

MOSADOLUWA ADETOLA BADEJO, STEFFEN WOAS &amp; LUDWIG BECK

# *Atropacarus (Hoplophorella) nigeriensis*, a new species of phtiracarid mite (Acari, Oribatida) from Nigeria

## Abstract

This paper is the first of a series in which more information will be added to the existing on biogeographical distribution of oribatid mites. Here we describe a new species of a phtiracarid mite collected from forest floor litter in southwestern Nigeria. Differences between this species, *Atropacarus (Hoplophorella) nigeriensis*, and other *Hoplophorella* species are the foveoli on the aspis and notogaster, the shape of notogastric setae, as well as shapes and chaetotaxy of the genital and anal plates. More differences in taxonomically important features such as the morphological features of the infracapitulum and epimeron as well as leg chaetotaxy between this species and others could not be determined, not only because of lack of information on the latter in literature, but also because many type specimens are not available for dissection which must be done in order to reveal fine morphological details. *Atropacarus (Hoplophorella) nigeriensis* belongs to the "cucullata" group of *Hoplophorella* which possess one enlarged adanal seta. It differs from other members of this group in respect of adanal and tarsal chaetotaxy. *Hoplophorella* is considered as a subgenus of *Atropacarus* in this paper, because there is no evidence in literature that *Hoplophorella* as a group is a separate phylogenetic entity.

## Authors

Prof. Dr. MOSADOLUWA ADETOLA BADEJO, Department of Zoology, Obafemi Awolowo University, Ile-Ife, Nigeria;  
Dr. STEFFEN WOAS & Prof. Dr. LUDWIG BECK, Staatliches Museum für Naturkunde Karlsruhe, Erbprinzenstr. 13, D-76133 Karlsruhe, Germany.

## Key words

taxonomy, Acari, Oribatida, Africa, Nigeria

## 1. Introduction

It is widely known among acarologists that the oribatid mite fauna of much of the tropics and southern hemispheres has been poorly investigated when compared with the huge amount of information on palaeartic and nearctic fauna. If identification keys which were designed based on observed morphological features of oribatid mites from northern Europe are not suitable for identifying oribatid mites of temperate environments in North America (NORTON 1990), one could imagine the magnitude of difficulties encountered while using them to identify tropical fauna.

The Nigerian experience has been that available identification keys only allow family-level identification of

adult oribatid mites with minimum error. Identifications beyond this level are usually problematic because the authors of the keys did not have the Nigerian species in mind when designing their keys. This is one major reason why little information exists on the oribatid mite fauna of Nigeria.

It is in the light of the above that the authors of this paper came together to start extensive taxonomic investigations on oribatid mite specimens collected in Nigeria. The aim of this exercise is to add to the existing information on biogeographical distribution of oribatid mites and create basic data for an identification-key of palaeotropical taxa. In this paper, we present the results of our investigations on a species of lower oribatid mites which was collected from the litter cover of a secondary regrowth tropical rainforest soil in Nigeria.

## 2. Systematics

### *Atropacarus (Hoplophorella) nigeriensis* BADEJO, new species

Figures 1-5

Phtiracaroida PERTY, 1841  
Steganacaridae NIEDEBALA, 1986  
*Atropacarus* EWING, 1917  
*Hoplophorella* BERLESE, 1923

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

Paratypes: 7 females with the same collecting dates, deposited in MNH, 5 females with the same collecting dates, deposited at Staatliches Museum für Naturkunde Karlsruhe (SMNK), Germany.

### Description

Measurements: Aspis length 200 - 250 µm, Aspis height 95 - 120 µm, Notogaster length 387 - 490 µm, Notogaster height 300 - 335 µm.

Integument yellowish, surface covered with concavities which are more evident on the notogaster than on the aspis.

Aspis: A conspicuous lateral carina (lc) (fig. 1) and two posterior furrows extending towards the two bothridia and meeting to form an arch at the middle are present

Table 1. Morphological traits of other *Hoplophorella* species that are different from *Atropacarus (Hoplophorella) nigeriensis*.

Characters	<i>H. andrei</i> (BALOGH, 1958) = <i>Steganacarus andrei</i>	<i>H. collaris</i> (BALOGH, 1958) = <i>Steganacarus collaris</i>	<i>H. prominens</i> (BALOGH, 1958)	<i>H. africana</i> WALLWORK, 1967
Size	AL 221-279 µm NL 435-549 µm Nh 254-353 µm	AL 180 µm NL 344 µm Nh 196 µm	AL 176-283 µm NL 378-606 µm NH 202-364 µm	AL 168-224 µm AH 84-112 µm NL 392-470 µm NH 207.2-280µm
Aspis		foveolated medially, punctate or smooth laterally, rugose basally; no ex; short and thick prodorsal setae long with small head; lamella setae slightly dialted, spoon-shaped and finely spiculate; ro spiniform	surface strongly foveolate dorsally, less strongly medially, smooth marginally, rugae present basally; low crista; ro largest prodorsal setae	
Notogaster			*characteristic shape - elongated anterior part covering basal part of prodorsum; foveoles on this protusion very fine and similar than foveolates on the rest of the notogaster	Presence of lyrifissure ip - not true of Hoplophorella;
Notogastric setae	c <sub>1</sub> more anteriorly placed; *h <sub>3</sub> also more anteriorly placed than in other <i>Hoplophorella</i>	All well dialated; spoon- shaped with many spicules on the dialated end		
Genital Plates				4 pairs of aggenito- genital setae
Ano-adanal setae	3 pairs of adanal setae; anterior anal setae rounded distally; ad <sub>2</sub> spoon-shaped	3 pairs of adanal seate; ad <sub>2</sub> spoon-shaped with many spicules on the dilated end	3 pairs of adanal setae; ad3 simple and the shortest of all	3 pairs of adanal setae;
Leg chaetotaxy				Tarsal setal formula is I (16) - II(12) - III(10) - IV(10).
* Diagnostic features				

on the aspis (fig. 2). There are five pairs of setae on the aspis. These are the rostral setae (ro); the sensillus (ss); two interbothridial setae (in<sub>1</sub> & in<sub>2</sub>) and the exobothridial seta (ex) (Figs 2, 3). Setae ro and in<sub>2</sub> are spatulate and conspicuous. In lateral view, seta ro is directed upwards but the frontal view reveals that it also extends beyond the rostrum (fig. 3). Setae in<sub>1</sub> and ex are spiniform and can only be seen after careful examination. The bothridium (pseudostigma) has an alveolar surface. It is circular in shape and bounded on one side by a chitinized shelf which extends backwards along the aspis (fig. 4). The ss is relatively long (110 µm), sigmoid and expands gradually along its length like a narrow leaf with a thick midrib.

Notogaster: covered by a relatively thin layer of cerotegument and appearing arched in lateral view but quadrangular in dorsal view (fig. 2). The concavities which ramify all over the integumental surface are

seen better in dorsal view. Those on the lateral margin look like grotesque red blood cells in dorsal view. There is no notogastral hood but a collar inside which the aspis retracts when necessary is very conspicuous in lateral view (fig. 1). The two anterior corners of the rectangular notogaster is strengthened by thickened integument which projects upwards and extends down the length of the notogaster gradually becoming less thickened towards the posterior corners (fig. 2). There are 15 pairs of notogastral setae which are very conspicuous, bent backwards and spatulate in shape (fig. 5). The number and arrangement of the setae is typical of the subgenus *Hoplophorella*. Seta c<sub>1</sub> originates farther from the collar line than c<sub>2</sub> and c<sub>3</sub> (fig. 2). There are two pairs of lyrifissures, the anterior (ia) and posterior (im) lyrifissures which are represented by small refractive circles inbetween cp and d<sub>2</sub> (ia), and inbetween c<sub>2</sub> and ps<sub>4</sub> (im). This is a general rule for all

<i>H. angolensis</i> MAHUNKA, 1984.	<i>H. benoiti</i> MAHUNKA, 1984.	<i>H. ensifera</i> MAHUNKA, 1984.	<i>H. horida</i> MAHUNKA, 1984	<i>H. cochlearia</i> PEREZ-INIGO & BAGGIO, 1993.
AL 227 µm NL 414 µm Nh 273 µm	AL 170-179 µm NL 353-386 µm Nh 223-244 µm	AL 430 µm NL 859 µm NH 546 µm	AL 328-427 µm NL 754-910 µm NL 418-517 µm	AL 194-200 µm NL 390-410 µm NH 207.2-280 µm
No crista (?)	weakly developed carina; anterodorsal part foveolate; *short ro; ro and in equal in length	prodorsal surface with deep depressions in front of la & ro; *la & in both strong and well spiculate; ss long, small head, strongly dilated	Quadrangular in lateral view; wide rostral margin with 3 crista; prodorsal setae thin, simple, setiform	
	foveoles widely separated		*anterior part very large, protruding forward in dorsal view covering the basal part of the aspis; *surface with large protuberances at areas of insertion of setae	
*Long, bent, blunt at the tip, finely roughened, all nearly equal in length	strong, erectile, slightly dilated, distal end with spickles	all strong, thick, partly erect, spiculate with a sharp edge on the inner side; all with setae far from the collar line	all fine, thin, simple and setiform	Distal end enlarged to give a spoon-shaped appearance
3 pairs of adanal setae; ad <sub>1</sub> slightly lanceolate; ad <sub>2</sub> rounded with dilated head	3 pairs of adanal setae; ad2 sword-shaped	3 pairs of adanal setae; ad2 very long, dagger-shaped, finely roughened	genito-aggenital and ano-adanal plates with some ribs and rugae 3 pairs of ano-adanal setae	3 pairs of adanal setae; shape of ad2 different from notogaster setae

*Hoplophorella*. Lyrifissure ip is absent in all specimens examined.

#### Ventral Region

**Mouthparts:** The infracapitulum is the stenarthrous type which is common in all Phthiracaroida (Fig 6). The rutellum is well developed and the anterior (or<sub>1</sub>) and posterior (or<sub>2</sub>) adoral setae are ciliated. The posterior-antiaxial setae (or<sub>3</sub>) is setiform. The anterior (a) and median (m) smooth setae on the genae (G) are also setiform. Posteriorly, there is a pair of small setiform setae (h) which lies inbetween the inner edges of a triangular shaped membrane which not only covers the posterior part of the infracapitulum but also connects the whole labiogenal articulation of the infracapitulum to the musculature in the leg-bearing hysterosoma. The chelicera is the chelate-dentate type that bears the dorsal (cha) and lateral (chb) setae on the fixed digit

(fig. 7). There are a few spines on the antiaxial surface and the surface ornamentation on the blunt posterior end which is usually within the infracapitulum is denser than the ornamentation on the free anterior end. The pedipalp is 3-segmented with setal formula 2-2-8. There is a solenidion (ω) and an euphthalidial seta (sul) at the base of the solenidion on the tarsus. (fig. 8).

**Epimeral region:** The epimera is clearly divided into two regions. Epimere I and II are more or less fused and larger than epimere III and IV which overlap partially to facilitate retraction of the aspis into the notogaster (fig. 9). The chaetotaxy of the epimera is 1-0-1-1 which is typical of all Phthiracaroida.

**Legs:** Leg I is the strongest of all legs (fig. 10). Each leg has five segments. Tiny pores similar to the ornamentation on the epimera are seen on either the trochanter or the femur or both. The tarsus of each leg is monodactyl. Each claw is strongly developed

and bidentate midventrally. The anterior tooth is always more developed than the posterior. Leg chaetotaxy is as follows: I (1-4-3-5-18-1), II (1-3-3-12-1), III (2-2-2-2-9-1), IV (2-1-1-2-8-1). The absence of seta I' on genu IV distinguishes this genus from *Steganacarus* and the ratio of the length of  $v''$  to  $v'$  on femur I is exactly 2.25, which confirms that the specimens observed belong to the genus *Atropacarus*. Solenidiotaxy on the genu, tibia and tarsus I (2-1-3), II (1-1-2), III (1-1-0), IV (0-1-0) is typical for all Phthiracaroida.

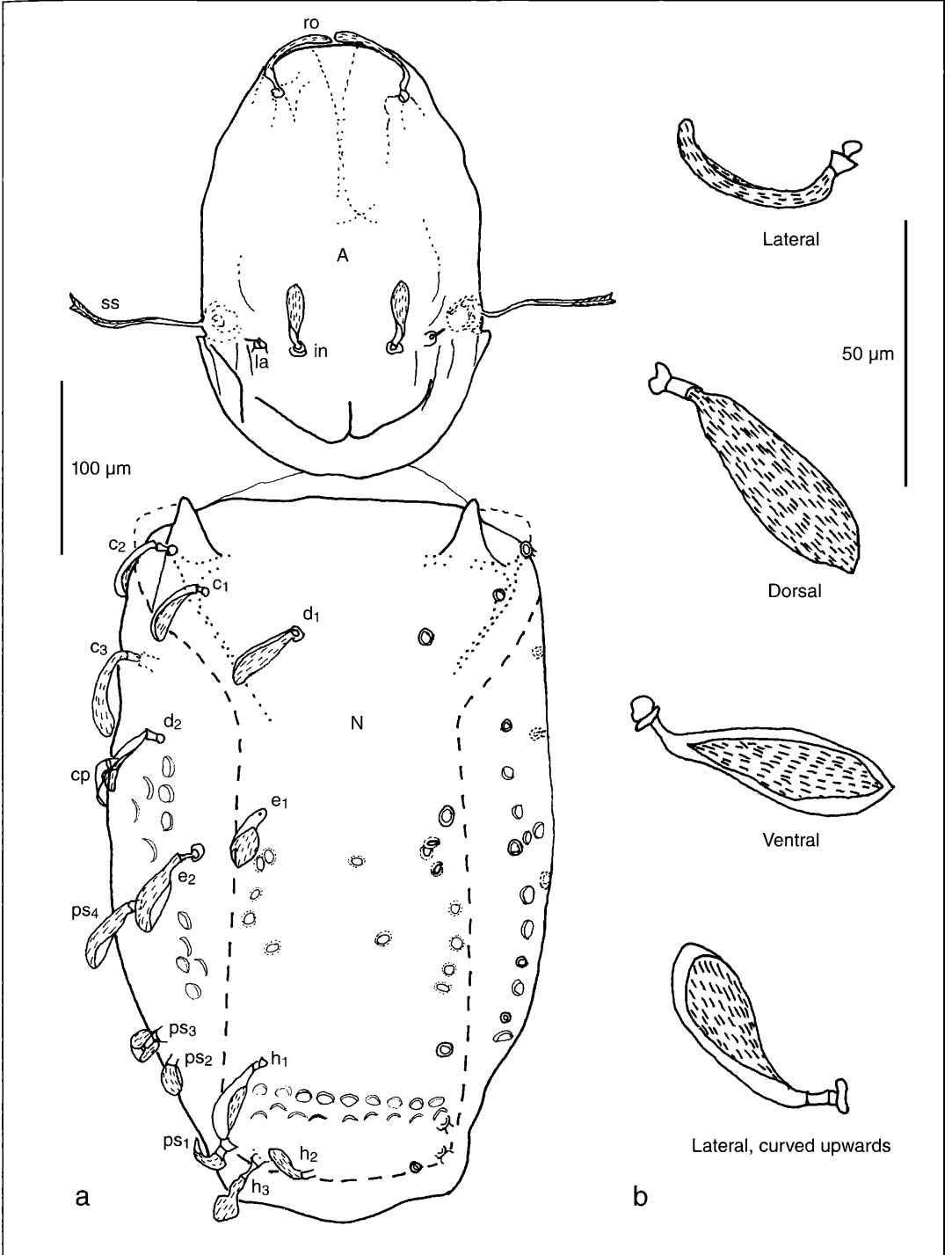
Ano-genital plates: The anogenital region is clearly visible in lateral view (fig. 1). The anal and adanal plates are fused on the one hand while the genital and aggenital plates are fused on the other. These plates articulate directly with the notogaster and both occupy the whole of the ventral region leaving no room for a separate ventral plate. This is a remarkable trait of all Phthiracaroida. The adano-anal plate is somewhat triangular in shape. The proximal margin projects anteriorly to form an interlocking device with the posterior corner of the aggenito-genital plate and all along the anterior margin, there are overlapping chitinized lobes on the right and left adano-anal plates (fig. 11a) which probably control the opening and closing of both plates and most likely the aggenito-genital plates too. The paraxial margin which bears 5 pairs of setae is convex, protruding slightly beyond the anterior aggenito-genital plate in ventral view (fig. 1). The relative positions of the setae are not clearly seen from the lateral view but when the plates are removed and viewed from above, 3 pairs of setae of similar shape and length are seen arranged on a line closer to the paraxial margin than the other 2 pairs. The marginal pairs of setae are filiform and designated as  $an_1$ ,  $an_2$  and  $an_3$  while the other two pairs which are believed to be in the adanal area are designated as  $ad_1$  and  $ad_2$ . Setae  $ad_1$  is spiniform, while  $ad_2$  is spatulate like the notogastral setae. On the other hand, the aggenito-genital plate is quadrangular in shape, with rounded corners and slanting vertical edges which make it look like a parallelogram (fig. 11b). The fused plates bear 10 pairs of setae, one of which is clearly in the aggenital region on the anterior top corner of each plate. This setae which is inserted within a furrow on the antiaxial side is the aggenital setae (ag). The remaining pairs of setae are on the paraxial side of the aggenito-genital plate. Setae  $g_1$  to  $g_5$  are minute setae which are arranged closely together along a line within a furrow at the anterior lower corner of each plate. Behind these minute setae are the more conspicuous and widely spaced  $g_6$  to  $g_9$  which are also arranged in a line along the entire length of the plate. The ovipositor has many lobes and is richly setose just as in many oribatid mites.

### 3. Discussion

Opinion on the taxonomic status of *Hoplophorella* appears divided among oribatologists. While NIEDBALA (1986) considers *Hoplophorella* as a subgenus of *Atropacarus* based on phylogenetic considerations, PEREZ-ÍÑIGO & BAGGIO (1993) suggested that *Hoplophorella* should be distinguished from *Atropacarus* as a separate genus. About fifty species of *Hoplophorella* have been described (cited in PEREZ-ÍÑIGO & BAGGIO 1993), but many of them have either been considered as synonyms or as a subgenus of *Atropacarus* by NIEDBALA (1992) and not *Steganacarus* as originally suggested by BERLESE (1923). This is in order as *Atropacarus* was a subgenus of *Steganacarus* (JACOT 1930) until recently (KAMIL & BAKER 1980, NIEDBALA 1992). In order to avoid further misconceptions, *Hoplophorella* should remain a subgenus of *Atropacarus*. A comprehensive definition of *Hoplophorella* does not exist in literature up to date, unlike *Atropacarus* and *Steganacarus* which are phylogenetic entities.

The differences between *Atropacarus* (*Hoplophorella*) *nigeriensis* described in this study and many related *Hoplophorella* species are presented in Table 1. The observed specimens fall within the same size range as all the species in Table 1 except *H. ensifera* MAHUNKA, 1984 which is bigger. The differences are observed in respect of the foveoli on the aspis and notogaster, shape of notogastral setae as well as shapes and chaetotaxy of the genital and anal plates. Other differences may exist in respect of certain other morphological traits such as the morphological features of the infracapitulum and epimeron as well as leg chaetotaxy. These traits were hardly described in many species so, the differences can only be determined by examination of the type specimens, many of which may not be available for dissection to reveal the fine details of the structures that we have reported in this study.

Morphological traits of *A. (H.) nigeriensis* that have not been reported for other related *Hoplophorella* species are the membrane linking the labiogenital articulation of the infracapitulum to the musculature in the leg-bearing hysterosoma, the 3 pairs of anal setae on the paraxial margin of the adano-anal plate, 2 pairs of adanal setae, spatula shaped prodorsal and  $ad_2$  seta (except *H. andrei*) and interlocking device of the anal and genital plates. *H. africana* WALLWORK, 1967 was collected from organic debris in Tchad and it shares similar morphological traits with *A. (H.) nigeriensis*. However, the illustration of *H. africana* in WALLWORK (1967) suggests that it is somewhat dorsoventrally compressed and many morphological traits were not described. Leg chaetotaxy for example, is not fully known. Only the tarsal formula was provided in Wallwork's description and it is different from the tarsal formula of *A. (H.) nigeriensis*. Both species however belong to the " *cucullata*" group which has been identified by PEREZ-ÍÑIGO & BAGGIO (1993) as *Hoplophorella*



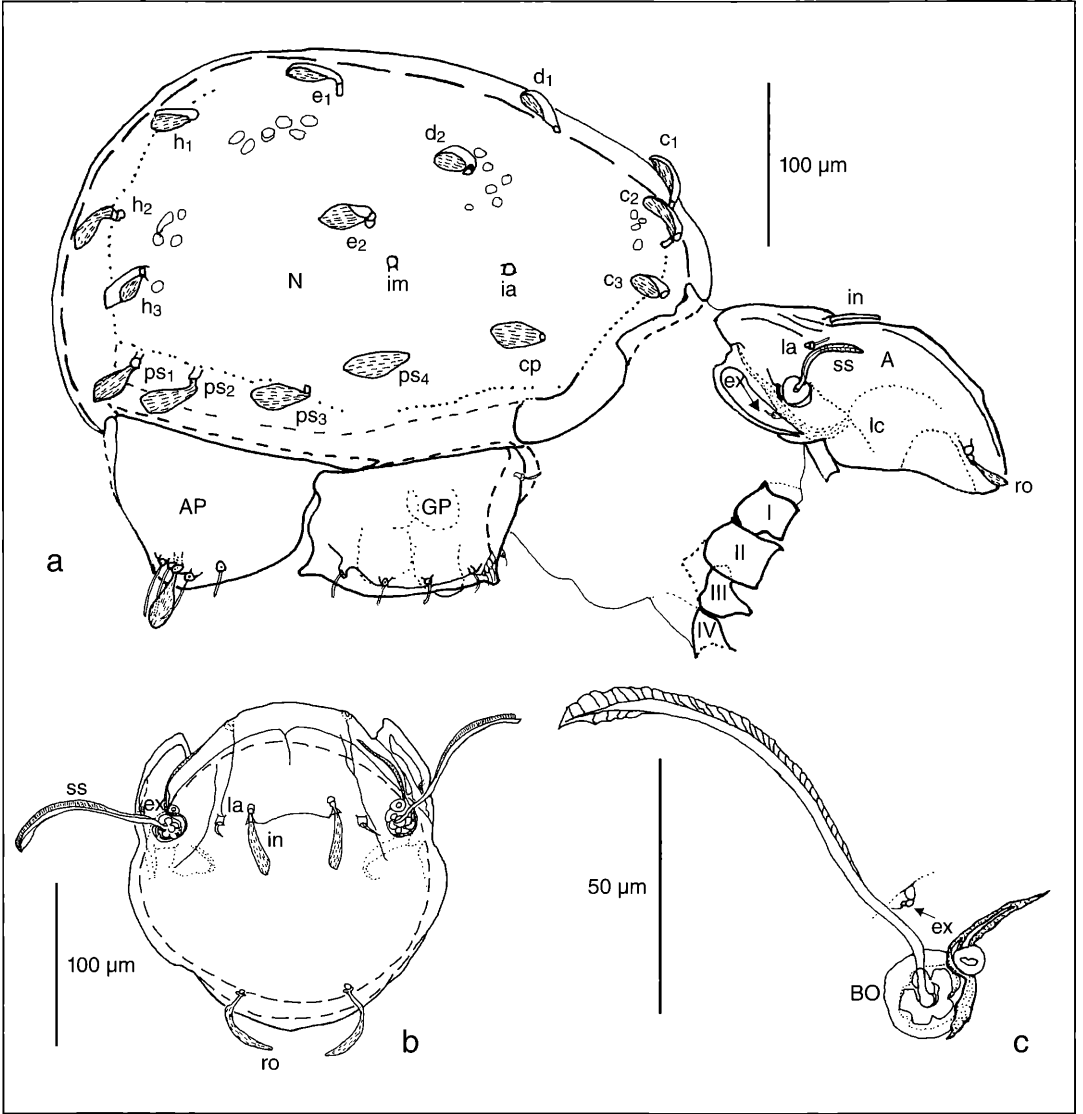


Figure 2. a) *Atropacarus (Hoplophorella) nigeriensis* BADEJO, new species: lateral view. ro, in, ss, la, ex - prodorsal setae; lc - lateral carina; A - Aspis; I, II, III, IV - epimeral plates at the bases of legs I-IV; N - Notogaster; c<sub>1</sub>, c<sub>2</sub>, c<sub>3</sub>, c<sub>p</sub>, d<sub>1</sub>, d<sub>2</sub>, e<sub>1</sub>, e<sub>2</sub>, h<sub>1</sub>, h<sub>2</sub>, h<sub>3</sub>, ps<sub>1</sub>, ps<sub>2</sub>, ps<sub>3</sub>, ps<sub>4</sub> - notogastral setae; ia, im - lyrifissures; AP - adano-anal plate; GP - aggenito-genital plate; b) frontal view of aspis. ro, in, ss, la, ex - prodorsal setae; c) sensillus. BO - bothridium.m; ex - exobothridial seta.

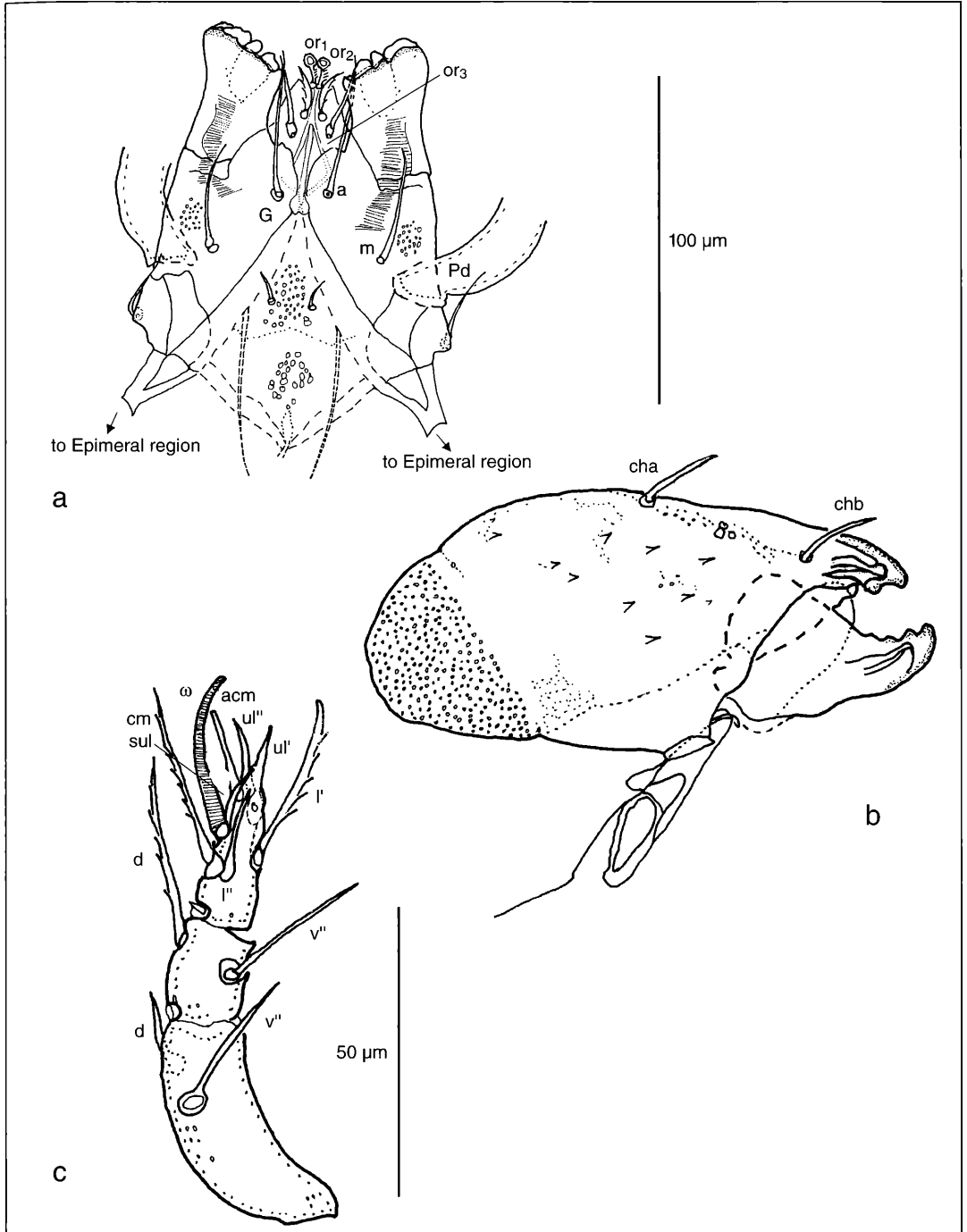


Figure 3. a) *Atropacarus (Hoplophorella) nigeriensis* BADEJO, new species: infracapitulum.  $or_1$  - anterior adoral setae,  $or_2$  - posterior adoral setae;  $or_3$  - posterior antiaxial setae,  $a$  - median setae,  $m$  - smooth setae;  $G$  - genua;  $Pd$  - distal segment of pedipalp; b) chelicera:  $cha$  - dorsal setae,  $chb$  - lateral setae; c) pedipalp..

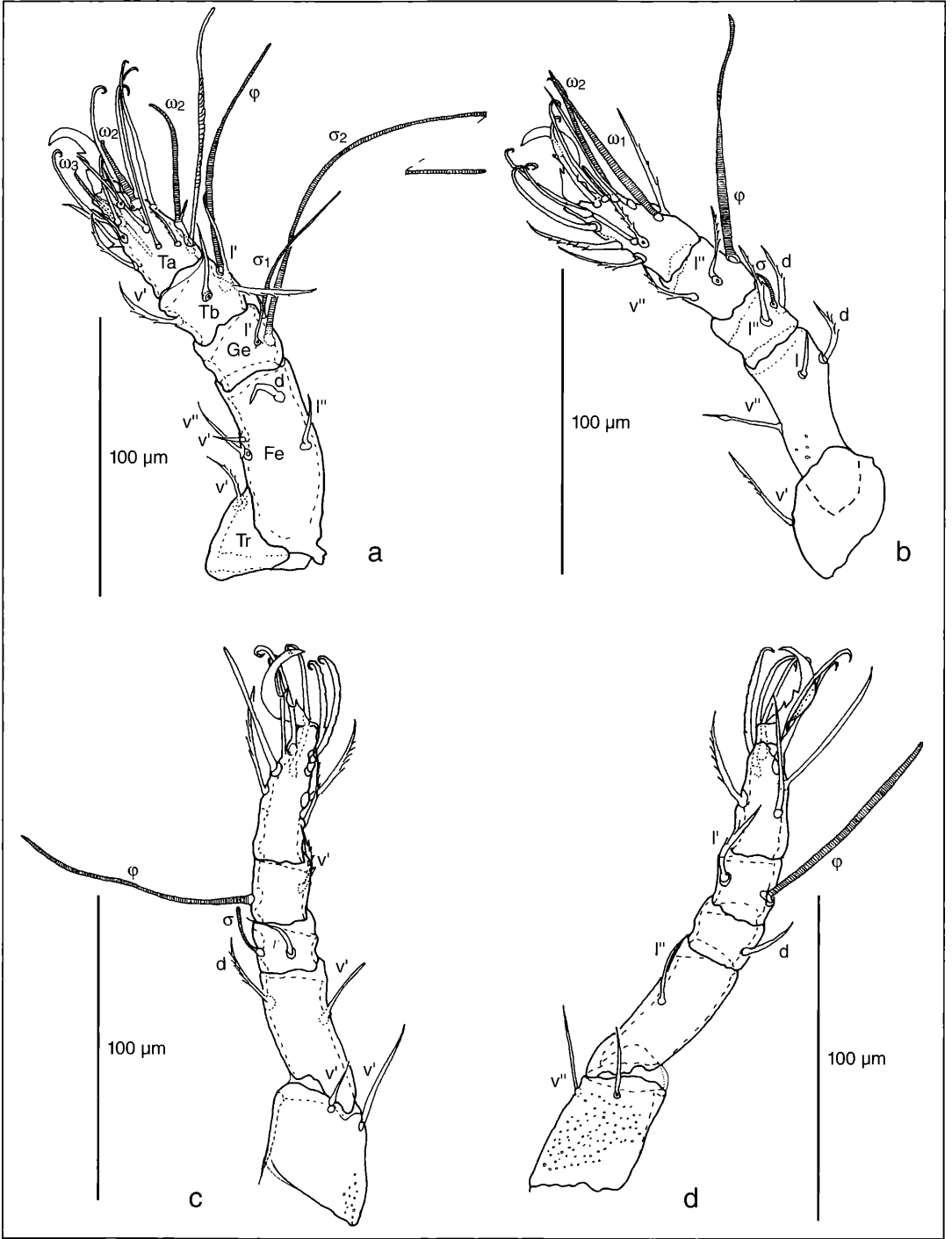


Figure 4. *Atropacarus (Hoplophorella) nigeriensis* BADEJO, new species: a) leg I, b) leg II, c) leg III, d) leg IV; Tr - trochanter; Fe - femur; Ge - genu; Tb - tibia; Ta - tarsus.



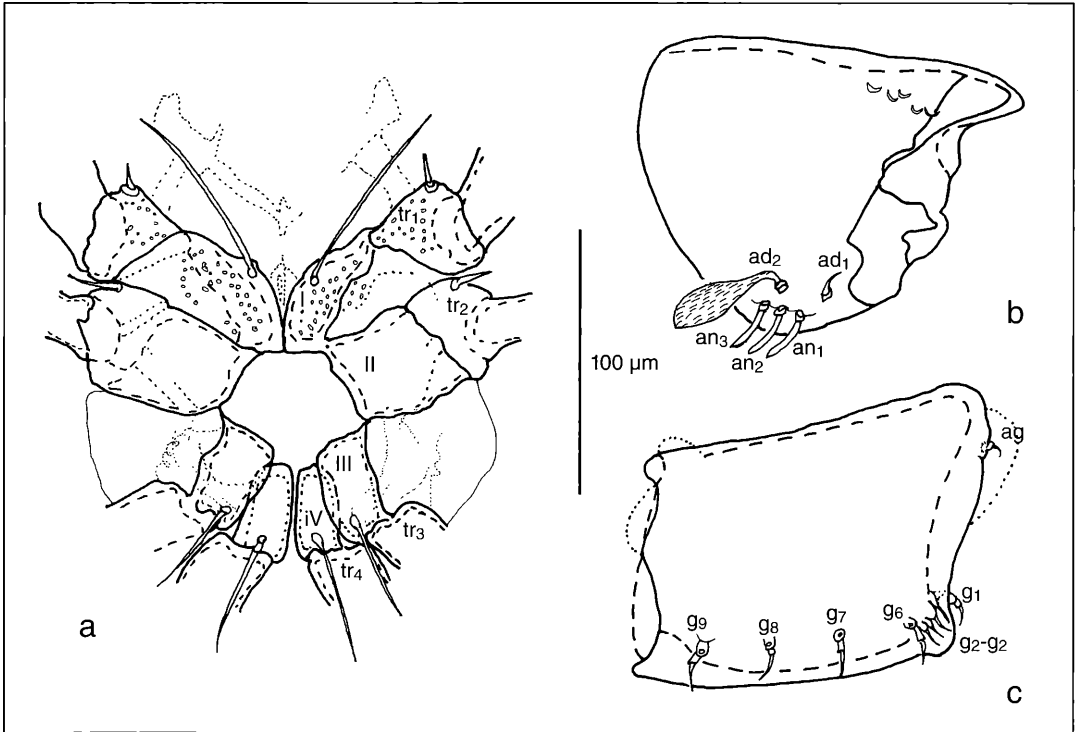


Figure 5. a) *Atropacarus (Hoplophorella) nigeriensis* BADEJO, new species: epimeral region. I, II, III, IV - epimeral plates;  $tr_1$ ,  $tr_2$ ,  $tr_3$ ,  $tr_4$  - trochanters of legs I-IV; b) adano-anal plate.  $an_1$ ,  $an_2$ ,  $an_3$  - anal setae;  $ad_1$ ,  $ad_2$  - adanal setae; c) aggenito-genital plate.  $ag$  - aggenito-genital setae;  $g_1$  -  $g_9$  - genital setae.

with one enlarged adanal seta. The morphological differences between *H. africana* and other *Hoplophorella* in this group (e.g. *H. obsoletior* BALOGH, 1962, *H. cuculata* BALOGH, 1962, both collected from Madagascar, and *H. thoreani* JACOT, 1933 from Florida) have already been highlighted by WALLWORK (1967).

#### Acknowledgement

We are grateful to the Alexander-von-Humboldt-Stiftung (AvH) for awarding the George-Foster-Research Fellowship to M.A. BADEJO which made it possible for us to work together at the State Museum of Natural History in Karlsruhe/Germany where this study was carried out.

#### 4. Literature

- BALOGH, J. (1958): Oribatides nouvelles de l'Afrique tropicale. – *Rev. Zool. Bot. Afr.*, **58**: 1-34.
- BALOGH, J. (1962): LXXV - Acari Oribates – *Ann. Mus. Roy. Afr. Centr.*, In-8°, **Zool.**, **110**: 90-131.
- BERLESE, A. (1923): Centuria sesta di Acari nuovi. – *Redia*, **15**: 237-262.
- JACOT, A.P. (1930): Oribatid mites of the subfamily Phthiracarinae of the northeastern United States. – *Proc. Boston Soc. Nat. Hist.* **39**: 209-261.
- JACOT, A.P. (1933): Phthiracarid mites of Florida. *Journ. Elisha Mich. Sci. Soc.*, **48**: 232-267
- KAMIL, B.W. & BAKER, A.S. (1980): The genus *Atropacarus* EWING (Acari: Cryptostigmata). – *Bull. Br. Mus. Nat. Hist. (Zool.)* **39**: 189-204.
- MAHUNKA, S. (1984): Description and redescription of Ethiopian oribatids (Acari: Oribatida). – *I Folia Entomologica Hungarica, Rovartani Közlemenyek*, **2**: 127-142.
- NORTON, R.A. (1990): Acarina: Oribatida. – In: DINDAL, D.L. (Ed.): *Soil Biology Guide*: 779-803; New York (John Wiley & Sons).
- NIEDBALA, W. (1986): System des Phthiracaroida (Oribatida, Euptyctima). – *Acarologia*, **27**: 61-86.
- NIEDBALA, W. (1992): Phthiracaroida (Acari, Oribatida) Systematic Studies. – Polish Scientific Publishers, Warszawa, 612 pp.
- PÉREZ-ÍÑIGO, C. & BAGGIO, D. (1993): Oribates edaphiques du Bresil (VII). Oribates de l'état de São Paulo (Quatrième partie). – *Acarologia*, **34**: 249 - 264.
- WALLWORK, J. (1967): Some Oribatei (Acari: Cryptostigmata) from Tchad (3. Series). – *Rev. Zool. Bot. Afr.*, **1-2**: 35-45.