A Rapid Assessment of the Ants of the Grensgebergte and Kasikasima Regions of Southeastern Suriname

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Chapter 7

A rapid assessment of the ants of the Grensgebergte and Kasikasima regions of Southeastern Suriname

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SUMMARY

A total of 149 ant species from 35 genera and 10 subfamilies have been identified from the collections made during the 2012 RAP survey of Southeastern Suriname. Additional work is ongoing to process and identify the remaining samples, which will undoubtedly raise the total number of species, possibly to over 200 species. The results indicate a healthy and diverse ant fauna reflective of pristine rainforest. Ants play important roles as predators, scavengers, and seed-dispersers in tropical forests. The ant data from Southeastern Suriname will add to a growing dataset on the ant ant fauna of the Guiana Shield, which is still poorly documented, to help identify areas of high diversity and endemism that are important to conserve within the region. Data on ants and other invertebrates are important since these groups may be able to illustrate differences between habitats within the Guiana Shield that larger animals with wide geographical ranges do not discern.

INTRODUCTION

With over 12,000 described species of ants in the world (see AntWeb), and their social lifestyle consisting of colonies ranging in size from just a few to millions of workers, ants are a dominant force in all terrestrial ecosystems, especially tropical rainforests. They are important members of the ecosystem, with high biomass and population size, and provide key ecological functions such as aerating and turning soil, dispersing plant seeds, consuming dead animals, and controlling pest insects. In addition to their ecological importance, ants have several features that make them especially useful for conservation planning, including: 1) they are dominant members of most terrestrial environments, 2) they are easily sampled in sufficiently high numbers for statistical analysis in short periods of time (Agosti et al. 2000), 3) they are sensitive to environmental change (Kaspari and Majer 2000), and 4) they are indicators of ecosystem health and of the presence of other organisms, due to their numerous symbioses with plants and animals (Alonso 2000).

Ants have been poorly surveyed in Suriname. After the 2005 RAP survey of the Lely and Nassau Mountains (Sosa Calvo 2007) and the 2010 RAP survey in the Kwamalasamutu region of SW Suriname (Alonso 2011), a conservative estimate of about 370 ant species had been recorded in Suriname. However, given the low effort of ant sampling in Suriname and the few localities sampled, there are likely many more ant species in the country.

METHODS

Ants were surveyed at RAP Site 1 (Upper Palumeu River), RAP Site 2 (Grensgebergte), and RAP Site 4 (Kasikasima). Ants were surveyed using hand search-collecting methods and the Winkler method (Agosti et al. 2000). In the search-collecting method, the ants nesting under stones, under or inside decayed wood and those foraging on ground, litter, tree trunk and plants were searched for and collected. This method was employed at all three camps around the camp and in the forest along the principal trails.

The second sifting method used was the Ants of the Leaf Litter (ALL) protocol (Agosti et al. 2000). Along each transect, a 1×1-m quadrat was set up every 10 m (for a total of 10 quadrats per transect). The leaf-litter, rotten twigs, and first layer of soil present in the quadrat were collected into a cloth sifter and shaken for about a minute. Within the sifter was a wire sieve of 1-cm^2 mesh size, which allowed small debris and invertebrates such as ants to fall through the mesh into the bottom of the sifting sack. The sifted leaf litter was then placed in a full-sized Winkler sack, which is a cotton bag into which four small mesh bags containing the leaf litter are placed. Due to their high level of activity, ants run out of the litter and the mesh bag and fall to the bottom of the sack into a collecting cup of 95% ethanol. The Winkler sacks were hung in the field lab for 48 hours.

A total of 10 Winkler Transects were sampled at the following sites:

1. Upper Palumeu (RAP Site 1, approx. 270 m a.s.l.): Two 100 m winkler transects were sampled in the forest along the trail to Brazil, starting after the helipad. Leaf litter was dry and fairly thin. Two 100 m winkler transects were sampled in the forest up the hill behind the camp. 5 days collecting.
2. Grensgebergte (RAP Site 2, approx. 800 m a.s.l.): One 100 m winkler transect was sampled in forest behind the RAP tent. Leaf litter was very wet due to heavy rain the night before and in the morning. One 100 m winkler transect was sampled in the forest at the top of the mountain above the rocky outcrops. Litter was wet and thick. These two transects were combined when hung in the Winkler sacs due to logistical difficulties when RAP Camp 1 flooded. 1 day collecting.
3. Kasikasima (RAP Site 4, approx. 200 m a.s.l.): Two 100 m winkler transects were sampled along the trail by the river (towards the METS camp). Three 100 m winkler transects were sampled in forest along the trail between the RAP camp and the Kasikasima rock, most on the tops of hills on flat plateaus. 6 days collecting.

The ant specimens were preserved in 95% ethanol and sorted to morphospecies. Some specimens were identified to species level by L. Alonso and J. Sosa-Calvo using ant taxonomic literature and the ant collection at the National Museum of Natural History in Washington, D.C.

PRELIMINARY RESULTS

For this report, ants from six of the 10 winkler transects were sorted and identified to morphospecies. These included: 2 transects from RAP Site 1 (Upper Palumeu), 2 transects from RAP Site 2 (Grensgebergte), and 3 transects from RAP Site 4 (Kasikasima). Only a few of the hand collecting samples have been identified so far, with an emphasis on the ants collected from ant-plants.

A total of 149 ant morphospecies representing 35 genera and 10 subfamilies were identified from the sorted collections (see Appendix 7.1). Most of the species were from the Winkler transects since only a few of the hand collections have been sorted so far. Additional work is ongoing to process and identify the remaining samples, which will undoubtedly raise the total number of species, possibly to over 200 species. A total of 72 ant species were recorded from RAP Site 1, 25 species from RAP Site 2, and 92 species from RAP Site 4 (Appendix 7.1).

Genera typical of the region including many large ants that were commonly seen in the forest, including the arboreal species *Daceton armigerum*, *Cephalotes* spp., and *Camponotus* spp., the large-eyed terrestrial *Gigantiops destructor*, and several species of army ants. Many species of tiny leaf litter dwelling dacetines (*Strumigenys, Octostruma*) were collected at all three sites, indicating good primary forest. Species of the genera *Pheidole, Pachycondyla* and *Odontomachus* were commonly observed and collected. *Pheidole* was the most speciose genus, which is typical for tropical rainforest.

Many ant-plants in the family Melastomataceae (*Tococa* sp.?) were found in the area, housing obligate ant mutualists in domatia at the base of leaves. Most of these plants contained *Pheidole* (possibly cf. *minutula)* or *Crematogaster* sp. 7. The ant-plant *Hirtella duckei* (Chrysobalanaceae) was collected at RAP Site 4 and housed *Allomerus* sp. (see page 26) *Pseudomyrmex* sp. was collected from *Triplaris* near the Kasikasima Camp (Site 4), and *Azteca* sp. was collected from *Cecropia* on top of the rock at RAP Site 2.

One or two species of fire ants, *Solenopsis* spp., were collected during the RAP survey. They may both be *S. geminata*, the tropical fire ant, which is native to the region. A light orange species was found under a log in the forest near RAP Camp 1 and in Palumeu village, and a darker species was common on open rocks on top of the Grensgebergte mountain (Site 2) at about 500 m. Further study is needed to determine the species.

DISCUSSION

Ants were abundant at the Southeastern Suriname RAP sites but did not seem as numerous or conspicuous as they were at the Werehpai RAP site during the Kwamalasamutu RAP survey (Alonso 2011). Much of the area surveyed was in seasonally flooded forest, which may partially explain the perceived lower abundance of ants and thin leaf litter in many areas. The forest between the RAP camp at RAP Site 1 (Upper Palumeu River) and the helipad became completely inundated on August 17. Ants and other organisms in the leaf litter are adapted to this environment and often must move when the floodwaters come. *Atta* sp. (leaf cutting ants) nests were observed only on higher terra firme ground.

Tropical lowland rainforests typically harbor a high diversity of ants. For example, Longino et al. (2002) found over 450 ant species in an area of approximately 1500 ha in Costa Rica, and LaPolla et al. (2007) reported 230 species from eight sites in Guyana. A RAP survey in Papua New Guinea (Lucky et al. 2011) reported 177 ant species from the lowland site (500 m). More studies of ant diversity throughout Suriname are needed to estimate the country's ant diversity, and thereby provide important baseline data for conservation and management of Suriname's biodiversity.

While in-depth analysis cannot be done until all the ant samples have been processed, these preliminary results indicate that Southeastern Suriname has high ant diversity. Data from winkler transects sampled at eight sites in Guyana (LaPolla et al. 2007) reveal comparable levels of ant species richness per transect. The winkler transects done in Guyana included 20 samples each while those from this RAP survey included 10 samples each. Thus two transects from this survey would roughly equal the sampling effort of one transect in Guyana. Table 7.1 shows the number of ant species recorded in each of the Winkler transects in this RAP survey and in Guyana at comparable elevations.

Table 7.1. Number of ant species recorded in per Winkler transects during this RAP survey of Southeastern Suriname (this RAP survey) and from Guyana (LaPolla et al. 2007).

Site	Elevation	Transect #	# samples per transect	# ant species
RAP Site 1, SE Suriname	277 m	1	10	27
RAP Site 1, SE Suriname	277 m	4	10	22
RAP Site 2, SE Suriname	800 m	5	20	16
RAP Site 4, SE Suriname	200 m	6	10	20
RAP Site 4, SE Suriname	200 m	8	10	34
RAP Site 4, SE Suriname	200 m	9	10	38
Kanuku Mountains, Guyana	224 m	1	20	55
Base Camp, Guyana	732 m	1	20	63
Dicymbe Camp, Guyana	717 m	1	20	38

Likewise, further analyses are needed to determine if there are differences between the ant species composition of the three RAP sites sampled in Southeastern Suriname, and also between Southeastern Suriname and other sites within the Guiana Shield. However, the preliminary morphospecies data for the six winkler transects sorted suggest that there may be some differences in species composition between the sites (see Appendix 7.1). Many of the leaf litter ant morphospecies identified so far (collected in Winkler transects) were found at only one of the RAP sampling sites. RAP Sites 1 and 3 were sampled for an equivalent amount of time (5 and 6 days respectively) so further comparisons can be made between the two sites.

Altitudinal differences in ant species richness and composition have been well documented in many tropical regions of the world with higher richness at lower elevations (Johnson and Ward 2002, Lessard et al. 2007). Thus it may be that the Grensgebergte site (RAP Site 2, 800 m) has lower ant richness than the two other sites. However, this difference is more likely due to the almost constant rainy conditions during sampling at that site and to the short duration of sampling there (1 day). The site was overcast with clouds during most of the survey. The winkler transect was collected during rain and thus the leaf litter was very wet and sticky. Furthermore, the leaf litter sample had to be taken to RAP Site 1 to be hung in the winkler sacks, but RAP Camp 1 flooded at that time and thus the sample was hung two days later, which likely affected the survival of the ants in the sample.

Ants play many critical roles in the functioning of the tropical terrestrial ecosystem, including dispersing seeds, tending mutualistic Homoptera, defending plants, preying on other invertebrates and small vertebrates, and modifying the soil by adding nutrients and aeration (Philpott et al. 2010). Another critical function provided by ants is that of scavenging (see page 27); ants are often the first animals to arrive upon a dead animal and start the decomposition process. Ants are particularly important to plants since they move soil along the soil profile through the formation of their mounds and tunnels, which directly and indirectly affects the energy flow, habitats, and resources for other organisms (Folgarait 1998). Thus ants are important to study and to include in conservation planning.

ANT SPECIES OF NOTE

Several ant species in Southeastern Suriname are common and conspicuous and have interesting life histories and behaviors. These ant species can thus serve to highlight the key roles that ants play in the ecosystem.

Gigantiops destructor—the Jumping Ant—is a large black ant common on the forest floor in the Werehpai area. These ants have extremely large eyes with which to see and avoid their predators and their prey. They move very quickly and actually jump around on the leaf litter, which is unusual for an ant. Despite its name—*destructor*—these ants are timid, so you have to sneak up on them carefully. They do not bite or sting but defend themselves by spraying formic acid from their gaster. These ants forage for small invertebrates in the leaf litter and are often found nesting near *Paraponera clavata* nests, possibly to benefit from the aggressive defense of the larger ants.

Daceton armigerum—the Canopy Ant—is a beautiful golden-colored ant that lives high in the canopy of trees. They have large heads with strong muscles that power their sharp mandibles. Their eyes are under their head so that they can see below them as they walk along branches in the treetops. Another key to their success in the canopy is that their claws are very clingy and can keep a tight hold on branches and tree trunks.

Cephalotes atratus—the Turtle Ant, or Gliding Ant, lives high up in the tree canopy. With its flattened body and large turtle-shaped head, it lives within rotting twigs and branches and blocks the entrance to its nest with its head. Living so high in the canopy, these ants face the threat of falling out of their tree into the terrestrial territories of other, more ferocious ants. Thus they have evolved a way to avoid falling to the forest floor. If they fall from their tree, these ants stretch out their bodies and legs to glide (Yanoviak 2005). They can detect the tree trunk by the relative brightness against the dark greenery and twist in the air to point their abdomen toward their host tree, making a safe landing back home.

Eciton burchellii—the Army Ant—has very large colonies with millions of workers that move through the forest in a swarm raid, capturing everything in their path. These ants do not have a permanent nest but have a "bivouac"—a temporary nest site consisting of a giant ball of ants, usually found under a rotting log or in the hollow of a tree. These ants sting and bite and are very aggressive, even to humans, so one needs to watch where they step around these ants. It is very interesting to watch an army ant swarm since many other creatures can be seen jumping and running to get out of the path of the ants, and some specialized antbirds follow the swarm to catch these invertebrates for their meal. The soldiers of *E. burchellii* have very long mandibles that are used to suture wounds by some indigenous peoples. In addition to their swarms for catching food, these ants are also often seen moving their colony to a new bivouac (which is necessary when they run out of food in an area), carrying their larvae and pupae slung under their bodies.

***Odontomachus* spp.**—Trap-Jaw Ants—are large ants common on the forest floor (see page 27). These ants hold the world record for the fastest reflex in the animal kingdom. They forage by walking around with their mandibles (jaws) wide open. They have small trigger hairs between the mandibles that detect prey items (such as small invertebrates) and trigger the mandibles to snap shut very quickly to capture the prey. These ants often nest in the leaf litter trapped in small palm trees, in the terrestrial leaf litter, or in the soil. They are long, sleek, elegant ants, but have a nasty sting, so care must be taken to avoid touching them.

Paraponera clavata—the Bullet Ant or Congo Ant—is famous for its very powerful and painful sting. It is one of the world's largest ant species and is common in Neotropical lowland rainforests. These ants nest in the ground at the base of trees but forage up in the tree-tops on nectar and invertebrates. While they forage solitarily, they often have a relay of ants for passing large nectar droplets from the treetops to the nest, from one ant to another. These ants are one of the few ant species that make sound to communicate with one another. They can "stridulate" by rubbing their legs along their thorax to make a high-pitched squeaky sound.

***Atta* sp.**—the Leaf-cutting Ant—is well known for its unique and fascinating agricultural lifestyle. *Atta* are fungus-growers—the workers cut pieces of leaves from a wide variety of trees to bring back to their nest where the leaves are chewed up by smaller workers and inserted into a large fungus garden, which the ants tend and cultivate. The ants do not feed on the leaves. Instead, they feed the fruiting bodies of the fungus to their larvae. Their nests are very large with many large underground chambers. It is fun to watch the workers cutting leaves and carrying them over their head back to the colony. *Atta* are parasitized by tiny phorid flies, which lay their eggs on the ants. When a fly larvae hatches, it burrows into an ant's head and develops inside, thereby killing the ant. Small *Atta* workers are often seen hitching a ride on the leaf carried by a larger worker- it is thought that these small ants serve to ward off attacking phorid flies.

***Pseudomyrmex* spp.**—the Tree-dwelling Ants. Many species live in the rotting, hollow twigs and branches up in the trees. They often fall from the trees, landing on the top of tents and even on your shirt, especially after a wind blows through the forest. Some species are specialized, obligate inhabitants of ant-plants, which provide a hollow cavity and sometimes food bodies or nectar for the ants. In exchange, the ants protect the plant by capturing and eating herbivorous insects that may eat the plant. These ants have large eyes and very long, slender bodies (their body form is distinctive) and a painful sting, so it's best to take care when observing them.

CONSERVATION DISCUSSION AND RECOMMENDATIONS

The ant data from this RAP survey are part of an ongoing program of the "Ants of the Guiana Shield" led by Dr. Ted Schultz of the Smithsonian's National Museum of Natural History in Washington, D.C. and collaborators. These data will be combined with the winkler data collected by J. LaPolla and colleagues in Guyana (LaPolla et al. 2007), data from previous RAP surveys, and future surveys in the Guiana Shield to determine hotspots of ant diversity and endemism in the Guiana Shield to guide conservation priorities. The data will also be used to select indicator groups that can be used to more quickly assess the status of the ant community and the ecosystem.

Data on ants and other invertebrates are important since these groups may be able to illustrate differences between habitats within the Guiana Shield that larger animals with wide geographical ranges do not discern. This will aid in identifying important areas of the Guiana Shield for conservation. More data should be collected on ants and other invertebrates for the Guiana Shield in order to determine these patterns.

Like many tropical taxa, many ant species and populations face a range of threats. The most immediate and widespread threat comes from the loss, disturbance, or alteration of habitat. Fragmentation studies have revealed that ant species richness and genetic diversity can be affected even in large forest patches of 40 km^2 (Brühl et al. 2003, Bickel et al. 2006). Nomadic ant species such as army ants need large expanses of habitat to find enough food to feed their exceptionally large colonies (Gotwald 1995). Likewise, deforestation and forest fragmentation can cause local extinctions of the neotropical swarm-raiding army ant *Eciton burchellii* and other army ants (Boswell et al. 1998, Kumar and O'Donnell 2009).

Global climate change is likely already affecting the distribution of many ant species. For example, Colwell et al. (2008) predict that as many as 80% of the ant species of a lowland rainforest could decline or disappear from the lowlands due to upslope range shifts and lowland extinctions (biotic attrition) resulting from the increased temperature of climate change.

Solenopsis geminata is native to South American rainforests but can become a destructive pest when it spreads into disturbed areas or is introduced to other parts of the world. This species was present in disturbed areas in the villages and could become more widespread in the forest if it moves in along trails. This species often invades areas that have been disturbed so their absence is a good sign of a healthy ant fauna and ecosystem. It is recommended to survey and monitor the presence of this species on the trail to Kasikasima to avoid spread of this species by humans.

Given that ants are highly conspicuous and abundant in Southeastern Suriname they should be a key component of nature walks and eco-tourism visits in the region. Several ant species are large enough to attract the attention and admiration of tourists. These ant species have fascinating life histories and behaviors that give them "personalities" which tourists will find fascinating.

Many ant species require closed canopy forest to maintain the appropriate microclimate they need to survive. These species are found only at pristine sites. Preliminary indications of the ant fauna at all three sites indicate the presence of many forest species among the ant fauna. A full analysis of the ant species, once identified, will reveal whether any ant species are of conservation concern and also how some of the ant species can serve as indicators of the health of the ecosystem.

Southeastern Suriname is one of the last extensive pristine rainforests of the world, containing high and unique biodiversity. This region should be protected from fragmentation by development such as roads and hydropower projects. Likewise, mining and other extractive industries should also be prohibited in the region to avoid impacts on the forests, its species, and the freshwater resources of the region.

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Appendix 7.1. Ants collected during the 2012 RAP survey of Southeastern Suriname. W=winker leaf litter transect, H=hand collecting

			Upper Palumeu (270 m)	Grensgebergte (800 m)	Kasikasima (200 m)
Subfamily	Genus	Species	5 days sampling, 2 winkler transects	1 day sampling, 2 winkler transects*	6 days sampling, 3 winkler transects
Amblyoponinae	*Amblyopone*	sp. 1			W
Amblyoponinae	*Amblyopone*	sp. 2			W
Dolichoderinae	*Azteca*	sp. 1		H	
Dolichoderinae	*Azteca*	sp. 2	H		
Dolichoderinae	*Dolichoderus*	sp. 1	H	H	
Dolichoderinae	*Dolichoderus*	sp. 2	H		
Dolichoderinae	*Dolichoderus*	sp. 3			W
Ecitoninae	*Eciton*	sp. 1	H		H
Ecitoninae	*Eciton*	sp. 2	H		H
Ectatomminae	*Ectatomma*	*ruidum*			W
Ectatomminae	*Ectatomma*	sp. 1	H		
Ectatomminae	*Gnamptogenys*	cf. *regularis*			W
Ectatomminae	*Gnamptogenys*	sp. 1		W	
Formicinae	*Acropyga*	sp. 1	W		
Formicinae	*Camponotus*	sp. 1			W
Formicinae	*Camponotus*	sp. 2	H	H	
Formicinae	*Camponotus*	sp. 3	H		
Formicinae	*Camponotus*	sp. 4	H		
Formicinae	*Gigantiops*	*destructor*	H		H
Formicinae	*Nylanderia*	sp. 1		W	W
Formicinae	*Nylanderia*	sp. 2			W
Formicinae	*Nylanderia*	sp. 3		W	
Formicinae	*Nylanderia*	sp. 4		H	
Formicinae	*Nylanderia*	sp. 5	W		W
Formicinae	*Nylanderia*	sp. 6	W		
Myrmicinae	*Allomerus*	sp. 1	H		H
Myrmicinae	*Apterostigma*	sp. 1			W
Myrmicinae	*Apterostigma*	sp. 2	W		
Myrmicinae	*Apterostigma*	sp. 3			W
Myrmicinae	*Apterostigma*	sp. 4	W		
Myrmicinae	*Apterostigma*	sp. 5	W		
Myrmicinae	*Atta*	sp. 1	H		H
Myrmicinae	*Carebara*	*inca*			W
Myrmicinae	*Carebara*	*brevipilosa*			W
Myrmicinae	*Cephalotes*	sp. 1	H		
Myrmicinae	*Crematogaster*	sp. 1			W
Myrmicinae	*Crematogaster*	sp. 2			W
Myrmicinae	*Crematogaster*	sp. 3		W	
Myrmicinae	*Crematogaster*	sp. 4	W		W
Myrmicinae	*Crematogaster*	sp.5	H		

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Appendix 7.1. continued

Subfamily	Genus	Species	Upper Palumeu (270 m) 5 days sampling, 2 winkler transects	Grensgebergte (800 m) 1 day sampling, 2 winkler transects*	Kasikasima (200 m) 6 days sampling, 3 winkler transects
Myrmicinae	*Crematogaster*	sp. 6	H		
Myrmicinae	*Crematogaster*	sp. 7			H
Myrmicinae	*Crematogaster*	sp.8	W		W
Myrmicinae	*Cyphomyrmex*	sp. 1	W		W
Myrmicinae	*Cyphomyrmex*	sp. 2			W
Myrmicinae	*Cyphomyrmex*	sp. 3			W
Myrmicinae	*Daceton*	*armigerum*	H		H
Myrmicinae	*Megalomyrmex*	sp. 1			W
Myrmicinae	*Megalomyrmex*	sp. 2			W
Myrmicinae	*Myrmicocrypta*	*longinoda*			W
Myrmicinae	*Myrmicocrypta*	*buenzlii*	W		
Myrmicinae	*Ochetomyrmex*	*semipolitus*		W	W
Myrmicinae	*Octostruma*	cf. *balzani*		W	W
Myrmicinae	*Octostruma*	sp. 1			W
Myrmicinae	*Pheidole*	sp. 1			W
Myrmicinae	*Pheidole*	sp. 2			W
Myrmicinae	*Pheidole*	sp. 3			W
Myrmicinae	*Pheidole*	sp. 4			W
Myrmicinae	*Pheidole*	sp. 5			W
Myrmicinae	*Pheidole*	sp. 6	W		W
Myrmicinae	*Pheidole*	sp. 7			W
Myrmicinae	*Pheidole*	sp. 8	W		W
Myrmicinae	*Pheidole*	sp. 9			W
Myrmicinae	*Pheidole*	sp. 10			W
Myrmicinae	*Pheidole*	sp. 11			W
Myrmicinae	*Pheidole*	sp. 12			W
Myrmicinae	*Pheidole*	sp. 13	H		W
Myrmicinae	*Pheidole*	sp. 14			W
Myrmicinae	*Pheidole*	sp. 15	W		W
Myrmicinae	*Pheidole*	sp. 16			W
Myrmicinae	*Pheidole*	sp. 17		W	
Myrmicinae	*Pheidole*	sp. 18	W		
Myrmicinae	*Pheidole*	sp. 19		W	
Myrmicinae	*Pheidole*	sp. 20	W		
Myrmicinae	*Pheidole*	sp. 21	W		W
Myrmicinae	*Pheidole*	sp. 22	H		
Myrmicinae	*Pheidole*	sp. 23	W		
Myrmicinae	*Pheidole*	sp. 24			W
Myrmicinae	*Pheidole*	sp. 25	W		

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Appendix 7.1. continued

Subfamily	Genus	Species	Upper Palumeu (270 m)	Grensgebergte (800 m)	Kasikasima (200 m)
			5 days sampling, 2 winkler transects	1 day sampling, 2 winkler transects*	6 days sampling, 3 winkler transects
Myrmicinae	*Pheidole*	sp. 26	W		
Myrmicinae	*Pheidole*	sp. 27			W
Myrmicinae	*Pheidole*	sp. 28		H	
Myrmicinae	*Pheidole*	sp. 29	H		
Myrmicinae	*Pheidole*	sp. 30	W		
Myrmicinae	*Pheidole*	sp. 31	W		W
Myrmicinae	*Pheidole*	sp. 32 (cf. *minutula)*	H		H
Myrmicinae	*Pheidole*	sp. 33	W		
Myrmicinae	*Pheidole*	sp. 34	W		
Myrmicinae	*Pheidole*	sp. 35	W		
Myrmicinae	*Pheidole*	sp. 36	W		
Myrmicinae	*Pheidole*	sp. 37	W		
Myrmicinae	*Rogeria*	sp. 1			W
Myrmicinae	*Rogeria*	sp. 2	W		
Myrmicinae	*Solenopsis*	sp. 1	W		W
Myrmicinae	*Solenopsis*	sp. 2			W
Myrmicinae	*Solenopsis*	sp. 3	W		W
Myrmicinae	*Solenopsis*	sp. 4	W	W	W
Myrmicinae	*Solenopsis*	sp. 5			W
Myrmicinae	*Solenopsis*	sp. 6	W		W
Myrmicinae	*Solenopsis*	sp. 7			W
Myrmicinae	*Solenopsis*	sp. 8	W		W
Myrmicinae	*Solenopsis*	sp. 9		W	
Myrmicinae	*Solenopsis*	sp. 10	W	W	
Myrmicinae	*Solenopsis*	sp. 11 (fire ant)		H	
Myrmicinae	*Solenopsis*	sp. 12 (fire ant)	H		
Myrmicinae	*Strumigenys*	cf. *subdentata*	W		W
Myrmicinae	*Strumigenys*	*denticulata*			W
Myrmicinae	*Strumigenys*	*perparva*			W
Myrmicinae	*Strumigenys*	*beebei*	W		W
Myrmicinae	*Strumigenys*	sp. 1	W		
Myrmicinae	*Trachymyrmex*	*ruthae*			W
Myrmicinae	*Trachymyrmex*	sp. 1	W		W
Myrmicinae	*Wasmannia*	*auropunctata*	W	W	W
Paraponerinae	*Paraponera*	*clavata*	H		H
Ponerinae	*Anochetus*	*horridus*	W		
Ponerinae	*Anochetus*	sp. 1			W
Ponerinae	*Anochetus*	sp. 2			W
Ponerinae	*Anochetus*	sp. 3			W

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Appendix 7.1. continued

Subfamily	Genus	Species	Upper Palumeu (270 m)	Grensgebergte (800 m)	Kasikasima (200 m)
			5 days sampling, 2 winkler transects	1 day sampling, 2 winkler transects*	6 days sampling, 3 winkler transects
Ponerinae	*Hypoponera*	sp. 1		W	W
Ponerinae	*Hypoponera*	sp. 2			W
Ponerinae	*Hypoponera*	sp. 3			W
Ponerinae	*Hypoponera*	sp. 4	W		W
Ponerinae	*Hypoponera*	sp. 5			W
Ponerinae	*Hypoponera*	sp. 6			W
Ponerinae	*Hypoponera*	sp. 7			W
Ponerinae	*Hypoponera*	sp. 8	W		W
Ponerinae	*Hypoponera*	sp. 9		W	
Ponerinae	*Hypoponera*	sp. 10	W		W
Ponerinae	*Hypoponera*	sp. 11	W		
Ponerinae	*Hypoponera*	sp. 12	W		
Ponerinae	*Odontomachus*	cf. *bauri*			W
Ponerinae	*Odontomachus*	sp. 1			W
Ponerinae	*Odontomachus*	sp. 2		W, H	
Ponerinae	*Odontomachus*	sp. 3	H		
Ponerinae	*Pachycondyla*	sp. 1			W
Ponerinae	*Pachycondyla*	sp. 2			W
Ponerinae	*Pachycondyla*	sp. 3			W
Ponerinae	*Pachycondyla*	sp. 4			W
Ponerinae	*Pachycondyla*	sp. 5		W	
Ponerinae	*Pachycondyla*	sp. 6	H		W
Ponerinae	*Pachycondyla*	sp. 7	W		
Ponerinae	*Pachycondyla*	sp. 8	W		
Ponerinae	*Pachycondyla*	sp. 9	W		
Ponerinae	*Pachycondyla*	sp. 10		H	
Ponerinae	*Pachycondyla*	sp. 11		H	
Proceratiinae	*Discothyrea*	cf. *denticulata*			W
Pseudomyrmecinae	*Pseudomyrmex*	sp. 1		H	
Pseudomyrmecinae	*Pseudomyrmex*	sp. 2			H
Pseudomyrmecinae	*Pseudomyrmex*	sp. 3	W		

Number of Species collected at each RAP site	72	25	92
Number of Species in Winkler Samples	48	16	82
Number of Species from Hand Collecting (limited)	24	10	10 (4 from ant plants)

Total Number of Species collected at all 3 RAP sites	149		
Total Number of Species in Winkler Samples	118		
Total Number of Species from Hand Collecting	34		

*rainy conditions likely affected results of winkler transects (see text)