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A new genus of egg case-carrying water scavenger beetle from the Guiana Shield (Coleoptera: Hydrophilidae: Acidocerinae)

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Abstract

Radicitus gen. n. is described to accommodate three new species of water scavenger beetles from the Guiana Shield region of South America: R. ayacucho sp. n. (Venezuela), R. granitum sp. n. (Venezuela), and R. surinamensis sp. n. (Suriname). The genus is placed in the subfamily Acidocerinae, and likely shares an affinity with the genus Helochares Mulsant and its relatives. It is characterized by its convex body form, short maxillary palps, partially glabrous hind femora, and complete fifth abdominal ventrite. All collections of the new genus were made from root mats and debris from seepages over rock outcrops or, rarely, root mats from streams. Individual females of all three species were observed to adhere their egg case to the venter of the abdomen.

Key words: Hydrophilidae, new species, Tepuis, Venezuela, Suriname, maternal care

Introduction

Over the last few years, ongoing surveys of aquatic insects in the Guiana Shield have yielded series of an unusual, brown water scavenger beetle in equally unusual habitats: submerged root mats along streams and in the roots of vegetation growing on seepage areas on granite outcrops. First discovered at the "Tobogan de la Selva" locality in northwestern Amazonas State, Venezuela (e.g. Spangler & Steiner 2005), additional series and species were found along the northwestern edge of the Guiana Shield and later at several sites in Suriname, including the summit of Tafelberg Tepui. In total, three species have been found to date. Frequently, females have an egg case affixed to the ventral side of their abdomen, in a similar manner to some species of *Helochares* Mulsant and *Helobata* Bergroth.

While these beetles share a number of characters with several genera of Acidocerinae (e.g. a short basal piece of the aedeagus, systematic punctures, inwardly curved maxillary palps, partially pubescent hind femora), they also possess a number of unusual or novel characters such as a fifth ventrite lacking an emargination and (usually) bearing a small glabrous patch, an unusual aedeagal morphology, and short maxillary palps. Here, we describe a new genus to accommodate these three new species of hydrophilids, and provide detailed summaries of their habitat, distribution, and potential phylogenetic affinities.

Material and methods

We examined 129 specimens for this study. Terminology follows Hansen (1991), except for the substitution of meso- and metaventrite for meso- and metasternum respectively. Museum and depository abbreviations: MALUZ-Museo de Artrópodos de la Universidad del Zulia, Maracaibo, Venezuela (J. Camacho, M. García); MIZA-Museo del Instituto de Zoología Agrícola, Maracay, Venezuela (L. Joly); NMPC-Czech National Collection, National Museum, Prague, Czech Republic (M. Fikáček); USNM-US National Museum of Natural History, Washington DC (C. Micheli, W.E. Steiner); NMW-Naturhistorisches Museum Wien, Austria (M.A. Jäch, A. Komarek); SEMC—University of Kansas, Lawrence, USA (A. Short).

Taxonomy

Radicitus Short & García gen. n.

Type species. Radicitus ayacucho Short & García sp. n.

Diagnosis. Medium sized beetles, total body length: 4.5–6.2 mm. Antennae with nine antennomeres, including three-segmented club (Fig. 3). Maxillary palps short, shorter than the width of the head. Prosternum not carinate. Elytra without sutural striae (Fig. 4). Mesoventrite with longitudinal carina medially which is elevated and forming a posteriorly pointing process (Fig. 5A). Fifth abdominal ventrite evenly rounded, without apical emargination or coarse setae (Fig. 6). Metafemora with pubescence along anterior half on basal three-quarters (Fig. 5B). Aedeagus with basal piece extremely short (Fig. 7).

Description. Color. Dorsum dark brown, the margins of pronotum and elytra sometimes slightly paler.

Head. Antennae with nine antennomeres, including three-segmented pubescent club. Maxillary palps curving inward; short, distinctly shorter than the width of the head. Apical palpomere distinctly shorter than penultimate palpomere. Labial palps short, distinctly shorter than mentum width. Mentum slightly concave with a few scattered setae (Fig. 3). Frons with series of irregular systematic, setae bearing punctures anterior to each eye. Systematic punctures also present on clypeus and labrum but blend with ground punctation, appearing almost absent. Eyes slightly bulging laterally, interrupting the outline of the head. Gular sutures subparallel and moderately close.

Thorax. Pronotum with systematic punctation in lateral thirds, each puncture usually bearing a short seta. Prosternum sometimes bulging but not carinate medially; slightly elevated anteromedially into a small tooth. Mesoventrite with anapleural sutures distinctly concave (Fig. 5A). Mesoventrite with a conical, strongly elevated projection (Fig. 5A), which is directed posteriorly. Metaventrite without posteromedial projection between metacoxae. Elytra with indistinct and irregular rows systematic punctures bearing short setae. Each elytron with ten rows of weakly to moderately impressed punctate striae, but without a sutural stria (Fig. 4). Procoxae set with setae, but without thickened spines. Metafemora pubescent along anterior half on basal three-quarters (Fig. 5B). All tarsi with five segments; with short, sparse setae on dorsal face but without long natatory setae. Ventral surface of tarsomeres 1-4 set with two rows of short brush-like setae.

Abdomen. Abdomen with five exposed ventrites that are covered with a dense, fine, short pubescence. Third laterosternite without a ribbed stridulatory file. Fifth ventrite entire, without a medioapical emargination or coarse bristles (Fig. 6). Aedeagus with abbreviated basal piece (Fig. 7).

Etymology. *Radicitus* (derived from the Latin *radix*, root), meaning 'by the roots', referring to the habitat of known members of the genus. Masculine.

Radicitus ayacucho Short & García sp. n.

(Figs. 1, 3A, 4A, 6A, 7A, 8, 9)

Type locality. Venezuela, Amazonas State, Tobogan de la Selva, 5°23.207'N, 67°36.922'W, 125 m.

Type material. Holotype <male>: "VENEZUELA: Amazonas State/ 5°23.207'N, 67°36.922'W, 125 m/ Tobogan de la Selva; 8.viii.2008/ leg. A. Short, M. Garcia, L. Joly/ AS-08-080b; old "tobogancito"", "[barcode]/ SM0829210/ KUNHM-ENT" (MIZA). **Paratypes (36): Venezuela: Amazonas State:** Same data as holotype (10 exs.: SEMC, MIZA); same data but with added habitat text: "on seepage area w/ detritus" (19 exs.: SEMC, USNM, MALUZ, MIZA, NMW, NMPC); Tobogan de la Selva, 7.i.2006, leg. A.E.Z. Short & M. García, AS-06-017 (4 exs.: SEMC). **Bolívar State:** outcrop ca. 15 km NE Pijiguaos, 6°57.904'N, 66°36.392'W, 51 m, 9.vii.2010, leg. A. Short & M. Tellez, detritus flotation, VZ10-0709-01B (3 exs.: SEMC).

Diagnosis. Size 4.7–6.2 mm. Elytra with coarse punctate striae (Fig. 4A). Fifth ventrite with apicomedial glabrous patch that extends anteriorly about half the width of the ventrite (Fig. 6A). Parameres divided into two projections medially (Fig. 7A).

The larger size and presence of punctate elytral striae and a glabrous patch on the fifth ventrite easily separate this species from the sympatric *R. granitum*. This species is externally almost identical to *R. surinamensis*, which possesses a larger glabrous patch on the fifth ventrite and undivided aedeagal parameres.





Description. *Color and punctation.* Dorsum of head, pronotum and elytra very dark brown with all margins of pronotum and lateral margins of the elytra slightly paler (Fig. 1). Anterolateral margins of clypeus with faint pale preocular patches. Thoracic and abdominal sterna and epipleura dark chestnut brown, with legs very slightly paler. Ground punctation on head and elytra moderately coarse; moderately coarse on elytral disc, and becoming extremely fine to almost obsolete laterally and posteriorly.

Head. Antennae (Fig. 3A) with scape c. three times as long as pedicel, antennomere 3 subequal in length as 4 and 5 combined. Maxillary palps slightly shorter in length to the width of the anterior margin of the clypeus with segments two and three subequal in length with apical segment slightly shorter.

Thorax. Elytra with rows of serial punctures strongly impressed in posterior half and laterally; serial punctures 5-8 times larger than surrounding, extremely fine ground punctuation. Mesoventrite with distinctive, large conical projection, which is flattened on the posterior face; the projection strongly elevated, rising to the same plane as the ventral surface of the mesocoxae; apex of projection set with a few setae. Metaventrite with distinct median glabrous area that is about as wide as long; total length of glabrous patch about half the metaventrite width. Metafemora with pubescence restricted to anterior fifth and extending distally to basal four-fifths.

Abdomen. Pubescence on ventrites 1-4 extremely fine and dense. Apex of fifth ventrite with a distinct glabrous patch along medioposterior margin, which extends c. half the width of the ventrite, and spans approximately the central fifth or less of the ventrite (Fig. 6A). Aedeagus (Fig. 7A) with each paramere dividing into two lobes at

midpoint, the outer lobe slightly longer than the inner one; median lobe forming a narrow projection, as long as inner paramere lobes, and expanded dorsoventrally into a plate like-structure at apex.

Etymology. Named after Puerto Ayacucho, the nearby capital of Amazonas State, Venezuela. Noun in apposition.

Distribution. Known from two localities in southern Venezuela (Fig. 8).

Remarks. Most specimens have been collected along the margins of the Rio Coromoto at the "Tobogan de la Selva" site. The species occurs on both exposed granite seepages that border the creek (usually where detritus is covering the rocks) as well as in the (water saturated) roots of herbaceous plants that are growing along the margin of the creek. A few specimens were found by collecting detritus from a granite outcrop and placing it in a pan of water such that the specimens float to the surface.

Radicitus granitum Short & García sp. n.

(Figs. 2, 3B, 4B, 5, 6B, 7D, 8, 9)

Type locality. Venezuela, Bolívar State, Los Pijiguaos, 6°35.617'N, 66°49.238'W, 80 m.



FIGURE 2. Radicitus granitum, dorsal, ventral, and lateral habitus (paratype).



FIGURE 3. Heads of Radicitus spp., ventral view. A) R. ayacucho, B) R. granitum.

Type material. Holotype <male>: "VENEZUELA: Bolivar State/ 6°35.617'N, 66°49.238'W, 80 m/ Los Pijiguaos; 16.ix.2007/ leg. A. Short, M. Garcia, L. Joly/ AS-07-015; morichal/rock outcrop" (MIZA). **Paratypes (40): VENEZUELA: Amazonas State:** Tobogan de la Selva, 5°23.207'N, 67°36.922'W, 125 m, 7.i.2006, leg. A.E.Z. Short & M. García, AS-06-017 (1 ex.: SEMC); same locality but "old tobogancito", 8.viii.2008, AS-08-080b, (2 exs.: SEMC); same locality but 14.i.2009, "upstream slide", leg. Short, García, Miller & Joly, VZ09-0114-01F (1 ex.: SEMC). **Bolívar State:** Same data as holotype (24 exs.: SEMC, USNM, MALUZ, MIZA, NMW, NMPC); Same data as holotype but 6.viii.2008, AS-08-076 (1 ex.: SEMC); ca. 25 km E. El Burro, 6°13'4.6"N, 67°14'26.4"W, 60m, 7.viii.2008, leg. A. Short, M. García, & L. Joly, rocky morichal, AS-08-077 (1 ex.: SEMC); same locality but 12.i.2009, leg. A. Short & M. García, VZ09-0113-01X (8 exs.: SEMC, MIZA, MALUZ); 2 km E. Rio Cuchivero, 7°29'47.3"N, 65°51'44.8"W, 45m, 6.viii.2008, leg. A. Short, M. García, & L. Joly, rock outcrop seeps, AS-08-075 (1 ex.: SEMC); rock outcrop ca. 15 km NE Pijiguaos, 6°57.904'N, 66°36.392'W, 51 m, 9.vii.2010, leg. A. Short & M. Tellez, detritus flotation, VZ10-0709-01B (1 ex.: SEMC).

Diagnosis. Size 4.5–5.0 mm. Elytra with extremely fine serial punctures, with punctures smaller than surrounding ground punctation (Fig. 4B). Fifth ventrite entirely pubescent. Parameres not divided into two projections (Fig. 7D).

The smaller size and lack of coarsely punctate elytral striae, and completely pubescent fifth ventrite will easily separate this species from both *R. ayacucho* and *R. surinamensis*.

Description. *Color and punctation.* Dorsum of head, pronotum and elytra very dark brown with all margins of pronotum and lateral margins of the elytra slightly paler (Fig. 2). Clypeus without pale preocular patches. Thoracic and abdominal sterna and epipleura dark chestnut brown, with legs very slightly paler. Ground punctation on head and elytra moderately coarse; moderately coarse on elytral disc, and becoming extremely fine to almost obsolete laterally and posteriorly.

Head. Antennae (Fig. 3B) with scape c. three times as long as pedicel, antennomere 3 subequal in length as 4 and 5 combined. Maxillary palps subequal in length to the width of the anterior margin of the clypeus, with segments two and three subequal in length with apical segment slightly shorter.

Thorax. Elytra with rows of serial punctures weakly impressed along entire length (Fig. 4B); serial punctures subequal in size as surrounding ground punctuation, making them almost appear absent. Mesoventrite with

distinctive, large laterally compressed projection, which appears as a large "tooth"; the projection strongly elevated, rising to the same plane as the ventral surface of the mesocoxae; apex of projection set with a several coarse spine-like setae. Metaventrite almost entirely pubescent, with posteromedial glabrous region represented by a narrow line in the posterior half of the metaventrite width. Metafemora with pubescence restricted to anterior third and extending distally to basal four-fifths.

Abdomen. Pubescence on ventrites 1-4 extremely fine and dense. Fifth ventrite with pubescence slightly less dense at apex, but without a glabrous patch (Fig. 6B). Aedeagus (Fig. 7D) with parameres forming a single lobe, tapering apically. Lateral margins of median lobe gradually tapering, with apex slightly shorter than parameres.

Etymology. Named after the Latin word for granite, reflecting the habitat of this species. Noun in apposition.

Distribution. This species is known from a series of localities along the northwestern edge of the Guiana Shield in Venezuela (Fig. 8)



FIGURE 4. Elytra of Radicitus spp. A) R. ayacucho, B) R. granitum.



FIGURE 5. Details of Radicitus granitum. A) thoracic sternum. B) metafemur.

Biology. This species, the most frequently encountered of the genus to date, has been found on a variety of habitats associated with streams and seeps on rock outcrops. It has been found by collecting detrital debris from seepages and floating them in pans of water (Fig. 9C), and also in the roots vegetation along the margins of shallow streams and seeps that are flowing over open granite (e.g. Fig. 9A).

Radicitus surinamensis Short & García sp. n.

(Figs. 7B, 8, 10)

Type locality. Suriname, Sipaliwini Department, Mt. Kasikasima, N 2°58.613', W 55°24.683', 400 m elev.

Type material. Holotype <male>: "SURINAME: Sipaliwini District/ N 2°58.613', W 55°24.683', 400 m/ Camp 4 (high), Kasikasima/ leg. A. Short; main seepage area/ 24.iii.2012; SR12-0324-01C/ 2012 CI-RAP Survey", "[barcode]/SEMC1088423/ KUNHM-ENT" (NZCS). **Paratypes (38): SURINAME: Sipaliwini Department:** Same data as holotype (35 exs.: SEMC, USNM, NMW, NMPC, NZCS); Grensgebergte Rock, Camp 2, rock seepages, 12.iii.2012, leg. A.E.Z. Short, SR12-0312-01A (3 exs.: SEMC); Summit of Tafelberg Tepui, Arrowhead Basin, flotation of wet rocks and moss, leg. Short & Bloom, SR13-0820-04A (1 ex.: SEMC).

Diagnosis. Size 4.9–5.6 mm. Elytra with coarse punctate striae (e.g. Fig. 4A). Fifth ventrite with apicomedial glabrous patch that extends anteriorly about three-fourth the width of the ventrite. Parameres divided not divided into two projections (Fig. 7B).

The larger size and presence of punctate elytral striae and a glabrous patch on the fifth ventrite easily separate this species from *R. granitum*. The species is externally almost identical to *R. ayacucho*, which possesses a smaller glabrous patch on the fifth ventrite and divided aedeagal parameres.

Description. *Color and punctation.* Dorsum of head, pronotum and elytra very dark brown with all margins of pronotum and lateral margins of the elytra slightly paler. Anterolateral margins of clypeus with faint pale preocular patches. Thoracic and abdominal sterna and epipleura dark chestnut brown, with legs very slightly paler. Ground punctation on head and elytra moderately coarse; moderately coarse on elytral disc, and becoming extremely fine to almost obsolete laterally and posteriorly.



FIGURE 6. Abdominal ventrites of Radicitus spp. A) R. ayacucho, B) R. granitum.

Head. Antenna with scape c. three times as long as pedicel, antennomere 3 subequal in length as 4 and 5 combined. Maxillary palps with palpomeres two and three subequal in length with apical palpomere slightly shorter.

Thorax. Elytra with rows of serial punctures strongly impressed in posterior half and laterally; serial punctures 5-8 times larger than surrounding, extremely fine ground punctuation. Mesoventrite with distinctive, large conical projection, which is flattened on the posterior face; the projection strongly elevated, rising to the same plane as the ventral surface of the mesocoxae; apex of projection set with a few setae. Metaventrite with distinct median glabrous area that is about as wide as long; total length of glabrous patch about half the metaventrite length. Metafemora with pubescence restricted to anterior fifth and extending distally to basal four-fifths.

Abdomen. Pubescence on ventrites 1-4 extremely fine and dense. Apex of fifth ventrite with a distinct glabrous patch along medioposterior margin, which extends three-fourths the width of the ventrite, and spans approximately the central third of the ventrite. Aedeagus (Fig. 7B) with parameres forming a single lobe, which is strongly constricted to a narrow, linear production in apical third; median lobe forming a narrow, tapering projection with a slight apical hook visible in lateral view.

Etymology. Named after the country from which it is known.

Distribution. Known from several localities in the interior of Suriname (Fig. 8), including the summit of Tafelberg Tepui.

Remarks. All series were collected from seepages on exposed granite. Specimens from the Grensgebergte mountains were collected by submerging tufts of moss and roots from grasses growing on the seepages into tubs of

water. The longer type series from Kasikasima, an enormous granite inselberg in southern Suriname, were collected by placing detrital debris that was on a granite seepage into pans of water (Fig. 10). In Short (2013), this species is recorded as "Hydrophilidae gen. nov. 3, sp. 1".



FIGURE 7. Aedeagi of *Radicitus* spp. A) *R. ayacucho*, B) *R. surinamensis*, C) *R. cf. granitum* (Suriname), D) *R. granitum* (Venezuela).

Radicitus cf. granitum

(Fig. 7C)

Material examined (14): SURINAME: Sipaliwini District: Tafelberg Summit, nr. Caiman Creek Camp, large seepage, 19.viii.2013, leg. Short & Bloom, SR13-0819-01A (13: SEMC, NZCS); Kappel Airstrip, seepage flowing into canal along airstrip, 24.viii.2013, leg. Short & Bloom, SR13-0824-02B (1: SEMC).

Remarks. These specimens were collected from both the summit of Tafelberg Tepui in central Suriname and a seep alongside Kappel Airstrip near its base. They closely resemble *R. granitum*, and we have been unable to

externally distinguish them from one another. The aedeagus of these specimens (Fig. 7C) is also extremely similar in form to *R. granitum*; however, there do appear to be some differences, including the narrowness of the apex of the parameres and curvature of the median lobe. These differences are apparent when comparing Figs. 7C and 7D, but there is variation and not all of these features are consistent in the series examined, and thus we are reluctant to base the concept of a fourth new species on this evidence alone. Given the significant disjunction between the localities in northwestern Venezuela and Tafelberg, we also refrain from assigning these specimens to *R. granitum* for the time being until genetic or other suitable data can be obtained to provide further insight into the relationships among these populations.



FIGURE 8. Distribution of Radicitus spp.

Key to species of Radicidus gen. n.

1	Elytra with coarsely punctate striae laterally and in posterior half (Fig. 4A). Fifth abdominal ventrite with a glabrous patch api- cally (Fig. 6A). Size slightly larger on average (4.7–6.2 mm)
-	Elytra without coarsely punctate striae (Fig. 4B). Fifth abdominal ventrite pubescent throughout (Fig. 6B). Size smaller, less
	than 5.0 mm
2	Glabrous region of fifth ventrite smaller, not exceeding half the width of the ventrite. Parameres each divided into two projec-
	tions (Fig. 7A)
-	Glabrous region of the fifth ventrite larger, extending three-fourths the width of the ventrite. Parameres not divided into two
	projections (Fig. 7B)

Discussion

We place *Radicitus* in the Acidocerinae (*sensu* Short & Fikáček 2013) based on the following characters: the presence of systematic punctures on the head, pronotum, and elytra, five-segmented tarsi, antennae with 9 antennomeres, inwardly curved maxillary palps, morphology of the mesoventral process, the short basal piece of the aedeagus, and lack of natatory setae and a sternal keel. However, the genus lacks some of the most common

features of the subfamily, such as long maxillary palps and an apical emargination of the fifth ventrite. These characters are also absent in other acidocerine genera such as the Old World *Agraphydrus*, which coincidentally also occurs frequently in seepage habitats (however, *Agraphydrus* is far smaller in size, not as strongly convex, and does not have rows of serial punctures). An additional affinity for the Acidocerinae is the egg-carrying ability of the females. This behavior is extremely rare in the Hydrophilidae, but common in several genera of Acidocerinae (e.g. *Helochares, Helobata*); it is also known to occur in the hydrophiloid families Epimetopidae and Spercheidae (Hansen 1991).

Given its somewhat problematic placement in the subfamily Acidocerinae, it should come as no surprise that the precise affinities of *Radicitus* relative to other genera of acidocerines are also unclear. We view the eggcarrying behavior as a very strong indicator that the genus is allied to the *Helochares*-group of genera. The genus *Helochares* itself also is quite morphologically variable (and possibly non-monophyletic), though we are not aware of any species that have the characters described here. Some of these characters (particularly the short palps) may possibly be ecologically correlated to seep habitats, but the shape of mesoventrite and condition of the abdominal ventrites not as easily accommodated.

The genus is currently a Guiana Shield endemic taxon. Extensive sampling in the Venezuelan Andes in comparable rock seep habitats did not yield any specimens. We suspect the genus is likely more widespread in the Guiana Shield region in areas that have inselbergs and other similar exposed rock habitat.



FIGURE 9. Habitat of *Radicitus* spp. in Venezuela. A) Venezuela, Bolivar State, 25 km E. El Burro (collecting event AS-08-077). B) Specimen of *R. granitum* clinging to root mat that was pulled from the margin of the seepage shown in A. C) Venezuela: Bolivar State, 15 km NE Pijiguaos (collecting event VZ10-0709-01B). D) Venezuela, Amazonas State, Tobogan de la Selva (collecting event AS-06-017).



FIGURE 10. Habitat of *Radicitus surinamensis*. A) Suriname, Grensgebergte Mountains (collecting event SR12-0312-01A). B) Suriname, Mt. Kasikasima (collecting event SR12-0324-01C).

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