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A New Species of *Discothyrea* Roger from Mauritius and a New Species of *Proceratium* Roger from Madagascar (Hymenoptera: Formicidae)

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The worker of *Discothyrea berlita* sp. nov. from Mauritius is described. This is the first record of the genus from Mauritius. *D. berlita* is known from a single locality, Le Pouce, a small sanctuary of native ants on an island overrun with invasive ant species. *Proceratium avium* is recollected at Le Pouce and is the senior synonym of *Proceratium avioide* de Andrade (syn. nov.). The practice of manually removing alien plants from native forest plots in Mauritius is not advised for the Le Pouce forest patch because this practice facilitates the establishment of invasive ants, which eliminate native ants. *Proceratium google* sp. nov. is described from Madagascar.

KEYWORDS: Conservation, *Discothyrea*, Formicinae, Hymenoptera, Invasive, Madagascar, Mauritius, *Proceratium.*

In May 2005, I joined a team of Malagasy ant specialists on an expedition to the island of Mauritius, where we conducted an ant inventory and a search for indigenous species. The status of the remaining native species of Mauritius was called into question by P.S. Ward (1990). In inspired literary prose, he described, as W.L. Brown (1974) did earlier, the alarming difficulty of finding native species. Habitat destruction and introduced ants and plants dominate the landscape, pushing native ants up to and possibly over the brink of extinction.

Mauritius has had a long history of exploitation, habitat modification and extinction. With the extinction of the dodo in 1681, 80 years after humans first arrived on Mauritius, colonizers continued to modify habitat at an alarming rate (Lorence and Sussman 1986). The dense Mauritian forests were converted into tea and sugar plantations in the 19th century. During this time, habitat modification on Mauritius reached to almost every corner of the island (Safford 1997). Mauritius is an instructive example of what could happen to other insular environments, such as Madagascar, if habitat destruction is left unchecked. On Mauritius, as on Madagascar, invasive plant and animal species pose major problems. Once established, many invasive ants in Mauritius may be virtually impossible to eradicate, thus preventing the return of native ants (Holway et al. 2002).

The known native ant fauna of Mauritius includes 18 valid species, with 9 endemic to the island (Table 1). It is interesting that the endemic ants are all confined to upland forest. One could conclude that Mauritius has few endemics all of which are on mountaintops. On the other hand, these endemics could be the only remaining examples of a much richer endemic fauna that disappeared with the destruction of the lowland forest. The discovery of a new genus record on Le Pouce, suggests that there are more species to discover on the island and that Le Pouce is a surprising sanctuary of taxonomically peculiar endemic ants.

The site encompasses a rugged and spectacular mountain chain above the industrial city of Port Louis in north-west Mauritius. The main ridge runs approximately east to west, and three long spurs extend northward. Major peaks include Pieter Both (823 m), Le Pouce (812 m) and Montagne Ory (c.700 m). Le Pouce captures moisture from the prevailing wind and clouds, resulting in the presence of native cloud-forest there. This is the only remaining area of native vegetation, although native plants are scattered throughout the range. Exotic vegetation dominates, most notably a scrub of strawberry guava (*Psidium cattleianum*) and privet (*Ligustrum robustrum*) — but grassland and *Eucalyptus* plantations also occur. The best native forest found during our trip, and also the place of greatest number of endemic ants, was a small patch of forest, less than one hectare in area, just at the southeast face of the peak. Based on our survey results across the island, this forest patch on Le Pouce is the only remaining forest refuge for these mountain endemics of Mauritius and should receive high conservation priority.

TABLE 1 List of valid names for native ants recorded from the island of Mauritius. Native ants restricted to Rodrigues (*Monomorium elongatum* Smith, 1876, *Tapinoma fragile* Smith, 1876, *Tapinoma pallipes* Smith, 1876) are excluded. Species in bold are endemic to the island.

Camponotus aurosus Roger, 1863
Camponotus grandidieri Forel, 1886
Crematogaster sewellii Forel, 1891
Dicothryea berlita sp. nov.
Hypoponera johannae (Forel, 1891)
Nesomyrmex gibber Donisthorpe, 1946
Ochetellus vinsoni (Donisthorpe, 1946)
Pheidole picata Forel, 1891
Pheidole tarda Donisthorpe, 1947
Plagiolepis madecassa Forel, 1892
Pristomyrmex bispinosus (Donisthorpe, 1949)
Pristomyrmex browni Wang, 2003
Pristomyrmex trispinosus (Donisthorpe, 1946)
Proceratium avium Brown, 1974
Pseudolasius dodo (Donisthorpe, 1946)
Solenopsis mameti Donisthorpe, 1946
Strumigenys agetos Fisher, 2000
Technomyrmex primrosae Donisthorpe, 1949

MATERIALS AND METHODS

This work is based on ant inventories in Mauritius from 25 May–31 May, 2005. During that period, we visited Le Pouce Mt., Pieter Both Mt., and Calebasses Mt. in the Moka Range, and Camizard Mt., and Brise Mt. in the Bambous Range. We also collected at Basin Blanc, Ile aux Aigrettes, Cocotte Mt., and Petite Rivière Noire Mt. Ants were collected using general hand search techniques and leaf litter extraction. The work in Madagascar is based on arthropod surveys in Madagascar that included over 6,000 leaf litter samples, 4,000 pitfall traps, and 8,000 additional hand collecting events throughout Madagascar in 1992 through 2004 (Fisher 2005). The species described here was collected as part of an inventory of Réserve Spéciale d'Anjanaharibe-Sud organized by Steve Goodman (Fisher 1998).

All species and type material examined in this study have been imaged and are available on AntWeb (*www.antweb.org*). Material was deposited at California Academy of Sciences, San Francisco (CASC) Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts (MCZC), and British Museum of Natural History (BMNH).

Digital images (Fig. 1–17) were created using a JVC KY-F75 digital camera and Syncroscopy Auto-Montage (v 5.0) software. All metric measurements were taken at 80× power with a Leica MZ APO microscope using an orthogonal pair of micrometers and recorded to the nearest 0.001mm and rounded to two decimal places for presentation. The accuracy of the micrometers was tested against a 0.01 mm microscope micrometer before and after measurements. Measurement indices and their abbreviations used in the paper are based on those used by Ward (1988). Size and the shape of the IV abdominal segment are the most important characters for the identification and delimitation of Proceritiinae species.

List of Abbreviations Used

HL Head length: maximum longitudinal length from the anteriormost portion of the projecting clypeus to the midpoint of a line across the back of the head.
HW Head width: maximum width of head, including the eyes, and is taken behind them.
CI Cephalic index: HW/HL x 100.
SL Scape length: maximum chord length excluding basal condyle and neck.
SI Scape index: SL/HW x 100.
WL Weber's length: in lateral view of the mesosoma, diagonal length from posteroventral corner of mesosoma to the farthest point on anterior face of pronotum, excluding the neck.
LS4 Length of abdominal sternum IV as described in Ward (1988).
LT4 Length of abdominal tergum IV as defined in Ward (1988).
IGR Index of gastric reflexion: LS4/LT4

***Discothyrea berlita* Fisher, sp. nov.**
Fig. 1–4.

Type Material.— Holotype: Worker. Mauritius: Le Pouce Mt., Moka Range, 20°11′55″S, 057°31′44″E, 750 m, closed vegetation, 25 May 2005 (coll. B.L. Fisher et al.) Collection code: BLF12148, specimen code: CASENT0007016 (CASC).

Type worker measurements: HL 0.57, HW 0.52, CI 91, SL 0.36, SI 70, LS4 0.08, LT4 0.43, WL 0.64 IGR 0.19.

Diagnosis.— The following character combination differentiates *berlita* from all its congeners: scrobe absent, fused frontal carinae projecting perpendicular to the plane of the clypeus, expanding apically, not forming a thin lamellae; propodeal angle without acute teeth or spines; anterior margin of petiole concave when viewed from above.

Etymology.— The specific name is an arbitrary combination, to be treated as a noun in apposition.

Worker Description.— Form of head, mandibles, and body as shown in Figures 1–4. Antennae 10-segmented; medium segments extremely short and not distinct when viewed with less than 100× magnification; scape expanded apically, reaching mid-point of head. Eyes with 2 or 3 facets. Without depressed scrobal area. Palpal segmentation requires dissection and thus was not determined. Mandible masticatory margin concave, with two teeth, sharp apical tooth and smaller acute basal tooth. Propodeal angle without teeth or acute angles; declivitous face of propodeum concave. Petiole thick, with lateral margins on anterior face; anterior margin concave when viewed from above. Petiole with distinct convex subpetiolar process. Abdominal segment III longer than broad.

Head and mesosoma densely punctulate; petiole sculptured as mesosoma, abdominal segment III with sparse punctures; punctures evanescent on abdominal segment IV. Integument generally opaque, except shiny for impunctate areas of metasoma.

Body, including mandible and appendages, covered with dense fine, very short whitish decumbent pubescence, becoming sparse on abdominal segment III, and dense and nearly erect on abdominal segment IV.

Color testaceous red.

Distribution.— The single specimen was collected in a leaf litter sample in the only remaining patch of dense native vegetation near the summit of Le Pouce. Samples from other nearby mountain tops, Pieter Both (823 m), Calebasses (c.600 m), did not uncover any endemic Proceritiinae.

Comments.— The African species of *Discothyrea* fall into two groups: (1) those with the

FIGURE 1-4. *Discothyrea berlita* worker: holotype CASENT0007016.

clypeo-frontal fusion flat topped and broad and with a depressed scrobe region, and (2) those in which the process forms a simple convex or angular vertical plate and lack a depressed scrobe region (Brown 1958). The *Discothyrea* of Madagascar belong to the first group. *D. berlita* is most similar to those in the second group, but is distinct in that the vertical plate does not form a thin lamella, but is expanded apically (Fig. 3).

Proceratium avium **Brown, 1974**
Figs. 5–13.

Proceratium avium Brown, 1974: 71, figs. 1 and 2 (worker, gyne and male). Mauritius: Le Pouce Mt, 700-800 m, Native forest, 1 Apr. 1969 (coll. W.L. Brown) [examined] AntWeb MCZTYPE32216 (MCZC) [de Andrade 2000:75]

Proceratium avioide de Andrade 2003: 78, figs 37, 38 (worker, gyne and male). Mauritius: Le Pouce Mt, 700-800 m, Native forest, 30 March 1969 (coll. W.L. Brown) [examined] AntWeb MCZTYPE35017 (MCZC). **New synonymy** [see justification below]

During the trip to Le Pouce on May 25 and 30, seven new collections of *Proceratium* from Le Pouce were recorded (Table 2). Because of the small size of the forest patch, only two complete colonies were collected. For the other colonies we encountered, only a few foragers were removed. As Brown (1974) observed, foragers were returning to nests with what appeared to be spider eggs. In this case, they carried the eggs in the mandible, and did not support the eggs with the recurved gaster (Brown 1980). Baroni and de Andrade (2003) suggest the recurved gaster serves a phragmotic function, but I did not observe the recurved gaster being used to plug up the ant nest entrance.

TABLE 2. Collection of *Proceratium avium* on 25 and 30 May 2005 at Le Pouce Mt., Moka Range, 20°11′55″S, 057°31′44″E, 750 m, closed vegetation.

Collection	*Habitat*	*Caste*
BLF12011	foraging on *Nuxia verticillata* with *Pristomyrmex bispinosus*	1 w
BLF12014	foraging on *Nuxia verticillata* with *Pristomyrmex bispinosus*	2 w
BLF12136	ex rot pocket, *Nuxia verticillata*, 1. 5 m above ground	1 erg Q, 127 w
BLF12137	ex rot pocket, *Nuxia verticillata*, 1. 5 m above ground	1 erg. 352w
BLF12139	foraging on *Nuxia verticillata* with *Pristomyrmex bispinosus*	2 w
BLF12140	foraging on *Nuxia verticillata*	8 w
BLF12142	foraging on *Nuxia verticillata*	2 w

Of note is the fact that colony (BLF12137) included 352 workers, one ergatoid queen, and no males. Based on the colony size data reported in Baroni and de Adrade (2003), this is the largest colony size recorded for *Proceratium*. Collections in May by Brown in 1969 included males. All nests encountered were located in *Nuxia verticillata* Lamark (Loganiaceae), with entrances about 1.5–2 m above ground. This tree was also the preferred nesting site for *Pristomyremx bispinosus.* This tree, called bois maigre in Mauritius, has gnarled and twisted trunks. It is endemic to Mauritius and Reunion and appears to be the sole nesting site for *Pristomyremx bispinosus* and *Proceratium avium*. The high winds that are common on Le Pouce abrade the twisted and intertwined trunks and branches. This action damages the tree at the contact point between intersecting branches and leads to the creation of a rot pocket and nesting site.

Three collections of *Proceratium avium* (BLF12011, 12014, and 12139) were foragers following *Pristomyremx bispinosus.* These two species are very similar in color and general appearance. Brown in 1969 also observed this behavior. It is unclear why *Proceratium* is interspersed among the foraging workers of *P. bispinosus*. Conservation of either of these species should include further investigation of potential beneficial interactions between the species.

FIGURES 5–13 Profile, head in full-face view and mesosoma in dorsal view of *Proceratium avium* workers: Figures 5–7: CASENT0059014, BLF12136, collected May 30, 2005; Fig. 8–10: MCZTYPE32216 holotype of *Proceratium avium* collected 1 Apr. 1969; Fig. 11–13: MCZTYPE35017 holotype of *Proceratium avioide* collected 30 March 1969.

JUSTIFICATION OF SYNONYMY.— Brown (1980) collected three series of *Proceratium* at Le Pouce in 1969, one on March 30, and two on April 1. The latter were located less than 500 meters from the March 30 collecting site. He described both of these samples as *Proceratium avium* (Brown 1974). De Andrade (Baroni Urbani and de Andrade 2003) reexamined these three collections and determined that they represent two species, *P. avioide* and *P. avium*. She based this on the observation that *P. avium* differs from *P. avioide* by the less impressed sculpture, by the denser pilosity, and by longer antennal scapes (*P. avium* SI 87.3-88.6, *P. avioide* SI 81.8–83.3).

The measurements of Brown and de Andrade are not consistent, especially for the *P. avioide* material she examined. Brown noted measurements for the three collections (workers n = 19) as HL 0.92–0.98, HW .091–0.98, CI 96–101 SL 0.90–0.99. Brown did not calculate SI. De Andrade notes that for her *avium*: HL 1.05–1.12, HW .090–0.94, CI 84.5–85.7 SL 0.93–0.97, SI 87.3–88.6 and *P. avioide*, HL 1.10–1.16, HW .092–0.97, CI 82.1–85.1, SL 0.90–0.96, SI 81.8–83.3. Note that CI for Brown ranged from 96–101, while for De Andrade, CI ranged from 82.1–85.7.

One possible reason for these differences is the differences of HW and SL definitions. Based on the definitions presented above, I re-measured the type material using a calibrated micrometer (see Methods above). Measurements are presented in Table 3. These measurements confirm the relative differences between the Brown collections. However, when samples from the seven new collections are included, these differences become less distinct. The seven collections in the study, have even less impressed sculpture than *P. avium*, similar pilosity as *P. avium*, and longer antennal scapes then both *P. avium* and *P. avioide* (SI 98–103). Based on this study of Brown's material and the new collections in this study, I identify all these collections as one species.

TABLE 3. Measurements and scape index of type material and new collections. MCZTYPE32216 is the holotype of *Proceratium avium*, MCZTYPE35017 is the holotype of *Proceratium avioide.*

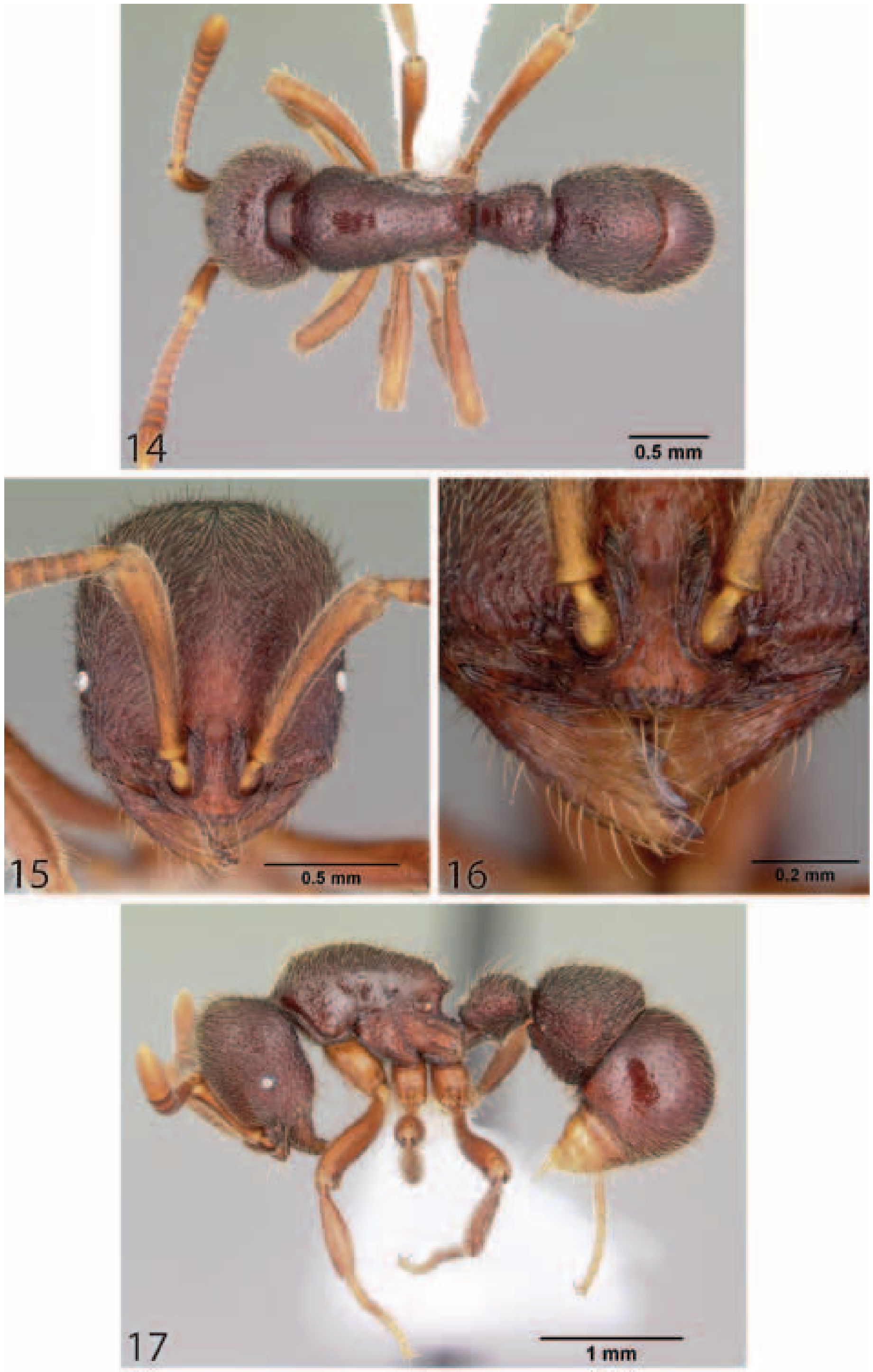
Specimen number	*HW*	*SL*	*SI*
MCZTYPE35017	0.97	0.92	95
MCZTYPE32216	1.01	0.96	96
CASENT0055844	0.98	1.01	103
CASENT0055842	0.99	1.00	101
CASENT0059012	0.97	0.99	102
CASENT0059013	1.03	1.01	98
CASENT0059026	1.00	1.01	101
CASENT0059030	0.99	1.01	102
CASENT0059029	1.01	1.00	98
min	0.97	0.92	95
max	1.03	1.01	103

The variation observed in these collections is interesting in such a small area. It is possible that because *P. avium* has ergatoid queens, and disperses presumably by budding with low dispersal ability, the complex topography of Le Pouce contributed to the observed variation. The possible restriction of the remaining population to the single forest patch at the base of the southeast peak, however, could severely limit the observed variation in the future.

***Proceratium google* Fisher, sp. nov.**
Figs. 14–17.

TYPE MATERIAL.— HOLOTYPE: Worker. MADAGASCAR: Antsiranana, 11.0 km WSW Befingotra, Réserve Spéciale Anjanaharibe-Sud, 14°45′S, 049°27′E, 1565 m, 16 Nov 1994 (coll. B.L. Fisher) sifted litter, montane rainforest, Collection code: BLF1232(6) — CASENT0100367, (CASC) PARATYPES: 2 workers with same data as holotype but with specimen codes CASENT010068 (BMNH), CASENT0100369 (MCZC); 1 worker 9.2 km WSW Befingotra, Réserve Spéciale Anjanaharibe-Sud, 14°45′S, 049°28′E, 1280 m, 5 Nov 1994 (coll. B.L. Fisher), CASENT0100370; (CASC); and 1 worker same as latter but collected at 1200 m on 9 Nov 1994, CASENT0100371 (CASC).

DIAGNOSIS.— The following character combination differentiates *P. google* from all its congeners: abdominal segment IV tergite evenly rounded posteriorly, without concave impression near apex and not hypertrophied; truncate median clypeal lobe; low nodiform petiole without peduncle but with blunt anteroventral tooth; fore tibia with a basal spine, frontal carinae separate and diverging posteriorly; posterior dorsum of mesosoma and propodeal spines granulate-foveolate. *P. google* is easily distinguished from *P. diplopyx,* the only other described *Proceratium* from Madagascar,



FIGURES 14-17. *Proceratium google* worker: holotype CASENT0100348.

TABLE 4. Worker measurements: maximum and minimum based on all five *Proceratium google* specimens.

Specimen CASENT #		*HL*	*HW*	*CI*	*SL*	*SI*	*WL*	*LS4*	*LT4*	*IGR*
0100367	Holotype	1.21	1.02	84	0.80	79	1.34	0.20	0.85	0.23
0100370	Paratype	1.24	1.07	86	0.92	86	1.49	0.18	0.79	0.23
0100371	Paratype	1.24	1.04	84	0.86	83	1.46	0.20	0.77	0.26
0100368	Paratype	1.15	1.03	89	0.84	82	1.36	0.19	0.79	0.23
0100369	Paratype	1.20	1.05	87	0.83	79	1.41	0.17	0.79	0.22
	min	1.15	1.03	84	0.83	79	1.36	0.17	0.77	0.22
	max	1.24	1.05	89	0.86	83	1.46	0.20	0.79	0.26

by the shape of the tergite of the abdominal segment IV. In *P. diplopyx*, the tergite is with a deep concave notch near apex.

ETYMOLOGY.— Named in recognition of the support from the Google company. I hope that Google will continue applying its talent to serve data relevant to the biodiversity community, conservation planners, and the general public. By creating a "Zoogle," Google could help achieve free and democratic access to taxonomic and biodiversity data on species. *P. google* is also suspected to be a specialist egg predator of spiders, which is also why this ant is aptly named after Google—for the ability to hunt down obscure prey. The specific name is an arbitrary combination, to be treated as a noun in apposition.

WORKER DESCRIPTION.— Form of head, mandibles, and body as shown in Figures 14-17. In full-face view, posterior margin of head rounded, not concave; sides of head more or less straight medially; in profile, dorsal margin marginate. Mandible with 4 teeth. Palpal formula 4, 3. Antennae 12-segmented, scape does not reach posterior margin of head. Median clypeal lobe raised and notched medially. Eye a single, large, clear, convex facet that projects beyond the margin of the head in full-face view.

Mesosoma in dorsal view pear-shaped, broader across pronotum than across propodeum. Metanotal grove unmarked. Propodeal spines granulate-tuberculate; declivitous face of propodeum concave, ending basally with an upturned tooth. Petiole longer than wide; subpetiolar process forming an obtuse tooth at midlength. Tibial spur present on each leg. Claws on all legs slender, simple.

Abdominal segment IV tergum evenly rounded posteriorly, without concave impression near apex.

Head, mesosoma, petiole, and abdominal segment III with dense granulate-foveolate sculpture. In contrast, abdominal segment IV predominantly smooth and shiny but with sparse foveae. Declivitous face of propodeum shiny smooth.

Body covered with abundant pilosity consisting of fine, curved, tapered, yellow-white setae.

Queen, male and larvae unknown.

DISTRIBUTION.— Known only from an isolated mountain in Northeastern Madagascar, Réserve Spéciale Anjanaharibe-Sud, 14°45′S, 049°27′E, collected at an elevation of 1565 m. Collections in nearby mountains such as Marojejy did not locate any specimens of this species.

CONSERVATION

Arthropods present several challenges to those dedicated to their conservation. First, they are small and inconspicuous, and thus often forgotten during the conservation planning process. Second, arthropods are overwhelmingly diverse and as a whole, barely known. Is it pragmatic to develop a conservation strategy for a fauna we scarcely know? Third, because arthropods show a remarkable level of local endemism, they will require strategies and policies that are different from those developed to conserve birds and plants. A case in point is Mauritius.

Conservation in Mauritius is heavily biased to bird and plant preservation (Safford and Jones, 1998; Fowler et al 2000, Nicholas et al. 2004). Land management practices are tailored to benefit plants and birds, but not invertebrates. They are fighting the battle to protect the dwindling patches of native vegetation and bird populations. For plants, this includes the establishments of Conservation Management Areas where alien plants are manually removed (Dulloo et al 2002). In these plots, weedy vegetation is removed up to three times a year. The active removal of large number of weedy plants, however, creates large areas of bare soil and understory (Dulloo et al 2002, pers. obs.). This disturbance facilitates the establishment of invasive ants, at the expense of any remaining native ants (pers. obs.).

The small, one-hectare patch of native forest left on Le Pouce could be destroyed for native ants if an active weeding program is initiated. The closed vegetation is essential for the survival of the endemic *Discothyrea*, *Pristomyremx*, and *Acropya*, which thrive in the cold, moist understory. With weeding and increased insolation and disturbance, the invasive ants that surround this small patch would quickly move in and destroy this ant sanctuary.

An alternative approach to the manual weeding strategy would be to plant native trees around this patch, including *Nuxia verticillata*, which is home to *Proceratium* and *Pristomyrmex*. The goal would be to create a dense closed canopy of natives around this patch without disturbing the patch itself. Over time, the effective size of this patch could expand. We also advise that future collections of endemic ants in Mauritius avoid collecting entire colonies.

Mauritius has shown that once invasive ants take hold, there is almost no way to return the land to native ants and healthy arthropod communities (pers. obs.). Therefore, in Madagascar, land managers must monitor for invasive arthropods. Even though remnant patches of forest may be preserved, invasion by aggressive exotic ants may drive native ants locally extinct. One of the simplest and most effective methods is to track the presence or absence of invasive ants. In this approach, targeted collecting can be performed in habitats and microenvironments most likely to harbor invasives.

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