New species of the superfamily Euphthiracaroidea (Acari: Oribatida) from Madagascar and Tanzania

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Five new species of the family Euphthiracaridae are described, identified and figured from the Afrotropical region: Oribotritia breviseta sp. nov. from Andasibe National Park of Madagascar; Acrotritia paraardua sp. nov. from Vohimana Experimental Reserve, Ambohitanely Special Reserve and Andasibe National Park of Madagascar; Acrotritia paradikra sp. nov. from Ranomafana National Park and Ankarafantsika National Park of Masagascar; Microtritia diaphoros sp. nov. from the Nguru Mountains of Tanzania; and Microtritia parahauseri sp. nov from the Uluguru Mountains of Tanzania. A comparison with the most closely related species of the genera Oribotritia, Acrotritia and Microtritia is also presented.

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Introduction

This study is focused on an investigation of soil ptyctimous mite fauna inhabiting the leaf litter of various types of primeval forests in Madagascar and Eastern Tanzania. Both of these areas are characterized by a high level of plant and animal endemism and are classified as the most important biodiversity hotspots (Myers et al. 2000). Madagascar is one of the largest islands in the world, with very diverse environments and its flora and fauna varying greatly in different parts of the island. Strong endemism of Madagascarian fauna seems to be due to a long isolation of the large island, which has a highly diverse environment. Madagascar was separated from Gondwanaland and the future African continent in the Jurassic period 165 million years ago and subsequently from the Indian subcontinent in the Cretaceous period 80 to 100 million years ago (Goodman and Benstead 2004). The East Usambara mountains including the Nguru Mts and Uluguru Mts are part of the Eastern Arc mountain range of South East Kenya and Eastern Tanzania. Different types of forests in the Eastern Arc are regarded as one of the top biodiversity hotspots in the world on the basis of the high number of endemic plant and animal species including soil invertebrates. This high level of endemism is caused by uninterrupted development of forests continuing for at

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least 30 million years and long-term isolation from the West and Central African forests for at least 10 million years (Burgess et al. 2007; Hall et al. 2009).

Altogether five new species of ptyctimus oribatid mites belonging to three genera *Oribotritia* Jacot, 1924, from the family Oribotritiidae Grandjean, 1954, *Acrotritia* Jacot, 1923 and *Microtritia* Märkel, 1964 from the family Euphthiracaridae Jacot, 1930 were found in rich material of soil mites collected by Dr Baňař and Dr Grebennikov from the leaf litter of various forest types in Madagascar and Eastern Tanzania. Their descriptions are the subject of this study (Jacot 1923, 1924, 1930; Grandjean 1954; Märkel 1964).

**Material and methods**

The leaf litter samples were collected by using a sifting method and were partly extracted by using a Winkler apparatus. All the extracted mite specimens were preserved in 85% ethanol, then mounted and cleared in 80% lactic acid on temporary cavity slides and mounted on temporary slides with glycerol. The determined material was preserved in vials with 80% ethanol. Observations, figures, and measurements were made using a standard light microscope equipped with a drawing attachment. All the measurements are given in micrometres. The terminology is based on that of Niedbała (2000). Type material is partly deposited at the Department of Animal Taxonomy and Ecology, Poznań, Poland (DATE) and partly at the Institute of Soil Biology BC ASCR, České Budějovice, in the Czech Republic (ISB), and partly at the Natural History Museum in Geneva, Switzerland (NHMG).

**Description of new species**

*Oribotritia breviseta* sp. nov.

(Figure 1)

**Material examined**

Holotype and six paratypes deposited at DATE from the *locus typicus*: MAG-008, Madagascar, Andasibe National Park, 12 April 2011, 18°56′2.5″ S, 48°25′12.2″ E, 951 m asl, sifting sample of residues under *Pandanus* sp., Winkler apparatus extraction, leg. P. Baňař and R.S. Rahanitriniaina, 12 paratypes deposited in DATE from the locality: MAG-058, Madagascar, Andasibe National Park, 9 April 2011, edge of Parc d’Orchidées, sifting sample of forest litter, Winkler apparatus extraction, leg. P. Baňař, L.S. Rahanitriniaina, 20 paratypes deposited at DATE and 15 paratypes at ISB from the locality: MAG-060, Madagascar, Andasibe National Park, 11 April 2011, 18°56′50.5″ S, 48°25′22.6″ E, 948 m asl, sifting sample of forest litter in stream ravine without water, Winkler apparatus extraction, leg. P. Baňař, five paratypes deposited at NHMG from the locality: MAG-063, Madagascar, Andasibe National Park, 12 April 2011, 18°56′50.6″ S, 48°25′22.2″ E, 944 m asl, sifting sample of forest litter, Winkler apparatus extraction, leg., L.S. Rahanitriniaina: two paratypes deposited at NHMG from the locality: MAG-066, Madagascar, Andasibe National Park,
Figure 1. *Oribotritia breviseta* sp. nov., holotype: (A) prodorsum, lateral view; (B) prodorsum, dorsal view; (C) opisthosoma, lateral view; (D) mentum of subcapitulum; (E) ventral plates, right side; (F) trochanter and femur of leg I.

12 April 2011, 18°56′24.8″ S, 48°25′12.1″ E, 947 m asl, sifting sample of forest litter, Winkler apparatus extraction, leg., L.S. Rahanitriniaina.
Measurements of holotype

Prodorsum: length 429, width 353, height 116, sensillus 101, length of prodorsal setae: interlamellar (in) 40, lamellar (le) 96, rostral (ro) 56; notogaster: length 818, width 626, height 545, length of notogastral setae: c₁ 35, c₃ 63, h₁ and p₁ 28, p₃ 53; genital and aggenital plates 207 × 116, anal and adanal plates 454 × 96.

Description

Large species, body colour light to dark brown. Integument densely punctate.

Prodorsum with weak median crista and two pairs of parallel, distinct lateral carinae, sensilli short needle-like, and smooth. Prodorsal setae simple, interlamellar (in) and lamellar (le) setae erect, rostral setae (ro) needle-like, smooth, exobothridial setae (ex) vestigial.

Notogastral setae very short (c₁/c₁ – d₁ = 0.2), all needle-like except filiform setae c₃ and p₃; oblique arrangement of setae c₁–3 very strange, setae c₁ situated very far from anterior margin of notogaster, setae c₂ in medium distance and setae c₃ in short distance from notogastral margin. Opening of opisthosomal gland and arrangement of lyrifissures and vestigial setae typical for genus.

Ventral region. Setae h of mentum considerably longer than distance between them. Anogenital cleft trv rather short. Nine pairs of genital and two pairs of short aggenital setae present. Anal plate without setae and three pairs of adanal setae present. Adanal setae ad₃ situated at level between anal setae an₂ and an₃, anal setae an₁ situated at level between adanal setae ad₁ and ad₂ setae considerably longer than between ad₂ and ad₃; lyrifissures iad situated laterally posteriorly of adanal setae ad₂.

Chaetome of legs (without tarsi): I: 1-4-5(2)-5(1), II:1-4-4(1)-3(1), III: 3-2-3(1)-3(1), IV: 3-2-2(1)-3(1); tarsi heterotridactylous.

Etymology

The name of the new species ‘brevis’ is Latin for ‘short’ and refers to the length of notogastral setae.

Comparison

The new species is easy distinguishable from the related species by the presence of short notogastral setae and the oblique arrangement of notogastral setae c₁–3.

Acrotritia paraarduα sp. nov.  
(Figure 2)

Material examined

Holotype deposited at DATE from the locus typicus: MAG-111, Madagascar, Reservation Expérimentale de Vohimana, 27 November 2011, 18°55’13.7” S, 48°30’50.8” E, 776 m asl, sifting of forest litter sample, Winkler apparatus extraction, leg. L. S. Rahanitriniaina, and P. Bañaf, one paratype deposited at DATE from the locality:
Figure 2. Acrotritia paraarduai sp. nov., holotype: (A) prodorsum, lateral view; (B) prodorsum, dorsal view; (C) opisthosoma, lateral view; (D) mentum of subcapitulum; (E) genitoaggenital plate, right side.

MAG-111, Madagascar, Reservation Expérimentale de Vohimana, 27 November 2011, 18°55'13.7" S, 48°30'50.8" E, 776m asl, sifting of forest litter sample, Winkler apparatus extraction, leg. L.S. Rahanitriniaina, and P. Baňař, one paratype deposited.
at DATE from the locality: MAG-089, Madagascar, Ambositra Special Reserve, 17 November 2011, 18°11′42.9″ S, 47°17′20.3″ E, 1640 m asl, sifting of forest litter sample, Winkler apparatus extraction, leg. L.S. Rahanitriniaina, one paratype deposited at ISB from the locality: MAG-114, Madagascar, Andasibe National Park, 2–5 May 2011, sifting of leaf litter sample, Winkler apparatus extraction, leg. L.S. Rahanitriniaina, one paratype deposited at NHMG from the locality: MAG-132, Madagascar, Ambositra Special Reserve, 3 September 2011, 18°10′58.3″ S, 47°17′22.2″ E, 1518 m asl, under palm tree near waterfall, sifting of leaf litter sample, Winkler apparatus extraction, leg. L.S. Rahanitriniaina.

Measurements of holotype
Prodorsum: length 260, width 190, height 114, sensillus 76, length of prodorsal setae: interlamellar (in) 119, lamellar (le) 71, rostral (ro) 66, exobothridial (ex) 13; notogaster: length 494, width 338, height 369, length of notogastral setae: c1, h1 and p1 81; genitoaggenital plate 172 × 81, anoanal plate 227 × 76.

Description
Colour light brown. Integument finely punctate.

Prodorsum with single, distinct, long lateral carinae. Sensilli with narrow pedicel and clavate head covered with small spines. Prodorsal setae: interlamellar (in) and lamellar (le) setae similar to notogastral setae, stout, covered with small spines in distal half; rostral (ro) setae fairly short, rough; exobothridial (ex) setae minute.

Notogaster with moderately long notogastral setae stout, covered with small spines in distal half. Setae c1 shorter than distance between setae c1 and d1, setae c remote from anterior margin of notogaster, setae c2 more removed than setae c1 and c3. Openings of lateral-opisthosomal gland (gla), lyrifissures and vestigial setae present and positioned typically.

Ventral region. Infracapitulum as for superfamily Euphthiracaroidea. Setae h of mentum longer than their mutual distance. Genitogenital plates with nine pairs of genital setae; all genital setae situated posteriorly of progenital area; two aggenital setae situated slightly obliquely. Anal plates with two pairs of setae. Anodanal plates with three pairs of stout adanal setae; anal setae an1 and an2 shorter, smooth, anal setae an3 minute. Lyrifissures iad situated anteriorly from adanal setae ad3.

Leg chaetome (tarsi not examined): I: 1-3-5(2)-5(1), II: 1-4-3(1)-4(1), III: 2-2-2(1)-3(1), IV: 2-1-2(0)-3(1). Tarsi of leg I bidactylous, tarsi II–IV tridactylous, all tarsi heterotridactylous.

Etymology
The prefix ‘para’ is Latin meaning ‘near’ and refers to the similarity the new species with Acrotritia ardua (C. L. Koch 1841).

Comparison
The new species is similar to A. ardua (C. L. Koch 1841) by the presence of simple, distinct lateral carinae of prodorsum and bidactylous tarsi I and tridactylous...
tarsi II–IV, but differs by the presence of a clavate head of sensillum (versus fusiform head), the presence of all genital setae outside the progenital area (versus setae $g_1$ in the progenital position) and by different chaetotaxy of the legs. Another two Acrotritia species have simple lateral carinae of the prodorsum, clavate sensilli and bidactylous tarsi I and tridactylous tarsi II–IV. However, *Acrotritia dinota* (Niedbała et Schatz, 1996) from Belize and the Galapagos islands has genital setae $g_1$ situated in a progenital position and *Acrotritia munita* Niedbała, 2006 from South Africa also has genital setae $g_1$ situated in a progenital position (Koch 1841; Niedbała and Schatz 1996; Niedbała 2006).

*Acrotritia paradikra* sp. nov.
(Figure 3)

**Material examined**

**Holotype** and 13 paratypes deposited at DATE from *locus typicus*: MAG-019, Madagascar, Ankarafantsika National Park, 25 April 2011, 16°17′32.9″ S, 46°48′38.1″ E, 75 m asl, sifting sample of forest litter, Winkler apparatus extraction, leg. L. S. Rahanitriniaina and R. Raveloson, three paratypes deposited at DATE from the locality: MAG-007, Madagascar, Ranomafana National Park, 16–18 November 2010, 21°14′51″ S, 47°24′13″ E, 1079 m asl, leaf litter sifting, leg. P. Baňař, six paratypes deposited at DATE from the locality: MAG-010, Madagascar, Ankarafantsika National Park, 25 April 2011, 16°17′37.9″ S, 46°48′43.2″ E, altitude 92 m asl, sifting sample of forest leaf litter, Winkler apparatus extraction, leg. L.S. Rahanitriniaina and R. Raveloson, five paratypes deposited at DATE from the locality: MAG-011, Madagascar, Ankarafantsika National Park, 23 April 2011, 16°18′05.9″ S, 46°49′06.4″ E, 71 m asl, sifting sample of forest litter, Winkler apparatus extraction, leg. L.S. Rahanitriniaina and R. Raveloson, 16 paratypes deposited at ISB from the locality: MAG-015, Madagascar, Ankarafantsika National Park, 23 April 2011, 16°18′10.7″ S, 46°48′47.1″ E, 81 m asl, sifting sample of forest litter, Winkler apparatus extraction, leg. L.S. Rahanitriniaina and R. Raveloson, 19 paratypes at NHMG from the locality: MAG-018, Madagascar, Ankarafantsika National Park, 25 April 2011, 16°18′46.7″ S, 46°48′57.9″ E, 88 m asl, sifting sample of forest litter, Winkler apparatus extraction, leg. L.S. Rahanitriniaina and R. Raveloson, eight paratypes deposited at NHMG from the locality: MAG-043, Madagascar, Ankarafantsika National Park, 22 April 2011, 16°18′46.6″ S, 46°48′58.8″ E, 89 m asl, sifting sample of forest litter, Winkler apparatus extraction, leg. L.S. Rahanitriniaina and R. Raveloson, and four paratypes deposited at NHMG from the locality: MAG-049, Madagascar, Ankarafantsika National Park, 25 April 2011, 16°18′47.0″ S, 46°48′57.1″ E, altitude 79 m asl, sifting sample of forest litter, Winkler apparatus extraction, leg. L.S. Rahanitriniaina and R. Raveloson.

**Measurements of holotype**

Prodorsum: length 278, height 101, width 192, sensillus 58, length of prodorsal setae: interlamellar (*in*) 142, lamellar (*le*) 86, rostral (*ro*) 71, exobothridial (*ex*) 23;
Figure 3. *Acrotritia paradikra* sp. nov., holotype: (A) prodorsum, lateral view; (B) prodorsum, dorsal view; (C) opisthosoma, lateral view; (D) mentum of subcapitulum.

notogaster: length 576, height 424, width 394, length of notogastral setae: $c_1$ 91, $h_1$ 83, $p_1$ 96; $c_1/c_1 - d_1 = 0.6$; length of genitoaggenital plate 202, length of anoadanal plate 283.
Description
Colour yellow, surface of body punctate.

Prodorsum with two pairs of distinct lateral carinae; inferior carina long, placed between bothridium and lateral border of prodorsum, superior carina short not parallel, located in anterior part of prodorsum, convergent to middle part of inferior carina. Sensilli fusiform with spinose head. Prodorsal setae with exception of exobothridial (ex) one erect, interlamellar (in) and lamellar (le) setae spinose in distal half, rostral (ro) setae rough. Distance between lamellar (le) setae larger than between rostral (ro) setae.

Notogastral setae rather short, spinose in distal half, their mutual length $c_1 < c_1 – d_1$. Setae $c_1–3$ remote from anterior border of notogaster, setae $c_3$ less than other. Openings of the latero-opisthosomal glands, lyrifissures and vestigial setae present and positioned typically. On the left side in holotype vestigial seta $f_1$ developed as short, filiform seta.

Ventral region. Setae $h$ of mentum longer than distance between them. Nine pairs of minute genital and two pair of minute aggenital setae present. Three pairs of rough anal and three pairs of adanal setae present. Anal setae $a_n_1$ and $a_n_2$ shorter than adanal setae, anal setae $a_n_3$ minute. Lyrifissures $iad$ located between anal $a_n_3$ and adanal setae $a_d_3$.

Chaetome of legs (without tarsi): I: 1-3-5(2)-5(1), II: 1-3-3(1)-4(1), III: 2-2-2(1)-3(1), IV: 2-1-2-2(1). Tarsi I bidactylous, tarsi II–IV tridactylous all tarsi heterodactylous.

Etymology
The prefix ‘para’ is Latin meaning ‘near’ and refers to some resemblance to the Neotropical species *Acrotritia dikra* (Niedbała et Schatz 1996).

Comparison
The new species is similar to *Acrotritia dikra* Niedbała et Schatz, 1996 in the shape of lateral carinae of prodorsum. These two similar species distinguish by the shape of sensilli, setiform in *Acrotritia dikra* Niedbała et Schatz, 1996 and fusiform in new species. Some other similar species are distinguishable by the shape of lateral carinae of prodorsum and by monodactylous tarsi (Niedbała and Schatz 1996).

*Microtritia diaphoros* sp. nov.
(Figure 4)

Material examined
Holotype and five paratypes deposited at DATE from the *locus typicus*: TAN-009, Tanzania, Nguru Mts, Turiani, 4 November 2010, 06°04'29" S, 37°32'19" E, 1277 m asl, deciduous forest on steep slope, leaf litter sifting, leg. V. Grebennikov, three paratypes deposited at ISB and three paratypes deposited at NHMG from the same locality.
Measurements of holotype

Prodorsum: length 215, width 159, height 86, sensillus 68, length of prodorsal setae: interlamellar (in) 15, lamellar (le) 23, rostral (ro) 33; notogaster: length 343, width 263, height 247, length of notogastral setae: $c_1$ 56, $c_1/c_1 - d_1 = 0.6$, $h_1$ 40, $p_1$ 35; genitoaggenital region 101 × 43, anoadanal region 139 × 30.

Description

Colour yellow. Surface of body punctuated, posterior part of prodorsum covered with feeble alveoli.

Prodorsum with sensilli narrowly spindle shaped, smooth. Prodorsal setae fine, short, distance between lamellar (le) setae considerably greater than between rostral (ro) setae; mutual length of prodorsal setae $ro < le > in$. 

Figure 4. Microtritia diaphoros sp. nov., holotype: (A) prodorsum, dorsal view; (B) lateral view of body; paratype: (C) ventral plates.
Notogastral setae fine, flexible, short, mutual length \( (c_1 < c_1 - d_1) \), setae \( c_{1-3} \) remote from anterior margin of notogaster, setae \( c_2 \) slightly more than other; fissura terminalis absent.

Ventral region. Four pairs of genital setae, no one situated in progenital position, aggenital setae absent. Three pairs of adanal setae present, adanal setae \( ad_1 \) the longest. One paratype has one more adanal seta in left side (Figure 4C). Anal setae \( an_1 \) and \( an_2 \) shorter than adanal setae, anal setae \( an_3 \) vestigial. Lyrifissures \( iad \) situated anteriorly of adanal setae \( ad_3 \).

Chaetome of legs (without tarsi): I: 1-2-3(2)-5(1), II: 1-2-3(1)-2(1); III: 2-2-2(1)-2(1), IV: 2-1-1-2(1).

**Etymology**
The specific name of the new species ‘*diaphoros*’ is Greek for ‘different’ and alludes to a significant difference between the mutual distance of the rostral and lamellar setae of the prodorsum.

**Comparison**
The new species differs from congeners by the presence of a very small distance between the rostral setae and a very large distance between the lamellar setae. It is similar to the South American species *M. schusteri* (Märkel 1964) and *M. incisa* (Märkel 1964) by the presence of a similar shape of sensilli and the presence of four pairs of genital setae. However, the new species is distinguishable by a significant difference between the mutual distance of the rostral and lamellar setae and the presence of well-developed anal setae \( an_1 \) and \( an_2 \) (Märkel 1964).

**Microtritia parahauseri** sp. nov.

(Figure 5)

**Material examined**
*Holotype* and five paratypes deposited at DATE from *locus typicus*: TAN-015, Tanzania, Uluguru Mts, Bunduki village, 22 November 2010, 07°01′17″ S, 37°39′10″ E, 1602 m asl, mid-altitude afro-montane deciduous forest, leaf litter sifting, leg. V. Grebennikov, one paratype deposited at ISB from the locality: TAN-017, Tanzania, Uluguru Mts, Bunduki village, 24 November 2010, 07°00′15″ S, 37°37′50″ E, 1848 m asl, mid-altitude afro-montane deciduous forest, leaf litter sifting, leg. V. Grebennikov, two paratypes deposited at ISB from the locality: TAN-022, Tanzania, Southern Uluguru Mts, east slope, 7 November 2010, 07°07′25″ S, 37°37′60″ E, 2220 m asl, mid-altitude afro-montane deciduous forest, leaf litter sifting, leg. V. Grebennikov, two paratypes deposited at NHMG from the locality: TAN-023, Tanzania, Uluguru Mts, Tchanzema village, 13 November 2010, 07°06′44″ S, 37°36′16″ E, 2258 m asl, mid-altitude afro-montane deciduous forest, leaf litter sifting, leg. V. Grebennikov.
Measurements of holotype

Prodorsum: length 202, width 157, height 76, sensillus 45, length of prodorsal setae: interlamellar (*in*) 10, lamellar (*le*) 28, rostral (*ro*) 40; notogaster: length 338, width

Figure 5. *Microtritia parahauseri* sp. nov., holotype: (A) prodorsum, dorsal view; (B) lateral view of body; (C) ventral plates, left side; (D) posterior end of ventral plates.

*Measurements of holotype*

Prodorsum: length 202, width 157, height 76, sensillus 45, length of prodorsal setae: interlamellar (*in*) 10, lamellar (*le*) 28, rostral (*ro*) 40; notogaster: length 338, width
202, height 217, length of notogastral setae: \( c_1 \approx 53, \ c_1/c_1 - d_1 = 0.6, \ h_1 \) and \( p_1 \approx 38 \);
genitoaggenital region \( 101 \times 56 \), anoadanal region \( 126 \times 45 \).

**Description**

Colour yellow. Surface of body punctuated, only posterior part of prodorsum covered with alveoli.

Prodorsum with sensilli broadly spindle shaped, smooth. Prodorsal setae fine, short, distance between lamellar (le) setae slightly greater than between rostral (ro) setae; rostral (ro) setae relatively far from distal end of prodorsum; mutual length of prodorsal setae: \( ro < le > in \).

Notogaster with notogastral setae fine, flexible, short, mutual length \( c_1 < c_1 - d_1 \), setae \( c_1 - 3 \) remote from anterior margin of notogaster, setae \( c_2 \) more than others; fissura terminalis absent.

Ventral region with four pairs of genital setae, no one situated in progenital position, aggenital setae absent. Anal setae \( an_2 \) and \( an_3 \) absent, adanal setae \( ad_1 \) and \( ad_2 \) the longest. Lyrifissures \( iad \) situated anteriorly of adanal setae \( ad_3 \).

**Etymology**

The prefix ‘para’ is Latin meaning ‘near’ and refers to some similarity of the new species with *Microtritia hauseri* Mahunka, 1993.

**Comparison**

The new species is distinguishable from congeners by the unusual absence of the anal setae \( an_2 \) and \( an_3 \). It is similar to *Microtritia hauseri* Mahunka, 1993 by the shape of sensilli and the presence of four pairs of genital setae, but is distinguishable by more broad sensilli, a distance between the rostral (ro) setae smaller than between the lamellar (le) setae (versus considerably more in the new species), not one genital setae is situated in a progenital position (versus setae \( g_1 \) and \( g_2 \) positioned in a progenital position in the new species), genua IV with setae \( d \) (versus absence of setae \( d \) in the new species) (Mahunka 1993).

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