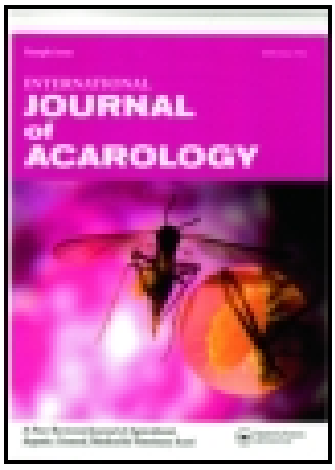

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Revision of the family Carabodidae (Acari: Oribatida) V (third part). Redefinition of Congocepheus, definition of Cavaecarabodes gen. nov., and descriptions of three new species, Congocepheus germani sp. nov., Cavaecarabodes pulchritude gen. nov., sp. nov., and Cavaecarabodes anouchkae gen. nov., sp. nov.

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Revision of the family Carabodidae (Acari: Oribatida) V (third part). Redefinition of *Congocepheus*, definition of *Cavaecarabodes* gen. nov., and descriptions of three new species, *Congocepheus germani* sp. nov., *Cavaecarabodes pulchritude* gen. nov., sp. nov., and *Cavaecarabodes anouchkae* gen. nov., sp. nov.

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Redefinition of *Congocepheus* Balogh, 1958 and description of *Congocepheus germani* **sp. nov.**, that displays notogastral neotrichy, which was previously unknown in the genus. Definition of *Cavaecarabodes* **gen. nov.** together with the descriptions of *Cavaecarabodes pulchritude* **sp. nov.** (type) from Gabon and *Cavaecarabodes anouchkae* **sp. nov.** from Madagascar has been provided.

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Keywords: *Congocepheus* redefinition; *Congocepheus germani* **sp. nov.**; *Cavaecarabodes pulchritude* **gen. nov., sp. nov.**; *Cavaecarabodes anouchkae* **gen. nov., sp. nov.**

Introduction

In previous papers, we redescribed *Congocepheus heterotrichus* Balogh, 1958, *Co. orientalis* Mahunka, 1987, *Co. hauseri* Mahunka, 1989, *Congocepheus involutus* Mahunka, 1997 and described *Congocepheus gabonensis* Fernandez et al., 2013 and *Congocepheus ektactesi* Fernandez et al., 2013. Here we describe *Congocepheus germani* **sp. nov.**, which displays notogastral neotrichy, hitherto unknown in the genus, we redefine *Congocepheus* and describe a new genus *Cavaecarabodes* with two new species *Cavaecarabodes pulchritude* **gen. nov., sp. nov.** and *Cavaecarabodes anouchkae* **gen. nov., sp. nov.**, and include some species previously belonging to *Congocepheus*. We studied the type material of *Congocepheus ornatus* Mahunka, 1983, *Co. latilamellatus* Mahunka, 1984 and *Co. velatus* Mahunka, 1986, in order to establish its position in the genus *Congocepheus* Balogh, 1958.

In Fernandez et al. (2013b, 2013c), we redescribed several species due to deficient and ambiguous original descriptions, and decided to search in the material from Madagascar, Gabon, Antilles, Namibia and Vietnam amongst others in the Collections of the Museum National d'Histoire Naturelles (MNHN) in Paris, and from Kenya, Tanzania, Costa Rica, Zimbabwe (previously Southern Rhodesia) and Rwanda belonging to the Natural History Museum of Geneva (NHMG), in an attempt to find the largest number of species possible in order to understand different aspects of this group, several of them are being studied at present and will be the subjects of further papers.

In this paper, due to the small number of obtained specimens of *Co. germani*, we decided to only use optical microscopy (OM) for studies, to enable us to deposit all specimens; in the case of *Ca. pulchritude* and *Ca. anouchkae*, we found four specimens of each species and decided to use two of each for additional studies with scanning electron microscopy (SEM) to enhance optical observations.

Materials and methods

Specimens studied by means of OM were macerated in lactic acid and observed in the same medium using the open-mount technique (cavity slide and cover slip) described by Grandjean (1949) and Krantz and Walter (2009). Drawings were made using a Zeiss Axio Scope (Carl Zeiss Microscopy GmbH, Jena, Germany) compound microscope equipped with a drawing tube.

Specimens were also studied under a scanning electron microscope (SEM). Specimens preserved in ethanol were carefully rinsed by sucking them into a Pasteur pipette several times, after which they were transferred to buffered glutaraldehyde (2.5%) in Sörensen phosphate buffer (pH 7.4; 0.1 m) for 2 hours. After postfixation for 2 hours in buffered 2% OsO4 solution and being rinsed in buffer solution, all specimens were dehydrated in a series of graded ethanols and dried in a critical point apparatus. After mounting on Al-stubs with double-sided sticky tape, specimens were gold coated in a sputter apparatus (Alberti and Fernandez 1988).

SEM observations were very complex, due to limited numbers and anatomic particularities shown by specimens. Two different types of SEM were used in order to obtain observations of adequate quality: (1) Tescan Vega II LSU (Tescan Orsay Holdings, Kohoutovice, Czech Republic), (Direction of Collections – SEM-EDS (scanning electron microscopy with energy dispersing spectrometry) – MNHN) and (2) Hitachi SU3500 (Hitachi High-Technologies Europe, Krefeld, Germany) (Plateau technique de Microscopie Electronique et de Microanalyse (PMEM) (MNHN) using the accelerating voltages of 15 and 10 Kv, respectively. The critical point apparatus used was an Emitech K 850 (Quorum Technologies Ltd., Ashford, Kent, United Kingdom) and the sputter a Jeol JFC-1200 (Jeol Ltd. Tokyo, Japan) (metalized 80″).

In the legends to figures, images obtained with Tescan Vega II LSU are indicated with a small number 1 and those obtained with Hitachi SU3500, with a small number 2.

Measurements taken: total length (tip of rostrum to posterior edge of notogaster); width (the widest part of notogaster) in micrometres (µm).

Leg chaetotaxy studies executed with the aid of standard, polarized and phase contrast microscopes are provisional, due to the fact that only adult specimens were available for study. Setal formulae of the legs include the number of solenidia (in parentheses); tarsal setal formulae include the famulus (ε).

Morphological terminology

Morphological terms and abbreviations used are those developed by F. Grandjean (1928–1974) (cf. Travé and Vachon 1975; Norton and Behan-Pelletier 2009; Fernandez et al. 2013a, 2013b, 2013c). For setal types Evans (1992, p. 73) and for ornamentation of cuticular surfaces Murley (1951, p. 9) were used.

We add the following terminology used in previous papers (see above): ornamentation: snap-like (press stud-like) structures (*snp*); round-ovoid depressions (*r-o*); promontories (*prm*).

Historic review

We have been studying the genus *Congocepheus* for a number of years and found the taxonomic situation very complex (see Fernandez et al. 2013a, 2013b, 2013c).

Eight species were placed in the genus (Subias 2004) of which two were described by J. Balogh: *Co. heterotrichus* Balogh, 1958 and *Co. taurus* Balogh, 1961. Six others were described by S. Mahunka: *Co. hauseri* Mahunka, 1987; *Co. involutus* Mahunka, 1997; *Co. latilamellatus* Mahunka, 1984; *Co. orientalis* Mahunka, 1987; *Co. ornatus* Mahunka, 1983; and *Co. velatus* Mahunka, 1986.

We recently redescribed *Co. heterotrichus, Co. hauseri, Co. involutus* and *Co. orientalis*, and also added two new species, namely *Co. gabonensis* and *Co. ektactesi* (Fernandez et al. 2013c).

Due to remaining uncertainties, we more recently studied *Congocepheus ornatus* Mahunka, 1983; *Co. latilamellatus* Mahunka, 1984 and *Co. velatus* Mahunka, 1986a.

We have studied all species currently placed in the genus except *Co. taurus* (unfortunately unable to secure on loan from Hungarian Natural History Museum, Budapest) and not found in the collection at MNHN.

The genus was described by Balogh (1958) and redescribed by Mahunka (1986b), but several species were included even though not strictly in accordance with the genus description.

Knowledge obtained in the past couple of years, along with recent redescriptions, in depth studies of *Co. ornatus, Co. latilamellatus* and *Co. vellatus* and a series of recently discovered species, necessitated redefinition of the genus *Congocepheus* and the species included in it, together with the establishment of a new genus, *Cavaecarabodes*.

Note that the latter three species cited do not belong to the genus *Congocepheus*, and will not be included in the present paper. Redescriptions of these will be the subject of future papers (see "Discussion" section).

In order to facilitate understanding of the inconsistencies present in the genus *Congocepheus* and related species descriptions, it was deemed necessary to transcribe the original description and redescription of the genus in the corresponding sections.

New taxa descriptions

Congocepheus germani **sp. nov.**
(Figures 1–12)

Etymology

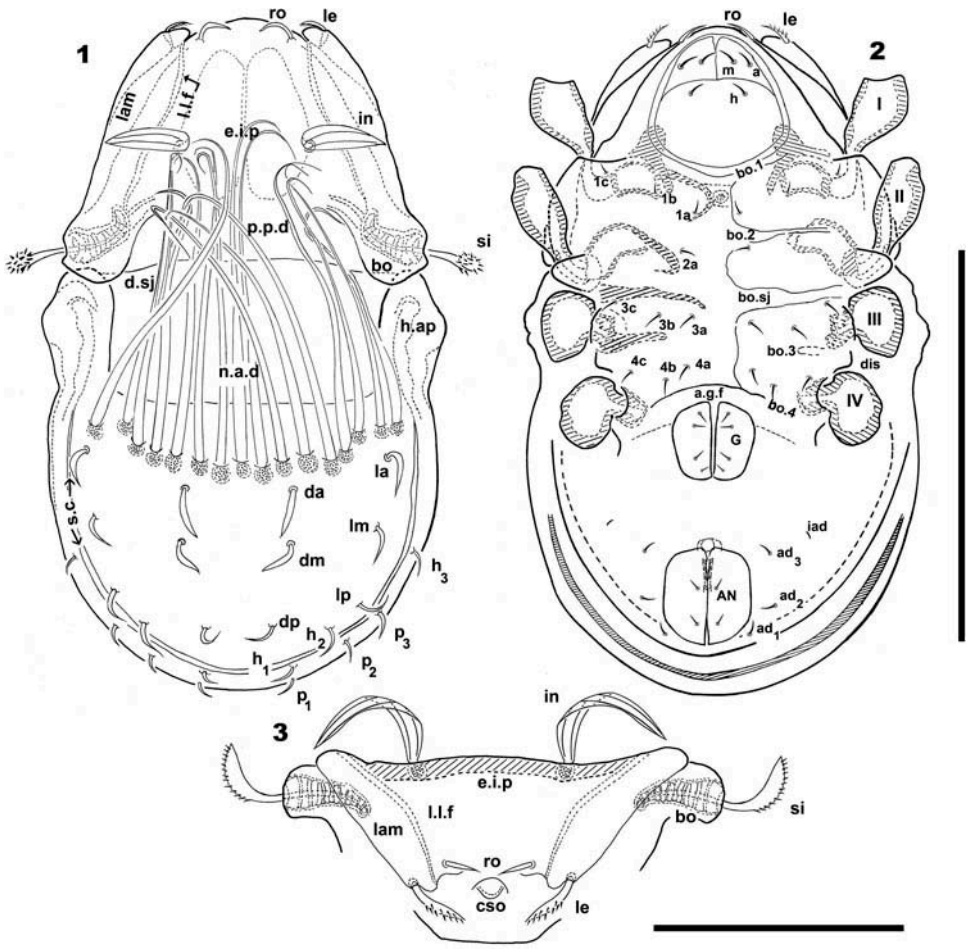
The specific epithet is dedicated in homage to German Shtefec, adopted son of the first author.

Material examined

Holotype: female and one paratype male. "Mad, 876. Madagascar nord-est. Province de Tamatave. Baie d'Antongil. Ivontaka (15 km au S. de Mananara), alt. 150 m, en bordure de FDHBA (**F**orêt **D**ense **H**umide de **B**ase **A**ltitude) – décharge de bois, vue sous planches et écorces-6-7-67". Coll. J.M. Betsch, deposited in the Collection of the MNHN, Paris, France, preserved in 70% ethanol.

Diagnosis – adult female

Setae. Prodorsum: *ro* simple; *in* lanceolate with two medial longitudinal veins; directed externally; *le* lanceolate, barbate. Notogaster: setae neotrichous, simple, very long, sharp apex; *da, dm, dp, la, lm, lp,* h_1, h_2, h_3, p_1, p_2, p_3, lanceolate; neotrichous setae directed forward; *da, dm, dp, la, lm, lp,* h_1, h_2, h_3, p_1, p_2, p_3 setae directing posteriorly.



Figures 1–3. *Congocepheus germani* **sp. nov.:** 1. dorsal view, adult female; 2. ventral view, male; 3. frontal view, female. Abbreviations: "Materials and methods" section. Scale bar: 1, 2 = 150 μm; 3 = 80 μm.

All notogastral setae situated outside notogastral anterior depression. Epimeral, genital, adanal and anal setae, simple. Aggenital setae absent. Twenty pairs of setae.

Prodorsum. Polyhedral (dorsal view); convex (lateral view); interlamellar process, complete, slightly elevated. Posterior prodorsal zone slightly depressed. Rostral margin slightly rounded. Dorsolateral lamellae truncate with paraxial rounded lamellar apex.

Notogastral shape. Anterior part rectangular (dorsal view); posterior part oval; in lateral view, anterior part depressed, posteriorly convex; dorsosejugal furrow narrow, rectilinear; notogastral anterior depression ovoid, conspicuous, extending forward; dorsosejugal furrow and posterior prodorsal depression forming a conspicuous depressed zone, extending to basal central zone of prodorsum. Circumgastric depression present; humeral apophysis very long, clearly visible; giving characteristic shape to anterior notogastral zone. Tutorium: curving rod-like cuticular thickening. Supratutorial depression deep, both anterior tutorial depressions present. Bothridia cup-shaped; smooth bothridial ring incomplete with bothridial tooth. Sensillus uncinate arching to the top. Pedotectum I and II, present. Only lyrifissures *ih* and *ips* clearly visible. Discidium easily discernible as a triangular structure with rounded apex; large shallow depression well-discernible anterior to genital opening.

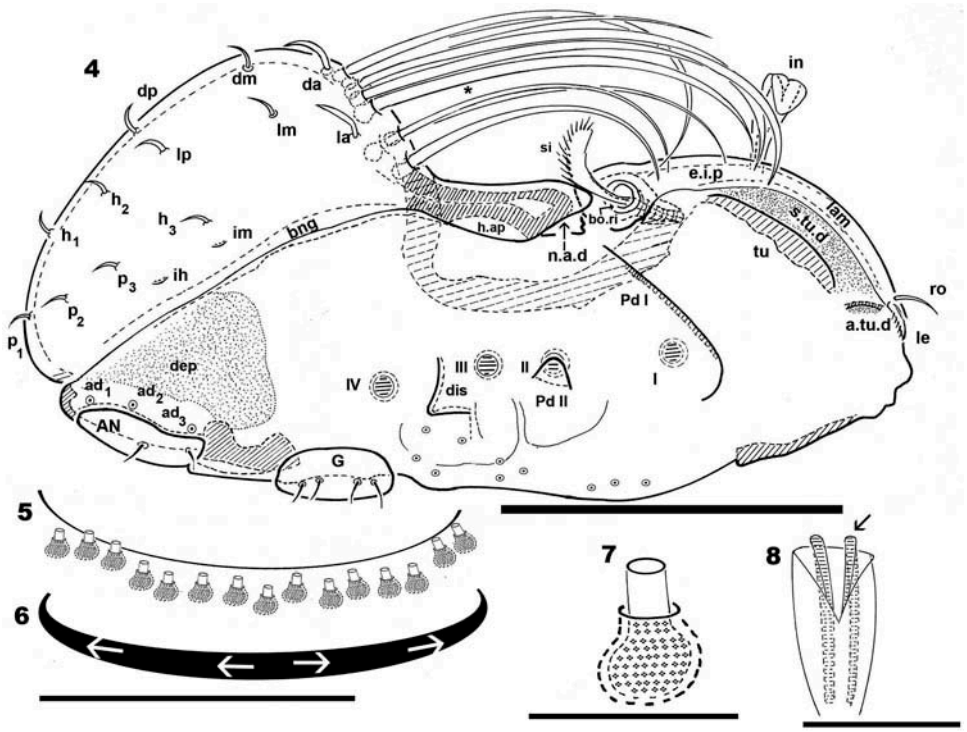
Epimeres slightly elevated, delimited by furrow. Epimeres 3 and 4 fused. Epimeral chaetotaxy 3-1-3-3. Small rounded depression in central zone between apodeme 1; anterior genital furrow clearly visible. Large genital plate; four pairs of genital setae. Aggenital setae absent. Three pairs of adanal seta. Anal plate slightly larger than genital plate. Two pairs of anal setae. Lyrifissures *iad* situated laterally to ad_3.

Description

Measurements. 260 μm (262–259) × 166 (168–164) (measurements on two specimens).

Shape. Elongate oval (Figures 1 and 2).

Colour. Specimens without cerotegument, male: light yellow; female brown light to yellow-brown, observed in reflected light.



Figures 4–8. *Congocepheus germani* **sp. nov.**, adult female.:4. lateral view; 5. neotrichous setal disposition; 6. neotrichous territory; 7. neotrichous setal insertion; 8. *in* setae. Abbreviations: see "Materials and methods" section. Scale bar: 4 = 80 μm; 5, 6 = 100 μm; 7 = 10 μm; 8 = 20 μm.

Cerotegument. Cerotegument completely removed for study.

Integument. Prodorsal and Notogastral microsculpture: *smooth* to *slightly irregularly tuberculate*.

Lateral microsculpture: *slightly irregularly tuberculate* to *smooth*. Ventral microsculpture: *smooth.*

Setation. Neotrichous setae simple, more or less cylindroid, very long sharp apex; *ro* simple (Figure 3); *in* lanceolate with two medial longitudinal veins (Figures 1 and 8); *le* lanceolate, barbate (Figure 3); *da, dm, dp, la, lm, lp, h_1, h_2, h_3, p_1, p_2, p_3*, lanceolate (Figure 1); epimeral, genital, adanal and anal setae simple (Figure 2). Aggenital setae absent (Figure 2).

Neotrichous setae directing forward (Figure 1); *in, da, dm, dp, la, lm, lp, h_1, h_2, h_3, p_1, p_2, p_3* directing backward (Figure 1).

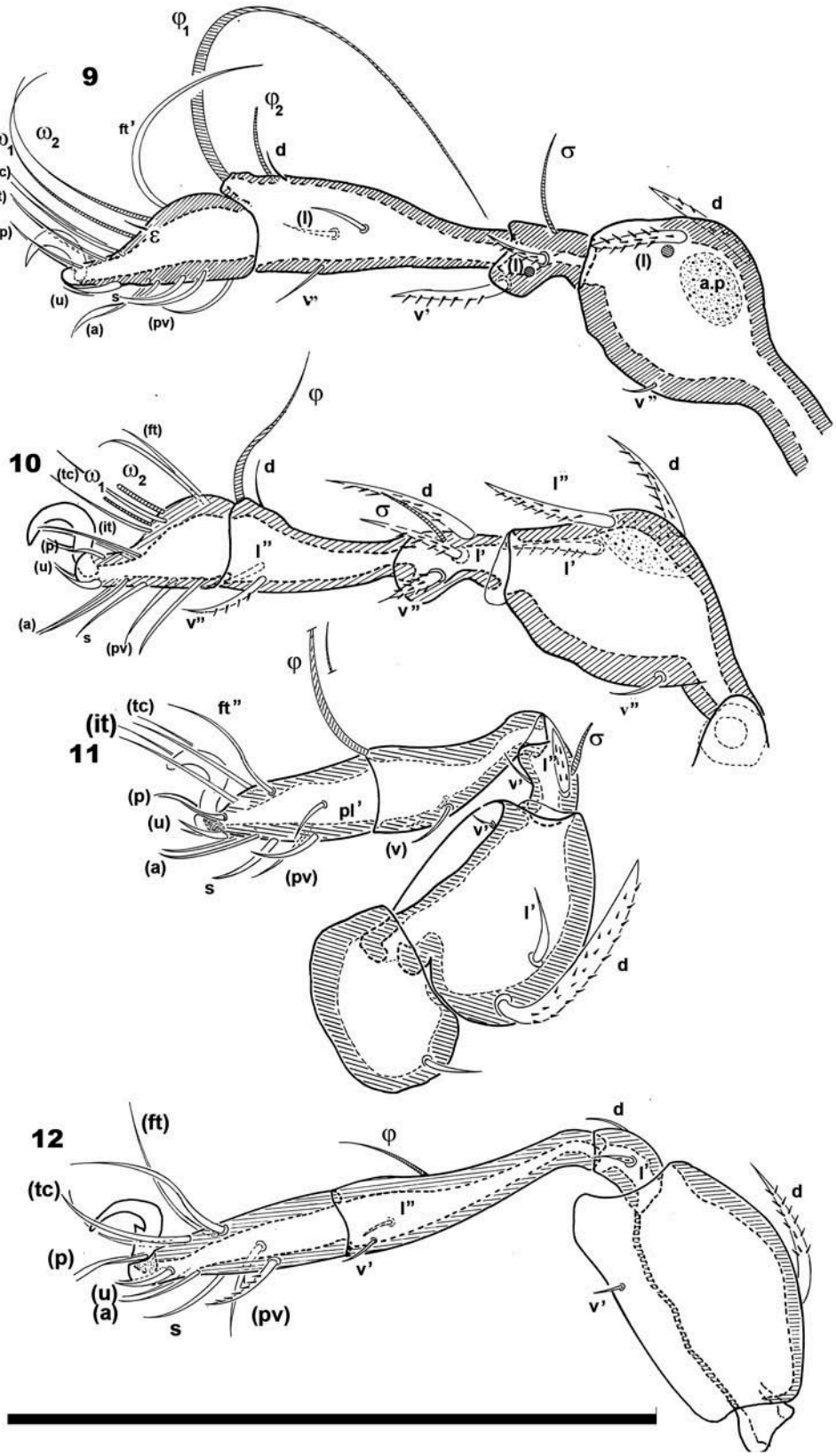
Prodorsum. Polyhedral (dorsal view) (Figure 1); convex lateral view (Figure 4); small elevated interlamellar process (*e.i.p*), complete (Figures 1 and 3). Posterior prodorsal zone slightly depressed (*p.p.d*); with notogastral anterior depression (*n.a.d*) (Figure 1), delimiting a significant depressed area. Three pairs of setae; size *in* > *le* > *ro* (Figure 3). Setae *ro* inserted slightly posterior to *le* insertion, directing forward and paraxially; apical tips not touching each other (Figure 3); *in* setae inserted antiaxially to medial plane on *e.i.p,* slightly external to *ro* insertion level; externally directed laterally, do not exceed prodorsal margin (Figures 1 and 3); *le* setae laterally situated on lamellar apical zone (Figures 3 and 4)

Rostral margin slightly rounded to hexagonal (Figure 3). Lamellae run laterally; inner paraxial margin of prodorsal anterior zone demarcated by a shallow furrow (*l.l.f*) (Figure 3); this furrow presenting as a slightly darker zone in bleached animals. *l.l.f* terminating in the internal zone of rounded lamellar apex (*la.ti*). In frontal view (Figure 3), the superior cornea of naso (*cso*) clearly visible as convex elevation situated anterior to *ro* setae insertion level. In this last view, it is possible to observe the complete *eip*; the disposition of the shallow lamellar furrow and the particular shape of the lamellar tip.

Notogaster. Shape: in dorsal view anterior part rectangular and posterior part oval (Figure 1); in lateral view, anterior part clearly depressed and rest convex (Figure 4); *d.sj* narrow, slightly rectilinear, well delimited (Figure 1); notogastral anterior depression (*n.a.d*), ovoid and prominent, extending forward, depressed area exceeding *d.sj* up to basal central zone of prodorsum (*p.p.d*). All neotrichous setae situated in front of *n.a.d* (Figure 1) posterior margin zone.

Circumgastric depression (*s.c*) present, hardly discernible (Figure 1), situated between *h_1, p_1, p_2, p_3, h_3* and *h_2, lp, lm, la* insertion levels.

Twenty pairs of setae: eight pairs of setae *c* (neotrichy), and *da, dm, dp, la, lm, lp, h_1, h_2, h_3, p_1, p_2, p_3, la, da, dm* > *lm, dp, h_2* > *h_1, h_3* > *p_1, p_2, p_3*.



Figures 9–12. *Congocepheus germani* **sp. nov.** adult female: 9. leg I antiaxial view; 10. leg II antiaxial view; 11. leg III antiaxial view; 12. leg IV antiaxial dorsal view. Abbreviations: see "Materials and methods" section. Scale bar: 9–12 = 100 μm.

Neotrichous setae very long, with the two central pairs exceeding *in* insertion level (Figure 1); other pairs of setae slightly shorter (Figure 1). All neotrichous setae placed far from *n.a.d* margin with clearly visible insertions (Figure 7).

Humeral apophysis (*h.ap*) very long, clearly visible as a pronounced projection, giving characteristic shape to anterior zone of notogaster (Figure 4).

Lateral region (Figure 4). Lamellae (*Lam*) easily discernible, more or less truncate; prodorsal margin with small rounded protuberance (Figure 3).

Tutorium (*tu*) rod-like curving cuticular thickening, clearly visible. Between lamellae and tutorium a deep supratutorial depression (*s.tu.d*) running parallel to both structures; pocket depression (*a.tu.d*) anteriorly. Posterior zone *tu* extending to *Pd I*.

Bothridia particularly cup-shaped (Figure 3) with smooth bothridial ring (*bo.ri); bo.ri* incomplete with bothridial tooth (*bo.to*), well discernible. Sensillus uncinate arching apex (Figure 3). Pedotectum I prominent extended lamina covering first acetabulum, rounded apex. Pedotectum II small ovoid lamina. Sejugal depression slightly deeper, hardly discernible. Humeral apophysis (*h.ap*) long extended structure, rounded apex, basally curved; anterior tip overlapping posterior bothridial part. Between anterior part of humeral apophysis and posterior part of bothridia, the *n.a.d* is partially visible (indicated by arrow, Figure 4).

Only lyrifissures *ih* and *ips* clearly visible. Discidium easily discernible as triangular structure with rounded apex.

A large shallow depression (*dep*) clearly discernible lateral to anal opening.

Ventral region (Figure 2). Epimere slightly elevated, delimited by shallow furrow (*bo.1, bo.2, bo.sj*). Epimere 4 fused, slight epimeral furrow (*bo.3); apo.1, apo.2, apo.sj* and *apo.3* well discernible.

Epimeral chaetotaxy 3-1-3-3. Small rounded depression on central zone between *apo.1*. Discidium (*dis*) hardly discernible; anterior genital plate furrow (*a.g.f*) clearly visible situated anterior to genital plate.

Genital plate large; four pairs of genital setae, two pairs anteriorly and two posteriorly on plate; setae small, but well discernible by conspicuous round insertion. Aggenital setae absent. Three pairs of adanal setae. Anal plate slightly larger than genital plate. Two pairs of anal setae. Lyrifissures *iad* well discernible, situated laterally to ad_3.

Legs (Figures 9–12) Table 1. All legs monodactyle. Setal formulae I (1-4–3-4-15-1) (1-2-2); II (1-4-3-3-15-1) (1-1-2); III (1-3-2-2-15–1) (1-1-0); IV (1-2-2-2-13-1) (0-1-0).

Femora I and II, paraxial clearly discernable porose areas; tibia I, solenidion φ_1 on prominent apophysis; φ tibia II situated on small apophysis. Leg III, only one seta on trochanter; short, robust femur, with clearly discernible femoral groove (*f.g)* containing ventral setae inside. Femur IV presenting a conspicuous ventral carina.

Remarks. The first known instance of neotrichy observed in the genus. Only *c* setae are involved; the setae are on the margin of *n.a.d*.

All setae showing neotrichy presenting more or less similar characteristics, only the middle pair is longer than the others (see "Discussion" section).

New taxa description

Cavaecarabodes gen. nov.

Etymology

The generic prefix "*cavae*" (Latin = hollow) is derived from the presence of a conspicuous cavity or depressed area situated on anterior notogastral zone.

Diagnosis – adult female

Body compact, not elongate.

Prodorsum. Elevated interlamellar process, either undivided or divided in two; interlamellar setae situated on elevated interlamellar process; lamellar setae situated laterally on apical zone of lamella, setae generally barbate. Lamellar apical tip present, shape and size variable.

Table 1. *Congocepheus germani* **sp. nov.**, setae and solenidia.

	Femur	Genu	Tibia	Tarsus	claw
Leg I					
Setae	*d, (l),v″*	*(l),v′*	*d, (l),v″*	*ft′,ε,(tc),(it),(p), (u),(a),s,(pv)*	1
Solenidia		σ	φ_1 φ_2	ω_1 ω_2	
Leg II					
Setae	*d, (l), v″*	*(l),v″*	*d,l′, v″*	*(pv), s,(a),(u),(p), (it), (tc), (ft)*	1
Solenidia		σ	φ	ω_1 ω_2	
Leg III					
Setae	*d, l′, v′*	*L′,v′*	*(v)*	*,(pv),s,(a),(u),(p),pl′(it),(tc), ft″*	1
Solenidia		σ	φ	–	
Leg IV					
Setae	*d, v′*	*d, l′*	*l″,v′*	*(pv), s,(a),(u), (p),(tc), (ft)*	1
Solenidia		–	φ	–	

Rostral setae present. Cornea superior of medial eye, when present, situated between or anterior to rostral setal insertion. Posterior part of prodorsum depressed. Bothridium generally with bothridial ring, more or less visible; commonly with bothridial tooth.

Notogaster. Notogastral anterior depression conspicuous, together with posterior prodorsal depression forming significant depressed zones on either side of dorsosejugal furrow; 14 to 12 pairs of setae, regression involving setae *c*. Notogastral setae never observed inside notogastral anterior depression; never long, never exceeding dorsosejugal suture. Diverse notogastral setal dispositions, with varied shapes and lengths. Notogaster, mostly ovoid, more or less elevated in lateral view, with prominent cuticular ornamentations; finger-like projection (see Fernandez et al. 2013b) either present or not.

Lateral zone. Tutorium well developed; supratutorial depression present, with various types of other depressions (anterior, posterior or numerous), all pocket-shaped. Structural evidence of protective mechanisms (leg folding, see Fernandez et al. 2013a) always present. Pedotecta I, II, discidium present.

Ventral region. Epimeral zone simple to very complex, sometimes with complex cuticular structures, ribs, costulae and depressions. Epimeres 1, 2 generally clearly visible, separated by epimeral furrow; epimeres 3 and 4 generally fused. Epimeral formulae generally 3-1-3-3 or 3-1-2-2. Anterior genital furrow present, more or less noticeable. Four pairs of genital setae; Aggenital setae present or absent. Adanal setae, three pairs. Anal setae, two pairs. Lyrifissure *iad* generally visible. Several depressed areas at level of genital and anal openings or between them. Anal plates sharply tipped or not.

Type species: *Cavaecarabodes pulchritude* **sp. nov.**
Other species: *Cavaecarabodes hauseri* (Mahunka, 1989)
Cavaecarabodes orientalis (Mahunka, 1987)
Cavaecarabodes anouchkae **sp. nov.**

Type species *Cavaecarabodes pulchritude* **gen. nov., sp. nov.**
(Figures 13–35)

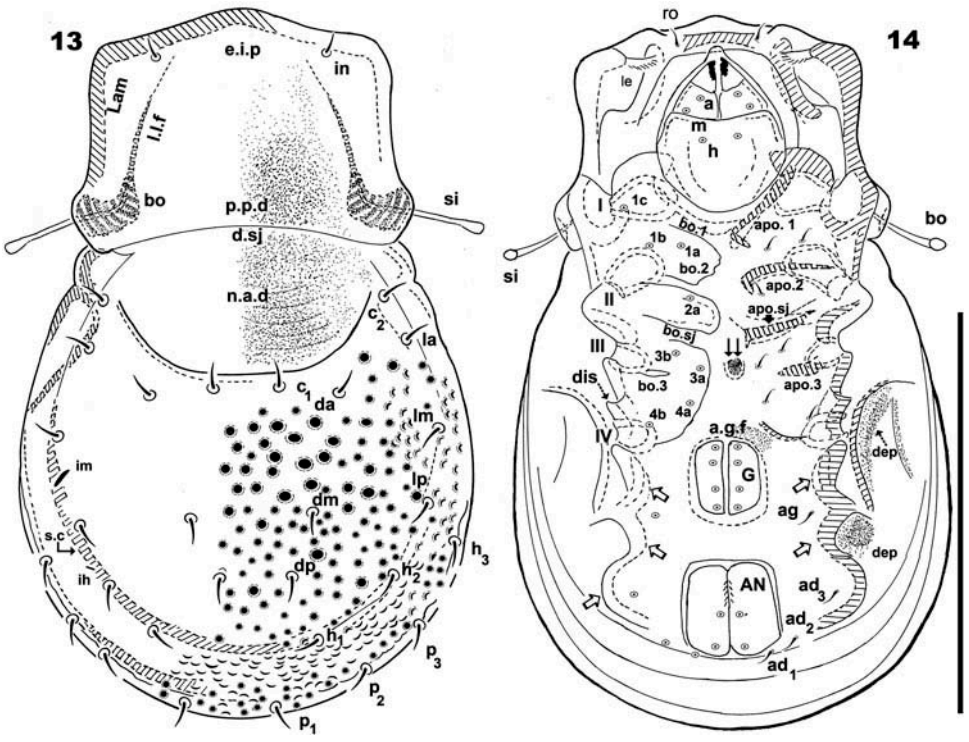
Etymology

The specific epithet is derived from "*pulchritude*" (Latin = beauty) from the aspect and characteristics of the specimens.

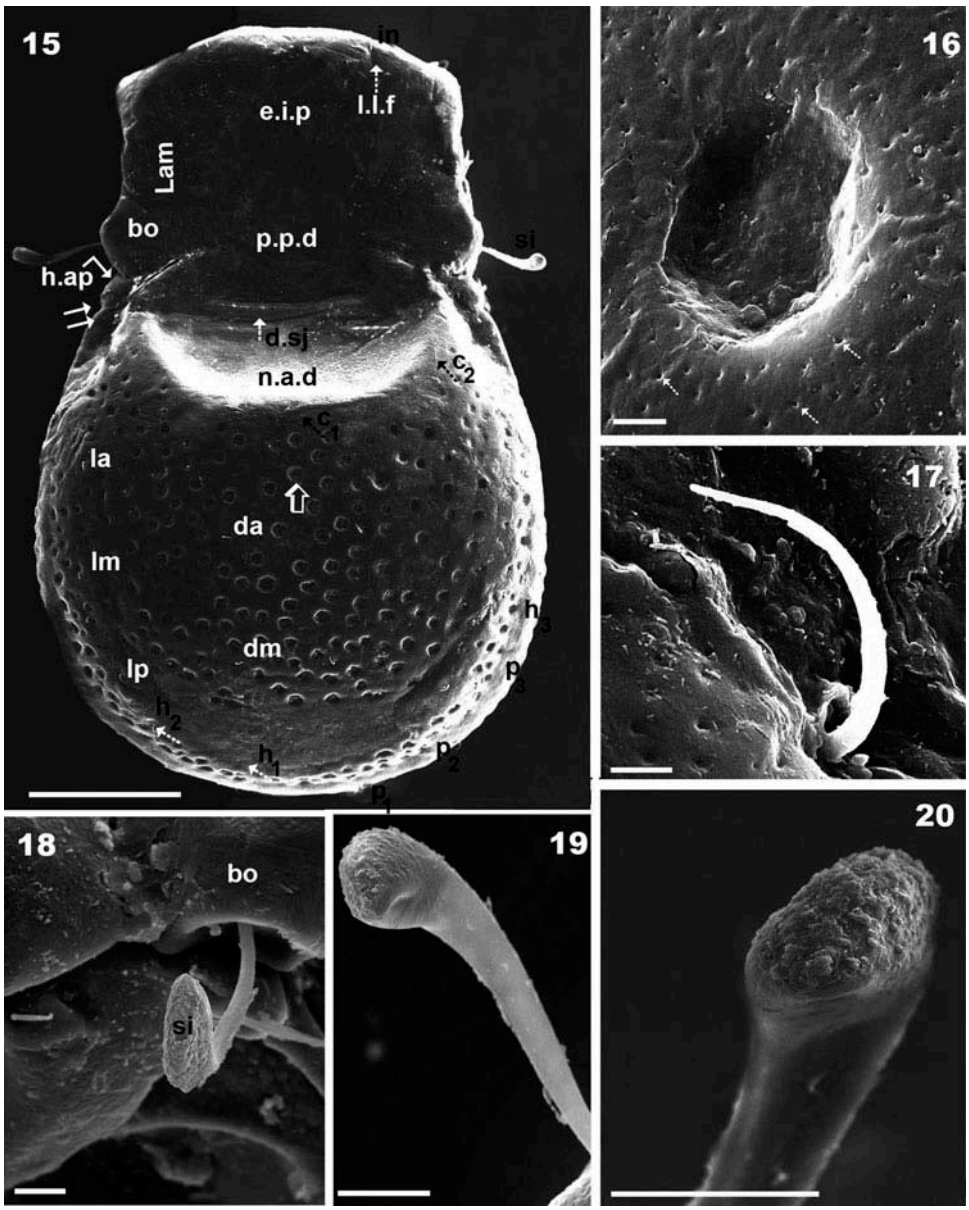
Material examined

Holotype female and one paratype male: Makokou, Northeastern Province of Ogoové-Ivindo, Gabon, 500 m. altitude; dense evergreen humid forest; Y. Coineau coll. Jan /1974.

Holotype and Paratype: deposited in the Collection of the Muséum National d'Histoire Naturelle, Paris, France, preserved in 70% ethanol.



Figures 13–14. *Cavaecarabodes pulchritude* **gen. nov., sp. nov.** adult: 13. female, dorsal view; 14. male, ventral view. Abbreviations: see "Materials and Methods" section. Scale bar: 13, 14 = 170 μm.



Figures 15–20. *Cavaecarabodes pulchritude* **gen. nov., sp. nov.** adult female: 15. dorsal view [(1)]; 16. notogastral ornamentation [(1)]; 17. interlamellar (*in*) setae [(1)]; 18. sensillus and bothridia dorsal view[(1)]; 19. sensillus ventral view[(1)]; 20. sensillus, apical aspect[(2)]. Abbreviations: see "Materials and methods" section. Scale bar: 15 = 60 μm; 18–20 = 10 μm; 16, 17 = 2 μm.

Diagnosis – adult female

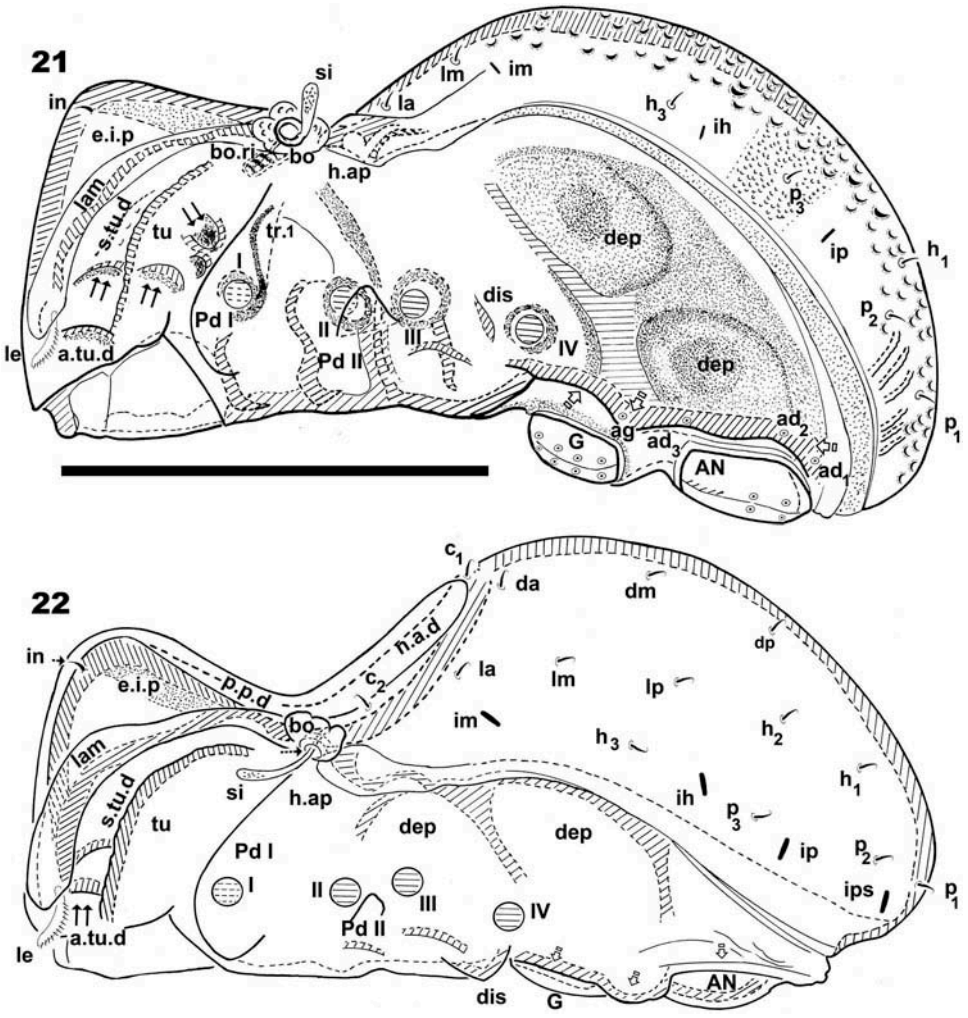
Elongate-oval shape. Setae: simple: interlamellar, rostral, notogastral, epimeral, genital, aggenital, anal; *le* barbate. Prodorsum: polyhedral (dorsal view); triangular, lateral view. Interlamellar process elevated, with *in* setae situated anteriorly and directing forward. Depressed posterior prodorsal zone present. Lamellar tip rounded. Shallow lamellar furrow well defined in posterior part near the bothridia, anterior part less visible.

Notogaster: ovoid (dorsal view); convex (lateral view); *dsj*, narrow well-defined notogastral anterior depression, well defined and delimited, ovoid, prominent. Fourteen pairs of minute setae; circumgastric depression clearly discernible.

Tutorium with rod-like cuticular thickening; supratutorial depression conspicuous; several pocket-shaped depressions situated internally and anterior to supratutorial depression, anterior to and between tutorium and pedotectum I. Bothridia cup-shaped, hardly discernible smooth bothridial ring. Sensillus with slightly dilated elongate tip, with very small denticles. Pedotecta I, II and discidium present. Humeral apophysis long extended structure, rounded apex, basally curved; anterior tip overlapping posterior bothridial part.

Four pairs of lyrifissures, *im, ih, ip, ips*, bean-shaped. Lyrifissures *iad* not discernible.

Several depressions situated laterally to genital and anal openings and between them. Conspicuous sigmoid cuticular ribbon extending laterally to anal and genital openings. Posterior ventral zone between genital and anal opening complex with several overlapping cuticular ribbons.



Figures 21–22. *Cavaecarabodes pulchritude* **gen. nov., sp. nov.** adult female: 21. lateral view inclined; 22. lateral view (normal). Abbreviations: see "Materials and methods" section. Scale bar: 21–22 = 150 µm.

Epimeres well defined, 3 and 4 fused. Epimeral chaetotaxy 3-1-2-2. Pocket-shaped depression central zone at level *apo.3*; anterior genital furrow present, clearly visible; genital plate small compared to anal plate; four pairs of small genital setae; aggenital setae posterior and lateral to genital opening. Three pairs of adanal seta. Two pairs of anal setae.

Description

Measurements. Light microscopy: 321 µm (327–318) × 176 µm (181–173) (two specimens); SEM: 349 µm (366–321) × 181 µm (208–175) (two specimens).

Shape. Elongate oval (Figures 13 and 15).

Colour. Specimens without cerotegument, both sexes: light yellow to light brown, observed in reflected light.

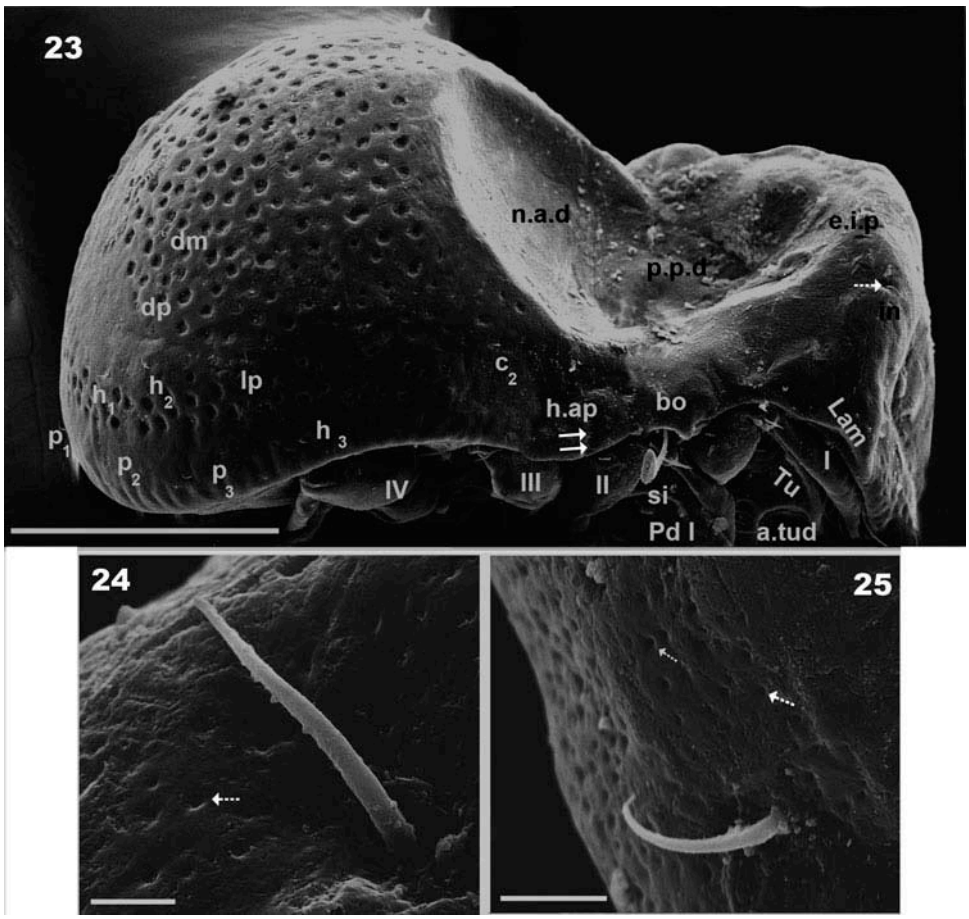
Cerotegument. Cerotegument completely removed for study.

Integument. Prodorsal microsculpture *smooth* to *slightly puncticulate* (Figures 17 and 25, indicated by arrow); notogaster *puncticulate* (Figures 16 and 24, indicated by arrow); *foveate*, with fovea varying in size (Figures 13, 15, 16 and 23); in optical studies fovea appear rounded, but with SEM showing polyhedral contours (Figure 16).

Ventral microsculpture with diverse cuticular ribs and depressions (Figures 14, 21 and 22).

Setation. Prodorsum: *in, ro* simple (Figures 17 and 24), (10–15 µm length); *le* barbate (Figures 21, 22 and 26). Notogastral, epimeral, genital, aggenital, adanal, simple, (8.5–11 µm length), sharp or slightly curving tips (Figures 24 and 30); setae of similar shape in notogastral and ventral regions.

Prodorsum. Polyhedral (dorsal view) (Figures 13 and 15); triangular (lateral view) with strongly obliquely decreasing anterior part (Figures 21–23). Interlamellar process (*e.i.p*) elevated, with *in* setae situated anteriorly and directing forward (Figures 21, 22 and 23). Conspicuous depressed



Figures 23–25. *Cavaecarabodes pulchritude* **gen. nov., sp. nov.** adult female: 23. lateral posterior inclined view [(1)]; 24. notogastral setae *dm*[(1)]; 25. rostral (*ro*) setae[(2)]. Abbreviations: see "Materials and methods" section. Scale bar: 23 = 100 µm, 25 = 10 µm; 24 = 2 µm.

posterior prodorsal zone (*p.p.d*) (Figures 13, 15, 22 and 23). Three pairs of setae; size *le* > in > *ro*. *Ro* setae clearly visible in frontal view (Figure 26), situated in medial zone, inserted slightly anteriorly to *le* insertion level; between *ro* seta a rounded structure, probably vestige of superior cornea of naso *CSO* (Figure 26); *bo* cup-shaped, *bo.ri* smooth; bothdial tooth present (Figures 13, 18, 21, 22 and 28). *Si* upturned, with dilated apical zone, with varying degree of roughness (Figures 18, 19, 20 and 28); *le* setae situated laterally (Figures 21, 22 and 26); *la.ti*, rounded (Figures 21, 22, 26 and 27) (see lateral view).

Rostral margin slightly rounded (Figures 15 and 26) with complex ribs in ventral anterior zone. Lamellae run dorsolaterally; dorsally clearly delimited by *l.l.f* (Figure 26); *l.l.f* well defined (optic studies) immediately posterior to the bothridia, but in anterior less visible; SEM observations clarify observation in anterior part.

Notogaster. Studies in OM are complex; observations from different positions and angles are necessary in order to obtain complete information regarding existent structures; the use of SEM proving vital for clarity (Figures 13, 15, 21, 22 and 23).

Shape: ovoid (dorsal view) (Figures 13 and 15); ovoid (lateral view) (Figures 21, 22 and 23)*; d.sj* narrow, convex, well defined (Figures 13 and 15); prominent ovoid *n.a.d* clearly defined and delimited (Figures 13, 15 and 23), extending posteriorly on notogaster. Anterior of *n.a.d* together with *p.p.d* determining a depressed zone on either side of *d.sj*.

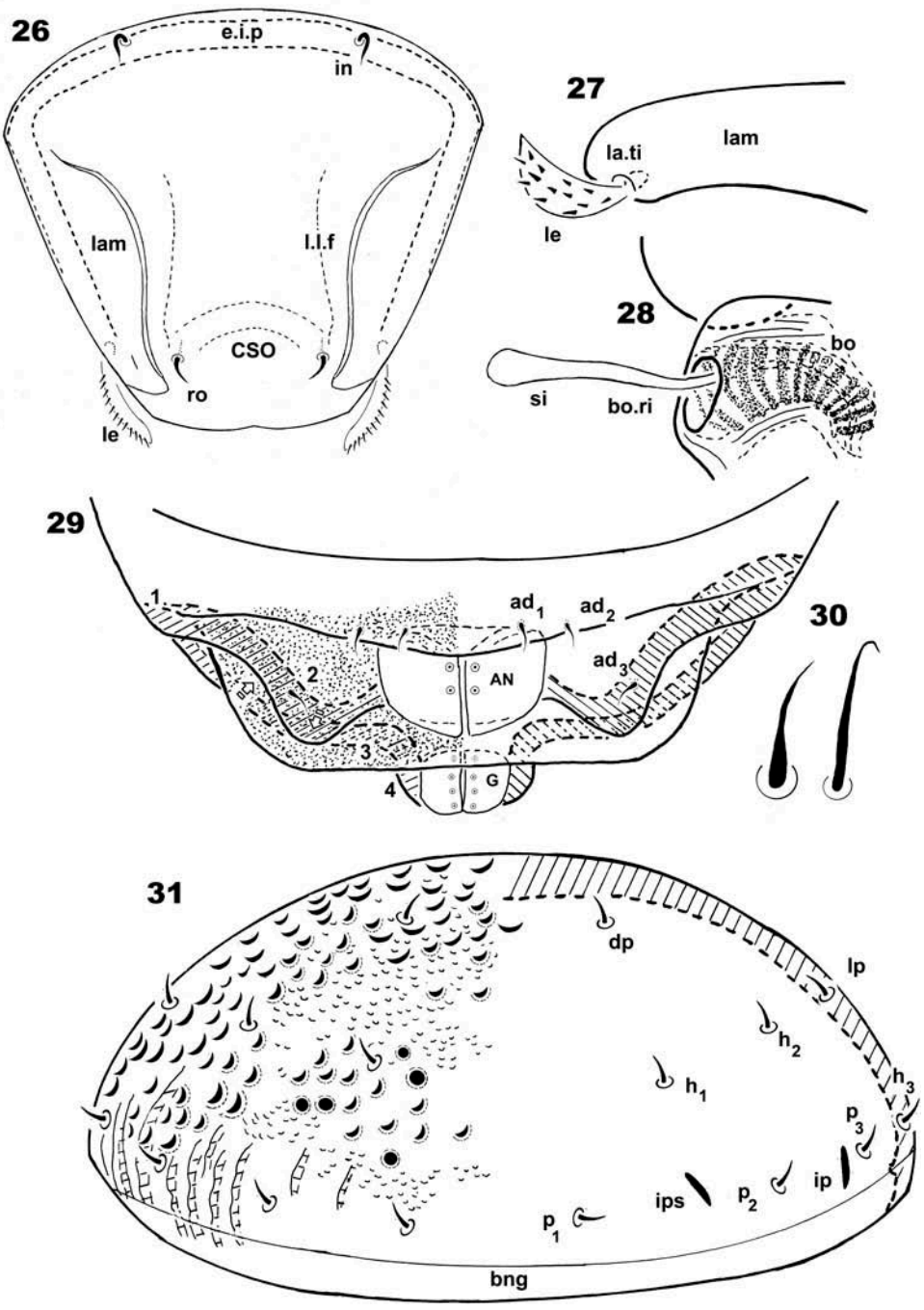
Fourteen pairs of *c* setae situated in anterior margin of *n.a.d* (Figures 13, 15, 22 and 23).

Circumgastric depression (*s.c*) present, easily discernible (Figure 13) situated at insertion level of *lm, lp,* h_2 setae and h_1. Lyrifissures hardly discernible in dorsal view (see lateral region).

Lateral region. For adequate observation of lateral region, different angles of observation were necessary, one in strictly lateral position (Figure 22) another in lateral inclined position (Figure 21) and also in lateral posterior inclined view (Figure 23).

Lamellae (*Lam*) robust, well-discernible, lamellar tip (*la.ti)* ovoid (Figures 21, 22 and 27); lamellar setae barbate, curving, insertion situated far from *la.ti* (Figure 27).

Tutorium rod-like cuticular thickening, curving, clearly visible. Between *Lam* and *tu* a deep supratutorial depression (*s.tu.d*) running parallel to both structures (Figures 21, 22 and 23). Anterior to *s.tu.d* large pocket-shaped anterior tutorial depression (*a.tu.d*). Internally to *s.tu.d* and



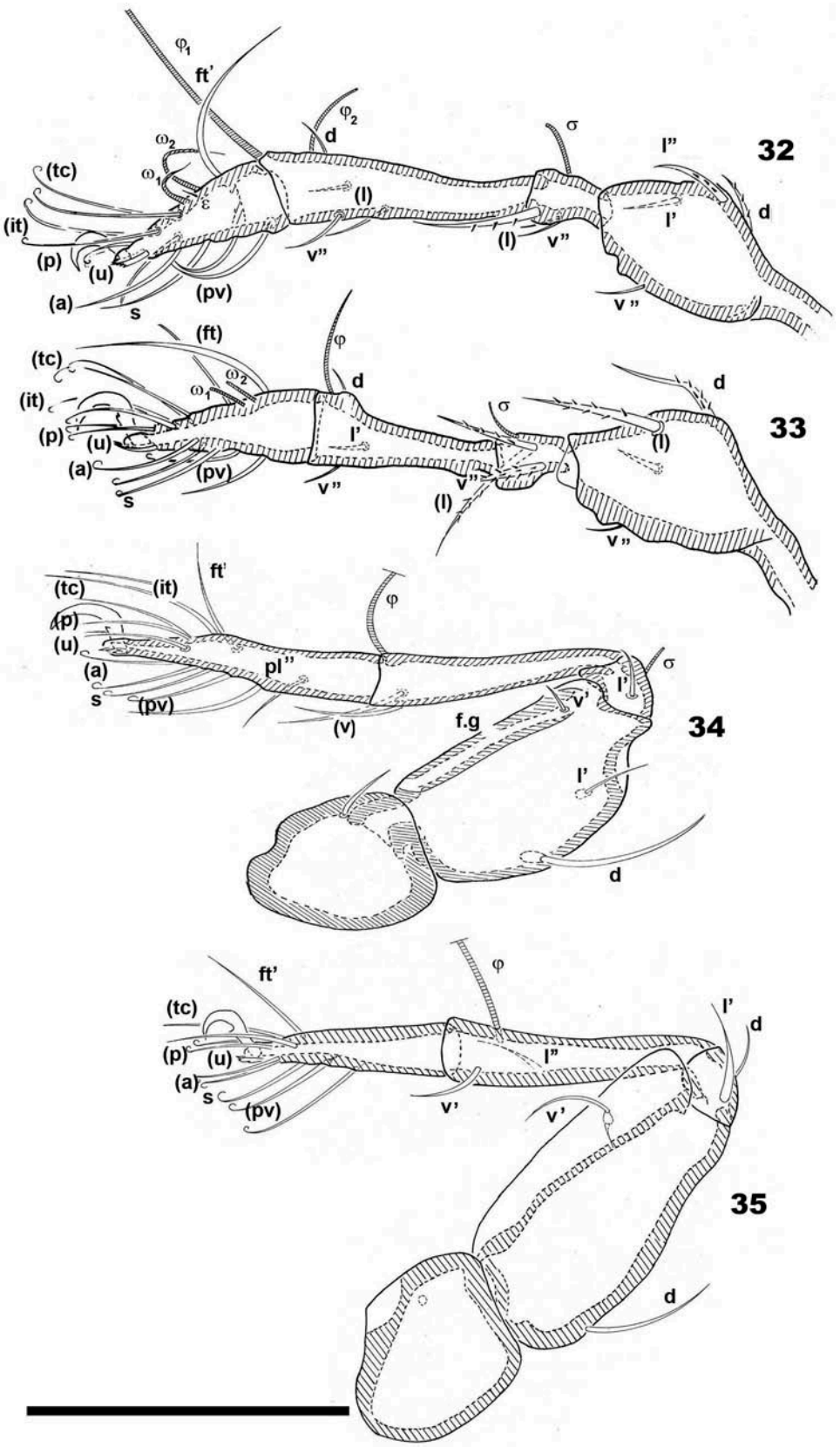
Figures 26–31. *Cavaecarabodes pulchritude* **gen. nov., sp. nov.** adult: 26. frontal view, male; 27. lamella, lateral view, male; 28. bothridia and sensillus, female; 29. posterior view, ventral region, female; 30. notogastral setae; 31. posterior view, notogaster, male. Abbreviations: see "Materials and Methods" section. Scale bar: 26 = 50 µm; 27, 28 = 30 µm; 29, 31 = 80 µm; 30 = 5 µm.

between *tu* and *Pd I*, several pocket-shaped depressions (indicated by double arrow, Figures 21 and 22).

Bothridia cup-shaped, with hardly discernible *bo.ri* (Figures 18, 21, 23 and 28). Pedotectum I prominent extended lamina covering the first acetabulum, rounded apex. Pedotectum II, small ovoid-triangular lamina (Figures 21 and 22). Sejugal depression shallow, well discernible (Figure 21). Humeral apophysis (*h.ap*) long extending structure, rounded apex, basally curving; anterior tip overlapping posterior bothridial part (Figures 21 and 22). Depressed zone permitting concealment of *si* during leg folding (protection process) present, hardly discernible (Figure 23, indicated by ↑↑).

Only Figure 22 permits observation of the complete set of notogastral setae and lyrifissures. Lyrifissures long, bean-shaped structures, hardly discernible, except when inclination is changed to obtain a clear view. Four pairs of lyrifissures present: *im, ih, ip, ips*, lyrifissure *ia* not observed.

Lateral inclined position (Figure 21) gives interesting information as observation becomes possible of several



Figures 32–35. *Cavaecarabodes pulchritude* **gen. nov., sp. nov.** adult female: 32. leg I, antiaxial view; 33. leg II antiaxial view; 34. leg III, antiaxial view; 35. leg IV, antiaxial view. Abbreviations: see "Materials and methods" section. Scale bar: 32–35 = 40 μm.

Table 2. *Cavaecarabodes pulchritude* **gen. nov., sp. nov.**, setae and solenidia.

	Femur	Genu	Tibia	Tarsus	claw
Leg I					
Setae	*d, (l),v″*	*(l),v″*	*v″, (l),d*	*ft′,ε,(tc),(it),(p), (u),(a),s,(pv)*	1
Solenidia		σ	φ_1 φ_2	ω_1 ω_2	
Leg II					
Setae	*d, (l),v″*	*(l), v″*	*d, l′, v″*	*(pv), s,(a),(u),(p), (it), (tc), (ft)*	1
Solenidia		σ	φ	ω_1 ω_2	
Leg III					
Setae	*d, l′,v*	*l′*	*(v)*	*,(pv),s,(a),(u),(p) (it),(tc),ft′pl″*	1
Solenidia		σ	φ	–	
Leg IV					
Setae	*d, v′*	*d, l′*	*v′,l″*	*(pv), s,(a),(u), (p), (tc), (ft)*	1
Solenidia		–	φ	–	

depressions (*dep*) situated at genital and anal opening level, and between them and the external border of ventral shield. Also observed is a very prominent cuticular ribbon extending laterally to anal and genital openings and between posterior zone of anal opening to genital opening level (indicated by ⇪ in Figure 21).

Posterior view. Notogastral posterior view (Figure 31); clearly discernible p_1, p_2, p_3, h_3, h_1, h_2 setae and lyrifissures *ip, ips*.

Posterior view of ventral region (Figure 29) very complex with presence of various overlapping cuticular ribbons (indicated in Figure 29 with numbers); 1 overlapping 2; 2 overlapping 3; and 3 overlapping 4. (Ribbon number 2 is indicated by special arrow Figures 14, 21 and 23). Ribbons 1 and 3 are elevated zones; the first is situated behind anal opening; 3 situated between the genital and anal openings; 2 and 4 sigmoid-shaped, terminating near the anal and genital openings, respectively.

Ventral region. Slightly elevated epimeres, delimited by shallow furrow (*bo.1, bo.2, bo.sj*) Epimeres 3 and 4 fused, epimeral furrow (*bo.3*) small; *apo.1, apo.2, apo.sj* and *apo.3* well discernible (Figure 14). Epimeral chaetotaxy 3-1-2-2. Pocket-shaped depression central zone at level *apo.3* (indicated by double arrow in Figure 14); *dis* easily discernible; *a.g.f* clearly visible, situated anterior to genital plate (Figure 14).

Genital plate small in relation to anal plate; four pairs of small, easily discernible genital setae. Aggenital setae situated posterior and lateral to genital opening.

Very prominent ribbon with sigmoid pattern, situated behind acetabulum IV, directing backward, terminating in the proximity of anal opening (route indicated in Figure 14 by special arrows). The aggenital and adanal setae situated close and internally to the ribbon (Figures 21 and 29). Three pairs of adanal seta. Two pairs of anal setae. Lyrifissures *iad* not discernible. Complex elevations and ribbons on the zone laterally and between the genital and adanal openings, but only discernible in posterior view (see posterior view). Externally to the sigmoid ribbon, several large *dep* (Figures 14 and 21).

*Legs (*Figures 32–35*)* Table 2. All legs monodactyle. Setal formulae I (1-4–3-4–15-1) (1-2-2); II (1-4-3-3-15-1) (1-1-2); III (1-3-1-2-15-1) (1-1–0); IV (1–2-2-2-12-1) (0-1-0).

All legs slightly less robust than in *Co. germani*.

Cavaecarabodes anouchkae **gen. nov., sp. nov.** (Figures 36–53)

Etymology

The specific epithet is dedicated in homage to Anouchka Krygelmans Sato, technician at the MNHN, Paris, France, who assisted us in our work.

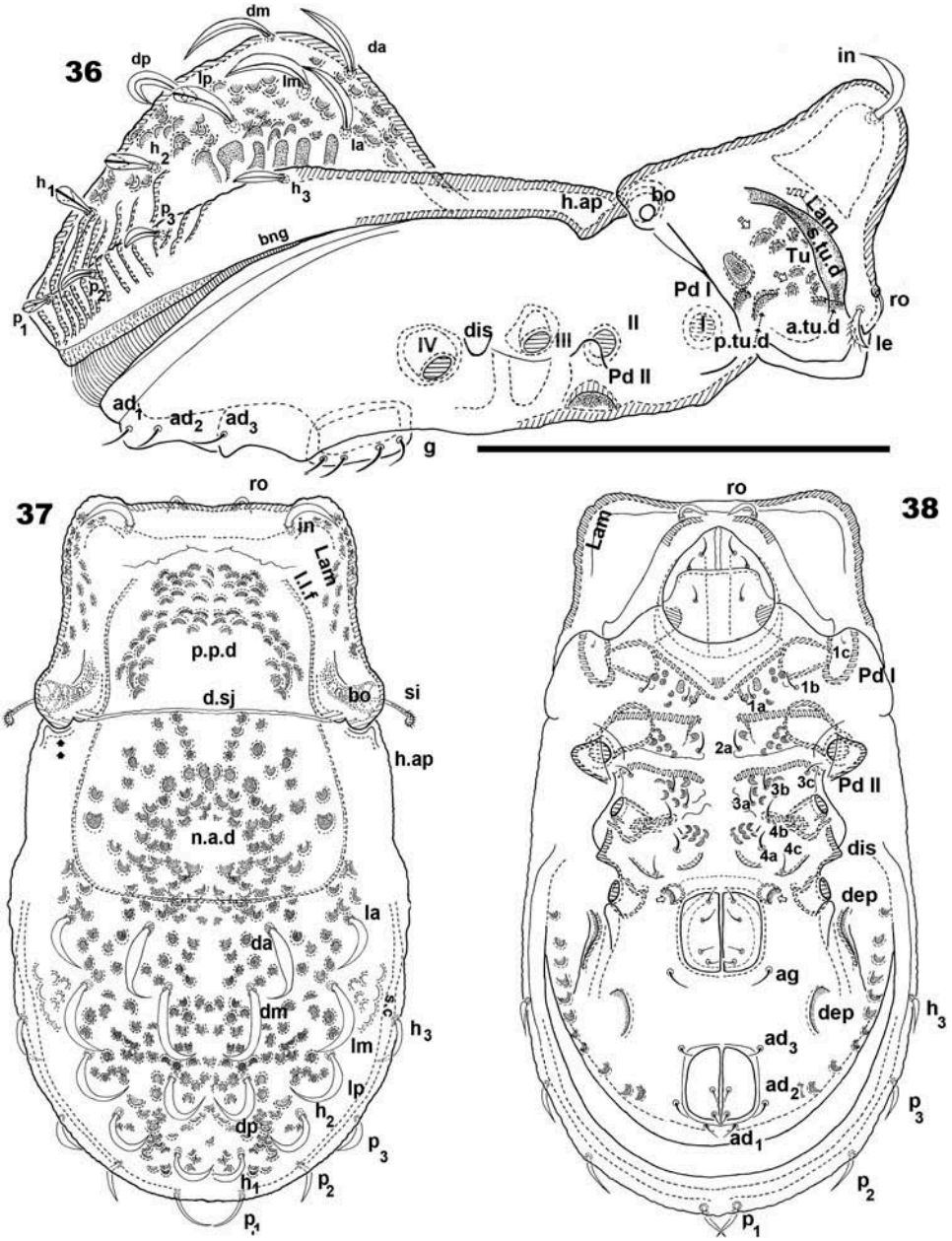
Material examined

Holotype and one paratype female. “Mad, 842. Madagascar centre. Province de Tananarive. Tampoketsa d’Ankazobe, station forestière de Manankaza, Ambohitantely, FDHMA (Forêt dense humide moyenne altitude) Alt. 1550 m. Litière (3 repetitions) 10-4-1967”. Coll. J.M. Betsch, deposited in the Collection of the Muséum National d’Histoire Naturelle, Paris, France, preserved in 70% ethanol. Two other specimens, observed in SEM, not deposited.

Diagnosis – adult female

Body polyhedral-ovoid in shape, with oval notogaster and polyhedral prodorsum. Integumental ornamentation complex: large ornamentation 5–13 µm, with snap-like structures (*snp*); round-ovoid depressions (*r-o*) and promontories (*prm*); small ornamentation 0.8–3 µm, with small promontories. Setae: filiform: interlamellar and rostral, with two central nerves; notogastral: one central nerve; lamellar: setae barbate; all others simple. Sensillus uncinate.

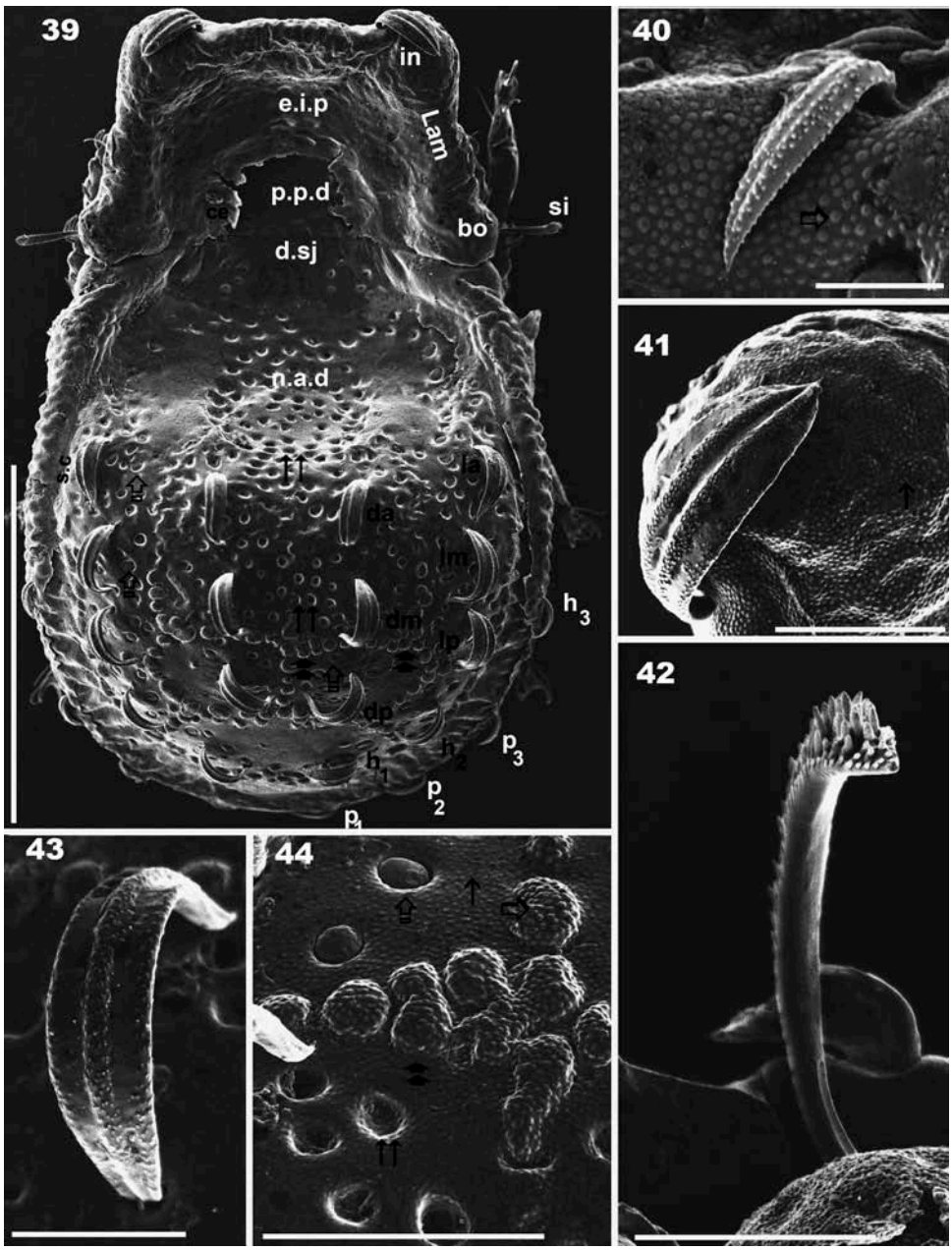
Prodorsum (lateral view) triangular. Elevated interlamellar process, with interlamellar setae directing backward and paraxially. Posterior prodorsal depressed zone present. Lamellar tip large, rounded; lamellar setae situated far from lamellar apical zone; shallow lamellar furrow well defined from interlamellar setal insertion towards anterior; humeral apophysis rounded apex, basally curved; anterior



Figures 36–38. *Cavaecarabodes anouchkae* **gen. nov., sp. nov.** adult female: 36. lateral view; 37. dorsal view; 38. ventral view. Abbreviations: see "Materials and methods" section. Scale bar: 36–38 = 200 μm.

tip overlapping posterior bothridial part. Dorsosejugal furrow narrow, slightly convex. Notogastral anterior depression ovoid, conspicuous. Twelve pairs of setae *da, dm, dp, la, lm, lp, h_1, h_2, h_3, p_1, p_2, p_3*; all setae directing backward; circumgastric depression situated between *la, lm, lp, h_2, h_1* and *h_3, p_3, p_2, p_1*. Tutorium curving, clearly visible, with round-ovoid depressions; supratutorial depression deep; anterior tutorial depression, large pocket-shaped structure; conspicuous posterior tutorial depression. Bothridium cup-shaped; smooth bothridial ring (*bo.ri*) and bothridial tooth. Sensillus large, uncinate. Pedotectum I, extending lamina, rounded apex, striated superior anterior margin. Pedotectum II, small ovoid-triangular lamina. Lyrifissures *im, ih, ip, ips*. Lamellar and rostral setae clearly visible ventrally; ventral cuticula with ornamentation of round-ovoid depressions.

Epimeres 3–4 fused; epimeral furrow not observed. Epimeral chaetotaxy 3-1-2-2. Anterior aggenital furrow shallow with large pocket-shaped depression; discidium small, triangular. Genital plate large in relation to anal plate; four pairs of genital setae; aggenital setae posterolateral, near genital opening; three pairs of adanal setae; *ad_3* situated far from aggenital setae. Anal plate with short sharp tip; two pairs of anal setae, situated on posterior third of plate. Lyrifissures *iad* not discernible; series of round-ovoid depressions following along ventral shield margin.



Figures 39–44. *Cavaecarabodes anouchkae* **gen. nov., sp. nov.** adult female: 39. dorsal view[(1)]; 40. rostral (*ro*) [(1)]; 41. lamellar (*le*) setae[(1)]; 42. sensillus, medial view[(1)]; 43. notogastral (*dm*) setae [(1)]; 44. notogastral ornamentation[(1)]. Arrows: ⇈ indicating round-ovoid depressions (*r-o*); ⇧ indicating (*snap*); ⬍ indicating promontories (*prm*). Abbreviations: see "Materials and methods" section. Scale bar: 39 = 200 µm; 41, 44 = 30 µm; 42, 43 = 20 µm; 40 = 10 µm.

Description

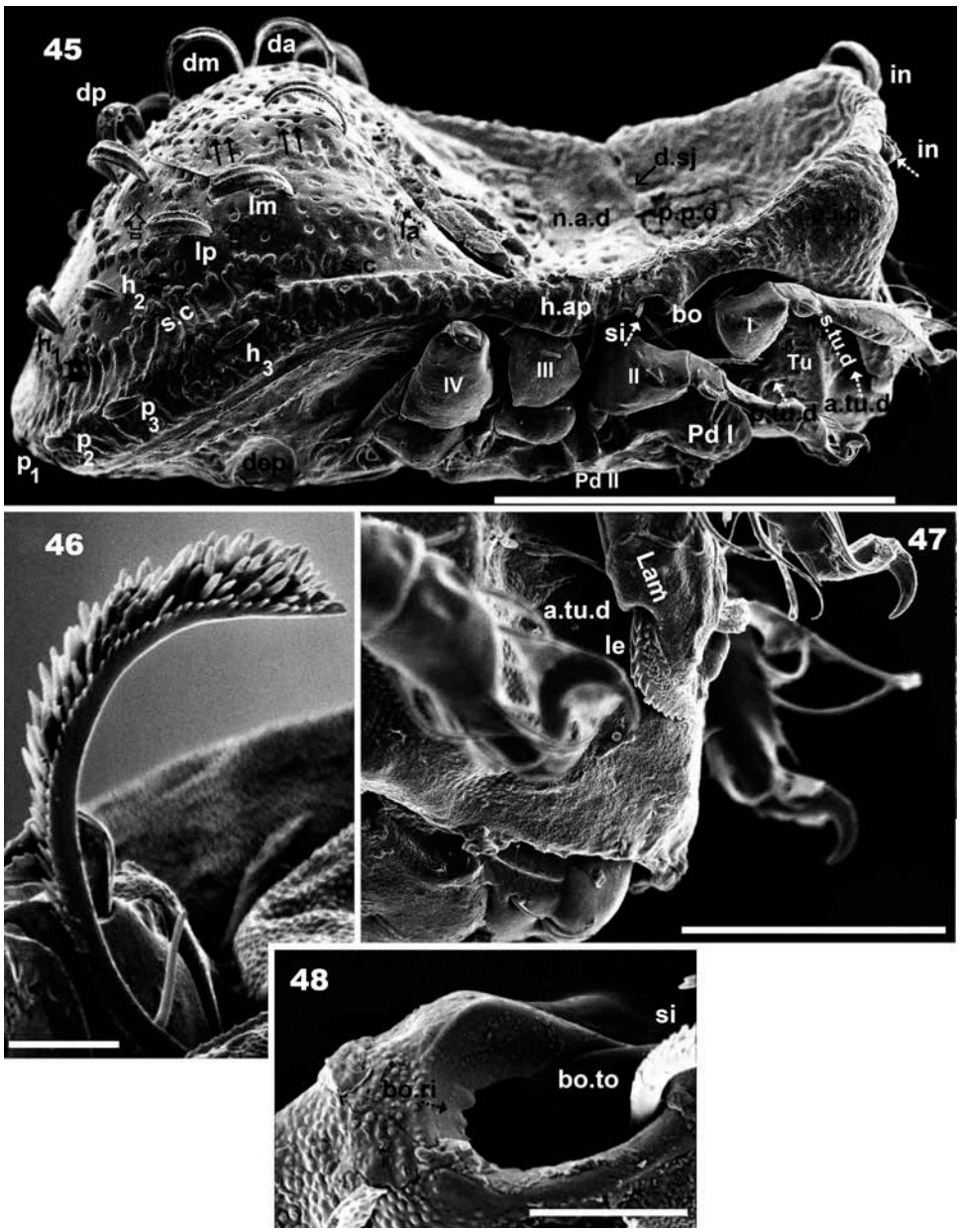
Measurements. 450 (440–460) µm × 288,3 µm (287–289) (SEM measurements on two specimens); optic measurements 455 µm (449–462) × 299 µm (297–301).

Shape. posterior oval, anterior polyhedral (Figures 37 and 39).

Colour. Specimens without cerotegument both sexes: light yellow to light brown, observed in reflected light.

Cerotegument. thin amorphous layer (thickness around 0.05 µm) (Figures 39 and 50) covering entire body and legs; generally the anterior zone of *p.p.d* (Figure 39) lacking cerotegumental layer. It was necessary to remove cerotegument for optical studies; after macerating for a few days in warm lactic acid, it was easily removed.

Integument. Observation with SEM was absolutely necessary in order to gain understanding of forms of ornamentation. Two types of ornamentation were observed on the body: (1) large, approximately 5–13 µm (Figures 39 and 44) (2) small, approximately 0.8–3 µm (Figures 40, 41, 44, 48 and 50).

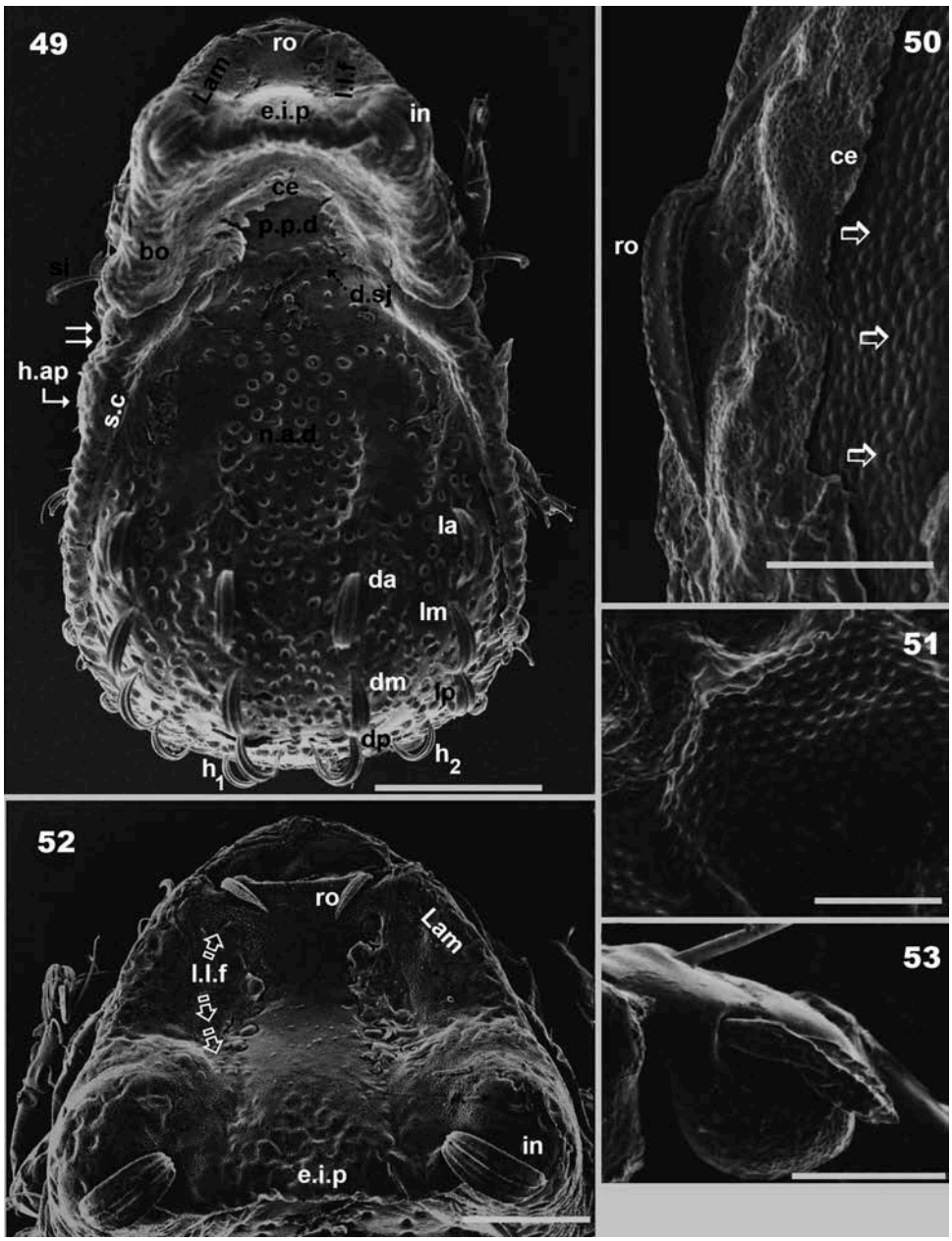


Figures 45–48. *Cavaecarabodes anouchkae* **gen. nov., sp. nov.** adult female: 45. lateral view [(1)]; 46. sensillus, lateral view [(1)]; 47. lamellae and *le* setae[(1)]; 48. bothridial ring[(1)]. Abbreviations: see "Materials and methods" section. Scale bar: 45 = 200 µm; 47 = 40 µm, 48 = 10 µm, 46 = 10 µm.

Large ornamentations very complex (Figures 39 and 44). Optic observation was inadequate as all structures looked similar. Observed variation was: snap-like structures (*snp*); round-ovoid depressions (*r-o*) and promontories (*prm*) (Figure 39). The *r-o* (indicated with ⇈, Figure 39) are seen on prodorsum and notogaster including *n.a.d* and *p.p.d* (Figures 36, 44 and 49). On ventral side *r-o* occur ubiquitously (Figures 38 and 51). Promontories (*prm*) (indicated with ⇕ Figure 39), vary in shape and are found principally between and posterior to setae *dm* and laterally and posterior to *lm* setae; the cuticular ridge is situated laterally, terminating in a structure of *prm* type (Figures 36 and 45 indicated by ⇕). The *snp* (indicated by ⇪ Figure 39) are more randomly distributed.

Small ornamentations are promontories, around 3 µm in size, found superficially to *prm* and on prodorsum, in the bothridial zone and *ro* setal zone (Figures 44 indicated with ⇨, 48 and 50) while an even smaller variant, between 0.8 to 2 µm in size, is found distributed on prodorsum and notogaster (Figures 41 and 44, indicated by ↑).

Setation. Prodorsal and notogastral setae filiform (Figures 40, 41 and 43). Prodorsal *in* and *ro* setae with two central nerves; thin in the case of *ro* (Figure 40) and broad in *in* (Figure 41); *le* barbate (Figures 36 and 47). Notogastral setae with one central nerve (Figure 43). Subcapitular, epimeral, genital, aggenital, anal and adanal setae, simple (Figure 38).



Figures 49–53. *Cavaecarabodes anouchkae* **gen. nov., sp. nov.** adult female: 49. dorsal posterior inclined [(1)]; 50. rostral (*ro*) setae – cuticle recovered and without cerotegument [(1)]; 51. epimeral cuticular ornamentations [(1)]; 52. prodorsum; 53. leg II genu, antiaxial view [(1)]. Abbreviations: see "Materials and methods" section. Scale bar: 49 = 200 μm; 52 = 50 μm; 50 = 20 μm; 51, 53 = 10 μm.

Prodorsum. Rectangular to polyhedral (dorsal view) (Figures 37 and 39); triangular in lateral view with concave anterior part (Figures 36 and 45). Interlamellar process (*e.i.p*) elevated, with *in* setae situated anteriorly and directing backward (Figures 37 and 39). Posterior prodorsal zone depressed (*p.p.d*), well discernible with a continuity of shape with the notogastral anterior depression (*n.a.d*) (Figures 37, 39 and 45). Prodorsal setae size *ro* 23 (21–26) μm; *in* 65 (63–67) μm; *le* 21 (19–23) μm; *ro* setae directing backward and paraxially (Figures 40, 49 and 50), covered by small asperities; *in* setae directing backward and antiaxially (Figures 37, 39 and 45); *le* setae situated laterally (Figures 36 and 47).

Sensillus uncinate (Figures 42 and 46), with barbs, digitiform aspect, smaller situated marginally and larger in central zone.

Lamellar tip (*la.ti*) large, insertion setae *le* far from lamellar tip (see explanation under lateral view). Rostral margin slightly rounded (Figure 52) but with complex ribs. Lamellae (*Lam*) run dorsolaterally, robust, easily discernible; delimited by shallow furrow (*l.l.f*) (Figures 49 and 52). The *l.l.f* is well-defined anterior to *in* setae insertion (Figures 49 and 52).

Notogaster. Position and angle of observation crucial to understanding (Figures 39 and 49) due to shape and structures present.

Shape: dorsal and lateral view ovoid (Figures 39 and 45); notogastral setae 53 (51–57) µm, long; *dsj* well-defined, narrow, slightly convex. Notogastral anterior depression (*n.a.d*) well defined (Figures 37, 39, 45 and 49); ovoid, conspicuous, extending backward on notogaster. Continuity of shape between anterior part of *n.a.d* and posterior part of prodorsum (*p.p.d*).

Twelve pairs of setae *da, dm, dp, la, lm, lp,* h_1, h_2, h_3, p_1, p_2, p_3; placement of *c* setae not observed. All setae directing backward (Figures 39 and 45).

Circumgastric depression (*s.c*) present, easily discernible (Figures 37, 39, 45 and 49), situated between setae *la, lm, lp,* h_2, h_1 and h_3, p_3, p_2, p_1. Ornamentation obscures observation of lyrifissures, for this reason, lyrifissure not discernible.

Lateral region. Lamellae (*Lam*) robust, well-discernible, lamellar tip (*la.ti)* large (Figures 36 and 47); lamellar setae barbate, curving, situated far from lamellar tip.

Tutorium, curving, clearly visible (Figures 36 and 45), with prominent cuticular ornamentation, round-ovoid depressions (*r-o*). Between *Lam* and *tu* a deep supratutorial depression (*s.tu.d*) running parallel to both structures. In the anterior zone of *s.tu.d*, a clearly visible anterior tutorial depression (*a.tu.d*), large pocket-shaped structure; posterior to *tu* and near *Pd I*, presenting large *p.tu.d* (Figures 45 and 47). Between *tu* and *Pd I*, several small pocket-shaped depressions (Figure 36 indicated by ⇧ arrow).

Bothridia cup-shaped (Figures 39, 45 and 48), with smooth bothridial ring (*bo.ri*) and bothridial tooth (*bo.to),* hardly discernible in optic observation, but clearly visible with SEM (Figure 48). Sensillus large, uncinate (Figures 42 and 46); antiaxial zone with barbs, paraxial zone smooth; barbs small in periphery and large in central zone (Figures 42 and 46). Pedotectum I, prominent extended lamina covering the first acetabulum; rounded apex and striated superior anterior margin (Figures 36 and 45). Pedotectum II a small ovoid-triangular lamina (Figures 36 and 45).

Humeral apophysis (*h.ap*) long, extended structure, rounded apex, basally curved; anterior tip overlapping posterior bothridial part (Figures 36 and 45).

Four pairs of lyrifissures present: *im, ih, ip, ips*. Notogastral *s.c* easily discernible, delimited by presence of cuticular ribbons (Figure 45).

*Ventral region (*Figure 38*).* Lamellae and *ro* setae clearly visible. Ventral surface with conspicuous cuticular ornamentation, round-ovoid depressions (*r-o*) hampering observation.

Epimeres slightly elevated, delimited by shallow furrow (*bo.1, bo.2, bo.sj*), hardly discernible. Epimere 4 fused, epimeral furrow (*bo.3*) not observed; *apo.1, apo.2, apo.sj* and *apo.3* well discernible. Epimeral chaetotaxy 3-1-2-2. Anterior aggenital furrow shallow, with large pocket shape depression situated in posterior extremity (indicated by simple arrow). This pocket depression, difficult to observe, generally filled by cerotegumental layer. With cerotegument removed, clear observation becomes possible. Pd I, Pd II and *dis*, clearly visible.

Genital plate large relative to anal plate; four pairs of genital setae. Aggenital setae situated posterior and laterally near genital opening.

A short ribbon, situated behind acetabulum IV, directing backward, with sigmoid pattern.

Three pairs of adanal setae; all situated near the anal opening. Ad_3 situated far from *ag*. Anal plate small relative to genital plate; short, sharply tipped; two pairs of anal setae, situated on posterior third of plate. Lyrifissures *iad* not discernible. Zone laterally and between the genital and anal openings with depressions (*dep*). Series of round-ovoid depressions (*r-o*) following along ventral shield margin.

Legs. All legs monodactyle. Setal formulae I (1-4-3-4-15-1) (1-2-2); II(1-4-3-3-15-1) (1-1-2); III(1-3-1-2-15-1) (1-1-0); IV(1-2-2-2-13-1) (0-1-0) (Table 3).

Discussion

After initiating our revision of the family Carabodidae, we scanned through the large collections of available material housed at several Museums, not only for new taxa, but also for interesting evolutionary phenomena. Because we found two very interesting processes, neotrichy and regressive evolution, we chose to focus on the genus *Congocepheus* for a series of papers (Fernandez et al. 2013b, 2013c). We understood from the outset the need to examine all specimens, but eventually realized that redescriptions were also necessary. In this paper, only the genus *Congocepheus* and a new genus *Cavaecarabodes* are discussed, and we elucidate problems

Table 3. *Cavaecarabodes anouchkae* **gen. nov., sp. nov.**, setae and solenidia.

	Femur	Genu	Tibia	Tarsus	claw
Leg I					
Setae	*d, (l), v″*	*(l), v″*	*v″, (l),d*	*ft″,ε,(tc),(it),(p),(u),(a),s,(pv)*	1
Solenidia		σ	φ_1 φ_2	ω_1 ω_2	
Leg II					
Setae	*d, (l),v″*	*(l),v*	*(v),d*	*(pv), s,(a),(u),(p), (it), (tc), (ft)*	1
Solenidia		σ	Φ	ω_1 ω_2	
Leg III					
Setae	*d, l′,v*	*l′*	*(v)*	*(pv),s,(a),(u),(p) (it),(tc),ft′pl″*	1
Solenidia		σ	φ	–	
Leg IV					
Setae	*d, v′*	*d, l′*	*(v)*	*(pv), s,(a),(u), (p), (tc), (ft)*	1
Solenidia		–	φ	–	

found in three species, *Congocepheus latilamellatus, Co. velatus* and *Co. ornatus*. Other interesting evolutionary processes observed in different genera of the family will be the subject of further studies.

The Genus Congocepheus

The definition of the genus by Balogh (1958) as well as a redefinition by Mahunka in 1986 is transcribed in order to illustrate why a new redefinition was deemed necessary.

Balogh (1958, p. 21) established:

> Corpus inter propodosoma et hysterosoma late excavatum. Hysterosoma a latere visum altissimum, sed rotundato-obtusum, postice obtuse marginatum. Pili dorsuales orones perconspicui, magni, partim anguste foliiformes, apicibus leviter dilatatis, partim longi, anguste gladiiformes, apicibus incurvatis. Species typica: *Congocepheus heterotrichus* spec. nov.

Mahunka (1986b) redefined the genus as

> "*Congocepheus* Balogh, 1958 (Figures 19–21 and 86). (Balogh 1958, p. 21). Prodorsum: highly elevated, with a strong translamellar projection, interlamellar setae arising on it. Lamellar setae arising on the outer margin of lamellae; all prodorsal setae phylliform, but of different shape. Sensillus uncate. Tutorium strongly developed, with undulate margin.
>
> Notogaster: Dorsosejugal region with a deep hollow, median part of notogaster highly convex. Fourteen pairs of phylliform notogastral setae, two pairs of them directed forward. No setae in humeral position.
>
> Coxisternal region: Third and fourth epimeres not completely fused. Epimeral setae formula: 3-1-3-3.
>
> Anogenital region: Ornamented by longitudinal and transversal ribs. Anogenital setal formula: 4-1-2-3. Lyrifissure iad situated laterally far from adanal setae.
>
> Type species: *Congocepheus heterotrichus* Balogh,1958. Dem.Rep.of Congo.

Balogh (1958) created the genus based on the unique species *Co. heterotrichus*. Mahunka redefined the genus in 1986, but did not add new information to existing knowledge. For this reason, it is impossible to include the species *Co. taurus* Balogh, 1961, *Co. ornatus* Mahunka, 1983, *Co. latillamellatus* Mahunka, 1984. Later, in 1986b, Mahunka described *Co. velatus*, and in 1989, *Co. orientalis* and *Co. hauseri*, including them in the genus without problems. With reference to *Co. ornatus*, only a remark was made (see below). A similar situation arose with the two species we described, *Co. gabonensis* and *Co. ektactesi*.

To demonstrate inconsistencies in the genus redefinition by Mahunka (1986b), for example, the text reads "Fourteen pairs of phylliform notogastral setae, two pairs of them directed forwards" (p. 86), but in *Co. taurus* Balogh, 1961, only one pair is directed forward. In *Co. ornatus* Mahunka, 1983 and *Co. latillamellatus* Mahunka, 1984, the prodorsum, notogaster and notogastral setae are very different to those established in the genus; as is the case for *Co. orientalis* Mahunka, 1987 and *Co. hauseri* Mahunka, 1989; where the prodorsum and the type, disposition and orientation of the notogastral setae are not in agreement with the genus redefinition.

In reality the redefinition of *Congocepheus* (cf. Mahunka 1986b) is clear, but only fitting two species, viz. *Co. heterotrichus* Balogh, 1958 and *Co. involutus* Mahunka, 1997.

We give a new redefinition of the genus *Congocepheus*, realizing that it is probably temporary and will need to be substantiated, following further knowledge gained.

Genus Congocepheus

Redefinition. Specimens rather compact.

Prodorsum: Elevated interlamellar process, undivided or divided in two; interlamellar setae situated on elevated interlamellar process; lamellar setae situated laterally on the apical zone of lamella, generally barbate. Apical lamellar tip, shape and size variable. Rostral setae present. Cornea superior of medial eye, when present, situated between anterior setal insertion. Posterior part of prodorsum depressed, due to anterior notogastral depression. Bothridium, generally with bothridial ring, more or less visible; generally with bothridial tooth.

Notogaster: Notogastral posterior depression absent, only notogastral anterior depression present; notogastral anterior depression continuous with posterior prodorsal depression, forming a depressed zone on either side of dorsosejugal furrow.

Notogastral chaetotaxy: fourteen pairs (holotrichy bideficient) or neotrichy (20 pairs of setae; when neotrichy exists, setae *c* involved; notogastral setae *heterotrichus*; both setae c_1 and c_2, or only c_2, very long, directing forward, crossing notogastral anterior depression, exceeding dorsosejugal furrow and extending to prodorsum. Notogastral setae never in notogastral anterior depression even when neotrichy occurs.

Notogaster ovoid, smooth, or with small ornamentations; finger-like projection present or absent; aggenital setae present or absent.

Lateral zone: Tutorium well developed; supratutorial depression present, with various depressions (anterior tutorial depression, posterior supratutorial depression or numerous others) all pocket-shaped. Protection mechanism and related structures always present. Pedotecta I, II, discidium present.

Ventral region: Epimeral zone simple to very complex, sometimes with complex cuticular structures, ribs, costulae and depressions. Epimeres 1 and 2 generally clearly visible, separated by epimeral furrow; epimeres 3 and 4 generally fused. Epimeral formulae generally 3-1-3-3 or 3-1-2-2. Anterior genital furrow present, more or less conspicuous. Four pairs of genital setae; Aggenital setae present or not. Three pairs of adanal setae. Two pairs of anal setae. Lyrifissure *iad* generally visible. Several depressed

areas at level of genital and anal openings or between them. Anal plates terminating in sharp tip or not.

Type species: *Congocepheus heterotrichus* Balogh, 1958
Other species: *Congocepheus germani* **sp. nov.**
Congocepheus gabonensis Fernandez, Theron, Rollard & Tiedt, 2013
Congocepheus involutus Mahunka, 1997
Congocepheus ektactesi Fernandez, Theron, Rollard & Tiedt, 2013
Congocepheus taurus Balogh, 1961

Additional studies of the three species at hand delayed this paper by almost a year, and originally we expected these to be more closely related to *Cavaecarabodes.* Initially working with original descriptions, our first concern was that, in the original description of *Congocepheus ornatus* Mahunka, 1983, a short description included it in the genus without any comments. In the description of *Congocepheus latilamellatus* Mahunka, 1984, the author indicated in remarks:

> The new species is conditionally ranged to the genus *Congocepheus* Balogh (p. 101), 1958, because of notogaster not completely identical. The known *Congocepheus* species display a much larger hollow between the prodorsum and notogaster, the new species stands very near to *Co. ornatus* Mahunka, 1982 but the lamellae of the latter species are thinner, and the ornamentation of the notogaster and the ventral plate are highly different.

This phrase represents enormous inconsistencies and errors; for example, *Congocepheus ornatus* was described by Mahunka in 1983 not 1982, and it is unclear if the much larger hollow between the prodorsum and notogaster indicates the presence of the posterior prodorsal depression and the anterior notogastral depression or only one of them. It was impossible to interpret; therefore, the decision was made to study the type material of the three cited species.

We requested the material and uncovered several revelations. (1) Two labels were in the tube of *Co. ornatus*, one indicating "*Carabodes ornatus* **sp. nov**." and the other "rev. Mah. 1983 *Congocepheus ornatus*"; our interpretation is that Mahunka originally ascribed this species to *Carabodes* but finally included it in *Congocepheus*, but he did not mention this in the description of *Co. ornatus*, while in 1984, in the description of *Co. latilamellatus*, he expressed his doubts. (2) The notogastral anterior depression does not exist. With regard to *Co. latilamellatus*, the situation is even more complex. (3) In the material available for study (two paratypes, Museum of Geneva), the prodorsum is quite different to that as described by Mahunka. (4) The given lateral figure is incorrect due to a significant problem with the interpretation of lamellar and rostral setae; there are two setae on the lamellae. Our study assisted us to understand the error. The lamellar and rostral setae exist in the normal position; the lateral figure is incorrect. Finally, *Co. velatus* has 13 pairs of notogastral setae, as indicated by Mahunka (1986a).

We consider it necessary perform a redescription (in a future paper which will be completed soon), to address several issues. It can be stated that the three species *Co. ornatus, Co. latilamellatus* and *Co. velatus*, from Tanzania, have many characters in common, and are of the same group, but belong to neither *Congocepheus* nor *Cavaecarabodes.*

The neotrichy of Congocepheus germani

The neotrichy displayed by *Co. germani* is very interesting; however, only a limited number of adult stase specimens were available. The arrangement of *c* setae is caused by this phenomenon and only for this group of setae. We can speak of cosmotrichie (Grandjean 1965), as the setae are ordered simply, in this instance bordering the notogastral anterior depression (*n.a.d*).

The term "territory" (Coineau 1974) is defined as "the surface in which the secondary setae appear" (p. 115). The secondary setae regroup around the primitive setae and create the "neotrichous fields" (Coineau 1974). At times, the association between the primitive setae and the secondary setae can be established by their different morphologies; in other cases, both setae are affected by the same process and their morphologies are indistinguishable. In this instance (with only two specimens), identifying the primitive and secondary setae are very uncertain; little variation can be observed in the insertions and lengths of a pair of setae (probably primitive setae) in both specimens, but this may be individual variation.

Alignment of *c* setae is affected by neotrichy and the delimited territory is located around the posterior border of the *n.a.d* (Figures 2B, C) but setae are never found inside it.

Congocepheus germani is unique to the genus *Congocepheus*, with specimens that present notogastral neotrichy.

The regression of setae in Cavaecarabodes anouchkae

The gastronotic setal notations of the adult stase pose significant problems due to regression of setae. Generally the *c* and central dorsal *da, dm* and *dp* setae are most affected. In this instance, the setae affected by this process are c_1 and c_2, resulting in a species with 12 pairs of notogastral setae. The notation of notogastral setae is therefore simple.

The genera *Cavaecarabodes* and *Congocepheus* are related, although differences are found in the type, shape and disposition of notogastral setae. Also, the same group of setae affected by neotrichy in *Congocepheus* are in *Cavaecarabodes* affected by regression.

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