



## **A Herpetofaunal Survey of the Grensgebergte and Kasikasima Regions, Suriname**

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## Chapter 9

### A herpetofaunal survey of the Grensgebergte and Kasikasima regions, Suriname

Stuart Nielsen, Rawien Jairam, Paul Ouboter and Brice Noonan

#### SUMMARY

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We conducted a herpetofaunal inventory at four sites in Southeastern Suriname from March 8–28<sup>th</sup> 2012, and recorded 47 species of amphibians and 42 species of reptiles. These numbers are lower than other areas within the Guiana Shield that are better sampled (e.g. Iwokrama, Guyana; Nouragues, French Guiana), but are relatively high when compared with other sites sampled over the same time period (e.g., recent RAP surveys in Suriname). Seven (six frogs and one snake) of the total 89 species encountered could not be assigned to any nominal species. These unidentified taxa may represent novel species, yet require validating genetic and morphological data before formal diagnoses can be made. A number of records represent range expansions for taxa within the Guiana Shield (e.g. *Rhinatrema bivittatum*, *Alopoglossus buckleyi*). Additionally, a teiid lizard (*Cercosaura argulus*) is recorded for just the second time in Suriname. Encountering >80 total species (including 19 snake species) is evidence of a healthy, diverse and seemingly pristine forest ecosystem.

#### INTRODUCTION

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Reptiles and amphibians form a prominent, speciose component of tropical forests and many aspects of their biology (e.g. small body size in concert with large population sizes, intermediate roles in food webs, strict micro-habitat requirements, etc.) contribute to their value as a focal group for biotic surveys. Amphibians are very good indicators of disturbance (Stuart et al. 2004) because they are sensitive to changes in microclimate, particularly as most possess a biphasic lifestyle (i.e. two distinct life stages, larval and adult) heavily dependent on high quality water resources. Amphibians are well suited for rapid assessments as they are often easy to sample; but when that is not the case, their species-specific diagnostic calls aid passive identification, particularly for hard to collect species (e.g. canopy dwellers; Marty and Gaucher 2000). Biotic surveys of amphibians in particular are imperative as widespread and poorly understood disease

vectors (e.g. chytrid fungus and ranavirus) are causing worldwide declines, even in seemingly pristine areas (Lips 1998). Lizards are more diverse in primary forest, compared to secondary or modified forest (i.e. plantation; Gardner et al. 2007), suggesting they are also sensitive to changes in microhabitat. Presence of turtles and tortoises can also be a good indicator of hunting pressure as they are often targeted for subsistence hunting by local Amerindians (Peres 2001). Although one of the smallest South American countries, Suriname possesses a wide variety of amphibians (>100 species according to Señaris and MacCullough 2005; 107 species according to Ouboter and Jairam 2012) and reptiles (>170 species; Ávila Pires 2005). While very few of these species are endemic to Suriname itself, most are endemic to the larger Guiana Shield or the more inclusive Amazonian Subregion. The goal of this RAP survey in southern Suriname was to provide baseline information on the diversity and abundance of amphibians and reptiles for the areas in and around the Grensgebergte and Kasikasima Mountains. We sampled four sites incorporating both upland and lowland habitat, from seasonally flooded forest to human modified secondary forest to exposed granite outcrops. We also provide basic statistics comparing our findings with other RAP surveys in Suriname, as well as other well-studied regions in the Guianas (e.g. Iwokrama, Guyana; Nouragues, French Guiana). Finally, we discuss conservation recommendations for the region.

#### METHODS

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Of the four main RAP study sites, herpetological collections were made in only three (Upper Palumeu River—Site 1 [9 days], Grensgebergte Mountains—Site 2 [2 days], and Kasikasima—Site 4 [6 days]; the unsampled site (Site 3) was visited only by the aquatic team while they were heading downriver between Sites 1 to 4). In addition, some species were encountered at the METS resort in Palumeu (Site 5 [1 day]), a subset of which was encountered at other sites.

In order to encounter as many species as possible, opportunistic encounters and captures were made primarily via

active searching. We walked pre-established trails through forest, in forest clearings, and on stream banks. Surveys were conducted at various times of the day (although focusing on main activity periods at dusk and dawn) and early evening to mid-night. Passive frog call surveys were performed at night and if the calling male was suspected of being near the ground, efforts were made to locate it. Special attention was taken to search in a variety of habitats, particularly in streams/creeks and under logs/fallen bark—areas known to harbor rarely seen species or those with strict habitat requirements, as well as after inclement weather (i.e. heavy rains). We turned stones and logs, opened rotting logs, and raked litter to reveal hidden animals. At times, we deviated off of the main trail/transect to search adjacent habitat or features (e.g. fallen log, swampy pool) we deemed of interest or where animal activity was observed. Opportunistic surveys are effective for collecting as many species as possible in a short time period and sampling total species richness (Donnelly et al. 2004). Unfortunately, care was not taken to painstakingly record each individual of each species encountered, so only qualitative assessments of species relative abundance are provided (Appendix 9.1).

When possible and/or necessary, animals were caught either by hand, noose, net or rubber band, and preliminary identifications were made. Additionally, a portion of the total catch was euthanized (via subcutaneous injection of dilute Euthanaze®), fixed in 10% formalin solution, and then stored in 70% ethanol as museum voucher specimens (stored at the National Zoological Collection of Suriname, Anton de Kom, Universiteit van Suriname). These specimens were given unique field identification tags and many have representative life photographs (taken by S. Nielsen, P. Naskrecki and/or T. Larsen). R. Jairam later performed more rigorous, museum-based, morphological identification to verify species IDs. Samples of liver/muscle tissue for DNA analyses were extracted from voucher specimens (before formalin fixation) and stored in 95% ethanol (stored in the University of Mississippi frozen tissue collection).

We compared data on amphibian and reptile surveys from five sites in the Guiana Shield (Nouragues and Arataya, French Guiana—Born and Gaucher 2001; Petit Saut, French Guiana—Duellman 1997; Piste Ste. Elie, French Guiana—Born and Gaucher 2001; and Iwokrama, Guyana—Donnelly et al. 2005) originally assembled by Watling and Ngadino (2007), as well as three additional sites from two previous RAP surveys in Suriname (RAP 43, Watling and Ngadino 2007; RAP 63, Ouboter et al. 2011). Although undetected and/or undescribed species certainly exist throughout the Guiana Shield, the non-RAP surveys—which occurred over multiple seasons—are better sampled compared to RAP surveys (which generally span just a number of days), therefore, direct comparisons must be viewed with some uncertainty. Additionally, the geological complexity of the Guiana Shield makes comparisons of species communities/composition between high elevation inselbergs and low elevation seasonally flooded forests

difficult, as different habitats support different species and different overall levels of species richness may be expected may provide counterintuitive arguments. Instead, we provide these data as a benchmark with which to compare this current study.

## RESULTS AND DISCUSSION

We observed a total of 89 species of reptiles and amphibians during this survey (Table 9.1). While most of the species are confidently sorted to known species, seven (six frogs and one snake) of the total species encountered could not be assigned to any nominal species and 23 are listed as *cf.*, meaning only informal identifications are possible without more comparative material and rigorous morphological and/or molecular examination. Appendix 9.1 lists the species we recorded and a qualitative measure of abundance for each species for the four collection localities. Upper Palumeu River (Site 1) provided the most diverse list of species (56 species, 63% of total—30 amphibians and 26 reptiles; of which, 12 amphibians and 16 reptiles were only encountered at Site 1; see Table 9.2). This result may partially be explained by the amount of time spent collecting in that locality versus the other sites (8 days total versus the 2<sup>nd</sup> longest stay—6 days [Site 4]), thus affording us greater opportunity to encounter a wider variety of species. However, some other subtle

**Table 9.1.** Herpetofaunal richness at 12 sites in the Guiana Shield, including data from the two previous RAP surveys to Nassau/Lely Mountains and Kwamalasamutu. In each column, data are presented as raw species number/percentage of total herpetofauna.

Site	Amphibians	Reptiles	Total
Iwokrama	37/0.34	71/0.66	108
Nourague	51/0.47	58/0.53	109
Arataya	62/0.49	65/0.51	127
Piste Ste. Elie	33/0.38	53/0.62	86
Brownsberg	64/0.44	80/0.56	144
<i>Mean=</i>	<i>49</i>	<i>65</i>	<i>115</i>
Nassau	16/0.55	13/0.45	29
Lely	20/0.55	16/0.45	36
Kwamalasamutu	42/0.54	36/0.46	78
<i>Mean=</i>	<i>26</i>	<i>22</i>	<i>48</i>
Upper Palumeu	30/0.54	26/0.46	56
Grensgebergte	6/0.46	7/0.54	13
Kasikasima	24/0.53	21/0.47	45
Palumeu	13/0.72	5/0.28	18
<i>Mean=</i>	<i>18</i>	<i>15</i>	<i>33</i>
Total species recorded on this RAP	47/0.53	42/0.47	89

**Table 9.2.** Breakdown of reptile and amphibian species encountered at each locality and the site-specific percentage of the total species recorded, as well as how unique each site was for both taxonomic groups.

Collection Site	1. Upper Pal.	2. Grensgebergte	4. Kasikasima	5. Palumeu
# of reptiles and amphibian species encountered (% of total sp. encountered [89 spp.])	56 (63%)	13 (15%)	45 (51%)	18 (20%)
# of amphibian species encountered (% of total amphibians [47 spp.])	30 (64%)	6 (13%)	24 (51%)	13 (28%)
# of amphib. species encountered that were unique to locality (% of spp. encountered for each site that were unique)	12 (40%)	1 (16%)	6 (25%)	7 (53%)
# of reptile species encountered (% of total reptile species encountered [42 spp.])	26 (62%)	7 (17%)	21 (50%)	5 (12%)
# of reptile species encountered that were unique (% of spp. encountered for each site that were unique)	16 (62%)	3 (43%)	10 (48%)	2 (40%)

vegetation or habitat differences might also have played a role (e.g. presence of seasonally flooded lowland forest in Site 1). Grensgebergte Mountain (Site 2: 13 species, 15% of total species encountered; 6 amphibians and 7 reptiles, of which 1 amphibian and 3 reptiles were only encountered at Site 2) was by no means speciose, but provided two unique snake records: *Dipsas copei* and the only sighting of *Bothrops atrox*. Kasikasima (Site 4) was the second most diverse site (45 species, 51% of total—24 amphibians and 21 reptiles; of which, 6 amphibians and 10 reptiles were encountered only at Site 4). Palumeu (Site 5) was not particularly diverse (18 species, 20% of total—13 amphibians and 5 reptiles; of which 7 amphibians and 2 reptiles were encountered only at Site 5), although we suspect that the surrounding area could potentially harbor other species. As the expedition was not focused on this area, the species encountered were all observed/collected within one 24-hr. period (including one rainy night) before continuing on to Site 1.

When the results for all localities are combined, our findings are comparable to those of RAP 63 of the Kwamalasa-mutu region of southwestern Suriname (Ouboter et al. 2011; see Table 9.1), which recorded 78 species of amphibians and reptiles (42 and 36, respectively), and is from a geographically close region. However, when each site is analyzed separately, our numbers are much more similar to those found by Watling and Ngadino (2007; RAP 43) in eastern Suriname, which also spent a similar amount of time sampling each of their two sites (~5 days). RAP 43 focused solely on areas of intermediate/high elevation, which harbored fewer (albeit more highland endemic) species. All recent RAP surveys, including the present study, generally recorded fewer species than other areas within the Guiana Shield (see Table 9.2), which can likely be explained by total days of search effort.

A number of species (24 of 89 total sp.) were recorded at the two sites that received the greater proportion of our search effort (Sites 1 & 4). Of the species that were recorded at just one site (45 spp.), most had congeneric relatives present at other sites, possibly/effectively filling similar ecological niche space (e.g. the snake *Atractus torquatus* was present only at Site 1 and *A. flammigerus* only at Site 4; however, one could argue that these two species occupy similar niches

in the ecosystem). Albeit an extraneous assumption, there remains the possibility that given more search effort, other congeneric (and potentially ecologically similar) species could also be found (or that competitive niche exclusion restricts them to microhabitats that we failed to survey adequately). This pattern is also seen when comparing our results to the two other recent RAP surveys (RAPs 43 & 63); of the 89 species recorded in the present study, RAP 43 (49 spp. total) recorded 23 (26%) and RAP 63 (78 spp. total) recorded 44 (49%) of the same species (see Appendix 9.1 and Table 9.1). However, in both of these two related surveys, congeneric species (which have the potential to be ecologically similar) were collected (see species marked as “N\*” in Appendix 9.1). Thus, at a higher taxonomic scale, our results are similar (see further description below). A number of species that were recorded by these previous RAPs were noticeably absent from our collection efforts (e.g. frogs such as the microhylid, *Chiasmocleis shudikarensis*, the ceratophryid, *Ceratophrys cornuta*, and the pipid, *Pipa aspera*), although these species are generally less likely to be sampled due to their cryptic, semi-fossorial, and/or fully aquatic lifestyles.

The ~104 currently recognized amphibian species recognized in Suriname are representative of 38 genera in 13 families (Señaris and MacCullough 2005, Ouboter and Jairam 2012). Due to the “rapid,” abbreviated nature of RAP surveys, we were unlikely to encounter all the biodiversity a geographic area harbors (especially as some of Suriname’s ~104 amphibian species are restricted to coastal lowlands or other areas/habitat we were unlikely to survey in southern Suriname; see Ouboter and Jairam 2012). During the course of this RAP, we recorded ~47 species from 19 genera and 7 families (45%, 50%, and 54% of Suriname’s currently recognized totals, respectively). Considering the aforementioned shortcomings of this type of survey, capturing roughly 50% of the known amphibian biodiversity of Suriname is a positive result. By comparison, RAP 43 (36 spp. from 13 genera and 5 families) and RAP 63 (42 spp. from 19 genera and 10 families) each recorded approximately 35% and ~50–70% of the diversity, respectively.

Although we observed and/or collected a smaller percentage of the total reptile diversity of Suriname (~170 spp., 92 gen., 23 fam.), our results are roughly similar in pattern to those for amphibians outlined above. We collected 42 species from 37 genera and 17 families (25%, 40% and 74% of the Surinamese total, respectively). Similar to the above results, RAP 43 collected a smaller percentage of the total (17% of Suriname's total spp., 24% of gen., 48% of fam.), whereas RAP 63 had results similar to (albeit less than) the present study (21% of Suriname's total spp., 35% of gen., 65% of fam.). Why these results represent a larger proportion of the higher-level diversity than we recovered in amphibians is unknown, but could be representative of an underestimate of amphibian familial diversity.

Without further work, it is difficult to say whether we adequately surveyed the region in our limited time during this survey, but we did achieve comparable results to recent, previous RAP surveys. Although the number of 'new' or rare species we collected was comparatively low (and really awaits thorough taxonomic revision of a number of groups) the real value of this region was the great diversity of herpetofauna seen and/or collected in a short time. We propose that these results suggest that southern Suriname is a local hotspot for herpetofaunal richness and if conserved in this pristine/semi-pristine state, this region will remain a true preserve of biodiversity.

Below are brief accounts of some of the species/taxonomic groups we encountered that are of interest due to their conservation status, distribution, natural history or potential as a new species, etc.

### **Class Amphibia, Order Anura**

**Allophrynidae:** This family contains a single genus, *Allophryne*, and until this year was monotypic (Castroviejo-Fisher et al. 2012). The species we encountered, *A. ruthveni* is distributed throughout the Guiana Shield (GS; LaMarca et al. 2010). Numerous individuals were observed/captured at Site 1 that displayed a divergent color pattern when compared to "typical" *A. ruthveni*. As the recently described species from eastern Peru, *A. resplendens*, is diagnosed from *A. ruthveni* primarily on dorsal color pattern and mitochondrial DNA sequence divergence (Castroviejo-Fisher et al. 2012), we initially hoped we had found a third species for the genus. However, preliminary genetic data (unpub. 12S data) does not provide resounding evidence for elevating the Suriname population to a separate species. Further work is underway.

**Dendrobatidae:** We encountered two subfamilies within this super group of dart-poison frogs, Dendrobatinae and Aromobatinae. The latter contains >100 species in five genera, whereas Dendrobatinae contains 12 genera and >170 species. These frogs are terrestrial, largely diurnal, and display a unique reproductive mode exhibiting parental care.

Within Aromobatinae, we encountered four 'species' representative of two genera, *Allobates* and *Anomaloglossus*. *Allobates femoralis* is widely distributed across the

Amazo-Guianan subregion (AGR; La Marca et al. 2010), whereas *Allobates granti* is distributed within a more limited area of the eastern GS (Kok 2008; Ouboter & Jairam 2012). Although neither species possessed particularly aberrant morphologies, Fouquet et al. (2012) has shown that there is considerable, geographically concordant genetic substructure across each species' respective range, potentially harboring complexes of cryptic species. As the taxonomic work is ongoing, it is difficult to accurately assess whether the populations sampled during this RAP survey are distinct from the larger Surinamese (or GS) groups delimited by Fouquet et al. (2012). *Anomaloglossus baeobatrachus* (IUCN Data Deficient) and *Anomaloglossus* sp. (see page 23) were abundant where they were found (Sites 1 and 4). Individuals of the latter found at the Kasikasima site possessed atypical (in comparison to *A. baeobatrachus*) dorsal color patterns (i.e. blotchy, not uniform). Similar to *Allobates*, Fouquet et al. (2012) has shown considerable, geographically concordant genetic divergence across these species' respective ranges, although it is currently unclear whether the *Anomaloglossus* "sp." referenced in that paper is the same taxon we encountered on this RAP. Unfortunately, at present we have been unsuccessful at obtaining informative DNA sequence information to compare to that of Fouquet et al. (2012), although work is ongoing.

Within Dendrobatinae, we encountered two species representative of two genera. Of the two species of *Ameregea* that occur in Suriname, we found just *A. trivitatta* (see page 29), which is widespread across the AGR, although absent from the eastern GS. Such a wide distribution could harbor cryptic species, as has been found in closely related species within the genus (see Brown and Twomey 2009). However, of the individuals we collected, there was no significant morphological divergence to suggest that scenario. We encountered this species in three of our four collection localities (all lowland), including the relatively altered forest surrounding Palumeu (Site 5), where they were quite common. We also encountered *Dendrobates tinctorius* (see page 29), which is found only within the GS, but is unique in possessing highly variable, geographically isolated color patterns. Although there is some taxonomic contention whether the different morphs should be treated as unique taxa, genetic data suggests the different color morphs (i.e. populations) are representative of *within* species variation only (Noonan and Gaucher 2006). This taxon was only observed at Sites 1 and 2 (including egg masses and tadpoles at Site 1), although two strikingly different color morphs were found at each locality. At the Grensgebergte Mtns. Site (2), L. Alonso and P. Naskrecki encountered a differently colored morphotype of *D. tinctorius* compared to the lowland coloration found near Site 1, although based solely on a partially out of focus photo voucher we believe it to represent the "common" color morph.

**Bufonidae:** This hyper-diverse, globally distributed family contains >35 genera with >500 described species, with a number of genera and species endemic to South

America. Although only seven species were encountered on this RAP, they were by far the most abundant amphibians at each of the lowland sites (Sites 1, 4 and 5). The genus *Amazophrynella* was recently separated from *Dendrobrynicus* (Fouquet et al. 2012a), and of the two described and one undescribed species, one—*A. minuta* (see page 29)—has a broad AGR distribution that includes Suriname. Although the common name—tree toads—suggests an arboreal existence, we encountered numerous individuals at Sites 1 and 4 during the day hopping around in the leaf litter. Although we are fairly certain of their taxonomic placement based on morphology, evidence suggests this taxon is actually a species group (Coloma et al. 2010; Fouquet et al. 2012a). Further taxonomic work is required, albeit beyond the scope of this report.

*Rhaebo guttatus* also has a widespread pan Amazo-Guianan distribution (Azevedo-Ramos et al. 2010). This prodigious species is terrestrial and nocturnal, and was common where it occurred (Sites 1 and 4). As it requires undisturbed primary forest, this species was absent from disturbed, human-modified areas (Site 5), where it was instead replaced by the more ecologically tolerant cane toad, *Rhinella marina* (e.g. observed around human habitation and in a maintained airstrip). Members of the genus *Rhinella* are generally nocturnal, explosive breeders, and representative species were found at all four sampled sites during this RAP survey. *Rhinella marina* has a large native distribution spanning from central South to southern North America, but is considered an invasive species in numerous other countries, notably Australia and the US (Solís et al. 2009). We also encountered at least three other species in this genus, *R. lescurei*, *R. margaritifera* and *R. martyi*. *Rhinella lescurei* and *R. martyi* are described species of the *R. margaritifera* species group (Fouquet et al. 2007), which is broadly distributed in primary rainforest across northern South America (Solís et al. 2009). We encountered a fourth form, *R. sp.*, that we believe could be an additional member of the *R. margaritifera* group. Unfortunately, many of the specimens we collected were juveniles, and the named species are quite similar morphologically, so accurate identification has proven difficult. Further work is required.

**Centrolenidae:** Members of this family are commonly called glass frogs, as their transparent venter makes visible their internal organs. They are nocturnal, colored in shades of neon green and are often found in overhanging vegetation along streams and rivers, although their coloration and behavior make them particularly difficult to locate. Suriname has at least five species of centrolenids (Ouboter and Jairam 2012). We collected just two specimens on this RAP survey, both tentatively identified as *Hyalinobatrachium cf. taylori*, which is widespread across the GS. Only one specimen was collected from each of the sites where they were present (Sites 1 and 4), although numerous males were heard calling at both places.

**Hylidae:** This mega-diverse family is composed of “true tree frogs and their allies” comprising 900+ species in 45+

genera that are distributed mainly in the New World (particularly South and Central America) as well as Australia. They are nocturnal, generally arboreal and display a variety of reproductive modes. There are ~40 species known from Suriname (Ouboter and Jairam 2012), however, just 15 were encountered on this RAP, representative of six genera. We collected six species of *Hypsiboas* treefrogs, including a putatively undescribed taxon, *H. sp.* “chocolate” (see page 23) and four species of *Scinax*, including a putatively undescribed taxon (see page 23) that we believe could represent a Surinamese population of a novel species proposed by Fouquet et al. (2007). The genus *Scinax* is in great need of revision and specimens we collected could represent novel species, but further evidence is required to better understand genetic patterns and species boundaries. These species were not particularly common, but representative hylids were present at each site—although not all species were present at each site. A single specimen of the species *Trachycephalus coriaceus* and two *Dendropsophus cf. brevifrons* specimens were recorded (one via cell phone camera photo). The former species has an interesting disjunct distribution with populations present in the eastern GS and southwestern Amazonia, but absent from northeastern Amazonia. Frogs from the genus *Osteocephalus* representing two species (*O. taurinus* and *O. lepriouri*) were some of the most commonly encountered vertebrates at Site 1, yet only a single individual of the latter was found at any of the other sites (Site 4). Lastly, we also recorded the charismatic tiger leg monkey frog species, *Phyllomedusa tomopterna* (see page 29) from Site 1. This species requires pristine forest habitat and is distributed widely across the AGR (La Marca et al. 2004).

**Leptodactylidae:** Colloquially known as southern frogs, this group is composed of 190 species in 13 genera, all of which are restricted to the New World. This group of frogs is diverse in body size (e.g. 26mm SVL in *Adenomera heyeri* vs. 185mm in *Leptodactylus pentadactylus*) and in ecology (e.g. *Lithodytes lineatus* is often associated with ant nests, whereas *Leptodactylus leptodactyloides* prefers open areas like savannahs and forest edges). We found up to 12 different species (two currently identified to “sp.”) from three genera, ~60% of Suriname’s total leptodactylid diversity. Members of this family were observed at all four sites, with the greatest diversity of species from Sites 1 and 5 (i.e. Upper Palumeu and Palumeu). Most of the species we encountered are assignable to the genus *Leptodactylus*, although we also collected two forms we cannot yet accurately identify: *Adenomera sp.* and *Leptodactylus sp.* With the exception of *L. longirostris* and *L. myersi* (which have a more restricted distribution in the GS), the species we encountered are all widely distributed across the AGR—and a few even extend into southern Central America. At site 2, *L. myersi* was the most abundant terrestrial vertebrate observed and it was quite easy to find juvenile frogs living in the moist spaces under nearly every granite exfoliation in the seeps on the exposed inselberg face.

**Craugastoridae:** This family contains the most speciose genus of vertebrates, *Pristimantis*, with over 400 species

(~5 in Suriname) of direct-developing frogs (i.e. lacks a free-living larval stage). Their deviation from the reproductive strategy norm, liberating them from semi-/permanent water sources, may be one reason for their widespread distribution and successful speciation in a variety of habitats. One described species was encountered (*Pristimantis chiastonotus*), which is distributed throughout the eastern GS. This species is found in leaf litter, generally at low altitudes (<700m asl), and it has been suggested that they are able to cope with some degree of habitat disturbance (Gaucher and Rodrigues 2004). We also collected individuals not immediately identifiable to a named species (which we are calling *Pristimantis* sp.) (see page 23). We found *Pristimantis* species at all four collection localities, including disturbed habitat (i.e. Palumeu) and in the Grensgebergte Mtns. (roughly 750m asl).

### **Class Amphibia, Order Gymnophiona**

**Rhinatreumatidae:** This family of caecilians (a fossorial group of primitive, limbless amphibians) is composed of two species-poor genera endemic to South America. Only one species was encountered on the RAP, *Rhinatrema bivittatum* (see page 28), which appears to be distributed across the northern Guiana Shield, from Guyana to Brazil (Gaucher et al. 2004). It was previously only known from the Brownsberg region of Suriname (Nussbaum and Hoogmoed 1979) and thus our record represents a significant southern range extension. Our local guides collected a single specimen while clearing the area of vegetation for the tent camp at Site 1.

### **Class Reptilia, Order Squamata**

**Gekkota:** This diverse lizard group has a near worldwide distribution as geckos are found on every continent but Antarctica. Representatives of three families (Sphaerodactylidae, Phyllodactylidae and Gekkonidae) were encountered during this RAP survey. All three families have representative species from the New and Old Worlds, as well as northern and southern hemispheres, although the history of occupation in the New World for sphaerodactylids and phyllodactylids is much older than for gekkonids. Gamble et al. (2011) found evidence to suggest that modern New World sphaerodactylids reached northern South America in the Cretaceous before the break-up of Gondwana (i.e. Gondwanan vicariance), and phyllodactylids arrived shortly thereafter (either via vicariance or dispersal), whereas geckos in the family Gekkonidae reached the New World much later (i.e. within the last 5-10 mil. yrs.) via long-distance, over-water dispersal. We only encountered one species of gekkonid on this RAP, *Hemidactylus mabouia*, which is native to Africa, although it can now be found throughout South and Central America and the Caribbean (via either natural or anthropogenic forces of dispersal). This species was common on the main building of the METS resort in Palumeu. The sphaerodactylid gecko species, *Gonatodes humeralis*, was also fairly common in primary forest and forest edges (Sites 1, 4 and 5) and is distributed widely across northern South America. Although neither was common,

the two other sphaerodactylids encountered, *G. annularis* (see page 28) and the rather diminutive *Pseudogonatodes guianensis*, are restricted to moist microhabitats generally in lowland forest (although the former can be found at ~800m on the Tafelberg; Ouboter pers. comm.). We consider encountering both of these species as a good indicator of forest health. Lastly, we encountered the phyllodactylid gecko *Thecadactylus rapicauda*, a prodigious species that reaches 125mm in snout-vent length. What was once considered one widely distributed taxon found throughout northern South America, Central America and the Lesser Antilles, this species has recently been split into three (*T. solimoensis* is restricted to the western Amazon and *T. oskrobapreinorum* from Sint Maarten). This species is sometimes commensal with man-made structures.

**Lacertiformes:** This morphologically and ecologically diverse group (sensu Townsend et al. 2004) is distributed throughout the Americas and includes three lizard families: Teiidae, Gymnophthalmidae and Amphisbaenidae. Teiid and gymnophthalmid lizards were the most commonly encountered reptiles at each site during this RAP. Species of lizards in these families are active hunters and were commonly encountered moving through the leaf litter (e.g. *Alopoglossus*, *Arthrosaura*, *Leposoma*), in streams/pools (e.g. *Neusticurus*) (see page 28), under logs (e.g. *Gymnophthalmus*), or moving in the open near tree falls and around camp (e.g. *Ameiva*, *Kentropyx*). The existence of *Cercosaura argulus* in Suriname was previously based on one record from Palumeu (Hoogmoed 1973) and the distribution map provided by the IUCN website does not confirm its presence in the country (Doan and Avila-Pires 2010). We here provide confirmation of its residence in southern Suriname. Additionally, our tentative taxonomic designation for *Alopoglossus buckleyi* would suggest a significant range extension for this taxon. There are morphological differences separating this taxon from the widespread *A. angulatus* (corroborative genetic data is also being gathered), however, this designation is still tentative and will require more comparative material for us to be confident. A single worm lizard putatively identified as *Amphisbaena* cf. *vanzolinii* (see page 28) was encountered during the second night at Site 4 moving through our recently constructed camp. This taxon—like most amphisbaenian species—is infrequently collected due to its fossorial habits but it appears to be patchily distributed across the western AGR.

**Scincomorphs:** Skinks are the second most diverse squamate group (behind Gekkota) and are also distributed nearly worldwide, although there are only ~18 species in South America. We encountered a single species, *Mabuya nigropunctata*, at all forest sites—including high elevation—and were commonly observed basking or foraging around open canopy tree falls. *Mabuya nigropunctata* is widespread across Amazonia and can even be found in St. Vincent in the southern Caribbean. Miralles and Carranza (2010) recently published molecular evidence suggesting this taxon might be a complex of three largely allopatric lineages, although

they did not suggest new names for the distinct lineages they recovered. We observed numerous individuals at Sites 1, 2 and 4, yet this wily taxon successfully evaded capture so we have no voucher or genetic material with which to compare to Miralles and Carranza (2010).

**Serpentes:** According to Ávila Pires (2005), Suriname possesses more than 100 snake species from 8 families. Although most of our records were of single individuals, we encountered 19 species from 6 different families. While this may seem like a paltry sum compared to the total, snakes in general are difficult to collect due to their cryptic biology, and some are restricted to specific habitat types/food sources (e.g. mangroves) that were not targeted or near the sampling sites of this study. By comparison, the two previous RAP surveys to Suriname, Lely/Nassau (RAP 43) and Kwamalasamutu (RAP 63) recorded just 6 and 17 snake species, respectively. The family Colubridae comprised the majority of the species we encountered (13 sp.), including the most commonly encountered species (i.e. the Blunthead Tree Snake (*Imantodes cenchoa*) and two species of ground snake (*Atractus* spp.), although still only a small fraction of Suriname's total colubrid diversity (>75 sp.). Colubridae is the largest snake family and includes about two-thirds of all described snake species (>300 genera, >1,900 species). Site 2 (Grensgebergte) provided the only records of Cope's Snail-eater, *Dipsas copei*, and the fer-de-lance, *Bothrops atrox*. There is some confusion regarding the type locality of the former (i.e. Suriname; see Kornacker 1999), although undoubtedly it is quite rare and is represented by only a handful of specimens collected in Suriname. The fer-de-lance on the other hand is often one of the more common snakes encountered in lowland tropical forests; yet we saw only one, and at >700 m. We posit that this is a result of undersampling rather than absence of the species from the lowland sites and if we had utilized pitfall trap arrays with funnel traps on this survey, we are confident we would have encountered more "common" terrestrial species, such as *Bothrops* spp.

**Testudines:** Although only a few individuals of two species were observed, we argue that presence of turtles and tortoises are positive signs of limited hunting pressure. Due to their ease of capture and convenient storage, humans have been subsistence hunting tortoises for millennia (Thorbjarnarson et al. 2000) and many cultures in South America continue this practice. A single individual of the flat-headed turtle, *Platemys platycephala*, was observed by R. Jairam at Site 1 foraging in partially flooded lowland forest. At least two different individuals of the yellow-footed tortoise, *Chelonoidis denticulata*, were encountered at the high elevation site 2, sitting in vegetation near slowly flowing seeps, while a third individual was also observed foraging in the lowlands between camp and Kasikasima mountain (Site 4). While by no means an extensive survey, the presence of these species is likely correlated to the seemingly pristine quality of the forests.

## CONSERVATION RECOMMENDATIONS

Of the species we encountered, only a fraction has been assessed for the IUCN Red List of Threatened Species, and most are listed as Least Concern or Not Evaluated since they are widely distributed across either the greater Guiana Shield or some portion of Amazonia. Due to myriad factors (e.g. weather, collection technique, collector fatigue), it is likely that we failed to collect all representatives of the herpetofaunal community at each site. With repeated surveys, we expect that our species lists would increase. Given the amount of time available at each site, we found a community that appeared speciose and could be harboring a few putatively "new" species (e.g. *Hypsiboas* sp. "chocolate"). This survey also provided collection records that have contributed to geographic range extensions for species not previously known from Suriname (e.g. *Cercosaura argulus* and *Alopoglossus buckleyi*), as well as new records for particularly rarely encountered species (e.g. *Dipsas copei*, *Rhinatrema bivittatum*, *Amphisbaena* cf. *vanzolinii*). Observing little in the way of disturbance or man-made alterations, we suggest that these sites (with the possible exception of the altered forest near Palumeu) are healthy and productive, and are presumably acting as a corridor for gene flow through this region of the Guiana Shield. The presence of species that are rarely seen or were previously unrecorded in Suriname helps to substantiate that there is (or was) an historical connection between this and surrounding areas. Helicopter flights over the area confirm that the forest is widespread and contiguous, which is hopefully contributing to species/genetic admixture between protected areas. Future conservation/landscape genetic work might confirm a connection between the forests surrounding our main study sites and adjacent protected areas, but we nonetheless advocate that maintaining the pristineness of this corridor should be a priority for healthy ecosystem function and to maintain natural gene flow throughout the Guiana Shield.

## ACKNOWLEDGEMENTS

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**Appendix 9.1.** Amphibians and reptiles recorded during the current RAP study. A qualitative assessment of species abundance for each site where the occurred is included (VC: very common, >10 individuals observed; C: common, 1>x >10 individuals observed; UC: uncommon, only 1 observed/captured), as well as general geographic distribution (W: widespread; GS: Guiana Shield; AGR: Amazo-Guianan Subregion; E: exotic), IUCN threat status (LC: least concern; NE: not evaluated; DD: data deficient) and type of microhabitat in which the species was recorded. The last two columns indicate whether the same (Y or N) species were recorded by the two most recent RAP surveys in Suriname. In some cases, congeners (N\*; i.e. a close taxonomic relative) were recorded instead of the species we documented in the present study.

Taxon	cf.?	Per Locality Qualitative Records				Distribution	IUCN Threat Status	Microhabitat Type	RAP 43	RAP 63
		Upper Palumeu	Grensgebergte	Kasikasima	Palumeu					
<b>AMPHIBIA (47 species)</b>										
<b>AMPHIBIA-ANURA (46 species)</b>										
<b>Allophrynidae</b>										
<i>Allophryne ruthveni</i>		C		UC		GS	LC	lowland forest	N	Y
<b>Aromobatidae</b>										
<i>Allobates femoralis</i>		VC		VC	UC	AGR	LC	lowland forest	Y	Y
<i>Allobates granti</i>	cf.	UC				GS	LC	forest?	N	Y
<i>Anomaloglossus baeobatrachus</i>	cf.			C		GS	DD	lowland forest	N	Y
<i>Anomaloglossus</i> sp.		UC?		VC		??	??	lowland forest	-	-
<b>Bufonidae</b>										
<i>Amazophrynella minuta</i>		VC		VC		AGR	LC	lowland forest, forest stream	N	N
<i>Rhaebo guttata</i>		C		C		AGR	LC	forest (high/lowland)	Y	Y
<i>Rhinella lescurei</i>	cf.	C		C		GS	LC	lowland forest	N	Y
<i>Rhinella margaritifera</i>	cf.	VC		VC		W	LC	lowland forest	Y	N
<i>Rhinella marina</i>				C	VC	W	LC	lowland forest	Y	Y
<i>Rhinella martyi</i>	cf.	C	C			GS	LC	lowland forest	N	Y
<i>Rhinella</i> sp.		C		C		??	??	lowland forest	-	-
<b>Centrolenidae</b>										
<i>Hyalinobatrachium taylori</i>	cf.	C		C		GS	LC	forest stream side		
<b>Dendrobatidae</b>										
<i>Ameerega trivitatta</i>		VC		VC	C	AGR	LC	forest	Y	Y
<i>Dendrobates tinctorius</i>		C				GS	LC	lowland forest	N	Y

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Appendix 9.1. continued

Taxon	cf.?	Per Locality Qualitative Records				Distribution	IUCN Threat Status	Microhabitat Type	RAP 43	RAP 63
		Upper Palumeu	Grensgebergte	Kasikasima	Palumeu					
<b>Hylidae</b>										
<i>Dendropsophus brevifrons</i>	cf.			UC		AGR (patchy)	LC	lowland forest	N*	N*
<i>Hypsiboas boans</i>			UC	UC		AGR	LC	lowland forest	Y	Y
<i>Hypsiboas calcaratus</i>		C				AGR	LC	lowland forest	N	Y
<i>Hypsiboas fasciatus</i>		C		UC		AGR	LC	lowland forest	N	Y
<i>Hypsiboas geographicus</i>				UC		AGR	LC	lowland forest	N	Y
<i>Hypsiboas ornatissimus</i>					UC	GS	LC	lowland forest	N	N
<i>Hypsiboas</i> sp.				UC		??	??	lowland forest	-	-
<i>Osteocephalus lepreuri</i>		C		UC		AGR	LC	lowland forest	N	Y
<i>Osteocephalus taurinus</i>		C				AGR	LC	lowland forest	Y	Y
<i>Phyllomedusa tomopterna</i>		C				AGR	LC	lowland forest	N*	N*
<i>Scinax cruentommus</i>		C				AGR	LC	lowland forest	N*	N*
<i>Scinax ruber</i>	cf.				UC	W	LC	lowland forest	N*	N*
<i>Scinax</i> sp. "hybrid"		C				??	??	lowland forest	N*	N*
<i>Scinax x-signathus</i>	cf.				UC	W	LC	lowland forest	N*	N*
<i>Trachycephalus coriaceus</i>	cf.	UC				AGR (patchy)	LC	forest stream side	N	N*
<b>Leptodactylidae</b>										
<i>Adenomera beyeri</i>				C		GS	LC	lowland forest	N*	Y
<i>Adenomera</i> sp.			C			??	??	lowland forest	-	-
<i>Leptodactylus bolivianus</i>					VC	AGR	LC	open grassland, human habitation	N	Y
<i>Leptodactylus knudseni</i>					C	AGR	LC	open grassland, human habitation	Y	Y
<i>Leptodactylus leptodactyloides</i>	cf.	C		C	C	AGR	LC		Y	N
<i>Leptodactylus lineatus</i>					C	W	LC	modified forest, human habitation	N	N
<i>Leptodactylus longirostris</i>		UC				GS	LC	lowland forest	Y	N
<i>Leptodactylus myersi</i>			VC	UC		GS	LC	granite outcrop, human hab.	N	Y
<i>Leptodactylus mystaceus</i>		UC			UC	AGR	LC	lowland forest, human hab.	Y	Y
<i>Leptodactylus pentadactylus</i>		UC				AGR	LC	lowland forest	Y	Y
<i>Leptodactylus rhodomystax</i>		UC				AGR	LC	lowland forest	N	Y
<i>Leptodactylus</i> sp.		UC			UC	??	??	lowland forest, human hab.	-	-
<i>Leptodactylus stenodema</i>	cf.			UC		AGR	LC	lowland forest	Y	N

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## Appendix 9.1. continued

Taxon	cf.?	Per Locality Qualitative Records				Distribution	IUCN Threat Status	Microhabitat Type	RAP 43	RAP 63
		Upper Palumeu	Grensgebergte	Kasikasima	Palumeu					
<b>Strabomantidae</b>										
<i>Pristimantis chiastonotus</i>	cf.	C	C	C		GS	LC	lowland forest, granitic forest	Y	Y
<i>Pristimantis</i> sp.		C	UC	C		??	??	varied	-	-
<i>Pristimantis zeuctotylus</i>					UC			forest edge	Y	N
<b>AMPHIBIA-GYMNOPHIONA (1 sp.)</b>										
<b>Rhinatreumatidae</b>										
<i>Rhinatrema bivittatum</i>		UC				GS	LC	lowland forest	N	N*
<b>REPTILIA (42 sp.)</b>										
<b>SQUAMATA-GEKKOTA (5 sp.)</b>										
<b>Gekkonidae</b>										
<i>Hemidactylus mabouia</i>	cf.				VC	E	LC	human habitation	N	N
<b>Sphaerodactylidae</b>										
<i>Gonatodes annularis</i>		C		C		W	NE	lowland forest	Y	Y
<i>Gonatodes humeralis</i>		C		C	C	W	NE	forest gaps/edges	Y	Y
<i>Pseudogonatodes guianensis</i>		UC				AGR	NE	lowland forest	N	N*
<b>Phyllodactylidae</b>										
<i>Thecadactylus rapicauda</i>		C				W	NE	lowland forest	N	Y
<b>SQUAMATA-LACERTIFORMES (12 sp.)</b>										
<b>Amphisbaenidae</b>										
<i>Amphisbaena vanzolinii</i>	cf.			UC		AGR (patchy)	DD	lowland forest	N*	N*
<b>Gymnophthalmidae</b>										
<i>Alopoglossus angulatus</i>		UC				AGR	LC	lowland forest	N	N
<i>Alopoglossus buckleyi</i>	cf.		UC			???	NE	granitic forest	N	N
<i>Arthrosaura kockii</i>				UC		GS	LC	lowland forest	Y	Y
<i>Arthrosaura reticulata</i>		C				W	NE	lowland forest	N	N
<i>Gymnophthalmus underwoodi</i>					UC	GS*	LC	modified forest edge	N	Y
<i>Leposoma guianense</i>	cf.	C	C	C	UC	GS	NE	1o/2o/granitic forest	Y	Y
<i>Neusticurus bicarinatus</i>		UC				AGR	NE	lowland forest	N*	Y
<i>Cercosaura argulus</i>	cf.	C				AGR	NE	lowland forest	N*	N
<i>Tretioscincus agilis</i>		UC		UC		AGR	NE	lowland forest	N	N

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Appendix 9.1. continued

Taxon	cf.?	Per Locality Qualitative Records				Distribution	IUCN Threat Status	Microhabitat Type	RAP 43	RAP 63
		Upper Palumeu	Grensgebergte	Kasikasima	Palumeu					
<b>Teiidae</b>										
<i>Ameiva ameiva</i>		VC	VC	VC	VC	W	NE	varied	Y	N
<i>Kentropyx calcaratta</i>		VC		VC		AGR	NE	forest gaps in 1o forest	Y	Y
<b>SQUAMATA-IGUANIA (3 sp.)</b>										
<b>Polychrotidae</b>										
<i>Norops nitens</i>	cf.	C		C		AGR	NE	lowland forest	N*	Y
<b>Tropiduridae</b>										
<i>Plica (=Tropidurus) umbra</i>				C		AGR	NE	lowland forest	N*	Y
<i>Uranoscodon superciliosus</i>	cf.	C				AGR	NE	lowland forest	N	N
<b>SQUAMATA-SCINCOIDEA (1 sp.)</b>										
<b>Scincidae</b>										
<i>Mabuya nigropunctata</i>		C	C	C		W	NE	lowland/granitic forest; tree falls	Y	Y
<b>SQUAMATA-SERPENTES (19 sp.)</b>										
<b>Aniliidae</b>										
<i>Anilius scytale</i>				UC		W	NE	lowland forest	N	Y
<b>Boiidae</b>										
<i>Corallus caninus</i>				UC		AGR	NE	river edge	N	N*
<i>Epicrates cenchria</i>				UC		W	NE	lowland forest	N	N
<b>Colubridae</b>										
<i>Atractus flammigerus</i>	cf.			UC		AGR	NE	lowland forest	N	Y
<i>Atractus torquatus</i>	cf.	C				AGR	NE	lowland forest	N	Y
<i>Chironius exolatus</i>		UC				W	NE	lowland forest	N*	N
<i>Chironius fuscus</i>		UC				W	NE	lowland forest	N*	N
<i>Dipsas copei</i>			UC			GS	NE	granitic forest	N*	N*
<i>Erythrolamprus aesculapi</i>		UC				AGR	NE	lowland forest	N	N
<i>Helicops angulatus</i>	cf.	UC				AGR	NE	lowland forest stream	N	Y
<i>Imantodes cenchoa</i>		C		C		W	NE	lowland forest	N*	Y
<i>Oxybelis argenteus</i>		UC				W	NE	lowland forest	N	N
<i>Oxyrhopus formosus</i>	cf.			UC		AGR	NE	lowland forest	Y	N
<i>Pseudoboa</i> sp.		C		UC		??	??	lowland forest	-	-
<i>Pseustes poecilonotus</i>				UC		W	LC	lowland forest stream	N	N
<i>Tripanurgos (Siphlophus) compressus</i>		UC				W	NE	lowland forest	N	N*

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## Appendix 9.1. continued

Taxon	cf.?	Per Locality Qualitative Records				Distribution	IUCN Threat Status	Microhabitat Type	RAP 43	RAP 63
		Upper Palumeu	Grensgebergte	Kasikasima	Palumeu					
<b>Elapidae</b>										
<i>Micrurus psyches</i>		UC			GS	NE	lowland forest	N	N	
<b>Typhlopidae</b>										
<i>Epictia (Leptotyphlops) tenella</i>				UC	W	NE	lowland forest clearing (i.e. camp)	N	N*	
<b>Viperidae</b>										
<i>Bothrops atrox</i>			UC		AGR	NE	high altitude grassland	Y	Y	
<b>TESTUDINES (2 sp.)</b>										
<b>Chelidae</b>										
<i>Platemys platycephala</i>		UC			AGR	NE	lowland, flooded forest	Y	Y	
<b>Testudinidae</b>										
<i>Chelonoidis denticulata</i>			C	UC	W	LC	high altitude grassland, lowland forest	N	Y	
<b>CROCODYLIA (1 sp.)</b>										
<b>Alligatoridae</b>										
<i>Paleosuchus</i> sp.					AGR			Y	Y	