

NEW SPECIES OF THE GENERA *DIPLOBODES* AND  
*MACHADOCEPHEUS* (ACARI, ORIBATIDA, CARABODIDAE)  
FROM THAILAND, WITH REMARKS ON SOME RELATED GENERA

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Two new species of oribatid mites of the family Carabodidae are described from litter in Thailand. *Diplobodes parakanekoi* sp. n. differs from *Diplobodes kanekoi*, *D. africanus* and *D. aokii* by fewer notogastral setae in the *c*-row, different number of notogastral tubercles, presence of a translamella, and the localization of dorsal notogastral setae. *Machadocepheus pararachii* sp. n. differs from *Machadocepheus rachii* by the positions of dorsal notogastral setae *c*<sub>1</sub>, *da* and *la*. The generic status of the related genera *Diplobodes*, *Machadocepheus*, *Gibbicepheus*, *Gibbibodes*, *Kalloia*, *Neocarabodes*, *Sagittabodes* and *Zimbabweae* is discussed.

Key words: carabodid mites, systematics, morphology, Oriental region, Oribatida.

## INTRODUCTION

At present, oribatid mites (Acari, Oribatida) of the family Carabodidae are poorly studied in Thailand, and only a few species have so far been recorded (AOKI 1965, MAHUNKA 2008, FERNANDEZ *et al.* 2018, 2019) namely: *Aokiella latiseta* Mahunka, 2008; *Archegocepheus imadatei* Aoki, 1965; *Congocepheus thailandae* Fernandez, Theron, Leiva et Jordaan, 2018; *Diplobodes kanekoi* (Aoki, 1958), *Diplobodes thailandae* Fernandez, Theron, Leiva et Jordaan, 2019, and *Gibbicepheus frondosus* (Aoki, 1959).

In the course of taxonomic survey of carabodid mites collected from Thailand during the Russian expedition in 2017 we found two new species belonging to the genera *Diplobodes* Aoki, 1958 and *Machadocepheus* Balogh, 1958. The genus *Diplobodes* was proposed by AOKI (1958) with *Diplobodes kanekoi* Aoki, 1958 as type species. According to ERMILOV *et al.* (2013) and FERNANDEZ *et al.* (2019) it comprises seven species, which are distributed in the Oriental and Ethiopian regions, and Japan. The genus *Machadocepheus* was proposed by BALOGH (1958) with *Machadocepheus excavatus* Balogh, 1958 as type species. According to the catalogue of SUBÍAS (2019), it comprises 10 species, which are distributed in the Ethiopian region, New Guinea, Sri Lanka, and Mexico.

The main goal of our present paper is to describe and illustrate two new species *Diplobodes parakanekoi* sp. n. and *Machadocepheus pararachii* sp. n. and discuss some morphological and taxonomic similarities and differences be-

tween *Diplobodes*, *Machadocephus* and some related taxa, e.g., *Gibbicepheus* Balogh, 1958, *Gibbibodes* Mahunka, 1986, *Kalloia* Mahunka, 1985, *Neocarabodes* Balogh et Mahunka, 1969(a), *Sagittabodes* J. et P. Balogh, 1992, and *Zimbabweae* Fernandez, Theron et Leiva, 2016.

## MATERIAL AND METHODS

The oribatid mite material was collected during the Russian expedition to Thailand in 2017. Litter was collected by using a manual method. The mites were extracted into 75% ethanol using Berlese's funnels without electric lamps in laboratory conditions.

Specimens were mounted in lactic acid on temporary cavity slides for measurement and illustration of the new species. Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the notogaster. Notogastral width refers to the maximum width of notogaster in dorsal view. Lengths of body setae were measured in lateral aspect. All body measurements are presented in micrometer. 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". Images were obtained with an AxioCam ICc3 camera using a Carl Zeiss transmission light microscope "Axio Lab.A1".

The general morphological terminology used in this paper mostly follows that of F. Grandjean: see TRAVÉ and VACHON (1975) for references, NORTON (1977) for leg setal nomenclature, and NORTON and BEHAN-PELLETIER (2009) for overview.

The following abbreviations are used: *lam* = lamella; *tlam* = translamella; *r* = ridge; *dep* = depression; *tu* = tutorium; *ro*, *le*, *in*, *bs* = rostral, lamellar, interlamellar and bothridial setae, respectively; *bo* = bothridium; *t* = tooth; *hls* = hump-like structure (process); *tub* = tubercle; *c*, *da*, *dm*, *dp*, *la*, *lm*, *lp*, *h*, *p* = notogastral setae; *cl<sub>d</sub>* = circumlateral depression; *im*, *ip*, *ih*, *ips* = notogastral lyrifissures; *gla* = opisthonotal gland opening; *a*, *m*, *h* = subcapitular setae; *Pd I*, *Pd II* = pedotecta I and II, respectively; *1a*, *1b*, *1c*, *2a*, *3a*, *3b*, *3c*, *4a*, *4b*, *4c* = epimeral setae; *dis* = discidium; *g*, *ag*, *an*, *ad* = genital, aggenital, anal and adanal setae, respectively; *iad* = adanal lyrifissure; *p.o.* = preanal organ; *cvr* = circumventral ridge; *Tr*, *Fe*, *Ge*, *Ti*, *Ta* = leg trochanter, femur, genu, tibia and tarsus, respectively; *p.a.* = porose area;  $\omega$ ,  $\sigma$ ,  $\phi$  = leg solenidia;  $\varepsilon$  = leg famulus; *v*, *ev*, *bv*, *l*, *d*, *ft*, *tc*, *it*, *p*, *u*, *a*, *s*, *pv* = leg setae.

## SYSTEMATICS

### *Diplobodes parakanekoi* sp. n.

(Figs 1A–C, 2A–D, 5A–C)

**Diagnosis.** Body size 581–630 × 282–332. Notogaster foveolate. Translamella present. Rostral setae thick, spinose. Lamellar and interlamellar setae setiform, roughened. Bothridial setae with slightly developed lanceolate head, heavily barbed. Notogaster with 12 or 13 (one pair of setae *c* present or absent) pairs of notogastral setae of medium size, setiform, roughened; *da*, *dm*, *dp*, *la*, *lm* and *lp*, *h*<sub>1</sub> (together) located on the six pairs of large tubercles. Five

pairs of notogastral setae ( $p_1$ – $p_3$ ,  $h_2$  and  $h_3$ ) in posterolateral position. Epimeral setation 3–1–3–3;  $1a$ ,  $1c$ ,  $2a$  and  $3a$  minute,  $1b$ ,  $3b$ ,  $3c$ ,  $4a$ ,  $4b$  and  $4b$  of medium size, setiform, roughened. Anogenital region with specific system of anogenital depressions. Anal setae short, spiniform, other anogenital setae of medium size, setiform, roughened.

Description. Measurements. Body length 630 (holotype: male), 581, 614 (two paratypes: males); notogaster width 332 (holotype), 282, 298 (two paratypes).

Integument (Figs 1A–C, 2A–D). Body color brown. Body covered by thick layer of gel-like cerotegument. Body surface (including subcapitular mentum and genae, genital and anal plates) microgranulate (diameter of tubercles less than 1). Notogaster, circum-marginal region of ventral plate and antiaxial part of all leg femora and trochanters III, IV sparsely foveolate (diameter of foveoles up to 10). Projecting parts of lamellae foveate.

Prodorsum (Figs 1A–C). Rostrum broadly rounded. Lamellae long (slightly shorter than prodorsum), slightly divided mediolaterally by transverse ridge into two parts, distally with triangular projection. Translamella broad. Tutoria long, strong, ridge-like, not reaching lateral margins of prodorsum. With depressions between lamellae, tutoria and pedotecta I (Fig. 1C). Region between lamellae slightly depressed. Interbothridial region with indistinct longitudinal wrinkles. Rostral setae (45–49) thick, with numerous spines. Lamellar and interlamellar setae similar in length (41–45), setiform, roughened;  $le$  located on lamellae,  $in$  located in interlamellar region. Bothridial setae (53–61) with slightly developed lanceolate head, heavily barbed, curved semiovally in mediolateral part. Bothridia interrupted ventrally, with small ventroposterior tooth. Exobothridial setae and their alveoli not observed.

Notogaster (Figs 1A, 1C, 5A, 5C). Narrow furrow between prodorsum and notogaster present. Anterior notogastral margin almost straight, posterior notogastral margin broadly rounded. Posterolateral part of notogaster with indistinct longitudinal wrinkles. Notogaster with six pairs of tubercles and 12 or 13 (one pair of setae  $c$  present or absent) pairs of notogastral setae (36–45) setiform, roughened; of these,  $da$ ,  $dm$ ,  $dp$ ,  $la$  and  $lm$  located on five pairs of separated tubercles,  $lp$  and  $h_1$  located on the sixth pair of tubercles, and setae  $p_1$ – $p_3$ ,  $h_2$  and  $h_3$  in posterolateral position. Anterior part of notogaster with or without one pair of medial setae ( $c$ ), humeral shoulders always without setae. Posterior notogastral and circumlateral depressions well developed. Lyrifissures  $ia$  not observed, other lyrifissures and opisthonotal gland openings well visible;  $im$  and  $gla$  close and lateral to lateral tubercles bearing setae  $la$ ,  $ip$  between  $p_1$  and  $p_2$ ,  $ips$  and  $ih$  on lateral sides of notogaster.

Gnathosoma (Figs 1B, 1C). Typical for Carabodidae (ERMILOV & CORPUZ-RAROS 2016, ERMILOV & STARÝ 2018, Ermilov *et al.* 2019). Subcapitulum longer than wide (139–147 × 94–102). Subcapitular setae ( $a$  16;  $m$  16;  $h$  14) setiform, similar in thickness, roughened. Postpalpal setae (8) spiniform. Palps (77–82) with setation 0–2–1–3–9(+ $\omega$ ). Solenidion of palptarsi long, bacilliform. Chelicerae (139–147) with two setiform, barbed setae,  $cha$  (41) longer than  $chb$  (16). Trägårdh's organ of chelicerae elongate triangular.

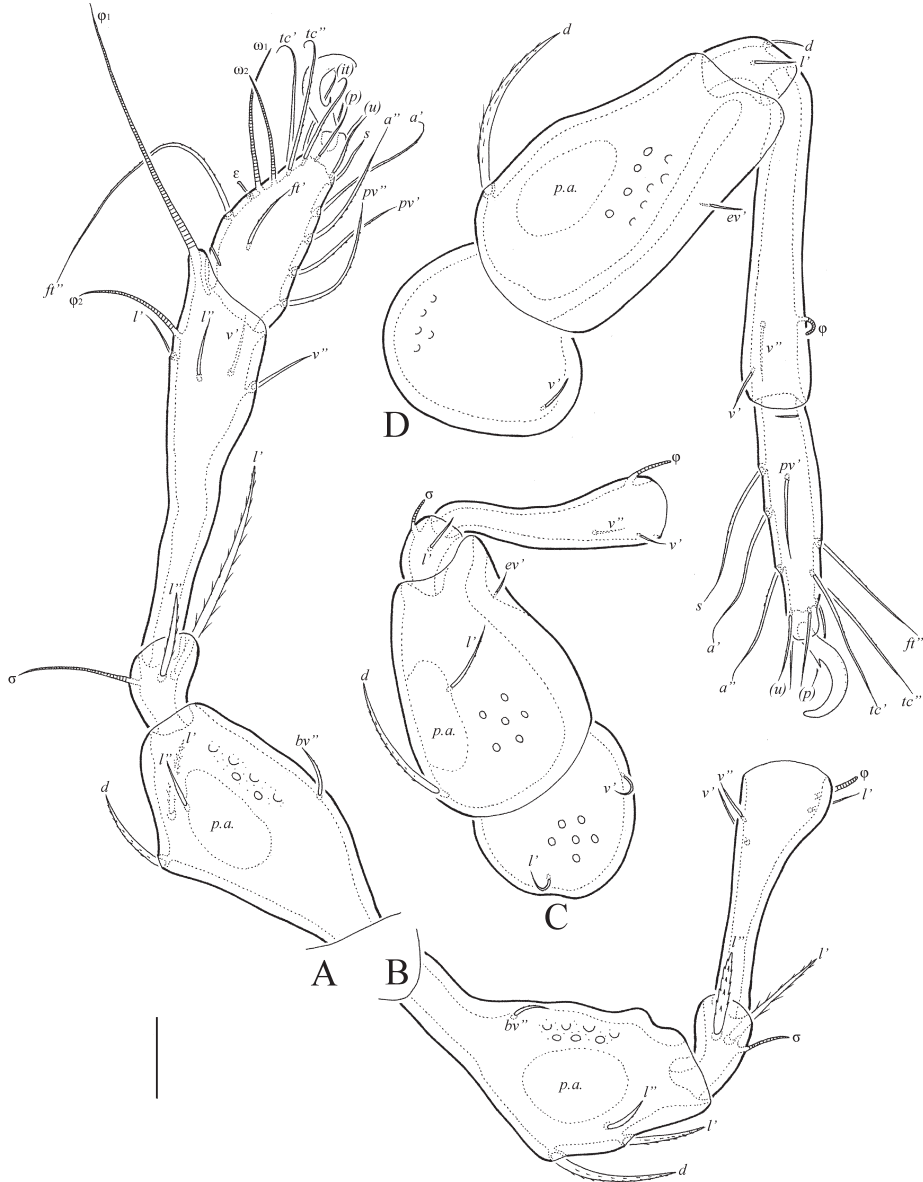
Epimeral and lateral podosomal regions (Figs 1B, 1C, 5B, 5C). Epimeral setation 3–1–3–3. Epimeral setae  $1a$ ,  $1c$ ,  $2a$  and  $3a$  minute (4), spiniform,  $1b$ ,  $3b$ ,  $3c$ ,  $4a$ ,  $4b$  and  $4b$  (32–36) setiform, roughened. Sternal region depressed. Pedotecta II rounded in ventral view. Discidia triangular, rounded distally. With one small depression behind acetabula IV and with one large elongate depression on lateral sides of body (between acetabula IV and notogastral margin).

Anogenital region (Figs 1B, 1C, 5B). With specific system of anogenital depressions (Fig. 1B): one large depression between genital and anal apertures, partially divided longitudinal median border; one pair of depressions close and lateral to genital aperture; one pair of depressions bearing aggenital setae; one pair of depressions bearing adanal setae *ad*<sub>3</sub>; one pair of depressions lateral to the former and latter depressions. Usually with slight-



**Fig. 1.** *Diplobodes parakanekoi* sp. n., adult: A = dorsal view, B = ventral view (legs not shown), C = lateral view (legs not shown). Scale bar: 100  $\mu$ m

ly visible, thin, diagonal furrows lateral to genital aperture. Four pairs of genital (20–28), one pair of aggenital (32–36) and three pairs of adanal (32–36) setae setiform, roughened. Two pairs of anal setae (12) spiniform. Adanal lyrifissures removed from anal aperture and located close to  $ad_3$ . Circumventral ridge visible.



**Fig. 2.** *Diplobodes parakanekoi* sp. n., adult: A = leg I, without trochanter, right, antiaxial view, B = leg II, without trochanter and tarsus, left, antiaxial view, C = leg III, without tarsus, left, antiaxial view, D = leg IV, left, antiaxial view. Scale bar: 20  $\mu$ m

Legs (Figs 2A–D). Claw of each leg strong, sparsely barbed dorsally and with one tooth ventrobasally. Porose area on all femora visible; porose area on trochanters not observed. Formulas of leg setation and solenidia: I (1–4–2–4–16) [1–2–2], II (1–4–2–3–15) [1–1–2], III (2–3–1–2–15) [1–1–0], IV (1–2–2–2–11) [0–1–0]; homology of setae and solenidia indicated in Table 1. Famulus of tarsi I short, erect, blunt-ended, inserted posterior to solenidium  $\omega_1$ . Solenidium  $\phi_1$  on tibiae I very long, setiform;  $\omega_1$  and  $\omega_2$  on tarsi I,  $\phi_2$  on tibiae I and  $\sigma$  on genua I, II of medium size, slightly thickened, blunt-ended; other solenidia short, bacilliform. Dorsoanterior apophysis of tibiae I (bearing  $\phi_1$ ) developed.

Material examined. Holotype (male) and two paratypes (two males): southwest Thailand, Phuket Province, close to Karon Beach, 7°49'32.8"N 98°17'46.5"E, litter in forest vegetation, 4.04.2017 (A. A. Khaustov).

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 in ethanol with a drop of glycerol.

Etymology. The species name *parakanekoi* refers to the similarity between the new species and *Diplobodes kanekoi* Aoki, 1958.

Remarks. *Diplobodes parakanekoi* sp. n. differs from the other representatives of the genus *Diplobodes* by one important morphological trait: notogaster with 12 or 13 pairs of setae (without or with one pair of setae *c*) versus 14 or 15 pairs (with two or three pairs of setae *c*). However, the general morphology of the new species corresponds well to the generic diagnosis of *Diplobodes* (ERMILOV *et al.* 2013) in other morphological traits therefore, we included this species into the genus *Diplobodes*.

*Diplobodes parakanekoi* sp. n. is morphologically most similar to *Diplobodes kanekoi* Aoki, 1958 from Japan and the Oriental region (see AOKI 1958, ERMILOV *et al.* 2013), *D. africanus* Mahunka, 1987 from Kenya (see MAHUNKA 1987, FERNANDEZ *et al.* 2019) and *D. aokii* Mahunka, 1989 from Kenya (see MAHUNKA 1989) in having several large notogastral tubercles bearing the notogastral se-

**Table 1.** Leg setation and solenidia of adult *Diplobodes parakanekoi* sp. n. and *Machadocephalus pararachii* sp. n.

Leg	Tr	Fe	Ge	Ti	Ta
I	<i>v'</i>	<i>d</i> , ( <i>l</i> ), <i>bv''</i>	( <i>l</i> ), <i>v''</i> , $\sigma$	( <i>l</i> ), ( <i>v</i> ), $\phi_1$ , $\phi_2$	( <i>ft</i> ), ( <i>tc</i> ), ( <i>it</i> ), ( <i>p</i> ), ( <i>u</i> ), ( <i>a</i> ), <i>s</i> , ( <i>pv</i> ), $\varepsilon$ , $\omega_1$ , $\omega_2$
II	<i>v'</i>	<i>d</i> , ( <i>l</i> ), <i>bv''</i>	( <i>l</i> ), <i>v''</i> , $\sigma$	<i>l'</i> , ( <i>v</i> ), $\phi$	( <i>ft</i> ), ( <i>tc</i> ), ( <i>it</i> ), ( <i>p</i> ), ( <i>u</i> ), ( <i>a</i> ), <i>s</i> , ( <i>pv</i> ), $\omega_1$ , $\omega_2$
III	<i>l'</i> , <i>v'</i>	<i>d</i> , <i>l'</i> , <i>ev'</i>	<i>l'</i> , $\sigma$	( <i>v</i> ), $\phi$	( <i>ft</i> ), ( <i>tc</i> ), ( <i>it</i> ), ( <i>p</i> ), ( <i>u</i> ), ( <i>a</i> ), <i>s</i> , ( <i>pv</i> )
IV	<i>v'</i>	<i>d</i> , <i>ev'</i>	<i>d</i> , <i>l'</i>	( <i>v</i> ), $\phi$	<i>ft''</i> , ( <i>tc</i> ), ( <i>p</i> ), ( <i>u</i> ), ( <i>a</i> ), <i>s</i> , <i>pv'</i>

Note: Roman letters refer to normal setae, Greek letters to solenidia (except  $\varepsilon$  = famulus). Single prime (') marks setae on anterior and double prime (') setae on posterior side of the given leg segment. Parentheses refer to a pair of setae.

\* = seta *v'* on genua I and II not observed in *D. parakanekoi* sp. n. (versus developed in *M. pararachii* sp. n.)

tae and a foveolate notogaster. However, the new species differs from *D. kane-koi* by fewer notogastral setae of the *c*-row (one pair or without them versus two or three pairs), the absence of notogastral tubercles in position of setae *c*-row (versus one pair of tubercles present), setae *c* (if developed) inserted on notogastral surface (versus setae *c*<sub>1</sub> inserted on tubercles) and the localization of notogastral setae *la* and *lm* on separate tubercles (versus tubercles bearing *la* and *lm* connected). The new species differs from *D. africanus* and *D. aokii* by fewer notogastral setae of the *c*-row (one pair or without them versus two pairs), the presence of a translamella (versus absent), and the localization of notogastral setae *lp* and *h*<sub>1</sub> on one tubercle on either side (versus *lp* and *h*<sub>1</sub> inserted on separate tubercles).

### ***Machadocepheus pararachii* sp. n.**

(Figs 3A–C, 4A–D, 5D–F)

**Diagnosis.** Body size 481–564 × 282–332. Notogaster foveolate. Translamella present. Rostral setae spinose. Lamellar and interlamellar setae setiform, roughened. Bothridial setae with slightly developed lanceolate head, heavily barbed. Broad and deep depression in anterior half of notogaster and median notogastral hump-like process well developed. Notogaster with 15 pairs of notogastral setae short, setiform, roughened; of these, *c*<sub>1</sub>, *c*<sub>2</sub>, *dp* and *la* located in anterior notogastral depression, *c*<sub>3</sub> located on humeral shoulders, *dm*, *lm*, *dp*, *lp*, *h*<sub>1</sub> and *h*<sub>2</sub> located on hump-like process, and setae *p*<sub>1</sub>–*p*<sub>3</sub> and *h*<sub>3</sub> in posterolateral position. Epimeral setation 3–1–3–3; *1a*, *1c*, *2a* and *3a* minute, *1b*, *3b*, *3c*, *4a*, *4b* and *4c* of medium size, setiform, roughened. Anogenital region with specific system of anogenital depressions. Anal setae short, spiniform, other anogenital setae of medium size, setiform, roughened.

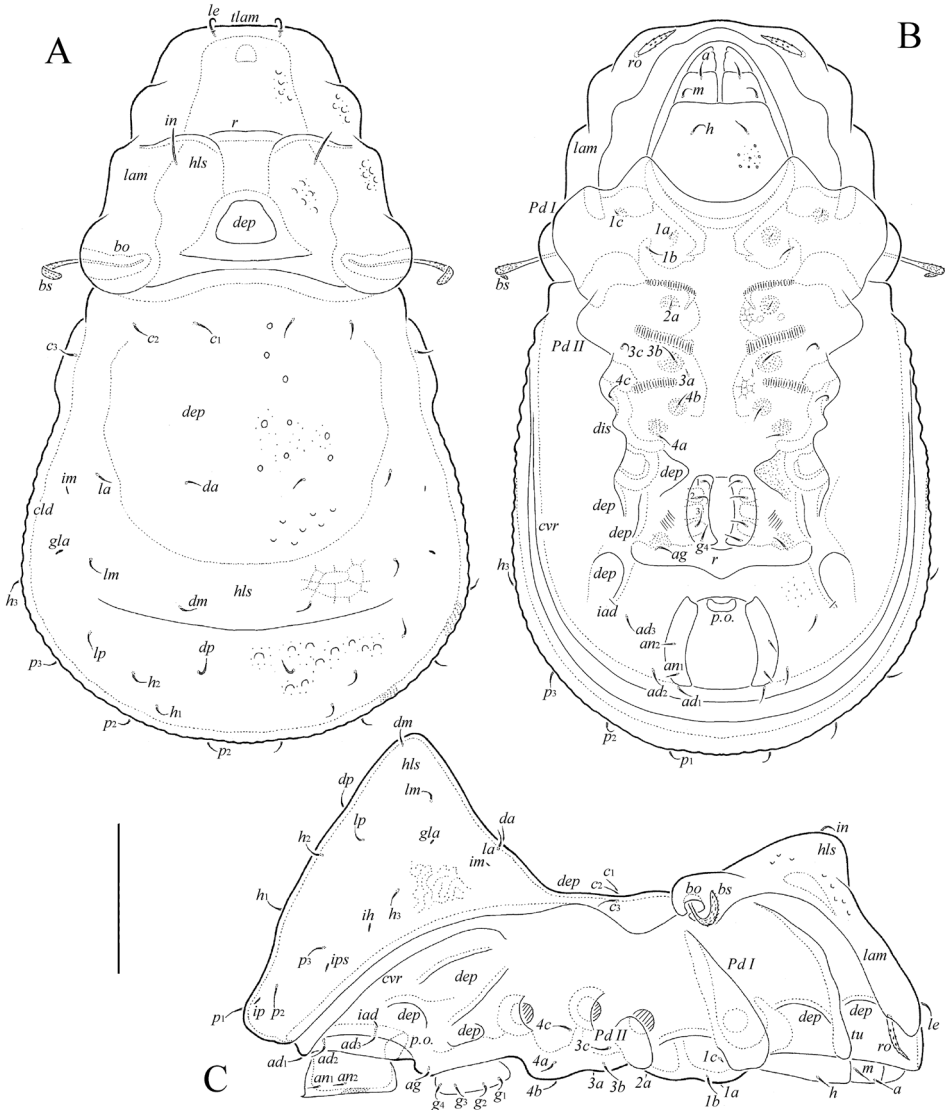
**Description. Measurements.** Body length 481 (holotype: male), 514, 564 (two paratypes: male and female, respectively); notogaster width 282 (holotype), 298, 332 (two paratypes: male and female, respectively).

**Integument** (Figs 3A–C, 4A, C, D). Body color brown. Body covered by thick layer of gel-like cerotegument. Body surface (including subcapitular mentum and genae, genital and anal plates) microgranulate (diameter of tubercles less than 1). Prodorsum, notogaster, circummarginal region of ventral plate, subcapitulum and antiaxial part of all leg femora sparsely foveolate (diameter of foveoles up to 8). Projecting parts of lamellae foveate.

**Prodorsum** (Figs 3A–C). Rostrum broadly rounded. Lamellae long (slightly shorter than prodorsum), distally with triangular projection. Translamella broad. One pair of interlamellar hump-like processes well developed, connected anteriorly by thick, transverse ridge. Basal part of prodorsum with median depression. Tutoria long, strong, ridge-like, reaching lateral margins of prodorsum. With depressions between lamellae, tutoria and pedotecta I (Fig. 2C). Rostral setae (32–36) thick, with numerous spines. Lamellar and interlamellar setae similar in length (16), setiform, roughened; *le* located on lamellae, *in* located

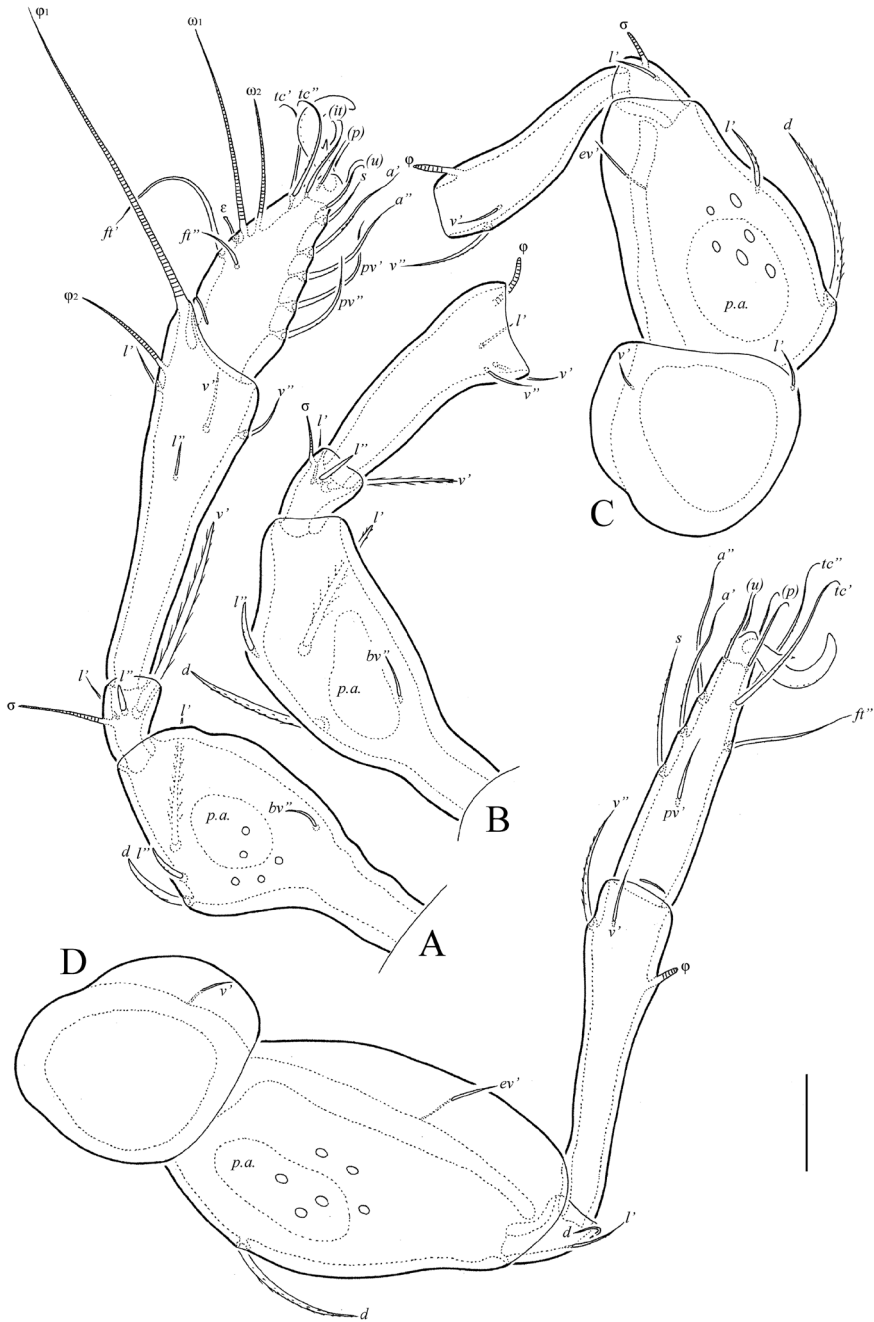
on hump-like processes. Bothridial setae (45–53) with slightly developed lanceolate head, heavily barbed, curved semiovally in mediobasal part. Bothridia slightly interrupted ventrally. Exobothridial setae and their alveoli not observed.

Notogaster (Figs 3A, 3C, 5D, 5F). Furrow between prodorsum and notogaster absent. Anterior notogastral margin almost straight, posterior notogastral margin broadly rounded. Broad and deep depression in anterior half of notogaster and median notogastral



**Fig. 3.** *Machadocepeus pararachii* sp. n., adult: A = dorsal view, B = ventral view (legs not shown), C = lateral view (legs not shown). Scale bar: 100  $\mu$ m





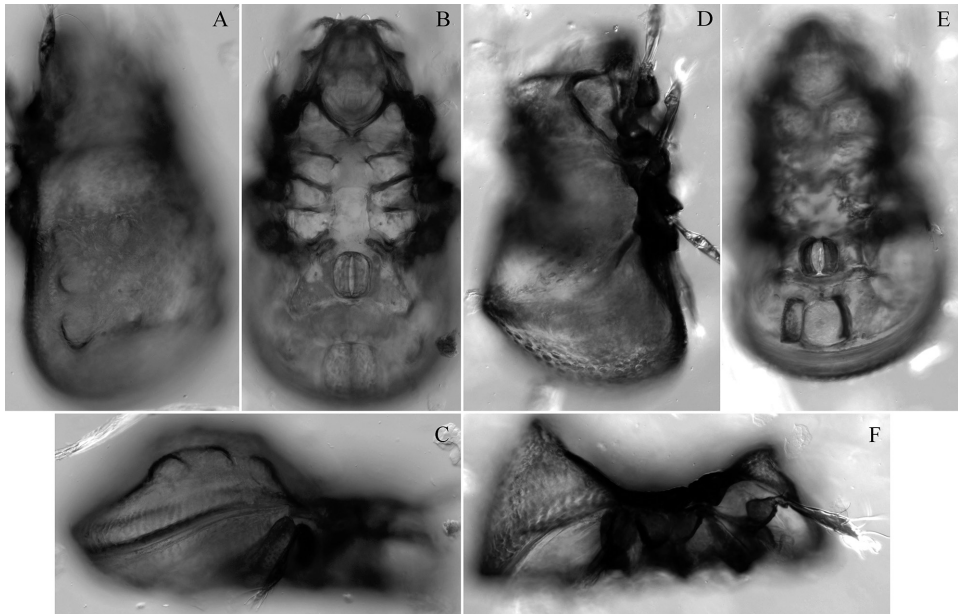
**Fig. 4.** *Machadocepheus pararachii* sp. n., adult: A = leg I, without trochanter, right, antiaxial view, B = leg II, without trochanter and tarsus, right, antiaxial view, C = leg III, without tarsus, right, antiaxial view, D = leg IV, right, antiaxial view. Scale bar: 20  $\mu$ m

hump-like process well developed. Hump-like structure with slight, numerous longitudinal wrinkles, forming partially reticulate pattern. Notogaster with 15 pairs of notogastral setae (16) setiform, roughened; of these,  $c_1$ ,  $c_2$ ,  $dp$  and  $la$  located in depression,  $c_3$  located on humeral shoulders,  $dm$ ,  $lm$ ,  $dp$ ,  $lp$ ,  $h_1$  and  $h_2$  located on hump-like process, and setae  $p_1$ – $p_3$  and  $h_3$  in posterolateral position. Circumlateral depressions slightly developed. Lyrifissures  $ia$  not observed, other lyrifissures and opisthonotal gland openings well visible;  $im$  located lateral to  $la$ ,  $gla$  lateral to  $lm$ ,  $ip$  between  $p_1$  and  $p_2$ ,  $ips$  and  $ih$  on lateral sides of notogaster.

Gnathosoma (Figs 3B, 3C). Typical for Carabodidae (ERMILOV & CORPUZ-RAROS 2016, ERMILOV & STARÝ 2018, ERMILOV *et al.* 2019). Subcapitulum longer than wide (123–131 × 77–90). Subcapitular setae ( $a$  12–14;  $m$  12–14;  $h$  8–10) setiform, similar in thickness, roughened. Postpalpal setae (8) spiniform. Palps (77–77) with setation 0–2–1–3–9(+ $\omega$ ). Solenidion of palptarsi long, bacilliform. Chelicerae (123–131) with two setiform, barbed setae,  $cha$  (41) longer than  $chb$  (16). Trägårdh's organ of chelicerae elongate triangular.

Epimeral and lateral podosomal regions (Figs 3B, 3C, 5E, 5F). Epimeral setation 3–1–3–3. Epimeral setae  $1a$ ,  $1c$ ,  $2a$  and  $3a$  minute (4), spiniform,  $1b$ ,  $3b$ ,  $3c$ ,  $4a$ ,  $4b$  and  $4c$  (16) setiform, roughened, often located in round cluster of granules. Pedotecta II rounded in ventral view. Discidia triangular, rounded distally. With one small depression behind acetabula IV and with one large elongate depression on lateral sides (between genitoaggenital region and notogastral margin).

Anogenital region (Figs 3B, 3C, 5E). With specific system of anogenital depressions (Fig. 3B): one pair of depressions removed and lateral to genital aperture; one pair of depressions removed and lateral to aggenital region. Thick transverse ridge located posterior to genital aperture. Usually with slightly visible, thin, diagonal furrows lateral to genital



**Fig. 5.** *Diplobodes parakanekoi* sp. n. (A–C) and *Machadocepheus pararachii* sp. n. (D–F), adult, microscope images: A, D = dorsolateral view; B, E = ventral view; C, F = lateral view

aperture. Four pairs of genital (12), one pair of aggenital (16) and three pairs of adanal (16) setae setiform, roughened. Two pairs of anal setae (8) spiniform. Adanal lyrifissures removed from anal aperture and located close to  $ad_3$ . Circumventral ridge visible.

Legs (Figs 4A–D). Claw of each leg strong, sparsely barbed dorsally and with one tooth ventrobasally. Porose area on all femora visible; porose area on trochanters 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 (1–2–2–2–11) [0–1–0]; homology of setae and solenidia indicated in Table 1. Famulus of tarsi I short, erect, blunt-ended, inserted posterior to solenidion  $\omega_1$ . Solenidion  $\phi_1$  on tibiae I very long, setiform;  $\omega_1$  and  $\omega_2$  on tarsi I,  $\phi_2$  on tibiae I and  $\sigma$  on genua I, II of medium size, slightly thickened, blunt-ended; other solenidia short, bacilliform. Dorsoanterior apophysis of tibiae I (bearing  $\phi_1$ ) developed.

Material examined. Holotype (male) and two paratypes (male and female): south-west Thailand, Phuket Province, close to Karon Beach, 7°49'32.8"N 98°17'46.5"E, litter in forest vegetation, 4.04.2017 (A. A. Khaustov).

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 in ethanol with a drop of glycerol.

Etymology. The species name *pararachii* refers to the similarity between the new species and *Machadocephus rachii* Fernandez, Theron, Rollard et Leiva, 2014.

Remarks. *Machadocephus pararachii* sp. n. is morphologically most similar to *Machadocephus rachii* Fernandez, Theron, Rollard et Leiva, 2014 from Gabon (see FERNANDEZ *et al.* 2014) in having well developed prodorsal and notogastral hump-like structures, a deep, smooth notogastral depression, and the presence of 15 pairs of short notogastral setae. However, the new species differs from the latter by the localization of notogastral setae  $c_1$ ,  $da$  and  $la$  in the notogastral depression (versus on the hump-like process).

## GENERAL REMARKS

1. *Diplobodes*, *Machadocephus*, *Gibbicepheus*, *Kalloia*. These genera are morphologically similar in many traits, therefore their taxonomic status is treated differently by different authors (see some opinions, synonymies and combinations in AOKI 1970, MAHUNKA 1986, J. & P. BALOGH 1992, ERMILOV *et al.* 2013, 2019, FERNANDEZ *et al.* 2016, 2019, SUBÍAS 2004, 2018, 2019).

According to recent studies of the family Carabodidae, the prodorsal and notogastral depressions and hump-like processes are basic morphological traits on generic level. Based on these traits, *Diplobodes* differs from the other related genera by the presence of a large posterior notogastral depression, the absence of a large anterior notogastral depression, and the presence of centrodorsal prodorsal and notogastral hump-like processes. *Machadocephus* differs from the other related genera by the presence of a large anterior notogastral depression, centrodorsal prodorsal and notogastral hump-like processes and

by the absence of (or slightly developed) large posterior notogastral depression. *Gibbicepheus* differs from the other related genera by the absence of large anterior and posterior notogastral depressions and centrodorsal prodorsal and notogastral hump-like processes. *Kalloia* differs from other related genera by the presence of large anterior and posterior notogastral depressions and a centrodorsal notogastral hump-like process, and by the absence of centrodorsal prodorsal hump-like processes.

However, several important morphological structures of some carabodid species were not described and drawn well in the original descriptions and detailed redescriptions are mostly absent therefore, interpretation and judgment on generic traits and status of the listed genera and systematic placement of their species are problematic. Perhaps, the basic morphological traits given above (presence or absence of prodorsal and notogastral depressions and hump-like processes), may not be the only differential traits, and other traits (e.g. morphology, number and localization notogastral setae or ventral depressions) might also be important for systematics of *Diplobodes*, *Machadocepheus*, *Gibbicepheus* and *Kalloia* as well. For example, we note a group of species in *Gibbicepheus* (e.g., *G. baccanensis* Jeleva et Vu, 1987, *G. chinensis* Wen, 1992, *G. frondosus* (Aoki, 1959), *G. micheli* Mahunka, 1978, *G. novus* Hammer, 1973, *G. rugosus* Mahunka, 1978, *G. waterhousei* Balogh et Mahunka, 1978) which have phylliform notogastral setae, of these, anterior setae located close to each other and removed from anterior notogastral margin, what distinguishes this group from the type species *Gibbicepheus elevatus* Balogh, 1958 and other *Gibbicepheus* species. Perhaps, this group may have an independent generic or subgeneric status.

Preliminarily we support the independence of *Diplobodes*, *Machadocepheus*, *Gibbicepheus* and *Kalloia* and reject any synonymies and lowering of generic rank however, additional studies (especially phylogenetic or molecular) are necessary to clarify the status of each.

2. *Neocarabodes* and *Gibbibodes*. The monotypic genus *Neocarabodes* was proposed by BALOGH and MAHUNKA (1969a) with *Neocarabodes sexpilosus* Balogh et Mahunka, 1969 as type species. The monotypic genus *Gibbibodes* was proposed by MAHUNKA (1986) with *Gibbibodes similis* Mahunka, 1986 as type species. *Neocarabodes sexpilosus* and *G. similis* (see also MAHUNKA 1986) have posterior notogastral depression (generic traits of *Diplobodes*) and correspond to other morphological traits of *Diplobodes*, except in having six and five pairs of genital setae, respectively. Therefore we consider these taxa as subgenera of *Diplobodes*.

Furthermore, the number of genital setae is an important subgeneric trait in Carabodidae: four pairs are the standard number of genital setae. Species with similar morphology, but with more than four pairs of genital setae are

grouped in one separate subgenus (e.g., *Austrocarabodes (Uluguroides)* Mahunka, 1983 (five to nine pairs); *Carabodes (Phyllocarabodes)* Balogh et Mahunka, 1969(b) (five to six pairs); *Yoshiobodes (Dongnaibodes)* Ermilov, Shtanchaeva, Subías et Anichkin, 2014 (five to six pairs); see ERMILOV *et al.* 2014; SUBÍAS 2019). *Neocarabodes* and *Gibbibodes* have more than four pairs of genital setae and it is of little importance how many more pairs, be it either six or five. Hence, it would be logical to consider *Gibbibodes* as a subjective junior synonym of the subgenus *Diplobodes (Neocarabodes)*.

3. *Sagittabodes, Zimbabweae*. The genus *Sagittabodes* was proposed by J. and P. BALOGH (2002) with *Machadocepheus sagitta* Balogh et Mahunka, 1966 as type species. The genus *Zimbabweae* was proposed by FERNANDEZ *et al.* (2016) with *Zimbabweae pluosiae* Fernandez, Theron et Leiva, 2016 as type species. All morphological traits of these genera and their type species are very similar, therefore SUBÍAS (2018) fairly synonymized *Zimbabweae* (we completely support this opinion), and included *Sagittabodes* as subgenus in *Machadocepheus*.

The genus *Sagittabodes* differs from *Machadocepheus* by the presence of a median longitudinal ridge in the anterior notogastral depression. However, some other species form different carabodid genera having similar structure (e.g., *Camcarabodes korupensis* Ermilov et Starý, 2018, *Gibbicepheus sisiri* Sanjal, 1990, *Kalloia gerdweigmanni* Ermilov, Sandmann et Scheu, 2019, *Machadocepheus filiferus* Mahunka, 1986, *Machadocepheus leoneae* Fernandez, Theron, Rollard et Leiva, 2014, *Machadocepheus tuberculosus* Mahunka, 1987), therefore we believe that this trait is most likely a species trait (not generic/subgeneric). Hence, it would be more logical to consider *Sagittabodes* as a subjective junior synonym of the genus *Machadocepheus*.

\*

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