

A rare ant on Samoa: first record of the cryptic subfamily Proceratiinae (Hymenoptera, Formicidae) and description of a new *Proceratium* Roger species

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Abstract

In this study we present a taxonomic update for the Oceanian *Proceratium*. A recent ant biodiversity survey in Samoa collected an unknown *Proceratium* species, which we describe here as *Proceratium silisili* **sp. n.** This new species also presents the first record of this genus, as well as the whole subfamily Proceratiinae, in Samoa. *Proceratium silisili* is clearly distinguishable from the other Oceanian *Proceratium* species based on the differences in petiole node shape, number of mandible teeth, shape of the abdominal segment IV, as well as the surface sculpture on the head. A detailed description of *P. silisili*, high-quality specimen images, as well as an identification key to Oceanian species and a diagnostic discussion are provided.

Keywords

Oceania, *Proceratium*, Samoa, taxonomy, *Proceratium silisili*

Introduction

Proceratium is the type genus of the Proceratiinae subfamily which also includes the genera *Discothyrea* Roger, *Probolomyrmex* Mayr, as well as the extinct *Bradoponera* Mayr. Within the subfamily, *Proceratium* represents the genus with the highest species diversity of currently 82 extant species (*Discothyrea*: 34, *Probolomyrmex*: 26 valid species; Bolton 2015). All three genera are more or less globally distributed, although comparatively patchily. *Discothyrea* and *Probolomyrmex*, however, both seem to be absent from temperate climates and most of the Nearctic and Palearctic regions. Many species live hypogaeically, nest in soil, leaf litter, rotten wood, under deep-set stones (Brown 1958a, Baroni Urbani and de Andrade 2003, Fisher 2005), but also in tree branches (Brown 1974). Due to cryptic lifestyles and local rarity uncertainties about their biologies and biogeographic distributions are high (Baroni Urbani and de Andrade 2003, Hita Garcia et al. 2014). Specialised predatory behaviour has been documented in both *Discothyrea* and *Proceratium*. Workers were carrying and feeding on arthropod (probably spider) eggs and storing them in their nests (Brown 1958a, 1958b, 1974, 1980, Dejean and Dejean 1998, Dejean et al. 1999, Fisher 2005b, Katayama 2013).

According to Hita Garcia et al. (2014) the taxonomy of the genus is in a moderately good condition, with a relatively recent global revision by Baroni Urbani and de Andrade (2003) providing a valuable basis for smaller taxonomic updates and regional revisions (Bharti and Wachkoo 2014, Fisher 2005b, Hita Garcia et al. 2014, Hita Garcia et al. 2015, Xu 2006). For Japan Onoyama and Yoshimura (2002) provided a taxonomic revision for the genus, raising the number of *Proceratium* species from three to four. With increasing use of subterranean sampling techniques, more new taxa can be expected in the future. For example, due to recent intensive collection efforts on Madagascar and neighboring islands (Fisher 2005a), 11 undescribed species have been recorded for the Malagasy region (Hita Garcia and Fisher, unpublished – see www.antweb.org) – which is a large number for this relatively small genus.

In the Oceanian region, nine species are presently known, eight of them recognized by Baroni Urbani and de Andrade (2003): *Proceratium austronesicum* De Andrade, 2003, *P. ivimka* De Andrade, 2003 and *P. snellingi* Baroni Urbani & de Andrade, 2003 in Papua New Guinea, *P. caledonicum* De Andrade, 2003 and *P. politum* De Andrade, 2003 in New Caledonia, *P. oceanicum* De Andrade, 2003 and *P. relictum* Mann, 1921 in Fiji, and *P. papuanum* Emery, 1897 in Malaysia, Indonesia, Papua New Guinea, Philippines, and the Solomon Islands. Earlier this year, Hita Garcia et al. (2015) described *P. vinaka* as a third Fijian *Proceratium* species (= *P.* sp FJ01 in Sarnat and Economo (2012)).

In the present publication, *Proceratium silisili* sp. n., the tenth Oceanian species, is described. It was collected on Samoa and represents the first record for both, the genus *Proceratium* and the subfamily Proceratiinae on these islands (Wetterer and Vargo 2003). Morphologically, it is very distinct from the other species found across the region and shows a unique combination of characters that distinguishes it from all other Oceanian *Proceratium* species. Thus, it seems likely that *P. silisili* sp. n. is not a

member of the *silaceum* clade as defined by Baroni Urbani and de Andrade (2003). This clade currently includes all other Oceanian species (Hita Garcia et al. 2015) and 20 species with very different geographic distributions. Judging by the presence of mostly ancestral character states and an absence of real synapomorphies in the majority of species belonging to this clade (Baroni Urbani and de Andrade (2003) – see strict consensus tree, fig. 29), it is possible that the *silaceum* clade is not a phylogenetic unit and instead comprises several unrelated clades. The outer morphology of *P. silisili* sp. n. more closely resembles that of several Neotropical *Proceratium* species in the *micrommatum* clade – in particular with mandibles often containing less than six teeth (e.g. *P. micrommatum* & *P. mexicanum* with 4 teeth), petiole node stoutly nodiform, not squamiform as in *silaceum* clade, ventral petiole process small triangular, and abdominal segment IV strongly recurved. However, since the different clades were defined on the basis of presence-absence analyses of 62 morphological characters, it seems prudent to exercise caution in equating them with true phylogenetic relationships. A phylogenetic analysis including molecular data would be the next logical step in untangling the taxonomy of this phylogenetically basal ant genus.

Abbreviations of depositories

The collection abbreviation follows Evenhuis (2015). The holotype of the new species will be deposited at the following institution:

OSAKA Osaka Museum of Natural History (OMNH), Osaka, Japan

Material and methods

The holotype of the new species was collected during an inventory of the ant fauna of Samoa in 2015 by C. Liu and E.M. Sarnat. Morphological observations and measurements were performed with a Leica M165 C stereomicroscope equipped with an orthogonal pair of micrometres at a magnification of 100×. Measurements were recorded in millimetres to three decimal places and rounded to two decimal places for presentation. The measurements and indices used in this study follow Hita Garcia et al. (2014, 2015) who introduced a few new measurements and indices to *Proceratium* taxonomy:

- EL** Eye length: maximum length of eye measured in oblique lateral view.
HL Head length: maximum measurable distance from the mid-point of the anterior clypeal margin to the mid-point of the posterior margin of head, measured in full-face view. Impressions on anterior clypeal margin and posterior head margin reduce head length
HLM Head length with mandibles: maximum head length in full-face view including closed mandible

HW	Head length: Maximum head width directly behind the eyes, measured in full-face view
HF_eL	Hind femur length: maximum length of hind femur measured along its external face
HT_iL	Hind tibia length: maximum length of hind tibia measured along its external face
HB_aL	Hind basitarsus length: maximum length of hind basitarsus measured along its external face
LT₃	Abdominal tergum III length: maximum length of abdominal tergum III (= length of segment III) in lateral view
LS₄	Abdominal sternum IV length: maximum length of abdominal sternum IV following Ward (1988)
LT₄	Abdominal tergum IV length: maximum length of abdominal tergum IV following Ward (1988)
PeL	Petiolar length: maximum length of the petiole in dorsal view including its anterior prolongation
PeW	Petiolar width: maximum width of petiole in dorsal view
SL	Scape length: maximum length of scape shaft excluding basal condyle
TL	Total body length: combined length of HLM + WL + PeL + LT ₃ + LT ₄
WL	Weber's length: diagonal length of mesosoma in lateral view from the anterior-most point of pronotal slope (excluding neck) to posteroventral margin of propodeal lamella or lobe
CI	Cephalic index: $HW / HL \times 100$
OI	Ocular index: $EL / HW \times 100$
SI	Scape index: $SL / HL \times 100$
DPeI	Dorsal petiole index: $PeW / PeL \times 100$
ASI	Abdominal segment index: $LT_4 / LT_3 \times 100$
IGR	Gastral reflexion index: LS_4 / LT_4

Results

Identification key to workers of Oceanic islands *Proceratium* (adapted from Baroni Urbani and de Andrade (2003), not including Papua New Guinea)

- 1 Dorsal face of petiole node sub-rectangular, almost as wide as long (DPeI 128) (Fig. 1A); mandibles with 4 distinct teeth; body covered with short, dense, decumbent pilosity, longer erect or suberect hairs completely absent; abdominal segment IV strongly recurved (IGR 0.25) (Fig. 1B) (Samoa) *P. silisili*
- Dorsal face of petiole node narrow and transversally compressed, distinctly wider than long (DPeI > 150) (Fig. 1C); mandibles with 6 or more teeth or denticles; longer erect or suberect hairs present in addition to short decumbent pilosity; abdominal segment IV distinctly less recurved (IGR 0.46–0.54) (Fig. 1D) 2

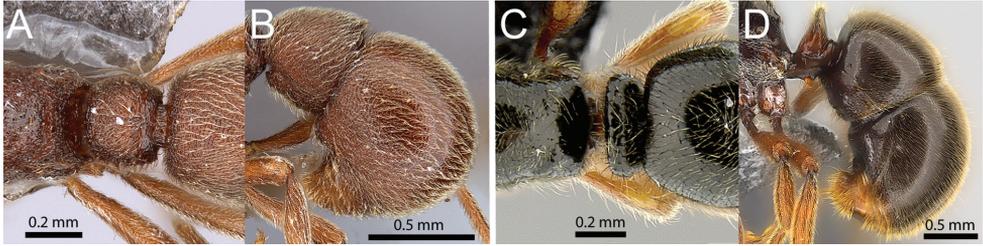


Figure 1. *Proceratium silisili* sp. n. (CASENT0741888). **A** Petiole in dorsal view **B** Gaster in profile. *Proceratium oceanicum* (CASENT0171053) **C** Petiole in dorsal view. *Proceratium relictum* (CASENT0194740) **D** Petiole in profile.

- 2 Subpetiolar process reduced and rounded without any distinct projections (Fig. 2A) (Fiji) *P. vinaka*
- Subpetiolar process not reduced and rounded, either with spiniform or subtriangular / subrectangular lamellate projections (Fig. 2B, C, D) **3**
- 3 Petiole shape in profile squamiform, dorsally distinctly narrower than at the base and anterior face oblique (Fig. 2B, C) **4**
- Petiole shape in profile flattened subrectangular, at apex not distinctly narrower than at the base and anterior face vertical or subvertical (Fig. 2D)..... **5**
- 4 Subpetiolar process spiniform (Fiji) (Fig. 2B) *P. oceanicum*
- Subpetiolar process lamellate, subtriangular (Fiji) (Fig. 2C) *P. relictum*

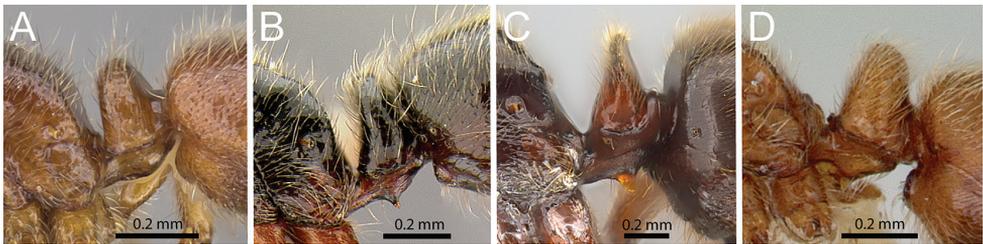


Figure 2. Petiole and subpetiolar process in profile view. **A** *Proceratium vinaka* (CASENT0187587) **B** *Proceratium oceanicum* (CASENT0171053) **C** *Proceratium relictum* (CASENT0194740) **D** *Proceratium caledonicum* (CASENT0172099).

- 5 Frontal lobes very small, each lobes' surface area covering less than clypeal area in between frontal lobes (New Caledonia) (Fig. 3A) *P. caledonicum*
- Frontal lobes larger than clypeal area between frontal lobes (Fig. 3B, C) **6**
- 6 Larger species (HL 0.69–0.74, WL 0.91–1.00); body smooth and shiny, head minutely punctate (New Caledonia) (Figs 3B, 4A) *P. politum*
- Distinctly smaller species (HL 0.55–0.60, WL 0.66–0.70); head and body weakly punctate (Fig. 3C, 4B) (Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands)..... *P. papuanum*

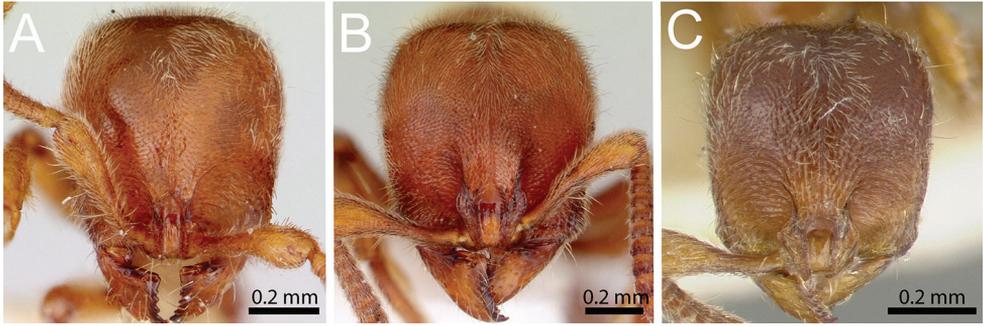


Figure 3. Head in full-face view. **A** *Proceratium caledonicum* (CASENT0172099) **B** *Proceratium politum* (CASENT0172113) **C** *Proceratium papuanum* (CASTYPE06965).



Figure 4. Body in profile view. **A** *Proceratium politum* (CASENT0172113) **B** *Proceratium papuanum* (CASTYPE06965).

***Proceratium silisili* Liu, Fischer & Economo, sp. n.**

<http://zoobank.org/9AB0E143-16D2-4006-AEC1-F356097C9F03>

Fig. 5

Type material. Holotype. Pinned worker, Samoa, Savai, 5.4km SSW A'opo vil, Mt. Silisili, 13°38'10"S, 172°30'23"W, 1200m, montane rainforest, leaf litter, 22.iv.2015 (*E. Sarnat & C. Liu*) (OSAKA: CASENT0741888).

Diagnosis. *Proceratium silisili* differs from the other Oceanian members of *Proceratium* by the following combination of characters: mandible with 4 distinct teeth; petiole node in dorsal face-view subrectangular, almost as long as wide (DPeI 128); abdominal segment IV in profile view strongly recurved (IGR 0.25), highly rounded and almost spherical in its appearance; whole body very densely punctate, except for small smooth and shiny spot posterior of frontal lobes; pilosity dense, uniformly short and decumbent, long and erect or suberect hairs completely absent. Using the above character combination, *P. silisili* can also be distinguished easily from its geographically closest congeners in Fiji. *Proceratium oceanicum*, *P. relictum* and *P. vinaka* all have elongate-triangular mandibles with relatively long masticatory margins and more than six teeth

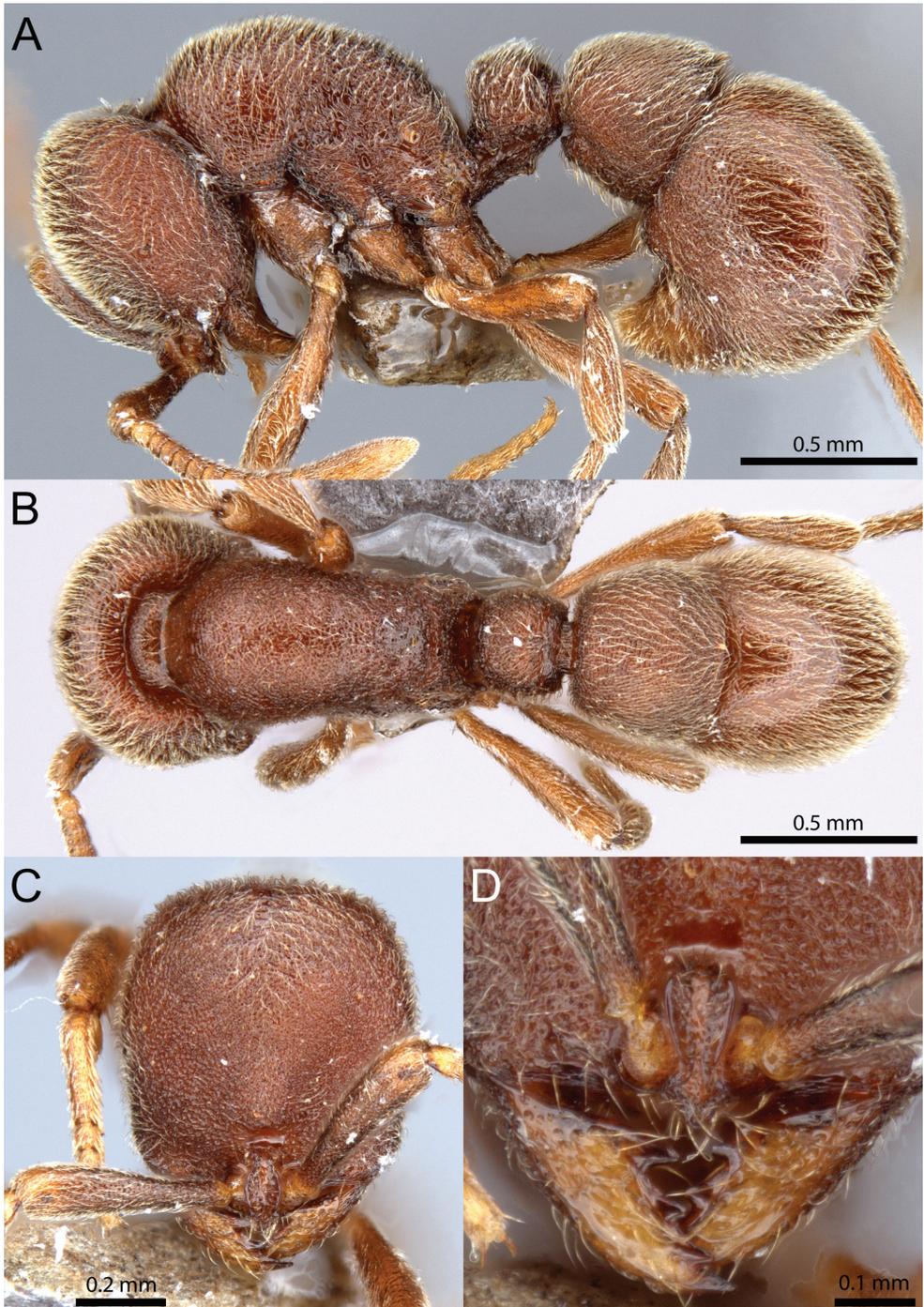


Figure 5. *Proceratium silisili* sp. n. (CASENT0741888). **A** Body in profile **B** Body in dorsal view **C** Head in full-face view **D** Mandible in frontal view.

or denticles, petiole in profile either squamiform or narrow, transversally compressed subrectangular, abdominal segment IV not strongly recurved ($IGR > 0.45$), and long standing hairs present.

Worker measurements (N=1). TL 3.36; EL 0.04; SL 0.56; HL 0.83; HLM 0.99; HW 0.75; WL 0.97; HFeL 0.65; HTiL 0.52; HBaL 0.27; PeL 0.24; PeW 0.31; DPeL 128; LT3 0.4; LS4 0.2; LT4 0.8; OI 6; CI 90; SI 74; IGR 0.25; ASI 204.

Worker description. In full-face view, head subrectangular, longer than wide (CI 90), sides and posterior head margin convex. Mandibles with four distinct, well developed teeth, curved triangular with short masticatory margin. Clypeus strongly reduced, anteromedially with a small, triangular projection, anterolaterally reduced to extremely narrow with a thin wall in front of antennal sockets. Frontal carinae absent or vestigial, frontal lobes narrow, not covering the antennal sockets, posteriorly strongly convergent, ending just after posterior limit of antennal sockets. Eyes very small (OI 6), consisting of single ommatidium.

Mesosoma in profile convex, almost as long as maximum head length including mandibles. Lower mesopleuron with well impressed sutures, propodeum without posterior teeth, propodeal lobes small, reduced and blunt, posterior declivity relatively steep, in posterolateral and posterodorsal view separated from lateral propodeum by a distinct margin, propodeal spiracle circular and facing posterior end of mesosoma, situated slightly above mid height. Front and hind tibia with pectinate spur present, both without calcar of strigil, mesotibial spur absent, pretarsal claws simple, arolia absent. Petiole node in profile about as high as long, anterior face almost vertical, the dorsum almost flat, anteriorly and posteriorly weakly rounded, in dorsal view subrectangular with convex sides and slightly wider than long (DPeL 128), ventral process a small, blunt tooth.

Abdominal segment III in dorsal view anteriorly wider than petiole, posteriorly diverging, in profile abdominal sternite III anterolaterally with small, angulate anterior projection on either side of shallow median depression. Constriction between abdominal segments III and IV distinctly impressed. Abdominal segment IV strongly recurved ($IGR 0.25$), highly rounded and almost spherical in its appearance, abdominal tergum IV about twice as long as abdominal tergum III (ASI 204). Remaining abdominal segments reduced and comparatively inconspicuous, curved forwards.

Whole body in profile and in dorsal view covered with uniform dense layer of short, decumbent hairs, longer erect hairs completely absent.

Sculpture on mandibles irregularly punctate, on remainder of body very densely punctate, except for small smooth and shiny spot posterior of frontal lobes. Punctuation also less strongly developed on abdominal segment IV, tergum IV appearing more shiny.

Body color dark red, legs and flagella of lighter, reddish brown coloration.

Distribution and ecology. At present, the new species is only known from Savai island in Samoa, and is likely endemic to Samoa. The type locality is a montane rainforest on Mt. Silisili, situated at an elevation of 1200m. Only one single worker of the new species was collected through leaf litter extraction. The genus *Proceratium* has not been previously reported from Samoa according to the GABI database (Guénard et

al. in review). There is no additional information about its ecology due to the limited available material.

Taxonomic notes. The identification of *P. silisili* within the Oceanian region can be easily performed with the character combination given in the diagnosis. The new species is morphologically distinct from all the other members in the Oceanian region. It is thus possible that the Samoa species has a different origin than the other species in the region and that it is a descendent of a New World ancestor from the *micrommatum* clade. Several of the observed morphological characters are in support of this hypothesis: the mandibles have four teeth only, clypeus medially narrow with triangular projection, and mesotibiae without pectinate spur present. Also the subrectangular shape of the petiole and the absence of a lamellate ventral process, as well as the strongly recurved and almost spherical shape of the abdominal segment IV point in the same direction, although a triangular to strongly reduced ventral process can also be observed in the *Proceratium* species present on Fiji. A more definitive placement of the new species within the genus phylogeny, however, has to be postponed until more conclusive (e.g genetic) data can be analysed.

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