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Article

A new species of *Carabodes* (*Klapperiches*) (Acari, Oribatida, Carabodidae) from Malawi, with a key to known species of the subgenus from the Afrotropical region

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ABSTRACT

The family Carabodidae (Oribatida) is recorded in Malawi for the first time. A new species of the subgenus *Carabodes* (*Klapperiches*) is described from sifted litter in a highland forest of Central Malawi. *Carabodes* (*Klapperiches*) *dedzaensis* **sp. nov.** can be distinguished from the related species *C. (K.) coronatus* Mahunka, 1986 by the larger body size, longer and fusiform bothridial seta, flexible interlamellar seta, longer lamellar cusp, and the absence of foveolae on genital and anal plates. An identification key to known species of *Carabodes* (*Klapperiches*) from the Afrotropical region is provided.

KEY WORDS: Africa; identification key; morphology; oribatid mites; taxonomy.

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INTRODUCTION

The oribatid mite genus *Carabodes* (Acari, Oribatida, Carabodidae) was proposed by Koch (1835) with *Carabodes coriaceus* Koch, 1835 as type species. According to the catalogue of Subías (2004; online version 2022), it comprises four subgenera and 133 species, which have collectively a cosmopolitan distribution (*C. (Carabodes)* Koch, 1835 – 73 species; *C. (Flexa)* Kulijev, 1977 – eight species; *C. (Klapperiches)* Mahunka, 1978 – 46 species; *C. (Phyllocarabodes)* Balogh & Mahunka, 1969 – six species).

The main goal of the paper is to describe and illustrate a new species, *Carabodes* (*Klapperiches*) *dedzaensis* **sp. nov.**, based on adults, collected from Malawi. It is first record of the family in the fauna of this country. The subgenus was described by Mahunka (1978) as an independent genus, with *Klapperiches nigrosetosus* Mahunka, 1978 as type species. The main subgeneric traits were presented by Mahunka (e.g. 1978, 1986).

So far, 10 species (including the new species) of *C. (Klapperiches)* are known in the Afrotropical region. The additional goal of the paper is to provide an identification key to these

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known species.

METHODS

Specimens

Oribatid mites were kindly provided by the Moravian Museum, Brno, Czech Republic. See ‘Type material’ for details about locality and habitat.

Observation and documentation

Specimens were mounted in lactic acid on temporary cavity slides for measurement and illustration. Body length was measured in dorsal view, from the tip of the rostrum to the posterior edge of the notogaster. Notogastral width refers to the maximum width of the notogaster in dorsal view. Lengths of body setae were measured in lateral aspect. All body measurements are presented in micrometers. Formulas for leg setation are given in parentheses according to the sequence trochanter-femur-genu-tibia-tarsus (famulus included). Formulas for leg solenidia are given in square brackets according to the sequence genu-tibia-tarsus. Drawings were made with a camera lucida using a Leica transmission light microscope “Leica DM 2500”.

Terminology

General morphological terminology used in this paper mostly follows that of Grandjean (see Travé and Vachon 1975 for references), Norton (1977), Mahunka (1986), and Norton and Behan-Pelletier (2009).

Abbreviations

Prodorsum: *lam* = lamella; *ro*, *le*, *in*, *bs* = rostral, lamellar, interlamellar, and bothridial seta, respectively; *tu* = tutorium. *Notogaster*: *c*, *la*, *lm*, *lp*, *h*, *p* = setae; *ia*, *im* = lyrifissures; *gla* = opisthonotal gland opening. *Gnathosoma*: *a*, *m*, *h* = subcapitular setae. *Epimeral and lateral podosomal regions*: *1a–1c*, *2a*, *3a–3c*, *4a–4c* = epimeral setae; *PdI*, *PdII* = pedotectum I, II, respectively; *dis* = discidium. *Anogenital region*: *g*, *ag*, *an*, *ad* = genital, aggenital, anal, and adanal seta, respectively; *iad* = adanal lyrifissure; *p.o.* = preanal organ. *Legs*: *Tr*, *Fe*, *Ge*, *Ti*, *Ta* = trochanter, femur, genu, tibia, and tarsus, respectively; ω , φ , σ = solenidia; ε = famulus; *d*, *l*, *v*, *bv*, *ev*, *ft*, *tc*, *it*, *p*, *u*, *a*, *s*, *p.v.* = leg setae; *p.a.* = porose area.

RESULTS

Family Carabodidae

Genus *Carabodes* Koch, 1835

Subgenus *Carabodes (Klapperiches)* Mahunka, 1978

Type species: *Klapperiches nigrosetosus* Mahunka, 1978

Carabodes (Klapperiches) dedzaensis sp. nov. (Figs. 1–7)

Diagnosis

Body length: 480–540. Prodorsum, notogaster and anogenital region tuberculate. Lamella with long distal triangular projection. Translamella absent. Tutorium dentate dorsally. Rostral and lamellar setae setiform, curved and directed anteromedially, barbed. Interlamellar seta setiform, curved and directed anteriorly, barbed. Bothridial seta long, slightly fusiform, barbed. All notogastral setae thickened, erect, barbed; *p*_{1–3}, *h*₃ shorter than others. Epimeral setae *1a*, *1c*, *2a*, and *3a* minute; other epimeral setae as well as genital, aggenital and anal setae setiform, erect,

slightly barbed. All adanal setae thickened, erect, barbed. Leg tarsus IV with 12 setae.

Description

Measurements – Species of comparatively large size. Body length: 525 (holotype: male), 480, 540 (two paratypes, both males); notogaster width: 300 (holotype), 270, 315 (two paratypes). Body ratio (length/width): 1.7.

Integument – Body color brown. Body covered by thick layer of gel-like cerotegument including masses of natural dirt, forming a solid crust on the surface of prodorsum and notogaster. Body densely microtuberculate; in addition, prodorsum, notogaster and anogenital region tuberculate (diameter of tubercle up to 8). Tutorium and subcapitular mentum foveolate (diameter of foveola up to 6). Lateral (outer) side of pedotecta I and II slightly rugose. Genital plate with some indistinct longitudinal stria.

Prodorsum – Rostrum broadly rounded. Lamella long and broad, with distal triangular projection reaching level of insertion of rostral seta (visible in lateral aspect). Translamella absent. Tutorium long, ridge-like, heavily dentate dorsally. With elongate depression between lamella and tutorium. Rostral and lamellar setae (26–30) setiform, curved and directed anteromedially, barbed; *le* inserted on dorsal side of lamella. Interlamellar seta (56–64) setiform, curved and directed anteriorly, barbed, inserted on tubercle. Bothridial seta (97–105) with long stalk and shorter, slightly developed, elongate, fusiform head, barbed. Bothridium interrupted ventrally. Exobothridial seta not observed.

Notogaster – Anterior notogastral margin slightly convex medially. Humeral processes indistinct. Ten pairs of notogastral setae (p_1 – p_3 , h_3 : 34–37; others: 49–56) thickened, erect, barbed. Opisthonotal gland opening and lyrifissures *ia* and *im* slightly visible; *ip*, *ih* and *ips* not observed.

Gnathosoma – Typical for Carabodidae (e.g., Ermilov 2016; Ermilov and Starý 2020). Subcapitulum size: 120–131 × 86–94. All subcapitular setae (*a*: 19–22; *m*: 11–13; *h*: 9–11) setiform, roughened; *a* thickest. Postpalpal setae (9) bacilliform, roughened. Palp (length: 63–67) setation: 0–2–1–3–9(+ ω). Chelicera (131–139) with two setiform, barbed setae (*cha*: 37; *chb*: 22).

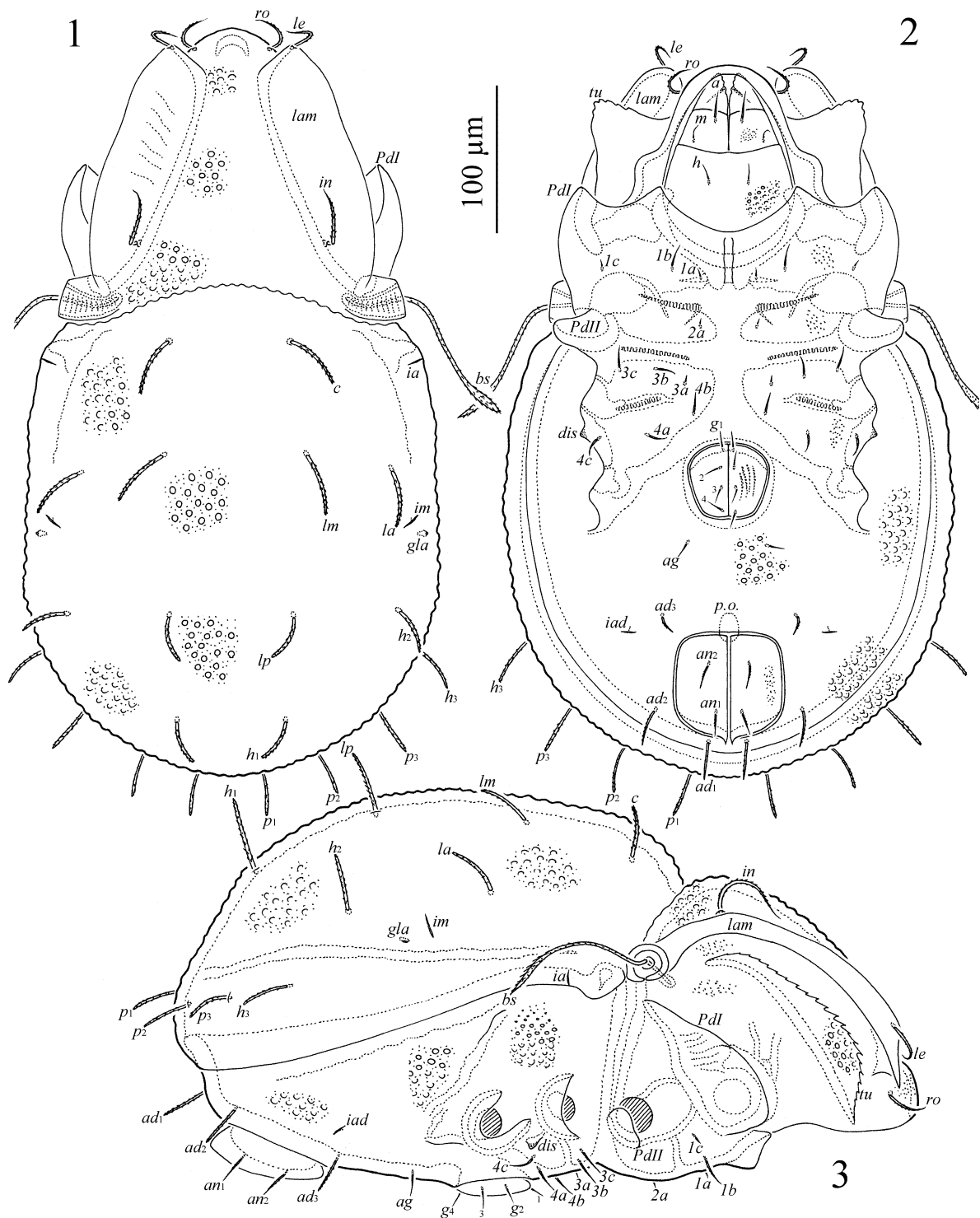
Epimeral and lateral podosomal regions – Epimeral setation: 3–1–3–3. Epimeral setae *1a*, *1c*, *2a*, and *3a* short (4–5), setiform, smooth; others (22–26) setiform, erect, slightly barbed. Discidium tubercle-like.

Anogenital region – Genital (11–15), aggenital (11–15) and anal (19–22) setae setiform, erect, slightly barbed. Adanal setae (*ad*₁, *ad*₂: 30–34; *ad*₃: 19–22) thickened, erect, barbed. Adanal lyrifissure visible, removed from anal aperture and located lateral to adanal setae *ad*₃.

Legs – Claw of each leg strong, sparsely barbed dorsally. One porose area on all femora distinct, porose areas on trochanters III, IV not observed. Formulas of leg setation and solenidia: I (1–4–3–4–16) [1–2–2], II (1–4–3–3–15) [1–1–2], III (2–3–1–2–15) [1–1–0], IV (1–2–2–2–12) [0–1–0]; homology of setae and solenidia indicated in Table 1. Famulus of tarsus I short, erect, slightly swollen distally, located posterior to solenidium ω . Phylliform seta *l*'' absent on femora and genua.

Remarks

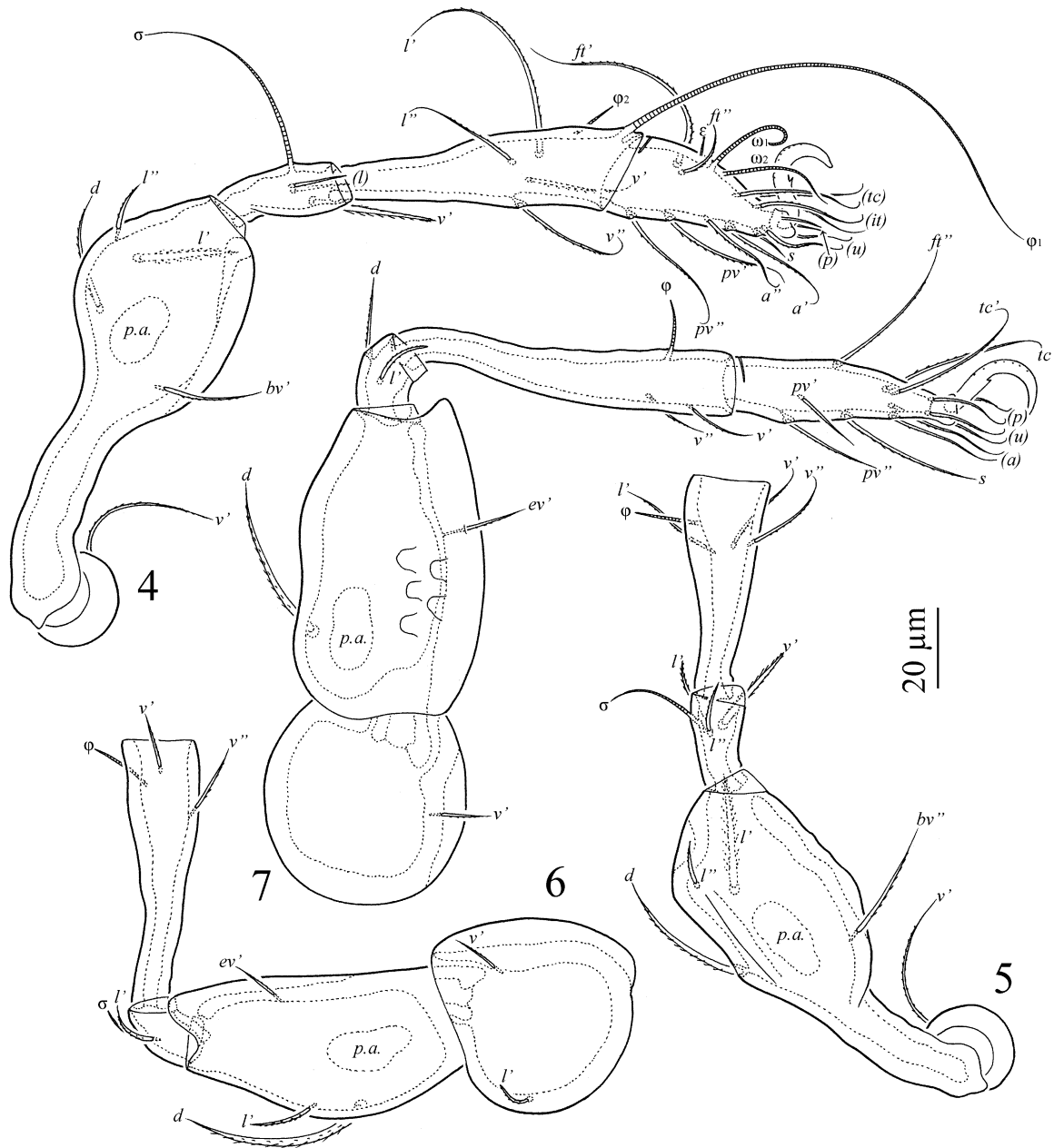
In having tuberculate body surface, dorsally dentate tutorium and medium-sized, thickened, erect notogastral setae, *Carabodes (Klapperiches) dedzaensis* sp. nov. is most similar to *C. (K.) coronatus* Mahunka, 1986 from South Africa. However, the new species can be distinguished from the later by the larger body size (480–540 × 270–315 versus 422 × 246), distinctly longer bothridial seta (as long as length of three notogastral setae versus as long as length of two notogastral setae) and fusiform bothridial seta having narrowed distally head (versus bothridial seta dilated distally, brush-shaped), flexible (versus erect) interlamellar seta, longer lamellar cusp (reaching insertion of rostral seta versus not reaching), and the absence (versus presence) of foveolae on genital and anal plates.



Figures 1–3. *Carabodes (Klapperiches) dedzaensis* sp. nov. (adult, not shown: legs) – 1. Dorsal view; 2. Ventral view; 3. Right lateral view.

Type material

Holotype and two paratypes: Central Malawi, Dedza District, Dedza Mountain, 14° 21' 13.4" S, 34° 19' 36.3" E, 2032 m a.s.l., sifted forest litter, Winkler extraction, 29.XI.2012 (leg. P. Baňar and P. Hlaváč).



Figures 4–7. *Carabodes (Klapperiches) dedzaensis* sp. nov. (adult) – 4. Leg I, right, antiaxial view; 5. Leg II, without tarsus, right, antiaxial view; 6. Leg III, without tarsus, left, antiaxial view; 7. Leg IV, left, antiaxial view.

Table 1. Leg setation and solenidia of adult *Carabodes (Klapperiches) dedzaensis* sp. nov.

Leg	Tr	Fe	Ge	Ti	Ta
I	v'	d, (l), bv''	(l), v', σ	(l), (v), φ ₁ , φ ₂	(ft), (tc), (it), (p), (u), (a), s, (pv), ε, ω ₁ , ω ₂
II	v'	d, (l), bv''	(l), v', σ	l', (v), φ	(ft), (tc), (it), (p), (u), (a), s, (pv), ω ₁ , ω ₂
III	l', v'	d, l', ev'	l', σ	(v), φ	(ft), (tc), (it), (p), (u), (a), s, (pv)
IV	v'	d, ev'	d, l'	(v), φ	ft'', (tc), (p), (u), (a), s, (pv)

Note: Roman letters refer to normal setae, Greek letters to solenidia (except ε = famulus); single quotation mark (') designates setae on the anterior and double quotation mark (') setae on the posterior side of a given leg segment; parentheses refer to a pair of setae.

Type deposition

The holotype is deposited in the collection of the Senckenberg Museum of Natural History, Görlitz, Germany; two paratypes are deposited in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia. All specimens are preserved in ethanol with a drop of glycerol.

Etymology

The species name *dedzaensis* refers to the place of origin, Dedza Mountain.

Key to known species of *Carabodes* (*Klapperiches*) from the Afrotropical region

1. Interlamellar and notogastral setae phylliform (dilated mediodistally)..... 2
 - Interlamellar and notogastral setae setiform or thickened 4
2. Interlamellar region rugose; body length: 380..... *Carabodes* (*Klapperiches*) *penicillatus* Berlese, 1916 (see also Mahunka 1991). Distribution: Somalia.
 - Interlamellar region tuberculate 3
3. Bothridial seta medium-sized (longer than notogastral seta), with clavate head; posterior notogastral setae (h_3, p_1-p_3) shorter than others; body length: 365–464 *Carabodes* (*Klapperiches*) *dilatatus* Ermilov, Sidorchuk & Rybalov, 2010. Distribution: Ethiopia.
 - Bothridial seta short (shorter than notogastral seta), with calyciform head; all notogastral setae similar in length; body length: 432 *Carabodes* (*Klapperiches*) *pocsi* Mahunka, 1983. Distribution: Tanzania.
4. Interlamellar and notogastral setae medium-sized (clearly longer than diameter of bothridium).. 5
 - Interlamellar and notogastral setae short (not longer than diameter of bothridium)..... 6
5. Bothridial seta long (as long as length of three notogastral setae), with fusiform head; interlamellar seta flexible; genital and anal plates without foveolae; body length: 480–540 *Carabodes* (*Klapperiches*) *dedzaensis* **sp. nov.** Distribution: Malawi.
 - Bothridial seta medium-sized (as long as length of two notogastral setae), dilated distally, with brush-shaped head; interlamellar seta erect; genital and anal plates with foveolae; body length: 422 *Carabodes* (*Klapperiches*) *coronatus* Mahunka, 1986. Distribution: South Africa.
6. Bothridial seta without developed head, curved backward 7
 - Bothridial seta with developed head, not curved backward 8
7. Interlamellar region not tuberculate; notogastral tubercles mostly sparsely spaced, connected by dendrite-like ridges; body length: 247–277 *Carabodes* (*Klapperiches*) *andasibe* Mahunka, 1993. Distribution: Madagascar.
 - Interlamellar region tuberculate; notogastral tubercles densely spaced, without connection by dendrite-like ridges; body length: 296–304 *Carabodes* (*Klapperiches*) *afrominusculus* Mahunka & Mahunka-Papp, 2011. Distribution: Madagascar.
8. Interlamellar region and notogaster not tuberculate; bothridial seta short (clearly shorter than distance between insertions of interlamellar setae), with calyciform head; translamella absent; body length: 310–360 *Carabodes* (*Klapperiches*) *agenjoi* Pérez-Íñigo, 1969. Distribution: Equatorial Guinea.
 - Interlamellar region and notogaster tuberculate; bothridial seta long (not shorter than distance between insertions of interlamellar setae), with lanceolate head; translamella present 9
9. Dorsal notogastral setae inserted on hump-like apophyses; body length: 426–558 *Carabodes* (*Klapperiches*) *problematicus* Mahunka, 1985. Distribution: South Africa.
 - Dorsal notogastral setae inserted on notogastral surface, hump-like apophyses absent; body length: 280–344 *Carabodes* (*Klapperiches*) *microtrichus* Mahunka, 1984. Distribution: South Africa.

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گونه جدیدی از *Carabodes (Klapperiches)* (Acari, Oribatida, Carabodidae) از مالاوی، همراه با کلید گونه‌های شناخته شده زیرجنس از منطقه افروتروپیکال

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چکیده

خانواده *Carabodidae* (Oribatida) برای نخستین بار در مالاوی گزارش می‌شود. گونه جدیدی از زیرجنس *Carabodes (Klapperiches)* از بستر الک شده در جنگلی مرتفع در مرکز مالاوی توصیف می‌شود. گونه جدید *Carabodes (Klapperiches) dedzaensis* را می‌توان از گونه نزدیک *C. (K.) coronatus* Mahunka, 1986، با اندازه بزرگتر بدن، موی تریکوبوتری بلندتر و دوکی شکل، موی بین تیغه‌ای انعطاف‌پذیر، بلندتر بودن نوک تیغه، و نبود فرورفتگی‌ها در صفحات جنسی و مخرجی تشخیص داد. کلید شناسایی گونه‌های شناخته شده *Carabodes (Klapperiches)* از منطقه افروتروپیکال ارائه شده است.

واژگان کلیدی: افریقا؛ کلید شناسایی؛ ریخت‌شناسی؛ کنه‌های اربیاتید؛ آرایه‌شناسی.

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