

FRESHWATER HALACARID MITES (ACARI: HALACARIDAE) FROM MADAGASCAR. NEW RECORDS AND THE DESCRIPTION OF A NEW SPECIES

Ilse BARTSCH

(Received 12 June 2012; accepted 24 August 2012; published online 29 March 2013)

Forschungsinstitut Senckenberg, c/o DESY, Notkestr. 85, 22607 Hamburg, Germany. ibartsch@senckenberg.de

ABSTRACT — In recent years the numbers of aquatic mite species from Madagascar has increased considerably (Gerecke 2004a, b, 2006, 2009; Goldschmidt 2008; Tuzovski and Gerecke 2009), but the area is still a white spot with respect to knowledge of its freshwater halacarid (Halacaridae) fauna. Recently, some halacarid specimens were extracted from sandy deposits of the banks of streams and creeks. These samples included four species, namely *Limnohalacarus cultellatus* Viets, 1940, *Limnohalacarus novus* Bartsch, 2013, *Lobohalacarus weberi* (Romijn and Viets, 1924), and a new species of the genus *Ropohalacarus*. The new species, *Ropohalacarus pallidus* n. sp., is described, and the characters of the other species are outlined. The three genera collected in Madagascar are cosmopolitan and the *Lobohalacarus* and *Limnohalacarus* species are wide-spread. The halacarid fauna of Madagascar seems to be poor in endemic species, which is contrary to the situation for the freshwater Hydrachnidia mites. Future studies will certainly increase the number of halacarid species but not the percentage of endemics.

KEYWORDS — Halacaroidea; Madagascar; running water; description; *Limnohalacarus*; *Lobohalacarus*; *Ropohalacarus*; biogeography

INTRODUCTION

Madagascar with its diverse aquatic mite fauna (Gerecke 2004b; Goldschmidt 2008) is a terra incognita as to the knowledge of its freshwater halacarids. From the African continent, most records and descriptions of halacarids are from the 1950th to 1970th (Walter and Bader 1952; Bader 1967, 1968; Green *et al.* 1974). Reasons for absence of halacarid records from Madagascar may be the size of the mites, their colour and life-style. Most of the adults have an idiosomal length of distinctly less than 600 µm, often the species are pale and lack conspicuous pigment spots, and halacarids are benthic, crawling rather slowly amongst a substratum.

At present eight halacarid species are known from continental Africa, *i.e.* *Limnohalacarus africanus* Walter, 1935 (Sahara, Burkino Faso, Cameroon, South Sudan), *L. fontinalis* Walter and Bader, 1952 (Kenya, South Sudan), *L. major* Bader, 1968 (DR Congo, Lake Tanganyika), *L. portmanni* Bader, 1967 (DR Congo, Lake Tanganyika), *Lobohalacarus weberi* (Romijn and Viets, 1924) (Kenya, Tunisia), *Porohalacarus alpinus* (Thor, 1910) (Algeria), *Ropohalacarus uniscutatus* (Bartsch, 1982) (Tunisia), and *Soldanelonyx monardi* Walter, 1919 (Kenya, Tunisia) (Walter 1935; Walter and Bader 1952; Bader 1967, 1968; Green 1984; Green *et al.* 1974; Bartsch 2008a, 2013).

MATERIALS AND METHODS

The halacarid mites were extracted from the banks of small streams and creeks by digging pits into the sandy deposits and filtering the seeped water (Karaman-Chappuis Method). Collectors are Drs R. Gerecke and T. Goldschmidt. The mites were cleared in lactic acid, rinsed in glycerine and mounted in glycerine jelly. The holotype, paratypes and voucher specimens are deposited in the Zoological Museum, Hamburg (ZMH), additional material in the author's collection.

Rarely occurring numbers of setae or acetabula are in parentheses. The legs are numbered I to IV, the segments are trochanter, basifemur, telofemur, genu, tibia, and tarsus. The number of setae on the tarsi includes the solenidion but excludes the parambulacral setae. In the illustrations marginal setae are shown either in the dorsal or in the ventral aspect but not in both. Drawings were done with a drawing tube.

RESULTS

Four species were extracted from sandy deposits of banks of rivers, *Limnohalacarus cultellatus* Viets, 1940, *Limnohalacarus novus* Bartsch, 2013, *Lobohalacarus weberi*, and a new *Ropohalacarus* species, *R. pallidus* n. sp.

GENUS *Limnohalacarus* WALTER, 1917

Type species — *Halacarus wackeri* Walter, 1914.

Diagnosis (adults) — Plates delicately and evenly punctate. Dorsum with anterior and posterior dorsal plate and pair of ocular plates, five pairs of gland pores and three to four pairs of very short dorsal setae. Ocular plate and sclerite with third gland pore often fused. Venter with anterior and pair of posterior epimeral plates and genital plate. Either plates separated or all fused to a shield. Anterior epimeral plate with three pairs of setae, posterior plates with a dorsal, lateral and ventral seta. Acetabula arranged along lateral margins of genital plate (or part corresponding to this plate). Females

with 3-10 pairs of perigenital setae, males with 17-30 pairs of setae. Female genital opening near posterior margin of genital plate and covered by large genital sclerites. Male genital opening smaller, removed from posterior margin of genitoanal plate. Anal sclerites much smaller than genital sclerites. Base of gnathosoma wide, rostrum conical. Palps four-segmented, attached dorsally. Second palpal segment with short basal and long distal seta, third segment with large ventral spine, fourth segment with six setae and apical spine. Leg segments slender, in general bearing conspicuously long setae. Genua I and II shorter than these legs' telofemora. Tibia III with four ventral setae, mostly two of them bipectinate. Tarsi I to IV with 1, 0, 0, 0 ventral setae and 4, 4, 4, 3 dorsal setae. Tarsi I to III with solenidia in dorsolateral position. Paired claws of tarsi with pectines. Arrangement and size of tines on claw I different from those of following tarsi.

Comments — The genus is spread on all continents except Antarctica. Records are from fresh water as well as from coastal and inland saline waters. *Limnohalacarus* includes at present 13 species (Bartsch 2009, 2013).

Limnohalacarus cultellatus Viets, 1940

Collecting data — One female (slide), ZMH, northern Madagascar, Antisiranana, Antalaha, Marofinaritra, River Andranomenaheli, upstream confluence with River Ankavia (right affluent below MD 135), 70 m, 22.3°C, 0.009 mS/cm, riffle; 04 Nov. 2001; coll. R. Gerecke and T. Goldschmidt.

Diagnosis (female, Madagascar individual) — Idiosoma pale, its length 274 µm. Dorsal plates with reticulate ornamentation. Anteriormost part of anterior dorsal plate smooth and separated from reticulate major part; anterior dorsal plate rectangular, 1.1 times longer than wide. Ocular plates sub-circular, 1.1 times longer than wide. Sclerite with gland pore triangular, not fused with ocular plate. Posterior dorsal plate elongate, 1.7 times longer than wide and 2.4 times longer than anterior dorsal plate. With four pairs of dorsal setae, second pair of setae in striated integument between anterior dorsal plate and ocular plates; adanal setae on anal cone, in ventrolateral position. Ventral plates

(anterior, pair of posterior epimeral plates and genital plate) separated. Genital plate with four to five pairs of acetabula, three pairs of perigenital and two pairs of subgenital setae. Gnathosoma 1.7 times longer than wide. Rostrum slender. Both pairs of maxillary setae slender. Pharyngeal plate removed from basal margin of gnathosoma by more than half the length of pharyngeal plate. Second palpal segment basally abruptly increased in height; its dorsal margin straight. Telofemora I to III 1.8–1.9 times longer than high. Leg chaetotaxy, from trochanter to tarsus: leg I, 1, 4, 4, 6, 7, 5; leg II, 1, 3, 4, 6, 6, 4; leg III, 1, 2, 3, 4, 7, 4; leg IV, 1, 1, 3, 3, 6, 3. Ventromedial seta on tibia I and II and both ventromedial setae on tibia III bipectinate, all other setae smooth. All tarsi with pair of single parambulacral setae. Each claw with lamellar ventral process. Claws on tarsus I slender, with about eight delicate tines near apex. Claws of following tarsi with J-shaped arranged pectines, each with about 15 – 18 tines.

Distribution — Records are from North, Central and South America, from Europe (Hungary) and India (Bartsch 2011b, 2013).

Limnohalacarus novus Bartsch, 2013

Collecting data — Three females (slides), ZMH; south central Madagascar, Fianarantsoa, Ionilahy, small stream crossing the railroad east of village, 200 m; 15 Aug. 2001; coll. R. Gerecke and T. Goldschmidt. Two females (slides), author's collection; northern Madagascar, Antsiranana, Antalaha, Marofinaritra, River Andranomenaheli, upstream confluence with River Ankavia (right affluent below MD 135), 70 m, 22.3°C, 0.009 mS/cm, riffle; 04 Nov. 2001; coll. R. Gerecke and T. Goldschmidt.

Diagnosis (female, Madagascar individuals) — Idiosoma pale; length 260 – 270 µm. Anterior dorsal plate hexagonal, slightly (1.1 times) wider than long. Ocular plate 1.4 times longer than wide, including sclerite with gland pore. Posterior dorsal plate 1.9 times longer than wide and 2.7 times longer than anterior plate. Setae equalling second pair of dorsal setae lacking. Ventral plates fused. Female genital plate with three pairs of perigenital setae and five to six pairs of acetabula, each genital sclerite with two or three subgenital setae. Gnatho-

soma 1.2 times longer than wide; rostrum short. Dorsal pair of maxillary setae wider than basal pair. Dorsal margin of second palpal segment arched, with small notch between setae. Pharyngeal plate extending close to basal margin of gnathosoma. Telofemur I 2.3 times longer than high. Leg chaetotaxy, from trochanter to tarsus (parambulacral setae omitted): leg I, 1, 4, 4, 6, 8, 5; leg II, 1, 4, 4, 6, 7, 4; leg III, 1, 2, 3, 4, 7, 4; leg IV, 0, 1, 3, 3, 6, 3. Ventromedial seta on tibia II and both ventromedial setae on tibia III bipectinate, all other setae smooth. All tarsi with spiniform basal lamellae. Tarsi I and II with pairs of doubled parambulacral setae, tarsi III and IV with pairs of singlets. Claw I with numerous slender tines. Claws III and IV with lamellar ventral process, each process with about four tines.

Remarks — Adults of the two species at present known from Madagascar can easily be separated because of (1) the shape of the ocular plates, including versus excluding the sclerite with the gland pore, (2) the ventral plates, separated versus fused to a shield, (3) the length of the rostrum, short versus elongate, and (4) the claws on tarsus I, with numerous long tines versus a few delicate ones. The size of the rostrum and the shape of claw I can be used to separate the nymphal and larval stages of the two species.

Distribution — Madagascar and Australia (Queensland) (Bartsch 2013).

GENUS *Lobohalacarus* VIETS, 1939

Type species — *Walterella weberi* Romijn and Viets, 1924

Diagnosis (adults) — Idiosoma often with frontal spine. Dorsum with anterior and posterior dorsal plate, pair of ocular plates and seven pairs of idiosomatic setae. Gland pores inconspicuous. Ocular plate with two setae. Ventral plates fused to a shield. Area corresponding to anterior epimeral plate with three pairs of setae and one pair of epimeral pores, area of posterior epimeral plates with one dorsal, one marginal and one ventral seta. Female genitoanal plate with three to seven perigenital setae on either side of genital opening and

one to three acetabula on each genital sclerite; no acetabula outside genital sclerites. Gnathosoma slender. Four-segmented palps attached laterally. Second palpal segment with single seta, third palpal segment with small spur, fourth palpal segment basally with three setae. Leg I slightly more robust than leg II. Telofemora and genua of legs almost equal in length. Genu and tibia I with ventral spurs. Tarsi I to IV with 4, 4, 3-4, 3(-4) dorsal and 3, 0-1, 0-1, 0-1(-2) ventral setae. Tarsus I with enlarged lateral fossa membrane. Solenidion on tarsus I in dorsolateral, on tarsus II in dorsomedial position. Paired claws distinct, central sclerite with dent-like process.

Remarks — Freshwater genus, regularly found in groundwater-fed habitats though also common in surface waters, even in coastal brackish water. Most of the presently known species are expected to be variants or subspecies of *L. weberi* (i.e. *L. w. bucharensis* Jankovskaja, 1967, *L. w. bunurong* Harvey, 1988, *L. w. hummelincki* Viets, 1940, *L. w. processifer* (Walter, 1919), *L. w. gotoensis* Imamura, 1970, *L. w. tristanensis* Bartsch, 1995). A second species of this genus is *L. subterraneus* Bartsch, 1995.

Distribution — Cosmopolitan.

***Lobohalacarus weberi* (Romijn and Viets, 1924)**

Material examined — One female (slide), ZMH, one female (in ethanol) ZMH; northern Madagascar, Antsiranana, Andapa, right affluent River Ambendrana downstream, large cascade, 600 m; 11 Nov. 2001; coll. R. Gerecke and T. Goldschmidt. Two deutonymphs (in ethanol) ZMH; Center of Madagascar, Antananarivo, Anjarobe, River Ranisoanavola (stream east from main mountain stream), 1200 m; 23 Jul. 2001; coll. R. Gerecke and T. Goldschmidt. One deutonymph (in ethanol) ZMH; south central Madagascar, Fianarantsoa, Ionilahy, small stream crossing the railroad east of village, 200 m; 15 Aug. 2001; coll. R. Gerecke and T. Goldschmidt.

Diagnosis (female, Madagascar individuals) — Length 284 – 304 μm . With frontal spine. Dorsal plates uniformly foveate. Genital sclerites with two and three acetabula, genital area with five pairs of perigenital setae. Telofemora III and IV with 2/0

dorsal/ventral setae. Ventral flank of genu I on one leg with spur and seta, on other leg with two spurs; each ventral flank of tibiae II to IV with one smooth and two pectinate setae, tarsi III with 4/1 dorsal/ventral setae, and tarsi IV with 3/1 setae. Length of deutonymphs 234 – 244 μm .

Remarks — In *Lobohalacarus weberi* in general, character states are known to vary in individuals from different localities but also within a population (cf. Bartsch 2007b, 2011b). From Madagascar only two adults were available for study.

Distribution — Cosmopolitan with records from Africa, Europe, Asia, Australia, New Zealand, North and South America, and Oceanic Islands (Bartsch 2008a: fig. 1; Pešić *et al.* 2010).

GENUS *Ropohalacarus* BARTSCH, 1989

Type species — *Porohalacarus uniscutatus* Bartsch, 1982.

Diagnosis — Anterior and posterior dorsal plate fused, ocular plates reduced to minute sclerites or absent. Gland pores reduced. Dorsum with four to five pairs of idiosomatic setae; adanal setae lacking. Anterior and posterior epimeral plates and genitoanal plate fused. Area representing anterior epimeral plate with three pairs of setae, posterior epimeral plates with two to three setae. Female with three pairs of acetabula, all on genital sclerites, and two to three pairs of perigenital setae on genitoanal plate. Subgenital setae lacking. Palps four-segmented, attached dorsolaterally. Second palpal segment with one to two similar-sized setae, third palpal segment with small medial spur, fourth palpal segment with conspicuously wide seta. First and second pair of legs similar in shape. Genua of all legs shorter than both telofemora and tibiae. Tarsi I to IV with 4, 3-4, 3, 2 dorsal and 0-1, 0-1, 0, 0 ventral setae. Solenidia on tarsi I and II in dorsolateral position. Paired claws large, central sclerite with small, dent-like process.

Remarks — Two species are known, both preliminary inhabit the groundwater, in the hyporhithral and springs.

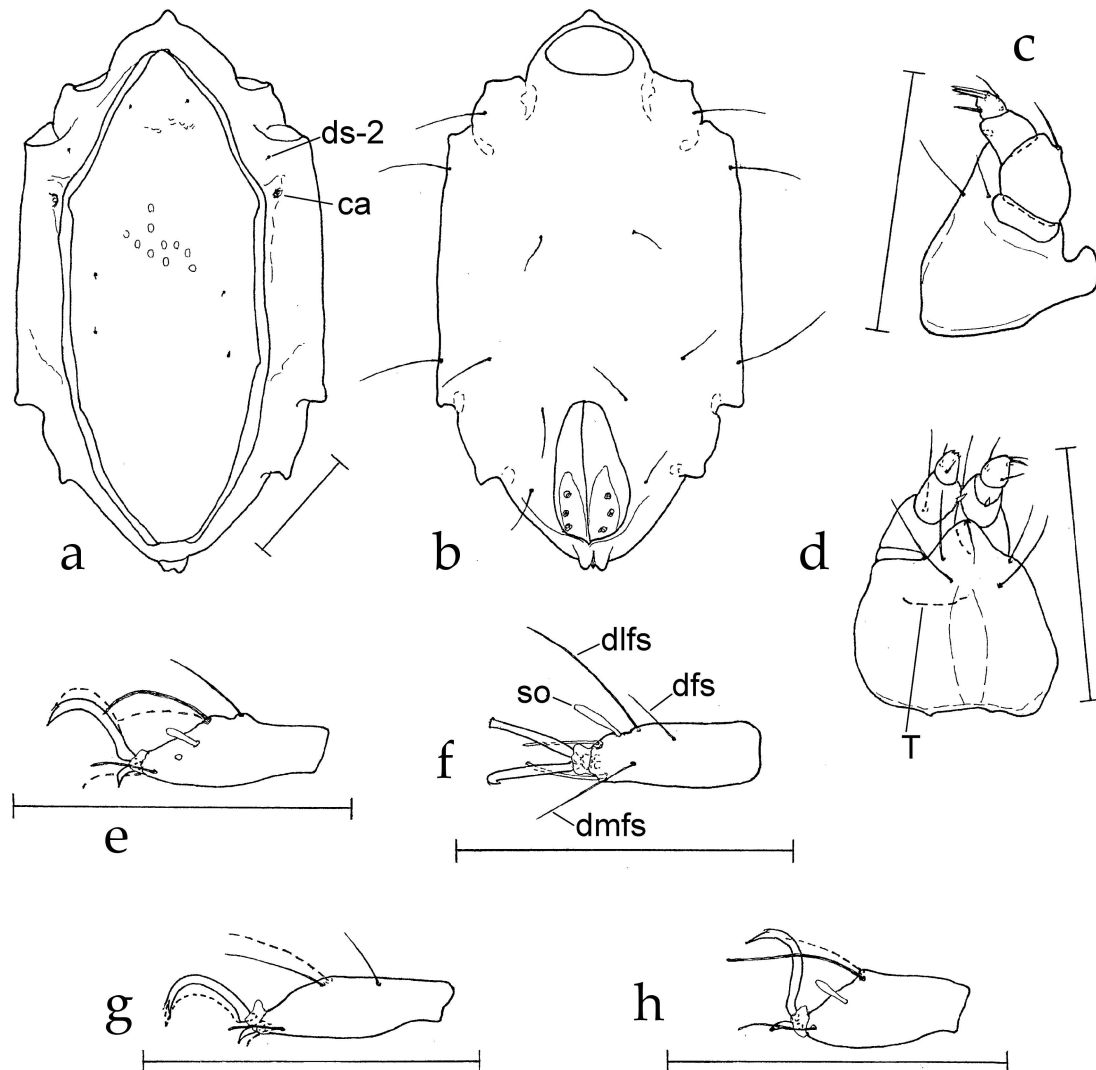


FIGURE 1: *Ropohalacarus pallidus* n. sp., female: a – idiosoma, dorsal; b – idiosoma, ventral; c – gnathosoma, lateral; d – gnathosoma, ventral (with outline of dorsal tectum); e – tarsus I, lateral (medial claw, fossary and parambulacral seta in broken line); f – tarsus II, dorsal; g – tarsus III, lateral (medial claw, fossary and parambulacral seta in broken line); h – tarsus II, lateral (medial fossary seta in broken line, medial claw and parambulacral seta omitted). (Scale bar = 50 μ m) (ca, canaliculus; dfs, dorsal fossary seta; dlfs, dorsolateral fossary seta; dmfs, dorsomedial fossary seta; ds-2, second dorsal idiosomatic seta; so, solenidion; T, tectum)

***Ropohalacarus pallidus* n. sp.
(Figures 1 and 2)**

Material examined — Holotype female and paratype deutonymph (slide), ZMH; northern Madagascar, Antisiranana, Andapa, right affluent River Ambendrana downstream, large cascade, 600 m; 11 Nov. 2001; coll. R. Gerecke and T. Goldschmidt. Two paratype females (slide), ZMH; collection data as above. One paratype female (in

ethanol), ZMH; collection data as above. Paratype deutonymph and protonymph (slide), author's collection; collection data as above. One female (slide), female and protonymph (in ethanol), ZMH; south central Madagascar, Fianarantsoa, Ionilahy, small stream crossing the railroad east from village, 200 m; 15 Aug. 2001; coll. R. Gerecke and T. Goldschmidt. One female (slide), author's collection; collection data as above.

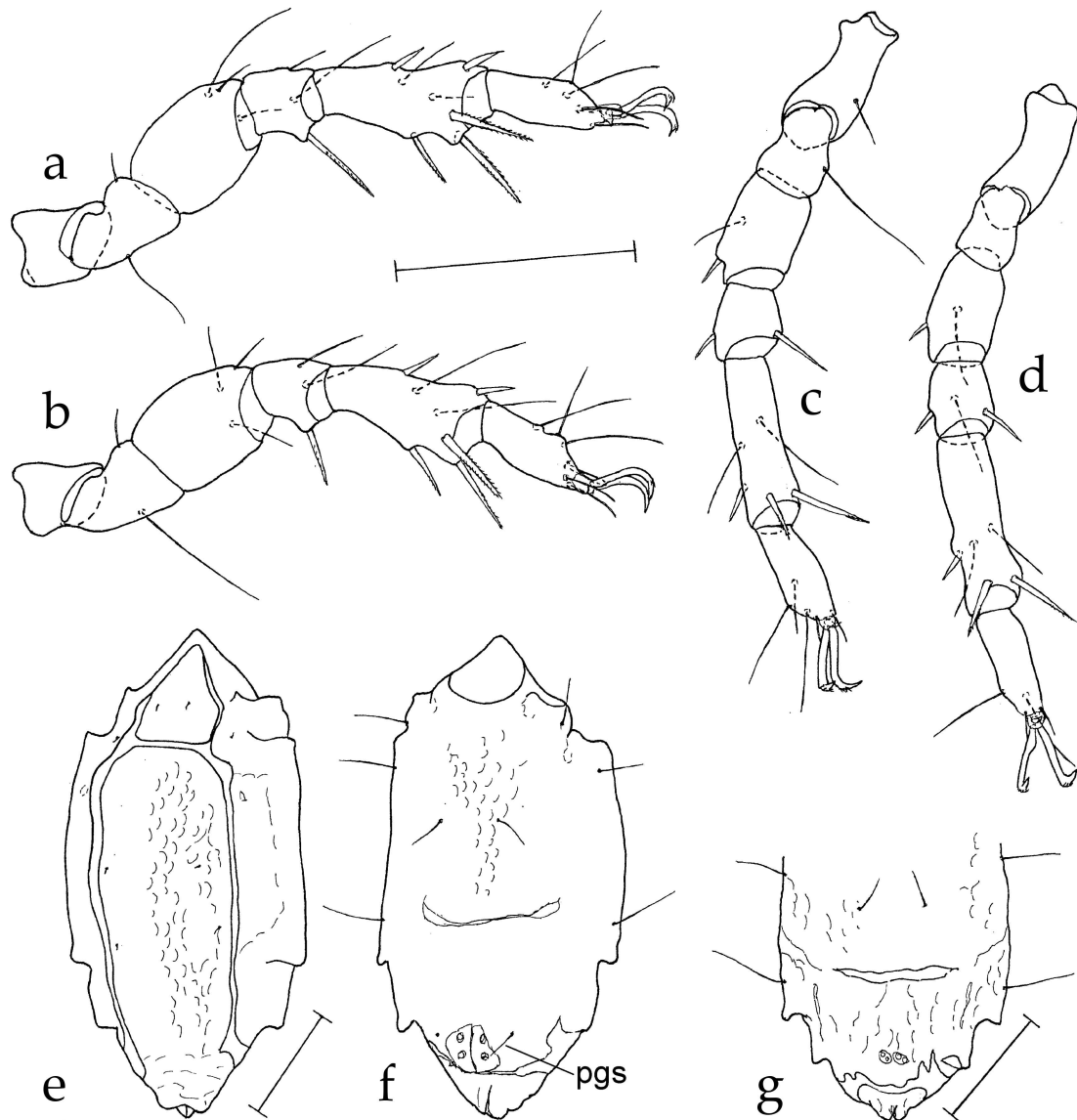


FIGURE 2: *Ropohalacarus pallidus* n. sp.: a – leg I, ventromedial, female; b – leg II, ventromedial, female; c – leg III, ventromedial, female; d – leg IV, ventromedial, female; e – idiosoma, dorsal, deutonymph; f – idiosoma, ventral, deutonymph; g – posterior part of idiosoma, ventral, protonymph. (Scale bar = 50 μ m) (pgs, perigenital seta)

Etymology — Derived from the Latin adjective *pallidus*, pale, because the specimens lack pigment spots.

Diagnosis (female) — Length of idiosoma 217 – 238 μ m. Anterior and posterior dorsal plate fused to a dorsal shield. All ventral plates fused and extending dorsad, anteriorly forming a frontal process. Second pair of dorsal setae and canaliculi in dorsal part of ventral shield. Genital sclerites with

three pairs of acetabula. Gnathosoma about as long as wide. Second palpal segment with single seta. Tibiae I to IV with 3, 3, 2, 2 spiniform ventral setae. All tarsi lack ventral setae. Paired claws with delicate apical tines.

Description (female) — Length of idiosoma 217 – 238 μ m, length of holotype 238 μ m, width 132 μ m. Idiosoma about 1.8 times longer than wide; its colour pale, without spots of eye pigment. Inter-

val between insertions of legs II and III equalling almost half the length of idiosoma. Anterior and posterior dorsal plate fused to a shield, 215 μm long, 80 μm wide (Figure 1a). Ocular plates reduced, marginal parts incorporated into dorsomarginal parts of ventral shield. All ventral plates fused to a shield, its length 212 μm (from camerostome to end of anal cone). Ventral shield extending dorsad, forming frontal margin of idiosoma with its short, obtuse frontal process. Surface of dorsal shield with delicate porosity and faint foveate ornamentation (Figure 1a). Dorsal setae extremely small. First pair of dorsal setae within area equalling anterior dorsal plate, slightly posterior to level of insertion of leg I. Second pair of dorsal setae and canaliculi posterior to insertions of leg II, in dorsomarginal part of ventral shield. Dorsal shield with two pairs of setae, both pairs anterior to level of insertion of leg III. Adanal setae not seen. Area of anterior epimeral plate with three pairs of setae, lateral setae in marginal position. Each area of posterior epimeral plate with a ventral, a lateral but no dorsal seta. Area of genital plate with two pairs of perigenital setae. Genital opening in posterior part of ventral shield (Figure 1b). Length of genital opening 60 μm , width 36 μm . Each genital sclerite with three external acetabula arranged within a line. Acetabula 3–4 μm in diameter. Anal sclerites small.

Gnathosoma short, wider than long, its length 37 μm , width 40 μm . Rostrum wider than long, triangular in ventral aspect (Figure 1d). Tectum truncate. Palps extending beyond rostrum. Second palpal segment with single seta in apical half. Third palpal segment with spur in medial position (Figure 1c). Ventral seta of fourth palpal segment wider than dorsal seta.

All legs distinctly shorter than idiosoma. Legs III and IV slightly longer and more slender than legs I and II. Telfemora I and II about 1.5 times longer than high, telfemora III and IV 1.6 times. Leg chaetotaxy from trochanter to tarsus (parambulacral setae excluded): legs I and II, 0, 2, 3, 3, 7, 4; leg III, 1, 1, 2, 2, 5, 3; leg IV, 0, 0, 2, 3, 5, 2 (Figure 2a–d). Ventral spine on genu I slightly longer than length of that segment. Tibiae I to IV with 3, 3, 2, 2 ventral spines and 2, 2, 1, 1 short dorsal spurs. Tarsi I and II

each with three fossary setae, a dorsolateral clavate solenidion but no ventral setae. Tarsus I with delicate porus that may be remnant of a famulus (Figure 1e). On tarsi I and II paired fossary setae unequal in length, dorsolateral seta somewhat thicker and longer than dorsomedial seta (Figure 1f). Tarsus III with three dorsal setae, one of setae in dorsolateral position and equalling a solenidion (Figure 1g). Tarsus IV with two dorsal setae, both equal in size. On tarsi III and IV dorsal fossary seta lacking. Paired claws with a slightly widened apical process, each process with four delicate tines. No tines on shaft of claw. Median claw slender, hook-like.

Deutonymph — Length of idiosoma 212 – 226 μm . Ornamentation of dorsal and ventral plates more intense than in female (Figure 2e). Anterior and posterior dorsal plate separated by few striae of soft integument. Ocular plates and dorsal part of posterior epimeral plates fused. First pair of dorsal setae on anterior dorsal plate, second pair of setae on dorsal part of anterior epimeral plate and medial to insertion of leg II, two pairs of setae on posterior dorsal plate. With striated (soft) integument between anterior epimeral plate and genital plate (Figure 2f). Anterior epimeral plate with three pairs of ventral setae, posterior epimeral plates with pair of lateral setae. Genital plate with single pair of perigenital setae and two pairs of acetabula. Acetabula 4 μm in diameter. Leg chaetotaxy from trochanter to tarsus (parambulacral setae excluded): legs I and II, 0, 2, 3, 3, 6, 4; leg III, 1, 1, 2, 2, 5, 3; leg IV, 0, 0, 2, 3, 5, 2. Tibiae I to IV with 2, 2, 2, 2 ventral spines and 2, 2, 1, 1 dorsal spurs. Tarsi I to IV with 4, 4, 3, 2 dorsal setae and 0, 0, 0, 0 ventral setae.

Protonymph — Length of idiosoma 155 μm . Dorsal aspect similar to that of deutonymph. Number and arrangement of dorsal idiosomatic setae and setae on anterior and posterior epimeral plates same as in deutonymph. Genital plate and posterior epimeral plates partly fused. Genital plate with single pair of acetabula (Figure 2g); perigenital setae lacking. Leg chaetotaxy from trochanter to tarsus (parambulacral setae excluded): legs I and II, 0, 2, 3, 3, 5, 4; leg III, 1, 1, 2, 2, 5, 3; leg IV, 0, 0+2 (basis + telfemur), 3, 5, 2. Tibiae I to IV with 2, 2, 2, 2 ventral spines and 1, 1, 1, 1 dorsal spurs. Dorsal fossary

seta absent on tarsus III and IV.

Variants — Tarsus II of one of the paratype females without dorsal fossary seta (Figure 1h).

Remarks — *Ropohalacarus pallidus* is the second species of this genus. Characters which separate *R. pallidus* from *R. uniscutatus* are: (1) dorsal plates delicately foveate versus reticulate, (2) anterior margin equivalent to dorsal portion of anterior epimeral plate versus to anterior part of dorsal shield, (3) second pair of dorsal setae within dorsal portion of anterior epimeral plate versus in striated integument, (4) second palpal segment with single seta versus two setae, (5) genu I with three versus four setae, (6) tarsi I and II without versus with a ventral seta.

NOTES ON MORPHOLOGICAL CHARACTERS

The two presently known *Ropohalacarus* species have the anterior and posterior dorsal plate and the anterior and posterior epimeral plates and genitoanal plate fused. Most halacarids have a pair of ocular plates, plates which often bear corneae and eye pigment, in *R. pallidus* the ventral shield extends dorsad and includes remnants of the ocular plates, whereas in *R. uniscutatus* the ocular plates are reduced to minute sclerites which are situated in the dorsal integument. Within several halacarid genera a fusion of two or more plates on either the dorsal or ventral flank is a common phenomenon, but a fusion of both the dorsal and ventral plates is at present known only in the two *Ropohalacarus* and a few *Rhombognathus* species (e.g., *R. aspidotus* Bartsch, 2006, *R. conjunctus* Bartsch, 1986, *R. parvulus* Viets, 1939, *R. peltatus* Viets, 1939, *R. similis* Bartsch, 1977, *R. scutulatus* Bartsch, 1983).

In general a fusion of plates seems to be correlated with a life in an environment with mechanical stress (Bartsch 2010). In adults of the above mentioned genus *Lobohalacarus* all ventral plates are fused, but not the dorsal plates. Due to the fusion of the plates to a dorsal and ventral shield, the two *Ropohalacarus* species have a solid exoskeleton. Both species are expected to live in subterranean or hyporhithral sandy deposits. The plates of the two nymphal stages of *R. pallidus* are, if at all, separated

by only few striae of soft integument and the surface of the plates is not as smooth as in the adults. In contrast, almost all halacarid nymphs have the dorsal and ventral plates distinctly separated by striated integument and the ornamentation of the plates is less conspicuous than in adults. In general the growth during a juvenile stage is by a dilatation of this striated integument, in *R. pallidus* the textured surface of the plates of nymphs may allow a slight dilatation.

The two *Ropohalacarus* species have their hind legs far in the posterior half of the idiosoma, the insertions of legs III and IV are at about 0.7 and 0.8 (with reference to the length of idiosoma, from anterior to posterior), the gap between insertions of legs II and III is somewhat less than half the length of the idiosoma. A similar posterior position of the legs is present in the marine genera *Anomalohalacarus*, *Arenihalacarus*, *Australacarus*, and *Parhalixodes* (Abé 1991; Bartsch 1987, 1993; Laubier 1960). *Anomalohalacarus* and *Arenihalacarus* live in sandy deposits (Abé 1991; Bartsch 2006), species of these two genera have small, delicate dorsal and ventral plates, the plates are separated by large areas of striated integument, their legs are slender, leg I is longer than the other legs. *Anomalohalacarus* has been watched alive, it moves rapidly on the convex surface of grains, the body is extremely flexible, able to turn back within minute interstitia. The two genera *Australacarus* and *Parhalixodes*, too, have small, reduced dorsal and ventral plates; their mode of living is not known but representatives of these genera are expected to feed as ectoparasites (Laubier 1960; Bartsch 1987, 1993). The two *Australacarus* species studied by the author had a dark body content; rostrum and chelicerae are slender, bristle- and stylet-formed, the palps form a trough (Bartsch 1987, 1993). The dark body content is expected to represent the remnants of a diet of, e.g., haemolymph. One may speculate that the ancestors of *Australacarus* have been interstitially living forms which got used to stick to a sedentary macrofauna and feed on the body fluids. In contrast to the above mentioned genera, the idiosoma of *Ropohalacarus* is less slender and both the dorsal and ventral plates are fused to shields. The legs of the *Ropohalacarus*

species are rather short, with only small differences in the length between the anterior and posterior legs, the gnathosoma is short. *Anomalohalacarus* and *Arenihalacarus* are restricted or bound to the interstia amongst sediment particles but *Ropohalacarus* is expected to push particles out of the path rather than wriggling around them.

Ropohalacarus pallidus has an unusual low number of setae. The chaetotaxy of the legs is reduced when compared with other halacarids. There are no setae on the trochanters I and II, whereas in *R. uniscutatus*, as well as in species of other halacarid genera, these leg segments bear a seta, in the adults as also in the juveniles (Bartsch 1982a, 1998, 2003, 2007a, 2011a, unpublished).

A reduction of the number of setae on the legs is documented in the genus *Copidognathus*. This genus holds one-third of all halacarid species, it is spread world-wide, records are from all depth and temperature zones, from marine and even freshwater habitats, from the mesopsammal as well as from the surface of sediment, algae and colonial organisms, the genus also includes a few parasitic living forms (Bartsch 2004). The more than 340 described species demonstrate a uniformity in the number of setae on idiosoma and legs. In general the genua I to IV bear 4, 4, 3, 3–4 setae, the tibiae I to IV 7, 7, 5, 5 setae, and in most species the telofemora I and II have five setae each. Only a few species have a reduced number of setae, e.g., *C. cerberoideus* Bartsch, 1991 and *C. consobrinus* Bartsch, 1991, both known from Hong Kong, *C. cribellus* Bartsch, 1993 and *C. psammobius* Bartsch, 2008, known from western and eastern Australia, respectively (Bartsch 1991, 1993, 2008b). All four species were extracted from sandy deposits, they are small in size (174 – 232 µm), the number of setae on the genua is reduced to 2–3, 2–3, 2–3, 3, the tibiae I and II of *C. cribellus* and *C. psammobius* bear six setae. Another species with a reduced number of setae on the genua I and II (three setae each) and tibia I (six setae) is *C. inusitatus* Bartsch, 1989. This species has very long and slender legs; it was extracted from a depth of 1508 m (Pacific Ocean) (Bartsch 1989) and does certainly not live within sandy deposits. The long-legged *C. curiosus* Bartsch, 1982, from about 800 m depth (Indian

Ocean), bears three and two setae on genua I and II, respectively (Bartsch 1982b). As demonstrated by species of the algae-inhabiting genus *Isobactrus* (Bartsch 2010), a reduction of the number of setae on the legs is not restricted to species living in and on a sediment. According to the though sparse data set, several of the *Isobactrus* species living in habitats exposed to long-term or severe desiccation have a lower number of setae on the legs than those living in almost permanently wet habitats. In general, reduction of setae seems to be correlated with life in a 'harsh' environment, with unfavourable biological (food intake) and chemical parameters. Though speculative, as the regime of dissolved and solid inorganic and organic matter in the interstitial water of the Madagascar river banks is unknown, the condition *R. pallidus* meets is expected to be meagre and may have led to a reduction of the number of setae on the legs.

MADAGASCAR AND ITS AQUATIC MITE FAUNA

Four halacarid species, in three genera, are now known from Madagascar. The four species are from running water; no samples have been taken in standing water. All three of the freshwater halacarid genera collected in Madagascar are cosmopolitan and three of the four halacarid species are known from outside Madagascar and outside Africa, the continent closest to Madagascar.

Lobohalacarus weberi is mentioned from the northern and southern hemisphere, from North and South America, Europe, Asia, Australia, Oceanic Islands, and also from Africa. *Limnohalacarus cultellatus* was first described from islands off the northern coast of South America, in the meantime there are records from North, Central and South America, Europe and India (Viets 1940; Bartsch 2011b, 2013). Representatives of the other *Limnohalacarus* species from Madagascar (*L. novus*) have been found in Australia, Queensland, Moreton Bay (Bartsch 2013). The fourth species, *Ropohalacarus pallidus*, may be restricted to Madagascar, though one should keep in mind, studies on halacarids in adequate habitats of the nearby Africa or India are lacking. Notewor-

thy is that *R. uniscutatus*, the second species of this genus, has records from North America, northern Africa and eastern Australia (Bartsch 2009).

In contrast to the sparse number of halacarids, the fauna of Hydrachnidia seems to be rich in species and numbers, obviously including a high percentage of endemisms. A recently updated list of Madagascar Hydrachnidia mentioned 63 species or subspecies, 35 species (56 %) were only known from Madagascar, 24 species (38 %) from both Africa and Madagascar, and four species (6 %) had an even wider distribution (Gerecke 2004b). Since, several more species have been described (Gerecke 2006, 2009; Goldschmidt 2008; Tuzovsky and Gerecke 2009). Goldschmidt (2008), who concentrated the studies on the family Anisitsiellidae (Hydrachnidia), found 24 species, 23 of which were new to science. A striking difference between the presence of halacarid and hydrachnid endemisms in the freshwater mite fauna is documented from New Zealand. At a species level almost all species of the Hydrachnidia are exclusively taken in New Zealand, and in respect to the genera, 35 out of 59 (59 %) are endemic; no more than 12 genera (20 %) of the New Zealand fauna are widespread, seven genera (12 %) are cosmopolitan (Sirvid *et al.* 2010). By contrast, the New Zealand freshwater halacarid fauna is surprisingly similar to that found in equivalent habitats in Europe and North America (Bartsch 2007b). Four species, in three genera, are at present known from New Zealand, and all genera and three of the species are cosmopolitans (Bartsch 2007).

ACKNOWLEDGEMENTS

Thanks are due to Drs R. Gerecke and T. Goldschmidt who collected the halacarid mites on Madagascar. Their journey to Madagascar was financed by Dave Cook (Paradise Valley, USA).

REFERENCES

- Abé H. 1991 — A new genus and species of the family Halacaridae (Acari, Prostigmata) from Japan. — Zool. Jb., Syst., 118: 247-256.
- Bader C. 1967 — *Limnohalacarus portmanni*, eine Süßwasserhalacaride aus dem Tanganika-See. — Revue Zool. Bot. afr., 75: 275-281.
- Bader C. 1968 — Wassermilben aus Zentralafrika. — Anns Mus. r. Afr. Cent., sér. A, Zool., 163, 50 pp.
- Bartsch I. 1982a — Halacariden (Acari) im Süßwasser von Rhode Island, USA, mit einer Diskussion über Verbreitung und Abstammung der Halacaridae. — Gewäss. Abwäss., 68/69: 41-58.
- Bartsch I. 1982b — Weitere Halacaridae (Acari) aus dem Kanal von Moçambique. — Cah. Biol. mar., 23: 435-457.
- Bartsch I. 1987 — *Australacarus inexpectatus* gen. et spec. nov. (Halacaridae, Acari), mit einer Übersicht über parasitisch lebende Halacariden. — Zool. Anz., 218: 17-24.
- Bartsch I. 1989 — Deep-sea mites (Halacaridae, Acari), from the southwestern Pacific. — Cah. Biol. mar., 30: 455-471.
- Bartsch I. 1991 — Arenicolous Halacaridae (Acari) from Hong Kong. — Asian mar. Biol., 8: 57-75.
- Bartsch I. 1993a — A new species of *Australacarus* (Halacaridae, Acari) from southwestern Australia. — Zool. Jb., Syst., 120: 65-70.
- Bartsch I. 1993b — Arenicolous Halacaridae (Acari) from south-western Australia. — In: Wells F.E., Walker D.I., Kirkman H., Lethbridge R. (Eds). The Marine Flora and Fauna of Rottnest Island, Western Australia. Perth: Western Australian Museum. p. 73-103.
- Bartsch I. 1998 — A new species of the *Copidognathus pulcher* group (Acari: Halacaridae) from Western Australia: Description of adults and juveniles and notes on developmental pattern. — Species Divers., 3: 187-200.
- Bartsch I. 2003 — The subfamily Rhombognathinae: developmental pattern and re-evaluation of the phylogeny (Arachnida, Acari, Halacaridae). — Senckenberg. Biol., 82: 15-57.
- Bartsch I. 2004 — Geographical and ecological distribution of marine halacarid genera and species (Acari: Halacaridae). — Exp. Appl. Acar., 34: 37-58. doi:10.1023/B:APPA.0000044438.32992.35
- Bartsch I. 2006 — Halacaroida (Acari): a guide to marine genera. — Org. Divers. Evol., 6, Electr. Suppl. 6: 1-104 (<http://www.senckenberg.de/odes/06-06.htm>)
- Bartsch I. 2007a — The freshwater mite *Porolohmannella violacea* (Kramer, 1879) (Acari: Halacaridae), description of juveniles and females and notes on development and distribution. — Bonner zool. Beitr., 55: 47-59.

- Bartsch I. 2007b — Freshwater Halacaridae (Acari) from New Zealand rivers and lakes, with notes on character variability. — Mitt. hamb. zool. Mus. Inst., 104: 73-87.
- Bartsch I. 2008a — Freshwater halacarid mites (Halacaridae: Prostigmata: Acari) from Tunisia, three new records and notes on geographical distribution of these species. — Ent. Mitt. zool. Mus. Hamb., 15: 15-27.
- Bartsch I. 2008b — Halacarid mites (Acari) in a freshwater influenced beach of North Stradbroke Island, Moreton Bay, Queensland. — In: Davie P.J.F., Phillips J.A. (Eds). Proceedings of the Thirteens International Marine Biological Workshop. The Marine Fauna and Flora of Moreton Bay, Queensland. — Mem. Qd Mus., 54 (1): 117-130.
- Bartsch I. 2009 — Checklist of marine and freshwater halacarid mite genera and species (Halacaridae: Acari) with notes on synonyms, habitats, distribution and descriptions of the taxa. — Zootaxa, 1998: 170 pp.
- Bartsch I. 2010 — Reflections on distribution and origin of the halacarid genus *Isobactrus* (Acari: Halacaridae). — Mar. Biodivers., 40: 17-32. doi:10.1007/s12526-009-0030-7
- Bartsch I. 2011a — The freshwater halacarid mite *Soldanelonyx chappuisi* Walter, 1917 (Acari: Halacaridae), character development from larva to adult and comparison with other halacarids. — Ent. Mitt. zool. Mus. Hamb., 15 (184): 223-235.
- Bartsch I. 2011b — North American freshwater halacarids (Acari), literature survey and new records. — Int. J. Acarol., 37: 490-510. doi:10.1080/01647954.2010.525528
- Bartsch I. 2013 — The freshwater halacarid genus *Limnohalacarus* (Halacaridae, Acari), species diagnoses, distribution and relationships. — Verh. naturw. Ver. Hamburg, 47: 185-220.
- Gerecke R. 2004a — Taxonomy and phylogeny in African water mites of the genus *Diplodontus* Dugés, 1834 (Acari, Hydrachnidia, Hydryphantidae). — Ann. Limnol. - Int. J. Limnol., 40 (1): 71-85. doi:10.1051/limn/2004007
- Gerecke R. 2004b — The water mites of Madagascar (Acari, Hydrachnidia): a revised list completed by original material conserved at the Muséum national d'Histoire naturelle, Paris. — Zoosystema, 26(3): 393-418.
- Gerecke R. 2006 — Revisional study on water mites of the family Harpagopalpidae K. Viets, 1924 (Acari: Hydrachnidia), with descriptions of new species from Cameroon and Madagascar. — Ann. Limnol. - Int. J. Limnol., 42 (2): 109-125. doi:10.1051/limn/2006008
- Gerecke R. 2009 — Revisional studies on *Thorcophoracarus* K. Viets, 1914 (Arachnida, Acari, Hydrachnidia, Arrenuridae). — Zoosystema, 31(1): 127-145. doi:10.5252/z2009n1a7
- Goldschmidt T. 2008 — Taxonomical, ecological and zoogeographical studies on anisitsiellid water mites (Acari: Hydrachnidia: Anisitsiellidae Koenicke, 1910) from Madagascar. — Zootaxa, 1954: 1-120.
- Green J. 1984 — The occurrence of *Limnohalacarus* (Acari: Halacaridae) in Lake No, White Nile. — Hydrobiologia, 110: 135-136. doi:10.1007/BF00025785
- Green J., Corbet S.A., Betney E. 1974 — Ecological studies on crater lakes in West Cameroon. Debundsha Lake. — J. Zool., London, 173: 199-223. doi:10.1111/j.1469-7998.1974.tb03126.x
- Laubier L. 1960. — *Parhalixodes travei* n. g., n. sp., un nouvel Halixodinae (Halacariens) ectoparasite de nemerte en Méditerranée occidentale. — Acarologia, 2: 541-551.
- Pešić V., Smit H., Datry T. 2010 — New records of water mites (Acari: Hydrachnidia, Halacaroidea) from Patagonia (Chile). — Syst. Appl. Acarol., 15: 151-160.
- Sirvid P.J., Zhang Z.Q., Harvey M. S., Rhode B.E., Cook D.R., Bartsch I., Staples D.A. 2010. — Phylum Arthropoda Chelicerata horseshoe crabs, arachnids, sea spiders. — In: Gordon D.P. (Ed.) New Zealand Inventory of Biodiversity. — Christchurch: Canterbury University Press. Vol. 2 (6): 50-89.
- Tuzovsky P.V., Gerecke R. 2009 — Water mites of the family Limnocharidae (Acariformes, Hydrachnidia) from Madagascar. — Acarina, 17(1): 33-55.
- Viets K. 1940 — Zwei neue Porohalacaridae (Acari) aus Südamerika. — Zool. Anz., 130: 191-201.
- Walter C. 1935 — Hydracarina. In: Voyage de Ch. Alluaud et P.A. Chappuis en Afrique Occidentale française (Déc. 1930-Mars 1931). — Arch. Hydrobiol., 28: 69-136.
- Walter C., Bader C. 1952 — Mission scientifique de l'Omo. - Hydracarina. — Mém. Mus. natn. Hist. nat., sér. A, 4, 87-236

COPYRIGHT

 Bartsch I. Acarologia is under free license. This open-access article is distributed under the terms of the Creative Commons-BY-NC-ND which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original author and source are credited.