



## A taxonomic revision of the *Pheidole roosevelti*-group (Hymenoptera: Formicidae) in Fiji

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### Abstract

This taxonomic revision treats a radiation of Fijian ants described here as belonging to the *Pheidole roosevelti*-group. Many of the species belonging to the group exhibit remarkable modification to the shape of their propodeal spines, mesonotums and heads. Seven species, five of which are described as new, are recognized: *P. bula* **sp. n.**, *P. colaensis* Mann 1921, *P. furcata* **sp. n.**, *P. pegasus* **sp. n.**, *P. roosevelti* Mann 1921, *P. simplispinosa* **sp. n.**, and *P. uncagena* **sp. n.** Descriptions and diagnostic keys are provided for the minor workers, major workers and queens. All species are illustrated with digital images, and their distributions across the Fijian archipelago are illustrated with a map. The group is compared to congeners known from the Pacific Island region with special attention given to species of the *Pheidole quadricuspis*, *P. quadrispinosa* and *P. cervicornis* groups. The biogeography of the group is briefly discussed. Preliminary morphological study suggests the group is monophyletic and most closely related to species of the *P. cervicornis*-group Emery from New Guinea.

**Key words:** Biogeography, Fiji, key to species, taxonomy, zoogeography

## Introduction

The *Pheidole roosevelti*-group (Formicidae: Myrmicinae), as recognized here, consists of seven ant species endemic to the montane forests of the Fiji Islands. Although Fiji supports an unusually rich number of endemic ant radiations (Mann, 1921; Sarnat, 2006; Ward & Wetterer, 2006; Wilson, 1959a; Wilson, 1961), few among them compare to the spectacular morphological modifications achieved by the *Pheidole roosevelti*-group. Despite a remarkable morphology, unusual ecology and enigmatic evolutionary history, this distinct group of *Pheidole* species has received little attention since its initial discovery nearly a century ago. The group is diagnosable from all other *Pheidole* by the unusual posterior mesonotal process and corresponding concave mesonotal declivity exhibited by the minor worker (Fig. 3), in combination with the lack of pronotal spines or processes. Within the group, there exist distinctive modifications of the propodeal spines and acute margination of the posterior region of the head.

In addition to their unique appearance, species of the *P. roosevelti*-group are characterized by a distinctive natural history. All species prefer the cooler, undisturbed wet forests of higher elevation mountains – a habitat where Fijian ant diversity becomes substantially diminished. Although ranges are often small, with some species known only from the moss forests of single mountain summits, the ants of the *P. roosevelti*-group are surprisingly abundant where populations persist. Where they do occur, minor workers patrol the ground and lower vegetation with long striding legs and sweeping antennae. Although most of the foraging is observed to be solitary, the species will recruit strongly to desirable food resources. While the minor caste is often ubiquitous in the vicinity of the nest site, the major caste is rarely seen above ground and is usually captured only by excavation of the nest or by patient baiting. Even if workers cannot be found foraging, the conspicuous vertical turret entrances of their nests, which stand 2-5 cm above the bare soil, serve as evidence of their presence.

Until the last five years, the only records of the group were from Fiji's largest and oldest island, Viti Levu, and the nearby island of Ovalau (Ward & Wetterer, 2006). Records of the group are now known from the highest peaks of all of the archipelago's main islands (Viti Levu, Vanua Levu, Taveuni, Kadavu) in addition to those of the smaller islands of Koro and Ovalau. Unlike the diversity of *Lordomyrma* Emery in Fiji, which is concentrated on Viti Levu (Sarnat, 2006), the diversity of the *P. roosevelti*-group is more evenly dispersed across the archipelago, with each of the larger islands supporting a distinct fauna. A salient question for this unique group is from which region, and from what lineage, it is derived. While the modified spines bear superficial resemblance to species previously assigned to the erstwhile Old World subgenus *Pheidole* (*Pheidolacanthinus*) F. Smith, the species of the *P. roosevelti*-group all bear consistent morphological distinctions that separate them from any other *Pheidole* species. A detailed phylogenetic study of the *P. roosevelti*-group holds the potential to illuminate biogeographic patterns and processes both within the Fijian archipelago and between Fiji and other regions of the Pacific.

## Taxonomic history

The taxonomic history of the *Pheidole roosevelti*-group reflects the aberrant morphology of its species and the uncertainty of its relationship to other groups within the genus. The first two species of the group were discovered by W. M. Mann during his survey of the Fiji Islands, and their descriptions appear in his subsequent monograph (1921). Acknowledging the resemblance of *P. roosevelti* Mann and *P. colaensis* Mann to *P. cervicornis* Emery of New Guinea, Mann nevertheless erected a new subgenus for the Fijian species, *Pheidole* (*Electropheidole*), based on the lack of pronotal spines (present on *P. cervicornis*) and the “lamellate development of the mesothorax [mesonotum], in the soldier and worker...and elongate, bifurcate epinotal [propodeal] spines and the distinctly margined head of the worker.”

Although both *P. roosevelti* and *P. colaensis* were collected over the next century, the only explicit discussions of the group are found in E. O. Wilson's work on the Melanesian ant fauna. Wilson (1959b), in discussing the ecology of *P. cervicornis*, considered the species as belonging to *Electropheidole*. However, Emery (1921) had already placed *P. cervicornis* in its own *P. cervicornis*-group in the subgenus *Pheidole* (*Pheidolacanthinus*). The next mention of *Electropheidole* occurs in Wilson's (1961) argument for the taxon cycle, in which he discussed the faunas of various Melanesian islands, including both New Guinea and Fiji. Although it is apparent in the work that Wilson considered *Electropheidole* distinct from *Pheidolacanthinus*, it is not clear if he was including *P. cervicornis*, or other non-Fijian *Pheidole*, in the former. *Electropheidole* is treated as a provisional junior synonym of *Pheidole* by Brown (1973), and as a junior synonym by D. R. Smith (1979). The first use of the nominal *P. roosevelti*-group appears in Wilson's (2003) revision of the New World *Pheidole*. In a brief discussion of the Old World *Pheidole*, Wilson ambiguously treats the *P. roosevelti*-group as either synonymous to, or part of, *Electropheidole*, and distinct from the *P. sexspinosa*-group and *Pheidolacanthinus*, although neither group is inclusively defined.

The *P. roosevelti*-group, as defined here, is reserved for the two Fijian species originally assigned to *Electropheidole* by Mann (1921) together with the five new species described below. The wisdom of defining such a group, to the exclusion of *P. cervicornis* and other spinescent members of the genus, will be judged by future phylogenetic analyses of Old World *Pheidole*.

## Sources and deposition of material

Although several museum collections serve as evidence that, over the course of the last century, a few intrepid individuals managed to obtain specimens of *Pheidole roosevelti* and *P. colaensis* from Viti Levu, the majority of the new records and new species collected since Mann's initial survey of the archipelago were collected by the author during three field expeditions from 2005—2007. Additional material was collected by a large survey of leaf litter arthropods conducted by the Wildlife Conservation Society (WCS) from 2002—2003 (Evenhuis & Bickel, 2005), and by extensive malaise trapping of arboreal and alate arthropods conducted by the Schlinger Fiji Bioinventory of Arthropods and the NSF Fiji Terrestrial Arthropod Survey with the help of WCS and local villagers (Evenhuis & Bickel, 2005). All specimens collected by the author are stored in 95% ethanol until pinned.

Holotypes and voucher specimens will be deposited in the Fiji National Insect Collection (FNIC), Suva. Where sufficient specimens allow, paratypes and positively identified specimens will be deposited in the ANIC (Australian National Insect Collection, CSIRO, Canberra, Australia), LACM (Natural History Museum of Los Angeles County, Los Angeles, CA, USA), MCZC (Museum of Comparative Zoology Collection, Cambridge, MA, USA), and NMNH (National Museum of Natural History, Washington D.C., USA). The NMNH, on account of its significant collection of Fijian ants (namely those of W. M. Mann) and active sequencing facilities is the repository of voucher specimens stored in 95% ethanol.

Additional identification tools, including a Lucid3 matrix key, images of type specimens, queens and males will be made available through the portals <<http://www.fijiants.org>> and <<http://www.antweb.org/fiji.jsp>>.

## Definition of morphological terms

Unless otherwise noted, morphological terms follow the definitions used in Table 2–5 of Hölldobler & Wilson (1990) and the glossary with corresponding figures 523–531 in Bolton (1994). Morphology specific to the queen caste, particularly the mesonotum, follows Richards (1977). Terms requiring further explanation are defined below, and additional morphological terms are defined in Table 1.

**TABLE 1.** Measurements and indices used for morphological analysis. Measurements are listed in the order in which they appear in the species descriptions. Abbreviations for major workers, minor workers and queens are as follows: S = major, W = minor, Q = queen.

Measurement	Description	Caste	View
TL	<i>Total length</i> : maximum length of specimen measured from the tip of the mandibles to the tip of the gaster, not including sting.	S, W, Q	lateral
HW	<i>Head width</i> : maximum width of head not including the eyes.	S, W, Q	full face (Fig. 1)
HL	<i>Head length</i> : maximum length of head from the posterior margin to the tip of the anterior clypeal margin measured along the midline.	S, W, Q	full face (Fig. 1)
CI	<i>Cephalic index</i> : HW/HL	S, W, Q	
FL	<i>Metafemur length</i> : length of metafemur measured along its long axis.	S, W, Q	posterior or anterior (Fig. 5)
FI	<i>Metafemur length index</i> : FL/HL	S, W, Q	
SL	<i>Scape length</i> : length of first antennal segment excluding the radicle.	S, W, Q	dorsal (Fig. 6)
SI	<i>Scape index</i> : SL/HL	S, W, Q	
AE	<i>Propodeal spine anterior edge</i> : maximum length of propodeal spine measured from the middle of propodeal spiracle to anterior point.	W	lateral (Fig. 3)
DE	<i>Propodeal spine dorsal edge</i> : maximum length of propodeal spine measured from anterior point to posterior point.	W	lateral (Fig. 3)
PSI	<i>Propodeal spine index</i> : DE/AE	W	
ML	<i>Mesonotal length</i> : maximum length of mesonotum measured along longitudinal axis.	Q	
MI	<i>Mesonotum length index</i> : ML/HW	Q	

*Posterior margin of head* (Fig. 1). In full face view, the visible edge furthest from the mandibles. Although many authors refer to this region as the *occipital margin*, the occiput is mostly obscured in the Formicidae (owing to the prognathous position of their heads), and is often not visible in full face view.

*Posterolateral lobes* (Fig. 1). In full face view of the major worker, the lateral lobes formed by the median emargination of the posterior margin of the head. Although many authors refer to these as the *occipital lobes*, the occiput, as explained above, is often not visible in full face view.

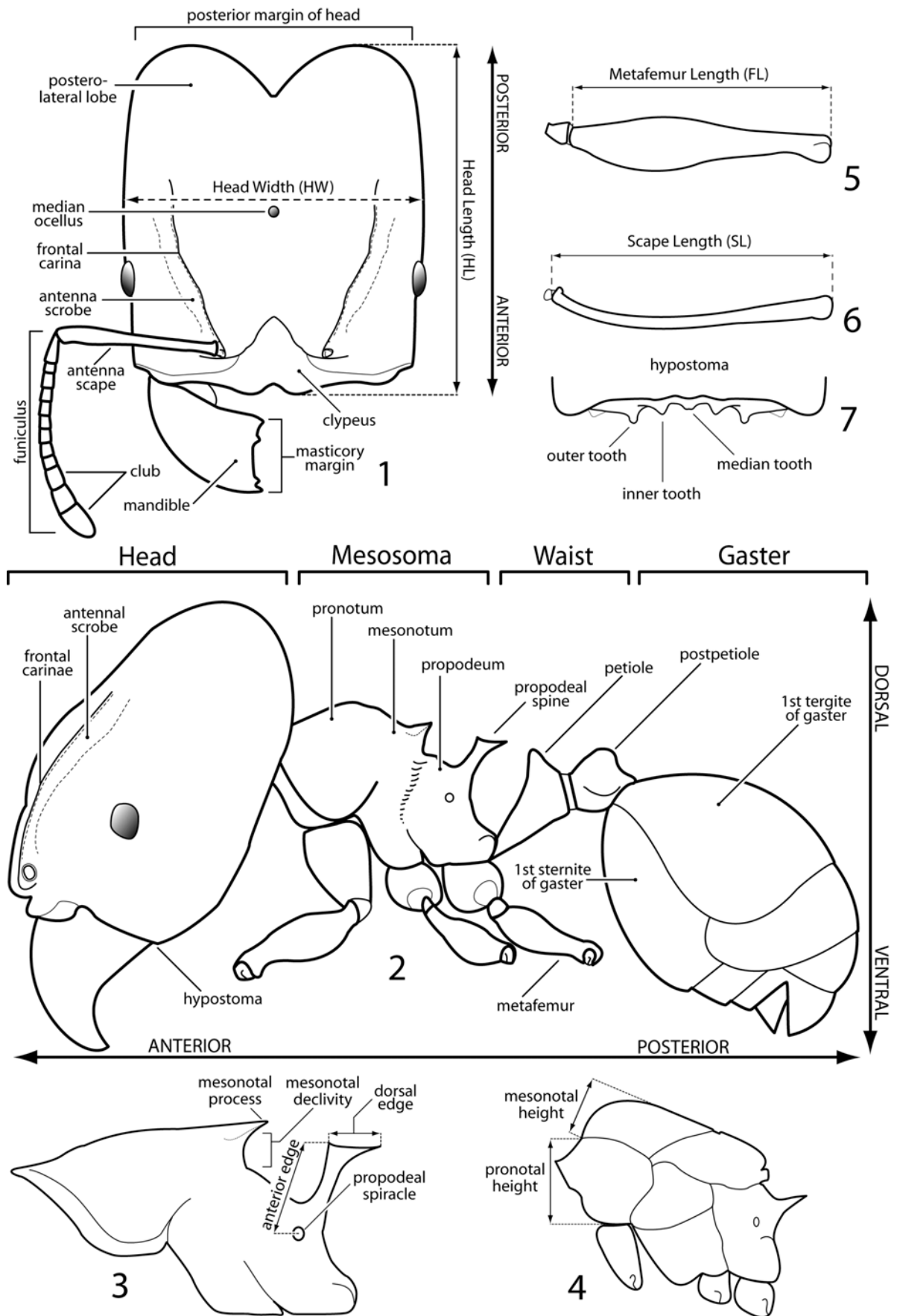
*Genal carina* (Figs. 25, 27b, 28b). The ventral portion of the occipital carina delineating the postgena from the occiput (Gauld & Bolton, 1988). Richards (1977) does not differentiate between the dorsal and ventral portions, and defines the entire delineation as the occipital carina. In the *Pheidole roosevelti*-group, the genal carinae are best observed from the lateral and oblique posterior views. The occipital (dorsal portion) of the carina is absent, such that the genal carinae (ventral portions) originate on the ventrolateral surface of the head. In some species of the *P. roosevelti*-group, the genal carinae form a ventral collar around the foramen, and in other species the carinae diverge away from the foramen and terminate without joining together ventrally.

*Mesonotal process*. In profile, the posteriormost portion of the mesonotum often forms a tapering plate or lamellate process that overhangs the propodeum (Figs. 3, 9a, 10a, 22a), but is occasionally truncated (Fig. 8a, 21a). It is present in minors, and to a lesser extent in majors, of the *P. roosevelti*-group.

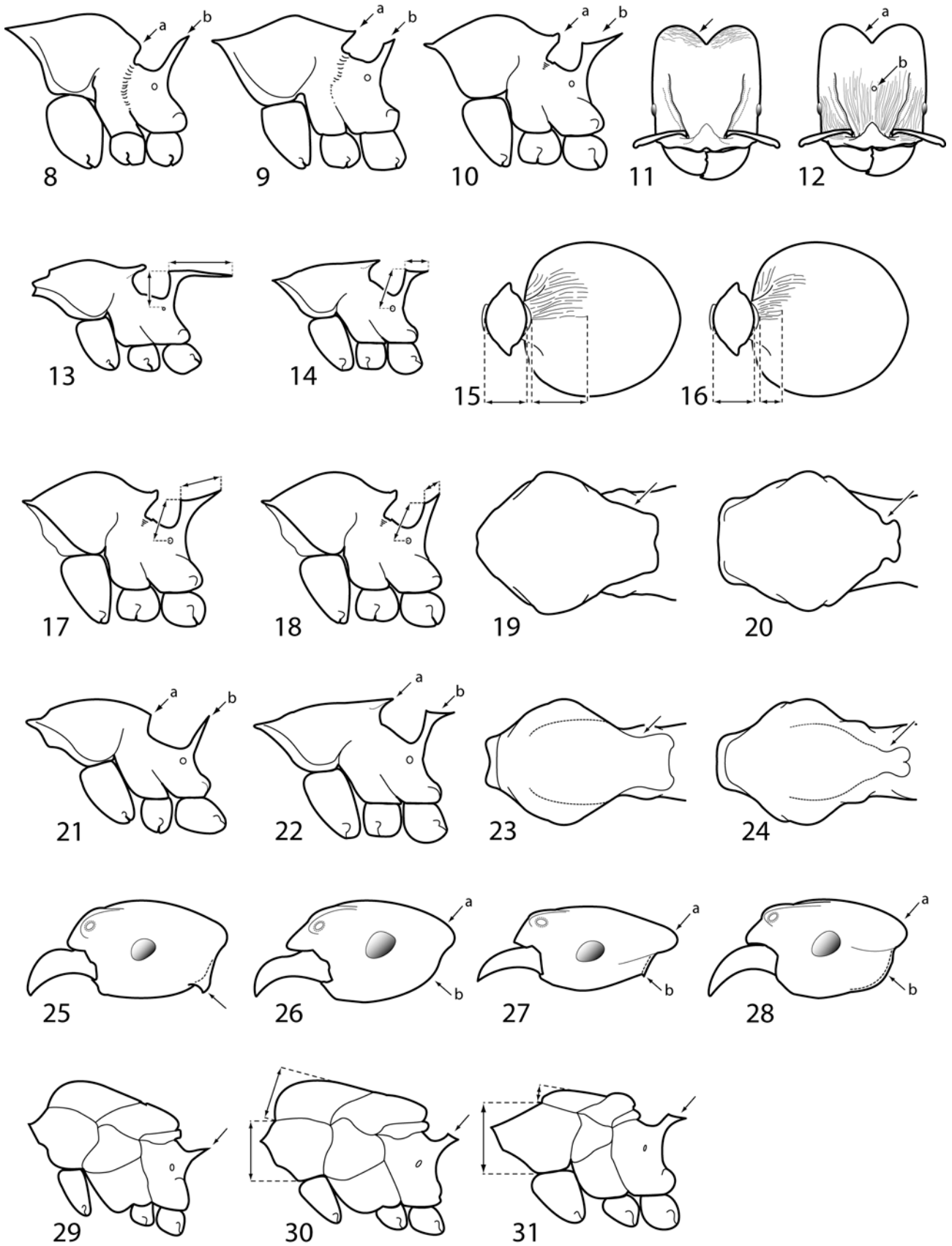
*Mesonotal declivity* (Fig. 3). In profile, the slope connecting the mesonotum to the propodeum.

#### Explanation of collection data

An effort is made to keep the format of collection data consistent throughout the study. The format is as follows.



**FIGURE 1–7.** Morphological terms and features. **1**, full face view; **2**, profile; **3**, mesosoma of worker caste; **4**, mesosoma of queen caste; **5**, metafemur length; **6**, scape length; **7**, hypostoma.



**FIGURES 8–31.** Morphological characters used to diagnose species.

COUNTRY. *Island*: Locality, day.month.year, elevation [meters], latitude [decimal degrees], longitude [decimal degrees], ecological community, behavioral and collection notes, (*Collector*), collection code [EMS codes refer to collections and corresponding data made by the author; FJ codes correspond to localities of the Fiji Terrestrial Arthropod Survey], *number of pinned individuals of a given caste* (specimen label [CASENT numbers correspond to unique codes generated by the California Academy of Sciences and assigned to individual specimens]).

#### Morphological analysis, measurements and indices

A total of 308 specimens (86 majors, 201 minors, 1 alate queen, 15 dealate queens and 4 males) from 50 collection series were studied in order to examine intraspecific and interspecific variation. All specimens were studied with respect to relative morphology using a Leica MZ7.5 dissecting microscope at magnifications ranging from 6.3x–50x. Series of standardized measurements were recorded to the nearest 0.001 mm at magnifications of 40x–70x, and reported in the species descriptions rounded to the nearest 0.01 mm. A total of 62 minors, 44 majors and 16 queens were measured using the Auto-Montage Pro® software package (Syncroscopy) in combination with a JVC KY-F75U digital camera mounted on a Leica MZ16 dissecting scope. Measurements and indices used in the study are defined below and illustrated in Figures 1–7.

#### Demarcation of species

Species are defined here under the premise of the biological species concept. However, without the benefit of experimental breeding or molecular phylogenetic analysis, inference of species boundaries is based on gross comparative morphology and aided by known geographic distributions. Where multiple populations exhibiting consistently different phenotypes occur in sympatry, they are considered different species. Where such populations are not found in sympatry, more caution is taken in ascribing them to separate species. Demarcation of ant species within the Fijian archipelago is made difficult because suitable habitat (land) is often isolated from other such habitats by vast, but not insurmountable, stretches of unsuitable habitat (ocean). Demarcation of species within the archipelago's *Pheidole roosevelti*-group is further complicated in that even within a single island, suitable habitats (high elevation montane forests) are often isolated from other such habitats by wide expanses of unsuitable habitats (lowlands) that have been under intense human cultivation for the past several thousand years.

#### Diagnosis of the *Pheidole roosevelti*-group

The species of the *Pheidole roosevelti*-group can be distinguished from those of other congeners by the following combination of characters.

1. Mesonotum of major and minor workers with a posteriorly projecting process.
2. Mesonotal declivity of major and minor workers concave.
3. Propodeal spines elongate and either simple or modified apically into an angulate point or bifurcation.
4. Pronotal spines or projections absent.
5. Hypostoma of major worker with a well developed median tooth, one pair of inner teeth, and one pair of outer teeth.
6. Palp formula 2:2 in major and minor workers.
7. Petiole peduncle elongate.
8. Occipital carina absent dorsally.

The recent discovery of five new species and an examination of additional material for the two previously described species requires a broadening of the original diagnosis outlined by Mann (1921) for the *P.*

*roosevelti*-group. *Pheidole simplispinosa* **sp. n.**, with its simple propodeal spines, truncated mesonotal process and unmargined head, is both the most aberrant of the group and the primary cause for broadening the definition. However, compared to other *Pheidole* of the Pacific region, *P. simplispinosa* is more similar in morphology to the other members of the *P. roosevelti*-group than to any other species examined.

#### Synopsis of *Pheidole roosevelti*-group

*P. bula* **sp. n.**

*P. colaensis* Mann, 1921

*P. furcata* **sp. n.**

*P. pegasus* **sp. n.**

*P. roosevelti* Mann, 1921

*P. simplispinosa* **sp. n.**

*P. uncagena* **sp. n.**

#### Key to species

The following keys diagnose the known minor workers, major workers, and queens of each species included in the *Pheidole roosevelti*-group with the exception of the queen caste of *Pheidole uncagena* sp. n, which is unknown.

#### Minors

- 1 Propodeal spines simple, evenly tapering to a single straight acuminate point without becoming bifurcate or angulate apically (Figs. 21b, 48); mesonotal process truncated into a blunt process without lamellate or distinct posterior margin (Figs. 21a, 48); head as broad as long, scapes shorter, metafemur shorter (CI 0.98–1.03, SL 0.77–0.85, FL 0.80–0.91,  $n = 10$ ) ..... *P. simplispinosa*, **sp. n.**
- Propodeal spines modified apically with bifurcate or angulate tip, but never evenly tapering to a single straight acuminate point (Figs. 22b, 33, 36, 39, 42, 45, 51); mesonotal process with lamellate or acute posterior margin (Figs. 22a, 33, 36, 39, 42, 51); head longer than broad, scapes longer, metafemur longer (CI 0.87–0.96, SL 0.97–1.66,  $n = 51$ ) ..... 2
- 2 Head, in full face view, smooth and shining above level of eyes (Figs. 35, 41, 50); promesonotum, in dorsal view, smooth and shining (Figs. 37, 43, 52) ..... 3
- Head, in full face view, rugose to rugoreticulate above level of eyes (Figs. 32, 38, 44); promesonotum, in dorsal view, transversely rugose to rugoreticulate (Figs. 34, 40, 46) ..... 5
- 3 Head venter, in profile, with genal carinae modified into elevated flanges (Figs. 25, 51); mesonotal process, in dorsal view, strongly attenuated (Figs. 24, 52); head, in full face view, oval shaped without posterolateral corners forming obtuse angles (Fig. 50); propodeal spines with dorsal edge approximately as long as anterior edge (PSI 0.87–1.13,  $n = 8$ ); color of petiole, postpetiole and gaster distinctly lighter than mesosoma and head ..... *P. uncagena*, **sp. n.**
- Head venter, in profile, with genal carinae either indistinct (Fig. 26b) or forming a collar around foramen (Fig. 27b), but never modified into elevated flanges; mesonotal process, in dorsal view, broad (Figs. 23, 37, 43); head, in full face view, subquadrate with posterolateral corners forming obtuse angles (Figs. 35, 41); propodeal spines with dorsal edge either distinctly shorter than anterior edge (PSI 0.29–0.77,  $n = 8$ ) or distinctly longer than anterior edge (PSI 1.46–1.71,  $n = 9$ ); color of petiole, postpetiole and gaster either lighter or same as mesosoma and head ..... 4
- 4 Propodeal spines with dorsal edge distinctly longer than anterior edge (PSI 1.46–1.71,  $n = 9$ ) (Figs. 13, 42); posterior of head strongly pinched dorsoventrally (Figs. 27a, 42), appearing flattened in profile and



- shield-like in full face view; color of petiole, postpetiole and gaster distinctly lighter than mesosoma and head; scapes longer, metafemur longer (SL 1.21–1.27, FL 1.58–1.66,  $n = 9$ ) ..... *P. pegasus*, **sp. n.**
- Propodeal spines with dorsal edge distinctly shorter than anterior edge (PSI 0.29–0.77,  $n = 8$ ) (Figs. 14, 36); posterior of head weakly pinched dorsoventrally (Figs. 26a, 36), but not appearing flattened in profile or a shield-like in full face view; color of petiole, postpetiole and gaster same as mesosoma and head; scapes shorter, metafemur shorter (SL 0.99–1.06, FL 1.12–1.23,  $n = 8$ ) ..... *P. colaensis*
- 5 Head venter smooth and shining (Fig. 39); in profile, genal carinae inconspicuous (Figs. 26b, 39) .....  
..... *P. furcata*, **sp. n.**
- Head venter sculptured (Figs. 33, 45); strongly produced genal carinae present (Figs. 28b, 33, 45) .....6
- 6 Head, in full face view, with strongly branching network of longitudinal and transverse rugae (Fig. 44); spaces between head rugoreticulum strongly foveolate; pronotum, in dorsal view, rugoreticulate (Fig. 46); mesonotal process, in dorsal view, broadly lamellate and with a medially excised posterior margin (Fig. 46) ..... *P. roosevelti*
- Head, in full face view, with discontinuous longitudinal rugae that branch occasionally, but become rugoreticulate only on posterolateral corners of head (Fig. 32); spaces between head rugae smooth and shining; pronotum, in dorsal view, shining with transverse rugae (Fig. 34); mesonotal process, in dorsal view, narrowly lamellate with flat to weakly concave posterior margin (Fig. 34) ..... *P. bula*, **sp. n.**

#### Majors

- 1 Mesonotal process, in profile, truncated into a blunt angle without lamellate or acute posterior margin (Figs. 8a, 69); propodeal spines simple, evenly tapering to a single straight acuminate point without becoming bifurcate or angulate apically (Figs. 8b, 69); posterolateral lobes, in full face view, with distinct transverse rugae extending from median cleft to posterolateral corners (Figs. 11, 68); scapes short (SL 0.73–0.84,  $n = 9$ ) ..... *P. simplispinosa*, **sp. n.**
- Mesonotal process, in profile, with acute posterior angle or lamella (Figs. 9a, 10a, 54, 57, 60, 63, 66, 72); propodeal spines usually modified apically with bifurcate or angulate tip (Figs. 9b, 10b, 54, 57, 60, 63, 66, 72); posterolateral lobes, in full face view, variably sculptured but never with distinct transverse rugae extending from median cleft to posterolateral corners (Figs. 53, 56, 59, 62, 65, 71); scapes of variable length (SL 0.90–1.19,  $n = 35$ ) .....2
- 2 Posterolateral lobes, in full face view, smooth and shining without rugae or carinae (Figs. 12a, 56); median ocellus present and well developed (Figs. 12b, 56); intercarinular spaces on head smooth and shining; postpetiole with anterior face and dorsum smooth and shining without rugulae; gaster with basal portion of first tergite smooth and shining (Fig. 58) ..... *P. colaensis*
- Posterolateral lobes, in full face view, sculptured with rugae or carina (Figs. 53, 59, 62, 65, 68, 71); median ocellus present or absent; intercarinular spaces on head smooth and shining to foveolate; postpetiole with anterior face and dorsum smooth and shining to rugulose-foveolate; gaster with basal portion of first tergite smooth and shining to densely sculptured .....3
- 3 Posterolateral lobes, in full face view, rugoreticulate, such that longitudinal rugae are intersected by transverse rugae (Figs. 53, 59, 65); pronotum, in dorsal view, rugoreticulate, such that transverse rugae are often intersected by longitudinal rugae (Figs. 55, 61, 67); sides of petiole, in posterior view, subparallel without laterally projecting processes .....4
- Posterolateral lobes, in full face view, carinate, such that longitudinal carinae are not intersected by transverse carinae (Figs. 62, 71); pronotum, in dorsal view, rugose, such that transverse rugae not intersected by longitudinal rugae (Figs. 64, 73); sides of petiole, in posterior view, emarginated with laterally projecting processes .....6
- 4 Posterolateral lobes, in full face view, with rugoreticulum terminating before obtaining posterior margin (Fig. 59); in dorsal view, length of median basigastral sculpturing immediately posterior to postpetiole

- attachment longer than length of postpetiole (Figs. 15, 61); head shorter (HL 1.95–2.04,  $n = 7$ ) ..... *P. furcata*, **sp. n.**
- Posterolateral lobes, in full face view, with rugoreticulum obtaining posterior margin (Figs. 53, 65); in dorsal view, length of median basigastral sculpturing immediately posterior to postpetiole attachment shorter than length of postpetiole (Figs. 55, 67); head longer (HL 2.06–2.38,  $n = 13$ ).....5
- 5 Head, in full face view, with intercarinular spaces densely and distinctly foveolate (Fig. 65); postpetiolar dorsum, in dorsal view, rugulose with foveolate interspaces; scapes shorter relative to head (SI 0.41–0.46,  $n = 8$ )..... *P. roosevelti*
- Head, in full face view, with intercarinular spaces smooth and shining to weakly impressed, but never densely nor distinctly foveolate (Fig. 53); postpetiolar dorsum, in dorsal view, smooth and shining; scapes longer relative to head (SI 0.48–0.53,  $n = 5$ )..... *P. bula*, **sp. n.**
- 6 Propodeal spines, in profile, with dorsal edge as long as or longer than anterior edge (Figs. 17, 63); mesonotal process, in dorsal view, broad basally (Figs. 19, 64); petiole with posterior face smooth and shining; head wider, metafemur longer, scapes longer (HW 2.20–2.35, FL 1.59–1.66, SL 1.15–1.19,  $n = 3$ ) ..... *P. pegasus*, **sp. n.**
- Propodeal spines, in profile, with dorsal edge distinctly shorter than anterior edge (Figs. 18, 72); mesonotal process, in dorsal view, strongly attenuated basally (Fig. 20, 73); petiole with posterior face rugoreticulate; head narrower, metafemur shorter, scapes shorter (HW 2.05–2.12, FL 1.51–1.57, SL 1.09–1.12,  $n = 5$ )..... *P. uncagena*, **sp. n.**

#### Queens

- 1 Propodeal spines simple and straight, evenly tapering to a single acuminate point without becoming bifurcate or angulate apically (Figs. 29, 90); scapes short (SL 0.87, FL  $n = 1$ )..... *P. simplispinosa*, **sp. n.**
- Propodeal spines modified apically with bifurcate or angulate tip, but never evenly tapering to a single straight acuminate point (Figs. 30, 31, 75, 78, 81, 84, 87); scapes long (SL 0.97–1.24,  $n = 15$ ) .....2
- 2 Mesonotum, in profile, lower than pronotum (Figs. 31, 75, 78, 81); pronotum, in dorsal view, largely visible (Figs. 76, 79, 82); sides of head, in full face view, subparallel or weakly diverging posteriorly (Figs. 74, 77, 80); head narrow (HW 1.12–1.35,  $n = 8$ ) .....3
- Mesonotum, in profile, subequal in height to pronotum (Figs. 30, 84, 87), pronotum, in profile, largely concealed by mesonotum (Figs. 85, 88); sides of head, in full face view, strongly diverging posteriorly (Figs. 83, 86); head broad (HW 1.55–1.95,  $n = 7$ ) .....5
- 3 Head venter densely sculptured; anterior face of postpetiole with regular longitudinal rugulae ..... *P. bula*, **sp. n.**
- Head venter smooth and shining; postpetiole with anterior face either smooth and shining or with weak irregular sculpture, but never with regular longitudinal rugulae .....4
- 4 Head with posterolateral corners smooth and shining (Fig. 77); petiolar node, in posterior view, concave; postpetiolar dorsum smooth and shining; in dorsal view, length of median sculpturing immediately posterior to postpetiole attachment shorter than length of postpetiole (Fig. 16); head wider and longer (HW 1.29–1.35, HL 1.27–1.30,  $n = 3$ ) ..... *P. colaensis*
- Head with posterolateral corners rugoreticulate and with intercarinular spaces foveolate (Figs. 80); petiolar node, in posterior view, flat; postpetiolar dorsum transversely striate; in dorsal view, length of median sculpturing immediately posterior to postpetiole attachment equal to or longer than length of postpetiole (Fig. 15); head narrower and shorter (HW 1.12–1.18, HL 1.14–1.17,  $n = 3$ ) ..... *P. furcata*, **sp. n.**
- 5 Head, in full face view, with posterior portion rugoreticulate such that irregular longitudinal rugae are often intersected by irregular transverse rugae (Fig. 86); ground sculpture between eyes and frontal carinae densely and distinctly foveolate; head narrower and shorter (HW 1.55–1.70, HL 1.37–1.52,  $n = 6$ ).... *P. roosevelti*

- Head, in full face view, with posterior portion longitudinally carinate such that longitudinal carinae may occasionally branch, but are never intersected by transverse carinae or rugae (Fig. 83); ground sculpture between eyes and frontal carinae smooth and shining; head wider and longer (HW 1.96, HL 1.73,  $n = 1$ )....  
..... *P. pegasus*, **sp. n.**

### Diagnosis of *Pheidole roosevelti*-group

**MAJOR.** Head, in full face view, subquadrate in shape, broadest at about 2/3 length, posterior margin triangularly emarginate; in profile vertex weakly concave. Eyes in full face view convex, situated in anterior 1/3 of head, breaking outline of head; in profile distance between eye and mandibular insertion approximately twice length of eye. Mandibles triangular, masticatory margin bidentate both apically and basally on younger individuals (older individuals often edentate). Hypostoma with one median tooth, two inner teeth and two outer teeth. Frontal lobes well developed, overhanging antennal insertions. Frontal carinae distinct and elevated, overhanging antennal scrobes, terminating at about 2/3 length of head before reaching posterolateral lobes. Antennal scrobes weakly impressed, bounded mesally by frontal carinae and laterally by longitudinal carinae. Clypeus distinctly concave between frontal lobes, anterior margin concave medially. Antennae 12-merous. Antennal scapes reaching approximately half the distance from antennal insertions to corners of posterolateral lobes, slender and arcuate basally, thickened at distal third. Funicular segments 2–8 about twice as long as broad. Antennal club 3-segmented and slender, distinctly shorter than remainder of funiculus. Promesonotum forming a high dome. Mesonotum with a posterior process that often overhangs anterior portion of propodeal dorsum. Mesonotal declivity concave. Pronotal humeri indistinct or obtusely angulate. Metanotal groove impressed. Propodeal spines extending approximately to level of mesonotal process, often bifurcate or bent apically so that they project posteriorly at an oblique angle; in dorsal view moderately divergent. Petiolar peduncle elongate and thick. Petiole broadly cuneate, dorsum of node excised. Postpetiole, in dorsal view, with lateral projections, much broader than long.

Sculpture varying strongly among species. Mandibles weakly striate with scattered piligerous pits. Scapes striate. Metapleuron rugose. Erect long, fine and yellow hairs abundant on all body surfaces. Body dark reddish-brown with lighter appendages; color of head sometimes redder than rest of body.

**MINOR.** Head ovate, subcordate or subquadrate with sides weakly to strongly convex; posterior margin, in full face view, roundly convex, truncate or weakly bilobed; in profile, posterior margin weakly to strongly dorsoventrally pinched, dorsum and venter meeting at an obtuse to acute angle. Eyes in full face view convex, in front of midline, break outline of head. Mandibles triangular, masticatory margin with 7–8 teeth. Frontal carinae short and weak, either terminating near eye level or integrating with other face sculpture. Clypeus with anterior margin convex laterally and flat to weakly concave medially. Antenna 12-merous. Antennal scapes distinctly surpassing posterolateral corners, slender and weakly arcuate basally, thickened at distal third. Funicular segments 2–8 approximately twice as long as broad, 3-segmented club slender, as long as remainder of funiculus. Mesonotum with a posterior process that often overhangs anterior portion of propodeal dorsum. Mesonotal declivity concave. Pronotal humeri inconspicuous. Metanotal groove occasionally impressed. Propodeal spines, in profile, obtaining height approximately level with mesonotal process, often bifurcate or bent apically so that they project posteriorly at an oblique angle; in dorsal view moderately divergent. Petiolar peduncle elongate and thin. Petiole cuneate, dorsum of node flat. Postpetiole, in profile, subtriangular with rounded dorsum.

Sculpture varying strongly among species. Mandibles weakly striate with scattered piligerous pits. Scapes smooth and shining. Erect long, fine and yellow hairs abundant on all body surfaces. Body dark reddish-brown to light reddish brown with lighter appendages and occasionally lighter waist and gaster.

**QUEEN.** Head with sides subparallel or diverging posteriorly, subquadrate to subtriangular in shape, posterior margin moderately to strongly concave. Eyes, in full face view, large convex, situated in front of mid-

line, breaking outline of head. Mandibles triangular, masticatory margin bidentate both apically and basally. Frontal lobes weakly overhanging antennal insertions. Frontal carinae distinct, diverging, overhanging antennal scrobes, terminating at about 2/3 length of head before reaching posterolateral lobes. Antennal scrobes weakly impressed, bounded mesally by frontal carinae and laterally by longitudinal carinae. Clypeus distinctly concave between frontal lobes, anterior margin convex laterally and concave medially. Antennal scapes reaching approximately half the distance from antennal insertions to corners of posterolateral lobes, slender and arcuate basally, thickened at distal third. Antenna 12-merous. Funicular segments 2–8 about twice as long as broad. Antennal club 3-segmented and slender, shorter than remainder of funiculus. Mesoscutum either small without obscuring pronotum in dorsal view, or large and obscuring pronotum in dorsal view. Scutellum produced as a weakly elevated circular to subtriangular plate. Metanotum transversely striate. Propodeal spines often bent apically so that they project posteriorly at an oblique angle; in dorsal view moderately divergent. Petiolar peduncle elongate and thick. Petiole broadly cuneate, dorsum of node weakly concave to strongly excised. Postpetiole, in dorsal view, with lateral projections, much broader than long.

Sculpture varying strongly among species. Mandibles weakly striate with scattered piligerous pits. Scapes striate. Metapleuron rugose. First gastral tergite and sternite sculptured basally. Erect long, fine and yellow hairs abundant on all body surfaces. Body reddish-brown with lighter appendages.

## Species accounts

### *Pheidole bula* Sarnat sp. n.

Figs. 32–34, 53–55, 74–76

Holotype major, FIJI: Viti Levu, Mt. Tomanivi 3.4 km E Navai Village, 1.ii.2005, 1320m, -17.61481°, 178.01825°, exposed mountain summit, nesting under stone, (*E. M. Sarnat*), EMS#1789, CASENT0171113 (FNIC).

Paratypes. From same nest series as holotype: 2 *alate queens* (CASENT0174000, CASENT0171114), 1 *dealate queen* (CASENT0174003), 2 *males* (CASENT0174008, CASENT0171115), 4 *majors* (CASENT0174001, CASENT0174004, CASENT0174006, CASENT0174009), 5 *minors* (CASENT0171017, CASENT0174002, CASENT0174005, CASENT0174007, CASENT0174010) (FNIC, NMNH, ANIC); additional specimens in alcohol (NMNH).

**MAJOR.** TL 5.60–6.27, HL 2.06–2.14, HW 2.05–2.12, CI 0.93–0.99, FL 1.51–1.57, FI 0.69–0.71, SL 1.09–1.12, SI 0.49–0.52 (5 measured).

Head distinctly broader behind eyes than in front of eyes. Median ocellus absent in type series. Mesonotal process produced as a thick lamellate plate overhanging propodeum, slightly upturned apically; in dorsal view attachment to mesonotum broad, posterior margin flat to weakly excised. Propodeal spines maintaining an evenly stout thickness for basal 4/5 length whereupon the anterior edge angles obliquely towards the posterior edge to form an acuminate tip. In posterior view, petiole node deeply excised. Postpetiole taller than long; as tall as petiole; steep anterior and posterior faces converging to form an obtusely angulate vertex; in dorsal view subpentagonal with modest lateral projections.

Region between frontal carinae with straight longitudinal carinae branching into reticulate network on vertex and full length of posterolateral lobes; intercarinular spaces smooth and shining to shallowly impressed. Eye surrounded by elevated rugoreticulum. Antennal scrobe smooth and shining in some specimens, overlain by short discontinuous rugae in others. Clypeus mostly smooth and shining; anterior margin with several short carinae in addition to those extending from frontal lobes, median carinae weak to absent. Lateral portions of posterolateral lobes with a smooth and shining patch surrounded by sculpture. Head venter densely rugoreticulate. Promesonotum rugoreticulate. Anepisternum weakly rugose. Katepisternum mostly

smooth and shining, occasionally with weak carinae. Petiole with anterior and posterior faces smooth, laterally and ventrally rugose. Postpetiole dorsum smooth and shining, sides rugose. First tergite of gaster with basal sculpture short and weak to absent. First sternite of gaster lightly sculptured laterally. Gaster otherwise smooth and shining. Body dark reddish-brown with lighter appendages.

**MINOR.** TL 3.60–3.92, HL 0.81–0.89, HW 0.70–0.78, CI 0.87–0.90, FL 1.08–1.23, FI 1.26–1.39, SL 0.97–1.08, SI 1.16–1.25, AE 0.27–0.31, DE 0.17–0.20, PSI 0.55–0.68 (8 measured).

Head, in full face view, subquadrate, sides weakly convex, posterolateral corners rounded and weakly obtuse, posterior margin flat to convex except where weakly excised medially; in profile, posterior margin dorsoventrally pinched where dorsum and venter join at an obtuse angle. Genal carinae strongly produced as elevated flanges on ventrolateral portion of head that weaken before joining together medially. Clypeus with anterior margin convex laterally, flat to weakly convex medially. Frontal carinae terminating near eye level. Mesonotal process produced as a short lamellate plate with upwardly deflected margins; in dorsal view, attachment to mesonotum broad, posterior margin convex to excised. Propodeal spines thickening apically into a bifurcation with a short blunt anterior point and a long acuminate posterior point that projects at an oblique angle; length of dorsal edge less than length of anterior edge.

Head medially smooth and shining with discontinuous and occasionally branching carinae, laterally and ventrally rugoreticulate. Clypeus with a few weak carinae attached to anterior border. Promesonotum, in dorsal view, mostly smooth and shining with a few weak and discontinuous transverse rugae. Anepisternum rugose. Katepisternum mostly smooth and shining. Dark reddish-brown with slightly lighter appendages.

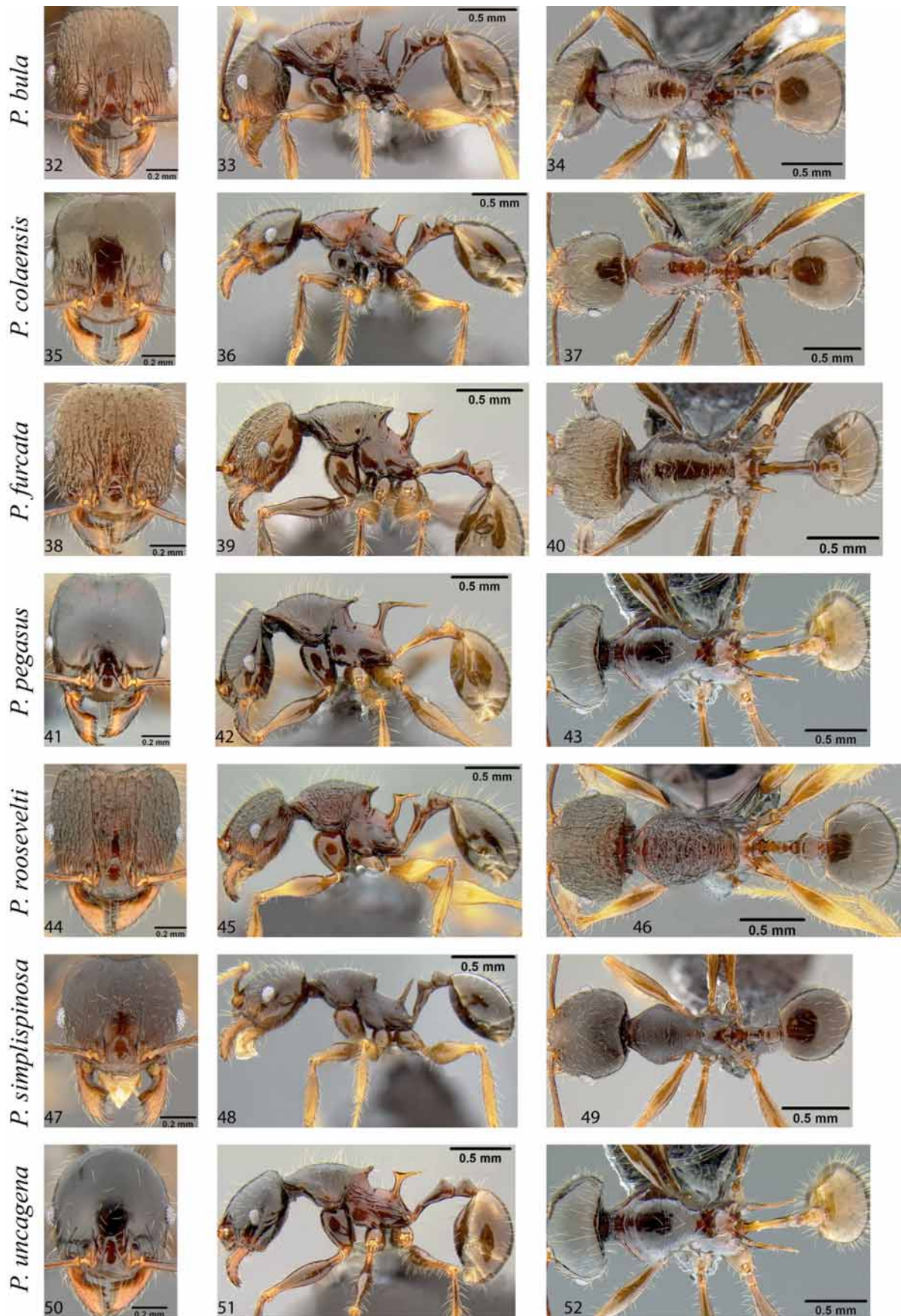
**QUEEN.** TL 5.85–6.36, HL 1.27–1.31, HW 1.28–1.29, CI 0.98–1.01, SL 1.00–1.01, SI 0.76–0.80, FL 1.02–1.04, FI 0.78–0.79, ML 0.71–0.76, MI 0.55–0.59 (3 measured).

Head subquadrate with sides approximately as wide anteriorly as posteriorly. Mesoscutum, in profile, small, less than half height of pronotum; in dorsal view, not obscuring pronotum. Scutellum, in dorsal view, with posterior portion produced as a weakly elevated circular plate. Propodeal spines maintaining an evenly stout thickness for basal 4/5 length whereupon the anterior edge angles obliquely towards the posterior edge to form an acuminate tip. Petiole broadly cuneate; in posterior view, petiole node flat to weakly concave. Postpetiole, in dorsal view, subpentagonal with modest lateral projections.

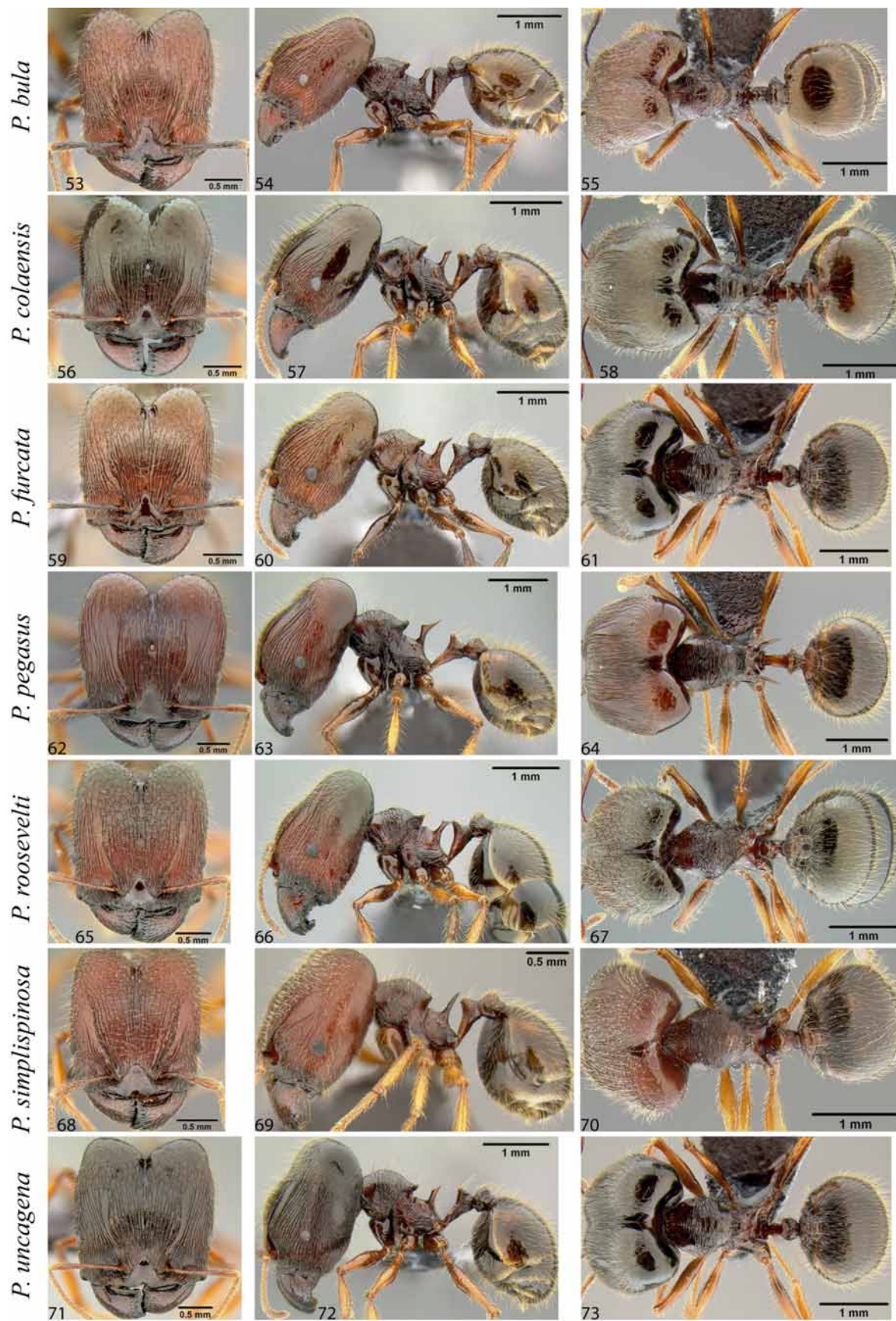
Region between frontal carinae with irregular longitudinal carinae that occasionally branch; intercarinular spaces smooth and shining to shallowly impressed. Head with lateral and ventral regions rugoreticulate. Antennal scrobe smooth and shining, overlain by short discontinuous rugae. Clypeus mostly smooth and shining; anterior margin with short carinae laterally, median carinae absent. Pronotum rugoreticulate. Mesoscutum, in dorsal view, with discontinuous rugae medially and long arcuate rugae laterally that curve towards median as they approach posterior margin. Scutellum mostly smooth and shining. Anepisternum rugoreticulate. Katepisternum mostly smooth and shining with weak rugulae. Petiole sculptured laterally, ventrally and on posterior face. Postpetiole longitudinally rugulose. First tergite of gaster longitudinally striate basally. First sternite of gaster with dense mat of fine sculpture basally. Body dark reddish-brown with lighter appendages.

**Etymology.** *Bula* is the Fijian word for 'life' and serves as the ubiquitous greeting among Fijians.

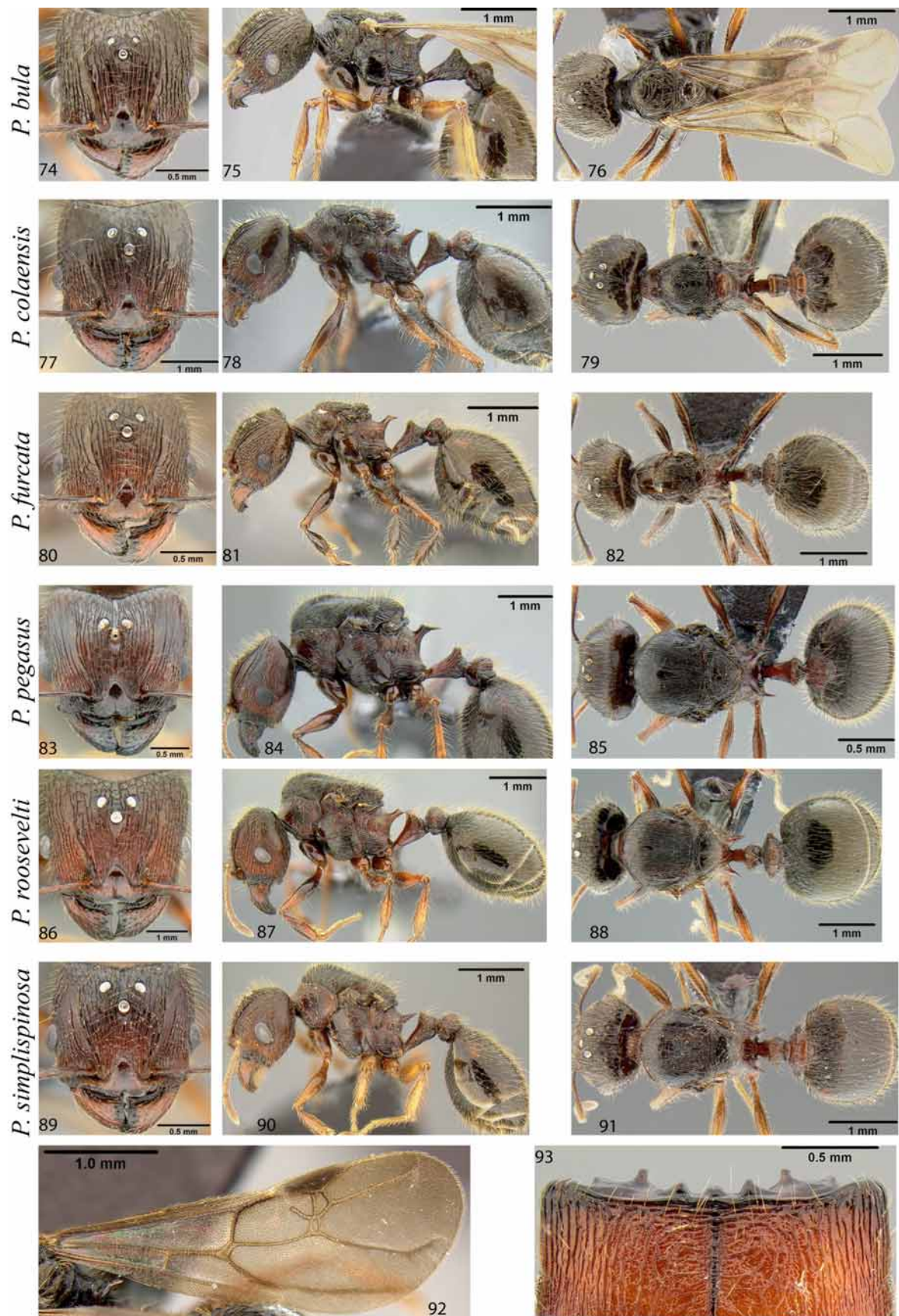
**Diagnosis, distribution and biology.** *Pheidole bula* is one of the smaller members of the *P. roosevelti*-group, and is endowed with modestly projecting spines and strong sculpturing. The species is most readily distinguished from its close relatives by the smooth and shining spaces between its facial rugae. While *P. roosevelti* and *P. furcata* both have facial rugoreticulum (majors) or rugae (minors) similar to *P. bula*, the interspaces between their rugae are filled with densely packed foveolae, giving them a duller appearance. The minor worker can be separated from all other minors of *P. roosevelti*-group by the strong sculpturing of the ventral surface of its head. While the rugoreticulate face of *P. bula* is similar to *P. roosevelti*, the small queen and morphometric measurements suggest closer relationship to *P. furcata* from Kadavu and *P. colaensis*, which also occurs on Mt. Tomanivi.



**FIGURES 32–52.** Minor workers. **32–34.** *Pheidole bula*, paratype; **35–37.** *P. colaensis*; **38–40.** *P. furcata*, paratype; **41–43.** *P. pegasus*, paratype; **44–46.** *P. roosevelti*; **47–49.** *P. simplispinosa*, paratype; **50–52.** *P. uncagena*, paratype.



**FIGURES 53–73.** Major workers. 53–55. *Pheidole bula*, holotype; 56–58. *P. colaensis*; 59–61. *P. furcata*, holotype; 62–64. *P. pegasus*, holotype; 65–67. *P. roosevelti*; 68–70. *P. simplispinosa*, holotype; 71–73. *P. uncagena*, holotype.



**FIGURES 74–93.** Queens. **74–76.** *Pheidole bula*, paratype; **77–79.** *Pheidole colaensis*; **80–82.** *Pheidole furcata*, paratype; **83–85.** *Pheidole pegasus*, paratype; **86–88.** *Pheidole roosevelti*; **89–91.** *Pheidole uncagena*, queen, paratype; **92.** Forewing of *Pheidole bula*; **93.** Hypostoma of *Pheidole roosevelti*.



Although *P. colaensis* was encountered with relative frequency throughout the higher elevations of Mt. Tomanivi (Fiji's tallest mountain), *P. bula* was encountered only at the mountain's summit. The population of *P. bula* may therefore be in a precarious situation. With perhaps its closest extant relative occupying the lower elevations, and with no higher elevation to retreat to, it is possible that the current trends in climate change will consign *P. bula* to extinction in the near future.

**Additional material examined.** FIJI. *Viti Levu*: Mt. Tomanivi 3.4 km E Navai Village, 1.ii.2005, 1320m, -17.61481°, 178.01825°, moss forest, from sifted leaf litter, (*E. M. Sarnat*), EMS#1791-5, 3 minors (CASENT0174011 – CASENT0174013); Mt. Tomanivi 3.4 km E Navai Village, 1.ii.2005, 1320m, -17.61481°, 178.01825°, exposed mountain summit, ground foraging, (*E. M. Sarnat*), EMS#1787, 3 minors (CASENT0174014 – CASENT0174016); Mt. Tomanivi summit, 27.viii.2006, 1320m, -17.61481°, 178.01825°, mossy rainforest and clearing, ground nest in moss mat, (*P. S. Ward*), PSW#15754.

### ***Pheidole colaensis* Mann**

Figs. 35–37, 56–58, 77–79

*Pheidole colaensis* Mann, 1921: 441. Syntypes, 2 majors, 4 minors. FIJI: Viti Levu, Nadarivatu, (W. M. Mann), (MCZ, examined; NMNH, examined).

**MAJOR.** TL 5.78–7.06, HL 1.91–2.19, HW 1.77–2.01, CI 0.88–0.93, FL 1.33–1.49, FI 0.65–0.70, SL 0.94–1.05, SI 0.46–0.49 (9 measured).

Head with sides not distinctly broader posterior to eyes than anterior to eyes. Median ocellus present and well-developed in all specimens examined. Mesonotal posterior process produced as a thick slightly upturned lamellate plate overhanging propodeum; in dorsal view attachment to mesonotum broad, posterior margin flat to excised. Propodeal spines maintaining an evenly stout thickness for basal 4/5 length whereupon the anterior edge angles obliquely towards the posterior edge to form an acuminate tip. In posterior view, petiole node moderately excised. Postpetiole taller than long; as tall as petiole; steep anterior and posterior faces converging to form an obtusely angulate vertex; in dorsal view subpentagonal with modest lateral projections.

Region between frontal carinae with straight longitudinal carinae extending onto vertex and terminating before reaching entirely smooth and shining posterolateral lobes; intercarinular spaces smooth and shining. Elevated carinae between eye and antennal insertion, eye and mandible insertion, and ventrad of eye. Antennal scrobe smooth and shining. Clypeus smooth and shining; carinae extend from anterior margin to frontal lobes. Lateral and ventrolateral portions of posterolateral lobes entirely smooth and shining, posteriorly with shallow oblong impressions. Head venter rugose. Promesonotum with weak transverse rugae. Anepisternum weakly rugose. Katepisternum entirely smooth and shining. Petiole with apical and posterior faces smooth, laterally and ventrally rugose. Postpetiole dorsum mostly smooth and shining, sides rugose. First tergite of gaster with sculpture short and weak to absent. First sternite of gaster lightly sculptured laterally at base. Gaster otherwise smooth and shining. Body reddish-brown with lighter appendages.

**MINOR.** TL 3.34–3.90, HL 0.78–0.88, HW 0.68–0.81, CI 0.88–0.93, FL 1.12–1.23, FI 1.37–1.48, SL 0.99–1.06, SI 1.18–1.28, AE 0.27–0.31, DE 0.08–0.22, PSI 0.29–0.77 (8 measured).

Head, in full face view, subquadrate, sides convex, posterolateral corners rounded and obtuse, posterior margin flat to convex except where weakly excised medially; in profile, posterior margin dorsoventrally pinched where dorsum and venter join at an obtuse angle. Genal carinae produced as an inconspicuous collar surrounding ventral foramen. Clypeus with anterior margin convex laterally, flat to weakly convex medially. Frontal carinae terminating near eye level. Mesonotal process produced as a lamellate plate with upwardly deflected margins; in dorsal view, attachment to mesonotum broad, posterior margin excised. Propodeal spines thickening apically into a weak bifurcation with a short anterior point or blunt angle, and a long acuminate posterior point that projects at an oblique angle; length of dorsal edge less than length of anterior edge.

Head entirely smooth and shining except for weak longitudinal carinae below level of eyes. Clypeus with a few weak carinae attached to anterior border. Promesonotum, in dorsal view, smooth and shining. Anepisternum rugose. Katepisternum mostly smooth and shining. Reddish-brown with slightly lighter appendages.

**QUEEN.** TL 6.44–6.77, HL 1.27–1.30, HW 1.29–1.35, CI 1.02–1.03, SL 0.99, SI 0.76–0.78, FL 1.34–1.35, FI 1.04–1.05, ML 0.55–0.57, MI 0.86–0.89 (2 measured).

Head subquadrate with sides approximately as wide anteriorly as posteriorly. Mesoscutum, in profile, small, less than half height of pronotum; in dorsal view, not obscuring pronotum. Scutellum, in dorsal view, with posterior portion produced as a weakly elevated circular plate. Propodeal spines maintaining an evenly stout thickness for basal 4/5 length whereupon the anterior edge angles obliquely towards the posterior edge to form an acuminate tip. Petiole broadly cuneate; in posterior view, petiole node concave. Postpetiole, in dorsal view, subpentagonal with modest lateral projections.

Region between frontal carinae with straight unbranching longitudinal carinae terminating before obtaining posterior margin; intercarinular spaces smooth and shining. Region between eyes and antennal insertions with elevated arcuate carinae. Posterolateral corners of head smooth and shining. Head venter mostly smooth and shining, weak sculpture present medially. Antennal scrobe smooth and shining. Clypeus mostly smooth and shining; anterior margin with short carinae laterally, median carinae absent. Pronotum mostly smooth and shining, rugoreticulate posteriorly. Mesoscutum, in dorsal view, with discontinuous rugae medially and long arcuate rugae laterally that curve towards median as they approach posterior margin. Scutellum mostly smooth and shining. Anepisternum rugoreticulate. Katepisternum mostly smooth and shining with weak rugulae. Petiole sculptured laterally and ventrally, anterior and posterior faces smooth and shining. Postpetiole with anterior face transversely rugulose, dorsum and posterior face smooth and shining. First tergite of gaster longitudinally costulate basally, sculpture immediately posterior to postpetiole shorter than length of postpetiole. First sternite of gaster sculptured basally. Body reddish-brown with lighter appendages.

**Diagnosis, distribution and biology.** *Pheidole colaensis* is most readily distinguished from other *P. roosevelti*-group species by its shiny integument and reduced sculpture. *Pheidole colaensis* is the only species in which the posterolateral lobes of the major caste are entirely free of sculpture. While the minor workers of the Vanua Levu species *P. pegasus* and *P. uncagena* also lack facial sculpturing above eye level, the propodeal spines of *P. colaensis* bear a distinctly shorter dorsal edge. Although Mann (1921) uses the presence of the median ocellus to distinguish *P. colaensis* from *P. roosevelti*, a review of material subsequently collected proves the character to be relatively variable. While all majors of *P. colaensis* examined by the author bear a prominent, well-developed median ocellus, the feature ranges from completely absent to poorly developed in the examined majors of *P. roosevelti*, often varying even within nest series. An even greater range of variability is seen within the type series of *P. pegasus*.

While *P. colaensis* appears to be restricted to the few high elevation ranges of Viti Levu, the species is locally abundant where it occurs. *Pheidole colaensis* is widely sympatric with *P. roosevelti*, with the former tending to occupy the higher elevations (800m – 1,300m) and the latter preferring a slightly lower range (300m – 1,000m). Although *P. colaensis* majors are scarce and timid, the minors can be observed foraging about the leaf litter some distance from their nests. The nest entrance of *P. colaensis* typically consists of a single turret built of small soil pellets that rises 3–5cm above the ground, and leads to chambers over one meter deep that contain many hundreds or thousands of workers. The multiple dealate queens recovered from nest excavations suggest that the species might be polygynous. The queens of *P. colaensis*, like those of *P. bula* and *P. furcata*, are small with reduced mesosomas.

**Additional material examined.** FIJI. *Viti Levu*: Koroyanitu National Heritage Park Mt. Batilamu near summit 3.2km SE Abaca Village, 24.viii.2006, 1125m, -17.56944°, 177.97000°, high elevation wet forest, from turret nest in bare soil, (*E. M. Sarnat*), EMS#2332, 3 majors (CASENT0174017, CASENT0174020, CASENT0174023), 6 minors (CASENT0174018 – CASENT0174022, CASENT0174024, CASENT0174025); Monasavu Rd. 1.75km SE Waimoque Settlement, 28.viii.2006, 850m, -17.67035°,

177.99375°, from turret nest in bare soil, (*E. M. Sarnat*), EMS#2365, 2 *dealate queens* (CASENT0174041, CASENT0174044), 7 *majors* (CASENT0174042, CASENT0174045, CASENT0174047, CASENT0174050, CASENT0174051, CASENT0174053, CASENT0174055), 7 *minors* (CASENT0174043, CASENT0174046, CASENT0174048, CASENT0174049, CASENT0174052, CASENT0174054, CASENT0174056); 7km S Monasavu Dam near powerstation headquarters, 2.ii.2005, 800m, -17.81018°, 178.03773°, from sifted leaf litter, (*E. M. Sarnat*), EMS#1806, 3 *minors* (CASENT0174036 – CASENT0174038); 7km S Monasavu Dam near powerstation headquarters, 2.ii.2005, 800m, -17.81018°, 178.03773°, from sifted leaf litter, (*E. M. Sarnat*), EMS#1808, 1 *minor* (CASENT0174039); Mt. Tomanivi 8 km ESE Navai Village, 3.ii.2005, 1023m, -17.62415°, 178.00558°, mid-elevation rainforest, foraging, (*E. M. Sarnat*), EMS#1823, 4 *majors* (CASENT0171103, CASENT0174026 – CASENT0174028), 5 *majors* (CASENT0171020, CASENT0174029, CASENT0174057 – CASENT0174059); 3 km E Navai Village trail to Mt. Tomanivi, 1.ii.2005, 1105m, -17.51850°, 178.00680°, mid-elevation rainforest, from turret nest in bare soil, (*E. M. Sarnat*), EMS#1784, 3 *minors* (CASENT0174030 – CASENT0174032); 3.2 km E Navai Village, trail to Mt. Tomanivi, 1.ii.2005, 1294m, -17.61583°, 178.01683°, moss forest, ground foraging, (*E. M. Sarnat*), EMS#1785, 3 *minors* (CASENT0174033 – CASENT0174035).

***Pheidole furcata* Sarnat sp. n.**

Figs. 38–40, 59–61, 80–82

Holotype major, FIJI: Kadavu, Mt. Washington 1.4 km SSW Lomaji Village, 5.ix.2006, 760m, -19.11806°, 177.98750°, high elevation moss forest, turret nest in bare soil, (*E. M. Sarnat*), EMS#2407, CASENT0171111, (FNIC).

Paratypes. From same nest series as holotype: 4 *dealate queens* (CASENT0171112, CASENT0174063, CASENT0174069, CASENT0174072), 11 *majors* (CASENT0171111, CASENT0174060, CASENT0174061, CASENT0174064, CASENT0174066, CASENT0174067, CASENT0174070, CASENT0174073, CASENT0174075, CASENT0174076, CASENT0174078, CASENT0174079), 8 *minors* (CASENT0171025, CASENT0174062, CASENT0174065, CASENT0174068, CASENT0174071, CASENT0174074, CASENT0174077, CASENT0174080), (FNIC, NMNH, ANIC, MCZ, LACM); additional specimens in alcohol (NMNH).

**MAJOR.** TL 6.01–6.61, HL 1.95–2.04, HW 1.82–1.96, CI 0.92–0.96, FL 1.31–1.41, FI 0.64–0.72, SL 0.99–1.04, SI 0.49–0.53 (7 measured).

Head with sides not distinctly broader posterior to eyes than anterior to eyes. Median ocellus absent in all specimens examined. Mesonotal process produced as a thick lamellate plate overhanging propodeum; in dorsal view attachment to mesonotum broad, posterior margin flat to excised. Propodeal spines maintaining an evenly stout thickness for basal 4/5 length whereupon the anterior edge angles obliquely towards the posterior edge to form a posteriorly projecting acuminate tip. Petiole node, in posterior view, moderately excised. Post-petiole taller than long; as tall as petiole; steep anterior and posterior faces converging to form an obtusely angulate vertex; in dorsal view subpentagonal with modest lateral projections.

Region between frontal carinae with straight longitudinal carinae that extend unto vertex before integrating with a finely produced rugoreticulum on the posterolateral lobes. Posterolateral lobes, in full face view, with rugoreticulum terminating before obtaining posterior margin. Intercarinular spaces smooth and shining between frontal carinae; moderately foveolate on vertex and posterolateral lobes. Eye surrounded by elevated carinae. Antennal scrobe foveolate and overlain by short carinae. Clypeus smooth and shining; anterior margin with several carinae laterally, some of which extend onto frontal lobes, median carina weak to absent. Lateral and ventrolateral portions of posterolateral lobes mostly smooth and shining, posteriorly with shallow oblong impressions. Head venter rugoreticulate. Promesonotum rugoreticulate. Anepisternum weakly rugore-

ticulate. Katepisternum weakly striate. Petiole with apical and posterior faces smooth, laterally and ventrally rugose. Postpetiole transversely rugose, sides rugose. Gaster costulate on basal quarter of first segment; sternite of first segment striate laterally; elsewhere smooth and shining. Body reddish-brown with lighter appendages.

**MINOR.** TL 3.55–3.85, HL 0.79–0.83, HW 0.72–0.77, CI 0.90–0.92, FL 1.09–1.15, FI 1.37–1.41, SL 0.99–1.05, SI 1.21–1.29, AE 0.29–0.31, DE 0.18–0.23, PSI 0.59–0.78 (8 measured).

Head, in full face view, subquadrate, sides weakly convex, posterolateral corners rounded and weakly obtuse, posterior margin flat to convex; in profile, posterior margin dorsoventrally pinched where dorsum and venter join at an obtuse angle. Genal carinae weakly produced on ventrolateral portion of head. Clypeus with anterior margin convex laterally, flat to weakly convex medially. Frontal carinae terminating near eye level or integrating with rugoreticulum. Mesonotal process produced as a short lamellate plate with upwardly deflected margins; in dorsal view, attachment to mesonotum broad, posterior margin flat to weakly concave. Propodeal spines thickening apically into a bifurcation with a short anterior point or angle and a long acuminate posterior point that projects at an oblique angle; length of dorsal edge less than length of anterior edge.

Head dorsally rugoreticulate with weak foveolate ground sculpture, ventrally smooth and shining. Clypeus with a few weak carinae attached to anterior border. Promesonotum, in dorsal view, mostly smooth and shining with a few weak and discontinuous transverse rugae. Anepisternum rugose. Katepisternum mostly smooth and shining. Reddish-brown with slightly lighter appendages.

**QUEEN.** TL 5.90–5.95, HL 1.14–1.17, HW 1.12–1.18, CI 0.98–1.01, SL 0.97–1.00, SI 0.84–0.85, FL 1.08–1.30, FI 0.94–1.11, ML 0.51–0.53, MI 0.94–1.01 (3 measured).

Head subquadrate with sides approximately as wide anteriorly as posteriorly. Mesoscutum, in profile, small, less than half height of pronotum; in dorsal view, not obscuring pronotum. Scutellum, in dorsal view, with posterior portion produced as a weakly elevated circular plate. Propodeal spines maintaining an evenly stout thickness for basal 4/5 length whereupon the anterior edge angles obliquely towards the posterior edge to form an acuminate tip. Petiole broadly cuneate; in posterior view, petiole node flat to weakly concave. Postpetiole, in dorsal view, subpentagonal with modest lateral projections.

Region between frontal carinae with straight longitudinal carinae that become rugoreticulate near posterior margin. Region between eyes and antennal insertions with crenulated rugoreticulum that continues to posterolateral corners; intercarinular spaces densely packed with foveolae. Head venter mostly smooth and shining, weak sculpture present medially. Antennal scrobe smooth and shining. Clypeus mostly smooth and shining; anterior margin with short carinae laterally, median carinae absent. Pronotum with scattered rugulae. Mesoscutum, in dorsal view, smooth and shining anteriorly with arcuate rugae laterally that curve towards median as they approach posterior margin. Scutellum mostly smooth and shining. Anepisternum rugoreticulate. Katepisternum mostly smooth and shining with weak rugulae. Petiole sculptured laterally and ventrally, anterior and posterior faces smooth and shining. Postpetiole with anterior face and dorsum rugulose. First tergite of gaster longitudinally sculptured basally, sculpture immediately posterior to postpetiole longer than length of postpetiole. First sternite of gaster sculptured basally. Body reddish-brown with lighter appendages.

**Etymology.** The specific epithet *furcata* is a noun in apposition derived from *furca*, the Latin word for fork, to describe the bifurcate propodeal spines of the species.

**Diagnosis, distribution and biology.** *Pheidole furcata*, owing to its strong facial sculpture, is most similar to *P. bula* and *P. roosevelti* in appearance. Whereas the facial sculpture of majors, in full face view, of *P. bula* and *P. roosevelti* reaches the posterior margin, that of *P. furcata* is conspicuously shorter, leaving the posterior margin smooth and shining. The minor of *P. furcata* is separated from these other two species by the completely smooth and shining ventral surface of its head.

Known only from Mt. Washington, *P. furcata* is also the only species of the *P. roosevelti*-group known from the southern island of Kadavu. Whereas many of the *P. roosevelti*-group species are locally abundant where they occur, no foragers of *P. furcata* were observed at the type locality during the afternoon spent on the

mountain. The collection was made by locating the signature earthen turret entrance of a nest rising several cm above the surrounding bare soil. Like *P. bula* and *P. colaensis*, the queens of this species have strongly reduced mesosomas.

***Pheidole pegasus* Sarnat sp. n.**

Fig. 41–43, 62–64, 83–85

Holotype major, FIJI: Vanua Levu, Mt. Delaikoro 4.3 km SE Dogoru Village, 31.vii.2006, 910m, -16.59028°, 179.31580°, high elevation moss forest, from turret nest in bare soil, (*E. M. Sarnat*), EMS#2370, CASENT0171108, (FNIC).

Paratypes. From same nest series as holotype: 1 *dealate queen* (CASENT0171109), 2 *majors* (CASENT0171108, CASENT0174264, CASENT0174267), 10 *minors* (CASENT0171024, CASENT0174265, CASENT0174266, CASENT0174268 – CASENT0174275), (FNIC, NMNH, ANIC, LACM); additional specimens in alcohol (NMNH).

**MAJOR.** TL 6.45–6.98, HL 2.18–2.37, HW 2.20–2.35, CI 0.98–0.99, FL 1.59–1.66, FI 0.70–0.73, SL 1.15–1.19, SI 0.50–0.53 (2 measured).

Head with sides distinctly broader behind eyes than in front of eyes. Median ocellus present in two of the three specimens examined. Mesonotal posterior process produced as a thick, upturned plate overhanging propodeum, in dorsal view attachment to mesonotum broad, posterior margin flat to excised. Propodeal spines, in profile, with posteriorly projecting dorsal edge as long as or longer than anterior edge. Petiole node, in posterior view, with dorsum and sides deeply excised. Postpetiole taller than long; shorter than petiole; steep anterior and posterior faces converging to form an obtusely angulate vertex; in dorsal view subpentagonal with strong lateral projections.

Region between frontal carinae with straight longitudinal carinae that extend onto the posterolateral lobes; intercarinular spaces smooth and shining. Eye surrounded by elevated carinae. Antennal scrobe smooth and shining. Clypeus mostly smooth and shining; anterior margin with several carinae extending to frontal lobes; median carina weak to absent. Posterolateral portion of posterolateral lobes smooth and shining. Head venter rugose. Promesonotum transversely rugose. Anepisternum weakly rugose. Katepisternum mostly smooth and shining, occasionally with weak striae. Petiole with apical and posterior faces smooth, laterally and ventrally rugose. Postpetiole anterior face with weak transverse striae; dorsum and posterior face smooth with a few weak transverse carinae. Gaster striate-foveolate on basal fifth of first segment; sternite of first segment with arcuate striae; elsewhere smooth and shining. Body reddish-brown with lighter appendages.

**MINOR.** TL 3.91–4.39, HL 0.90–0.97, HW 0.83–0.89, CI 0.92–0.96, FL 1.38–1.42, FI 1.45–1.56, SL 1.21–1.27, SI 1.29–1.39, AE 0.29–0.33, DE 0.46–0.50, PSI 1.46–1.71 (9 measured).

Head, in full face view, subquadrate, sides convex, posterolateral corners rounded and obtuse, posterior margin flat laterally and concave medially; in profile, posterior margin strongly dorsoventrally pinched where dorsum and venter join at an acute angle. Genal carinae produced as a weakly elevated collar surrounding ventral foramen. Clypeus with anterior margin convex laterally and flat to weakly concave medially. Frontal carinae weak and terminating before eye level. Mesonotal process produced as a lamellate plate with upwardly deflected margins; in dorsal view, attachment to mesonotum broad, posterior margin moderately to strongly concave. Propodeal spines thickening apically into a bifurcation with a short anterior point or angle, and a long acuminate posterior point that projects at an oblique angle; length of dorsal edge approximately 1.5 times length of anterior edge.

Head smooth and shining on all surfaces. Clypeus occasionally with a few weak carinae attached to anterior border. Promesonotum, in dorsal view, mostly smooth and shining with a few very weak transverse impressions. Anepisternum smooth and shining. Katepisternum smooth and shining. Metapleuron smooth and

shining with single carinae bordering metapleural gland. Head and mesosoma reddish-brown; waist, gaster and legs paler.

**QUEEN.** TL 8.77, HL 1.73, HW 1.95, CI 1.13, SL 1.24, SI 0.72, FL 1.67, FI 0.97, ML 0.73, MI 0.88 (1 measured).

Head subcordate with sides conspicuously narrower anteriorly than posteriorly. Mesoscutum, in profile, massive, approximately equal height as pronotum; in dorsal view, obscuring pronotum. Scutellum, in dorsal view, with posterior portion produced as a weakly elevated subtriangular plate. Propodeal spines with strongly projecting dorsal edge subequal in length to anterior edge. Petiole broadly cuneate; in posterior view, petiole node broad with strongly concave dorsum and moderately concave sides. Postpetiole, in dorsal view, subpentagonal with strong lateral projections.

Region between frontal carinae with straight longitudinal carinae that reach posterior margin. Region between eyes and antennal insertions with elevated carinae that continue to posterolateral corners; intercarinular spaces smooth and shining. Head venter with arcuate carinae bending toward median. Antennal scrobe smooth and shining. Clypeus mostly smooth and shining; anterior margin with short carinae laterally, median carinae present. Pronotum rugose and rugoreticulate. Mesoscutum, in dorsal view, with straight carinae that run posteriorly towards median. Scutellum densely rugose. Anepisternum rugose dorsally. Katepisternum rugose anteriorly. Petiole rugulose. Postpetiole rugulose. First tergite of gaster longitudinally sculptured basally, sculpture immediately posterior to postpetiole longer than length of postpetiole. First sternite of gaster sculptured basally. Dark reddish-brown with lighter appendages.

**Etymology.** The specific epithet *pegasus* is a noun in apposition in reference to the horse beast of Greek mythology, whose wings bear resemblance to the extraordinary propodeal spines of this species.

**Diagnosis, distribution and biology.** *Pheidole pegasus*, on account of its large size, long limbs, glassy integument, and extraordinarily long propodeal spines, is arguably the most distinctive species of the *roosevelti* group. The only species that it can be confused with is *P. uncagena*, with which it is sympatric. The major of *P. pegasus* can be distinguished from that of *P. uncagena* by the long dorsal edge of the propodeal spine and a broadly attached mesonotal process. The most distinctive differences between the minors of the two species, besides the longer spines and limbs of *P. pegasus*, are both found on the head. Whereas *P. pegasus* has a strongly ventrodorsally flattened subquadrate head and inconspicuous genal carinae, the head of *P. uncagena* is subovate, less flattened, and bears genal carinae that are produced conspicuously as elevated flanges.

Although *P. pegasus* is known only from the summit of Mt. Delaikoro, the species may occur on other tall peaks of Vanua Levu that remain unexplored. Where it does occur, it is locally abundant. The single turret of the nest belonging to the type series had a 5mm diameter entrance hole, and was also insulated by a tidy ring of vegetation debris apparently placed there by workers. The queens of the species are large, with strongly developed mesosomas.

### ***Pheidole roosevelti* Mann**

Figs. 44–46, 65–67, 86–88

*Pheidole roosevelti* Mann, 1921: 438, Fig. 15. Syntypes, 5 majors, 9 minors, 1 dealate queen. Fiji: Viti Levu, Nadarivatu, (W. M. Mann), (MCZC no. 23173, examined; USNM, examined).

**MAJOR.** TL 6.01–7.11, HL 2.15–2.38, HW 1.87–2.19, CI 0.87–0.94, FL 1.36–1.44, FI 0.60–0.64, SL 0.90–1.05, SI 0.41–0.46 (8 measured).

Head with sides not distinctly broader behind eyes than in front of eyes. Median ocellus usually absent; when present small and poorly formed. In profile, posterior process modestly produced as a thick upturned lamellate plate; in dorsal view attachment to mesonotum broad to attenuated, posterior margin deeply excised.

Propodeal spines maintaining an evenly stout thickness for basal 4/5 length whereupon the anterior edge angles obliquely towards the posterior edge to form an acuminate tip; variation in length of dorsal edge. In posterior view, petiole node dorsum deeply excised. Postpetiole taller than long; subequal height as petiole; steep anterior and posterior faces converging to form an obtusely angulate vertex; in dorsal view subpentagonal with moderate lateral projections.

Region between frontal lobes with straight longitudinal carinae that integrate with a strong rugoreticulum upon reaching vertex; rugoreticulum extends to posterior margin of posterolateral lobes. Intercarinular spaces packed with a dense network of well-defined overlapping foveolae. Median strip of short transverse rugae bisects posterolateral lobes. Crenulate carinae between eyes and frontal carinae. Antennal scrobe foveolate; overlain by short rugae. Clypeus mostly smooth and shining; anterior margin with several carinae extending to frontal lobes; median carina weak to absent. Ventrolateral portion of posterolateral lobes smooth and shining. Head venter rugoreticulate. Promesonotum rugoreticulate. Anepisternum rugose. Katepisternum striate. Petiole with apical and posterior faces mostly smooth, laterally and ventrally rugose. Postpetiole anterior face with weak transverse striae; dorsum and posterior face rugulose with foveolate interspaces. First tergite of gaster with long and dense to short and sparse sculpturing basally. First sternite of gaster lightly sculptured laterally. Gaster otherwise smooth and shining. Body reddish-brown with lighter appendages; some individuals with head distinctly more red than body.

**MINOR.** TL 3.48–4.25, HL 0.81–0.90, HW 0.75–0.84, CI 0.91–0.96, FL 1.09–1.27, FI 1.35–1.47, SL 1.04–1.13, SI 1.25–1.32, AE 0.29–0.35, DE 0.20–0.27, PSI 0.60–0.92 (10 measured).

Head, in full face view, subquadrate, sides weakly convex, posterolateral corners rounded and weakly obtuse, posterior margin flat to convex laterally, moderately to strongly excised medially; in profile, posterolateral corners dorsoventrally pinched with carinate margins. Genal carinae moderately elevated on ventrolateral portion of head, terminate without joining together medially on head venter. Clypeus with anterior margin convex laterally, flat to weakly concave medially. Frontal carinae terminating near eye level or integrating with rugoreticulum posteriorly. Mesonotal process produced as a thin lamellate plate with upwardly deflected margins; in dorsal view, attachment to mesonotum broad, posterior margin moderately to strongly concave. Propodeal spines thickening apically into a bifurcation with a short anterior point or angle, and a long acuminate posterior point that projects at an oblique angle; length of dorsal edge less than length of anterior edge.

Head dorsally rugoreticulate with densely packed foveolate ground sculpture, ventrally smooth and shining without rugae or ground sculpture. Clypeus with a few weak carinae attached to anterior border, weak median carina occasionally present. Promesonotum, in dorsal view, strongly rugoreticulate. Anepisternum rugose. Katepisternum mostly smooth and shining. Light reddish-brown with slightly lighter appendages.

**QUEEN.** TL 7.43–8.01, HL 1.37–1.52, HW 1.55–1.70, CI 1.12–1.13, SL 1.00–1.05, SI 0.69–0.73, FL 1.38–1.48, FI 0.94–1.03, ML 0.77–0.80, MI 0.91–0.94 (6 measured).

Head subquadrate with sides narrower anteriorly than posteriorly. Mesoscutum, in profile, massive, approximately equal height as pronotum; in dorsal view, obscuring pronotum. Scutellum, in dorsal view, with posterior portion produced as a weakly elevated subtriangular plate. Propodeal spines maintaining an evenly stout thickness for basal 4/5 length whereupon the anterior edge angles obliquely towards the posterior edge to form an acuminate tip. Petiole broadly cuneate; in posterior view, petiole node broad with dorsum strongly excised. Postpetiole, in dorsal view, subpentagonal with moderate lateral projections.

Region between frontal carinae with crenulated longitudinal occasionally branching carinae that become rugoreticulate near posterior margin. Region between eyes and antennal insertions with elevated crenulated carinae that become rugoreticulate at posterolateral corners; intercarinular spaces densely packed with overlapping foveolae. Head venter rugoreticulate. Antennal scrobe foveolate. Clypeus mostly smooth and shining; anterior margin with short carinae laterally, median carinae present. Pronotum rugoreticulate. Mesoscutum, in dorsal view, with straight parallel carinae that run posteriorly towards median. Scutellum rugulose medially, rugoreticulate laterally. Anepisternum rugose. Katepisternum rugose. Petiole rugose. Postpetiole rugoreticu-

late. First tergite of gaster longitudinally sculptured basally, sculpture immediately posterior to postpetiole approximately as long as length of postpetiole. First sternite of gaster sculptured basally. Reddish-brown with lighter appendages.

**Diagnosis, distribution and biology.** *Pheidole roosevelti* is a large species, most recognizable by the heavy sculpturing present on its face and promesonotum. The two other species with rugoreticulate faces are *P. furcata* from Kadavu, and *P. bula* from Viti Levu. In addition to the differences elaborated within the discussions of these other species, the majors and minors of *P. roosevelti* can be separated by the strongly produced facial rugoreticulum overlying a densely foveolate ground sculpture and thickly rugoreticulate mesosoma. Unlike *P. furcata* and *P. bula*, in which the queen caste is characterized by its smaller size and much reduced mesosoma, the queens of *P. roosevelti*, with their larger size and strongly developed mesosomas, bear closer resemblance to their northern relatives (*P. pegasus*, *P. simplispinosa*).

With the possible exception of *P. simplispinosa*, *P. roosevelti* exhibits the most intraspecific variation of any *P. roosevelti*-group species. Features that vary with high frequency are observed most easily in the minor caste, and include the length, shape and thickness of the propodeal spines, the sculpture of the median face region, the shape of the posterior margin of the face, and the strength of the facial rugoreticulum. A large nest series from Koroyanitu in western Viti Levu reveals that there can be significant variation even within the same colony. The propodeal spines and shape of the posterior margin of the head are two features that vary strongly. The pattern of facial foveolae, in contrast, appears to remain more constant among nest mates. The observed variation in shape and sculpture may, in part, be due to the wide range claimed by the species. Unlike many of its close relatives, *P. roosevelti* does not appear to be restricted to the upper elevational limits of Fiji's mountain ranges (Fig. 95), thus allowing its population to span significantly more suitable habitat.

The type series collected by Mann appears to occupy a relatively extreme position in the phenotypic continuum of the species. The faces of the minor workers of the series are characterized by deeply excised posterior margins, coarser foveolae and a smoother median region. The material most closely resembling Mann's Nadarivatu type series are two workers collected from Mt. Naqaranabuluti, which lies within the Nadarivatu area. The faces of workers collected to the south of the same central mountain range (Monasavu Dam area), however, differ markedly in their narrower nearly flat posterior margins and finer, more extensive foveolae. Despite Ovalau's current isolation from Viti Levu, the morphological variation observed in material collected from the small island does not appear to be greater between series from Ovalau and Viti Levu than within the Ovalau series. If a characterization is to be made, however, it is that the Ovalau material is more similar to that of the southern and western Viti Levu than to the northern region of the type locality.

*Pheidole roosevelti* is quite abundant where it occurs, and foragers can often be observed foraging on the ground and on vegetation. They nest in chambers deep underground in the soil, and the entrance to the nest is a turret approximately 2cm tall and 0.5cm wide that is composed of soil pellets. One nest found on the top of a mountain in Ovalau had three such turrets leading to the chambers below.

**Additional material examined.** FIJI. *Ovalau*: 1.2 km NNW Draiba Village, 25.vi.2003, 300m, -17.69028°, 178.82483°, lowland rainforest, from sifted leaf litter, (*Rakabula*), FJLA316\_K03, 10 minors (CASENT0174161 – CASENT0174170); 1.3 km SE Levuka, 6.ii.2007, 450m, -17.68728°, 178.82527°, rainforest, sifted litter, (*E. M. Sarnat*), EMS#2454, 2 workers (CASENT0174188, CASENT0174189); 1.6 km WSW Levuka, 6.ii.2007, 400m, -17.68710°, 178.82350°, rainforest, turret nest in bare soil, (*E. M. Sarnat*), EMS#2456, 1 dealate queen (CASENT0174141), 6 majors (CASENT0174137, CASENT0174138, CASENT0174142, CASENT0174145, CASENT0174148, CASENT0174151), 13 minors (CASENT0174124, CASENT0174125, CASENT0174139, CASENT0174140, CASENT0174143, CASENT0174146, CASENT0174147, CASENT0174149, CASENT0174150, CASENT0174152 – CASENT0174155); 1.6 km WSW Levuka, 6.ii.2007, 400m, -17.68710°, 178.82350°, rainforest, turret nest in bare soil, (*E. M. Sarnat*), EMS#2458, 1 dealate queen (CASENT0174200), 2 males (CASENT0174197, CASENT0174203), 4 majors (CASENT0174193, CASENT0174195, CASENT0174198, CASENT0174201),



*six minors* (CASENT0174194, CASENT0174196, CASENT0174199, CASENT0174202, CASENT0174204, CASENT0174205); 1.6 km WSW Levuka, 6.ii.2007, 400m, -17.68710°, 178.82350°, rainforest, turret nest in bare soil, (*E. M. Sarnat*), EMS#2459, *5 minors* (CASENT0174156 – CASENT0174160); 2.4 km W Levuka, 7.ii.2007, 500m, -17.68200°, 178.81247°, moss forest, turret nest in bare soil, (*E. M. Sarnat*), EMS#2464, *1 dealate queen* (CASENT0174182), *5 majors* (CASENT0174171, CASENT0174174, CASENT0174177, CASENT0174183, CASENT0174185); *11 minors* (CASENT0174172, CASENT0174173, CASENT0174175, CASENT0174176, CASENT0174178 – CASENT0174181, CASENT0174184, CASENT0174186, CASENT0174187); **Viti Levu**: Koroyanitu EcoPark 1.8 km NE Abaca Village, 19.iii.2003, 700m, -17.66667°, 177.56333°, from sifted leaf litter, (*E/ M/ Sarnat*), FJVL300\_K01, *1 minor* (CASENT0174144); Koroyanitu National Heritage Park Mt. Batilamu 2km SE Abaca Village, 24.viii.2006, 840m, -17.67939°, 177.54194°, primary rainforest, on stone, (*E. M. Sarnat*), EMS#2331, *1 major* (CASENT0174099), *2 minors* (CASENT0174100, CASENT0174101); Koroyanitu National Heritage Park Mt. Batilamu 2 km SE Abaca Village, 24.viii.2006, 840m, -17.67939°, 177.54194°, primary rainforest, on stone, (*E. M. Sarnat*), EMS#2325, *7 minors* (CASENT0174102 – CASENT0174105, CASENT0174130 – CASENT0174132); Koroyanitu National Heritage Park Mt. Batilamu 2 km SE Abaca Village, 24.viii.2006, 840m, -17.67939°, 177.54194°, primary rainforest, on stone, (*E. M. Sarnat*), EMS#2333, *4 minors* (CASENT0174133 – CASENT0174136); Koroyanitu National Heritage Park Savione Falls 2 km ESE Abaca Village, 25.viii.2006, 650m, -17.67593°, 177.55015°, rainforest, from turret nest in bare soil, (*E. M. Sarnat*), EMS#2343, *1 dealate queen* (CASENT0174090), *5 majors* (CASENT0174081, CASENT0174087, CASENT0174091, CASENT0174093, CASENT0174096); *14 minors* (CASENT0171023, CASENT0174082 – CASENT0174086, CASENT0174088, CASENT0174089, CASENT0174092, CASENT0174094, CASENT0174095, CASENT0174097, CASENT0174098, CASENT0174126); Mt. Korobaba near Lami Town, 7.viii.2003, 300m, -18.01667°, 178.35000°, lowland rainforest, from sifted leaf litter, (*M. Tokota'a*), FJVL303\_K05, *3 minors* (CASENT0174111 – CASENT0174113); Mt. Korobaba near Lami Town, 15.viii.2003, 300m, -18.01667°, 178.35000°, lowland rainforest, from sifted leaf litter, (*M. Tokota'a*), FJVL303\_K01, *1 minor* (CASENT0174114); Mt. Korobaba 5 km NW Lami Town, 5.vi.2005, 304m, -18.08803°, 178.37603°, primary rainforest, nesting in soil, (*E. M. Sarnat*), EMS#1968, *3 minors* (CASENT0174127 – CASENT0174129); 7 km S Monasavu Dam near powerstation headquarters, 2.ii.2005, 800m, -17.81018°, 178.03773°, from sifted leaf litter, (*E. M. Sarnat*), EMS#1806, *3 minors* (CASENT0174106, CASENT0174107, CASENT0174108); 7 km S Monasavu Dam near powerstation headquarters, 2.ii.2005, 800m, -17.81018°, 178.03773°, from sifted leaf litter, (*E. M. Sarnat*), EMS#1808, *1 minor* (CASENT0174109); Nadala, 1.xii.1954, montane rainforest, (*E. O. Wilson*), *3 minors* (CASENT0174190 – CASENT0174192); 2.7 km NE Naikorokoro Village, 27.v.2003, 300m, -18.08722°, 178.33139°, lowland rainforest, from sifted leaf litter, (*A. Rakabula*), FJVL319\_K01, *4 minors* (CASENT0174118 – CASENT0174120, CASENT0174207); 2.7 km NE Naikorokoro Village, 27.v.2003, 300m, -18.08722°, 178.33139°, lowland rainforest, from sifted leaf litter, (*A. Rakabula*), FJVL319\_K02, *3 minors* (CASENT0174121 – CASENT0174123); Nakobalevu 1.5 km NE Colo-i-Suva Village, 12.ii.2003, 340m, -18.05056°, 178.41667°, lowland rainforest, sifted leaf litter, (*M. Tokota'a*), FJVL301\_K06, *1 major* (CASENT0174117); Nakobalevu 1.5 km NE Colo-i-Suva Village, 25.iv.2003, 340m, -18.05056°, 178.41667°, lowland rainforest, sifted leaf litter, (*M. Tokota'a*), FJVL301\_K06, *1 minor* (CASENT0174115); Nakobalevu 1.5 km NE Colo-i-Suva Village, 29.iv.2003, 340m, -18.05056°, 178.41667°, lowland rainforest, sifted leaf litter, (*M. Tokota'a*), FJVL301\_K11, *1 minor* (CASENT0174116); Nakobalevu 1.5 km NE Colo-i-Suva Village, 29.vii.2003, 340m, -18.05056°, 178.41667°, lowland rainforest, sifted leaf litter, (*M. Tokota'a*), FJVL301\_K10, *1 minor* (CASENT0174206); Mt. Naqarababuluti 1.1 km NE Emporer Gold Mine Rest House, 3.ii.2005, 912m, -17.56973°, 177.95987°, mixed pine/native secondary forest, foraging on vegetation, (*E. M. Sarnat*), EMS#1832, *1 minor* (CASENT0174110).

***Pheidole simplispinosa* Sarnat sp. n.**

Figs. 47–49, 68–70, 89–91

Holotype major, FIJI: Koro I., Mt. Kuitarua 3.7 km NW Nasau Village, 20.vi.2005, 470m, -17.29083°, 179.40183°, primary rainforest, nesting in soil, (*E. M. Sarnat*), EMS#2084, CASENT0171106 (FNIC).

Paratypes. From same nest series as holotype: 1 *dealate queen* (CASENT0171107), 4 *majors* (CASENT0174208, CASENT0174209, CASENT0174211, CASENT0174212), 3 *minors* (CASENT0171022, CASENT0174210, CASENT0174213), (FNIC, NMNH, ANIC); additional specimens in alcohol (NMNH).

**MAJOR.** TL 5.65–6.78, HL 1.78–1.96, HW 1.64–1.84, CI 0.89–0.93, FL 1.09–1.22, FI 0.60–0.64, SL 0.73–0.84, SI 0.39–0.44 (7 measured).

Head with sides not distinctly broader posterior to eyes than anterior to eyes. Median ocellus occasionally present. Scapes short. Mesonotal process, in profile, truncated into a blunt process without lamellate posterior margin; in dorsal view posterior margin flat to convex. Propodeal spines simple, evenly tapering to a single straight acuminate point without becoming bifurcate or angulate apically. In posterior view, petiole node dorsum strongly excised, sides moderately excised. Postpetiole taller than long, as tall as petiole, steep anterior and posterior faces converging to form an obtusely angulate vertex; in dorsal view subpentagonal with strong lateral projections.

Region between frontal carinae with parallel longitudinal carinae extending posteriorly and arcing onto posterolateral corners. Posterolateral lobes, in full face view, with distinct transverse rugae extending from median cleft to posterolateral corners. Sculpture of vertex and posterolateral lobes varies from weakly to densely rugoreticulate. Intercarinular spaces vary from densely foveolate to smooth and shining. Rugoreticulum present between eye and antennal insertion. Antennal scrobe mostly smooth and shining to strongly foveolate. Clypeus smooth and shining; anterior margin without carinae. Lateral and ventrolateral portions of posterolateral lobes lightly sculptured to entirely smooth and shining; posteriorly with transverse striae, discontinuous rugae and shallow oblong impressions. Head venter rugose. Pronotal sculpture varies from dense foveolate ground sculpture overlain by transverse striae to weak foveolate ground sculpture overlain by weak transverse striae. Mesonotum, in dorsal view, varies from foveolate and striate to smooth and shining. Anepisternum weakly rugose. Katepisternum weakly striate. Petiole with apical and posterior faces smooth, laterally and ventrally rugose. Postpetiole dorsum mostly smooth and shining, sides rugose. Basigastral costulae weakly to moderate with interspaces smooth and shining to foveolate; sternite of first gaster segment lightly sculptured laterally. Gaster otherwise smooth and shining. Body reddish-brown with lighter appendages.

**MINOR.** TL 2.96–3.41, HL 0.66–0.75, HW 0.65–0.74, CI 0.98–1.03, FL 0.80–0.91, FI 1.18–1.29, SL 0.77–0.85, SI 1.10–1.23, AE 0.25–0.32, DE 0.00, PSI 0.00 (10 measured).

Head, in full face view, subcordate, sides convex, posterolateral corners rounded and obtuse, posterior margin concave; in profile, posterolateral corners not pinched. Genal carinae very short and weakly elevated on ventrolateral portion of head. Clypeus with anterior margin convex laterally, concave medially. Frontal carinae terminating before eye level. Mesonotal process truncated into a short process without lamellate or distinct margin; in dorsal view, attachment to mesonotum broad, posterior margin evenly convex. Propodeal spines simple, taper evenly to an acuminate point without distal angle or bifurcation.

Head mostly smooth and shining to latitudinally rugulose with densely packed foveolate ground sculpture; ventrally smooth and shining. Clypeus with a few weak carinae attached to anterolateral border. Promezonotum, in dorsal view, transversely rugulose with lightly impressed to densely packed foveolate ground sculpture. Mesopleuron mostly smooth and shining to foveolate. Reddish-brown with paler appendages.

**QUEEN.** TL 6.82, HL 1.29, HW 1.37, CI 1.06, SL 0.87, SI 0.68, FL 1.18, FI 0.91, ML 0.83, MI 1.05 (1 measured).

Head subquadrate with sides approximately as broad anteriorly as posteriorly. Mesoscutum, in profile, large, greater than half the height of pronotum; in dorsal view, mostly obscuring pronotum. Scutellum, in dorsal view, with posterior portion produced as a weakly elevated subtriangular plate. Propodeal spines simple,

evenly tapering to a single straight acuminate point without becoming bifurcate or angulate apically. Petiole broadly cuneate; in posterior view, petiole node dorsum weakly concave. Postpetiole, in dorsal view, subpentagonal with moderate lateral projections.

Region between frontal carinae with crenulated longitudinal and occasionally branching carinae reach posterior margin. Region between eyes and antennal insertions with elevated crenulated carinae that reach posterolateral corners; intercarinular spaces densely packed with overlapping foveolae. Head venter rugoreticulate. Antennal scrobe foveolate. Clypeus mostly smooth and shining; anterior margin with short carinae laterally, median carinae present. Pronotum rugoreticulate. Mesoscutum, in dorsal view, with straight parallel carinae that run posteriorly towards median. Scutellum mostly smooth and shining. Anepisternum finely rugoreticulate. Katepisternum weakly striate. Petiole rugose. Postpetiole rugulose. First tergite of gaster longitudinally sculptured basally, sculpture immediately posterior to postpetiole longer than length of postpetiole. First sternite of gaster sculptured basally. Reddish-brown with lighter appendages.

**Etymology.** The specific epithet *simplispinosa* is a noun in apposition derived from the combination of the Latin *simplex*, meaning simple, and *spina*, meaning spine.

**Diagnosis, distribution and biology.** *Pheidole simplispinosa* is the most distinctive of all *P. roosevelti*-group species. It is the only member of the group in which the spines are simple and evenly straight without becoming modified into distal angles or bifurcations. The mesonotal process so prominent in other all other *P. roosevelti*-group species is truncated into a blunt process such that the angle between the dorsal face of the mesonotum and the mesonotal declivity is obtuse (i.e.,  $>90^\circ$ ). Beyond the simplified spine and mesonotal process, *P. simplispinosa* is also the smallest of this group and has the shortest limbs relative to its size. The queens of *P. simplispinosa*, like those of *P. roosevelti* and *P. pegasus*, are characterized by their well-developed mesosomas.

Although single turret nests were observed, the species is also capable of constructing nests with multiple entrances. One such nest, from Mt. Delaikoro on Vanua Levu, was composed of irregular mounds of excavated soil.

*Pheidole simplispinosa* has a range within the Fiji archipelago rivaled only by *P. roosevelti*. Like *P. roosevelti*, this species tolerance of lower elevation habitat (Fig. 95), may serve as some explanation for its wide range. The two species, however, are entirely allopatric. Whereas *P. roosevelti* claims the more southern islands of Viti Levu and Ovalau, *P. simplispinosa* occurs in the northern islands of Vanua Levu, Taveuni and Koro.

A significant variation in sculpture is associated with the geography of *P. simplispinosa*. The Koro material, including the type series, exhibits the strongest rugulae on the face and body and the most dense, well defined foveolate ground sculpture. The Taveuni specimens, with only faint hints of facial foveolae and weak mesosomal rugulae, occupy the opposing end of the phenotypic spectrum. Were it not for the intermediate Vanua Levu material, these contrasting morphologies might argue for the designation of separate species. Fortunately, enough collections of *P. simplispinosa* have been made on Vanua Levu to study morphological variation on the longitudinal axis. When specimens are arranged according to longitude, it becomes apparent that the strength of sculpture diminishes eastwards as the collections approach Taveuni. If sculpture strength can be used as a surrogate for relationship, it suggests that more gene flow occurs between populations from western Vanua Levu and Koro, and eastern Vanua Levu and Taveuni, than between Koro and Taveuni.

While further study of the population structure of *P. simplispinosa* may reveal illuminating patterns concerning phylogeographic patterns within the archipelago, perplexing questions surround the evolution of this species within the larger context of the *P. roosevelti*-group. *Pheidole simplispinosa*, with its simple propodeal spines, truncated mesonotal process, and divergent anatomical proportions (Fig. 94) does not immediately suggest itself as a close relative to any of the other *P. roosevelti*-group species.

Several hypotheses can be proposed to explain the relationship of *P. simplispinosa* to the other members of the group. The first hypothesis submits that *P. simplispinosa* is sister to all other members of the *P.*

*roosevelti*-group. If this hypothesis is supported, it allows for the possibility that the *P. roosevelti*-group descended from a hypothetical ancestor that, with neither modified propodeal spines nor a mesonotal process, more closely resembled typical *Pheidole* species. The second hypothesis submits that *P. simplispinosa* is nested within the *P. roosevelti*-group. If *P. simplispinosa* is, in fact, nested within the group, it predicts that the species is derived from an ancestor that bore modified propodeal spines and an extended mesonotal process. In this scenario, the secondary reductions of propodeal spines and mesonotum render the similarities between *P. simplispinosa* and *Pheidole* species outside the *P. roosevelti*-group homoplasy.

A thorough multi-gene phylogeny with appropriate outgroup taxa (including *quadrspinosa*-group, *quadriscuspis*-group and *cervicornis*-group species) will help to resolve both population and species level relationships of this enigmatic ant, and serve as a tool for testing the proposed hypotheses.

**Additional material examined.** FIJI. **Koro:** Mt. Kuitarua 3.1 km WNW Nasau Village, 20.vi.2005, 440m, -17.29528°, 179.40433°, primary rainforest, nesting in dead tree fern, (*E. M. Sarnat*), EMS#2097, 3 majors (CASENT0174223 – CASENT0174225); Mt. Kuitarua 4 km WNW Nasau Village, 7.iii.2003, 380m, -17.29528°, 179.40433°, lowland rainforest, from sifted leaf litter, (*E. M. Sarnat*), FJKR312\_K01, 9 minors (CASENT0174226 – CASENT0174234); Mt. Nabukala 5.0 km WSW Nasau Village, 15.iii.2005, 520m, -17.31250°, 179.38617°, primary rainforest, in soil, (*E. M. Sarnat*), EMS#1906, 6 majors (CASENT0174214, CASENT0174215, CASENT0174217, CASENT0174218, CASENT0174220, CASENT0174221), 3 minors (CASENT0174216, CASENT0174219, CASENT0174222); **Vanua Levu:** 2 km NNW Kasavu Village, 28.viii.2003, 300m, -16.62000°, 179.83333°, lowland rainforest, from sifted leaf litter, (*A. Rakabula*), FJVN330\_K01, 1 minor (CASENT0174251); 2 km NNW Kasavu Village, 29.viii.2003, 300m, -16.71639°, 179.66333°, lowland rainforest, from sifted leaf litter, (*A. Rakabula*), FJVN330\_K02, 1 minor (CASENT0174252); Mt. Delaikoro 3.7 km SE Dogoru Village, 31.viii.2006, 699m, -16.57525°, 179.31638°, mid-elevation rainforest, from sifted leaf litter, (*E. P. Economo*), EPE#62, 1 minor (CASENT0174253); Mt. Delaikoro 3.7 km SE Dogoru Village, 31.viii.2006, 699m, -16.57525°, 179.31638°, mid-elevation rainforest, nesting in soil, (*E. M. Sarnat*), EMS#2375, 7 majors (CASENT0174240, CASENT0174241, CASENT0174243, CASENT0174244, CASENT0174246, CASENT0174248, CASENT0174249), 4 minors (CASENT0174242, CASENT0174245, CASENT0174247, CASENT0174250); Mt. Vatudiri 3km NW Waisali Village, 2.ix.2006, 570m, -16.62905°, 179.21103°, mid-elevation rainforest, from turret nest in bare soil, (*E. M. Sarnat*), EMS#2396, 3 majors (CASENT0174235, CASENT0174236, CASENT0174238), 2 minors (CASENT0174237, CASENT0174239); Mt. Vatudiri 3km NW Waisali Village, 2.ix.2006, 570m, -16.62905°, 179.21103°, mid-elevation rainforest, from sifted leaf litter, (*E. P. Economo*), EPE#79, 1 minor (CASENT0174254); **Taveuni:** Devo Peak 3.6 km SE Tavuki Village, 17.vi.2005, 734m, -16.83056°, -179.97433°, garden/primary rainforest edge, from sifted leaf litter, (*E. M. Sarnat*), EMS#1949, 1 major (CASENT0174255), 2 minors (CASENT0174256, CASENT0174257); Devo Peak 3.6 km SE Tavuki Village, 17.vi.2005, 734m, -16.83056°, -179.97433°, garden/primary rainforest edge, from sifted leaf litter, (*E. M. Sarnat*), EMS#2069, 3 minors (CASENT0174258 – CASENT0174260); Devo Peak 3.9 km SE Tavuki Village, 17.vi.2005, 775m, -16.83278°, -179.97343°, primary rainforest edge, from sifted leaf litter, (*E. M. Sarnat*), EMS#2068, 3 minors (CASENT0174261 – CASENT0174263).

### *Pheidole uncagena* Sarnat sp. n.

Figs. 50–52, 71–73

Holotype major, FIJI: Vanua Levu, Mt. Delaikoro, 4.3 km SE Dogoru Village, 31.vii.2006, 910m, -16.59028°, 179.31580°, high elevation moss forest, turret nest in bare soil, (*E. M. Sarnat*), EMS#2372, CASENT0171110, (FNIC).

Paratypes. From same nest series as holotype: 4 *majors* (CASENT0174276, CASENT0174277, CASENT0174279, CASENT0174280), 3 *minors* (CASENT0171026, CASENT0174278, CASENT0174281), (FNIC, NMNH, ANIC); additional specimens in alcohol (NMNH).

**MAJOR.** TL 6.62–7.21, HL 2.17–2.26, HW 2.05–2.12, CI 0.93–0.99, FL 1.51–1.57, FI 0.69–0.71, SL 1.09–1.12, SI 0.49–0.52 (5 measured).

Head with sides not distinctly broader behind eyes than in front of eyes. Median ocellus absent in all specimens examined. Mesonotal process, in profile, produced as a thick, upturned lamellate plate overhanging propodeum; in dorsal view attachment to mesonotum attenuated, posterior margin and anterolateral margins excised. Propodeal spines maintaining an evenly stout thickness for basal 4/5 length whereupon the anterior edge angles obliquely towards the posterior edge to form an acuminate tip. In posterior view, petiole node dorsum and sides deeply excised. Postpetiole taller than long; shorter than petiole; steep anterior and posterior faces converging to form an obtusely angulate vertex; in dorsal view subpentagonal with strong lateral projections.

Region between frontal carinae with straight longitudinal carinae that extend onto the posterolateral lobes where they become weaker and discontinuous; intercarinular spaces smooth and shining to lightly foveolate. Eye surrounded by elevated carinae. Antennal scrobe smooth and shining. Clypeus mostly smooth and shining with several weak carinae extending from frontal lobes that terminate before reaching anterior margin; median carina weak to absent. Posterolateral portion of posterolateral lobes mostly longitudinally striate. Head venter rugose. Promesonotum transversely rugose. Anepisternum rugose. Katepisternum mostly smooth and shining with several rugae. Petiole with apical face smooth; posterior face laterally and ventrally rugose. Postpetiole anterior and posterior face with dense transverse striae; dorsum with transverse carinae. Gaster costulate on basal quarter of first segment; sternite of first segment striate laterally; elsewhere smooth and shining. Body reddish-brown with lighter appendages.

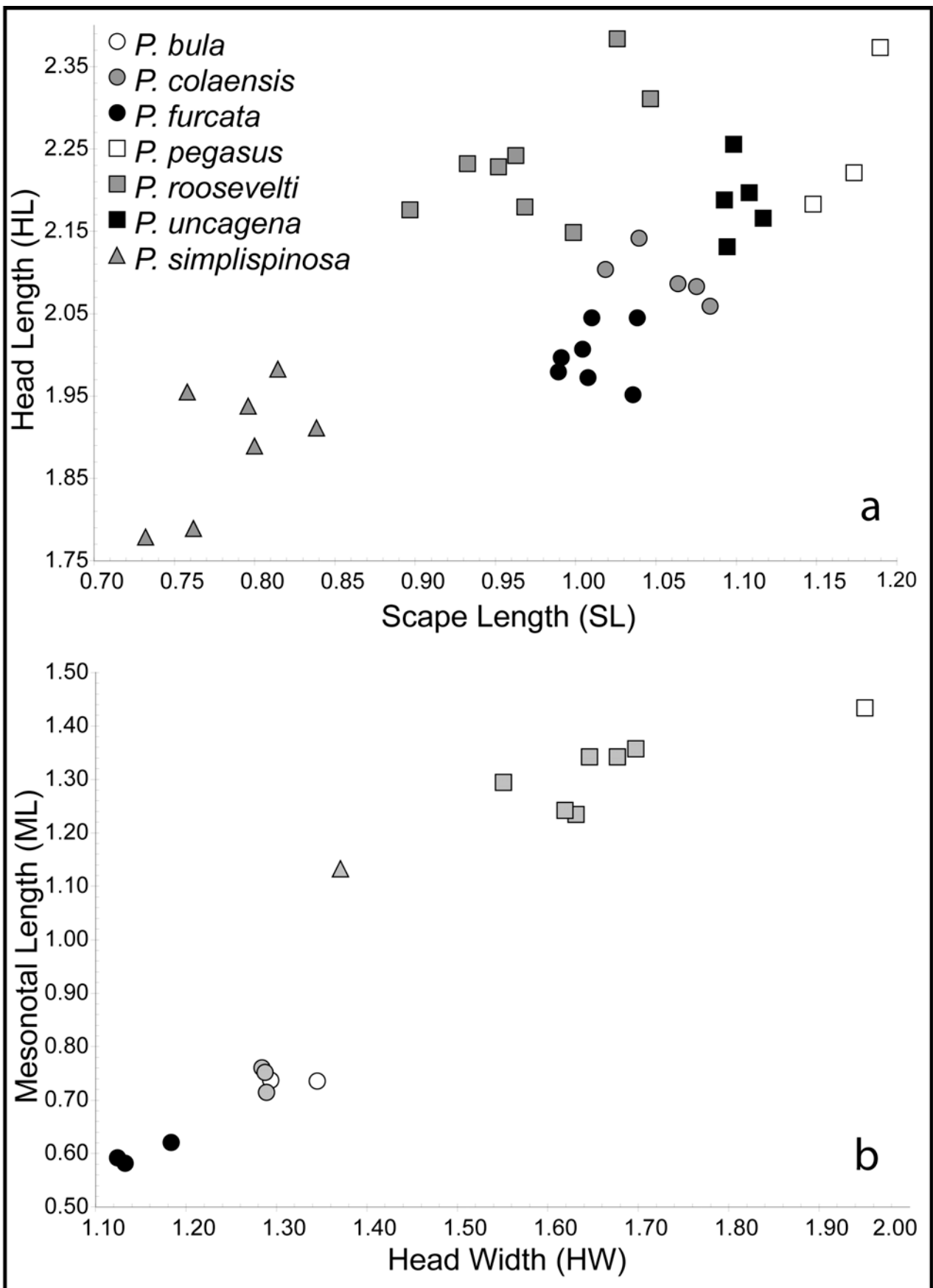
**MINOR.** TL 3.47–4.21, HL 0.75–0.89, HW 0.67–0.82, CI 0.88–0.93, FL 1.1–1.34, FI 1.50–1.58, SL 1.08–1.21, SI 1.31–1.45, AE 0.23–0.30, DE 0.22–0.31, PSI 0.87–1.13 (8 measured).

Head, in full face view, ovate, sides strongly convex and joining together evenly to form the posterior margin; in profile, posterior margin weakly dorsoventrally pinched where dorsum and venter join at an obtuse angle. Genal carinae strongly elevated into ventrolateral flanges with a long gently sloped posterior edge and a short steeply sloped anterior edge. Clypeus with anterior margin convex laterally, flat to weakly concave medially. Frontal carinae weak and terminating near eye level. Mesonotal process produced as a thin plate; in dorsal view, attachment to mesonotum strongly attenuated giving the sides a concave appearance, posterior margin moderately to strongly excised. Propodeal spines thickening apically into a bifurcation with a short anterior point or angle, and a long acuminate posterior point that projects at an oblique angle; length of dorsal edge approximately equal to length of anterior edge.

Head smooth and shining on all surfaces except for arcuate carinae between eyes and antennal insertions. Clypeus occasionally with a few weak carinae attached to anterior border. Promesonotum, in dorsal view smooth and shining with a few very weak transverse impressions. Anepisternum rugose. Katepisternum smooth and shining. Metapleuron rugose. Head and mesosoma reddish-brown; waist, gaster and legs paler.

**Etymology.** The specific epithet *uncagena* is a noun in apposition combining the Latin *uncus*, meaning hook, and *gena*, meaning cheek, in reference to the modification of the genal carina into a hook-like flange in this species.

**Diagnosis, distribution and biology.** *Pheidole uncagena* is most easily confused with *P. pegasus*. Both are sympatric on Vanua Levu, and are characterized by a smooth and shining integument, paler coloration, and long propodeal spines. The features that best separates *P. uncagena*, not only from *P. pegasus* but from all other *P. roosevelti*-group species, are the modified genal carina that appear almost hook-like in oblique lateral view, and the strongly attenuated mesonotal process, which is best seen in dorsal view.



**FIGURE 94.** Relative morphometric measurements of *Pheidole roosevelti*-group species: (a) scape length vs. head length for major workers, (b) head width vs. mesonotal length for queen caste.

Some variation exists between the Vanua Levu type series and the minor workers collected in malaise traps from Taveuni. The propodeal spines of the type series are bifurcate, with a distinct anterior point in addition to the posterior point, whereas the anterior point of the Taveuni specimens are reduced to blunt angle, and the posterior points are longer than those exhibited by the Vanua Levu specimens. Additionally, the genal carinae of the type series come to a more definite point, whereas those of the Taveuni specimens are more blunt.

Although no queen of *P. uncagena* has been collected, the similarities it shares with *P. pegasus* predict that it will be a large queen with a well-developed mesonotum. The type series was taken from a nest in bare soil with multiple turret entrances. The recovery of this species from malaise traps suggest that the workers at least, occasionally, forage in the arboreal stratum.

**Additional material examined.** FIJI. *Taveuni*: 5.6 km SE Tavuki Village [Mt. Devo], 3.i–10.i.2003, 1187m, -16.84300°, 179.95500°, primary rainforest, malaise, (*E. Schlinger, M. Tokota'a*), FJTA8a\_M01\_12, 3 minors (CASENT0174282 – CASENT0174284); Devo Peak Radio Tower, 13.xii–20.xii.2002, 1200m, -16.85000°, 179.96667°, rainforest, malaise, (*M. Irwin, E. Schlinger, M. Tokota'a*), 1 minor (CASENT0174285).

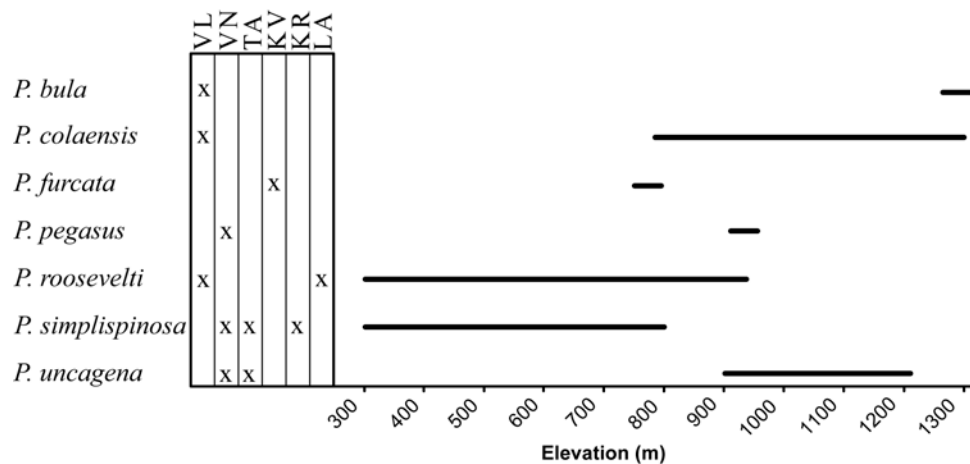
Two specimens, both minor workers, are labeled with the following locality: *Vanua Levu*: 6 km NW Kilaka Village Batiqere Range, 3.i.2003, 113m, -16.73170°, 178.99970°, malaise, (*E. Schlinger, M. Tokota'a*), FJVN58c\_M02\_06, (CASENT0174286, CASENT0174287). The record, if correct, would make this the lowest elevation occurrence of any *P. roosevelti*-group species. Remarkable, in itself, suspicion of erroneous data is further compounded by the observation that all other known records of the species are taken from the tallest peaks of Vanua Levu and Taveuni. It is with caution that the locality data is recorded here, and I refrain from including it in the presented figures.

### Distribution of the *Pheidole roosevelti*-group

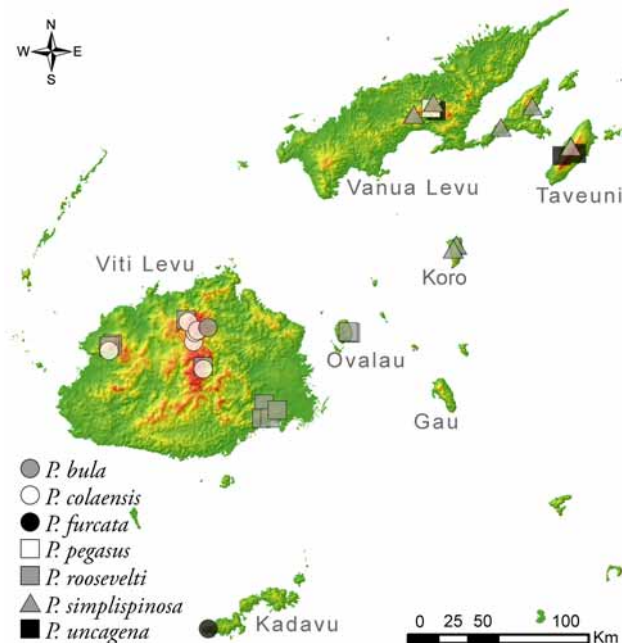
The *Pheidole roosevelti*-group is known only from six islands belonging to the Fijian archipelago (Fig. 96). While future expeditions to other higher elevation islands within the archipelago may produce new records of the group, preliminary examination of museum material from the Pacific region suggests the group is endemic to Fiji.

With two of the *P. roosevelti*-group species known only from their type localities (*P. bula*, *P. pegasus*), and a third (*P. uncagena*) known only from two localities, there is a distinct possibility that additional species remain undiscovered. Tempering this possibility is the narrow habitat range preferred by the group. For example, all of the three species known from two or fewer localities are restricted to the highest mountain peaks of their respective islands. *Pheidole bula* is known only from the summit Mt. Tomanivi (the highest mountain of Viti Levu), *P. pegasus* is known only from the summit of Mt. Delaikoro (the second highest mountain of Vanua Levu), and the only reliable records of *P. uncagena* are from Mt. Delaikoro and the summit of Devo Peak (the highest mountain of Taveuni). Fortunately, where they do occur, species of the *P. roosevelti*-group are relatively conspicuous, owing to the high numbers of their ground foragers, their strong recruitment to baits, their distinctive turret nest entrances built into bare soil, and the general paucity of other sympatric ant species. Therefore, a determined collector can be relatively certain whether or not a given locality harbors one or more species of the *P. roosevelti*-group.

The most likely candidate island within Fiji to support an unknown *P. roosevelti*-group population is Gau, with its intact high elevation interior forests. Gau remains the only island with significant elevation and suitable habitat that the author has not surveyed.



**FIGURE 95.** Geographical and elevational distribution of *Pheidole roosevelti*-group species. Elevation bars include  $\pm 50$  meters of known range. VL = Viti Levu, VN = Vanua Levu, TA = Taveuni, KV = Kadavu, KR = Koro, LA = Ovalau.



**FIGURE 96.** Distribution map of *Pheidole roosevelti*-group species across the Fiji Islands. Symbols are offset where they occur sympatrically.

### Comparison with other pacific *Pheidole*

The *Pheidole roosevelti*-group is morphologically most similar to their spinescent congeners originally assigned to the Old World subgenus *Pheidolacanthinus*. In his treatment of the subgenus Emery (1921) demarcated three groups: the *P. quadrispinosa* F. Smith group, the *P. quadricuspis* Emery group, and the *P. cervicornis* Emery group. Baroni Urbani (1995), in his treatment of the fossils *P. tethepa* Wilson and *P. primagenia* Baroni Urbani (the only putative members of *Pheidolacanthinus* known from the New World), discusses the validity of *Pheidolacanthinus* as a subgenus while submitting arguments for and against a single evolutionary origin of pronotal spines in *Pheidole*. Emery (1921) himself postulates that the subgenus is an



artificial assemblage based more on the convergent evolution of multiple spines than on phylogenetic relationship. He suggests that members of the *P. quadrispinosa*-group and the *P. quadricuspis*-group are more closely related to species outside the subgenus than to each other, and that the *P. cervicornis*-group is not closely related to either.

In preparation for a molecular analysis of the *P. roosevelti*-group and its relationship to other members of the genus, I have undertaken a cursory morphological study of the three *Pheidolacanthinus* groups. My initial investigations (based on the limited material currently available to me from Australia and New Guinea from the expeditions of P. S. Ward and myself, positively identified specimens on loan from the MCZC and NMNH, and the exemplary monograph of the Bornean *Pheidole* (Eguchi, 2001)), suggest that the *P. roosevelti*-group of Fiji is more closely related to the *P. cervicornis*-group than to either the *P. quadrispinosa*-group or the *P. quadricuspis*-group. While the *P. quadrispinosa*-group and the *P. quadricuspis*-group might well be rendered paraphyletic by relatives with unarmed pronota, the two groups share more similarity with each other than either does to the *P. cervicornis*-group.

This hypothesis of relationship is founded primarily on comparison of the hypostomal structure, propodeal spines, and mesonota of the groups in question. The hypostoma of the *P. roosevelti*-group, like that of the *P. cervicornis*-group, consistently bears three median processes. In contrast, the hypostomas of the *P. quadrispinosa*-group and the *P. quadricuspis*-group consistently lack the median tooth. The propodeal spines of the *P. cervicornis*-group are modified apically into bifurcations even more extreme than those of the *P. roosevelti*-group. In contrast, the propodeal spines of the *P. quadrispinosa*-group and the *P. quadricuspis*-group are consistently simple, never forming sharp angles or bifurcations. Lastly, the mesonotal spines of the *P. cervicornis*-group are quite reminiscent of the mesonotal processes of the *P. roosevelti*-group. Although none of *P. quadricuspis*-group species examined possess modified mesonota, several of the *P. quadrispinosa*-group species examined exhibit steep mesonotal declivities.

It should be mentioned that within the New Guinea material examined, there are many specimens that resemble those of the *P. cervicornis*-group, but which bear only a single median process on the hypostoma and lack the inner hypostomal teeth, and whose propodeal spines are either angulate (similar to many of the *P. roosevelti*-group species) or forked apically.

### **Biogeography of the *Pheidole roosevelti*-group**

Study of the *Pheidole roosevelti*-group has the potential to offer insights into both the biogeographic origin of Fiji's endemic ant fauna and the diversification of that fauna throughout the archipelago. While a discussion of the biogeographic origin of the *P. roosevelti*-group, *Lordomyrma* species and other endemic elements of Fiji's ant fauna will be tested and discussed more thoroughly in molecular phylogenetic work currently in progress, a brief outline of the competing hypotheses is presented here.

#### **Biogeographic origins**

Comparison with other Pacific congeners, as discussed previously, suggests the *P. roosevelti*-group is monophyletic, and is therefore derived from a single colonization of the archipelago by a shared common ancestor. If there is one argument to be made against monophyly, it is the questionable phylogenetic relationship of the enigmatic *P. simplispinosa* to the other members of the group. While it is possible that *P. simplispinosa* represents an independent colonization of the Fijian archipelago, a more likely scenario is that it is either sister to, or nested within, the remainder of the group.

If monophyly is assumed, then which region of the Pacific did the group's ancestral lineage inhabit before it colonized Fiji? The first step to answering this question is to determine the closest extant relatives of the *P. roosevelti*-group. Preliminary morphological study of the hypostoma, mesonotal declivity and propodeal

spines, suggests the *P. cervicornis*-group, which is currently known only from New Guinea, as a likely candidate. Although it has been suggested that Fiji was colonized by a number of ant lineages from New Guinea (Lattke, 2003; Mann, 1921; Wilson, 1959a; Wilson, 1961), no phylogenetic analyses have yet been undertaken to test this hypothesis. If the ancestor of the purported *P. roosevelti*-group clade did originate in New Guinea, or another part of western Melanesia, there are multiple processes by which it might have colonized the Fiji archipelago. While the few authors who have explored the issue with respect to ants propose long distance dispersal – either directly from New Guinea or via the Solomon Islands (Lattke, 2003; Mann, 1921; Sarnat, 2006; Wilson, 1959a; Wilson, 1961) – as the mode of colonization, the fragmentation of the ancient Vitiaz Arc (Hall, 2002; Kroenke, 1996; Kroenke & Yan, 1993) may have served as an alternative process to explain the existence of Fiji's endemic insect fauna (Bickel, 2006; Sarnat, 2006).

Another potential biogeographic origin of the *P. roosevelti*-group is the mesic forests of eastern Australia. Although no members of the *P. cervicornis*-group are known from Australia, the eastern rainforests of the continent support a diversity of other spiny *Pheidole* species. The two most significant criticisms of the Australia origin hypothesis are that the morphological similarities shared by the *P. roosevelti*-group and the Australian *Pheidolacanthinus* appear to be the product of homoplasy rather than common ancestry, and that long distance dispersal is the only process by which the colonization event could have occurred. New Caledonia, which supports a tremendous endemic ant fauna, is another alternative origin, but no *Pheidole* species of similar morphology have been reported from the island.

#### Biogeographic patterns within the Fijian archipelago

The most interesting biogeographic pattern exhibited by the *Pheidole roosevelti*-group within the Fijian archipelago is the restriction of its species to high elevation ranges, and often to the very summits of those mountains (Fig. 95). In effect, this high-elevation distribution may create a scenario in which species and populations are dispersed across the figurative islands of a mountain range network that is itself nested within the actual island network of the archipelago. One would expect limited gene flow from such geographically isolated populations that would, over time, produce distinct lineages incapable of interbreeding.

If the *P. roosevelti*-group is found to be monophyletic, it would suggest that its populations have not only spent enough time in isolation to diversify into at least seven distinct species, but that conditions have further allowed many of those species to achieve sympatry with each other. On Viti Levu, for example, across its lower elevation range, *P. colaensis* is widely sympatric with *P. roosevelti*, and in at least one locality of its higher range, the same *P. colaensis* is also sympatric with *P. bula*. On Vanua Levu, populations of the *P. pegasus* and *P. uncagena* (potential sister species) are both found at the summit of Mt. Delaikoro, and *P. simplispinosa* is nesting 100 meters lower down on the same mountain. On Taveuni, *P. uncagena* and *P. simplispinosa* are both found on Mt. Devo, with the former occurring at the summit and the latter occurring at the lower elevations.

Another biogeographical pattern of interest is what appears to be a phylogenetic split within the *P. roosevelti*-group between the southern species and the northern species. While phylogenetic analysis is required to test the hypothesis, similar morphologies unite *P. colaensis* (Viti Levu), *P. bula* (Viti Levu) and *P. furcata* (Kadavu) into one distinct group, and *P. pegasus* (Vanua Levu) and *P. uncagena* (Vanua Levu, Taveuni) into a second distinct group. The two most difficult species to place phylogenetically based on morphology are *P. roosevelti*, because it shares many similarities with both the aforementioned groups, and *P. simplispinosa*, because it shares few similarities with any of the aforementioned groups. Although *P. roosevelti* is widespread on Viti Levu and Ovalau, it does not occur in the northern islands. Similarly, although *P. simplispinosa* is widespread in the north, it does not occur on any of the southern islands. While it is tempting to invoke competitive exclusion or species replacement as causative agents responsible for the observed distributions, species pairs that share much closer morphological resemblance to each other (i.e. *P. colaensis* vs. *P. bula*, and *P. pegasus* vs. *P. uncagena*) are capable of maintaining a sympatric existence.

The historical conditions that might have contributed to the observed biogeographic patterns, together with a molecular phylogeny of the *P. roosevelti*-group and selected outgroups, will be discussed more thoroughly in a forthcoming paper.

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