each spatulate seta is entire while the distal part is organised into columns of overlapping lobes which gives it a wavy edge.



9. *Nothrus lasebikani* n. sp.: ventral region



10(a-d). *Nothrus lasebikani* n. sp.: legs

There is internal thickening of the scale right from the base through the entire length with the thickening extending into each lobe resembling closely the vein and veinlets of a dicotyledonous leaf (Fig. 4). Seta c_2 is about one-third of the size of c_1 and it is inserted at a position nearer to c_1 than c_3. Seta k_1 is very long (about half of the body length) and setiform. Three notogastral setae (pn_3, op_1 and op_2) can only be seen clearly from the lateral and ventral views (Figs. 2, 3) because they are located on the lateral part of the notogaster which has assumed a ventral position as it curves downwards to meet the ano-genital plates on both sides.

Ventral Region

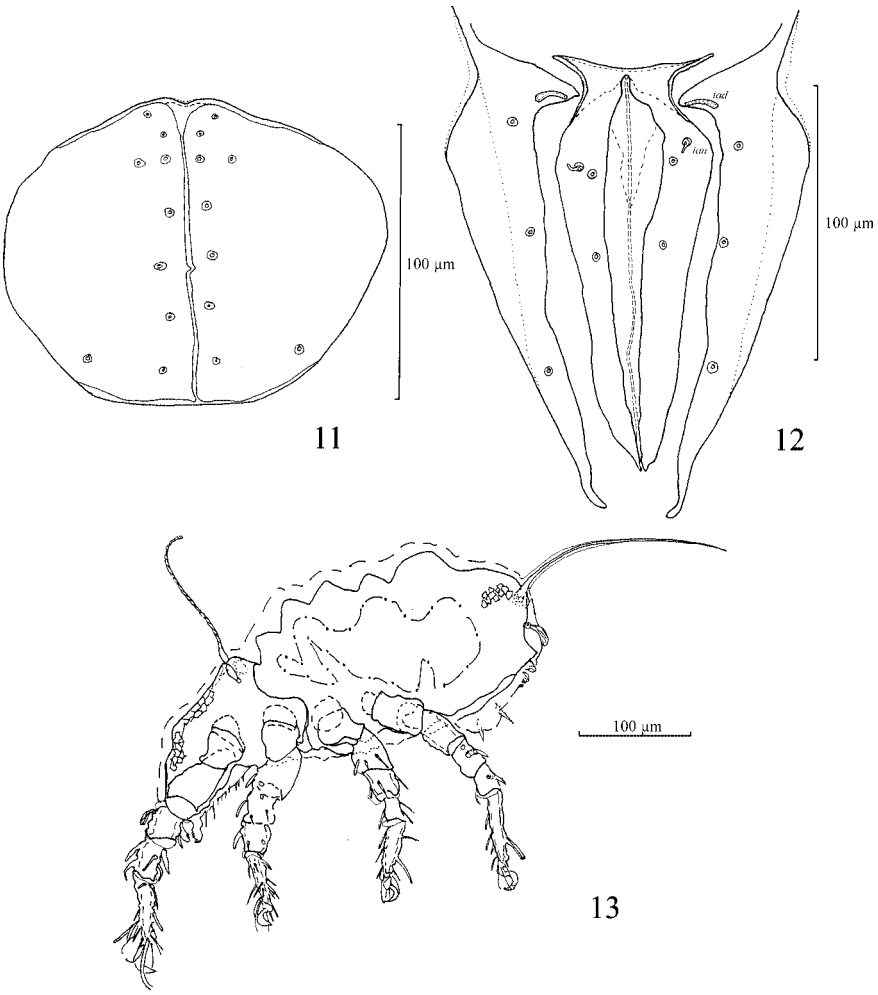
Mouthparts: The infracapitulum is the stenarthric type in which the labiogenal articulation is posterior to the base of the pedipalp with a conspicuous immovable supracoxal segment (Sc) (which bears a spine, *spp*) inbetween the pedipalp and the labiogenal articulation (Fig. 5). The articulation between the pedipalp and the infracapitulum is rather complex. The coxa of the pedipalp is completely lost within the supracoxal segment while an incomplete movable articulation exists between the femur and the mentum of the infracapitulum. The femur and genu bear one seta each while the tibia and tarsus bear three and nine setae respectively to give a setal formula of 1-1-3-9. The demarcation between the tibia and tarsus is hardly visible (Fig. 6). The rutellum (R) is equipped with well developed teeth with the protuding inner sides overlapping above the points of insertion of the adoral setae which are just two pairs (or_1 and or_2). The anterior adoral seta (or_1) is spiniform while the posterior adoral setae (or_2) is longer and bifurcated in such a way that one of the arms appears like a small branching spine off the main axis of the seta (Fig 7). The right or_2 of the holotype is longer than the left. The genu (G) bears one conspicuous pair of anterior smooth setae (*a*) and three pairs of smaller median smooth setae (m_1, m_2, m_3). A pair of posterior smooth setae (*h*) is present beneath the labio-genal articulation. The chelicerae is elongate, chelate-dentate and the fixed digit bears the lateral (*cha*) and dorsal (*chb*) setae both of which the distal two-thirds are organised into overlapping lobes (Fig. 8). One conspicuous spine is present on the antiaxial surface of the fixed digit which is uniformly foveolate. A Trägĺrdh's organ (To) which is displaced outside the chelicera in the figure is actually located within the chelicera.

Coxisternal region: The whole of the coxisternal region is covered with cerotegument which makes the real lines of segmentation hardly observable. These lines are covered by a layer of cerotegument which is thin along the midventral line and widens gradually towards the point of insertion of the coxae (Figs. 3, 9). Epimeral setal formula is 7-5-6-5.

Legs: Legs I and II are stout but leg II is shorter than leg I. Legs III and IV are thinner but leg IV is longer than leg III. Leg IV is also slightly longer than leg I. Legs II and III are of the same length. Leg IV is reticulate while the rest are foveolate. Leg chaetotaxy is as follows: I (0-4-4-7-28-1), II (1-3-4-6-24-1), III (3-3-3-6-19-1), IV (2-5-5-4-19-1) (Figs. 10a-d). A solenidion is coupled to a dorsal

seta on the tibia of legs I, II and III. The solenidiotaxy is I (0-1-1), II (0-1-0), III (0-1-0), IV (0-0-0).

Ano-genital region: The ano-genital region is organised into separate genital (GP) and anal (AN) plates inbetween which there is a preanal (PA) plate (Figs. 3, 9). There are 9 pairs of setae on the genital plate whose real points of insertion are more visible when the plate is dissected and viewed from above on a flat plane (Fig. 11). Only six of these setae occur in longitudinal row close to the midventral meeting point of the anal plates. On the anal plate, there are two pairs of setae, the left setae being slightly larger than the right one (Fig. 9). The aggenital plate (AG)



11-13. *Nothrus lasebikani* n. sp.: 11 - genital plate, 12 - anal and adanal plates, 13 - deutonymph

is continuous with the adanal plate (AD) to form an elongated aggenito-adanal plate. These two plates are linked through a twisted immovable joint. This "torsion" which occurs at the preanal area is very difficult to see due to accumulation of cerotegument in this region. There are two pairs of setae on the AG (Figs. 3, 9). Only the points of insertion of these setae were seen in all the specimens observed and they were almost completely obliterated by cerotegument cover. There are three pairs of setae on the adanal plate. Two lyrifissures are present in the anal area. The anal lyrifissure *ian* is located close to an_2 while the adanal lyrifissure, *iad* is located at the torsion area of the aggenito-adanal plate (Fig. 12).

The Deutonymph:

The deutonymph is completely covered with cerotegument which makes it difficult for the notogastral setae to be seen. Notable however is the conspicuous sensillus on the prodorsum which confirms the absence of trichobothridial regression in this species. The lateral view (Fig. 13) reveals several layers of infoldings which indicate previous moults and give it a plicated appearance.

***Nothrus incavatus* n. sp.**

(figs 14-18)

ETYMOLOGY

Named after the deep incavation along its length.

MATERIAL EXAMINED

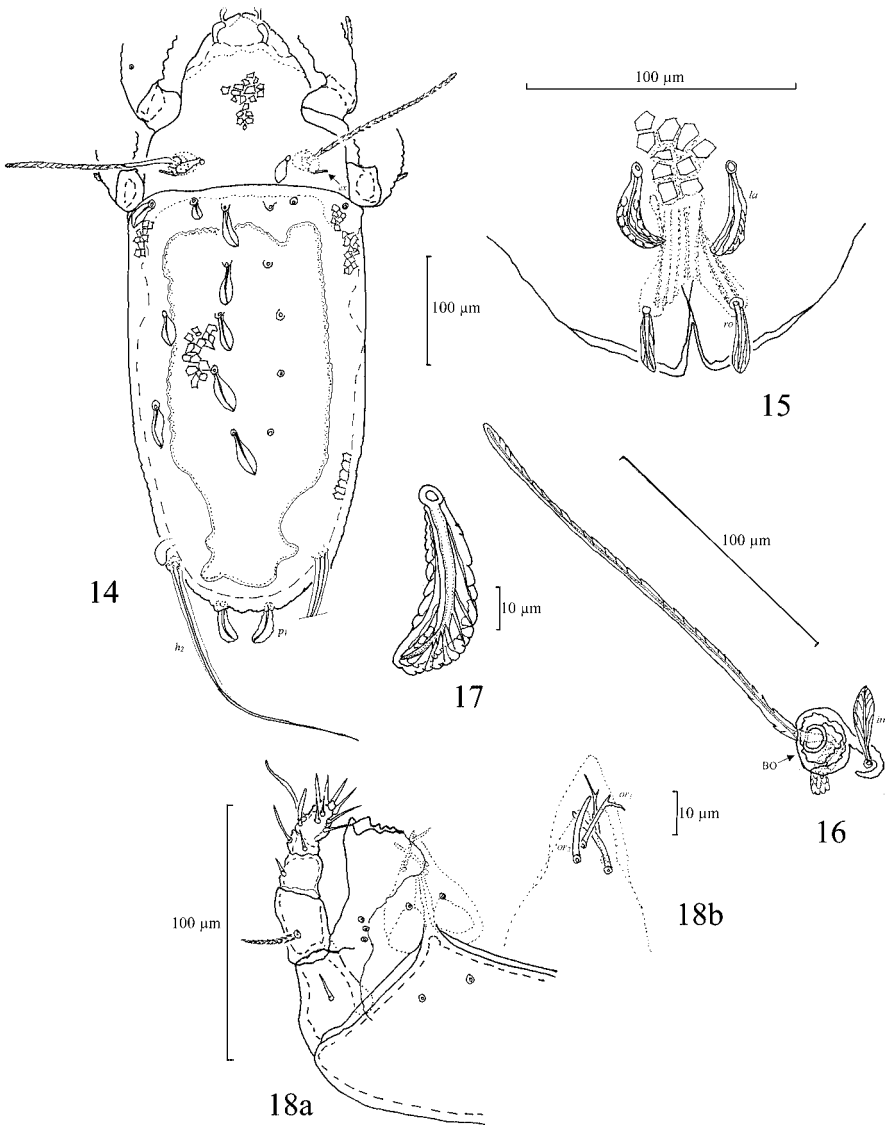
33 adults (females) and 2 juveniles collected from forest soil and litter in Ile-Ife, Nigeria.

Holotype: female from Ile-Ife, Nigeria. M.A. BADEJO col., June 2000, (specimen dissected for the description) deposited in the Museum of Natural History (MNH) at Obafemi Awolowo University, Ile-Ife, Nigeria.

Paratypes: 24 females and 2 juveniles deposited in MNH. 8 females deposited at Staatliches Museum für Naturkunde, Karlsruhe (SMNK), Germany.

DIAGNOSIS AND REMARKS

N. incavatus is a true *Nothrus* which complies with all the existing definitions of *Nothrus*. The described specimens were collected from the soil and litter samples from where *N. lasebikani* was collected. Some of the notable differences between this species and *N. lasebikani* are as follows: shape and structure of the notogaster, shorter k_1 in relation to the length of the body, chaetotaxy of the pedipalp, bifurcation of or_1 instead of or_2 and absence of aggenital setae. Being very close to *N. lasebikani*, *N. incavatus* also differs in many respects from other described *Nothrus* species (see Table 2). The elongate notogaster that tapers to the distal end, as well as the deep incavation along its length have not been reported before for any species of *Nothrus*.



14-18. *Nothrus incavatus* n. sp.: 14 - dorsal view, 15 - frontal view of the tip of the prodorsum, 16 - sensillus, 17 - notogastral seta, 18 - mouthparts – (a) infracapitulum, (b) adoral setae

DESCRIPTION

Measurements: length: 476-607 µm; width: 136-219 µm

Integument: Brownish. The body is covered with cerotegument and adherent debris. Areas not covered with debris reveal a polygonal reticulate body surface. The alveoli tend to be more elongate along the edges of depressed areas where the body surface appears more coriaceous than reticulate. (Fig. 14).

Prodorsum

The median incision on the rostrum is short and appears, at low magnification, like a gap created by two approaching sclerites at the tip of the prodorsum (Fig. 14). Dissection of the prodorsum reveals, under high power magnification, a more conspicous incision which closes up before the insertion point of *ro*. (Fig. 15). The *la* which is borne on a fairly conspicuous transverse ridge is arcuate and bigger than the *ro*. The sensillus (*ss*) is filliform, richly spinose (Figs. 14, 16) and longer than the distance between the two bothridia (BO). A tiny spiniform exobothridial seta (*ex*) is present on the edge of the bothridia. (Fig. 14).

Notogaster

The notogaster is elongate with a deep incavation which gives it a thin lateral edge that slopes down gently to provide a rather flat base which bears all the pairs of median notagastral setae. Setae d_3, e_2 and k_1 and pn_2 which are extremely difficult to see from above are borne on the slanting portion of the notogaster. The more or less straight anterior edge narrows down to the posterior end to form a convex distal edge (Fig. 14). There are 16 pairs of notogastral setae. All the setae on the anterior half of the notogaster are seen conspicuously from the dorsal view but at the posterior end, only the k_1 and pn_1 setae are easily seen, the rest being located either on the slanting surface of the notogaster above or on the ventro-lateral part below. All notogastral setae except k_1 are spatulate with a tendency for the tip to appear more pointed than blunt (Fig. 14, 17). Each seta is organised into overlapping lobes right from the base with branching inner thickenings which extend into each lobe (Fig. 17). Seta c_2 which is about one-third of the size of c_1 is inserted at a position nearer to c_1 than c_3. Seta k_1 is setiform and longer than every other setae but it is less than half of the body length.

Ventral Region

Mouthparts: The infracapitulum is the stenarthric type (Fig.18a). The pedipalp hardly extends beyond the rutellum and its tarsus bears a large and conical euphatidia. The setal formula of the pedipalp is 1-1-2-10. The conspicuously toothed rutella overlap in the region of their protuding inner sides to cover the points of insertion of the two pairs of adoral setae (or_1 and or_2) one of which (or_1) is bifurcated (Fig 18b). A conspicuous pair of anterior smooth setae (*a*) and three pairs of smaller median smooth setae (m_1, m_2, m_3) are borne on the genu (G). A pair of posterior smooth setae (*h*) is also present beneath the labio-genal articulation.

The chelicerae is exactly the same as that of *N. lasebikani* (Fig. 8).

Coxisternal region: The organisation of the coxisternal region is exactly the same as in *N. lasebikani*. Epimeral setal formula is also 7-5-6-5.

Legs: The legs are also the same as in *N. lasebikani* with the same chaetotaxy, solenidotaxy and relative lengths.

Ano-genital region: The ano-genital region is organised the same way as in *N. lasebikani* but the points of insertion of the aggenital setae are conspicuously absent from the aggenital plate. All other ventral plates of the ano-genital region possess the same number of setae as in *N. lasebikani*.

***Nothrus ifeensis* n. sp.**

(figs 19-23)

ETYMOLOGY

Named after its locus typicus, Ife in Nigeria.

MATERIAL EXAMINED

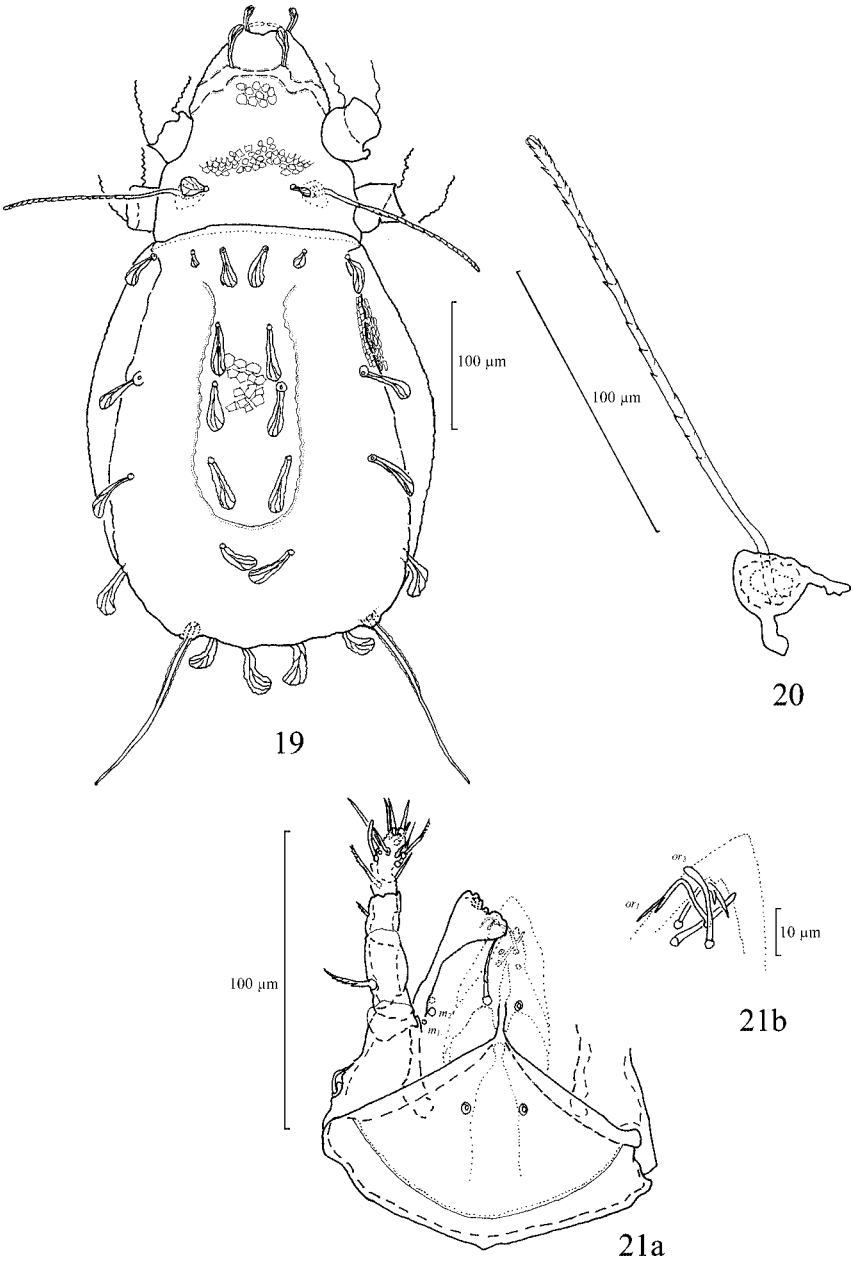
4 adults (females) collected from forest litter in Ile-Ife in Nigeria.

Holotype: female from Ile-Ife, Nigeria. M.A. BADEJO col., June 2000, (specimen dissected for the description) deposited in the Museum of Natural History (MNH) at Obafemi Awolowo University, Ile-Ife, Nigeria.

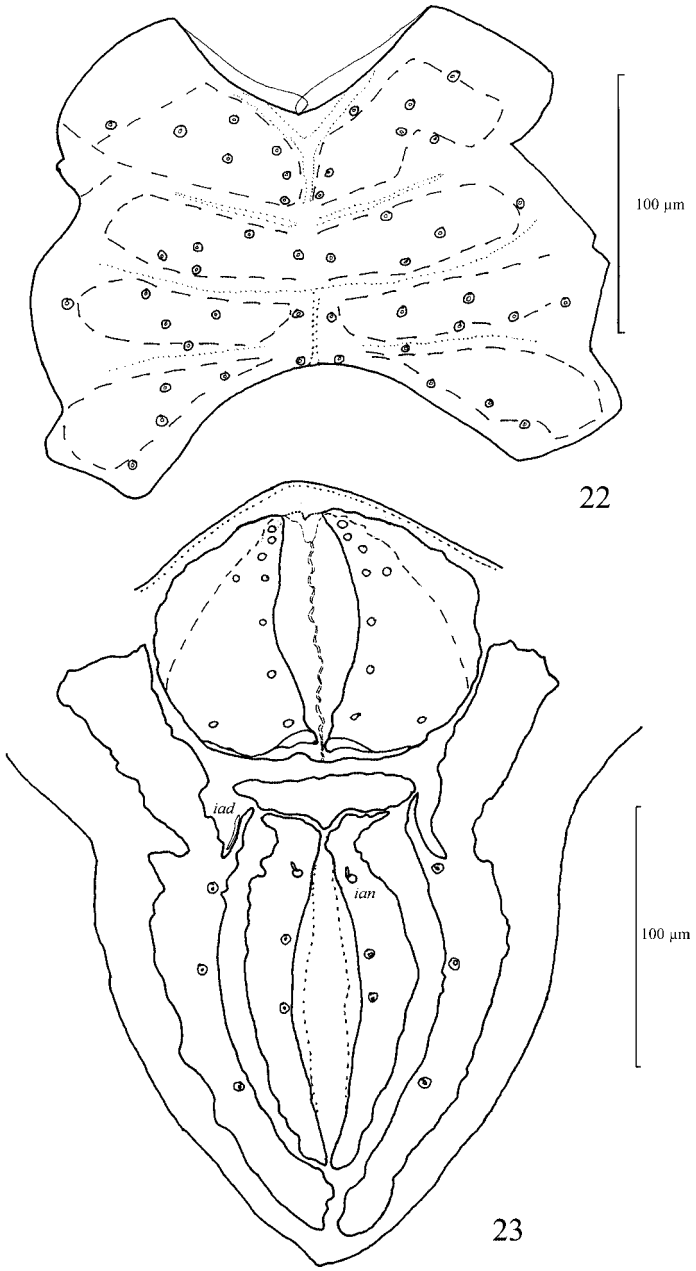
Paratypes: 3 females deposited in MNH.

DIAGNOSIS AND REMARKS

N. ifeensis is a rare species which was collected from forest litter where *N. lasebikani* and *N. incavatus* were very abundant. It possesses a unique combination of features which makes it difficult to assign it to *N. lasebikani*, *N. incavatus* or any of the existing species whose features are highlighted in Table 2. These features include the raised transverse ridge on the prodorsum on which the lamella seta (*la)* are borne (in *N. lasebikani* and *N. incavatus*, this ridge is internal and only the impression is seen through the integument), absence of exobothridial seta (*ex*), the shape and median dorsal bulge on the notogaster, the location of c_2, the relative length of the k_1 seta in relation to the body, shape of the rutellum, simple pre-anal plate and the organisation of the aggenito-adanal junction. Extra setae on the femur of legs I, II and III, as well as reduction in numbers of paired setae on the tarsus of Leg I, account for the differences between the leg chaetotaxy of *N. ifeensis* on the one hand and *N. lasebikani* and *N. incavatus* on the other. It is important to stress however that the shape of the notogaster of *N. ifensis* at the base is a deviation from the typical shape of notogaster in *Nothrus*. It resembles the shape of the notogaster of other genera of Nothroidea such as *Afronothrus* (WANG et al., 1999) and *Novonothrus* (CASANUEVA and NORTON, 1997). Two traits of *N. ifensis* which deserve special attention are the lack of torsion at the aggenito-adanal junction and the conical anterior end of the rutellum. The former suggests



19–21. *Nothrus ifeensis* n. sp.: 19 - dorsal view, 20 - sensillus, 21 - mouthparts – (a) Infracapitulum, (b) adoral setae



22-23. *Nothrus ifeensis* n. sp.- ventral region: 22 - epimeral region, 23 - ano-genital plates

a movement towards the separation of the aggenital and adanal plates, while the latter points towards a more advanced suctorial infracapitulum, both of which occur in higher oribatid mites. Further studies on this rare species is necessary.

DESCRIPTION

Measurements: length: 559-571 µm; width: 297-309 µm

Integument: Dark brown, covered with cerotegument and adherent debris. The body surface is reticulate, comprising of more or less regularly shaped and closely arranged polygonal alveoli which gradually reduce in size to form narrow rectanglar structures towards the edge and the slanting dorso-lateral axis of the notogaster (Fig. 19).

Prodorsum

The median incision of the rostrum is ventral and anterior to the dorsal tip (Fig. 19). The rostral (*ro*) and lamellar (*la*) setae are elongate and spatulate while the interlamellar setae (*in*) are assymmetrical and squat in appearance. Both the *ro* and *la* tend towards being arcuate but *la* is longer and situated on a raised transverse ridge that runs from one edge of the rostrum to the other. The sensillus is spinose, filliform (Fig. 20) and longer than the distance between the two bothridia (Fig. 19). It is doubtful if the exobothridial seta is present on the prodorsum.

Notogaster

The notogaster appears like a trapezoid with an oval base. The upper edge is trapezoid in shape while the lower edge is more or less oval due to the convex lateral sides. Both are linked by a gradually slanting dorso-lateral portion (Fig. 19). A median dorsal bulge on which three pairs of notogastral setae (d_1, d_2 and e_1) are borne, is present on the notogaster. Out of the 16 pairs of notogastral setae, only 13 can be seen from the dorsal view. The pn_3, op_1 and op_2 are completely located on the ventral portion of the notogaster. All setae except k_1 are spatulate with blunt conical ends and a "veination" that closely resembles that of *N. lasebikani* (Fig. 4). Seta c_2 is about one-third of the size of c_1 and it is more or less inserted midway bewteen c_1 than c_3. Seta k_1 is setiform and longer than other setae. It is exactly of the same length as the prodorsum which is one third of the length of the whole body.

Ventral Region

Mouthparts: The infracapitulum is the stenarthrous type (Fig.21a) with exactly the same complex articulation between the pedipalp and the infracapitulum observed in *N. lasebikani* and *N. incavatus*. The setal formula of the pedipalp is 1-1-2-11 and it extends above the rutellum as in *N. lasebikani*. Each rutellum is equipped with well developed outer and inner teeth and it protudes towards the other pair but does not overlap with it to cover the points of insertion of the two pairs of adoral setae (or_1 and or_2). The anterior adoral seta (or_1) is bifurcated while

the posterior adoral setae (or_2) is bacilliform (Fig 21b). The genu (G) bears one conspicuous pair of anterior smooth setae (*a*) and two pairs of smaller median smooth setae of unequal size (m_1 and m_2). A pair of posterior smooth setae (*h*) is present beneath the labio-genal articulation. The chelicerae is chelate-dentate as in *N. lasebikani* and *N. incavatus* (Fig. 8).

Coxisternal region: A very thin mentotectum, the two halves of which overlap in the middle, separates the base of the infracapitulum from the epimeral region. Epimeral neotrichy also occurs in this species as the epimeral setal formula is 7-5-6-5. Structurally, the organisation of the coxisternal region is as in *N. lasebikani* except that faint lines which indicate the demarcation between the epimeres are seen beneath the cerotegument cover. The surface is however devoid of foveoles (Fig. 22).

Legs: The relative lengths and sizes of the legs are the same as in *N. lasebikani* and *N. incavatus* but the chaetotaxy is slightly different. Leg chaetotaxy is as follows: I (0-7-4-7-24-1), II (1-7-4-6-24-1), III (3-4-3-6-19-1), IV (2-5-5-4-19-1). There is also coupling of solenidion and dorsal seta on the tibia of Legs I, II and III and the solenidiotaxy is also I (0-1-1), II (0-1-0), III (0-1-0), IV (0-0-0) as in *N. lasebikani and N. incavatus.*

Ano-genital region: The organisation of the ano-genital region is also as in *N. lasebikani and N. incavatus*. The genital (GP) and anal (AN) plates are separated by a pre-anal (PA) plate and the aggenital plate (AG) is continuous with the adanal plate (AD) to form an elongated aggenito-adanal plate (Fig. 23). However, there are conspicuous differences in the structures of these plates. The preanal plate is without a thickened lower lip and there is no torsion at the junction of the aggenital and adanal plates. Rather, the junction is extended into a process which is directed anteriorly beneath the preanal plate. The adanal lyrrifissure *iad* is also directed upwards on the surface of the *iad* to assume a longitudinal position. There are nine pairs of setae on the genital plate, three pairs on the adanal plate and two pairs on the anal plate which also bears the lyrrifissure *ian*. There is no seta on the aggenital plate.

***Nothrus seropedicalensis* n. sp.**

(figs 24-27)

ETYMOLOGY

Named after its locus typicus, Seropedica in Brazil.

MATERIAL EXAMINED

41 adults (females) and 37 deutonymphs collected from plots of *Arachis pintoi* in Seropedica in Brazil.

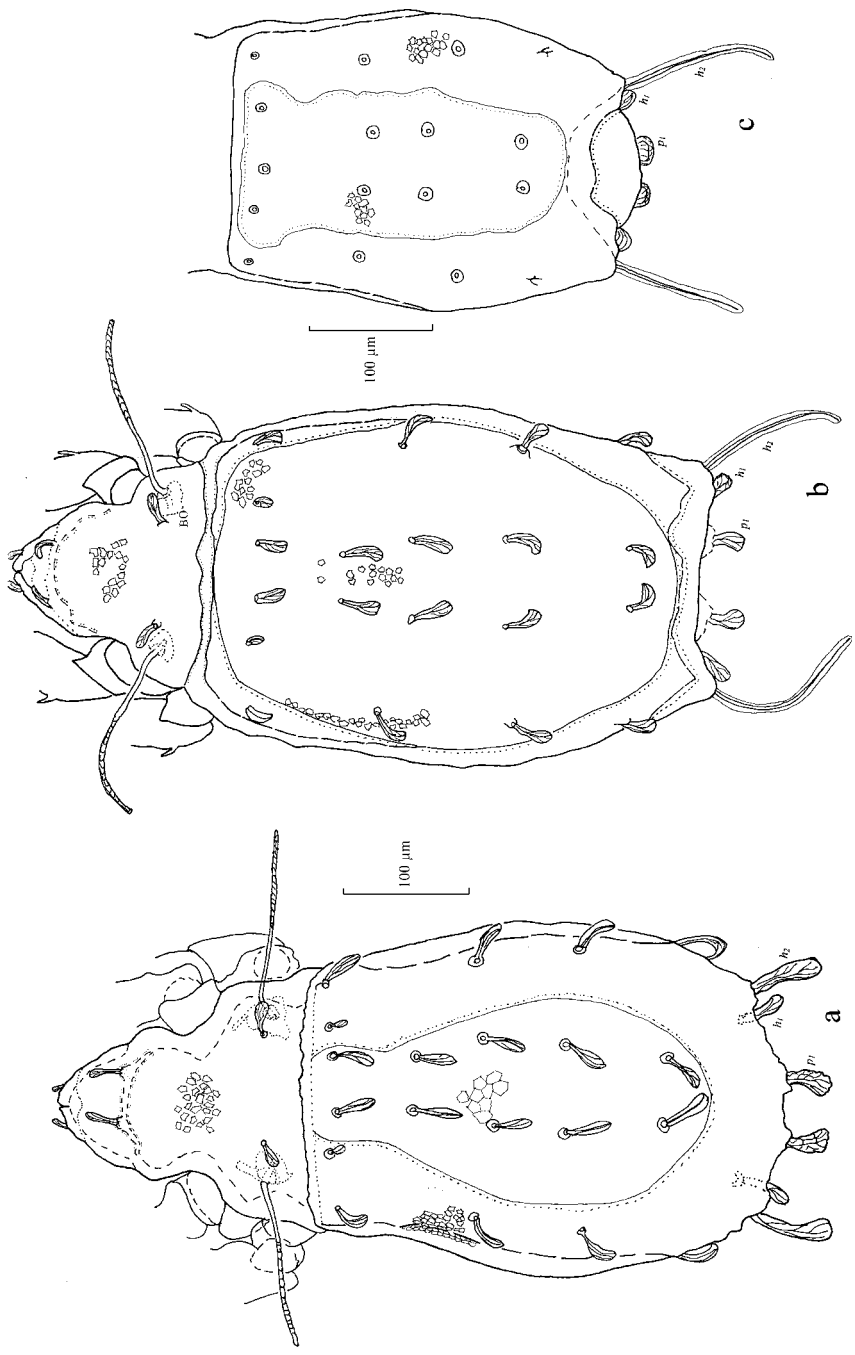
Holotype: female from Seropedica, Brazil. M.A. BADEJO col., April, 1998, (specimen dissected for the description) deposited in the Museum of Natural History (MNH) at Obafemi Awolowo University, Ile-Ife, Nigeria.

Paratypes: 20 females and 20 deutonymphs deposited in the Department of Soil Fauna, EMBRAPA-AGROBIOLOGIA, Seropedica, RJ., Brazil. 15 females and 10 deutonymphs deposited in MNH. 5 females and 6 deutonymphs deposited at Staatliches Museum für Naturkunde, Karlsruhe (SMNK), Germany.

DIAGNOSIS AND REMARKS

N. seropedicalensis is a very common oribatid species on the floor of leguminous cover crops in experimental plots of EMBRAPA-AGROBIOLOGIA in Seropedica in Brazil. It shares many features in common with *N. ifeensis*, which was collected from Nigeria but it differs from this species in a few respects. The most significant differences are the shape and length of seta k_1 as well as the tridactylous legs. Many species of European and Neotropical *Nothrus* have tridactylous legs unlike the Nigerian species which are all monodactylous. The species from Nigeria also have longer setiform h_2 setae than *N. seropedicalensis*. One striking similarity between *N. ifeensis* and *N. seropedicalensis* is the median bulge on the notogaster which is relatively bigger in *N. seropedicalensis* and likely responsible for the closeness of seta c_1 to c_2. These two species are closer to each other than each of them (especially *N. ifeensis*) is to *N. lasebikani* and *N. incavatus,* and they appear to have advanced further than *N. lasebikani* and *N. incavatus* in the transition from the lower to higher Oribatida. Being tridactylous, the fewer setae on the tarsi of the legs of *N. seropedicalensis*, when compared with the monodactylous *N. ifensis* is expected. But the tendency towards more setae on the genu and less on the tibia of *N. seropedicalensis* is difficult to explain. This may not really have significant taxonomic implications because leg chaetotaxy is sometimes variable within species of oribatid mites. *N. ifeensis* is rare in the forest where it was collected from in southwestern Nigeria while *N. seropedicalensis* is the dominant *Nothrus* in plots where it was collected from in southeastern Brazil. A detailed investigation into the factors responsible for the differences and similarities between these two spatially separated nothroid species which show similar tendencies towards the same grade of body organisation is desirable.

It is important to note, that another Brazilian species, *Nothrus brasiliensis* which appears similar to *N. seropedicalensis*, had been described from São Paulo by PEREZ-INIGO and BAGGIO (1988). We have however given *N. seropedicalensis* a separate identity not only because of significant differences which exist in their morphology (Table 3) but also because the description and illustration of *N. brasiliensis* have not permitted us to compare a few important features of taxonomic interest such as the mouthparts, leg chaetotaxy as well as the general organisation of the ventral plates of these two species. Features such as lyrifissures, preanal plates and fusion of the aggenital and adanal plates which are present in *N. seropedicalensis* were not reported for *N. brasiliensis*. It is certain however that both species do not belong to the ‚*palustris*' group. Perhaps the time is ripe to define another species group of *Nothrus*. This will be necessary only after a proper re-examination of the type specimens of *N. brasiliensis* confirms that it really has a completely different identity from *N. seropedicalensis* at the species level.



24a-c. *Nothrus seropedicalensis* n. sp. - dorsal view of (a) adult, (b) deutonymph with entire bulge on notogaster, (c) deutonymph with incavation on notogaster

The expression of morphological traits of *N. incavatus* and *N. ifeensis* from Nigeria in the deutonymph of *N. seropedicalensis,* a Brazilian species, confirm strongly the pylogenetic link between these species of *Nothrus* that are widely separated by geographical barriers. The differences in the length and shape of h_2 seta in the juveniles and adults of *N. seropedicalensis* is not unusual because this phenomenon has been reported in *Nothrus* species of the Paleartic region (SENICZAK 1992, SENICZAK and ZELAZNA 1992, and SENICZAK and NORTON 1993). The appearance of two more claws on the legs of the adult of *N. seropedicalensis* at the adult stage suggests that the monodactylous condition is probably a more advanced state of development which is already being expressed in the juvenile stage of *N. seropedicalensis*. Thus, the three nigerian species described in this paper, all of which are monodactylous are probably more evolved in respect of leg development than the tridactylous species described from other regions.

It should be noted that these deutonymphs are believed to be juveniles of *N. seropedicalensis* because they were collected from the same soil samples. The other possibility is that they could be juveniles of the species whose traits they possess. If this is true, it means that *N. incavatus* and *N. ifeensis* described from Nigeria are also present in Brazil. This assumption is probably not true not only because subsequent samplings in November 1998 and 1999 from the same plots revealed only the adults of *N. seropedicalensis*, but also because different species of *Nothrus* sometimes have morphologically similar juveniles (SENICZAK and NORTON 1993). Perhaps a more intensive sampling programme in Brazil and Nigeria as well as breeding of the different species of *Nothrus* in the laboratory will reveal more useful information.

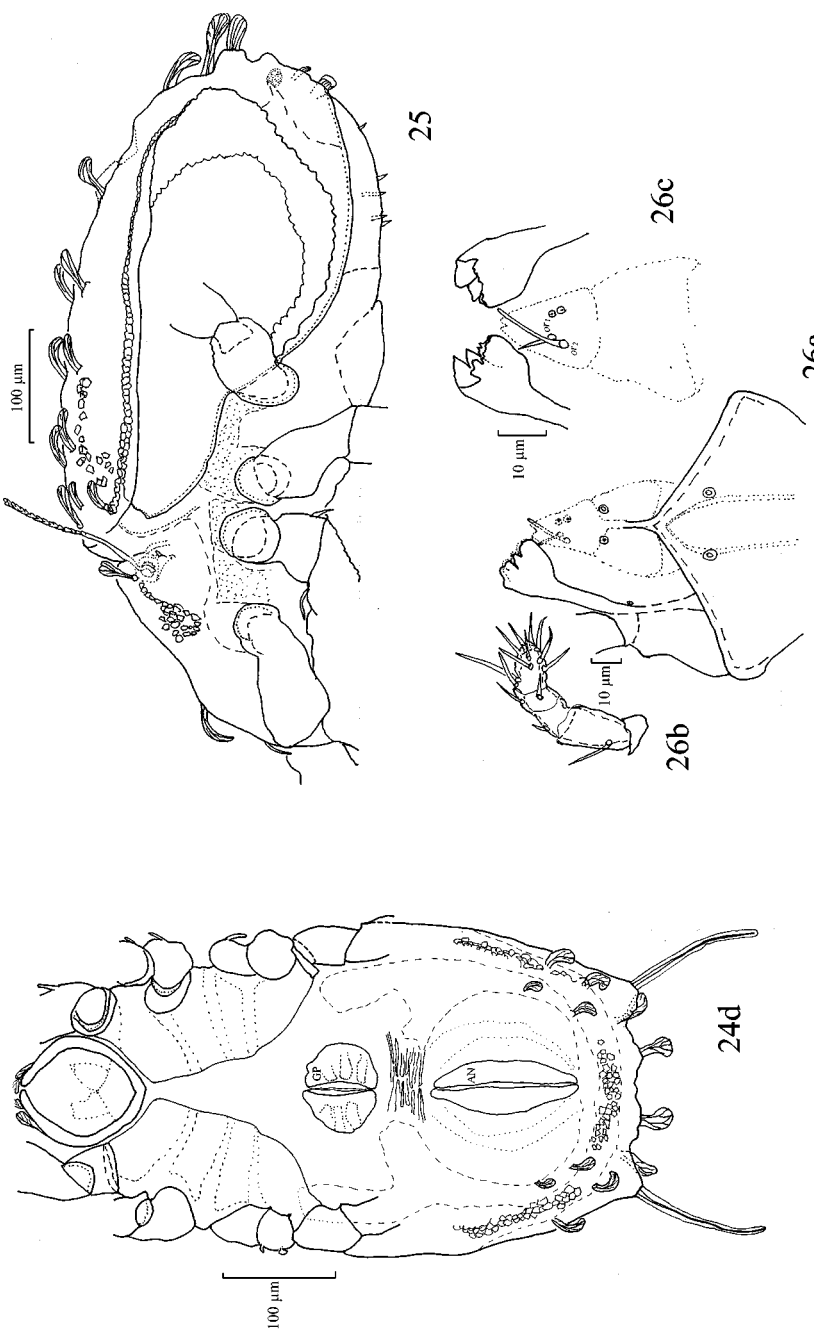
DESCRIPTION

Measurements: *Adults*: length: 607- 648 µm; width: 238-297 µm; *Deutonymphs*: length: 514-623 µm; width: 169-250 µm

Integument: The adult is light brown, covered with cerotegument and adherent debris. The body surface is reticulate and organised the same way as in *N. ifeensis*. The deutonymph is yellowish brown. The body surface is also reticulate but there is not so much cerotegument cover and adherent debris as in the adult.

Prodorsum

In the adults and deutonymphs, the median incision of the rostrum is dorsal (Fig. 24a,b). The rostral (*ro*), lamellar (*la*) interlamellar setae (*in*) are spatulate. Seta *la* is longer than *ro* and situated on a raised median transverse ridge. The sensillus is spinose, filliform and longer than the distance between the two bothridia (BO) as in *N. lasebikani, N. incavatus* and *N. ifeensis*. A tiny spiniform exobothridial seta is seen at the base of BO only in lateral view in the adult (Fig. 25).



24d-26. *Nothrus seropedicalensis* n. sp.: 24d -ventral view of deutonymph, 25 - lateral view of adult, 26 - mouthparts – (a) infracapitulum, (b) pedipalp, (c) rutella and adoral setae

Notogaster

Adults

When viewed from above, the upper part of the notogaster is trapezoid but the lower part is oval just as in *N. ifeensis*. The median dorsal bulge on the notogaster is however relatively bigger than in *N. ifeensis* and on it are borne five pairs of setae (c_1, d_1, d_2, e_1 and f_1). There are 16 pairs of notogastral setae, but only 13 are seen from the dorsal view. The pn_3, op_1 and op_2 are completely located on the ventral portion of the notogaster (Fig. 25). All setae are spatulate with blunt or pointed conical ends and a "veination" that closely resembles that of *N. lasebikani* (Fig. 4) and *N. ifeensis*. Seta c_2 is about one-third of the size of c_1 and and it appears to be inserted at a position nearer to c_1 than c_3 as in *N. lasebikani* and *N. incavatus* but the actual distance between them may be longer in view of the bulge on which c_1 is borne. Seta f_2, pn_1 *and* k_1 are longer and bigger than other setae but seta k_1 is the longest being about twice as long as most notogastral setae. Seta k_1 is however extremely short when compared with the k_1 of *N. lasebikani, N. incavatus and N. ifeensis*.

Juveniles

The bulge on the notogaster is not median but entire in 33 out of the 37 specimens examined (Fig. 24b). In the remaining four specimens, there is a deep incavation on the notogaster (Fig. 24c) as in the adults of *N. incavatus* (Fig. 14). In all the specimens, seta h_2 is about five times as long as the rest of the notogatral setae, thus resembling the situation in the nigerian species, *N. ifensis* (Fig. 19) except that it is filiform and not as long as the prodorsum.

Ventral Region

Adults

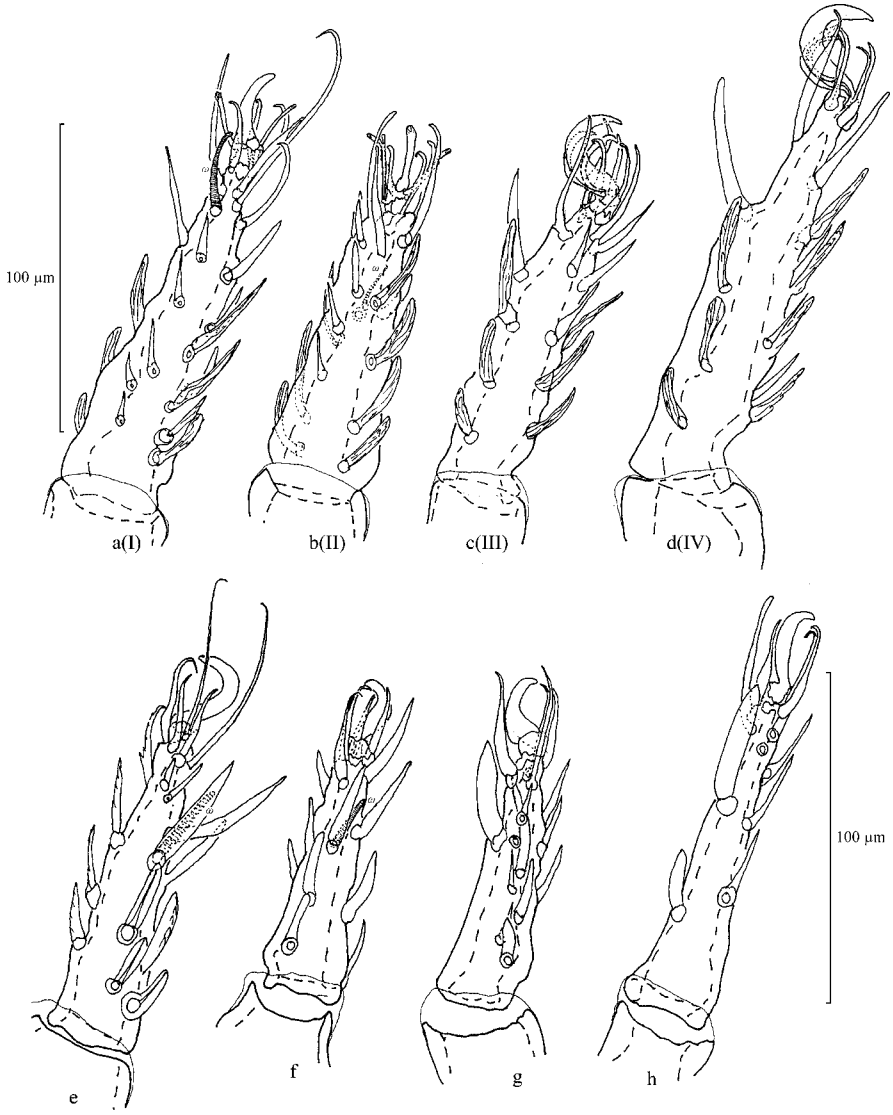
Mouthparts: The infracapitulum is stenarthric (Fig.26a) and it looks exactly like the infracapitulum of *N. ifeensis*. The setal formula of the pedipalp (Fig. 26b) is also the same as in *N. ifeensis*. At high magnification, the outer and inner teeth of the rutellum are clearly seen as well as the two pairs of adoral setae (or_1 and or_2) none of which is bifurcated (Fig. 26c). The pair of anterior smooth setae (*a*) and posterior smooth setae (*h*) are also present but there is only one pair of median smooth setae (m_1). The chelicerae is exactly the same as in *N. lasebikani* and *N. ifeensis* (Fig. 8).

Coxisternal region: The organisation of the epimeral region is exactly as in *N. ifeensis* (Fig. 22). Epimeral setal formula is also 7-5-6-5.

Legs: The relative lengths and sizes of the legs are the same as in *N. lasebikani*, *N. incavatus* and *N. ifeensis* but the legs are tridactylous and the chaetotaxy is totally different. Only one of the claws on each tarsus is very strong, the other two being thin and poorly developed (Fig. 27a-d). Leg chaetotaxy is as follows: I (0-4-6-7-24-3), II (1-7-5-4-23-3), III (3-4-5-5-17-3), IV (2-5-5-4-17-3). Coupling of solenidion and dorsal seta occur on the tibia and genu of leg I as well as the tibia

of leg II. The soledniditaxy is slightly different from the solenidotaxy of *N. lasebikani, N. incavatus* and *N. ifeensis* being I (1-1-1), II (0-1-0), III (1-1-0), IV (0-0-0).

Ano-genital region: The organisation of the ano-genital region is exactly as in *N. ifeensis* (Fig. 23).



27(a-h). *Nothrus seropedicalensis* n. sp.: a-d - tarsi of the tridactylous legs of adult, e-h - tarsi of the monodactylous legs of the deutonymph

Deutonymph

The ventral region is not as developed as in the adult. The epimeral borders are hardly discernible and the aggenito-adanal plate is not fully formed. The gental plates (GP) and anal plates (AN) are fully formed but the setae and their insertion points are conspicuously absent. However, all the notogastral setae that spill over to the ventral side are fully developed (Fig 24d).

Legs: Leg chaetotaxy is as follows: I (0-4-3-6-19-1), II (1-4-3-4-15-1), III (1-3-5-4-14-1), IV (1-3-4-6-10-1). Coupling of solenidion and dorsal seta occur on the tibia of all legs. The solednidotaxy is the same as in the adult. Unlike the adult which is tridactylous, all the legs are monodactylous Fig. 27e-h).

Superfamily Nothroidea Grandjean, 1954
Family Parallonothridae n. fam.

Type genus: *Parallonothrus* n. gen.

Diagnosis and description: see "Justification for Family Allonothridae", a chapter after description of new species of *Parallonothrus*.

Genus *Parallonothrus* n. gen.

Type species: *Parallonothrus nigeriensis* n. sp. Gender: masculine.

Diagnosis and description: see diagnosis and remarks under *Parallonothrus nigeriensis* n. sp.

Parallonothrus nigeriensis n. sp.

(figs 28-36)

ETYMOLOGY

Named after its terra typica.

MATERIAL EXAMINED

4 adults (females) and 24 juveniles collected from forest litter in Ile-Ife in Nigeria.

Holotype: female from Ile-Ife, Nigeria. M.A. Badejo col., June, 2000, (specimen dissected for the description) deposited in the Museum of Natural History (MNH) at Obafemi Awolowo University, Ile-Ife, Nigeria.

Paratypes: 3 females and 20 juveniles deposited in MNH. 4 juveniles deposited at Staatliches Museum für Naturkunde, Karlsruhe (SMNK), Germany.

DIAGNOSIS AND REMARKS

P. nigeriensis and *P. brasiliensis* have many characteristics in common with the few species of *Allonothrus* described in literature (VAN DER HAMMEN 1953,

1955, WALLWORK 1960, 1961, PEREZ-INIGO and BAGGIO 1988, PALACIOS-VARGAS and IGLESIAS 1997), all of which were found in the tropical or neotropical environment. The reasons why they have not been assigned to this genus are as follows: i) All the described species were reported to lack the f_1 seta which is very conspicuous in *P. nigeriensis* and *P. brasiliensis.* ii) The notogaster of *Allonothrus* was not portrayed as being dome-shaped with an upper and a lower dorsal bulge. Something close to this was reported in the description of *Allonothrus schuilingi* in which the central area of the notogaster is elevated. iii) The descriptions of the mouthparts of all described *Allonothrus* are not detailed enough to permit adequate comparison with the mouthparts of *P. nigeriensis* and *P. brasiliensis.*

Perhaps the most important reason why it is not proper to place *P. nigeriensis* and *P. brasiliensis* in the genus *Allonothrus* is that they are not unideficient. Unideficiency is a conspicuous trait reported for all known species of *Allonothrus*. It is quite possible however that the unideficient trait of *Allonothrus* was assigned to it in error because the posterior declivity of the opisthosoma, which was observed by VAN DER HAMMEN (1955) in *Allonothrus shuilingi*, is capable of making it impossible to see the h_1 seta if mounting is done on a flat slide. If this conjecture were true, then the h_1 seta of all *Allonothrus* is actually the f_1 seta which was reported to be absent. As aforesaid, the double elevation of the notogaster has pushed the f_1 seta backwards to the normal location of the h_1 seta. In the process of describing *P. nigeriensis* and *P. brasiliensis*, several specimens were manipulated in cavity slides so as to observe the specimens from many views. Many specimens were sacrificed through dissection in order to be able to make detailed and accurate description. Only a similar exercise carried out on the type specimens of all *Allonothrus* can clear all doubts on the notogastral setation of this genus. The brazilian species, *Allonothrus foveolatus* (PEREZ-INIGO and BAGGIO, 1988) shares many features with *P. brasiliensis* such that they should be closely related species of the same genus, but since *A. foveolatus* is reported to be unideficient like every other *Allonothrus*, it is difficult to place these two species in the same genus for now.

Three of the diagnostic features of Nothroidea possessed by *P. nigeriensis* and *P. brasiliensis* are presence of abdominal gland, presence of anal lyrrifissure (ian) and coupling of dorsal seta to solenidia on tibia. These two new species however do not possess the following diagnostic features of the Family Nothridae: i) epimeral neotrichy, ii) two pairs of adoral setae, iii) incision of the prodorsum at the tip. There are however many more differences between these species and members of the Family Nothridae in respect of leg chaetotaxy, mouth parts, general organisation of the body and setation of the genital plates.

Within the Desmonomata, the Nothridae is the only Family where characters are fairly uniform and stable. All other families possess highly variable characters. A consistent trait of Nothridae which none of them possess is epimeral neotrichy (Table 1). This is indeed a unifying trait which could be a good basis for splitting this paraphyletic group (NORTON and KETHLEY 1994) into just two families despite the obvious deficiency of Table 1 in comparing all the important taxonomic traits

of the various genera. These important traits are missing from Table 1 because the descriptions of many species did not include them. Such traits include the mouthparts, leg setation and organisation of the ventral plates, all of which have been given a fairly adequate attention in this investigation. The suggestion for just two families of Desmonomata based on epimeral setation can only be given legitimacy only after a thorough redescription and revision of the group have been carried out. Before this is done, *Parallonothrus* deserves to be placed in the right Family within the Nothroidea.

DESCRIPTION

Measurements: length: 495-507 µm; width: 243-269 µm

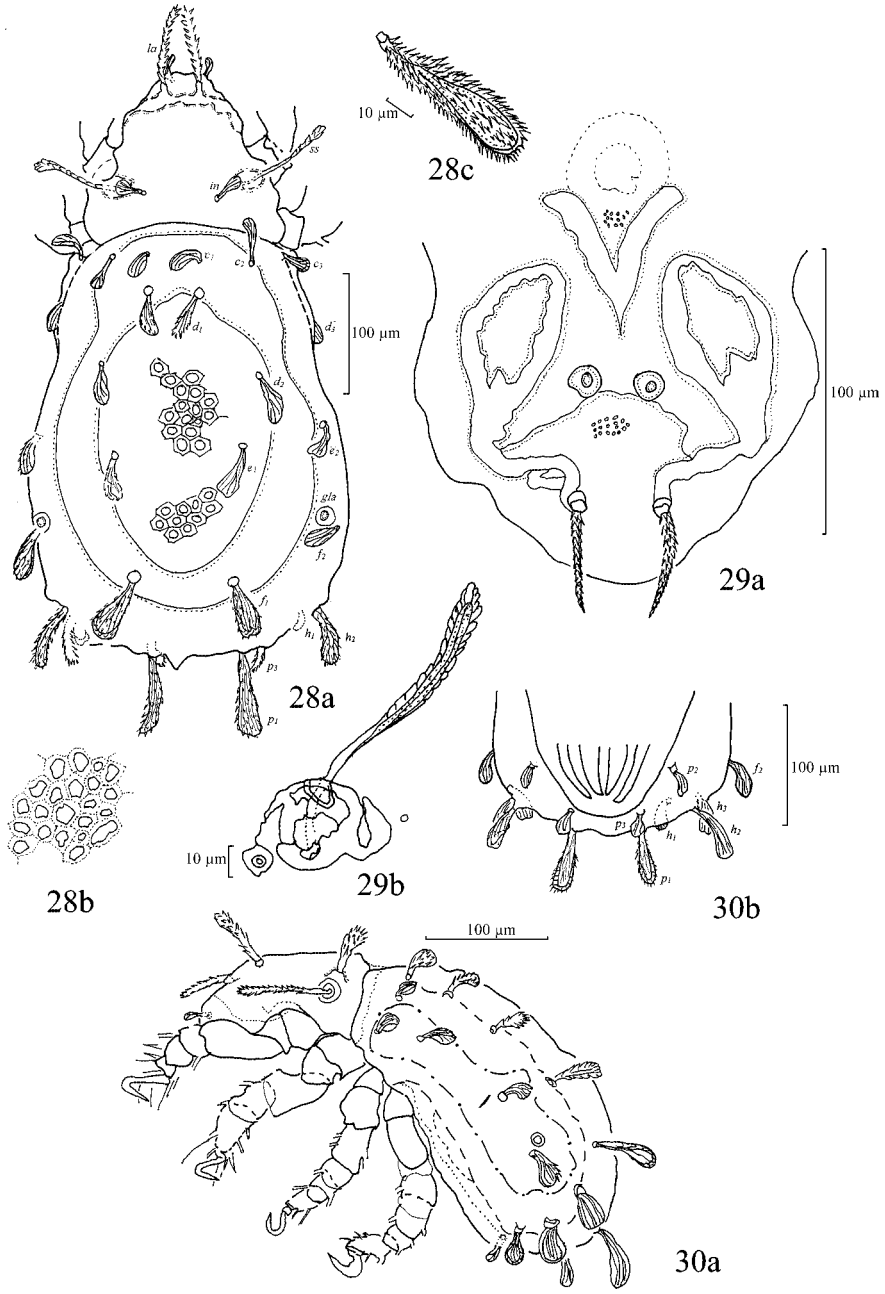
Integument: Reddish brown. The body is thickly sclerotized and covered with cerotegument and particles of adherent debris. There is a spectacular ornamentation of the notogaster which consists of golden yellow irregular circles or rough polygons which are separated by reddish brown ridges inside which are dotted lines arranged round the golden yellow areas to form an hexagon. Thus, a reticulate pattern of hexagons ramify throughout the surface of the notogaster (Fig. 28a,b). The prodorsum is devoid of this ornamentation. Rather, minute foveoles are seen in areas where there are no ridges. (Fig. 29a).

Prodorsum

The rostrum has no median incision. The insertion point of the rostral setae (*ro*) is dorsal and located on a ridge which runs transversely and curves downwards in the posterior direction to form a sphere on either side of the insertion point of the lamellar setae (*la*) (Fig. 29a). The *ro* and *la* are densely covered with tiny hairy projections which form a whorl along their length. The *la* which is very conspicuous and extends well beyond the tip of the rostrum is borne on raised tubercles arising from a bulging transverse ridge that cuts across the prodorsum not very far from the rostrum. The interlamellar setae (*in)* are spatulate with blunt conical ends. They are located as expected inbetween the bothridia (BO), each of which bulges out of the prodorsum like a raised pad, bearing a clavate sensillus (*ss*) which is of the same length, from the point of insertion, as the *la*. The distance between the pair of *ss* is longer than their length and at high magnification the distal two-thirds is organised into lobes around a longitudinal axis which increases in diameter gradually along its length to give the *ss* its club shaped appearance (Fig. 29b). It is doubtful if an exobothridial seta (*ex*) is present on the prodorsum. After dissection, and at high magnification, a tiny pore which probably represents the insertion point or what is left of the *ex* is seen very close to the BO at the normal position of the *ex*.

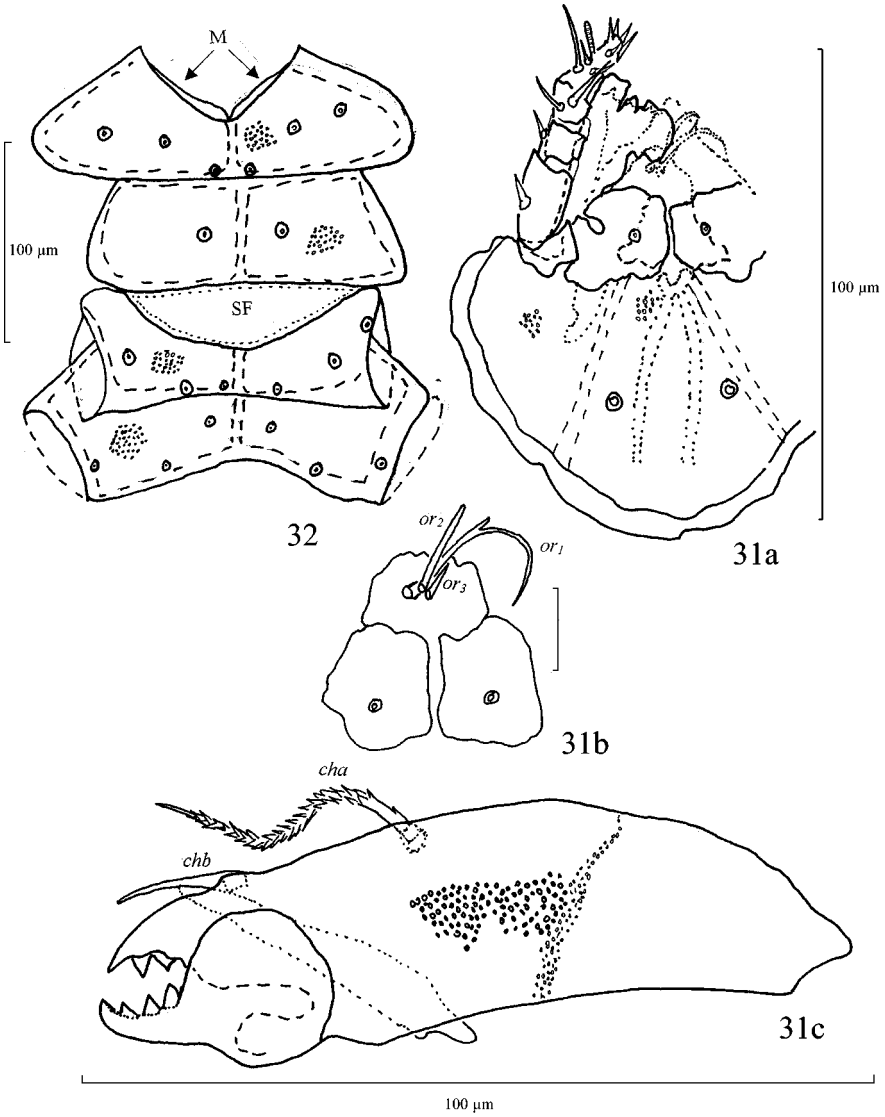
Notogaster

The notogaster is a dome-shaped polygonal vault with a spherical median bulge lying on top of a larger dome-shaped bulge. Posteriorly, the notogaster

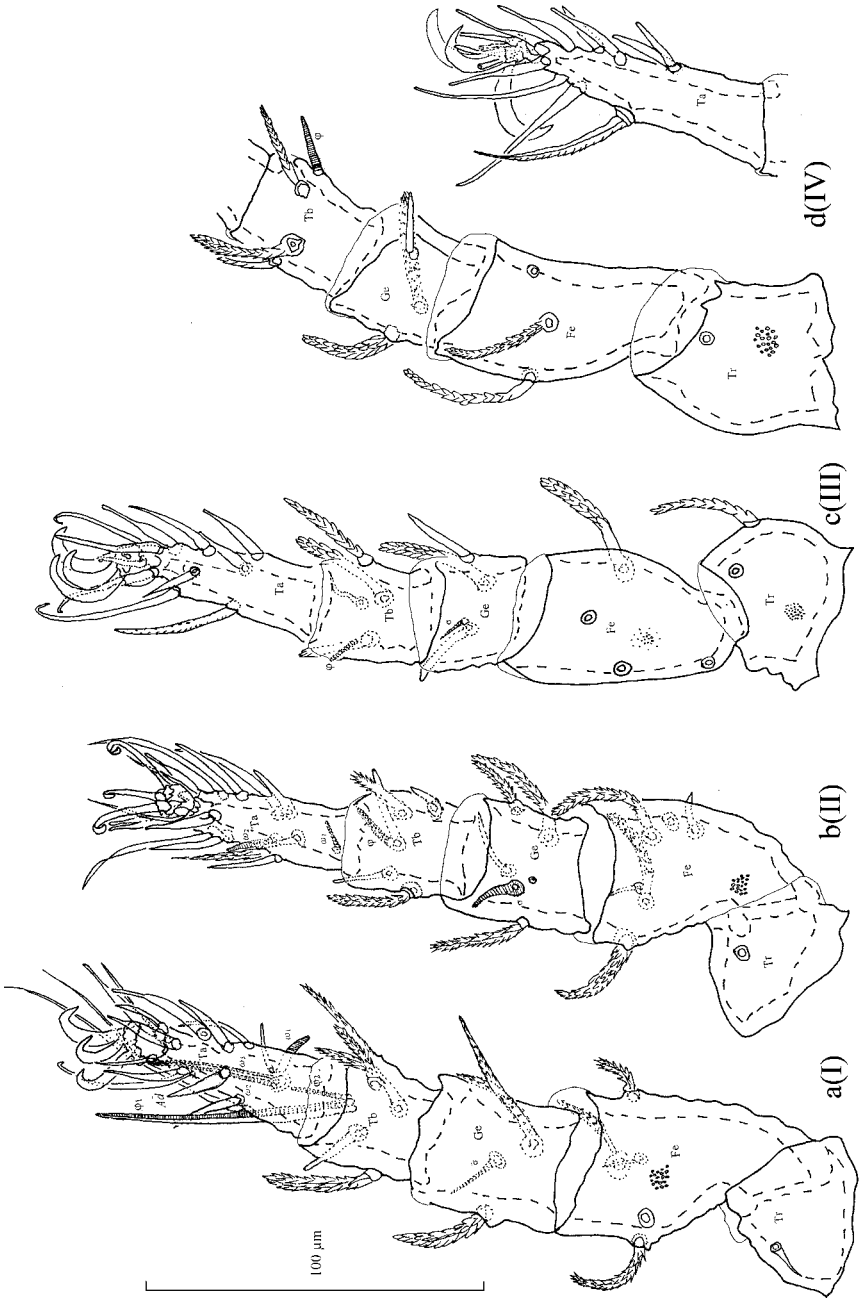


28-29. *Parallonothrus nigeriensis* n. sp.: 28(a) - dorsal view, 28(b) - surface of notogaster, 28(c) - notogastral seta, 29(a) - frontal view of prodorsum, 29(b) - sensillus, 30(a) - deutonymph, 30(b) - ventral view of the posterior end of the notogaster of the deutonymph

descends sharply just after the lower bulge thereby making whole setae located in that region (h_1, h_3) and the insertion points of those located more posteriorly (p_1, h_1) hardly visible from all views (Fig. 28a). These setae are however clearly visible in the less sclerotized deutonymph where all the 16 pairs of setae are more visible and the posterior sharp declivity of the notogaster has not occurred (Fig. 30a,b). In the adult, the raised areas tend to give a wrong impression of the actual



31-32. *Parallonothrus nigeriensis* n. sp.: 31 - mouthparts: (a) infracapitulum, (b) adoral setae, (c) chelicerae, 32 - epimeral region



33(a-d). *Parallonothrus nigeriensis* n. sp.: legs

distance between neighbouring seta on a one dimensional plane. For example, seta c_2 appears farther from c_1 than c_3 when in reality it is equidistant between them. So also, the raised areas tend to push the points of insertion of some setae towards the lateral edge. The upper bulge has pushed each of the d_2 and e_1 setae away from the median line while the lower bulge has pushed the f_1 seta to a more posterior location. There is a tendency towards asymmetry in the shape of all notogastral seta. Setae of the same pair tend to have slightly different shapes. All of them except h_2 and h_1 are fan-shaped and ciliated but the tips of some are wavy (Fig. 28c) while others are truncate. Seta h_2 and p_1 are more elongate, less fan-shaped and longer than other setae although p_1 is longer than h_2. Setae c_2 is also more elongate than c_1 and c_3. The *im* fissure is seen very close to the insertion point of e_2 in both the adult and deutonymph (Fig. 30a). This fissure is seen better in lateral than ventral view. A chitinized ring which surrounds the hollow aperture of the lateral abdominal gland (*gla*) is located close to the insertion point of the f_2 seta.

Ventral Region

Mouthparts: The infracapitulum tends towards being diathric but it has retained some stenathric features. The labiogenal articulation is directed laterally towards the base of the pedipalp but a triangular ridge that probably represents the rudiments of stenathry is seen beneath the mentum. The setal formula of the pedipalp is 1-1-2-9 (Fig. 31a). The rutellum is equipped with inner and outer teeth. The protuding lateral margins of each touch each other above the adoral sclerite where they cover most of the adoral setae excluding their insertion points which occur very close to each other. There are three pairs of adoral seta. The anterior adoral seta (or_1) is very long and setiform and it has a spine-like projection around the middle. The posterior adoral setae (or_2) is bacilliform and not as long as (or_1). The posterior antiaxial setae (or_3) is short and spiniform (Fig 31b). The anterior smooth setae (*a*) and posterior smooth setae (*h*) are present on the genu (G) and posterior to the labio-genal articulation respectively. Seta *a* is very short and spiniform. The median smooth setae (m) is lacking. The chelicerae (Fig. 31c) is more elongate than the chelicerae of *Nothrus* (see Fig. 8) but it is also chelate-dentate and the fixed digit bears a spiniform lateral (*cha*) and a densely cilliated longer dorsal (*chb*) setae. There is no spine on the antiaxial surface of the fixed digit on which there are foveoles in the anterior portion. The size of these foveoles decrease sharply along a line which make the blunt posterior end appear punctulate. This line separates the free anterior end of the chelicerae from the posterior end which is always inside the infracapitulum. A Trägardh's organ (To) is seen in position within the integument.

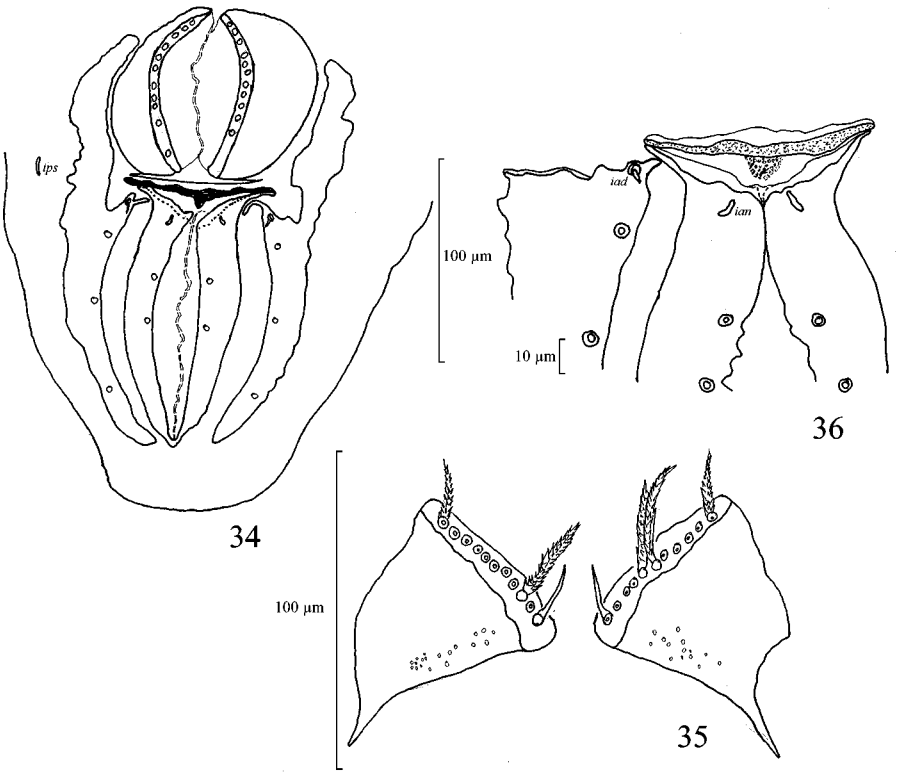
Coxisternal region: The whole of the coxisternal region is densely foveolate. Inbetween the base of the infracapitulum and epimere I are the two halves of the mectotectum (M) which are separated by a narrow v-shaped gap (Fig. 32). A sejugal furrow clearly separates epimere II from epimere III which in turn overlaps partially with epimere IV in what appears like an interlocking joint between the

anterior region of epimere IV and the posterior region of epimere III in the region of attachment to leg III. Epimeral setal formula is 3-1-3-3.

Legs: The relative sizes and lengths of the legs are similar to the situation in the Family Nothridae. Legs I and II are stouter than legs III and IV, while legs II and III are shorter than legs I and IV. Leg IV is the longest. Foveoles occur more on the distal segments than the proximal ones. All legs are tridactylous. Leg chaetotaxy is as follows: I (1-5-4-8-18-3), II (1-6-6-6-16-3), III (2-4-4-5-11-3), IV (1-3-3-4-14-3) (Figs. 33a-d). Coupling of solenidion to dorsal seta occurs on the tibia of Leg I and the tarsus bears an additional seta (*Ad*). Solenidiotaxy is I (1-2-3), II (1-1-2), III (1-1-0), IV (0-1-0).

Ano-genital region:

The ano-genital region is similar to that of the Family Nothridae in organisation only. There are remarkable differences on the genital plate (GP), the pre-anal plate (PA) and the aggenito-adanal plate. There are eleven pairs of setae which are irregularly spaced on the GP. These setae are born on a longitudinal ridge at the



34-36. *Parallonothrus nigeriensis* n. sp.: 34 - ano-genital plates, 35 - genital plate and setae, 36 - pre-anal, anal and adanal plates

midventral meeting point of the two plates (Fig. 34) just as in *Camisia* and *Platynothrus* (SELLINICK and FORSSLUND, 1955). The most distal seta is spiniform while the rest are heavily ciliated (Fig. 35), although only the insertion points of many of them were seen in all the specimens investigated. The pre-anal plate is thickened anteriorly and it rests on the bowl-shaped surface formed by the two anal plates that are closely apposed together (Fig. 36). The adanal plate is continuous with the aggenital plates without a visible joint just as in *N. ifensis* and *N. seropedicalensis*. There is therefore no torsion at the aggenito-adanal junction as it is in *N. lasebikani* and *N. incavatus*. In this area however, a process of the adanal plate lies below the lateral process of the anal plate like a pivot, thus resembling the situation in *N. ifensis* and *N. seropedicalensis*. The adanal lyrrifissure *iad* and anal lyrrifissure *ian* are present on the adanal and anal plates respectively. Another fissure, *ips* is also present on the ventral sclerite slightly anterior to *iad* and *ian*. There are two pairs of spiniform setae on the anal plate and three pairs on the adanal plate. The aggenital plate bears no setae.

Deutonymph:

The deutonymph is a miniature of the adult. It is plicated and possesses the full compliment of the prodorsal and notogastral setae. Unlike in the adults, the legs are monodactylous (Fig. 30a).

***Parallonothrus brasiliensis* n. sp.**

ETYMOLOGY

Named after its terra typica.

MATERIAL EXAMINED

24 adults (females) and 7 juveniles collected from Plots of *Arachis pintoi* in Seropedica in Brazil.

Holotype: female from Seropedica, Brazil. M.A. Badejo col., April, 1998, (specimen dissected for the description) deposited in the Museum of Natural History (MNH) at Obafemi Awolowo University, Ile-Ife, Nigeria.

Paratypes: 10 females and 3 juveniles deposited in the Department of Soil Fauna, EMBRAPA-AGROBIOLOGIA, Seropedica, RJ., Brazil. 9 females and 3 juveniles deposited in MNH. 4 females and 1 juvenile deposited at Staatliches Museum für Naturkunde, Karlsruhe (SMNK), Germany.

DIAGNOSIS AND REMARKS

See diagnosis and remarks under *Parallonothrus nigeriensis* n. sp.

DESCRIPTION

Measurements: length: 488-535 µm; width: 242-285 µm

Integument: Reddish brown which turned to light reddish brown after several days in lactic acid.. Just as in *P. nigeriensis*, the body is thickly sclerotized and covered with cerotegument and particles of adherent debris. The ornamentation of the notogaster is also a reticulate pattern of hexagons which enclose golden yellow structures ranging from irregular circles to rough polygons (Fig. 37). The prodorsum is devoid of this ornamentation but bears minute foveoles.

Prodorsum

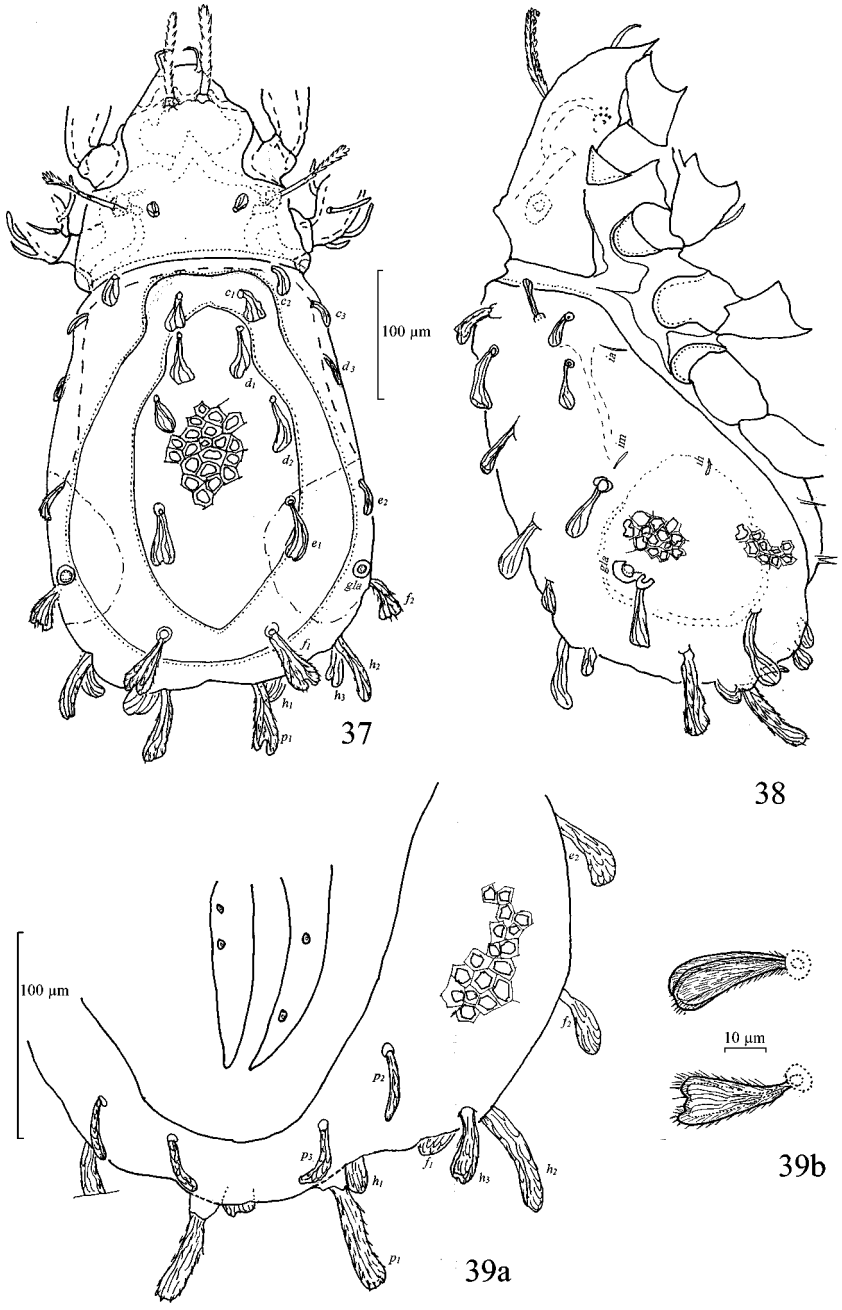
The shape and setation of the prodorsum is more or less the same as in *P. nigeriensis* with the following few differences. The rostral setae (*ro*) are strongly incurved. The transverse ridge on which the lamellar setae (*la*) are born is internal as in *N. lasebikani* and the insertion points are borne on shorter tubercles. All the internal ridges which are seen in *P. nigeriensis* only after dissection are seen through the integument (Fig. 37) probably because of the lighter colour of the prodorsum after insertion in lactic acid. The internal ridges extend both medially and laterally from the region of insertion of lamella setae through the area of insertion of leg I to the posterior extremity of the prodorsum.

Notogaster

The notogaster is also a dome-shaped polygonal vault with a spherical upper median bulge on top of a lower but larger dome-shaped bulge just as in *P. nigeriensis*. Setation is exactly the same as in *P. nigeriensis*, the only noticeable difference being the more anterior location of seta c_2. This could be as a result of the relatively narrower anterior end of the lower bulge when compared with the bulge in *P. nigeriensis* (see Figs. 28a, 37). The dark contents of the lateral hysterosomal gland is also seen on either side of the hysterosoma. This circular dark spot became visible in dorsal and lateral views (Figs. 37, 38) only after the integument became lighter. The lateral view also reveals the presence of the fissures *im*, *ih* and *ia* which were difficult to see in dorsal view. The microsculpture of the notogaster in both *P. nigeriensis* and *P. brasiliensis* is visible throughout the entire lateral region (Fig. 38), leaving no "bare" lateral area as in all the four species of *Nothrus* reported earlier (see Figs. 2 and 24). The extension of the notogaster to the ventral area and its conspicuous microsculputure are illustrated in Fig. 39a where all the posterior notogastral setae that were not clearly or convincingly seen in dorsal and lateral views are more conspicuous at higher magnification. All notogastral setae are fan-shaped and cilliated but some are visibly spatulate while the tips of others are either wavy or truncate as in *P. nigeriensis*. Two forms of notogastral setae in *P. brasiliensis* are illustrated in Fig. 39b.

Ventral Region

Mouthparts: The infracapitulum is diathric. The labiogenal articulation occurs at the level of the base of the pedipalp. This is a clear deviation from the

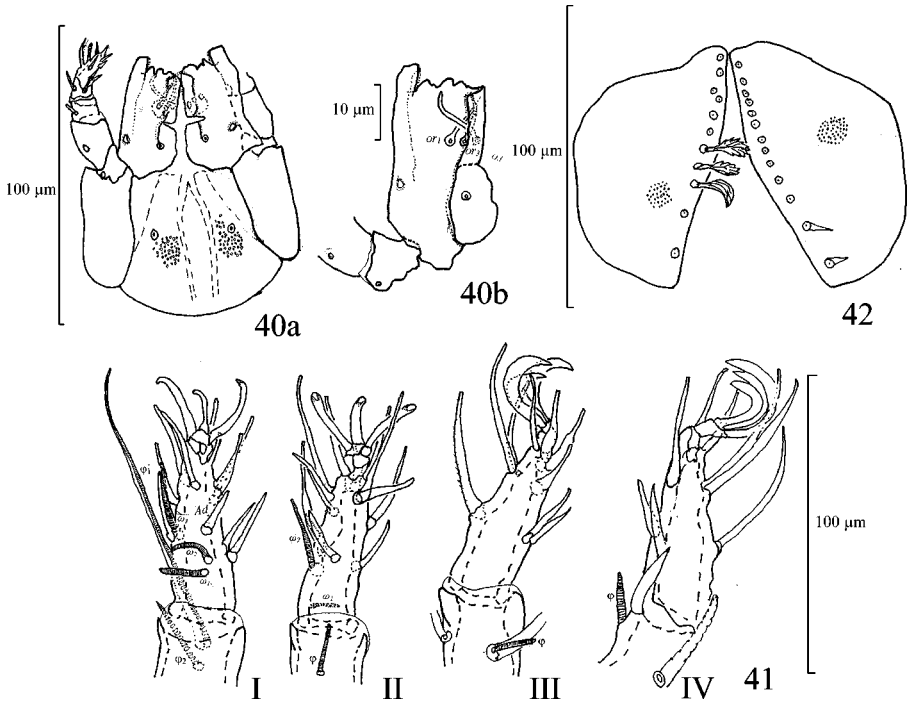


37-39. *Parallonothrus brasiliensis* n. sp.: 37 - dorsal view, 38 - dorso-lateral view, 39(a) - latero-ventral view, 39(b) - notogastral setae

stenathric infracapitulum of the Family Nothridae and it is completely different from the partial diathry in *P. nigeriensis.* The setal formula of the pedipalp is 1-1-2-9 (Fig. 40a) as in *P. nigeriensis*. The lateral margin of each rutellum folds inwards along its length to form a longitudinal lobe which covers the insertion point of the posterior antiaxial setae (or_3), with the edge cutting across the insertion point of the posterior adoral setae (or_2). The base of the anterior adoral seta (or_1) is exposed, but its tip is embedded within the groove created by the infolding lobe of the infracapitulum. All adoral setae are bacilliform. The teeth of each rutellum show a tendency towards flattening (Fig. 40b). Short and spiniform anterior smooth setae (*a*) and posterior smooth setae (*h*) are present on the genu (G) and posterior to the labio-genal articulation respectively. The chelicerae is exactly like the that of *P. nigeriensis* (see Fig. 31c).

Coxisternal region: The organisation and setation of the coxisternal region are exactly as in *P. nigeriensis*. (Fig. 32)

Legs: The legs are also tridactyl as in *P. nigeriensis* and the setation is nearly the same but they look more stumpy as they are relatively shorter and smaller. The tarsi of each leg which contains fewer setae. Coupling of solenidion to dorsal seta also occurs on the tibia of Leg I whose tarsus also bears an additioanl seta (*Ad*).



40-42. *Parallonothrus brasiliensis* n. sp.: 40 - mouthparts: (a) infracapitulum, (b) rutellum and adoral setae, 41 – tarsi, 42 - genital plate and setae

Leg chaetotaxy is as follows: I (1-5-4-8-14-3), II (1-6-6-6-14-3), III (2-4-4-5-9-3), IV (1-3-3-4-8-3). Solenidiotaxy is also the same as in *P. nigeriensis*. (Figs. 41a-d).

Ano-genital region: The ano-genital region is similar to that of *P. nigeriensis* except that there are remarkable differences on the genital plate (GP) which is more oval in shape and bears unequal and variable numbers of setae on each plate (Fig. 42). The number of setae, which are not arranged on a distinct ridge, vary from 11 to 14 and the right plate always bears one or two setae less than the left plate. All the setae are ciliated except the two distal pairs which are either spiniform or setiform as it is in *Allonothrus russeolus* (WALLWORK, 1960).

Justification for Family Allonothridae

When the genus *Allonothrus* was created by VAN DER HAMMEN (1953), it was not assigned to any family. The differences between *Allonothrus* and other genera such as *Camisia*, *Nothrus*, *Platynothrus*, and *Heminothrus* were highlighted and it was stressed that *Allonothrus* differed from the Camisiidae in chaetotaxy, thus preparing the stage for assigning *Allonothrus* to a new Family of Nothroidea when more information became available.

The creation of *Pseudonothrus* (BALOGH, 1958) as a genus of Family Camisiidae (when *Nothrus* was also regarded as a genus of Camisiidae) is a misnomer because it was later suggested by MAHUNKA (1985) that *Pseudonothrus* is conspecific with *Allonothrus*. This suggestion seems to be in order because there is virtually no difference between BALOGH's *Pseudonothrus hirtus* and *Allonothrus ghanaensis* (WALLWORK, 1961) from the available descriptions in literature. *Pseudonothrus* (= *Allonothrus*) therefore does not belong to the Family Camisiidae. We have also observed that *Allonothrus tuxlasensis*, PALACIOS-VARGAS and IGLESIAS (1997), is very similar to *A. ghanaensis and P. hirtus.* This species is most probably a synonym of *A. ghanaensis.*

Allonothrus was assigned to the Family Trhypochthoniidae by VAN DER HAMMEN (1955) based on setal development in the juvenile stages of *Allonothrus schuilingi.* Still not convinced that he had enough information, VAN DER HAMMEN called for a re-investigation of other genera of Trhypochthoniidae before a distinct definition of the Family Trhypochthoniidae is given. This exercise is a partial but unintentional fulfilment of this call for re-investigation. The original aim was to identify oribatid mites from southwestern Nigeria and Brazil to the species level.

Many members of the Family Trhypochthoniidae do not have sensillus. Genital setae vary from as low as 4 to as high as 20. Adanal setae are usually one pair. There is indeed no unifying trait possessed by members of the Trhypochthoniidae except lack of epimeral neothrichy which is not peculiar to them. Table 1 reveals that Trhypochthoniidae is a group of genera that do not fall within the other three families of Nothroidea. The Trhypochthoniidae as it is presently conceived therefore needs to be examined critically. The new genus *Parallonothrus* and the existing genus *Allonothrus,* as it is presently defined, have features which are

sufficient to put them in a genus group within a family of all nothroid mites that do not exhibit epimeral neotrichy. That family has not been created, hence it is inevitable that *Parallonothrus* and *Allonothrus* for now are placed in the Family Parallonothridae with *Parallonothrus* designated as the type genus.

The conspicuous *la* borne on conspicuous tubercles, club-shaped *ss* whose mutual distance is less than their length, double-layered, dome shaped notogaster with a sharp posterior declivity are unique traits of Parallonothridae which do not exist in combination in any other known Family of Nothroidea. Moreover, Parallonothridae shows signs of advancement over the Nothridae in respect of the transition from lower to higher Oribatida. The mouthparts for example have become diathric and the rutellum is loosing the sharpness of its teeth in preparation for a suctorial function as in higher Oribatida. *P. nigeriensis* appears to represent the transition state more than *P. brasiliensis* because it still retains certain traits of stenathry. *P. nigeriensis* is therefore designated as the type species of *Parallonothrus*. The *ex* on the prodorsum and the *m* on the genu of most Nothridae have disappeared in Parallonothridae. Torsion at the aggenito-adanal junction is lost. Leg chaetotaxy is radically different from Nothridae as the number of setae on the tarsus has decreased and the number of claws are consistently three, at least in these two new species. From the on-going, it seems as if the designation of Parallonothridae as a new Family is inevitable pending the investigation of more specimens, discovery of more species, adequate redescription of poorly described species and above all, a comprehensive revision of the Superfamily Nothroidea. The discovery, in this present exercise, of four new species from one location in Nigeria and two from another location in Brazil, each of them displaying new character combinations, underscores the need to expand the definitions of taxonomic units within the Nothroidea in this proposed comprehensive review. Another good reason for a comprehensive review of Nothroidea on a global scale is that correct identifications cannot be made with some keys that are currently available in literature. A good example is the key of BALOGH and BALOGH (1992) which recognises *Allonothrus* as being monodactylous. All described *Allonothrus* right from the first description of *A. schuilingi* (VAN DER HAMMEN, 1953) are tridactylous except *A. monodactylous* which was described by WALLWORK (1960).

GENERAL REMARKS

The four species of *Nothrus* described in this study are rather small in size when compared with other species from the Neotropical and Paleartic regions. The only species described from Senegal in the Ethiopian region *N. senegalensis,* is also longer than the longest of these new species *N. seropedicalensis*, and bigger than the biggest species, *Nothrus ifensis* (Table 4). However, the two new species of Parallonothridae fall within the same size range as all the species of *Allonothrus* from Ghana and New Guinea as well as *Pseudonothrus* (= *Allonothrus*) from Angola.

This investigation has revealed among others that there is a continuum of transitional grade of organisation from lower to higher Oribatida within the superfamily Nothroidea. *N. lasebikani* and *P. brasiliensis* appear to stand at the opposite ends in this continuum in respect of mouthparts, aggenito-adanal junction and chaetotaxy of the epimeral region, genital plates and the legs.

If the keys of NORTON (1990) which in addition to absence of aggenital setae, suggests that the body of Nothridae is without noticeable adherent debris were used for this investigation, all the species of *Nothrus* described in this paper will be erroneously excluded from Nothridae. Norton's focus is on the oribatid mite fauna of the Neartic region and he warned that the key "....is somewhat less applicable for subtropical regions, such as southern Florida..." A revision of the Superfamily Nothroidea across all regions as suggested earlier will increase the character traits used in defining the taxonomic units. The definition of Nothridae should be true for all Nothridae irrespective of their geographical location.

All the unique combination of characters and variations observed in the six species of Nothroidea described in this paper are probably due to the theletokous reproductory habit of Nothroidea (GRANDJEAN 1954, CASANUEVA and NORTON 1997) The absence of bisexual control of recombination of genes during reproduction prevents a fairly constant expression of traits in different generations. Each generation therefore has the tendency to develop character traits that are dictated by the peculiarities of different environments that are separated by spatial barriers. It is most likely that many more species would be discovered if more frontiers are explored globally, most especially the poorly investigated tropical environment.

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Table 1. Comparison of some diagnostic features of the families of Desmonomata (modified from BALOGH & BALOGH (1992) with additional information on Parallonothridae n. fam.

	Sensillus	Claws	Genital setae	Aggenital setae	Anal setae	Adanal setae	Epimeral setal formula
NOTHRIDAE							
Nothrus Koch, 1836	Present	1,2,3	9 pairs	0 or 2 pairs	2 pairs	3 pairs	7465; 7554; 7656
Novonothrus Hammer, 1966	Present	1	9 pairs	None	2 pairs	3 pairs	9565; 9665
Trichonothrus Mahunka, 1986	Present	3	9 pairs	None	2 pairs	3 pairs	16687
CROTONIIDAE							
Crotonia	Present	3	7,8 pairs	2 pairs	3 pairs	3 pairs	3133
Holonothrus	Present	3	8-10 pairs	2 pairs	2 pairs	3 pairs	4133
CAMISIIDAE							
Austronothrus	Present	3	8 pairs	2 pairs	2 pairs	3 pairs	3232
Camisia	Present	1,3	9 pairs	2 pairs	3 pairs	3 pairs	3133; 3123
Heminothrus	Present	1	9-23 pairs	2 pairs	2 pairs	3 pairs	3133; 2133
Platynothrus	Present	1	13-25 pairs	2 pairs	2 pairs	3 pairs	3133; 3134
Neonothrus	Present	1	13 pairs	2 pairs	2 pairs	3 pairs	3133; 3134
TRHYPOCHTHONIIDAE							
Mucronothrus	Absent	1	18-20 pairs	None	2 pairs	3 pairs	3122
Trhypochthoniellus	Absent	3				3 pairs	
Fossonothrus	Absent	3	8 pairs	None	1 pair	3 pairs	3133
Malaconothrus	Absent	1	4-6 pairs	None	0,1, pair	3 pairs	3133; 2132
Trimalaconothrus	Absent	3	4-12 pairs	None	1 pair	3 pairs	3133; 3123
Zeanothrus	Absent	3	5(6) pairs	None	1 pair	3 pairs	3133
Afronothrus	Present	3	4 pairs	None	None	2 pairs	3132
Archegozetes	Present	1	7 pairs	None	2 pairs	3 pairs	3133
Hydronothrus	Present	3	9 pairs	None	1 pair	2 pairs	3032
Trhypochthonius	Present	3	10 pairs	None	1 pair	3 pairs	3133
PARALLONOTHRIDAE							
Allonothrus	Present	1 or 3	7-14 pairs	None	2 pairs	3 pairs	3133
Parallonothrus	Present	3	11-14 pairs	None	2 pairs	3 pairs	3133

Table 2. Attributes of some previously described Nothrus species

Characters	*Nothrus macedi* Beck, 1962 - Peru	*N. espinarensis* Beck, 1962 - Peru	*N. borussicus* Sellinick, 1929 - Europe & New Guinea & *pseudoborussicus* Mahunka, 1978 – Mauritania	*N. reunionensis* Ma 1978 - Reunion
Size	L 940-1000µm B 500-560µm	L 900-950µm B 490-570µm	L 990µm *(borussicus)* B 558µm *(borussicus)* L 790-824µm (*peudoborussicus)* B 410-432µm (*pseudoborussicus)*	L 736-768µm B 380-395µm
Prodorsal setae	Sensillus shorter than the distance between the sensilli	Sensillus shorter than the distance between the sensilli	Sensilus apically weakly fusiform (*borussicus*), apically acute (*pseudoborussiscus*)	Sensillus more or less t the end (setiform)
Notogaster	Lateral sides more or less convex	Lateral sides convex; Posterior end not convex	Lateral sides convex	Lateral sides convex
Notogastral setae	seta k_1 is 1.5 to 2 times as long as the pn setae; setae pn_1 and pn_2 longer and bigger than other notogastal seta except k_1		All are weakly cilliate (*borussicus*); densely ciliate (*pseudoborussiscus*)	Setae c_2 about half as l setae pn_1 much longer setae pn_1 and k_1 are lon more apically rounded rest of the spatulate not setae; stae k_1 is broader base
Epimeral chaetotaxy	7-4-5-5	7-4-5-5	7-5-7-6 (*borussicus*); not reported (*pseudoborussiscus*)	Not reported
Aggenital setae	None	None	None	None
Anal setae				
Legs	All tarsi are tridactylous	All tarsi are tridactylous	All tarsi are tridactylous	All tarsi are tridactylou

Characters	*Nothrus mystax* Mahunka, 1984 – Tanzania	*Nothrus senegalensis* Mahunka, 1992 - Senegal	*Nothrus palustris* C.L. Koch, 1839 – Sweden, European	*Nothrus silvestris* Nicolet 1877 – Sweden, European	*Nothrus pr* 1929 – Swed
Size	L 1090µm B 574µm	L 688-720µm B 322-348µm	L 1000-1188µm B 700-756µm	L 720-810µm B 378-414µm	L 936µm B 540µm
Prodorsal setae	All setae (except *ss*) are phylliform or spatulate; *ss* is setiform with smooth distal end	*ro* and *la* arise from tubercles connected by transverse laths; all setae are ciliate			
Notogaster	Lateral sides convex		Lateral sides convex; posterior end concave		Lateral sides
Notogastric setae	All setae (except k_1) are phylliform;	Setae pn_1 nearly 21/2 times longer than pn_2	All setae are setiform: seta c_2 closer to c_1 than c_3; setae pn_2 longer than pn_1	All seta appear ensiform; seta k_1 is just slightly longer than pn_2 and about twice the length of pn_1	Seta k_1 is alm the length of
Epimeral chaetotaxy	Not reported	5-4-4-6	4-3-3-4 or 3-3-4-4	6-5-5-5	5-3-4-4
Aggenital setae	None	None	None	None	None
Anal setae		an_1 much larger than the others			
Legs	All tarsi are tridactylous		All tarsi are tridactylous	All tarsi are bidactylous	

Table 3. Morphological differences between *Nothrus seropedicalensis* n. sp. and *N. brasiliensis*

Morphological features	*Nothrus brasiliensis*	*N. seropedicalensis*
Size	Length:750-900µm Width: 410-480µm	Length:607-648µm Width: 238-297µm
Rostral setae (*ro*)	thin, curved and borne on tubercules	spatulate and not on tubercles
Lamella setae (*la*)	shorter than *ro* and dilated at the tip	spatulate and longer than *ro*
Bothridium	protudes out of the prodorsum	internal, not protuding
Interlamella setae (in)	borne on small tubercules and longer than *ro* and *la*	spatulate, not on tubercules and not longer than *la*
Exobothridial setae (ex)	not seen	Present, seen only from the lateral view
Notogaster	surface covered with irregular foveoles; all setae borne on tubercules; no median bulge reported but two parallel medio-longitudinal carinae present	surface reticulate, covered with regularly shaped and closely arranged polygonal alveoli; no tubercules but insertion points are conspicuous; median dorsal bulge present

Table 4. Comparison of the sizes of different species of nothroid mites

Nothroid species	Length (µm)	Width (µm)
NOTHRIDAE		
Nothrus lasebikani sp. n	514-623	169-250
Nothrus incavatus n. sp.	476-607	136-219
Nothrus ifeensis n. sp.	559-571	297-309
Nothrus seropedicalensis n. sp.	607- 648	238-297
Nothrus senegalensis Mahunka, 1992	688-720	322-348
Others (see Table 2)	720-1090	378-574
PARALLONOTHRIDAE		
Parallonothrus nigeriensis gen. n	495-507	243-269
Parallonothrus brasiliensis gen. n	488-535	242-285
Allonothrus shuilingi van der Hammen, 1953	435	225
Allonothrus monodactylus Wallwork, 1960	468-546	248-291
Allonothrus russeolus Wallwork, 1960	532-617	Not recorded
Allonothrus ghanensis Wallwork, 1961	497-540	248-277
Pseudonothrus hirtus (Balogh, 1958)	506-527	250-292