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Revision of the *Pachycondyla sikorae* species-group (Hymenoptera: Formicidae) in Madagascar

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Abstract

The Malagasy ponerine *Pachycondyla sikorae*-group is revised and a worker-based key to species is presented. Fourteen species are recognised, of which 13 are described as new. The species group is redefined and divided into two species complexes: the *sikorae*-complex (*P. gorogota* **sp. n.**, *P. haratsingy* **sp. n.**, *P. ivolo* **sp. n.**, *P.maeva* **sp. n.**, *P.mialy* **sp. n.**, *P. nosy* **sp. n.** and *P.sikorae* Forel) and the *vohitravo*-complex (*P. agnivo* **sp. n.**, *P. antsiraka* **sp. n.**, *P. daraina* **sp. n.**, *P. rovana* **sp. n.**, *P. tahary* **sp. n.**, *P. vohitravo* **sp. n.** and *P. zoro* **sp. n.**). All 14 species are endemic to Madagascar and distributed across the rainforests in the east and the transitional humid habitats in the northwest of Madagascar. Distribution maps of each species are included.

Key words: Taxonomy, *Pachycondyla, Euponera, P. sikorae*-group, Madagascar

Introduction

The ant genus *Pachycondyla* F. Smith has been shown to be broadly non-monophyletic (Ward 2011; Schmidt 2013). The Malagasy region includes six *Pachycondyla* lineages. The two most diverse lineages include the *wasmannii*-group (8 species) and the *sikorae*-group (14 species). The four remaining lineages include only one species each (*P. ambigua , P. darwinii, P. melanaria,* and *P. obscurans*). Since the first description of *Pachycondyla sikorae* by Forel in 1891 as *Euponera sikorae*, no additional species in the *sikorae*-group have been described. Recent research surveys of the arthropods of Madagascar have provided a wealth of new specimens belonging to this species-group. A revision of the Malagasy *Pachycondyla sikorae*-group is part of a larger effort to revise the Malagasy ants in order to better understand and manage the island's biodiversity.

Workers of the *P. sikorae* species-group are generally distinguishable from those of other ponerine groups in Madagascar by the presence of the dorsolateral circular pit or fovea near the base of the mandibles, the thick petiole node, and occasionally a deep metanotal groove. The species-group shows remarkable variation in morphology and presents useful diagnostic characters to separate its species. Among these characters are the shape of the clypeus, the development of the metanotal groove, the presence of sharp teeth or tubercles on the posterolateral margin of the petiolar node, the form of the petiolar node, and the size of the eyes. The shape of the clypeus divides the species-group into two species complexes.

Although the *P. sikorae* species-group is widespread in Madagascar and known to occupy the humid forests in the east and transitional forest habitats in the northwest of the island, nearly all species are rarely collected and have been recorded from a limited number of specimens. Little information is available on the ecology and reproductive biology of the group, but across these habitat ranges workers have been found foraging through the leaf litter and the forest floor, while colony nest sites vary from within soil layers and under rocks to inside rotten logs.

The present study is the first revision of the Malagasy *P. sikorae*-group and is based primarily on the morphology of the worker caste. As very few male specimens were collected with workers from the same colony, males are not included in this revision. Overall, 14 species are recorded, of which 13 are newly described.

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Materials and Methods

Abbreviation of depositories

BMNH: The Natural History Museum (British Museum of Natural History), London, UK.
CASC: California Academy of Sciences, San Francisco, CA, USA.
MCZC: Museum of Comparative Zoology, Harvard University, Cambridge, MA, USA.
MHNG: Musée d'Histoire Naturelle, Geneva, Switzerland.
MNHN: Musée National d'Histoire Naturelle, Paris, France.
PBZT: Parc Botanique et Zoologique de Tsimbazaza, Antananarivo, Madagascar.
PSWC: P.S. Ward Collection, University of California at Davis, CA, USA.

Materials

The present contribution includes all specimens of the *Pachycondyla sikorae*-group collected from the arthropod survey project conducted in Madagascar by B.L. Fisher and the members of the Madagascar Biodiversity Center from 1992 through 2012. This revision also integrates specimens from MCZC, MHNG, MNHN, and PSWC.

Methods

The biological species concept (Mayr 1963), which uses patterns of morphological discontinuities and phenotypic similarity as well as the framework of geographic distribution shown by populations to delimit species boundaries, is employed to define species in the Malagasy *P. sikorae* species-group. Each species is then described using morphological characters of the worker caste. An identification key to species is made based on diagnostic characters of the workers.

Morphological examinations were conducted using a Leica MZ12.5 binocular microscope. Hair (setae) types on the dorsum of the ant body are differentiated as erect or suberect hairs and pubescence (as defined by Bolton 1994; Rakotonirina & Fisher 2013).

Digital color images of lateral and dorsal views of the entire body and full-face views of the head of each species were created using a JVC KY-75 digital camera with a Leica Z16 APO microscope and LAS (v5.0) software. These images are available on the web portal AntWeb (www.antweb.org) and can be accessed using the unique identifying specimen code (e.g. CASENT0104547) assigned to each imaged specimen.

Distribution maps for each species were generated by importing specimen distribution records into the Diva GIS program (Hijmans *et al.* 2011). Some older and type specimens of *P. sikorae* were excluded from the map of the species when their geographic coordinates were insufficiently precise.

Article 74 in the ICZN's code states that the designation of a lectotype from syntype specimens which directly matches the original description of a named species is necessary to stabilize the nomenclature. As a consequence, the words "present designation" were used to indicate a lectotype. New species epithets used in the present work are arbitrary combinations of letters and thus invariant, as are genitive nouns or nominative singular nouns in apposition.

One new species (*P. ivolo*) is known only from a single alate queen; a detailed description is provided. When known, the queen castes of other species are also described but character states shared with the general diagnosis of the corresponding worker are not repeated.

Measurements and indices

Using an orthogonal pair of micrometers, a series of morphometric measurements was taken to the nearest 0.001 mm, and were rounded to the second decimal place. All indices were multiplied by 100 and rounded to the nearest integer. Ranges are presented as minimum and maximum if more than one specimen was measured.

Measurements:

Head length (HL): the length of the head in full-face view, taken along a straight line from the capsule at the mid-point of the anterior clypeal margin to the midpoint of the posterior cephalic margin or to the midpoint of the transverse line between the level of the posterior margin of both occipital lobes if the posterior margin of the head is concave.

Head width (HW): the maximum width of the head in frontal view, excluding the eyes.

Scape length (SL): the length of the straight line of the antennal scape excluding the basal condylar articulation.

Pronotum width (PW): the maximum width of the pronotum in dorsal view.

Weber's length (WL): the maximum length of the mesosoma measured diagonally from the meeting point between the pronotum and the neck to the furthest posterior extension of the metapleuron.

Petiole width (NW): the maximum width of the node in dorsal view.

Petiole height (NH): the height of the node in lateral view, measured vertically from the highest point of the dorsal margin of the node to the level of the ventral margin of the node at the junction with the subpetiolar process.

Petiole length (NL): the maximum length of the node in dorsal view, taken between the base of the anterior process which connects to the propodeum and the base of the posterior portion that forms an articulation with the gaster.

Indices:

Cephalic index (CI): head width divided by head length x 100.

Scape index (SI): scape length divided by head width x 100.

Lateral petiole index (LNI): petiole height divided by petiole length x 100.

Dorsal petiole index (DNI): petiole width divided by petiole length x 100.

Other abbreviations

The following abbreviations related to locality information are also made to indicate the status of protected areas and forest habitats in the Malagasy region:

PN: Parc National; **RS:** Réserve Spéciale; **F:** Forêt; **RF:** Réserve Forestière, **RP:** Réserve Privée; **FC:** Forêt classée; **SF:** Station forestière; **RNI:** Réserve Nationale Intégrale

Diagnosis of workers and queens of *P. sikorae* species-group

In the Malagasy region, the *P. sikorae*-group is most similar to species in the recently revised *P. wasmannii*-group (by Rakotonirina & Fisher 2013). These two groups share many characters listed below but the *sikorae*-group can be distinguished by the presence of a lateral circular pit at the base of the mandibles (Fig. 1). In the field, verification of the circular pit in the smaller species may be difficult, but workers of the *P. sikorae*-group can be recognized by their slender body, shiny integument, and their immediate moving reaction when their nests are disturbed. Conversely, those of the *P. wasmannii*-group can be identified by their robust body, matte integument, and their ability to simulate death when disturbed.

1. Mandible subtriangular, masticatory margin with 9–12 teeth and denticles.
2. Mandible with dorsolateral pit or fovea near the base; lateral sulcus present, running from the base to the apex.
3. Palp formula 2, 2.
4. Frontal lobes with an anteriorly broadly rounded outer margin which is posteriorly and laterally compressed to form a narrow surface at about the level of the eyes.
5. Anteromedian margin of clypeus straight and medially notched in *P. gorogota, P. haratsingy, P. ivolo, P. maeva, P. mialy, P. nosy, P. sikorae* or triangular or broadly rounded in *P. agnivo, P. antsiraka, P. daraina, P. rovana, P. tahary, P. vohitravo* and *P. zoro*.
6. Antenna with 12 segments, the funiculus gradually increasing in width towards the apex and without a distinct club.

FIGURE 1. Lateral view of the head showing the lateral circular pit near the base of the mandible (CASENT0497667).

7. Compound eyes variable in size, rarely larger than the maximum diameter of antennal scape or greater (*P. sikorae, P. agnivo*) and most often smaller than approximately half of the maximum diameter of antennal scape; located roughly at the midline of the head when viewed in profile.
8. Apical portion of hind tibiae with two spurs, a large pectinate spur and an anterior spur that is much smaller and simple.
9. Pretarsal claws simple.
10. Metanotal groove strongly impressed in *P. gorogota, P. maeva*, and *P. sikorae* to feebly distinct in *P. haratsingy* and *P. nosy,* or absent in other remaining species.
11. Mesopleural sulcus usually indistinct, present as three to fourbroad, discontinuous grooves or as a single narrow sulcus.
12. Posterolateral margin of propodeum simply rounded or marginate (*P. haratsingy, P. rovana, P. sikorae*), bordered with lamellae (*P. gorogota, P. maeva, P. daraina, P. zoro*) or covered with a series of sharp teeth or denticles (*P. antsiraka, P. tahary, P. vohitravo*).
13. Propodeal spiracle slit-like.
14. Metapleural gland opening just above the posteroventral angle of mesosoma.
15. Petiole node usually thick, very rarely a flattened scale with slight posteromedian notch (*P. gorogota, P. maeva*).
16. Helcium approximately at the anteroventral angle of the first gastral segment (fourth abdominal segment).
17. First and second gastral segments with distinct constriction.
18. Stridulitrum absent.
19. Sting well developed.

20. Queen comparatively similar to worker, but with the following distinctive features: broader head, presence of ocelli, eye diameter greater than the greatest width of antennal scape; mesopleuron divided into an episternum and katepisternum by a transverse sulcus; the mesosomal flight sclerites fully developed; petiole node more or less flattened anteroposteriorly; moderately larger body size with usually more voluminous gaster and denser and more elongate pubescence.

The worker caste of the *P. sikorae*-group in Madagascar can be identified by the combination of the following characters: presence of a pit on the lateral portion of the base of the mandibles (Fig. 1); the shape of the anterior clypeal margin either approximately straight with slight median notch (Fig. 2) or projecting into triangular lobe (Fig. 3); the slit-shaped opening of propodeal spiracles; metanotal groove either present or absent; hind legs with two tibial spurs, of which one is large and pectinate and the other smaller and simple; posterior margin of propodeum simple, lamellate or infrequently with a series of sharp teeth; thick petiolar node whose posterodorsal angle has no long spines and whose posterolateral margins occasionally have a series of sharp teeth or tubercles (Fig. 19); the frontal lobes are broadly rounded. Workers of the *P. sikorae*-group are superficially similar to those of the *P. wasmannii*-group, but the former have a lateral circular pit or fovea near the base of their mandibles, which is absent in the *P. wasmannii*-group.

The shape of the anterior margin of the clypeus allows the division of the *P. sikorae*-group into two species complexes. First, the *sikorae* complex, which includes seven species, has a broadly transverse and roughly straight anterior clypeal margin, with slight median notch (Fig. 2); second the *vohitravo* complex, which also contains seven species, is characterized by a medially convex or bluntly angulate anterior margin of clypeus (Fig. 3).

Synopsis of the taxonomic history of the *P. sikorae* species-group

Pachycondyla sikorae was first described as a subgenus (*Euponera*) of *Ponera* by Forel 1891: 127. The new subgenus *Euponera* was later raised to genus (Emery, 1901:46) and by 1911, included a heterogenous group of species placed in four subgenera: *Euponera*, *Mesoponera*, *Brachyponera*, and *Trachymesopus* (Emery 1911: 79–86). Brown in Bolton (1994) synonymized the genus as a junior synonym of *Pachycondyla*, which is where it remains today though molecular results suggest that *Pachycondyla* is paraphyletic (Ward 2011; Schmidt 2013).

Detailed taxonomic history of *Euponera* modified from AntCat.org 2013:

Euponera Forel, 1891: 126 [as subgenus of *Ponera*] Type-species: *Ponera sikorae*, by monotypy.
Euponera in Ponerinae, Ponerini: Emery, 1895: 767; Emery, 1911: 79 [subtribe Pachycondylini]; Wheeler, 1915: 37; Arnold, 1915: 63; Forel, 1917: 237; Wheeler, 1922: 648; all subsequent authors.
Euponera as subgenus of *Ponera*: Forel, 1891: 126; Emery, 1895: 767.
Euponera as genus: Emery, 1901: 46; Emery, 1909: 364; Wheeler, 1910: 135; Emery, 1911: 79; Arnold, 1915: 63; Forel, 1917: 237; Gallardo, 1918: 64; Wheeler, 1922: 648; Borgmeier, 1923: 70; Clark, 1934: 30; Creighton, 1950: 44; Chapman & Capco, 1951: 63; Bernard, 1953: 189; Wheeler & Wheeler, 1985: 256; Dlussky & Fedoseeva, 1988: 78; Hölldobler & Wilson, 1990: 11.
Euponera as junior synonym of *Pachycondyla*: Brown, in Bolton, 1994: 164; Bolton, 2003: 166.

Checklist of the Malagasy *P. sikorae* species-group

sikorae complex:
gorogota Rakotonirina and Fisher, sp. n.
haratsingy Rakotonirina and Fisher, sp. n.
ivolo Rakotonirina and Fisher, sp. n.
maeva Rakotonirina and Fisher, sp. n.
mialy Rakotonirina and Fisher, sp. n.
nosy Rakotonirina and Fisher, sp. n.
sikorae Forel 1891

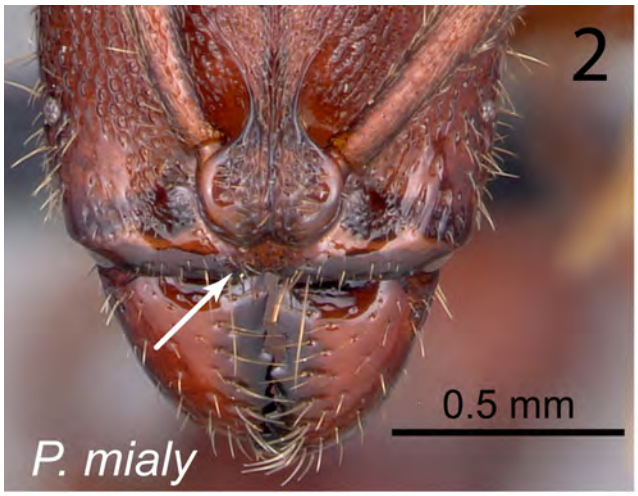
vohitravo complex:

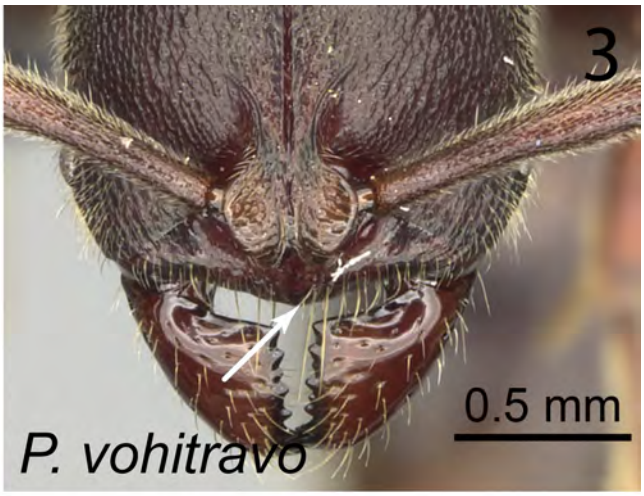
agnivo Rakotonirina and Fisher, sp. n.
antsiraka Rakotonirina and Fisher, sp. n.
daraina Rakotonirina and Fisher, sp. n.
rovana Rakotonirina and Fisher, sp. n.
tahary Rakotonirina and Fisher, sp. n.
vohitravo Rakotonirina and Fisher, sp. n.
zoro Rakotonirina and Fisher, sp. n.

Key to species of Malagasy *P. sikorae* species-group

The function of the key is primarily to identify workers, but can also identify ergatoid and winged queens to species as long as the shape of the mesosoma is not considered.

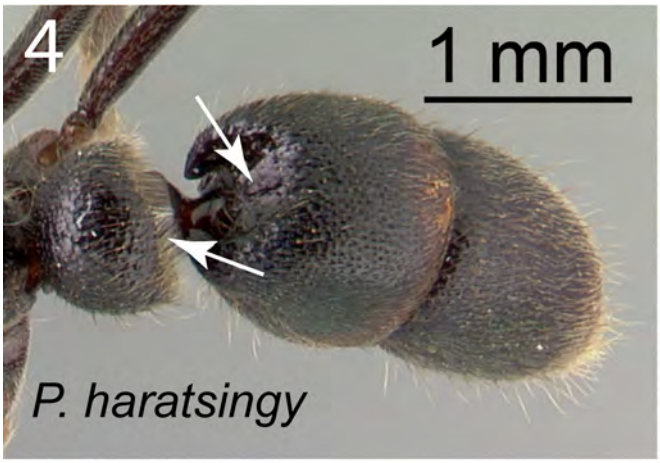
1. With head in full-face view, anterior margin of clypeus widely transverse and more or less straight, with weak median notch (Fig. 2) (*sikorae* complex). 2
- With head in full-face view, anterior margin of clypeus generally convex or medially bluntly angulate; slight median notch may be present (Fig. 3) (*vohitravo* complex) 8

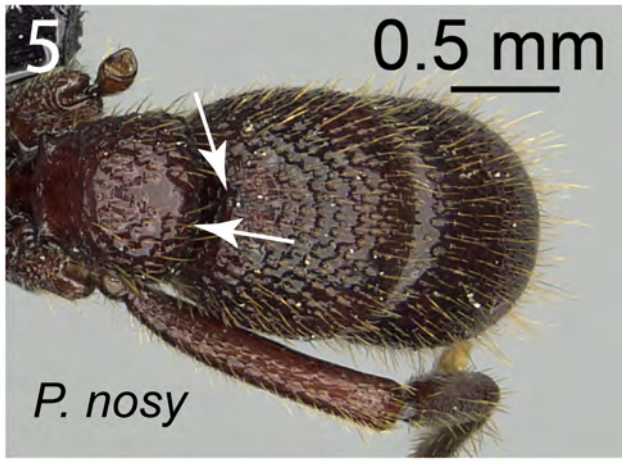




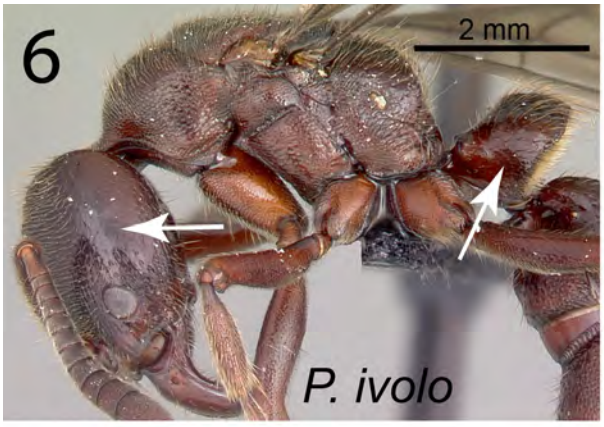
FIGURES 2–3. Shape of the clypeus with head in full-face view; Fig. 2: anterior margin widely transverse and straight with feeble median notch (CASENT0497667); Fig. 3: anterior margin medially convex or bluntly angulate (CASENT0050524).

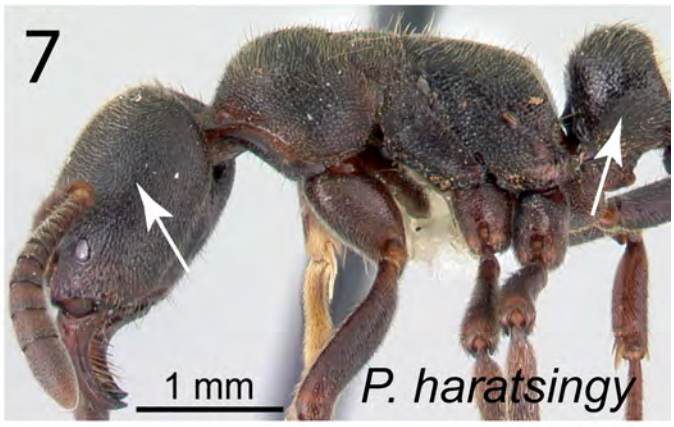
2. Posterior surface of petiole node covered with numerous slender hairs and abundant pubescence; anterior surface of third abdominal segment concave, forming a shallow cavity to lodge the posterior surface of the petiole (Fig. 4). 3
- Posterior surface of petiole node convex and not covered with numerous slender hairs and abundant pubescence; anterior surface of the third abdominal segment straight, without shallow cavity to lodge the posterior surface of the petiole (Fig. 5). . . . 4
3. Lateral surface of head and petiole node smooth and shiny, with scattered piligerous punctures (Fig. 6) [known from queen specimen] . . . . . ***ivolo***
- Lateral portion of head densely and finely reticulate-rugulose, sides of petiolar node densely and finely punctate (Fig. 7). . . . . ***haratsingy***
4. With mesosoma in dorsal view, metanotal groove deeply impressed (Fig. 8); in lateral view the dorsal outline of mesosoma complex, at least with distinct convex mesonotum (Figs 37, 46) 5
- With mesosoma in dorsal view, metanotal groove not impressed or absent (Fig. 9); in lateral view, the dorsal outline of mesosoma almost straight or slightly evenly convex, without breaks (Figs 49, 51) 7
5. Petiole node anteroposteriorly flattened in profile (Fig. 10), in dorsal view its posterior margin medially notched; posterior margin of head slightly concave; antennal scape not surpassing the concave posterior cephalic margin (Figs 38, 47); mandible smooth between small punctures; tegument densely and finely reticulate-punctate (Figs 37, 46). 6
- Petiole node thick in profile (Fig. 11); in dorsal view, the posterior margin broadly convex; antennal scape surpassing the broadly convex posterior cephalic margin (Fig. 59); mandible striate-punctate; black species with mostly smooth and shiny tegument (Fig. 58). . . . . ***sikorae***



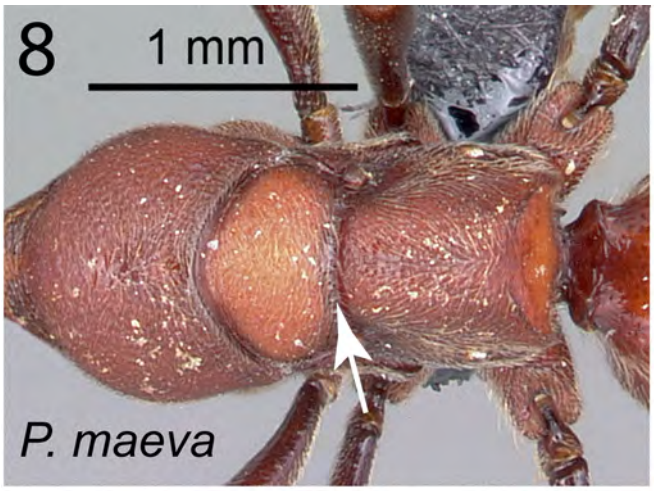


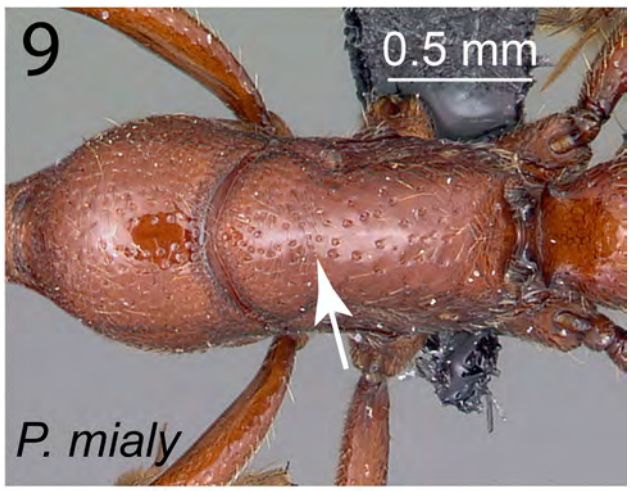
FIGURES 4–5. Petiole and gaster in dorsal view; Fig. 4: posterior surface of petiole with abundant pubescence and anterior face of first gastral segment forming shallow cavity (CASENT0195184); Fig. 5: abundant pubescence absent on posterior surface of petiole and anterior face of first gastral segment straight without shallow cavity (CASENT0231239).



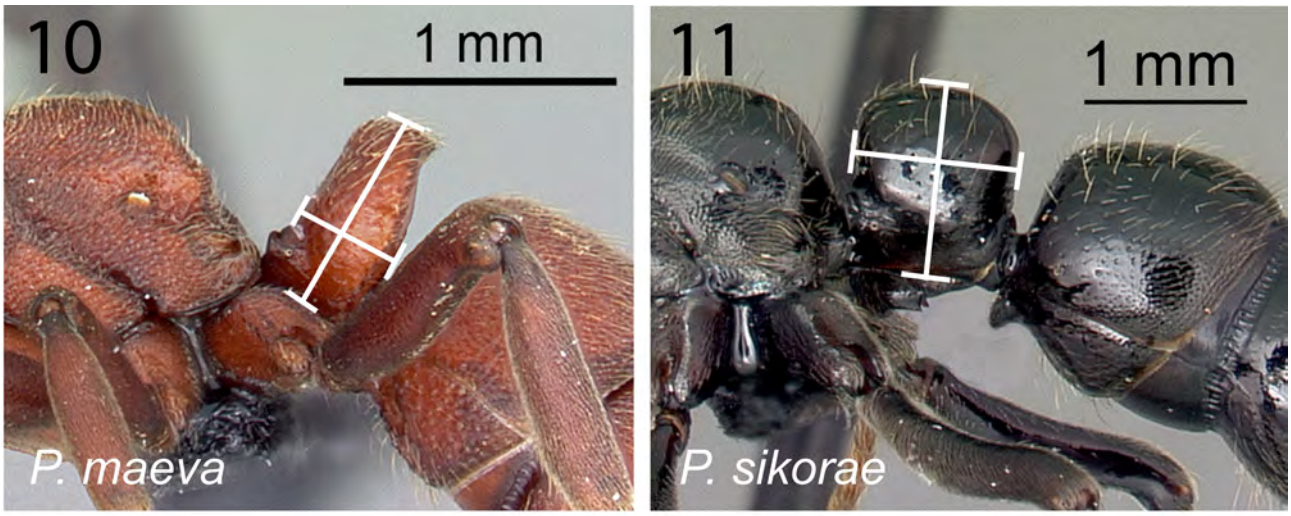


FIGURES 6–7. Lateral view showing the sculpture of lateral portion of head and petiole; Fig. 6: head and petiole smooth and shining (CASENT0050330: holotype); Fig. 7: head densely and finely reticulate-rugulose, petiolar node densely and finely punctate (CASENT0195184).



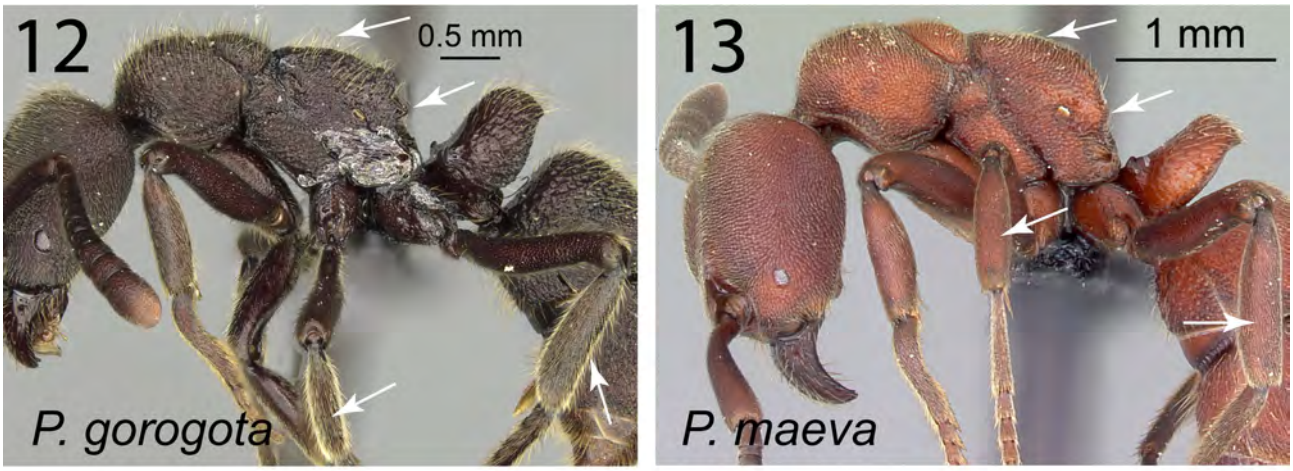


FIGURES 8–9. Mesosoma in dorsal view; Fig. 8: metanotal groove deeply impressed (CASENT0034340: holotype); Fig. 9: metanotal groove lacking (CASENT0497667).



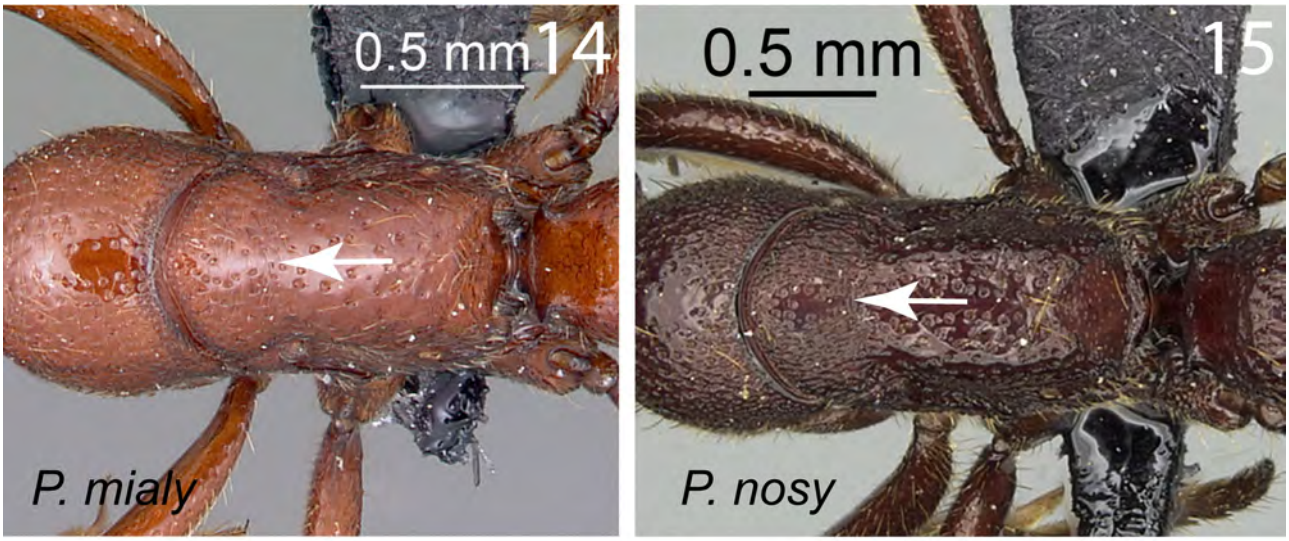
FIGURES 10–11. Form of petiole in profile; Fig. 10: anteroposteriorly flattened (CASENT0034340); Fig. 11: nodiform about as long as broad (CASENT0497202).

6. Posterolateral margin of propodeum bordered with broad lamellae which project as tubercles at about the level of propodeal spiracle; antennal scape and outer surface of each tibia covered with erect, slender hairs (Fig. 12); dorsum of head near the posterior margin and rest of body covered with numerous slender long hairs; posterior cephalic margin more or less straight. . . . . ***gorogota***
- Posterolateral margin of propodeum bordered with narrow lamellae which form an obtuse angle at about the level of propodeal spiracle; antennal scape and outer surface of each tibia lacking erect, slender hairs (Fig. 13); dorsum of head and rest of body covered with few erect, slender hairs; posterior cephalic margin concave . . . . . ***maeva***

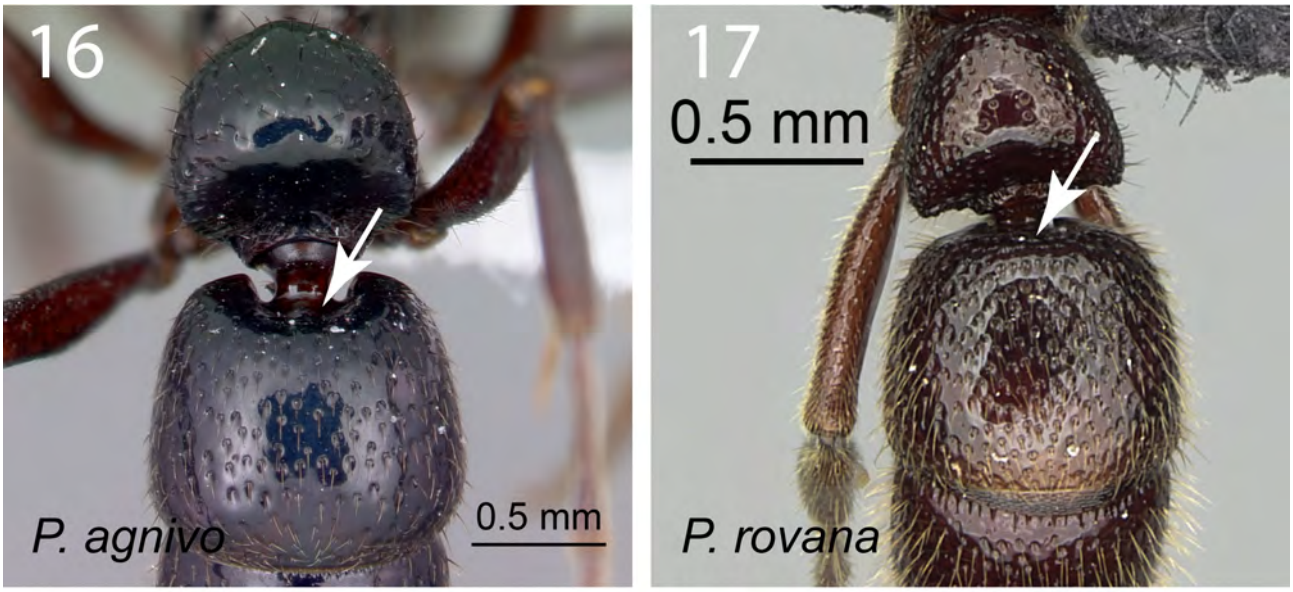


FIGURES 12–13. Hairs on the outer surface of tibiae and the width of lamellae on posterior margin of propodeum; Fig. 12: outer surface of each tibia covered with erect hairs and posterior margin of propodeum with broad lamellae that project as a tubercle at about the level of the propodeal spiracle (CASENT0166009: holotype); Fig. 13: outer surface of tibiae without erect hairs, posterior margin of propodeum with narrow lamellae that form an obtuse angle at about the level of propodeal spiracle (CASENT0034340).

7. Smaller species (HW: 1.15, HL< 1.5, WL: 1.78); eyes smaller, with seven to eight ommatidia; metanotal groove absent (Fig. 14); mesopleural suture lacking . . . . . ***mialy***
- Larger species (HW: 1.44, HL: 1.62, WL: 2.34); eyes larger, with 13 ommatidia; metanotal groove present as a dotted line (Fig. 15); mesopleural suture present. . . . . ***nosy***
8. Anterior surface of the third abdominal segment concave (Fig. 16), forming a shallow cavity to lodge the median portion of the posterior surface of petiole node . . . . . ***agnivo***
- Anterior surface of the third abdominal segment straight, not forming a shallow cavity to lodge the posterior surface of petiole node (Fig. 17) 9

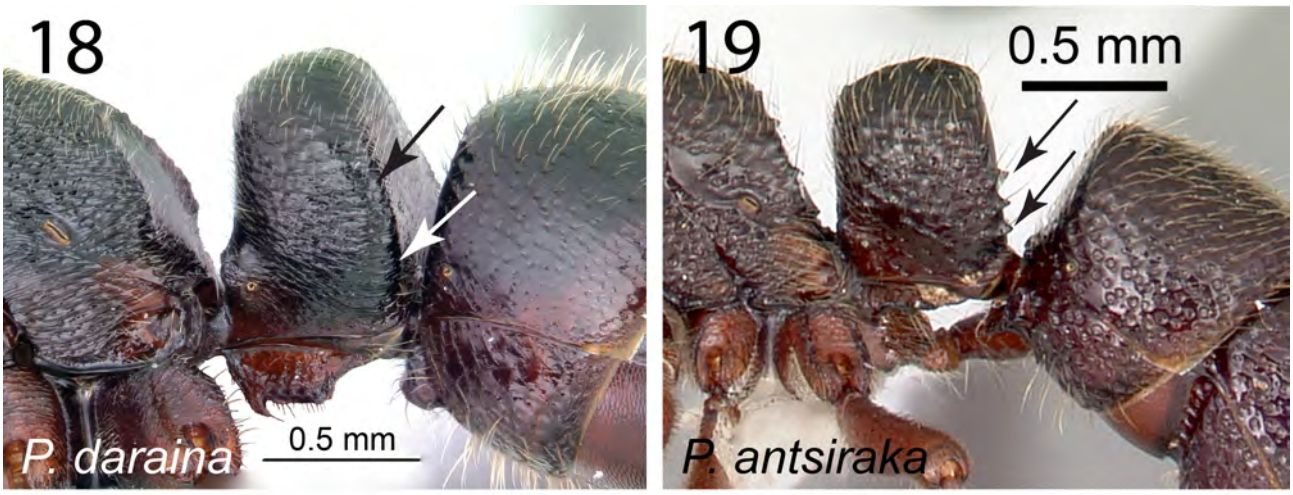


FIGURES 14–15. Mesosoma in dorsal view; Fig. 14: metanotal groove absent (CASENT0497667); Fig. 15: metanotal groove as a dotted line (CASENT0231239: holotype).

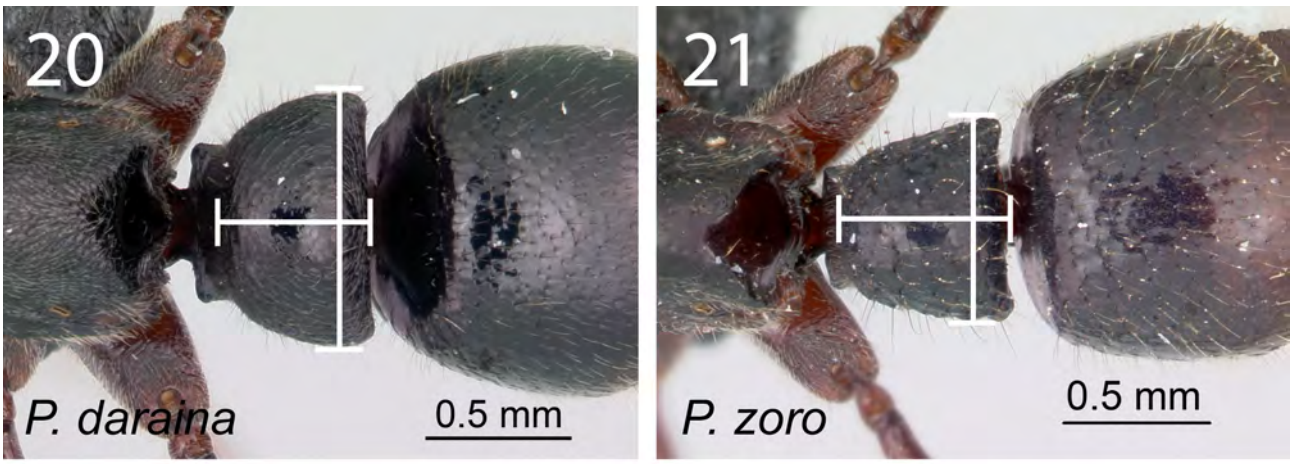


FIGURES 16–17. First gastral segment in dorsal view; Fig. 16: anterior face forming shallow cavity (CASENT0317589: holotype); Fig. 17: anterior face without shallow cavity (CASENT0247289).

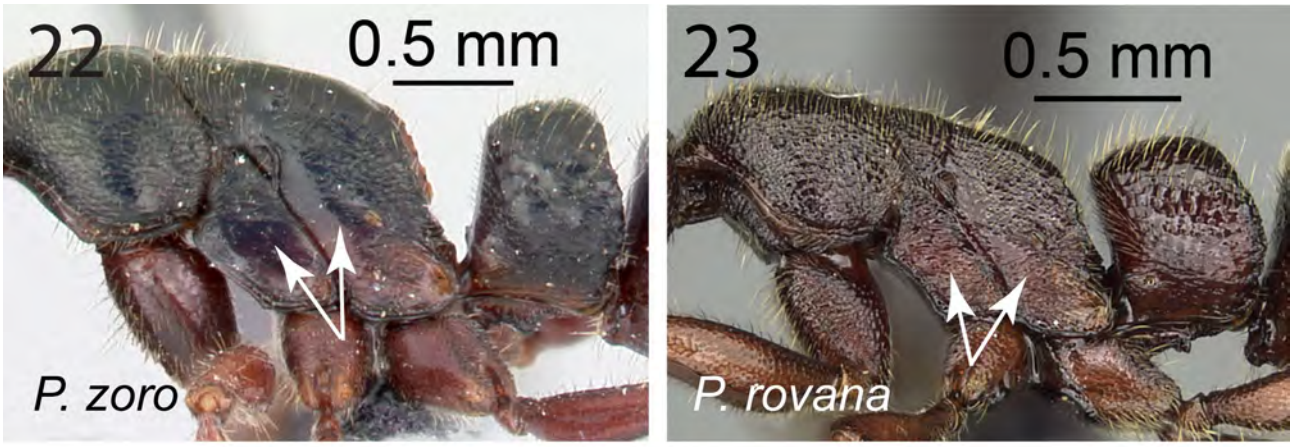
9. Posterolateral margins of petiole node without a series of sharp teeth or tubercles (Fig. 18); dorsum of node not tubercuate 10
- Posterolateral margins of petiole node armed with a series of sharp teeth or tubercles (Fig. 19); dorsum of node tuberculate . . . 12
10. In dorsal view, petiole node almost twice as broad as long (Fig. 20); in lateral view, subpetiolar process simple with only an anterior triangular lobe (Fig. 18) . . . . . ***daraina***
- In dorsal view, petiole nodenearly as broad as long (Fig. 21); in lateral view subpetiolar process with an anterior hook-like process and a posterior subtriangular process separated by a concavity (Fig. 55) 11
11. Larger ant (HW: 1.22–1.32, WL: 1.85–2.05); mesopleuron and lower half of the side of propodeum mostly smooth and shiny with scattered small punctures in the center and fine rugulae at the junction of anepisternum and katepisternum and the lower portion of the metapleuron near the opening of the metapleural gland (Fig. 22) . . . . . ***zoro***
- Smaller species (HW: 1.01–1.14, WL: 1.58–1.77); mesopleuron and lower half of the side of propodeum densely rugulose and superimposed with punctures or foveolae (Fig. 23) . . . . . ***rovana***



FIGURES 18–19. Petiolar node in profile; Fig. 18: posterolateral margin without a series of sharp teeth or tubercles (CASENT0043301: holotype); Fig. 19: posterolateral margin armed with a series of sharp teeth or tubercles (CASENT0317590: holotype).

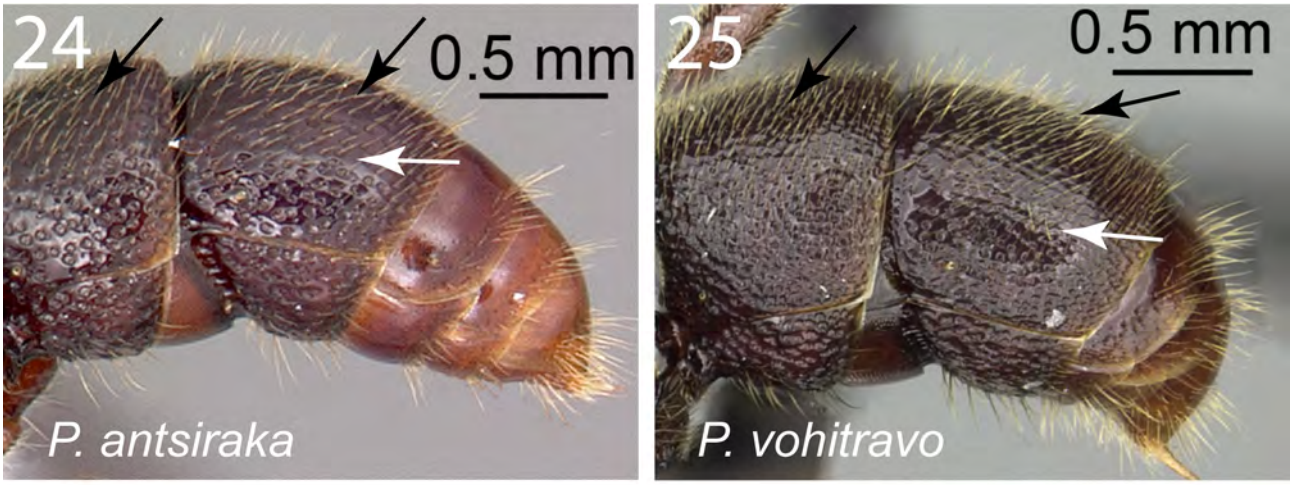


FIGURES 20–21. Petiole in dorsal view; Fig. 20: node approximately twice broader than long (CASENT0043301); Fig. 21: node nearly as broad as long (CASENT0045619: holotype).

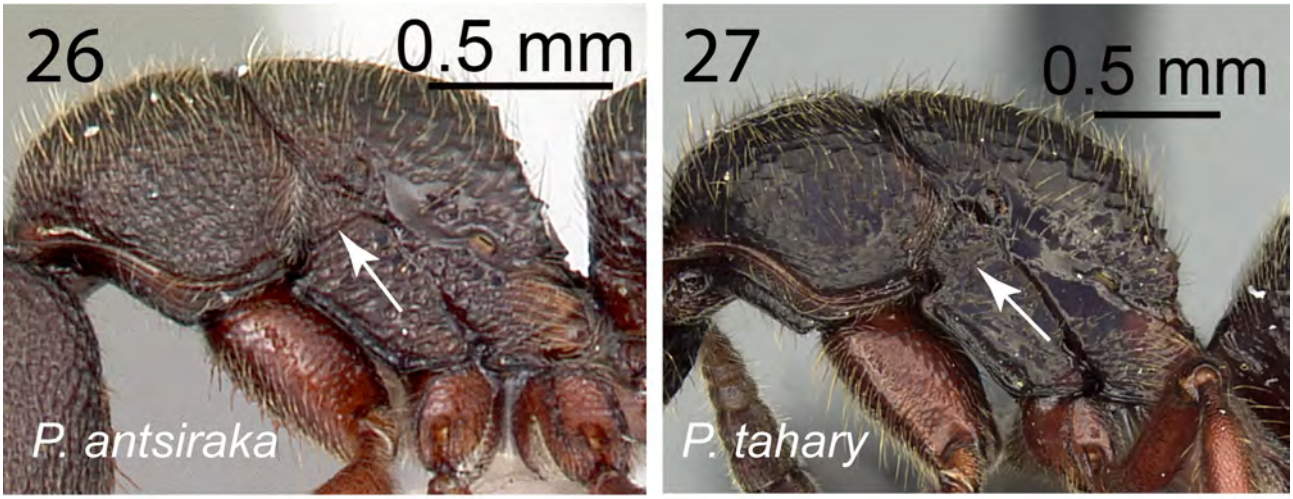


FIGURES 22–23. Sculpture of the lateral surface of mesosoma; Fig. 22: smooth and shiny mesopleuron and metapleuron with scattered small punctures (CASENT0045619); Fig. 23: densely rugulose mesopleuron and metapleuron superimposed with punctures (CASENT0247289).

12. Second gastral (fourth abdominal) tergite punctate to sparsely punctuate; pubescence absent or reduced in abundance on first and second gastral segments, distance between two adjacent pubescences generally equal to or greater than the length of the pubescence itself (Fig. 24) 13
- Second gastral (fourth abdominal) tergite densely punctate, with small punctures between larger ones; first and second gastral segments with abundant pubescence, distance between two adjacent pubescences always less than the length of the pubescence itself (Fig. 25) . . . . . ***vohitravo***
13. Mesopleural suture distinctly continuous and narrowly impressed (Fig. 26); head densely and finely reticulate-rugulose or reticulate-punctate behind the level of eye; with head in full-face view, the lateral borders at the level of anterior margin of eye not strongly curving towards the base of mandibles (Fig. 32); in profile, distance between eyes and base of mandibles roughly three times or more than the maximum diameter of eye. . . . . ***antsiraka***
- Mesopleural suture indistinct, with broad and discontinuous concavities or impressions in this region, but no obvious suture (Fig. 27); head mostly smooth and shiny with faintly effaced reticulate-punctate sculpture behind the level of eyes; with head in full-face view, the lateral margins from the level of anterior margin of eye abruptly curving toward the base of mandibles (Fig. 62); in lateral view, distance between eye and base of mandible slightly less than twice the maximum diameter of eye. . . . . ***tahary***



FIGURES 24–25. Sculpture and pubescence of the gaster; Fig. 24: first and second gastral tergites with few pubescence and second gastral tergite punctate to sparsely punctate (CASENT0317590); Fig. 25: first and second gastral tergites with abundant pubescence and second gastral tergite densely punctate (CASENT0050524).



FIGURES 26–27. Mesosoma in lateral view; Fig. 26: mesopleural suture distinctly continuous and narrowly impressed (CASENT0317590); Fig. 27: mesopleural suture indistinct (CASENT0162668: holotype).

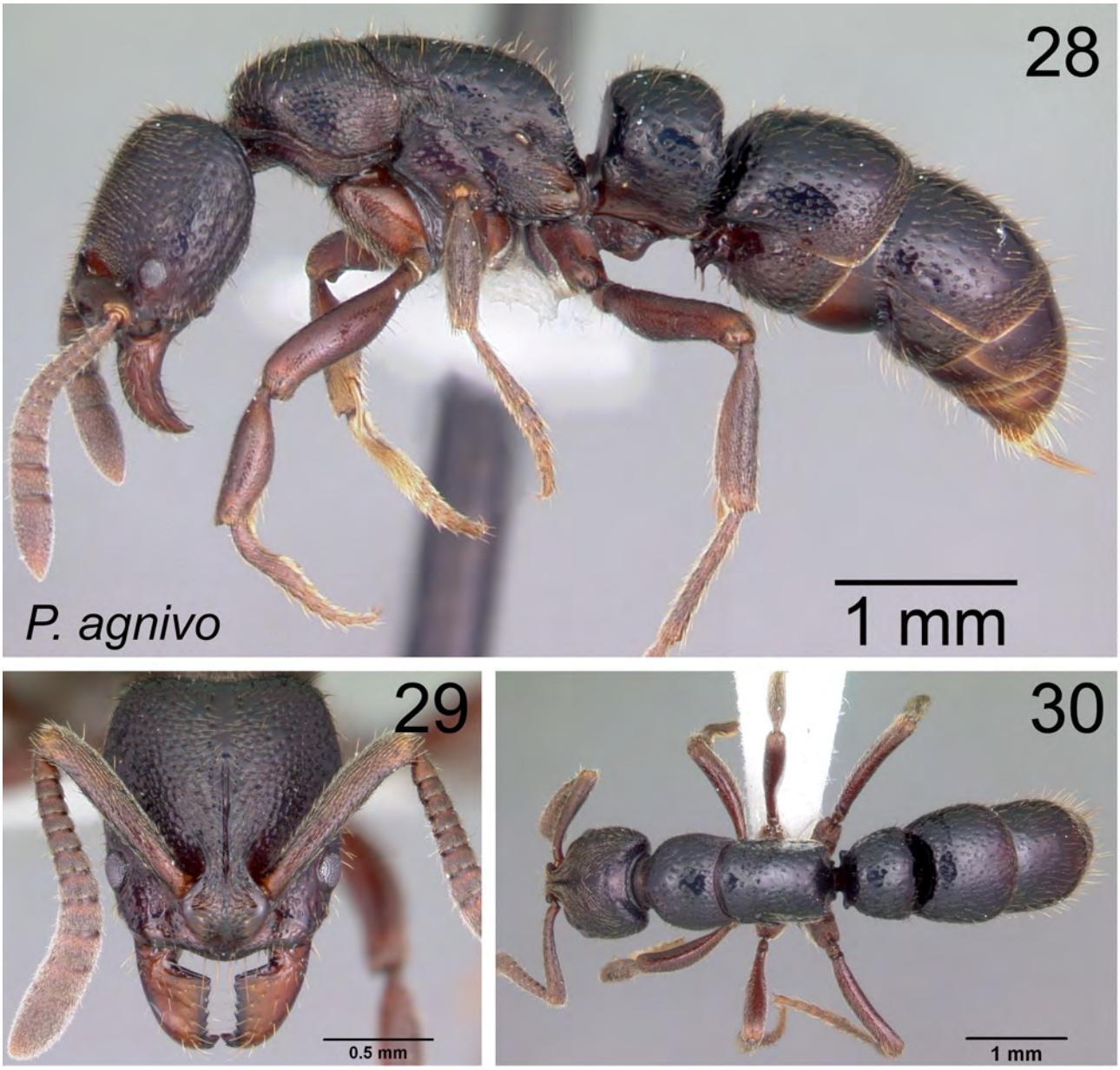
Malagasy species of *Pachycondyla sikorae*-group

In the Malagasy region, *P. sikorae*-group consists of 14 species that are only known from Madagascar.

***Pachycondyla agnivo* Rakotonirina and Fisher, sp. n.**
(Figures 16, 28, 29, 30, 70)

Holotype worker: Madagascar, Toamasina, FC Andriantantely, -18.695, 48.8133, 530 m, sifted litter, rainforest, 7–10 Dec 1998 (H.J. Ratsirarson), collection code: HJR122, specimen code: CASENT0317589 (CASC).

WORKER. Diagnosis: Anteromedian margin of clypeus broadly convex; posterolateral margins of propodeum and petiolar node smooth, without sharp teeth or tubercles; anterior surface of first gastral segment concave, forming a shallow impression to lodge the posterior surface of petiole.



FIGURES 28–30. Worker caste of *Pachycondyla agnivo*: lateral and dorsal view of body and full-face view of head, holotype CASENT0317589.

Measurements (3 specimens): HW: 1.14–1.15, HL: 1.36–1.40, CI: 82–84, SL: 1.01–1.03, SI: 88–90, PW: 1.01–1.03, WL: 1.96–2.04, NH: 0.87–0.89, NL: 0.63–0.68, NW: 0.94–0.96, DNI: 143–150, LNI: 129–138.

Description: In full face-view, head broader posteriorly ; sides slightly convex; posterior margin feebly concave. Dorsum of head reticulate-punctate anteriorly and densely punctate behind from about the posterior third. Eyes large, maximum diameter nearly the same as the greatest width of antennal scape. Scape barely reaching posterior cephalic margin. Anteromedian clypeal margin convex. Mandibles sparsely punctate, the space between punctures smooth and shiny; masticatory margin armed with 12 teeth or denticles.

With mesosoma in dorsal view, metanotal groove obsolete; in profile, mesopleural suture absent or indistinct; posterior magin of propodeum without a series of sharp teeth or tubercles; junction of lateral propodeal surface and declivity angulate, angles fairly emarginate. Dorsum of mesosoma with punctate sculpture. Petiole nodiform, anterodorsal angle faintly overhanging anterior margin in lateral view; subpetiolar process consisting of convex anterior face and broadly subquadrate posterior margin; in dorsal view node slightly broader than long, lateral border roughly convex and converging in a rounded line to the more or less straight anterior face; posterior margin medially broadly convex; dorsum of node sparsely punctate.

Anterior face of first gastral segment with shallow cavity, which is deeper near the insertion of petiole and becomes superficial towards the anterodorsal angle. With gaster in ventral view, anterior half of first gastral sternite with impressions on both sides of helcium; in profile anteroventral portion rounded and anteriorly projecting as hooklike process (the prora). Dorsum of first two gastral tergites smooth between piligerous punctures.

Dorsum of head and body covered with erect hairs; pubescence quite abundant on head dorsum and scarce or absent on the rest of body dorsum. Body color black with bluish reflection; appendages and tip of gaster brown.

Queen: unknown.

Discussion: *Pachycondyla agnivo* can be recognized easily by the medially convex anterior margin of its clypeus and the presence of a shallow impression on the anterior face of its first gastral tergite. No striking morphological variation is observed in this species despite the great distance between collection localities in the south and the center of Madagascar.

The shallow impression on the anterior face of the first gastral segment matches the shape of the posterior section of the petiolar node, suggesting this hollow plays a role in lodging the posterior face of the node.

Distribution and biology: *Pachycondyla agnivo* is an endemic species found in mid-elevation areas of eastern Madagascar. In addition to the type locality, the species occurs in the PN Mantadia in the central east and in the PN Andohahela in the southernmost portion of the island. It was collected by sampling leaf litter in the central east of Madagascar and was only recorded once from a pitfall trap in Andohahela.

Additional material examined: Province Toamasina: PN Mantadia, 895 m, rainforest (H.J. Ratsirarson) (CASC); Province Toliara: PN Andohahela, Col du Sedro, 3.8 km 113° ESE Mahamavo, 37.6 km 341° NNW Tolagnaro, 900 m, montane rainforest (Fisher-Griswold Arthropod Team) (CASC).

Pachycondyla antsiraka Rakotonirina and Fisher, sp. nov.

(Figures 26, 31, 32, 33, 71)

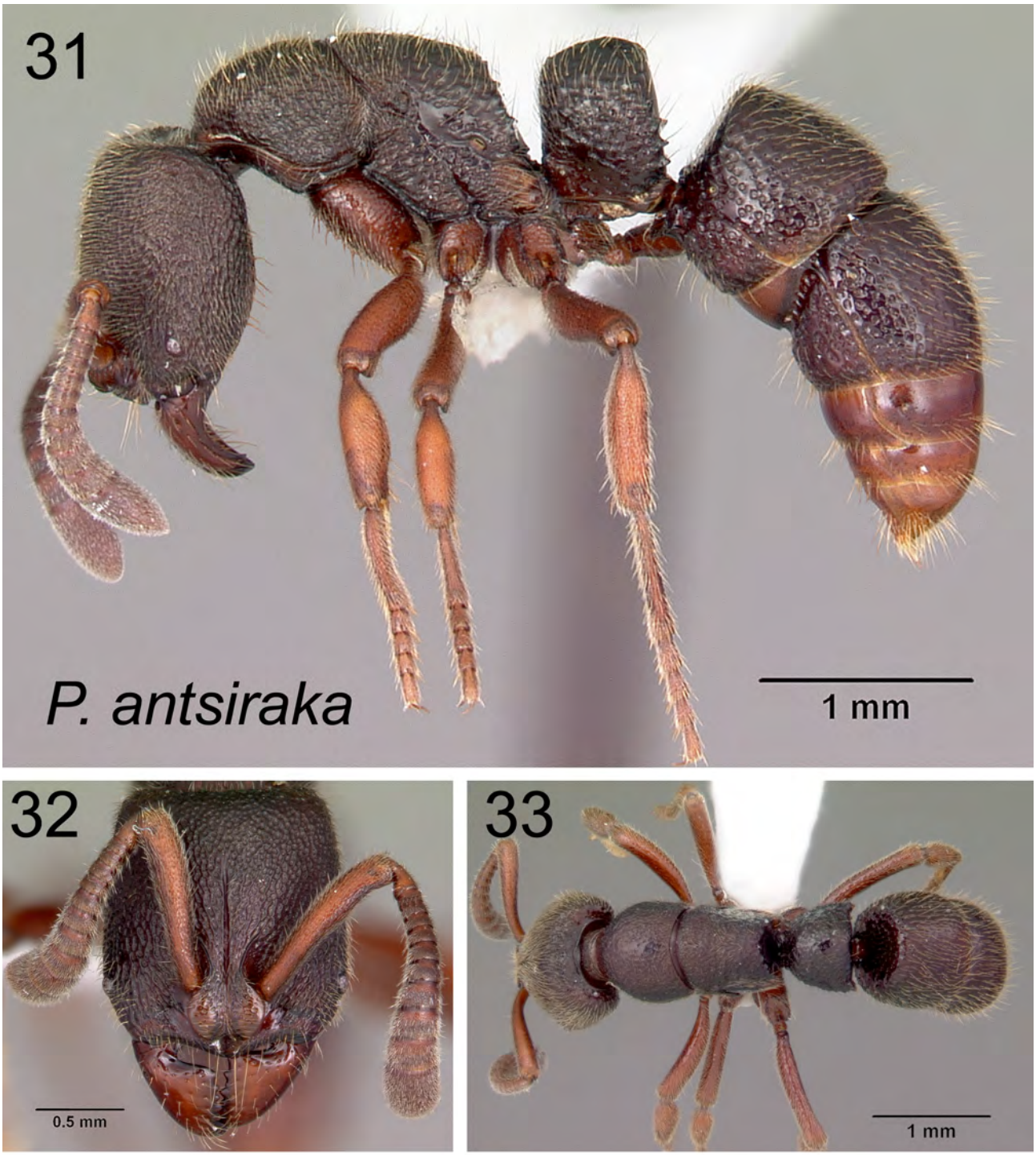
Holotype worker: Madagascar, Toamasina, FC Sandranantitra, -18.0483, 49.0917, 450 m, rainforest, sifted litter, 18–21 Jan 1999 (H.J. Ratsirarson) collection code: HJR101, specimen code: CASENT0317590 (CASC).
Paratype: worker with same data as holotype but with specimen code HJR101(3)–21 (CASC).

WORKER. Diagnosis: Anterior margin of clypeus medially convex or with blunt angle; posterolateral margins of propodeum and petiolar node armed with a series of sharp teeth or tubercles; head densely and finely reticulate-rugulose or reticulate-punctate behind the eye; with head in full face view, lateral borders anteriorly gradually curving towards the base of mandibles; in profile, distance between eyes and base of mandibles roughly three times or more the maximum diameter of eye; mesopleural sulcus distinctly continuous and narrowly impressed; second gastral tergite punctate, pubescence absent or reduced on first and second gastral segments.

Measurements (9 specimens): HW: 1.03–1.25, HL: 1.16–1.30, CI: 88–96, SL: 0.78–0.94, SI: 74–78, PW: 0.75–0.91, WL: 1.49–1.82, NH: 0.68–0.86, NL: 0.50–0.68, NW: 0.64–0.86, DNI: 125–141, LNI: 123–143.

Description: Head rectangular, with almost straight lateral margins which weakly converge to the base of the mandibles; posterior border more or less straight. Head capsule densely and finely reticulate-rugulose to reticulate-

punctate; space between punctures about the same or smaller than diameter of puncture. Eye small, slightly protruding from the head surface, with 13 or fewer ommatidia; distance between eyes and base of mandibles roughly three times or more the maximum diameter of eye. Antennal scape short, not attaining posterior cephalic margin. Anteromedian margin of clypeus convex or bluntly angulate. Mandibular surface with widely spaced punctulae, the spaces between which are smooth and shiny; apical margins with 8–9 teeth or denticles.



FIGURES 31–33. Worker caste of *Pachycondyla antsiraka*: lateral and dorsal view of body and full-face view of head, holotype CASENT0317590.

In dorsal view, metanotal groove absent; dorsum of mesosoma reticulate-rugulose, interspersed with punctures; sparse tubercles may be present on anterior portion of pronotum. In profile, mesopleural suture visible as a continuous transverse sulcus from anterior margin to posterior border of mesopleuron. Posterior margin of

propodeum with a sequence of teeth or denticles. In dorsal view, petiolar node punctate, lateral surface tuberculate, superimposed with punctures; in lateral view posterolateral margin of petiolar node armed with a series of sharp teeth or tubercles. First gastral segment without impression on its anterior face. First two gastral tergites with punctate sculpture.

Pilosity present on dorsum of body; pubescence sparse on first and second gastral tergites. Body color dark brown to reddish brown; appendages lighter.

Queen: unknown.

Distribution and biology: *Pachycondyla antsiraka* is recorded only from the lowland and littoral forests of the central east of the Madagascar (Fig. 71) and worker specimens have been found mostly from leaf litter. Due to the hypogaeic habits of workers, the biology of this species is poorly understood.

Additional material examined: Province Toamasina: FC Sandranantitra, 450 m, rainforest (H.J. Ratsirarson) (CASC); RS Ambatovaky, Sandrangato River, -16.7727, 49.2655, 450 m, rainforest (B.L. Fisher *et al.*) (CASC); RS Ambatovaky, Sandrangato River, -16.7633, 49.2669, 520 m, rainforest (B.L. Fisher *et al.*) (CASC); RS Ambatovaky, Sandrangato River, -16.8175, 49.295, 360 m, rainforest (B.L. Fisher *et al.*) (CASC); RNI Betampona, Camp Vohitsivalana, 37.1 km 338° Toamasina, -17.8867, 49.2025, 520 m, rainforest (B.L. Fisher *et al.*) (CASC); Réserve Ambodiriana, 4.8 km 306° Manompana, along Manompana River, -16.6723, 49.7012, 125 m, rainforest (B.L. Fisher *et al.*) (CASC); SF Tampolo, 10 km NNE Fenoarivo Atsinanana, -17.2825, 49.43, 10 m, littoral rainforest (B.L. Fisher) (CASC); Parcelle E3 Tampolo, -17.281, 49.4301, 10 m, littoral forest (Malagasy ant team) (CASC).

Pachycondyla daraina Rakotonirina and Fisher, sp. nov.

(Figures 18, 20, 34, 35, 36, 72)

Holotype worker: Antsiranana, Forêt de Binara, 9.4km 235° SW Daraina, -13.2633, 49.6, 1100 m, montane rainforest, sifted litter (leaf mold, rotten wood), 5 Dec 2003 (Fisher *et al.*), collection code: BLF09800, specimen code: CASENT0043301 (CASC).

Paratypes: 2 workers with same data as holotype but specimens coded as: CASENT0043300, CASENT0043302 (CASC).

WORKER. Diagnosis: Anterior margin of clypeus broadly convex medially; anterior surface of third abdominal segment straight, not forming shallow impression to lodge posterior surface of petiole; posterolateral margins of propodeum and petiolar node without a series of sharp teeth or tubercles, lamellae may be present on posterior margin of propodeum. In dorsal view, petiole node broader, almost twice as broad as long; in profile, subpetiolar process simple with only an anterior triangular lobe.

Measurements (6 specimens): HW: 1.41–1.54, HL: 1.55–1.72, CI: 88–91, SL: 1.20–1.29, SI: 84–85, PW: 1.13–1.25, WL: 2.13–2.26, NH: 0.89–0.97, NL: 0.62–0.63, NW: 0.87–0.98, DNI: 139–156, LNI: 142–155.

Description: With head in full-face view, slightly longer than broad with weakly concave posterior margin and feebly convex lateral margins which converge progressively toward the base of mandibles and without obtuse angle at or strong curve from the insertion of eye. Frontal lobe anteriorly more or less broad, outer margin medially bluntly angulate. Head capsule densely and finely reticulate-punctate, superimposed with small punctures. Eye medium-sized and protruding, with its diameter approximately as large as the widest part of scape. Antennal scape weakly surpassing posterior cephalic margin. Clypeus with weak anteriorly protruding median lobe and bluntly angulate or medially convex anterior margin. Mandible smooth and shiny between sparse piliferous punctulae; masticatory margin equipped with 12 teeth or denticles.

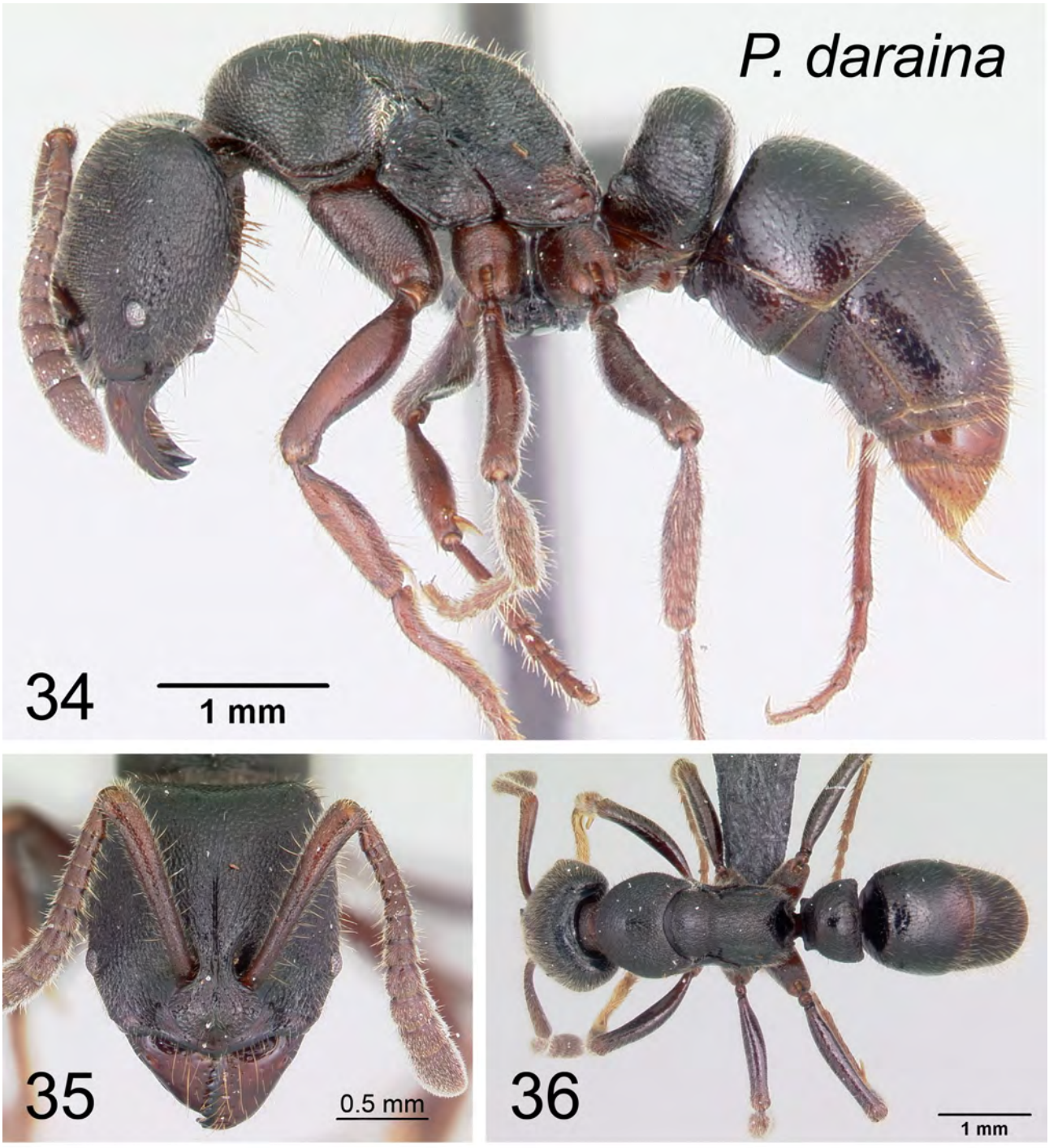
With mesosoma in dorsal view, metanotal groove indistinct; dorsum of mesosoma densely and finely reticulate-rugose, superimposed with small punctures. In profile, mesopleural suture indistinct; lower portion of mesopleuron and propodeum coarsely rugose interspersed with punctures. Posterior margin of propodeum emarginate, without series of sharp teeth or tubercles. Petiole node higher than long in profile; series of sharp teeth absent from convex posterior margin; anterodorsal angle weakly overhanging the anterior face; subpetiolar process anteriorly hook-like and posteriorly subquadrate, separated by a concavity. In dorsal view, node roughly twice as broad as long, with effaced reticulate-punctate sculptures. Anterior face of first gastral segment truncate, without cavity to lodge the posterior surface of petiolar node.

Dorsum of head and mesosoma with fewer golden short erect hairs than petiolar node and gaster; pubescence profuse over body dorsum. Integument blackish dark brown with brown ferruginous appendages and tip of gaster.

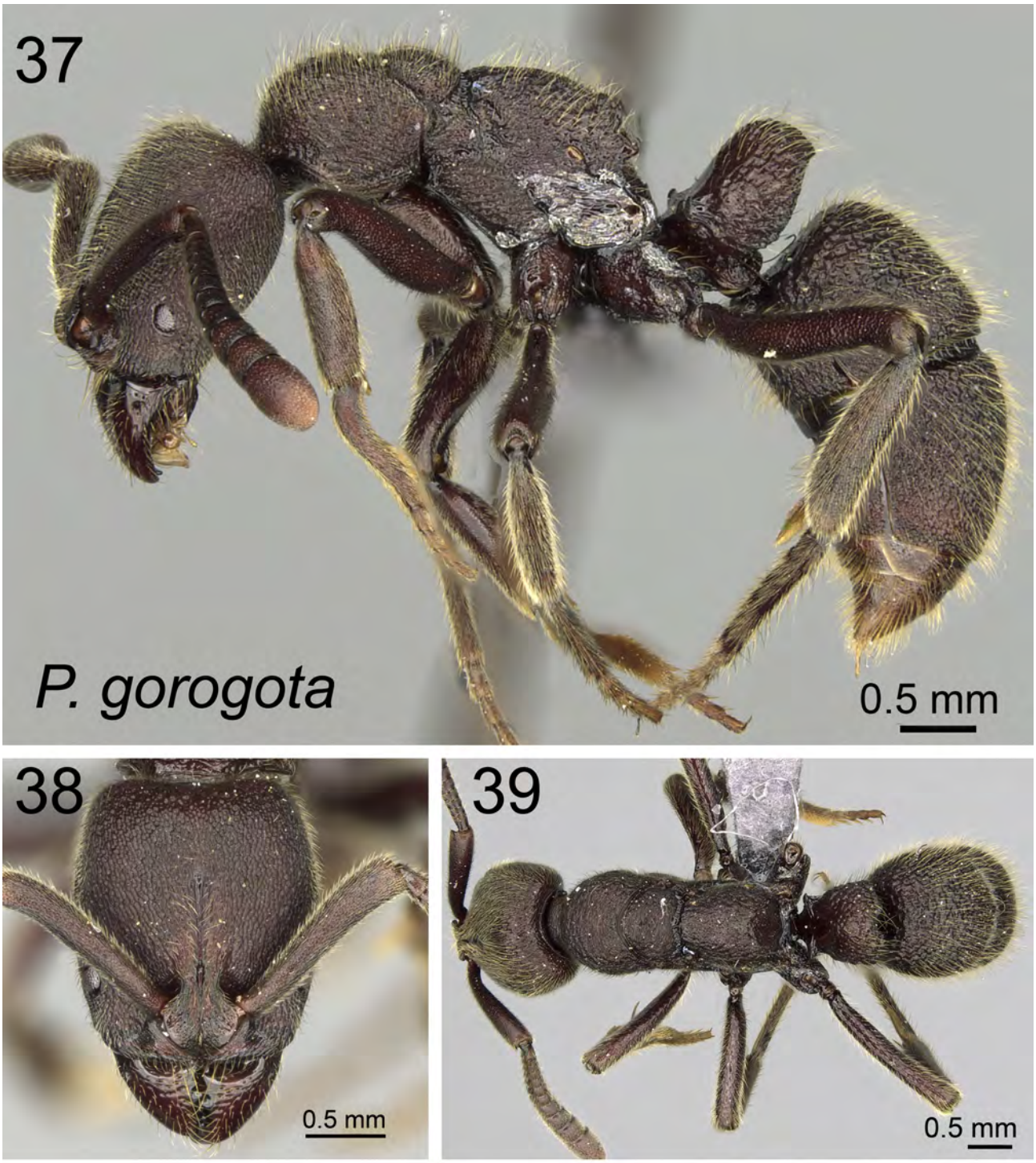
Queen: unknown.

Distribution and biology: *Pachycondyla daraina* is known only from northern Madagascar, between 800 m and 1100 m elevation, in the forest habitats of Binara near Daraina (Fig. 72). Worker specimens of this species have been recorded foraging mostly under leaf litter and rarely on the forest floor.

Additional material examined: Province Antsiranana: Forêt de Binara, 9.1 km 233° SW Daraina, -13.2633, 49.6033, 800 m, rainforest (B.L. Fisher) (CASC); Forêt de Binara, 9.4 km 235° SW Daraina, -13.2633, 49.6, 1100 m, montane rainforest (B.L. Fisher) (CASC).



FIGURES 34–36. Worker caste of *Pachycondyla daraina*: lateral and dorsal view of body and full-face view of head, holotype CASENT0043301.



FIGURES 37–39. Worker caste of *Pachycondyla gorogota*: lateral and dorsal view of body and full-face view of head, holotype CASENT0166009.

Pachycondyla gorogota **Rakotonirina and Fisher, sp. nov.**
(Figures 12, 37, 38, 39, 73)

Holotype worker: Madagascar, Antsiranana, Makirovana Forest, -14.1707, 49.9541, 415 m, rainforest, sifted litter, 28–29 Apr 2011 (B.L. Fisher *et al.*) collection code: BLF26523, specimen code: CASENT0166009 (CASC).

WORKER. Diagnosis: Anterior margin of clypeus wide and straight, slightly medially notched; mandible smooth between punctulae; eyes small and with very slightly convex surface; antennal scape not surpassing posterior

cephalic margin; antennal segments wider towards its apex; metanotal groove deeply impressed; posterolateral margin of propodeum bordered with broad lamella, which project as a tubercle at about the level of the propodeal spiracle; petiolar node anteroposteriorly flattened, its posterior margin medially notched in dorsal view; anterior face of first gastral segment not forming a shallow cavity; antennal scape and outer surface of each tibia covered with erect hairs; dorsum of head near posterior margin and rest of body covered with numerous long, slender hairs.

Measurements (1 specimen): HW: 1.56, HL: 1.79, CI: 87, SL: 1.34, SI: 86, PW: 1.22, WL: 2.67, NH: 1.10, NL: 0.58, NW: 0.98, DNI: 169, LNI: 189.

Description: Head elongate, narrower in front than behind and widest behind level of eyes; posterior margin feebly concave; head dorsum and its lateral surfaces densely and finely reticulate-rugulose or reticulate-punctate. Eyes very slightly convex with more than 30 ommatidia and located in anterior fourth of lateral borders of head. Antennal scape short, not reaching posterior border of head. Anterior margin of clypeus widely transverse and straight, with weak median notch. Mandibles smooth and shiny apart from hair bearing punctures; masticatory margins with ten teeth or denticles.

With mesosoma in dorsal view, metanotal groove deeply impressed and sinuate; in profile, dorsal outline of mesosoma complex, mesonotum distinctly convex; mesopleural suture visible; posterior margins of propodeum covered with broad lamella extending into a lobe or tooth at the level of propodeal spiracle. Mesosoma coarsely reticulate-rugose. Petiolar node anteroposteriorly flattened in profile, anterior face roughly straight and joining the dorsum at a rounded angle; posterodorsal angle feebly overhanging the slightly sinuate posterior margin of node. In dorsal view, posterior margin medially excised. Anterior face of first gastral segment straight, without shallow cavity or impression.

Head and body covered with many long, thin, and erect golden hairs; pubescence abundant on head and pronotum, and quite reduced on the rest of body dorsum. Coloration dark brown, with brown apices of antenna and tip of gaster.

Queen: unknown.

Discussion: *Pachycondyla gorogota* appears to be similar to *P. maeva* by the presence of the impressed metanotal groove and the antero-posteriorly flattened petiole node whose posterior margin is medially notched in dorsal view. But for *P. gorgota*, the posterior cephalic margin is roughly straight, the posterolateral margin of the porpodeum is bordered with much broader lamella which projects into tubercle at the level of propodeal spiracle, and the antennal scape and outer surface of tibiae are covered with erect slender hairs. In contrast, *P. maeva* has a more concave posterior cephalic border, narrow lamellae on the posterior margin of the propodeum and its antennal scape and outer surface of tibiae lack erect slender hairs.

Distribution and biology: The species is represented by only one worker specimen, which is from the lowland rainforest of Makirovana in the northeast of Madagascar (Fig. 73). The specimen was captured by leaf litter sampling.

Pachycondyla haratsingy Rakotonirina and Fisher, sp. nov.

(Figures 4, 40, 41, 42, 74)

Holotype worker: Madagascar, Antsiranana, RS Ankarana, 7 km SE Matsaborimanga, -12.9, 49.1167, 150 m, sifted litter (leaf mold, rotten wood), 28 Nov 1990, (P.S. Ward) collection code: PSW11010 specimen code: CASENT0195184 (PSWC).

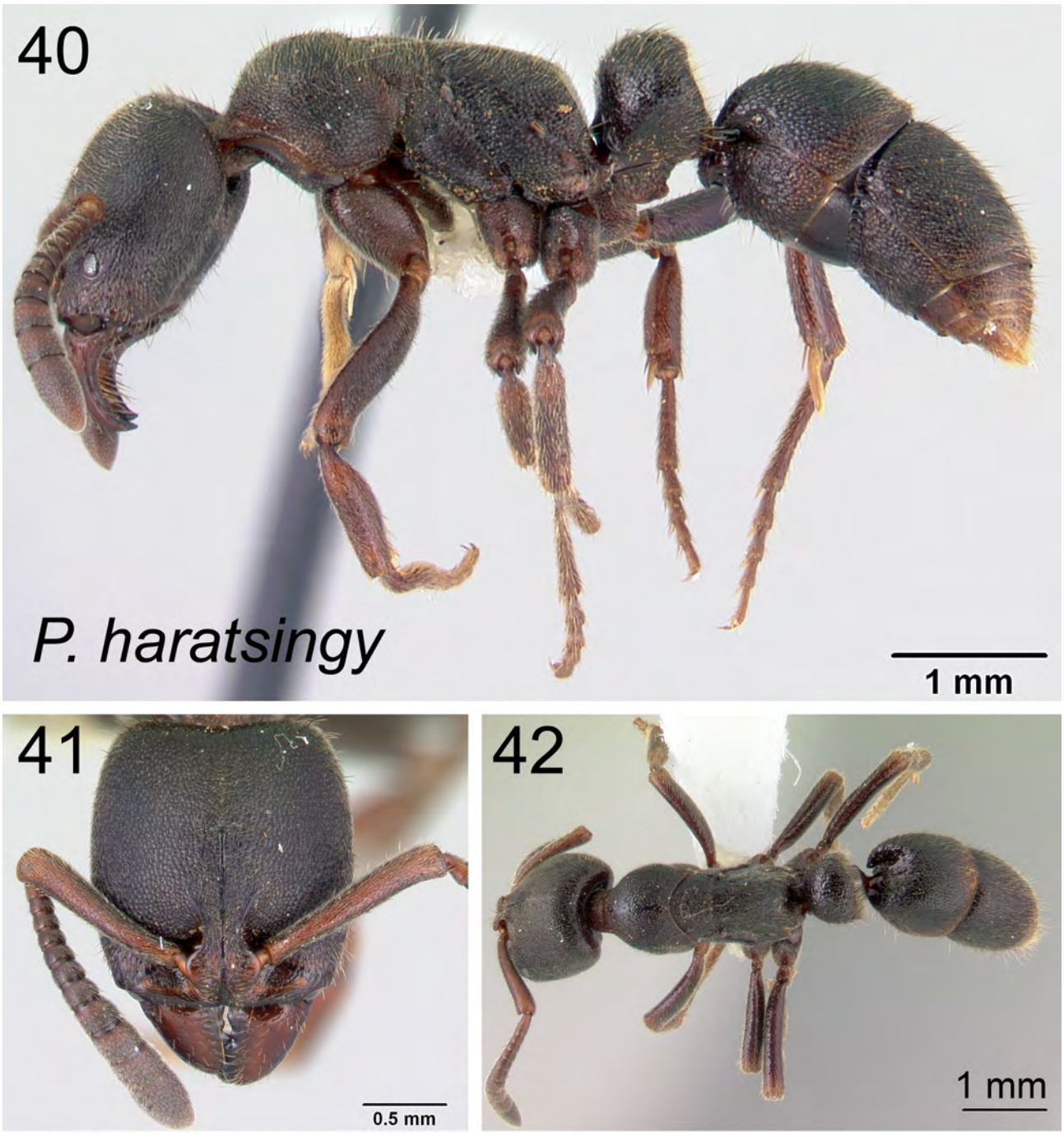
WORKER. Diagnosis: Anterior margin of clypeus widely transverse and slightly medially notched; metanotal groove weakly impressed; posterior surface of petiolar node with numerous slender hairs and abundant pubescence; anterior surface of first gastral segment concave, forming shallow impression to lodge posterior surface of petiole; lateral portion of head densely and finely reticulate-rugulose, sides of petiolar node densely and finely punctate.

Measurements (1 specimen): HW: 1.51, HL: 1.67, CI: 90, SL: 1.16, SI: 77, PW: 1.06, WL: 2.37, NH: 0.83, NL: 0.63, NW: 0.86, DNI: 137, LNI: 132.

Description: Head oblong, broadest at midlength; lateral borders generally convex and posterior margin weakly medially excised. Head capsule densely and finely reticulate-punctate. Eyes small, flushing with the head surface. Antennal scape short, not attaining posterior cephalic margin. Anterior margin of clypeus broad and transverse, not medially convex but slightly notched. Mandibular blades smooth and shiny apart from scattered

punctures; masticatory margins with ten teeth or denticles; outer margin of mandibles, from the base to apical portion, gradually curving towards the midline.

With mesosoma in dorsal view, metanotal groove a shallowly impressed transverse line; posterior margin of propodeum simple, not lamellate, and without a series of sharp teeth; dorsum of mesosoma reticulate-rugulose, superimposed with small punctures. Petiolar node broader than long in dorsal view, with medially bluntly angulate posterior margin and broadly convex anterior border; dorsum of node with large punctures; posterior surface covered with abundant pubescence; subpetiolar process anteriorly subquadrate followed by posteriorly acute angle. Anterior face of first gastral segment, from lower level of tergite towards anterodorsal angle, inclined posteriorly and shallowly impressed to lodge posterior face of petiolar node; this impression is deepest immediately above helcium and turns into a superficial cavity near the anterodorsal angle. First two gastral tergites covered with denser fine punctures.



FIGURES 40–42. Worker caste of *Pachycondyla haratsingy*: lateral and dorsal view of body and full-face view of head, holotype CASENT0195184.

Head and the rest of body dorsum with slender, elongate, erect hairs and abundant pubescence; dark brown in color with red to light brown appendages and tip of gaster.

Queen: unknown.

Discussion: *Pachycondyla haratsingy* may be confused with *P. ivolo* but the former has reticulate-rugulose sculpture on the lateral portion of the head and petiolar node, whereas the sides of the head and petiolar node of the latter are smooth and shiny between small piligerous punctures.

Distribution and biology: *Pachycondyla haratsingy* is only known from the RS Ankarana in northwestern Madagascar and represented by a single worker found foraging through leaf litter.

Pachycondyla ivolo Rakotonirina and Fisher, sp. nov.

(Figures 6, 43, 44, 45, 74)

Holotype queen: Madagascar, Toamasina, Torotorofotsy, -18.8708, 48.3474, 1070 m, montane rainforest marsh edge, ground forager, 29 Mar 2004 (Malagasy ant team), collection code: BLF10720, specimen code: CASENT0050330 (CASC).

QUEEN. Diagnosis: Anterior clypeal margin wide and straight, with slight median notch; posterior surface of petiolar node covered with slender hairs and abundant pubescence; anterior surface of first gastral segment forming shallow cavity; lateral section of head and petiolar node smooth and shiny, with scattered piliferous punctures.

Measurements (1 specimen): HW: 1.88, HL: 1.99, CI: 94, SL: 1.50, SI: 80, PW: 1.48, WL: 2.86, NH: 0.99, NL: 0.69, NW: 1.20, DNI: 172, LNI: 143.

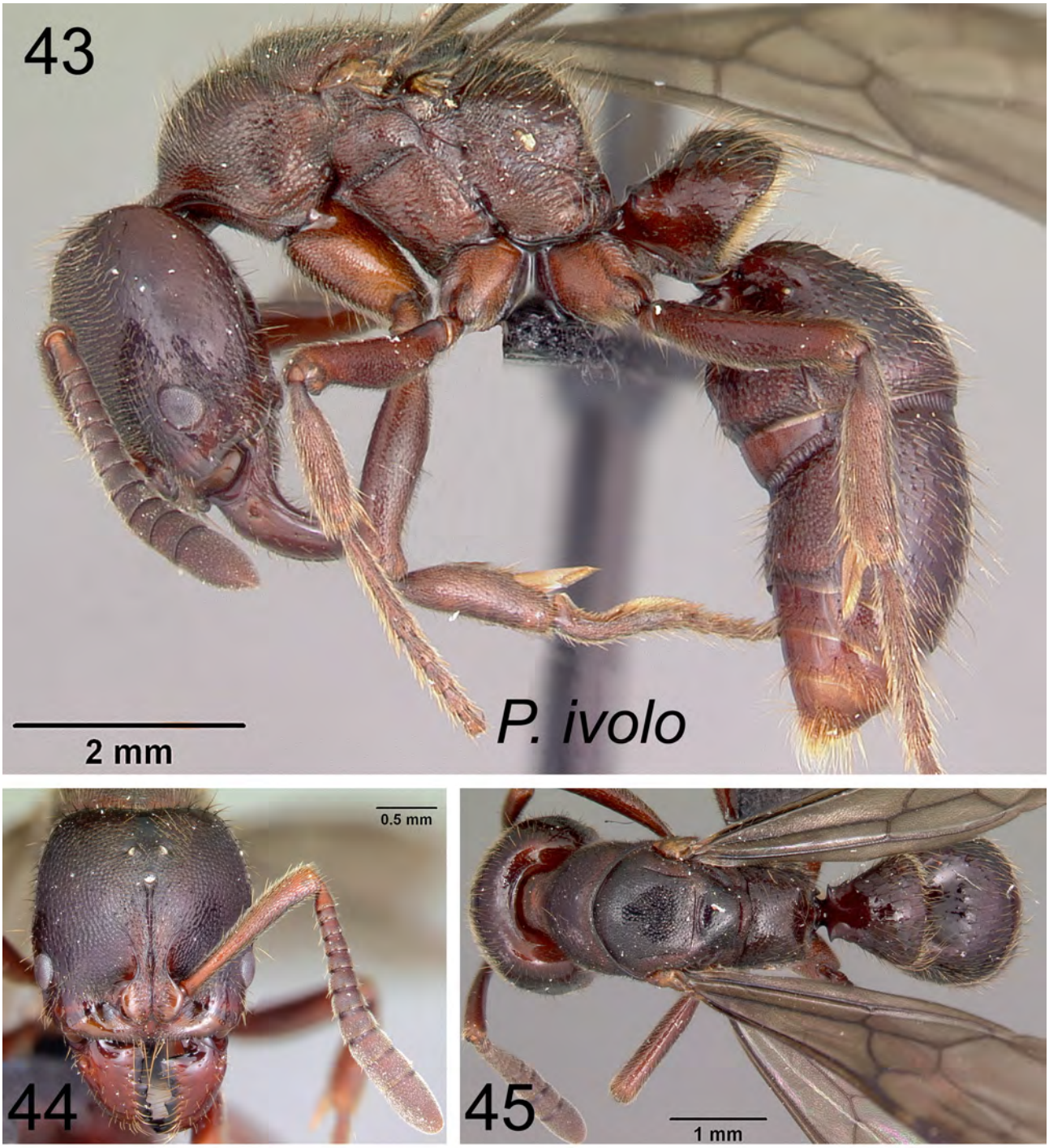
Description: Head subrectangular, the sides broadly convex, with slightly broader posterior portion; posterior margin weakly medially excised. Head dorsum densely and finely reticulate-punctate, the sculpture becoming densely punctulate near posterior margin; lateral section generally smooth and shining between shallow, small punctures. Eyes large and protruding from the surface of head. With head in full-face view, antennal scape not surpassing posterior border of head; anterior clypeal margin widely transverse and straight, slightly medially notched. Mandibles smooth and glossy between sparse piligerous punctures; masticatory margins armed with ten teeth; outer margin of mandibles near the apical portion strongly curving toward the midline.

With mesosoma in dorsal view, thoracic sclerites fully developed; in profile, mesopleural sulcus visible; posterolateral margin of propodeum without a series of sharp teeth or denticles. Lateral surface of mesosoma densely rugulose-punctate. In dorsal view, petiole node approximately twice as broad as long; lateral margins strongly converging to a straight anterior margin. Posterior face of node with a pair of glandular spots covered with dense and long pubescence; long, slender hairs are present around these glands. In lateral view, anterior margin of node inclined posteriorly; subpetiolar process subquadrate anteriorly with hook-like acute angle posteriorly; petiole mostly smooth and shiny. Anterior face of first gastral segment, from junction of tergite and sternite to anterodorsal angle, sloped strongly backwards and forming a shallow cavity which is deeper near the junction and becomes shallower at the anterodorsal angle; cavity with scattered, elongate, slender hairs. With gaster in profile, lateromedial portions apparently projecting anteriorly to form lateral shields for first gastral sternite. Petiole mostly smooth and shiny between small piligerous punctures, first two gastral tergites generally punctate.

Pilosity characterized by long golden hairs which are much denser and more slender on propodeum and petiole node; pubescence abundant and particularly dense on posterior surface of node. Integument shiny with reddish brown color and lighter appendages.

Discussion: *Pachycondyla ivolo* is only known from a single winged queen. This species is most similar to *P. haratsingy* based on the presence of a shallow cavity on the anterior face of the first gastral segment and the abundant pubescence on the posterior surface of the node, but can be distinguished easily by the smooth and shiny lateral surfaces of the head and petiolar node. It also can be confounded with *P. agnivo*, but the straight anterior clypeal margin and compressed petiole node with the posterior surface covered by abundant pubescence render *P. ivolo* separable from the latter species.

Distribution and biology: The alate queen specimen was found foraging on the floor of a high elevation rainforest near the marsh edge of Torotorofotsy in central eastern Madagascar (Fig. 74).



FIGURES 43–45. Queen of *Pachycondyla ivolo*: lateral and dorsal view of body and full-face view of head, holotype CASENT0050330.

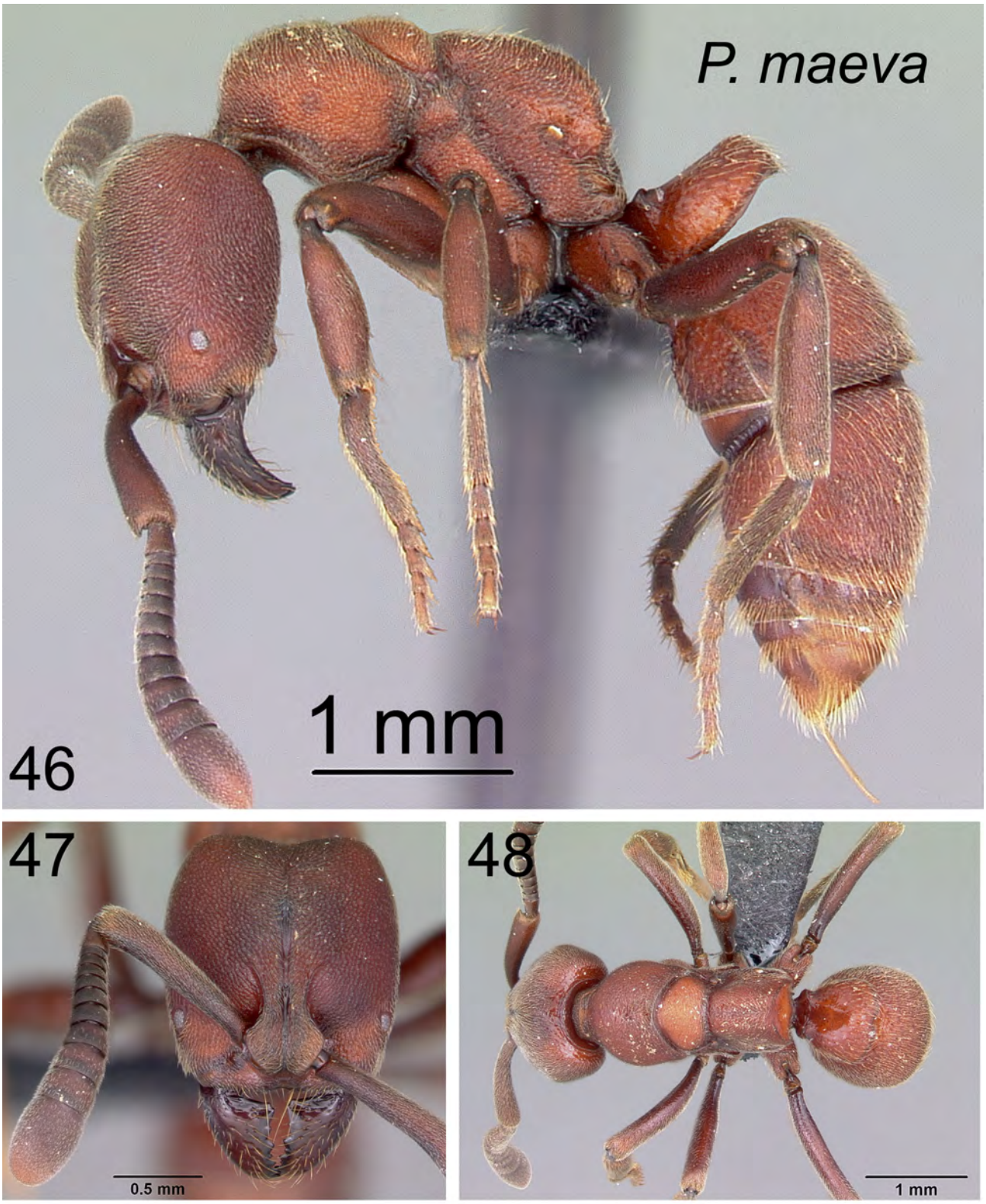
Pachycondyla maeva **Rakotonirina and Fisher, sp. nov.**

(Figures 8, 10, 13, 46, 47, 48, 75)

Holotype worker: Madagascar, Fianarantsoa, PN Ranomafana, Vatoharanana River, 4.1 km 231° SW Ranomafana, -21.29, 47.4333, 1100 m, sifted litter (leaf mold, rotten wood), montane rainforest, 27–31 Mar 2003 (Fisher, Griswold *et al.*), collection code: BLF08400, specimen code: CASENT0034340 (CASC).

WORKER. Diagnosis: Clypeus anteriorly wide and straight, with slight median notch; reddish ferruginous species with densely and finely reticulate-punctate sculpture; mandible smooth between punctulae; posterior

margin of head concave; antennal scape not surpassing posterior cephalic margin; metanotal groove deeply impressed; dorsal outline of mesosoma with clearly convex mesonotum; posterolateral margin of propodeum bordered with narrow lamellae, which form an obtuse angle at about the level of the propodeal spiracle; petiole node anteroposteriorly flattened, its posterior margin medially notched in dorsal view. Anterior face of third abdominal segment straight, not forming a shallow impression; antennal scape and outer surface of tibiae without erect hairs; dorsum of head and rest of body covered with a few erect, slender hairs.



FIGURES 46–48. Worker caste of *Pachycondyla maeva*: lateral and dorsal view of body and full-face view of head, holotype CASENT0034340.

Measurements (1 specimen): HW: 1.35, HL: 1.54, CI: 88, SL: 1.07, SI: 79, PW: 1.05, WL: 2.01, NH: 0.95, NL: 0.45, NW: 0.83, DNI: 186, LNI: 213.

Description: Head cordate, broader behind than in front; sides broadly convex; posterior margin distinctly medially excised. Head dorsum with dense and fine reticulate punctures. Eyes small and flattened, not protruding, situated in anterior fourth of lateral borders of head. Antennal scape not reaching posterior cephalic margin; funicular segments wider towards apical portion. Anterior clypeal margin straight and slightly notched medially. Mandibles smooth and shiny apart from scattered punctures; apical margin armed with eight teeth.

With mesosoma in dorsal view, metanotal groove deeply impressed and straight; in profile, mesonotum distinctly convex; junction between propodeal declivity and lateral portion of propodeum slightly marginate; posterior margin of propodeum narrowly lamellate, forming obtuse angle at about the level of propodeal spiracle; mesosoma dorsum densely and finely reticulate-rugulose. With petiole in lateral view, node anteroposteriorly flattened, posterior margin medially notched in dorsal view. Anterior face of first gastral segment not forming a shallow cavity; first two gastral tergites densely punctate.

Body covered with short golden hairs and very dense pubescence; antennal scape and outer surface of tibiae lacking erect hairs. Integument matte and red ferruginous in color.

Queen: unknown.

Distribution and biology: *Pachycondyla maeva* has been found only once from leaf litter in the montane rainforest of the PN Ranomafana in southeastern Madagascar (Fig. 75). Represented by one worker specimen, its biology is unknown, but its very small eyes and short antennal scape indicate that workers of this species would forage under soil layers and not on the surface.

Pachycondyla mialy Rakotonirina and Fisher, sp. nov.

(Figures 2, 9, 14, 49, 50, 51, 76)

Holotype worker: Madagascar, Fianarantsoa, PN Ranomafana, Vatoharanana River, 4.1 km 231° SW Ranomafana, -21.29, 47.4333, 1100 m, montane rainforest, ex rotten log, 27–31 Mar 2003 (Fisher, Griswold *et al.*), collection code BLF08535, specimen code CASENT0497667 (CASC).

Paratype: 1 worker with the same data as holotype but specimen coded as CASENT0009727 (CASC).

WORKER. Diagnosis: Anterior margin of clypeus wide and straight, with median notch; eyes small, with seven to eight ommatidia; metanotal groove absent; posterior face of petiolar node with sparse pubescence and lacking numerous slender hairs; anterior face of first gastral segment not forming a shallow cavity; antennal scape and outer surface of each tibia covered with shorter, erect hairs.

Measurements (2 specimens): HW: 1.15, HL: 1.38–1.41, CI: 81–83, SL: 0.94–0.95, SI: 82, PW: 0.87–0.88, WL: 1.78, NH: 0.59–0.62, NL: 0.46–0.47, NW: 0.63–0.66, DNI: 137–140, LNI: 125–134.

Description: Head distinctly longer than broad, widest at mid-length; posterior margin weakly medially excised; the dorsum with dense and fine reticulate punctures; anterior third of lateral surface punctate and sparsely punctulate posteriorly. Eyes very small, with at most eight ommatidia, and situated in anterior fourth of head. Antennal scape short, not extending beyond posterior cephalic border; length of erect hairs on scape about half of widest portion of scape. Anterior clypeal margin widely transverse and straight, with feeble median excision. Mandibles smooth and shiny between sparse punctures.

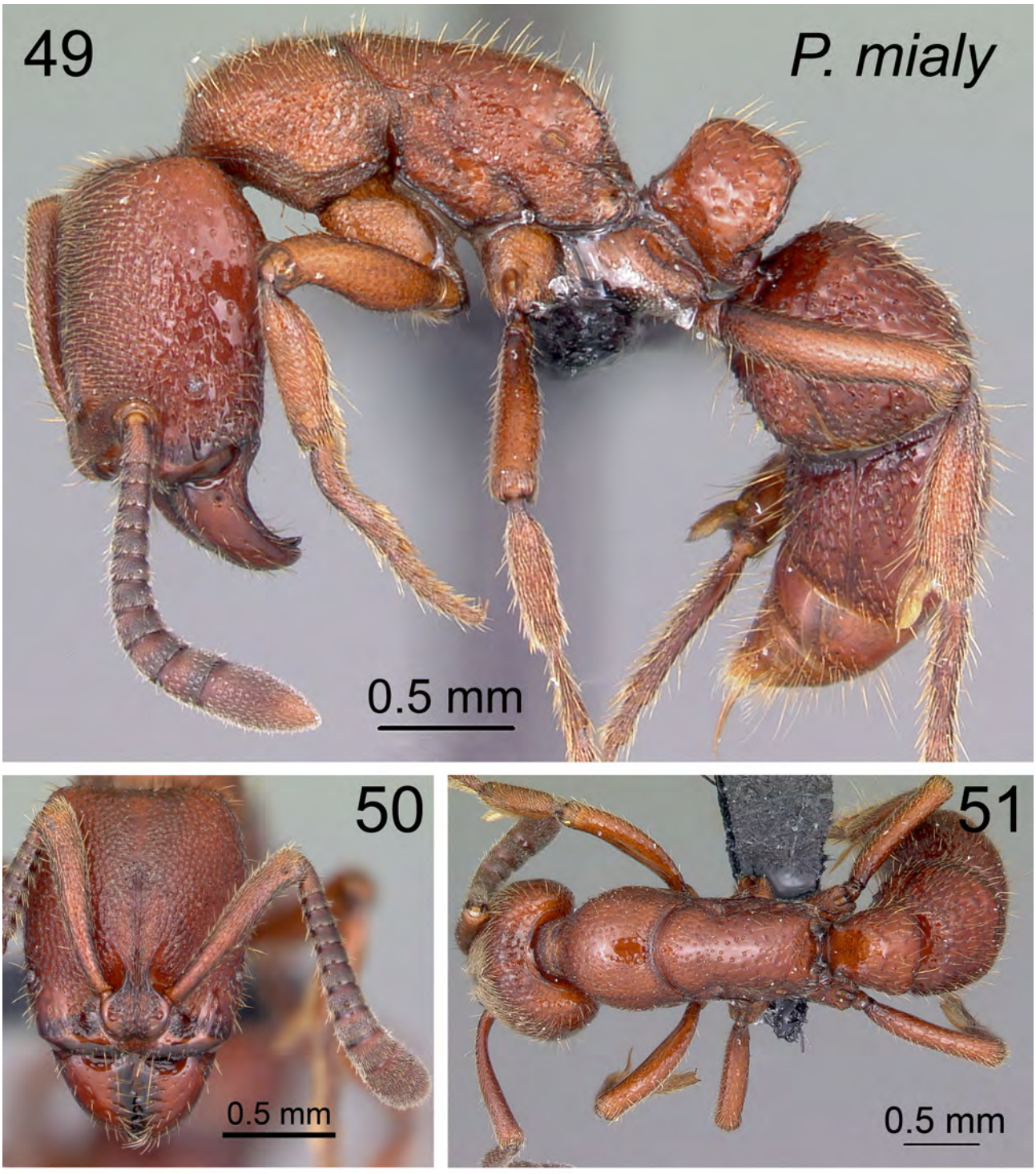
With mesosoma in dorsal view, metanotal groove lacking; in profile, dorsal outline of mesosoma simple, approximately a continuous line; posterolateral margin of propodeum covered with narrow lamellae, which project into a blunt angle near the mid-length at about the level of propodeal spiracle; mesopleural suture indistinct. Sculpture of promesonotum punctate; the punctures become more sparse toward the propodeum. With petiole in lateral view, node thick, posterior margin convex; in dorsal view, lateral margins rounding to a convex anterior face; posterior margin slightly excised medially; dorsum of node with scattered punctures. First gastral segment with straight anterior face; first and second gastral tergites laterally coarsely punctate or foveolate and dorsally smooth and shiny between punctures.

Body covered with erect golden pilosity; pubescence abundant on head dorsum, promesonotum, tip of gaster, and appendages, but absent or sparse on the rest of body dorsum. Integument glossy, reddish orange with orange apex of gaster and appendages.

Queen: unknown.

Discussion: One can confound *P. mialy* with *P. nosy* but workers of the former are smaller, have smaller eyes, no metanotal groove and no mesopleural suture while those of the latter are characterized by a larger body size, larger eyes, the presence of a mesopleural suture and a metanotal groove reduced to a dotted line.

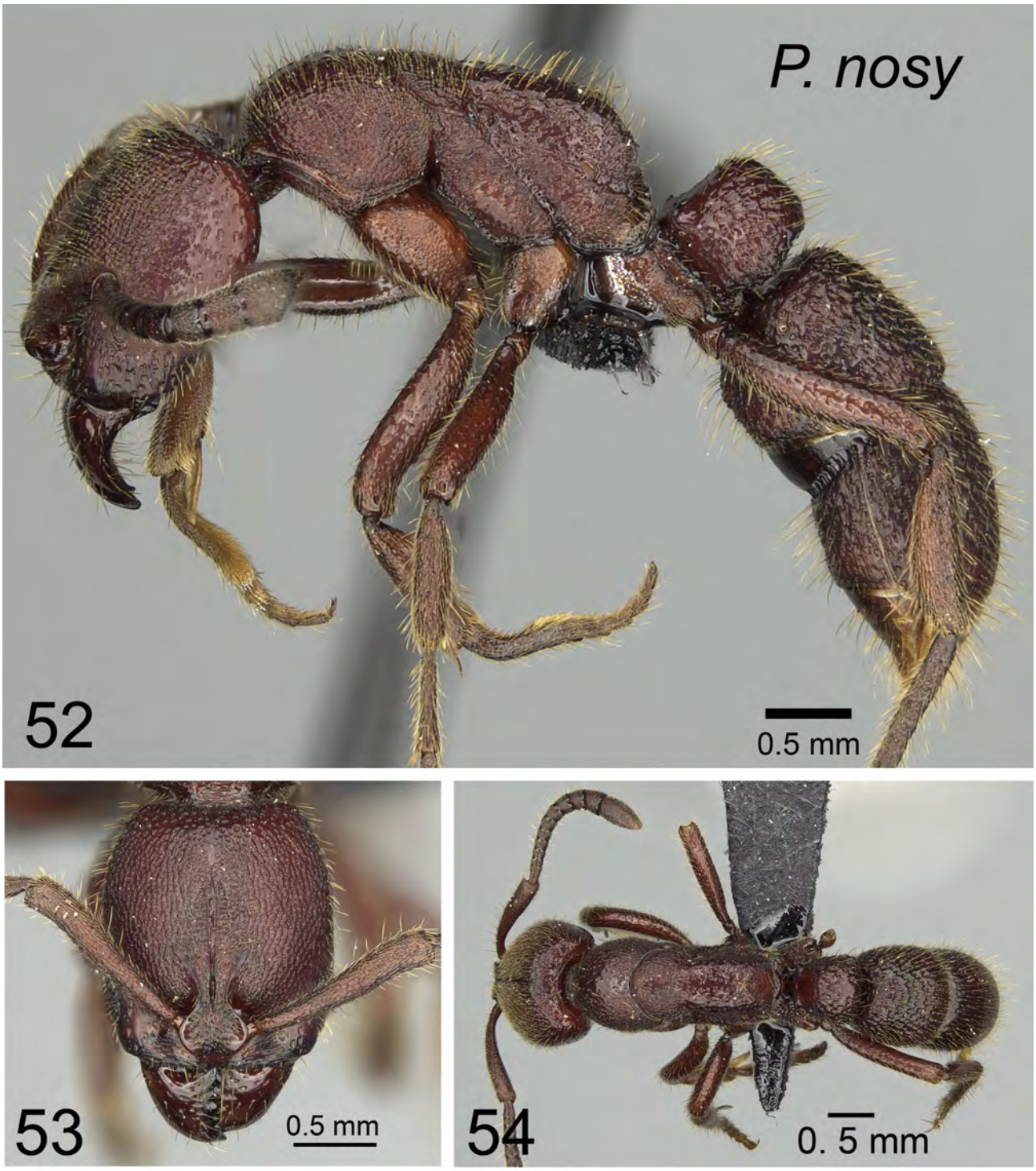
Distribution and biology: This species is recorded only from an elevation of 1100 m in the PN Ranomafana. Two worker specimens were collected from rotten logs.



FIGURES 49–51. Worker caste of *Pachycondyla mialy*: lateral and dorsal view of body and full-face view of head, holotype CASENT0497667.

***Pachycondyla nosy* Rakotonirina and Fisher, sp. nov.**
(Figures 5, 15, 52, 53, 54, 76)

Holotype worker: Madagascar, Antsiranana, Makirovana Forest, -14.1707, 49.9541, 415 m, 28 Apr 2011, ex rotten log (B.L. Fisher *et al.*) collection code: BLF26582, specimen code: CASENT0231239 (CASC).



FIGURES 52–54. Worker caste of *Pachycondyla nosy*: lateral and dorsal view of body and full-face view of head, holotype CASENT0231239.

WORKER. Diagnosis: Anterior margin of clypeus wide and straight, weakly medially notched; eyes medium, with 14 ommatidia; metanotal groove an incomplete dotted line; numerous slender erect hairs lacking and pubescence reduced from posterior face of petiole node; anterior surface of third abdominal segment straight, not forming a shallow impression; antennal scape and outer surface of each tibia covered with long, erect hairs.

Measurements (1 specimen): HW: 1.44, HL: 1.62, CI: 89, SL: 1.25, SI: 87, PW: 1.09, WL: 2.34, NH: 0.76, NL: 0.58, NW: 0.80, DNI: 138, LNI: 131.

Description: Head rectangular, broadest at midlength; posterior cephalic margin more or less straight. Head dorsum densely and finely reticulate-punctate; lateral section generally punctate and sparsely punctulate toward lateroventral angle. Eyes medium, with 14 ommatidia, and located at anterior fourth of head when viewed from the front. Antennal scape short, not reaching posterior cephalic margin; scape with long, erect hairs roughly equal in length to its maximum diameter. Anterior clypeal margin broadly straight, with weak median notch. Mandibles sparsely punctate with a smooth and shiny surface.

With mesosoma in dorsal view, metanotal groove a simple, shallowly dotted line; in lateral view, dorsal outline roughly a continuous line; mesopleural suture obsolete; posterior margin of propodeum narrowly lamellate and projecting into a blunt angle near midlength. In dorsal view, promesonotum with reticulate-punctulate sculpture close to dorsolateral angles and punctate towards the midline; propodeum punctulate. Petiole nodiform, with convex posterior margin in lateral view; in dorsal view, posterior margin slightly convex, anterior margin broadly rounded; sculpture coarsely punctate. Anterior face of first gastral segment straight, not forming a shallow cavity. First two gastral tergites rugulose punctate, with smooth and shiny spaces between coarse punctures.

Erect standing hairs present; pubescence abundant on head dorsum and promesonotum and sparse on the rest of body dorsum. Body color dark red, with brown tip of gaster and appendages.

QUEEN. Measurements (2 specimens): HW: 1.65–1.68, HL: 1.74–1.75, CI: 95–96, SL: 1.35–1.36, SI: 80–83, PW: 1.35–1.38, WL: 2.56, NH: 0.80–0.88, NL: 0.55–0.60, NW: 0.86–0.89, DNI: 147–155, LNI: 144–146. Two winged queens were captured using malaise traps from the montane humid forests in the north and in the central eastern Madagascar. They have the usual characteristics of alate queens, including three ocelli, developed thoracic sclerites, more abundant standing slender hairs; much broader head, and a wider, more anteroposteriorly flattened petiolar node.

Distribution and biology: *Pachycondyla nosy* is known from northeastern Madagascar, where a colony nest was found in a rotten log in Makirovana Forest. The species also occurs in the disjunct montane rainforests of the PN Montagne d'Ambre and the PN Andasibe (Fig. 76), where two alate queens were recorded from malaise traps.

Additional material examined: Province **Antsiranana**: PN Montagne d'Ambre [Petit Lac road], 1125 m, montane rainforest (R. Harin'Hala) (CASC); Province **Toamasina**: 7 km SE PN Andasibe Headquarters, 1050 m, montane rainforest (R. Harin'Hala) (CASC).

Pachycondyla rovana Rakotonirina and Fisher, sp. nov.

(Figures 17, 23, 55, 56, 57, 77)

Holotype worker: Madagascar, Antsiranana, Makirovana Forest, -14.16666, 49.95, 715 m, rainforest, ex rotten log, 2 May 2011, (B.L. Fisher *et al.*) collection code BLF26943, specimen code CASENT0242897 (CASC).

Paratypes: 2 workers with the same data as holotype but with the following specimen codes: CASENT0318040, CASENT0318041 (CASC).

WORKER. Diagnosis: Anteromedial clypeal margin broadly convex with median blunt denticle; series of sharp teeth or tubercles absent from posterolateral margins of propodeum and petiolar node; in dorsal view, petiole node nearly as long as broad; mesopleuron and metapleuron densely rugulose superimposed with punctures or foveolae.

Measurements (7 specimens): HW: 1.01–1.14, HL: 1.13–1.26, CI: 89–91, SL: 0.81–0.92, SI: 77–82, PW: 0.77–0.89, WL: 1.58–1.77, NH: 0.61–0.70, NL: 0.47–0.52, NW: 0.65–0.81, DNI: 138–155, LNI: 127–135.

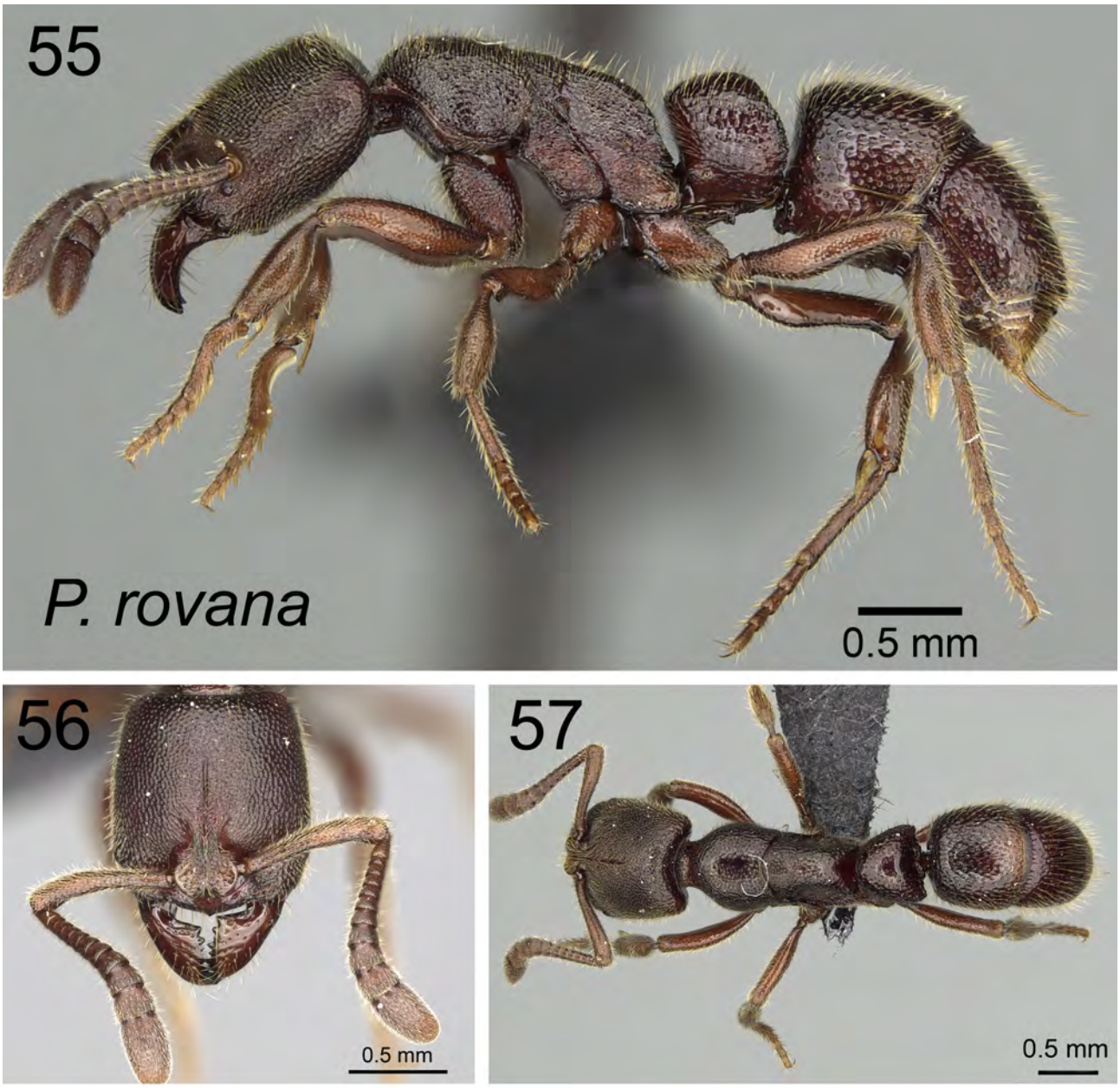
Description: Head elongate; in full-face view sides broadly convex, not strongly converging from level of eyes toward the base of mandibles; posterior margin more or less straight. Frontal lobes broad, with generally rounded outer margins. Head dorsum densely and finely reticulate-punctate. Eyes small, composed of nine ommatidia. Antennal scape short, not reaching posterior cephalic margin. Anterior clypeal margin medially convex, with median small denticle. Mandibles smooth and shiny between sparse punctures; apical margins armed with nine teeth or denticles.

With mesosoma in dorsal view, metanotal groove indistinct or an incomplete line; dorsum of mesosoma densely and finely punctate, the surface towards midline with reduced punctures. In profile, mesopleural suture absent or incomplete; posterior margin of propodeum emarginated, bordered with narrow lamellae. Sides of

pronotum reticulate-punctulate; mesopleuron and metapleuron rugulose-punctulate; sides of propodeum densely punctulate. In lateral view, petiolar node approximately as long as broad; anterodorsal angle slightly overhanging anterior face; posterior margin convex, without series of sharp teeth or tubercles; rugulose sculptures interspersed with sparse punctures present on lateral surface. In dorsal view, node broader than long, but width less than twice the length.

Erect, short, golden hairs numerous on dorsum of body, hairs much longer on petiole and gaster; dorsum of head and promesonotum with more abundant pubescence than dorsum of node and gaster. Integument dark brown in color; appendages and apex of gaster brown.

Queen: unknown.



FIGURES 55–57. Worker caste of *Pachycondyla rovana*: lateral and dorsal view of body and full-face view of head, CASENT0247289.

Distribution and biology: Makirovana Forest near Sambava, in north east of Madagascar is the only place where *P. rovana* has been collected. It was collected on the east facing slope of the mountain along an elevational gradients between 225 m and 715 m of altitude. Workers of this species have been found foraging through leaf litter and colonies have been collected from rotten logs and under a mat of roots and litter on a rock.

Additional material examined: Province **Antsiranana**: Makirovana Forest, -14.1707, 49.9541, 225 m, rainforest (B.L.Fisher *et al.*) (CASC); Makirovana Forest, -14.1707, 49.9541, 415 m, rainforest (B.L.Fisher *et al.*) (CASC); Makirovana Forest, -14.1604, 49.9522, 550 m, rainforest (B.L.Fisher *et al.*) (CASC); Makirovana Forest, -14.16666, 49.95, 715 m, rainforest (B.L.Fisher *et al.*) (CASC).

Pachycondyla sikorae Forel

(Figures 11, 58, 59, 60, 78)

Ponera (Euponera) sikorae Forel 1891: 127. Lectotype worker, Madagascar Central (Sikora), present designation, specimen code: CASENT0101862 (MHNG) [examined]. [Accepted by Dalla Torre 1893: 42. Raised to genus and combination in *Euponera (Euponera)* by Emery 1901: 46, 1911: 83, Wheeler 1922: 1008. Combination in *Pachycondyla* by Brown in Bolton 1995: 309].

WORKER. Diagnosis: Anterior margin of clypeus broadly transverse and straight, with slight median notch; mandible striate-punctate; posterior margin of head straight or broadly rounded; antennal scape surpassing posterior cephalic margin; metanotal groove deeply impressed; promesonotum clearly convex; posterior margin of propodeum and petiole node rounded in profile, but truncate when viewed dorsally; anterior surface of third abdominal segment straight, not forming shallow cavity; integument covered with brownish slender hairs; larger species (HW: 1.63–1.8 mm); overall a smooth and glossy black ant.

Measurements (19 specimens): HW: 1.63–1.98, HL: 1.98–2.29, CI: 80–86, SL: 1.56–1.78, SI: 90–101, PW: 1.33–1.55, WL: 2.85–3.29, NL: 0.84–1.03, NW: 0.92–1.17, NH: 0.98–1.15, DNI: 105–118, LNI: 104–118.

Description: Head longer than broad, lateral borders convex from posterior margin to the level of eyes, then straight towards the base of mandibles; posterior margin broadly convex; head dorsum smooth and shiny between dense and very small punctures. Eyes large and strongly protruding from head capsule; with head in full-face view, eyes situated in anterior third of lateral cephalic margins. Antennal scape long, extending over posterior border of head; three most apical antennal segments almost the same width. Anterior margin of clypeus roughly straight and weakly medially notched. Mandibles striate, interspersed with punctures; outer margin gradually converging toward midline; masticatory margins with eight teeth or denticles.

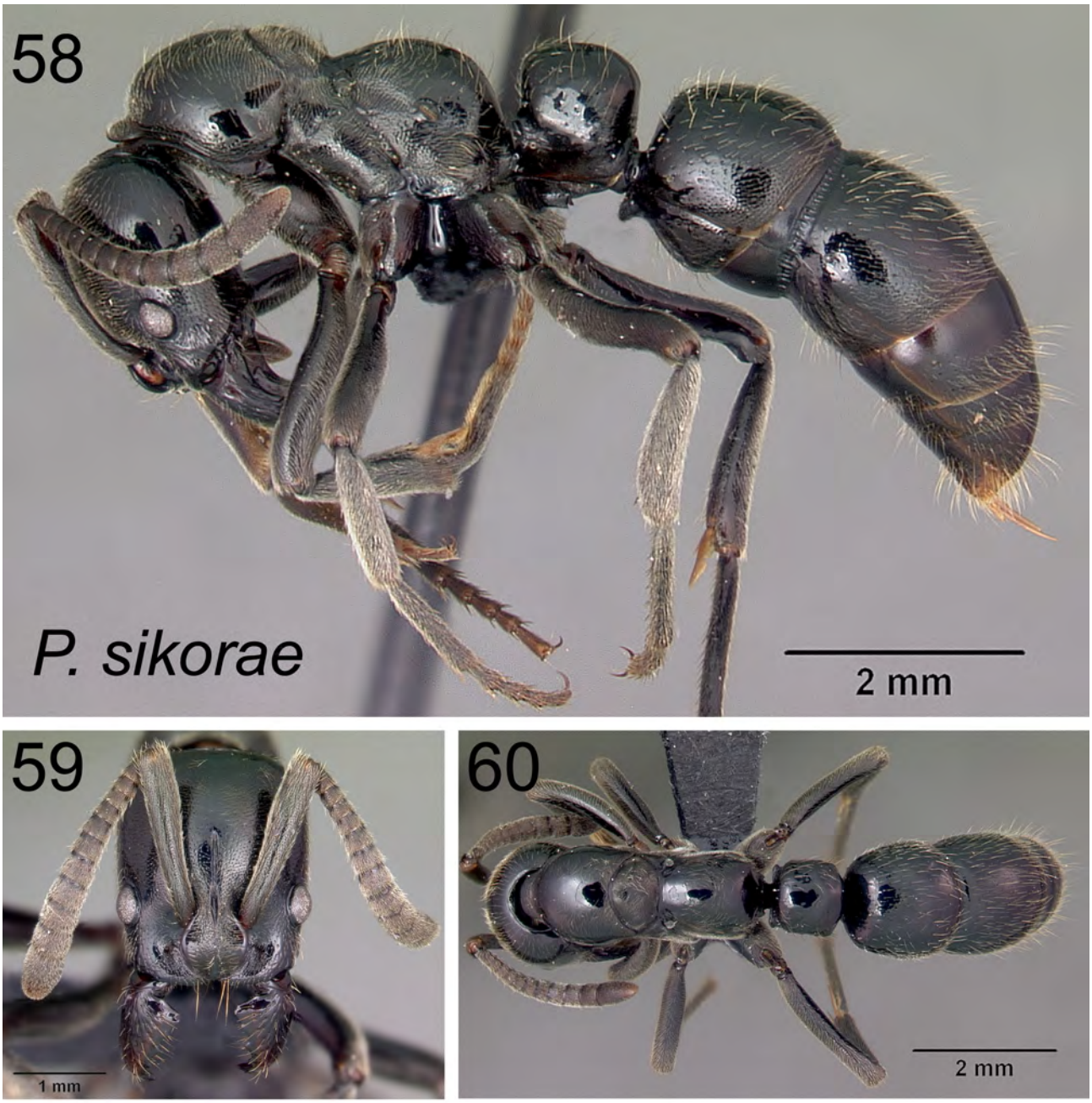
With mesosoma in dorsal view, metanotal groove deeply impressed; in lateral view, dorsal outline of mesosoma not a continuous line, promesonotum and propodeum clearly convex and separated by a groove; declivitous surface convex, meeting the sides of propodeum at a blunt angle; lamellate membrane lacking on posterior margin of propodeum. Mesosoma dorsum smooth and shiny; mesopleuron, metapleuron, and anterior portion of the sides of propodeum with dense and small punctures. Petiole nodiform; about as long as broad in profile; subpetiolar process at a posteriorly acute angle; in dorsal view anterior and posterior margins convex. Anterior face of first gastral segment straight, without shallow impression to lodge the petiole node. Gastral tergites generally smooth and shiny dorsally and covered with dense and fine punctures laterally.

Standing hairs slender and reduced in number, but frost-like or golden pubescence is abundant especially on appendages and lower portion of the sides of body. Body color black, with bluish reflection; appendages reddish-black and tip of gaster light brown.

Discussion: Of the several species with a deeply impressed metanotal groove and straight anterior clypeal margin, *P. sikorae* is the largest in size (HW 1.63–1.98, WL 2.85–3.29) in the group and most easily recognized by its smooth and shiny black integument, with bluish reflection, which is covered with golden pubescence.

Several winged queens of this species have been recorded across its distributional range. These queens are characterized by the presence of three ocelli, flight thoracic sclerites with shallowly impressed metanotal groove, and the presence of much denser erect hairs and pubescence on the body dorsum and appendages. Apart from these typical forms, their size looks apparently similar to that of the workers. Two colonies, collected from the PN Zahamena contained gamergates, which may function as a secondary reproductive (Peeters, pers. comm.).

Distribution and biology: *Pachycondyla sikorae* is an endemic, widespread species that is distributed across the humid forest habitats in eastern Madagascar and occurs at a wide range of altitudes, from lowlands to high mountains. In the north of the island, its distribution ranges from the RS Manongarivo in the west to the PN Marojejy in the east, down to the PN Zahamena in the central east, through the PN Ranomafana and down to the PN Andohahela in the south. It generally nests in rotten logs and dead branches on the forest floor. Worker specimens have been found foraging mostly on the ground and in the leaf litter, and rarely on low vegetation.



FIGURES 58–60. Worker caste of *Pachycondyla sikorae*: lateral and dorsal view of body and full-face view of head, CASENT0497202.

Additional material examined: Province **Antsiranana**: 9.2 km WSW Befingotra, RS Anjanaharibe-Sud, -14.75, 49.4667, 1200 m, montane rainforest (B.L. Fisher) (CASC); Betaolana Forest, along Bekona River, -14.53, 49.4404, 880 m, rainforest (B.L. Fisher *et al.*) (CASC); F Ambato, 26.6 km 33° Ambanja, -13.4645, 48.5517, 150 m, rainforest (B.L. Fisher) (CASC); Makirovana Forest, -14.1707, 49.9541, 415 m, rainforest, (B.L. Fisher *et al.*) (CASC); Makirovana Forest, -14.1604, 49.9522, 550 m, rainforest (B.L. Fisher *et al.*) (CASC); PN Marojejy, Antranohofa, 26.6 km 31° NNE Andapa, 10.7 km 318° NW Manantenina, -14.4433, 49.7433, 1325 m, montane rainforest (B.L. Fisher) (CASC); PN Marojejy, Manantenina River, 27.6 km 35° NE Andapa, 9.6 km 327° NNW Manantenina, -14.435, 49.76, 775 m, rainforest (B.L. Fisher *et al.*) (CASC); PN Marojejy, Manantenina River, 28.0 km 38° NE Andapa, 8.2 km 333° NNW Manantenina, -14.4367, 49.775, 450 m, rainforest, (B.L. Fisher *et al.*) (CASC); RS Manongarivo, 12.8 km 228° SW Antanambao, -13.9767, 48.4233, 780 m, rainforest, (B.L. Fisher) (CASC); RS Analamerana, 16.7 km 123° Anivorano-Nord, -12.8047, 49.3738, 225 m, tropical dry forest (B.L.

Fisher) (CASC); SAVA Region, district of Sambava, Marojejy National Park, 5 km W of Manantenina village, 1st Camp site (Mantella), -14.4382, 49.774, 487 m, low altitude rainforest (Rin'Ha, Mike) (CASC); Province **Fianarantsoa**: 2 km W Andrambovato, along Tatamaly River, -21.5117, 47.41, 1075 m, montane rainforest (B.L. Fisher *et al.*) (CASC); 3 km W Ranomafana, near Ifandiana, -21.25, 47.4167, 950 m, rainforest (P.S. Ward) (PSWC); 43 km S Ambalavao, PN Andringitra, -22.2333, 47, 825 m, rainforest (B.L. Fisher) (CASC); 45 km S. Ambalavao, 785 m, rainforest (B.L. Fisher) (CASC); 9.0 km NE Ivohibe, -22.4267, 46.9383, 900 m, montane rainforest (B.L. Fisher) [Sylvain] (CASC); PN Ranomafana, (L. Bartolozzi, S. Tiati & C. Raharimina) (MCZC); PN Befotaka-Midongy, Papango 27.7 km S Midongy-Sud, Mount Papango, -23.8352, 46.9637, 940 m, rainforest (B.L. Fisher *et al.*) (CASC); PN Befotaka-Midongy, Papango 28.5 km S Midongy-Sud, Mount Papango, -23.8408, 46.9575, 1250 m, montane rainforest (B.L. Fisher *et al.*) (CASC); PN Ranomafana, Vatoharanana River, 4.1 km 231° SW Ranomafana, -21.29, 47.4333, 1100 m, montane rainforest (Fisher, Griswold *et al.*) (CASC); Province **Mahajanga**: RS Marotandrano, Marotandrano 48.3 km S Mandritsara, -16.2832, 48.8144, 865 m, transitional humid forest (B.L. Fisher et al.) (CASC); Province **Toamasina**: [Madagascar central.] (MHNG); [Madagascar, Museum Paris, Grandidier 1893] (MNHN); Ambatovy, 12.4 km NE Moramanga, -18.8394, 48.3084, 1080 m, montane rainforest (B.L. Fisher *et al.*) (CASC); FC Didy, -18.1983, 48.5783, 960 m, rainforest (H.J. Ratsirarson) (CASC); FC Sandranantitra, -18.0483, 49.0917, 450 m, rainforest (H.J. Ratsirarson) (CASC); Manakambahiny, near Vavatenina Forest, -17.4667, 49.35, (A. Pauly) (CASC); PN Andasibe-Mantadia, F de Mantadia, 25.7 km 248° Moramanga, -18.814, 48.4303, 1040 m, rainforest (F.N. Raharimalala, B. Blaimer) (CASC); PN Zahamena, -17.7336, 48.7262, 950 m, rainforest (B.L. Fisher *et al.*) (CASC); PN Zahamena, Besaky River, -17.7524, 48.8532, 760 m, rainforest (B.L. Fisher *et al.*) (CASC); PN Zahamena, Onibe River, -17.7591, 48.8547, 780 m, rainforest (B.L. Fisher *et al.*) (CASC); RNI Betampona, Camp Vohitsivalana, 37.1 km 338° Toamasina, -17.8867, 49.2025, 520 m, rainforest (B.L. Fisher *et al.*) (CASC); RNI Betampona, Betampona 35.1 km NW Toamasina, -17.918, 49.2007, 500 m, rainforest (B.L. Fisher *et al.*) (CASC); Province **Toliara**: PN Andohahela, 10 km NW Enakara, -24.5667, 46.8167, 420 m, rainforest (B.L. Fisher) (CASC); PN Andohahela, 10 km SSW Eminiminy, -24.75, 46.7667, 830 m, rainforest (P.S. Ward) (PSWC); PN Andohahela, 13 km NW Enakara, -24.5667, 46.8167, 900 m, rainforest (B.L. Fisher) (CASC); F Ivohibe 55 km N Tolagnaro, -24.569, 47.204, 200 m, rainforest (B.L. Fisher *et al.*) (CASC); PN Andohahela, Col de Tanatana, 33.3 km NW Tolagnaro, -24.7585, 46.8537, 275 m, rainforest (B.L. Fisher *et al.*) (CASC); PN Andohahela, Col du Sedro, 3.8 km 113° ESE Mahamavo, 37.6 km 341° NNW Tolagnaro, -24.7639, 46.7517, 900 m, montane rainforest (Fisher-Griswold Arthropod Team) (CASC).

Pachycondyla tahary Rakotonirina and Fisher, sp. nov.

(Figures 27, 61, 62, 63, 79)

Holotype worker: Madagascar, Toamasina, RS Ambatovaky, Sandrangato River, -16.7727, 49.2655, 450 m, rainforest, ex rotten log, 20 Feb 2010 (B.L. Fisher *et al.*), collection code: BLF24323, specimen code: CASENT0162668 (CASC).

WORKER. Diagnosis: Anteromedial margin of clypeus projecting anteriorly as a blunt angle; with head in full-face view, lateral margins before level of anterior margin of eye strongly curving towards base of mandibles; in lateral view, distance between eye and base of mandible roughly less than twice the maximum diameter of eye; antennal scape attaining posterior cephalic margin; posterolateral margins of propodeum and petiolar node with a series of sharp teeth or denticles; mesopleural suture indistinct, while broad and discontinuous lines in different directions may be present; second gastral tergite punctate to sparsely punctate, pubescence absent or reduced on first and second gastral tergites; head behind the level of eye mostly smooth and shiny on faintly effaced reticulate-punctate sculptures.

Measurements (8 specimens): HW: 1.32–1.57, HL: 1.39–1.67, CI: 94–99, SL: 0.98–1.30, SI: 71–83, PW: 0.98–1.17, WL: 1.79–2.34, NH: 0.84–1.08, NL: 0.63–0.85, NW: 0.81–1.09, DNI: 122–132, LNI: 123–139.

Description: Head subquadrate, roughly as long as broad, sides nearly parallel posteriorly before curving abruptly from level of eyes towards base of mandibles; posterior border with weak median excision. Head dorsum reticulate-punctate, with large, smooth, and shiny spaces between punctures; sculptures become punctate and sparsely punctate near posterior margin and sides, respectively. Eyes medium, protruding from head surface, with more than 25 ommatidia; distance between eye and base of mandible approximately less than twice the maximum diameter of eye. Antennal scape barely surpassing posterior margin of head. Median lobe of clypeus convex,

anterior margin projecting anteriorly into a median convexity or blunt angle. Mandibles smooth and shiny, with scattered piliferous punctures; masticatory margins with ten teeth or denticles.

FIGURES 61–63. Worker caste of *Pachycondyla tahary*: lateral and dorsal view of body and full-face view of head, holotype CASENT0162668.

With mesosoma in dorsal view, metanotal groove absent; mesosoma dorsum mostly smooth between scattered punctures; blunt rugae or tubercles present on pronotum. In lateral view, mesopleural sulcus indistinct, and a broad superficial impression may be present; posterolateral border of propodeum with a series of teeth or tubercles. In profile, lower half of posterolateral margin of petiole node with a series of teeth or tubercles; dorsum and lateral surface of node coarsely bluntly tuberculate. In dorsal view, lateral margins of node forming a convex line to generally rounded anterior border; posterior margin slightly convex. Anterior face of first gastral segment without

shallow cavity; first and second gastral tergites punctate laterally, the punctures becoming widely spaced dorsally. Erect hairs long and thin; pubescence abundant on head and pronotum, but gradually reduced or absent from rest of mesosoma dorsum to second gastral tergite. Color black with bluish or opalescent reflection; appendages and tip of gaster brown.

Queen: unknown.

Distribution and biology: Endemic to Madagascar, *P. tahary* is only recorded from the rainforests of the RS Ambatovaky in the east of the island (Fig. 79). It forages mainly through the leaf litter and nests in rotten logs.

Additional material examined: Province **Toamasina**: RS Ambatovaky, Sandrangato river, 360 m, rainforest (B.L. Fisher *et al.*) (CASC); RS Ambatovaky, Sandrangato River, -16.7727, 49.2655, 450 m, rainforest (B.L. Fisher *et al.*) (CASC); RS Ambatovaky, Sandrangato River, -16.7633, 49.2669, 520 m, rainforest (B.L. Fisher *et al.*) (CASC); RS Ambatovaky, Sandrangato River, -16.8175, 49.295, 360 m, rainforest (B.L. Fisher *et al.*) (CASC); Sahafina Forest 11.4 km W Brickaville, -18.8144, 48.9621, 140 m, rainforest (B.L. Fisher *et al.*) (CASC).

Pachycondyla vohitravo Rakotonirina and Fisher, sp. nov.

(Figures 3, 25, 64, 65, 66, 80)

Holotype worker, Madagascar, Toamasina, Montagne d'Anjanaharibe, 18.0 km 21° NNE Ambinanitelo, -15.1883, 49.615, 470 m, sifted litter (leaf mold, rotten wood), rainforest, 8–12 Mar 2003 (coll. Fisher, Griswold *et al.*), collection code BLF08002, specimen code CASENT0034499 (CASC).

Paratype: one worker with same data as holotype but with specimen code CASENT0034500 (CASC).

WORKER. Diagnosis: Anteromedian margin of clypeus generally convex; posterolateral margins of propodeum and petiole node with a series of sharp teeth or tubercles, dorsal face of node bluntly tuberculate; second gastral tergite reticulate punctate or densely and coarsely punctate interspersed with small punctures; first and second gastral tergites covered with abundant pubescence.

Measurements (12 specimens): HW: 1.14–1.50, HL: 1.22–1.69, CI: 88–96, SL: 0.88–1.31, SI: 75–88, PW: 0.85–1.13, WL: 1.64–2.17, NH: 0.77–1.11, NL: 0.55–0.80, NW: 0.72–0.93, DNI: 115–141, LNI: 129–143.

Description: Head more or less elongate to subquadrate and broadest at about midlength; the sides normally convex and gradually converging from level of eyes to base of mandibles; posterior margin slightly concave. Head capsule reticulate-rugulose, rims of rugulation high and sharp. Eyes small and protruding, maximum diameter about the same as or less than widest part of antennal scape. Antennal scape barely reaching posterior border of head. Anteromedian margin of clypeus convex, with very slight median notch. Mandibles smooth and shiny between sparse punctures; apical margin equipped with 9–12 teeth or denticles.

With mesosoma in dorsal view, metanotal groove absent, pronotum generally densely punctate to reticulate-punctate interspersed with sparse blunt tubercles; propodeum reticulate-rugulose. In profile posterolateral margin of propodeum bordered with series of denticles or tubercles; mesopleural suture indistinct. With petiole in dorsal view, node roughly longer than broad; dorsum with scattered tubercles and small punctures, the spaces between which are smooth and shiny. In profile, petiolar node higher than long; lower half of posterior margin covered with a line of sharp teeth or denticles; subpetiolar process a simple anterior hooklike shape followed by small lobe posteriorly. Anterior face of first gastral segment straight, without shallow impression to lodge the petiolar node. Second gastral tergite reticulate punctate to densely punctate interspersed with small punctures.

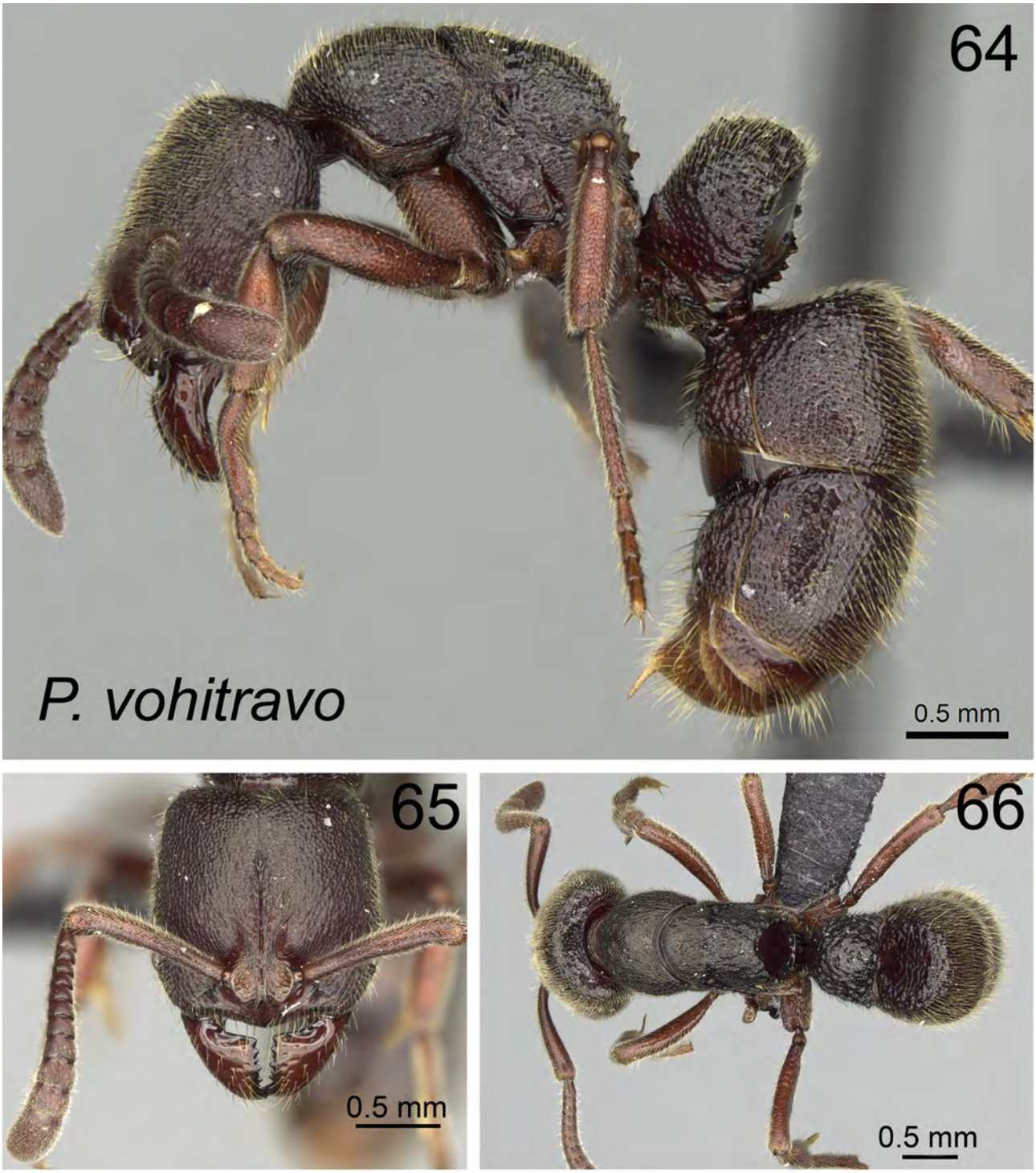
Standing hairs present and pubescence abundant on dorsum of head and body; pubescence particularly abundant on first and second gastral tergites. Head, mesosoma, and petiole node dark brown to reddish-brown in color; gaster and appendages brown or of lighter coloration.

Discussion: Samples of *P. vohitravo* came from three isolated montane rainforest habitats, and each population shows a striking morphological divergence that might indicate several species are involved. This character variation include overall body size, the shape of the sides of the head, the presence or absence of a blunt angle on the middle of the convex anteromedial clypeal margin, and the strength of body sculpture. However, gradations in body size and sculpture also appear among populations within the distributional range of the species and we consider them to belong to a single variable species.

Pachycondyla vohitravo may be confounded with *P. antsiraka* and *P. tahary*, but the presence of abundant pubescence on the first and second gastral tergites render it separable from both. Its first and second gastral

segments also have dense punctures, the spaces between which are less or about the same as their maximum diameter. For *P. antsiraka* and *P. tahary*, the distance between two punctures on first and second gastral segments is twice as long as the maximum diameter of the punctures.

Queen: unknown.



FIGURES 64–66. Worker caste of *Pachycondyla vohitravo*: lateral and dorsal view of body and full-face view of head, CASENT0050524.

Distribution and biology: *Pachycondyla vohitravo* is known to occupy the disjunct mountain tops of the RS Anjanaharibe-Sud and Makira Forest in the north east of Madagascar, Andranomay Forest in the high plateau and

the complex humid forests of Ambatovy-Analamay in the central eastern of the island (Fig. 80). Workers of *P. vohitravo* have been collected through leaf litter sampling, but one colony was collected from a rotten log.

Additional material examined: Province **Antananarivo**: 3 km 41° NE Andranomay, 11.5 km 147° SSE Anjozorobe, -18.4733, 47.96, 1300 m, montane rainforest (Fisher, Griswold *et al.*) (CASC); Province **Antsiranana**: RS Anjanaharibe-Sud, 9.2 km WSW Befingotra, -14.75, 49.4667, 1200 m, montane rainforest (B.L. Fisher) (CASC); Province **Toamasina**: Ambatovy, 12.4 km NE Moramanga, -18.8394, 48.3084, 1080 m, montane rainforest (B.L. Fisher *et al.*) (CASC); F Ambatovy, 14.3 km 57° Moramanga, -18.85083, 48.32, 1075 m, montane rainforest, (Malagasy ant team) (CASC); Torotorofotsy,-18.8708, 48.3474, 1070 m, montane rainforest, marsh edge, (Malagasy ant team) (CASC).

Pachycondyla zoro Rakotonirina and Fisher, sp. nov.

(Figures 21, 22, 67, 68,69, 81)

Holotype worker: Antsiranana, Parc National de Marojejy, Manantenina River, 28.0 km 38° NE Andapa, 8.2 km 333° NNW Manantenina, -14.4367, 49.775, 450 m, sifted litter (leaf mold, rotten wood), rainforest, 12–15 Nov 2003 (coll. B.L. Fisher *et al.*), collection code BLF08722, specimen code CASENT0045620 (CASC).

Paratypes: series of seven workers and one ergatoid queen with same data as holotype but specimens coded as CASENT0045613, CASENT0045615, CASENT0045616, CASENT0045618, CASENT0045619, CASENT0045623, CASENT0045627, CASENT0045614 (BMNH, CASC, MHNG, MCZC, PBZT).

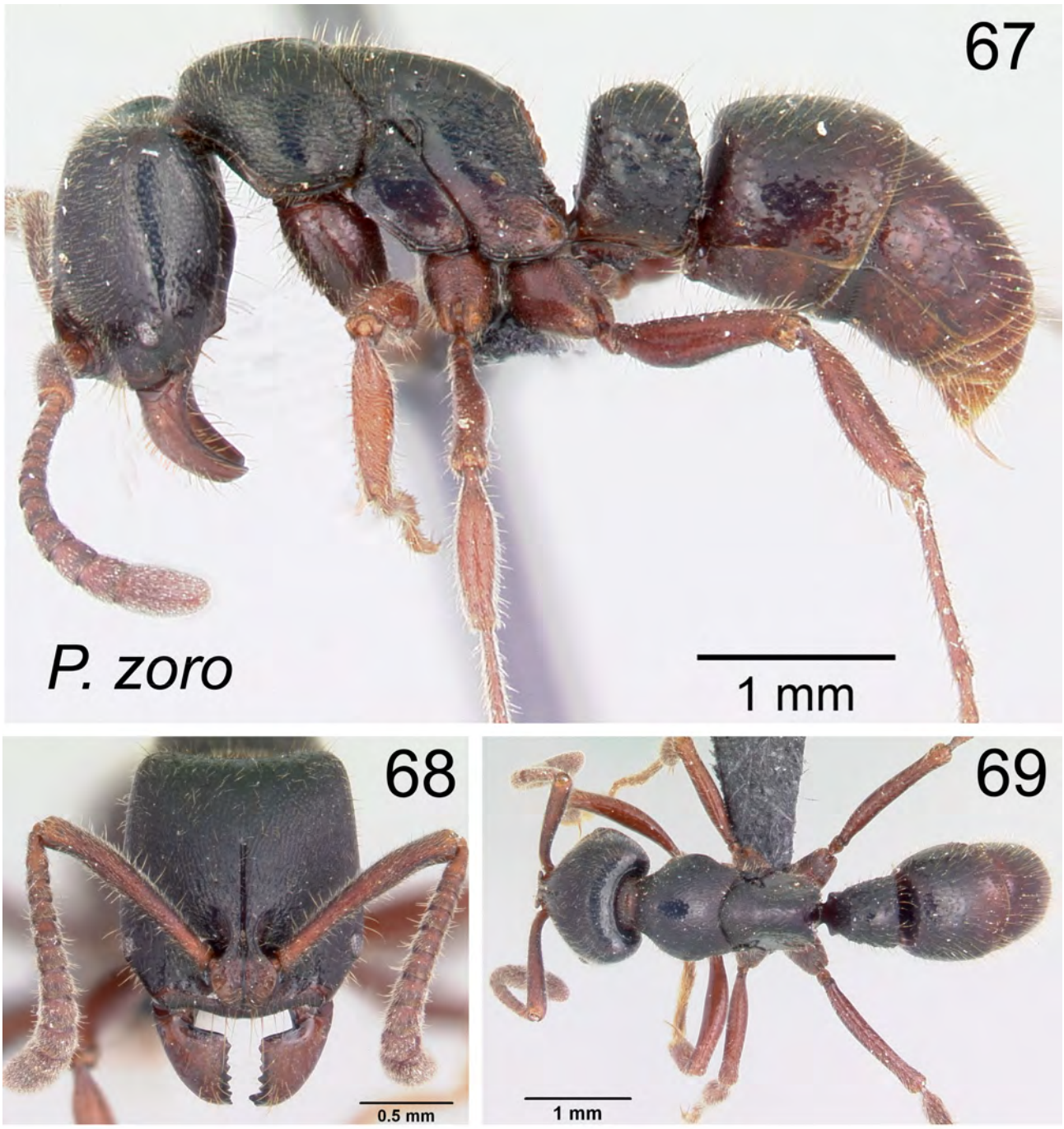
WORKER. Diagnosis: Anterior margin of clypeus medially convex or with median obtuse angle; with head in full-face view, lateral margins before level of anterior margin of eye strongly converging toward the base of mandibles; anterior surface of third abdominal segment straight, without shallow cavity. Posterolateral margins of propodeum and petiole node without succession of sharp teeth or denticles, posterior margin of propodeum bordered with subopaque lamella; in dorsal view, petiole node nearly as long as broad; in lateral view, subpetiolar process with anterior hook-like and posterior subtriangular processes separated by a concavity.

Measurements (8 specimens): HW: 1.22–1.32, HL: 1.33–1.46, CI: 90–94, SL: 1.11–1.17, SI: 87–92, PW: 0.95–1.02, WL: 1.85–2.05, NH: 0.77–0.83, NL: 0.53–0.61, NW: 0.67–0.73, DNI: 115–136, LNI: 135–154.

Description: In full-face view, head subrectangular; longer than broad, with almost straight lateral margins posterior to the level of eye. Anterior to the level of eye, lateral margin curves strongly toward the base of mandibles; posterior margin weakly concave. Frontal lobe narrow, with broadly rounded outer margin. Head dorsally finely reticulate-punctate, with smooth and shiny surface between punctures; side smooth and shiny apart from effaced reticulation and shallow scattered punctures. Eyes medium, their diameter about the same as greatest width of scape. Antennal scape barely extending beyond posterior cephalic margin. Median lobe of clypeus weakly protruding forwards, anterior margin medially convex and sometimes with feeble median notch. Mandible smooth between sparse piligerous punctulae, masticatory margin with 9–12 teeth or denticles.

In dorsal view, metanotal groove obsolete; promesonotum rugulose-punctate with smooth and shiny surface towards midline of mesosoma; propodeal dorsum sparsely punctate. In lateral view, mesopleural suture indistinct, median portion of mesopleuron and metapleuron shining and nearly smooth apart from widely spaced punctures or foveolae, with rugulose sculpture near lateroventral angle; sides of propodeum covered with dense, elongate punctures; posterolateral margin of propodeum bordered with subopaque lamellae. Petiole node in lateral view higher than long, with rugulose surface; anterodorsal angle extending somewhat over anterior face; posterior margin convex; subpetiole with both anterior hook-like and posterior subquadrate processes separated by a concavity. In dorsal view, node as long as broad, with nearly smooth dorsum apart from scattered rugulae and shallow punctures. Shallow cavity absent from anterior surface of first gastral segment. First and second gastral tergites with spaced punctures from which erect hairs arise.

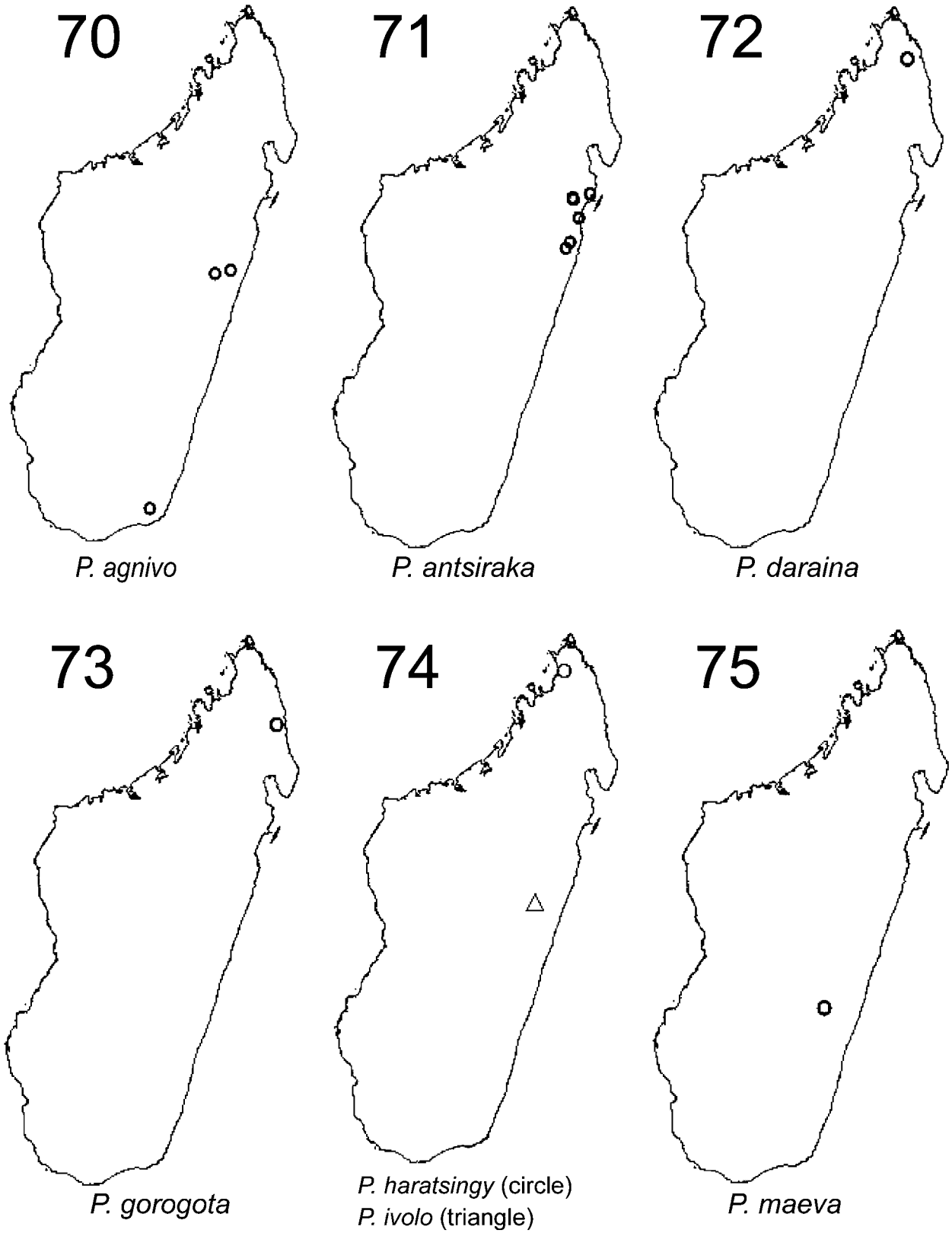
Pilosity consists of golden short erect hairs and abundant pubescence on head and promesonotum; rest of body dorsum with long erect hairs and very little pubescence. Head, mesosoma and petiolar node black; appendages and gaster brown ferruginous.



FIGURES 67–69. Worker caste of *Pachycondyla zoro*: lateral and dorsal view of body and full-face view of head, paratype CASENT0045619.

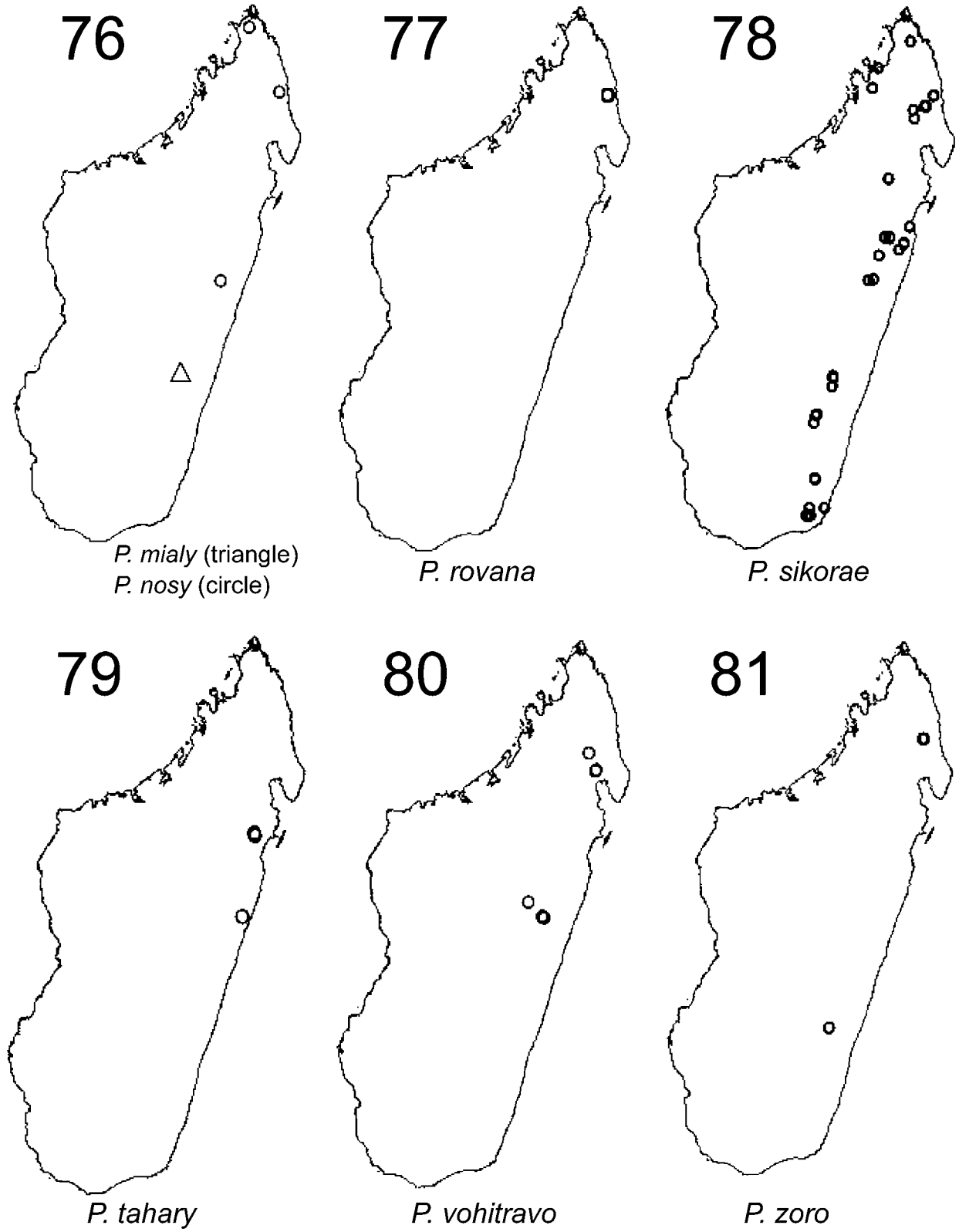
ERGATOID QUEEN. Measurements (1 specimen): HW: 1.25, HL: 1.28, CI: 98, SL: 1.08, SI: 86, PW: 0.99, WL: 1.91, NH: 0.81, NL: 0.51, NW: 0.79, DNI: 155, LNI: 159. This specimen is very similar to workers due to the absence of wings and thoracic sclerite development. It differs by the presence of one ocellus, the broader head and much more slender and numerous erect hairs on the dorsum of the body. In addition, the petiolar node looks shorter when viewed in profile and much broader than those of workers when in dorsal view.

Distribution and biology: *Pachycondyla zoro* occupies the lowland rainforests of Marojejy and Ambalagoavy Nord (Ikongo) located in the northeast and southeast of Madagascar respectively (Fig. 81). It has been collected via leaf litter extraction in Marojejy, and from malaise traps in Ambalagoavy.



FIGURES 70–75. Distribution maps of the *Pachycondyla sikorae* species-group in Madagascar. Fig. 70: *P. agnivo;* Fig. 71: *P. antsiraka;* Fig. 72: *P. daraina;* Fig. 73: *P. gorogota;* Fig. 74: *P. haratsingy* (circle) and *P. ivolo* (triangle); Fig. 75: *P. maeva.*

Additional material examined: Province **Antsiranana**: PN Marojejy, Manantenina River, 28.0 km 38° NE Andapa, 8.2 km 333° NNW Manantenina, Antsiranana, -14.4367, 49.775, 450 m, rainforest (B.L. Fisher *et al.*) (CASC); Province **Fianarantsoa**: F d'Ambalagoavy Nord, Ikongo, Ambatombe, -21.8275, 47.3389, 625 m (R. Harin'Hala & M.E. Irwin) (CASC).



FIGURES 76–81. Distribution maps of the *P. sikorae* species-group in Madagascar. Fig. 76: *P. mialy* (triangle) and *P. nosy* (circle)*;* Fig. 77: *P. rovana;* Fig. 78: *P. sikorae;* Fig. 79: *P. tahary*; Fig. 80: *P. vohitravo;* Fig. 81: *P. zoro.*

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