Floristic Assessment of the Upper Palumeu River, the Grensgebergte, and the Kasikasima Areas

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Chapter 3

Floristic assessment of the Upper Palumeu River, the Grensgebergte, and the Kasikasima areas

Olaf Bánki and Chequita Bhikhi

SUMMARY

We collected a total of 609 plant specimens during the RAP survey, including 433 fertile and 175 sterile plants. The majority, 238 plant specimens consisting of more than 50 percent of sterile collections, was collected in the surroundings of Kasikasima (site 4). Of these specimens, 602 were identified to family level, 512 to genus and 439 to species. The identified plant specimens belong to 354 species, 152 genera and 93 families. At site 1, along the upper Palumeu River, we collected 188 plant specimens. At the Grensgebergte (site 2) we collected 69 plant specimens and 75 at the Makrutu camp (site 3). We also collected 11 plant specimens at the Palumeu village and 27 specimens at the rapids of the Palumeu River. We found 15 new plant species records for Suriname and two new genera. Two of these belong to lianas, four to shrubs and herbs and ten to trees. The Grensgebergte and the Kasikasima Mountains contain several vegetation types which are dominant and floristically distinct for the central and southern parts of Suriname. These vegetation types include tall dryland tropical forest on laterite/granite hills, short savannah (moss) forest and open rock vegetation, including rocky outcrops around rapids, and tall seasonally flooded forest. Within these vegetation types, we recorded nearly all of the 15 new plant species records and the two new genus records for Suriname. We also recorded several rare species with only a few known occurrences in Suriname and/or in the Guianas. The noteworthy species include several rare orchids that are listed on appendices I and II of CITES, some carnivorous plants, and three tree species that are listed on the IUCN Red List, including one tree species listed as Critically Endangered. Plot surveys (0.1 ha) also indicated that the forests of South Suriname are floristically distinct from those of North Suriname, but do not significantly differ in tree alpha diversity. The forests on the Guiana Shield basement complex are not uniform as stated by some. Our findings indicate the pristine status of the forests and vegetation types in Southeastern part of Suriname, and the fact that these forests are still poorly explored.

INTRODUCTION

Plants are the principle building blocks of forests, and the fundamental components of ecosystems. On a global and national level, forests supply vital ecosystem services that sustain life on earth. Forests also support livelihood of millions of people throughout the developing world (Hall 2012). Forests in tropical regions, however, despite their importance are under pressure of global change (e.g. mostly human impacts). The countries in the Guianan region still contain large stretches of pristine tropical rainforest due to their low human populations. Together with the Amazonian forests, the Guianan forests belong to the largest area of pristine tropical rainforest in the world. Suriname, especially the southern region of the country, is the least botanically explored compared to the other countries in the Guianan region. Not much is known in terms of plant composition and diversity from the South of Suriname.

During the 2010 Rapid Assessment Program (RAP) survey around Kwamalasamutu in south-western Suriname, we recorded 9 plant species as new records for Suriname, including a newly recorded plant species for the Guianan region, and many rare and endangered species (Bánki and Bhikhi 2011). The knowledge that can be gained through this rapid assessment is needed to assess the conservation value of the forests in southern Suriname. This conservation value is needed for sound decision-making and conservation planning in the southern Suriname. During the 2012 three-week RAP survey reported here, we studied the flora of the Grensgebergte and the Kasikasima region of Southeastern Suriname. This report presents the preliminary results of the plants that were collected and inventoried.

METHODS

The floristic team consisted of approximately 10 members: André Semmy (tree spotter, plot inventories), Jeffrey Krimbo (field assistant plant collecting, plot inventories), about seven field assistants and the authors of this chapter for general plant collecting, plot inventories, and species identification.

We sampled at all four RAP sites: Upper Palumeu River (Juuru Camp, Site 1), Grensgebergte Granite Rock (Site 2), Makrutu Creek (Site 3), and Kasikasima camp (Site 4). At each of these sites we carried out general vegetation surveys. At Site 1 and Site 4 we carried out plot inventories. We collected for a period of nineteen days.

General Vegetation Surveys

General plant collecting took place at each of the four RAP sites in all the vegetation types encountered. This included collecting plants on the rocky outcrops of the Grensgebergte and the Kasikasima, along river edges and on rocky outcrops along rapids between the RAP sites, at the Palumeu Mets Lodge, and in Palumeu village. Flowering and fruiting plants were collected during the surveys, and all encountered vegetation types were recorded. Plant collections were collected in the number series of Olaf Bánki and Chequita Bhikhi (using OSB and CRB in plant collecting numbers). Plants were pressed and dried in the field above kerosene stoves. All plants were collected where possible in three duplicates, with one duplicate stored at the National Herbarium of Suriname (BBS), one stored at the National Herbarium of the Netherlands - Naturalis Biodiversity Center (NHN-NBC) and where relevant one duplicate send to a plant specialist for identifications. Leaf materials of plots were collected on silica to enable identification by DNA fingerprinting techniques, allowing phylogenetic classification of the plots in the future. Some plants and plant parts were collected on alcohol. Plants were identified by Chequita Bhikhi and Olaf Bánki at the NHN in Leiden, where plant collections of the Guianas are stored. The specimens were identified using standard identification techniques. Duplicates of 5 plant families were sent to their respective taxonomic group specialist, of the Herbier de Guyane (CAY) in Cayenne French Guiana (Rubiaceae), Kew Royal Botanic Gardens (Kew, Chrysobalanaceae and Myrtaceae), Smithsonian National Museum of Natural History (Sapindaceae) and The New York Botanical Garden (NYBG, Burseraceae) within the Flora of the Guianas network. We determined new records for Suriname by checking the occurrence of the species in the checklist of the Guianas (Funk et al. 2007), the Guianas collections of the NHN, and by consulting the collections of the Missouri Botanical Gardens through Tropicos and Discoverlife (www.discoverlife.org), and the available species occurrence data from the Global Biodiversity Information Facility (www.gbif.org). We also made use of the Encyclopedia of Life (eol.org), and the plant list (www.theplantlist.org).

Plot Inventories

We inventoried in total four 0.1 ha plots in 'tall dryland tropical forest on laterite/granite hills' (see Table 3.1 for the plot metadata). The plots were positioned on forested laterite/granite hills of 350 to 400 meters above sea level. The forests in these plots were standing on relatively shallow soils, with the bed rock occurring at various depths. Although we classified the forests in the plots as 'tall tropical forest on laterite/granite hills' at times these forests showed floristic elements of 'savannah forests', especially at those places where the bedrock was closer to the surface. All 0.1 ha plots had a dimension of 10 by 100 meters, and all trees above 2.5 cm dbh were pre-identified by tree spotter André Semmy of Conservation International Suriname and Olaf Bánki in the field. Palms were included in the assessment, while lianas were not assessed in these plots due to time constraints. Each new tree species encountered in the plots was collected. Collections of the tree species were processed in a similar way as the plant collections of the general surveys. We assessed the amount of timber species within the plots by using the Surinamese forest law of 1992 (see www.sbbsur.org).

At the first RAP Site at the Upper Palumeu River, we inventoried a plot (Gre1) on a granite hill in 'tall tropical forest on laterite/granite hills'. In the same area we tried to inventory another plot, as well as in 'savannah forest' on the rock outcrop of the Grensgebergte (Site 2). These two plots could not be inventoried because of logistical constraints. Close to the Kasikasima camp (Site 4), we assessed three 0.1 ha plots (Kas2-4). These three plots were established in 'tall tropical forest on laterite/granite hills' at a geographical distance of several hundreds of meters from one another.

Plot comparisons

To investigate floristic and diversity differences, we compared the four 0.1 ha plots of the current study with 0.1 ha plot data from other parts of Suriname. For the comparisons, we used six 0.1-ha plot data from Olaf Bánki (6 plots from Gros Rosebel on the Guiana Shield basement complex in the Northern part of Suriname), and three 0.1-ha plots from Kwamalasamutu and surroundings (Bánki and Bhikhi 2011).

Plot Analyses

To enable analyses, the four 0.1-ha plot datasets were brought together with the plots from Gros Rosebel (Bánki unpublished) and the Kwamalasamutu surroundings (Bánki and Bhikhi 2011) into one dataset of 13 0.1 ha plots in

Table 3.1. Metadata for the plots established at each site during the RAP. N = number of individuals, S = number of species, Fa = Fisher's alpha.

Plot Name	Ha	Dimension	N	S	Fa	Latitude	Longitude
Upper Palumeu River Plot 1 (Gre1)	0.1	100 × 10 m	177	67	39.27	N2 28.904	W55 37.898
Kasikasima Plot 2 (Kas2)	0.1	100 × 10 m	209	76	42.96	N2 58.493	W55 23.429
Kasikasima Plot 3 (Kas3)	0.1	100 × 10 m	203	73	40.86	N2 58.507	W55 23.526
Kasikasima Plot 4 (Kas4)	0.1	100 × 10 m	191	63	32.81	N2 58.522	W55 23.197

total, consisting of 2369 individual trees, and 369 (morpho-) species in total. Differences in floristic composition between plots were investigated with the ordination technique Non-Metric Multi-Dimensional Scaling (NMS) with Relative Sörenson as floristic distance measure, 250 real and randomized data runs, and 4-6 dimensions (NMS in PCORD 5, McCune and Grace 2002; McCune and Mefford 1999). We also performed a Detrended Correspondence Analysis on both the 0.1-ha plot dataset (DCA in PCORD 5, McCune and Grace 2002; McCune and Mefford 1999). We performed these ordinations for all species, for all species with five or more individual trees in total in the complete dataset, and by using genus data alone. In this report we show the NMS ordination results for the genus data set, and the species with 5 or more individual trees in the whole 13 0.1 ha plot data set.

We also ran species indicator analyses on the 0.1-ha plot dataset to investigate which species were responsible for the division of the plots in several floristic groups (in PCORD 5, Dufrene and Legendre 1997; McCune and Grace 2002; McCune and Mefford 1999). We did these indicator analyses for all species, for all species with five or more individual trees in total in the complete dataset, and by using genus data alone. In this report we show the ISA results for the genus data set, and the species with 5 or more individual trees in the whole 13 0.1 ha plot data set.

The tree alpha diversity of the plots was expressed as Fisher's alpha (Fisher et al. 1943). Fisher's alpha is a diversity index describing the relation between the number of individuals and species in a plot. Differences in the averages of the number of species, number of individuals, and in Fisher's alpha were statistically tested through ANOVA.

RESULTS

General Observations and Notes on Plant Diversity

In the RAP survey area, we discerned at least nine groups of vegetation types (following Lindeman and Moolenaar 1959; Bánki and Bhikhi 2011):

1. Tall herbaceous swamp and swamp wood

These vegetation types are abundant along the Upper Palumeu River, along the Makrutu Creek, and sporadically occur along the Palumeu River. Herbaceous swamps are characterized by the sheer dominance of herbaceous species like *Heliconia* sp. or *Montrichardia arborescens*, and mostly occur in shallow black waters associated with a peat or mud layer. Swamp wood consists of solitary trees standing in the water, such as *Erythrina* sp., or can be a combination of a herbaceous swamp with shrubs, and solitary trees, such as *Triplaris surinamensis*, *Virola surinamensis*, *Tachigali panurensis*, and *Cecropia* sp. In meandering black water rivers especially at the coastal areas in Suriname, extensive stretches of both herbaceous swamps and swamp wood can occur. Along the larger rivers the bands of herbaceous swamps and swamp wood can be fairly narrow almost immediately transitioning into real tall swamp forests or seasonally flooded forests (see also Lindeman and Moolenaar, 1959).

Typical for the Upper Palumeu River and prominent in river bends is the tall herbaceous swamp vegetation dominated by 'palulu' (*Heliconia* sp.). In this herb layer *Costus arabicus*, *Calathea comosa* and cyper grasses such as *Scleria flagellum* and *S. microcarpa*, were found. The occurrence of *Montrichardia arborescens* is scarce in the Upper Palumeu River. Vines and lianas such as *Manettia coccinea*, *Cayaponia cruegeri*, *Mucuna urens*, *Cynanchum blandum*, *Dioclea virgata* and *Stigmaphyllon sinuatum* occurred frequently in the swamp vegetation. The shrub and tree layer of the herbaceous swamp vegetation close to the camp of RAP site 1 consisted of *Bixa orellana*, *Senna alata*, *Inga nobilis*, *I. splendens*, *Conceveiba guianensis*, *Croton cuneatus and C. pullei*. Trees of *Senna alata*, *Inga nobilis*, *I. splendens* and *Guarea guidonia* were dominant in the river bends and formed a closed canopy of up to 5 to 10 meters in height.

Solitary trees of *Triplaris surinamensis* occurred frequently in the swamp wood and herbaceous swamp vegetation along the Upper Palumeu River. *Virola surinamensis* trees were also recorded in the swamp wood. At some places the band of swamp wood was very narrow, almost immediately transitioning into seasonally flooded forests. Within these narrow bands of swamp wood we found *Triplaris surinamensis* and *Virola* trees accompanied by small clumps of *Bactris brongniartii* palms, clumps of *Euterpe oleracea* palms, and *Cecropia* species. Tree species generally occurring in seasonally flooded forest such as *Alexa wachenheimii*, *Guarea guidonia*, *Dialium guianense*, *Genipa americana*, *Macrolobium bifolium*, and *Posoqueria longiflora* frequently occurred in the shrub and tree layers of these narrow bands of swamp wood, especially in the river bends.

Stretches of tall herbaceous swamp vegetation dominated by *Montrichardia arborescens* had a frequent occurrence in the Upper Palumeu River after the confluence with the Tapaje Creek. *Montrichardia arborescens* was also dominant along the Makrutu Creek. Several plant species were recorded in the shrub vegetation along the Makrutu Creek such as *Cissus erosa*, *Tabernaemontana sylvilitica*, *Annona hypoglauca*, *Strychnos guianensis*, *Combretum rotundifolium*, *Solanum pensile*, *Ipomoea squamosa*, *Vigna luteola*¸ *Gouania blanchetiana* and *Paullinia dasygonia*. In this vegetation we also found solitary trees of *Cecropia latiloba* and *Bactris brongniartii* growing in large clumps. *Croton pullei* trees were dominant along the Palumeu River and the Makrutu creek.

2. Tall Seasonally flooded forest

Seasonally flooded forest is a tall forest type that usually is standing directly or almost directly at the river edge. In composition the seasonally flooded forest does not differ substantially in species composition from tall tropical lowland rainforest on dryland (terra firme). At the river edges where the flooding is substantially more frequent tree species especially occur that are accustomed to some extensive

flooding. Where the river banks are higher, and the soils well drained tall tropical lowland rainforest on dryland (terra firme) occurs (see also Lindeman and Moolenaar, 1959).

Stretches of seasonally flooded forest were most extensive and frequent along the Upper Palumeu River. Most dominant trees along the river edge, where flooding is more frequent, were *Alexa wachenheimii*, *Elizabetha princeps*, *Guarea guidona*, *Zygia racemosa*, *Ceiba pentandra*, *Croton matourensis*, *Trichilia* sp., *Posoqueria longiflora* and species of Burseraceae and Annonaceae.

Along the Palumeu River at site 4 (Kasikasima) we found *Simaba orinocensis*, *Parinari campestris*, *Protium heptaphyllum subsp. heptaphyllum*, *Duguetia calycina*, *Licania laevigata*, *Homalium guianense*, *Elizabetha princeps*, and *Eschweilera pedicellata* as dominant species in the tree layer of the seasonally flooded forest. In the understory we found *Miconia minutiflora* and several species of Myrtaceae. The understory was covered with lianas and vines such as *Mikania micrantha*, *Passiflora costata*, *Paullinia capreolata*, *Bauhinia cupreonitens*, and *Coccoloba ascendens*.

Along the Palumeu River at site 4 (Kasikasima) we also found the newly recorded species *Paloue induta*, *Heteropterys orinocensis* and the noteworthy species *Taralea oppositifolia* in the tree layer of the seasonally flooded forest. The newly recorded species *Tovomitopsis membranacea*, *Prestonia cayennensis*, and *Platymiscium filipes* were found in the seasonally flooded forest along the Palumeu river.

3. Seasonally flooded palm swamp forest and creek forest

Patches of *Euterpe oleracea* palm swamp forests were dominant along the Upper Palumeu River upstream from our first camp. This forest type is dominant in the lowest parts of the coastal plain, characterized with an abundant growth of *Euterpe oleracea* (Lindeman and Molenaar 1959). From the helicopter in the Grensgebergte area, this forest type was frequently observed in the creek valleys between hills. Swamp forest consists of heavy clay soils which is inundated most of the year, and stays at least damp in the dry season (Lindeman and Molenaar 1959). Along the trail to Brazil (site 1) and the trail to the Kasikasima Mountain (site 4) we encountered patches of palm swamp forest in wet (or inundated) areas and close to creeks. These patches consisted of *Euterpe oleracea* trees mixed with *Geonoma baculifera*, *Heliconia acuminata*, and several Marantaceae species such as, *Hylaeanthe unilateralis, Ischnosiphon obliquus*, *Monotagma spicatum, M. secundum* and *Calathea elliptica* in the herbal layer. Dominant trees near creeks were *Spondias mombin*, *Tabebuia insignis*, *Macrolobium bifolium* and *Duroia aquatica*. Wet patches dominated by *Hylaeanthe unilateralis*, *Costus scaber*, *Ischnosiphon obliquus*, *Heliconia densiflora* and the noteworthy species *Costus lanceolatus subsp. pulchriflorus* were found at site 4.

Along the creek at site 1, close to the waterfall we recorded *Macrolobium bifolium* trees, and *Psychotria racemosa*, *Justicia secunda* , *Gurania bignoniacea*, *Hyptis lanceolata* and fern species such as *Salpichlaena volubilis* and *Selaginella parkeri* in the understory on the banks.

In a creek bed along the trail to the Mets camp at camp 4 we found a different set of species. The soil consisted of loam mixed with fine white sand and was inundated. The herb layer below a somewhat open canopy was covered with *Rapatea paludosa* (Rapateaceae), *Miconia bracteata*, *M. ceramicarpa*, *Calathea elliptica*, *Heliconia richardiana*, *Olyra obliquifolia*, and an ants housing shrub with red fruits *Maieta poeppigii.*

Ischnosiphon hirsutus is newly recorded herb species for Suriname, and was found together with *Hylaeanthe unilateralis* in a palm swamp forest close to the waterfall at site 1.

4. Tall tropical rainforest on dryland (terra firme)

This forest type was only found at the Upper Palumeu River (site 1) along the trail to Brazil. This forest type can be distinguished from other forest types by its high canopies reaching to 50 m, and the well-drained soil. We observed trees such as *Alexa wachenheimii*, *Parkia pendula* with purple flowers, *Couratari stellata*, *Ormosia* sp., *Tabernaemontana sananho*, *Tetragastris altisimma*, and *Lecythis zabucajo* reaching a canopy height of more than 30 m, and *Astrocaryum sciophilum* (bugru maka) palms dominant in the understory. We frequently encountered *Psychotria poeppigiana*, *P. apoda*, *Heliconia lourteigiae*, *Heliconia densiflora, Costus scaber*, *C. claviger*, *Duguetia calycina*, *Maieta guianensis*, different fern species, and *Monotagma secundum* and *M. spicatum* as the most dominant Marantaceae species in the understory. Unfortunately we could not properly assess this forest type with plot inventories due to logistics.

5. Tall dryland tropical forest on laterite/granite hills

'Tall dryland tropical forest on laterite/granite hills' can be shortly described as a terra firme forest type that occurs on the slopes and the tops of laterite/granite hills. This forest type is a mix between tree species occurring in 'tall tropical rainforest on dryland', and those tree species that respond to the more shallow soils caused by parent rock under the surface. At those places where on the slope or on the top of the hills the parent rock reaches close to the surface, this forest type can become a mix with 'savannah forest on granite rock'. On the slopes where the soils are deep, the canopy can be high and uniform. At those places on the slopes and on the top where the parent rock under the surface start to fluctuate leading to patches of shallow and deeper soils, the canopy becomes more erratic in height at short distances and becomes more open at times allowing more light to penetrate the forest floor.

Tall dryland tropical forest on laterite/granite hills was the most dominant forest type found around the Upper Palumeu River at site 1 and the trail to the Kasikasima Mountain. For this reason we placed all plots in this vegetation type. The whole area at these sites started to become hilly at approximately 10 meters from the river.

At both RAP sites 1 and 4 we recorded characteristic tree species such as *Astrocaryum sciophilum*, *Astrocaryum paramaca*, *Eperua falcata*, *Eschweilera corrugata*, *Geissospermum sericeum*, *Inga* spp., *Licania* spp., *Pouteria guianensis*, *Protium* spp., *Tetragastris* spp., *Unonopsis glaucopetala, Zygia racemosa* and *Vouacapoua americana*. Other dominant trees species found at the Upper Palumeu River site were *Siparuna decipiens* and *Sterculia* sp.. The understory of the forest contained small trees and shrubs such as *Connarus fasciculatus, Siparuna cuspidata, Retiniphyllum* sp., *Psychotria* sp. *Ischnosiphon obliquus, Rinorea amapensis, Henriettella caudata, Piper bartlingianum*, *Maieta guianensis*, and the following dominant understory palms *Geonoma leptospadix, G. maxima* and *Bactris acanthocarpa.*

At the Kasikasima site 4 the following tree species were found: *Brosimum guianense* (letterhout), *Dicorynia guianensis* (basralokus), *Elizabetha princeps*, *Eschweilera sp.*, *Guatteria schomburgkii* (pedrekupisi), *Inga alba* (rode prokoni), *Jacaranda copaia* (gubaja), *Laetia procera*, *Martiodendron parviflorum* (witte pintolokus), *Minquartia guianensis* (alata udu), *Oenocarpus bacaba*, *Parkia nitida*, *Pouteria* sp., *Pseudopiptadenia suaoveolens* (pikinmisiki), *Sclerolobium melinonii* (djakidja), *Sloanea spp.* (rafunyannyan), *Swartzia* sp. (zwarte bugubugu), *Talisia* sp., *Virola* sp., *Vochysia tomentosa* and *Zanthoxylum rhoifolium* (pritjari).

The following newly recorded species for Suriname were found (mostly) in the plot inventories: *Hirtella duckei* (plot 3), *Micropholis splendens* (plot 3), *Ouratea cerebroidea* (plot 3), *Quiina indigofera* (plots 1, 2 and 3), *Tabernaemontana angulata* (plot 3), *Tetrameranthus guianensis* (plots 2, 3 and 4).

Tall dryland tropical forest on laterite/granite hills was also found on the Grensgebergte granite mountain at an elevation of approximately 800 meters asl, but unfortunately due to logistics it could not be properly assessed. At the edges of this forest on the Grensgebergte we found two new recorded tree species for Suriname, namely *Clusia flavida* (see page 26) and *Solanum semotum*. The noteworthy species *Ixora piresii* was collected in the understory of the tall dryland forest a few meters from the trails of the Kasikasima Mountain site.

6. Short savannah (moss) forest on granite rock

Short savannah forest on granite rock was found on the top of the granite mountain of the Grensgebergte (site 2), along the rapids of the Palumeu River, in the surroundings of Kasikasima camp (site 4) and on top of the Kasikasima Mountains. This forest type is characterized by a short uniform canopy of several meters in height, many small tree stems, and a plant species composition that responds to the shallow soils on top of the granite rock. On the Grensgebergte Mountain and the Kasikasima Mountains (site 4) we observed low savannah forest covered in moss, potentially formed and sustained by the moisture from low hanging clouds. Typical tree species belonged to *Inga grandiflora*, *Myrcia bracteata*, *Myrsine guianensis*, *Symplocos guianensis*, *Byrsonima* sp. and to the families of Burseraceae (*Protium* spp.), Rubiaceae and Myrtaceae. *Inga stipularis* and *Miconia prasina* which occur along rivers or in inundated soils were also found on the Grensgebergte mountain.

At Kasikasima this forest type was most dominant at the base of the mountain, where large boulders occurred at the surface forming caves, small streams and pools, on top of the mountains, and along the steep slopes. Along the steep slopes and on the top of the mountain, we recorded a dominant IUCN Red Listed palm species *Syagrus stratincola*. This palm species also occurred on granite rocks along rapids of the Palumeu River. It was also observed in the bathing area of camp 4. At Kasikasima we also found a rare Myrtaceae species, *Eugenia tetramera* with large velvet haired yellow fruits in this forest type.

Except for *Syagrus stratincola* in the savannah forest on the rocks along the rapids of the Palumeu River we also found trees of *Cochlospermum orinocense*, *Topobea parasitica, Ouratea leblondii*, *Erythroxylum kapplerianum* and several species of Myrtaceae.

7. Open rock (Inselberg) vegetation, including rocky outcrops around rapids

Patches of open rock, and solitary rock outcrops such as Inselbergs have a distinct flora. The vegetation ranges from patches with shrubs and solitary trees to patches of herbs and solitary herbs such as cacti, bromeliads, Agavaceae or orchids. All plants occurring in this vegetation type are adapted to grow on the open rock surface. At places where there is a film of water flowing on the rock surface or where water is almost stagnant plants accustomed to nutrient poor conditions may occur. The same vegetation type can occur on rocky outcrops around rapids along rivers.

We encountered open rock vegetation on the Grensgebergte (site 2) and on the top of the Kasikasima Mountains. We also encountered open rock vegetation characterized by a gesneriad herb *Chrysothemis rupestris* on a large rocky slope under the canopy of the forest at site 1. This species was also recorded on the open rocks near the large rapids of the Palumeu river. These rock outcrops near large rapids were also characterized by open rock vegetation. We found some similar species among the rocky outcrops of the Grensgebergte, the Kasikasima Mountains and the rock outcrops near the rapids, irrespective of differences in elevation.

The herb layer on the Grensgebergte rock was dominated by a Bromeliaceae species, cyper grasses, an Apocynaceae shrub with white flowers, and orchids such as the *Epidendrum nocturnum*, *Maxillaria discolor*, *Phragmipedium lindleyanum*, and *Cleistes rosea*. In the herb layer, *Chelonanthus purpurascens* and *Turnera glaziovii* were also found. The shrub layer was made up by *Clusia* spp., Myrtaceae, Rubiaceae and Melastomataceae. In the shrub layer, the noteworthy species *Cavendishia callista* (Ericaceae) was encountered. This species is typical for the rock outcrops in the Guayana Highland region.

We observed several dominant species similar to the Grensgebergte and Kasikasima Mountains, such as the terrestrial Gesneriaceae with red flowers, *Sinningia incarnata*,

the dominant Bromeliaceae, *Pitcairnia geyskesii* and many Cyperaceae species. *Sinningia incarnata* was also recorded on the rock outcrops near the rapids of the Palumeu River. *Anthurium jenmanii,* an Araceae species, was also dominant on the bare rocks of the Kasikasima Mountains. Species such as *Costus spiralis*, an orchid species and *Clusia* sp. were similar among the Grensgebergte Mountain and the rock outcrops at the rapids of the Palumeu river.

On the slopes of the Grensgebergte (site 2), and on the rock outcrops near the rapids of the Palumeu River we also encountered wet patches with carnivorous herbs of Lentibulariaceae (e.g. *Utricularia* spp.), grasses, other herbs and *Portulaca sedifolia*. The occurrence of carnivorous plants indicates the low nutrient status that some of these microhabitats have for plants.

We found a terrestrial, perennial Gesneriaceae herb *Lembocarpus amoenus*, with a restricted distribution in Suriname and French Guiana. The same species was also conspicuous on the bare rocks near the waterfall of site 1. This herb has only been found on ferro-bauxite Mountains and could be associated to rocky outcrops, and seems to grow on wet thin organic detritus layers in shaded areas.

As rocky outcrops around rapids are also treated in this section, and there is no separate vegetation description of plants within and around rapids in the water, we provide the following observation here. In the shallow water areas before rapids, where the water stream is not too turbulent, we found monodominant patches of small trees of *Psidium cattleianum* with reddish green leaves. This species was also dominant in shallow areas in the river, which will inundate at high water levels. Large monodominant patches of this species were also recorded along the Palumeu River, between camp 4 (METS camp) and the Palumeu village.

At the waterfall at site 1 we found the herb species *Clidemia epiphytica*, a new record for Suriname.

8. Secondary vegetation.

Secondary vegetation occurs on (abandoned) cultivated fields. It was observed along the trail to the Mets Camp and close to the Kasikasima camp (site 4). The vegetation contained secondary shrubs such as *Trema micrantha, Miconia bracteata*, *Solanum paludosum, S. subinerme*, *Lasiacis ligulata*, *Psychotria* sp., and trees of *Cecropia* sp. We recorded a former farm field close to camp four, with cultivated cassava plants (*Manihot esculenta*) belonging to the Trio village of the area.

9. Bamboo forest

Bamboo forest (*Guadua* sp.) was only observed in a small patch along the trail to Brazil at site 1. From the helicopter we observed patches of bamboo forest throughout the lowlands of the Grensgebergte area.

Plant collection, new records, and noteworthy plant species

We collected a total number of 609 plants during the RAP, including 433 fertile and 175 sterile plants (see Table 3.2). The majority, 238 plants, mostly sterile, was collected at the fourth camp site.

Newly recorded genera and species for Suriname

According to the National Herbarium of the Netherlands (NHN-Leiden), the checklist of the plants of the Guiana Shield (Funk et al. 2007) and several other internet data portals (e.g. GBIF, Discoverlife, EOL, Tropicos) and checklists of plants (e.g. the plant list) we found 15 newly recorded plant species for Suriname during this expedition.

We also collected two genera that were recorded for the first time in Suriname. One, *Tetrameranthus,* is a rare genus within the family of the Annonaceae. The common characteristics within the Annonaceae are leaves positioned flat in a plane along a branch, and flowers that are divided into three parts. Within *Tetrameranthus* the leaf arrangement is spiral and flowers are divided in four parts (Westra and Maas 2012). Tetrameranthus guianensis is a newly recorded tree species for Suriname. We have collected the species in plots 2, 3 and 4 at RAP site 4 in 'tall dryland tropical forest on laterite/granite hills'. ***Tetrameranthus guianensis*** is recently described based on collections from French Guiana and the state of Amapá in Brazil (Westra and Maas 2012).

Tovomitopsis is the other newly recorded genus for Suriname, collected during this expedition. ***Tovomitopsis membranacea***, is a tree species known within the Guianas from the states of Amazonas and Bolivar in Venezuela, French Guyana, and Guyana. The species occurs as well in western Amazonia (e.g. Colombia, Ecuador, Panama, Peru) (Funk et al. 2007, EOL 2013, GBIF 2013, Tropicos 2013). This tree was collected in the 'seasonally flooded forest' along the Palumeu River.

Solanum semotum (Solanaceae) is a newly recorded species for Suriname. We made our specimen collections from a tree of approximately 5 meters in height, collected at the edge of 'tall dryland tropical forest on laterite/granite hills' on top of the Grensgebergte granite mountain at an elevation of approximately 800 meters asl. *Solanum semotum* was previously collected in Brazil, French Guiana, and Guyana (Funk et al. 2007, GBIF 2013).

The next new species for Suriname was ***Hirtella duckei*** (Chrysobalanaceae) (see page 26), which was a small understory tree found in a gully on the trail to the Kasikasima Mountains. The tree species was also found in plot 3 at RAP site 4 (Kasikasima) in 'tall dryland tropical forest on laterite/granite hills'. The species is covered with brown hairs, and the leaf base bears swollen ant cavities which house mutualistic ants. The ants receive shelter from the plant, in turn protect the plant from herbivores. *Hirtella duckei* is known from central and western Amazonia (Brazil), Colombia, Peru and from Guyana, and also from the state of Amazonas in Venezuela (Funk et al. 2007, Prance 2007, Discover Life 2013, GBIF 2013).

Clusia flavida is the fifth newly recorded species for Suriname. This tree was also collected at the edge of 'tall dryland tropical forest on laterite/granite hills' on top of the

Table 3.2. List of plants collected along the Palumeu River, the Grensgebergte, the Kasikasimagebergte and surroundings during the CI Rap survey of 2012. Numbers indicate number of specimens collected at each survey site (River: Along the Palumeu River between sites, Site 1: Upper Palumeu River (Juuru Camp), Site 2: Grensgebergte Granite Rock, Site 3: Makrutu Creek, Site 4: Kasikasima camp, Village: Palumeu village).

* new records for Suriname; **IUCN Redlist species, *** species on CITES Appendices

FAMILY	SPECIES	RIVER	SITE 1	SITE 2	SITE 3	SITE 4	VILLAGE
Acanthaceae	*Justicia secunda*		1				
	Mendoncia bivalvis	1	1				
	Mendoncia cf. *pedunculata*		1				
Annonaceae	*Anaxagorea dolichocarpa*		1				
	Annona hypoglauca			1			
	Duguetia					1	
	Duguetia calycina		1			4	
	Duguetia riparia		1				
	Duguetia surinamensis					1	
	Guatteria punctata		1				
	*Tetrameranthus guianensis**					1	
	Unonopsis					2	
	Unonopsis stipitata		1				
Apocynaceae	*Ambelania acida*					1	
	Aspidosperma cruentum					1	
	Geissospermum sericeum					1	
	Gonolobus ligustrinus					1	1
	Mandevilla	1					
	Mandevilla subspicata						1
	Mandevilla surinamensis						1
	Mesechites trifida			1			
	Pacouria guianensis		1				
	*Prestonia cayennensis**					1	
	spp.			1		2	
	*Tabernaemontana angulata**					1	
	Tabernaemontana sananho		1				
	Tabernaemontana siphilitica			1			
	Tabernaemontana undulata		1			1	
	Tassadia					1	
Araceae	*Anthurium jenmanii*					1	
	Anthurium rubrinervium		1				
	Colocasia	1					
	Monstera spruceana		1				
	Philodendron		1				
	Philodendron megalophyllum		1				
	Philodendron rudgeanum		1				
	sp.						1
Arecaceae	*Bactris*						1
	Bactris acanthocarpa var. *acanthocarpa*		1				
	Bactris brongniartii			1			

FAMILY	SPECIES	RIVER	SITE 1	SITE 2	SITE 3	SITE 4	VILLAGE
	Desmoncus polyacanthos			1			
	Geonoma leptospadix		1				
	Geonoma maxima		1				
	*Syagrus stratincola***					1	
Asclepiadaceae	*Cynanchum blandum*		1				
Aspleniaceae	*Asplenium laetum*					1	
Asteraceae	*Chromolaena odorata*					1	
	Mikania micrantha			1		1	
	Mikania parviflora			1			
	Piptocarpha						1
	spp.				1	1	
Balanophoraceae	*Helosis cayennensis*		1				
Begoniaceae	*Begonia glabra*		1				
Bignoniaceae	*Arrabidaea inaequalis*				1		
	Callichlamys latifolia		1				
	Distictella magnoliifolia		1				
	Mussatia					1	
	Paragonia pyramidata		1	2			
	spp.	1		1			
Bixaceae	*Bixa orellana*		1				
Blechnaceae	*Salpichlaena volubilis*		1				
Boraginaceae	*Cordia laevifrons*					2	
	Cordia tomentosa				1		
	Tournefortia cuspidata		1				
Bromeliaceae	*Aechmea mertensii*		1				
	Guzmania lingulata					1	
	Pitcairnia geyskesii						1
Burmanniaceae	*Apteria aphylla*						1
Burseraceae	*Protium*			1		5	
	Protium heptaphyllum ssp. *heptaphyllum*			1		1	1
	Tetragastris					3	
Cabombaceae	*Cabomba*				1		
Caryocaraceae	*Caryocar microcarpum*			1			
	Caryocar nuciferum					1	
Celastraceae	*Hippocratea volubilis*			1		1	
	Maytenus pruinosa			2			
Chrysobalanaceae	*Exellodendron barbatum*					1	
	Hirtella cf. *racemosa*		1				
	*Hirtella duckei**					1	
	Licania					5	
	Licania alba		1				
	Licania albiflora					1	
	Licania laevigata					1	
	Licania leptostachya			1			
	Parinari campestris					1	

FAMILY	SPECIES	RIVER	SITE 1	SITE 2	SITE 3	SITE 4	VILLAGE
Clusiaceae	*Clusia* aff. *flavida**						1
	Clusia leprantha			1			
	Clusia panapanari						1
	Rheedia macrophylla		1			1	
	Symphonia globulifera					1	
	Tovomita		1			1	
	Tovomita calodictyos		1				
	Tovomitopsis membranacea					1	
	*Tovomitopsis membranacea**				1		
Combretaceae	*Combretum*			1			
	Combretum laxum			1			
	Combretum rotundifolium			2			
	Terminalia amazonia					1	
Commelinaceae	*Dichorisandra hexandra*		1		1		
Connaraceae	*Connarus coriaceus*				1		
	Connarus fasciculatus		1				
	sp.					1	
Convolvulaceae	*Evolvulus alsinoides*			1			
	Ipomoea alba		1				
	Ipomoea tiliacea			1			
Costaceae	*Costus arabicus*		1				
	Costus claviger		1				
	Costus lanceolatus subsp. *pulchriflorus*					1	
	Costus scaber		1				
	Costus spiralis var. *spiralis*						1
Cucurbitaceae	*Cayaponia cruegeri*		1				
	Gurania bignoniacea		1				
	Gurania subumbellata		1				
Cyperaceae	*Calyptrocarya bicolor*		1				
	Cyperus			1			
	Diplacrum						1
	Rhynchospora barbata						1
	Rhynchospora cephalotes			1		1	
	Rhynchospora comata				1		
	Scleria				1		
	Scleria cyperina					1	1
	Scleria flagellum-nigrorum		1				
	Scleria microcarpa		1				
	Scleria stipularis		1				
	spp.	1	1			1	
Dennstaedtiaceae	*Lindsaea* cf. *parkeri*		1				
	Pteridium aquilinum						1
Dichapetalaceae	*Tapura amazonica*					1	
	Tapura guianensis		2			2	

FAMILY	SPECIES	RIVER	SITE 1	SITE 2	SITE 3	SITE 4	VILLAGE
Dilleniaceae	*Davilla kunthii*			1			
Dioscoreaceae	*Dioscorea*		1				
	Dioscorea cf. *debilis*			1			
Dryopteridaceae	*Tectaria incisa*		1				
	Triplophyllum dicksonioides		1				
Elaeocarpaceae	*Sloanea*					3	
Ericaceae	*Cavendishia callista*						1
Erythroxylaceae	*Erythroxylum*					1	
	Erythroxylum kapplerianum				1		
	Erythroxylum macrophyllum					1	
Euphorbiaceae	*Chaetocarpus schombugkianus*					1	
	Conceveiba guianensis		1			1	
	Croton cuneatus		1				
	Croton guianensis					1	
	Croton pullei		1	1			
	Euphorbia thymifolia	1					
	Sapium argutum						1
	sp.					1	
Fabaceae	*Alexa wachenheimi*		1				
	Bauhinia cupreonitens					1	
	Bocoa viridiflora					2	
	Candolleodendron brachystachyum					1	
	Chamaecrista nictitans var. *disadena*					1	
	Cynometra marginata					1	
	Dialium guianense			1			
	Dioclea coriacea			1			
	Dioclea elliptica		2				
	Elizabetha paraensis					1	
	Elizabetha princeps		1				
	Eperua falcata					1	
	Inga					3	
	Inga acrocephala		1			1	
	Inga brachystachys		1				
	Inga cf. *acrocephala*					1	
	Inga disticha			1			
	Inga graciliflora		1				
	Inga grandiflora						1
	Inga longiflora					1	
	Inga nobilis		4				
	Inga rubiginosa					1	
	Inga splendens		1	1			
	Inga stipularis						1
	Inga vera subsp. *affinis*			1			
	Inga virgultosa					2	

FAMILY	SPECIES	RIVER	SITE 1	SITE 2	SITE 3	SITE 4	VILLAGE
	Machaerium quinata			1			
	Machaerium trifoliolatum			1			
	Macrolobium bifolium		1				
	Mimosa myriadenia		1				
	Mucuna urens		1				
	*Paloue induta**					1	
	Phaseolus lunatus	1					
	*Platymiscium filipes**		1				
	Senna alata		1				
	Senna bicapsularis		1				
	Senna quinquangulata						1
	Senna silvestris var. *silvestris*			1			
	spp.	1				3	
	Swartzia					1	
	Swartzia benthamiana					1	
	Swartzia cf. *remiger*		1			1	
	Swartzia oblanceolata					5	
	Swartzia panacoco var. *polyanthera*			1		1	
	Taralea oppositifolia					1	
	Vigna juruana			1			
	Zygia latifolia var. *lasiopus*			1			
	Zygia racemosa		1				
Gentianaceae	*Chelonanthus purpurascens*						1
	Voyria clavata					1	
	Voyria rosea					1	
Gesneriaceae	*Besleria flavo-virens*		1				
	Chrysothemis rupestris		1				
	Codonanthe crassifolia		1				
	Drymonia coccinea		1				
	Drymonia serrulata		1				
	Lembocarpus amoenus		1				
	Nautilocalyx pictus		1				
	Paradrymonia campostyla		1				
	Sinningia incarnata					1	1
Haemodoraceae	*Xiphidium caeruleum*				1	1	
Heliconiaceae	*Heliconia acuminata*		1				
	Heliconia densiflora		2				
	Heliconia lourteigiae		1				
	Heliconia richardiana					1	
Hymenophyllaceae	*Hymenophyllum decurrens*						1
	Trichomanes vittaria					1	
Icacinaceae	*Discophora guianensis*					1	
indet			3			3	1

FAMILY	SPECIES	RIVER	SITE 1	SITE 2	SITE 3	SITE 4	VILLAGE
Lamiaceae	*Hyptis lanceolata*		1				
	Vitex orinocensis var. *multiflora*		1				
Lauraceae	*Licaria canella*					2	
	Ocotea guianensis					1	
	spp.		1			9	
Lecythidaceae	spp.		1			13	
Lentibulariaceae	*Utricularia*				1		1
	Utricularia subulata				1		
Linaceae	*Hebepetalum schomburgkii*					1	
Loganiaceae	*Spigelia hamelioides*		1				
	Strychnos			1			
	Strychnos guianensis			1			
Loranthaceae	*Oryctanthus alveolatus*			1			
	Phthirusa pyrifolia						1
Malpighiaceae	*Byrsonima spicata*						1
	*Heteropterys orinocensis**					1	
	Hiraea fagifolia		2				
	Stigmaphyllon convolvulifolium		1				
	Stigmaphyllon sinuatum	1					
	Tetrapterys crispa		1				
Malvaceae	sp.					1	
Marantaceae	*Calathea comosa*		1				
	Calathea elliptica		1				
	Hylaeanthe unilateralis		1				
	*Ischnosiphon hirsutus**		1				
	Ischnosiphon obliquus		1			1	
	Monotagma plurispicatum		1				
	Monotagma secundum		1				
	Monotagma spicatum		1				
Melastomataceae	*Aciotis indecora*		1				
	*Clidemia attenuata**						1
	Clidemia capitellata			1			
	Clidemia dentata		1				
	*Clidemia epiphytica**		1				
	Clidemia hirta			1			
	Ernestia granvillei					1	
	Henriettea patrisiana					1	
	Henriettea stellaris			1			
	Henriettea succosa			1			
	Henriettella caudata		2				
	Leandra rufescens					1	
	Macrocentrum fasciculatum						1
	Maieta guianensis		1				

FAMILY	SPECIES	RIVER	SITE 1	SITE 2	SITE 3	SITE 4	VILLAGE
	Maieta poeppigii		1				
	Miconia bracteata					1	
	Miconia ceramicarpa					1	
	Miconia ciliata						1
	Miconia lateriflora		1				
	Miconia minutiflora			1			
	Miconia prasina		1	1			1
	Miconia racemosa						1
	Miconia sagotiana						1
	Miconia serrulata		1				
	spp.	1	2			2	
	Topobea parasitica				1		
Meliaceae	*Guarea costata*					1	
	Guarea guidonia		2				
	Guarea pubescens subsp. *pubescens*		1	1			
	Guarea scabra					1	
	Trichilia		1			1	
	Trichilia schomburgkii subsp. *schomburgkii*					2	
Memecylaceae	*Mouriri*					1	
	Mouriri grandiflora		1				
	Mouriri vernicosa			1			
Menispermaceae	*Abuta grandifolia*		2				
	Abuta obovata				1		
	Orthomene schomburgkii					1	
Monimiaceae	*Siparuna cuspidata*					1	
Moraceae	*Brosimum guianense*					1	
	Ficus amazonica		1		1		1
	sp.					1	
	Trymatococcus amazonicus					2	
Myristicaceae	*Iryanthera*					1	
	Virola					1	
Myrsinaceae	*Cybianthus prieurii*		1			1	
	Myrsine guianensis						1
	Stylogyne atra		1				
Myrtaceae	*Calyptranthes*					1	
	Eugenia					1	
	Eugenia tetramera					1	
	Myrcia					2	
	Myrcia splendens					1	
	Psidium cattleianum					1	
	spp.		2	4	1	10	8
Nymphaeaceae	*Nymphaea glandulifera*		1				

FAMILY	SPECIES	RIVER	SITE 1	SITE 2	SITE 3	SITE 4	VILLAGE
Ochnaceae	*Ouratea cerebroidea*					1	
	Ouratea leblondi				1	2	
Olacaceae	*Heisteria cauliflora*					1	
	sp.		1				
Onagraceae	*Ludwigia affinis*					1	
	Ludwigia latifolia		1				
Orchidaceae	*Cleistes rosea***						1
	*Dichaea picta***		1				
	*Epidendrum densiflorum***		1				
	*Epidendrum nocturnum***						1
	*Maxillaria discolor***						1
	*Phragmipedium lindleyanum***						1
	spp.		2		1		
Parkeriaceae	*Ceratopteris deltoidea*			1			
Passifloraceae	*Passiflora costata*			1		1	
Piperaceae	*Peperomia serpens*		1				
	Piper anonifolium var. *anonifolium*		1				
	Piper arboreum		1				
	Piper bartlingianum		2				
	Piper demeraranum					1	
	Piper hostmannianum			1			
	sp.		1				
Poaceae	*Lasiacis ligulata*					1	1
	Olyra obliquifolia				1		
	Pariana radiciflora					1	
	spp.		3			2	
Polygalaceae	*Barnhartia floribunda*					1	
	Polygala adenophora						1
	Securidaca paniculata		1				
Polygonaceae	*Coccoloba ascendens*					1	
	Coccoloba parimensis						1
Polypodiaceae	*Microgramma lycopodioides*		2				1
	Microgramma persicariifolia			1			
	Niphidium crassifolium		1				
	Pecluma plumula				1		
	Pleopeltis percussa				1		
Portulacaceae	*Portulaca sedifolia*				1		
Putranjivaceae	*Drypetes variabilis*		1				
Quiinaceae	*Quiina indigofera*					1	
	*Quiina indigofera**					1	
Rapateaceae	*Rapatea paludosa*					1	
Rhamnaceae	*Gouania blanchetiana*			1			
	Gouania velutina		1				

FAMILY	SPECIES	RIVER	SITE 1	SITE 2	SITE 3	SITE 4	VILLAGE
Rubiaceae	*Alibertia edulis*						1
	Borreria			1			1
	Duroia aquatica					1	
	Duroia eriopila		1				
	Faramea multiflora		1				
	Genipa americana			1			
	Isertia coccinea			1			
	Ixora piresii					1	
	Manettia coccinea var. *spraguei*		1				
	Palicourea		2			1	
	Palicourea longiflora						1
	Palicourea quadrifolia						1
	Palicourea triphylla						1
	Posoqueria					1	
	Posoqueria latifolia		1				
	Posoqueria longiflora		2				
	Psychotria		4		1	1	
	Psychotria bracteocardia					1	
	Psychotria hoffmannseggiana var. *hoffmannseggiana*						2
	Psychotria poeppigiana		1				
	Psychotria racemosa		1				
	Retiniphyllum		1				
	Sabicea			1			
	Sabicea amazonensis						1
	Sabicea oblongifolia			1			
	Sipanea pratensis						1
	Sipanea pratensis var. *dichotoma*				1		
	Spermacoce verticillata			1		1	
	spp.		1			2	
Rutaceae	*Ertela trifolia*				1		
Salicaceae	*Casearia pitumba*						1
	Homalium guianense					1	
	Ryania pyrifera					2	
Santalaceae	*Phoradendron piperoides*					1	
Sapindaceae	*Paullinia capreolata*					1	
	Paullinia dasygonia			1			
	sp.					1	
	Talisia					1	
	Talisia mollis		1				
	Thinouia myriantha		1				
	Toulicia cf. *pulvinata*					1	
	Toulicia pulvinata					1	

FAMILY	SPECIES	RIVER	SITE 1	SITE 2	SITE 3	SITE 4	VILLAGE
Sapotaceae	*Micropholis* cf. *Splendens**					1	
	Micropholis guyanenis					3	
	Micropholis guyanenis subsp. *guyanensis*					2	
	Pouteria				1	3	1
	Pouteria cladantha					1	
	Pouteria guianensis					2	
	spp.					4	
Schizaeaceae	*Anemia villosa*						1
Selaginellaceae	*Selaginella parkeri*		1				
	Selaginella producta					1	
Simaroubaceae	*Simaba cedron*					1	
	Simaba orinocensis			1		1	
Siparunaceae	*Siparuna cuspidata*		2				
	Siparuna decipiens					1	
	Siparuna guianensis			1			
Solanaceae	*Brunfelsia guianensis*					1	
	Cyphomandra oblongifolia		1				
	Lycianthes pauciflora		1				
	Markea coccinea		1				
	Solanum crinitum	1					
	Solanum paludosum					1	
	Solanum pensile			1			
	Solanum rugosum	1					
	*Solanum semotum**						1
Symplocaceae	*Symplocos guianensis*						1
Turneraceae	*Turnera glaziovii*						1
Urticaceae	*Cecropia latiloba*			1			
Violaceae	*Gloeospermum sphaerocarpum*		1				1
	Leonia glycicarpa		1				
	Paypayrola hulkiana		2				
	Rinorea					1	
	Rinorea amapensis		2				
	Rinorea pubiflora		1				
	Rinorea pubiflora var. *pubiflora*		1	1			
Vitaceae	*Cissus erosa*						1
	Cissus verticillata			2			
Zingiberaceae	*Renealmia monosperma*		1				

Grensgebergte granite mountain. The species has a South American distribution, and was also recorded in the Guianas in the states of Amazonas and Bolivar in Venezuela, Guyana and French Guiana (Funk et al. 2007, Discover Life 2013, GBIF 2013).

Platymiscium filipes was collected in Brasil and French Guiana, but so far not in Suriname (Funk et al. 2007, GBIF 2013, Tropicos 2013). This liana was collected in the 'seasonally flooded forest' along the boven Palumeu River during our journey to the Makrutu camp.

We found the tree species ***Tabernaemontana angulata*** in plot 3 at RAP site 4 (Kasikasima) in 'tall dryland tropical forest on laterite/granite hills'. The tree species has an Amazonian distribution occurring in Brazil, Colombia, and Venezuela (Discover Life 2013, WCSP 2013). The species has also been recorded from French Guiana and Guyana, but so far not in Suriname (Funk et al. 2007).

Prestonia cayennensis is the eighth newly recorded species for Suriname. This liana species has an Amazonian distribution, and was collected before in the Guianas in French Guiana, Guyana, and Venezuela (state of Bolivar) , as well as in Brazil and Colombia but not in Suriname (Funk et al. 2007, Discover Life 2013). We found this liana in the seasonally flooded forest along the Palumeu River.

We found ***Paloue induta*** for the first time in Suriname along the edge of the Palumeu River in seasonally flooded forest close to RAP site 4 (Kasikasima). The tree species is known from Guyana and Brasil, but has so far to our knowledge, not been recorded for Suriname (Funk et al. 2007, GBIF 2013).

Heteropterys orinocensis is the tenth newly recorded species for Suriname. This liana species is known from Northern Brasil, and western Amazonia (e.g. Colombia, Venezuela, Peru), French Guiana, and from the states of Amazonas and Bolivar in Venezuela (Funk et al. 2007, GBIF 2013). It was found in the seasonally flooded forest along the Palumeu River at site 4.

We found the herb species ***Ischnosiphon hirsutus*** for the first time in Suriname in a wet patch of '(seasonally flooded) palm swamp forest and creek forest' at site 1. As far as we can assess the species has not been recorded for Suriname. *Ischnosiphon hirsutus* has been recorded in western Amazonian (e.g. Colombia, Peru, Bolivia, Colombia), the state of Bolivar in Venezuela, southern Guyana and Northwestern Brasil (Funk et al. 2007, GBIF 2013).

Clidemia attenuata is the twelfth newly recorded species for Suriname, and was found together with *Clusia flavida* at the edge of the tall dryland tropical forest on laterite/granite hills, on the Grensgebergte Mountain. The species was previously collected in French Guiana, Guyana and Venezuela (Funk et al. 2007, Tropicos 2013, GBIF 2013), but according to the data we have consulted, never before in Suriname.

The next newly recorded species for Suriname is ***Clidemia epiphytica***. The species was previously recorded in western Amazonian, but was found in French Guiana as well (Funk et al. 2007, GBIF 2013, Tropicos 2013).

At RAP site 1 (Upper Palumeu) and site 4 (Kasikasima) we found the tree species ***Quiina indigofera*** in plots 1, 2 and 3 in 'tall dryland tropical forest on laterite/granite hills'. The species has been collected before in Brazil, Colombia, Guyana and Venezuela (states of Bolivar and Delta Amacuro), but according to the data we assessed, never in Suriname (Funk et al. 2007, GBIF 2013, Tropicos 2013).

The last and fifteenth species newly recorded for Suriname was ***Micropholis splendens***. This tree species was found in plot 3 at RAP site 4 (Kasikasima) in 'tall dryland tropical forest on laterite/granite hills'. The species has been collected before in Brazil, Colombia, French Guiana, Guyana, and Venezuela (Funk et al. 2007, GBIF 2013, Tropicos 2013).

Noteworthy species

Several of the plant species we have collected during the expedition are interesting to mention in this report. This is mostly because of their rarity in geographical distribution and/or because the amount of known collections in the Guianas collections at National Herbarium of the Netherlands (NHN) is very small.

The palm tree *Syagrus stratincola* (Arecaceae) was collected in 'savannah forest on granite rock' on the top of the Kasikasima Mountains. *Syagrus stratincola* is a rare palm species endemic to the Guianas, and only known from ten localities in the Guianas (IUCN Redlist 2013). The status of this palm species on the IUCN Red List is Vulnerable. In Suriname this palm species is known from the Sipaliwini Savannah, the Tapanahony and Palumeu Rivers. The palm species occurs on granite plates and rocky outcrops. We also observed solitary trees of this palm in savannah forest on granite plates at the rapids along the Palumeu River and at the bathing place of camp 4, and in great abundance on the steep slopes of the Kasikasima Mountains.

We found the tree species *Ouratea cerebroidea* in plot 3 at RAP site 4 (Kasikasima) in 'tall dryland tropical forest on laterite/granite hills'. The species was previously recorded in Brazil, Guyana and French Guiana according to the encyclopedia of life (Funk et al. 2007, EOL 2013, GBIF 2013). The first collection of this species was collected by de Granville in the Tumuc Humac Mountains close to the border of French Guiana (GBIF 2013). We have collected the second collection for Suriname.

The orchid *Phragmipedium lindleyanum* found by us on top of the Grensgebergte RAP site 2 in open rock vegetation is a rarely collected species in Suriname (see page 26). According to Werkhoven (1986) and the National Herbarium of the Netherlands (NHN) collection, *Phragmipedium lindleyanum* is known in Suriname from the Wilhelminagebergte at an elevation above 800 m asl. It was collected by Stahel in 1926. The species most likely has a Guiana Shield distribution and has been recorded in Brazil, French Guyana, Guyana, and Venezuela and is associated with elevations above 500 m asl (WCSP 2013).

In the vicinity of plot 4 in a mixed forest of 'savannah forest on granite rock' and 'tall dryland tropical forest on

laterite/granite hills', we found the tree species *Eugenia tetramera*, with large velvet yellow haired fleshy fruits. This tree belongs to a rare Myrtaceae species, and was also collected by O.S. Bánki and Frits van Troon in 2005 close to Stondansi in Northwestern Suriname. The current collection of *Eugenia tetramera* is the sixth collection in total for Suriname according to NHN. Apart from Suriname, *Eugenia tetramera* has been recorded in Brazil, French Guiana and Guyana, and the species has a Guianan distribution (Funk et al. 2007, GBIF 2013).

According to the NHN *Ixora piresii* (Rubiaceae) was collected for the last time in 1975 on the Lely Mountains, by Lindeman et al. It was a tree of 1.5 meters high and was collected in the understory of the tall dryland forest on Laterite Hill, at the Kasikasima Mountain. Specimens of this species were also collected on the Nassau Mountains and along the Boven Coppename River. The species is also known from Brazil and French Guiana (Funk et al. 2007, EOL 2013).

Along the Palumeu River at site 4 (Kasikasima) we found the noteworthy tree species *Taralea oppositifolia* in the tree layer of the seasonally flooded forest. *Taralea oppositifolia* was collected in Suriname in 1936 along the Litanie River for the last time. We collected the fourth specimen for Suriname and the first with fruits. *Taralea oppositifolia* has a neotropical distribution. It was recorded from western to eastern Amazonia, for example Colombia, Venezuela, Peru, Brazil, the Guianas and Panama, Dominican Republic and Peru, (Funk et al. 2007, GBIF 2013).

On top of the Grensgebergte RAP site 2 on the forest floor of a short mountain savannah forest we found *Lembocarpus amoenus* a Gesneriaceae herb with one leaf and an inflorescence stalk with purple bell shaped flowers. Our collection of *Lembocarpus amoenus* is the second collection for Suriname at the NHN. The first specimen was collected on the Bakhuis Mountain, in 1965. Apart from Suriname, *Lembocarpus amoenus* has been recorded in French Guiana. The species has a restricted distribution and is so far only found on ferro-bauxite Mountains (Funk et al. 2007, EOL 2013, GBIF 2013).

On the top of the Grensgebergte RAP site 2, on the Kasikasima Mountains, and on rocky outcrops close to large *Sinningia incarnata*. This species is another Gesneriaceae herb with showy red flowers. *Sinningia incarnata* typically occurs on granitic rocks and is the second collection for Suriname. The first specimen is known from the Voltzberg, collected by de Granville et al. in 1932 (GBIF 2013). *Sinningia incarnata* has a neotropical distribution (Funk et al. 2007, GBIF 2013).

In seasonally flooded palm swamp forest and creek forest at RAP site 4 (Kasikasima) we encountered *Costus lanceolatus* subsp. *pulchriflorus* (see page 26). This herb species with showy red flowers is the fourth collection for Suriname at the NHN. It was previously collected in Oelemari and Taponte (Marowijne River). *Costus lanceolatus* subsp. *pulchriflorus* has also been recorded in Brazil and French Guiana (Funk et al. 2007, GBIF 2013).

Cavendishia callista (Ericaceae) is the fifth collection for Suriname according to the NHN. It was collected on the plateau of the Grensgebergte Granite Mountain, in full bright sun. It was previously recorded on the Hendriktop (1922), Bakhuis Mountain (1965) and Lely Mountain (1975, 2004) in Suriname. *Cavendishia callista* has a North South American and Middle American distribution (GBIF 2013).

IUCN Red list species

We encountered three tree species listed on the IUCN Red List, namely:

- *Minquartia guianensis* Lower Risk (LR)/near threatened (NT) ver 2.3 (1994)
- *Syagrus stratincola* Vulnerable B1+2c ver. 2.3, 1998
- *Vouacapoua americana* Critically Endangered (CR) A1cd+2cd ver 2.3 (1994)

It needs to be noted that *Vouacapoua americana* within Suriname can still be found at some places in reasonable amount of numbers. In total, we found 9 individual trees of *Vouacapoua americana* spread over all the four 0.1 ha plots.

We encountered 9 species of orchids that are listed on the CITES appendices. Three orchid species still need to be identified. The other six orchids are *Cleistes rosea*, *Dichea picta*, *Epidendrum nocturnum* (see page 26), *E. densiflorum*, *Maxillaria discolor* and *Phragmipedium lindleyanum*.

We encountered one tree species¸ *Manilkara bidentata* (boletri) that is protected against felling by the Surinamese law (Surinamese Forest Law of 1992).

Plot inventories

In all four 0.1 ha plots combined we found a total of 791 individual trees belonging to approximately 44 families, 79 genera, and 139 (morpho-) species. Of the total 791 individual trees, 1.4 % could so far not be identified to the family level, 16 % could so far not be identified to the genus level, and 32% of the species could only be identified to morpho-species level so far. The five most common tree families were: Fabaceae (175 individuals), Burseraceae (67), Sapotaceae (60), Lecythidaceae (55), and Apocynaceae (45). The five most common tree genera in the four plots were: *Inga* (50 individuals), *Eperua* (42), *Swartzia* (32), *Siparuna* (31), and *Pouteria* (30). The ten most common tree species across the four plots were: *Eperua falcata* (42 individuals), *Siparuna cuspidata* (30), *Inga acrocephala* (28), *Tabernaemontana undulata* (27), *Micropholis guyanenis* (26), *Bocoa virdiflora* (25), *Tetragastris altissima* (21), *Tetragastris panamensis* (20), *Brosimum guianense* (19), and *Toulicia pulvinata* (19).

Although the mean Fisher's alpha of the plots from southern Suriname (the plots of the current study combined with those from the Kwamalasamutu surroundings) was higher (Fa = 41.82) than the mean Fisher's alpha of the plots from northern Suriname (Fa = 31.74), the difference was not

significant. The plots in southern Suriname therefore did not have a significantly higher tree alpha diversity. The difference in total amount of species and total amount of individual trees per plot was also not significant between the plots of the southern and northern Suriname.

The Nonmetric Multidimensional Scaling (NMS) ordinations for all species, species with five or more individuals in total, and all genera showed the same patterns in floristic differences between plots. Most variation in floristic differences was explained by the difference between the plots from southern Suriname and plots from northern Suriname. There were however still some floristic differences between the plots of the Kwamalasamutu surroundings and the plots of this current study (see Figure 3.1 and 3.2).

The results of the Indicator Species Analyses showed that only a small number of species and genera were responsible for the floristic differences observed between the plots of southern and northern Suriname. Of all species in the total plot database, 11 % had five individuals or more. Of these species, we found 62 % of the species to be a significant indicator for either the plots in the northern Suriname or plots in southern Suriname (plots in the surroundings of Kwamalasamutu combined with plots of the current study). For the genera we found 12 % of all genera to be a significant indicator for either the plots of northern Suriname or plots in southern Suriname (plots in the surroundings of Kwamalasamutu combined with plots of the current study).

Within the four 0.1 ha plots combined of the current study we found 24% of the tree species to be listed as commercial timber species according to the Surinamese forest law of 1992. These 24% of all tree species in the plots made up 39% of the total individual trees found across all the four plots. In the plots of northern Suriname, 33% of all the tree species were listed as commercial timber species according to the Surinamese forest law of 1992. These 33% of the total tree species made up however 25% of the total amount of individual trees found in the six plots from northern Suriname. Although less commercial timber species seemed to occur in the four 0.1 ha plots of this study, these timber species did represent more individual trees in comparison to the plots of northern Suriname. It needs to be noted that quite common commercial tree species, like *Eperua falcata*, were represented by most individual trees. In the study in the surroundings of Kwamalasamutu, very few commercial timber species were observed. These findings showed the forests in the south of Suriname are not particularly rich in commercial timber species.

DISCUSSION

Of the total amount of 354 species found during the expedition to the regions of Grensgebergte and Kasikasima and identified so far, about 4% represent new records for Suriname. Eight of these newly recorded species have an

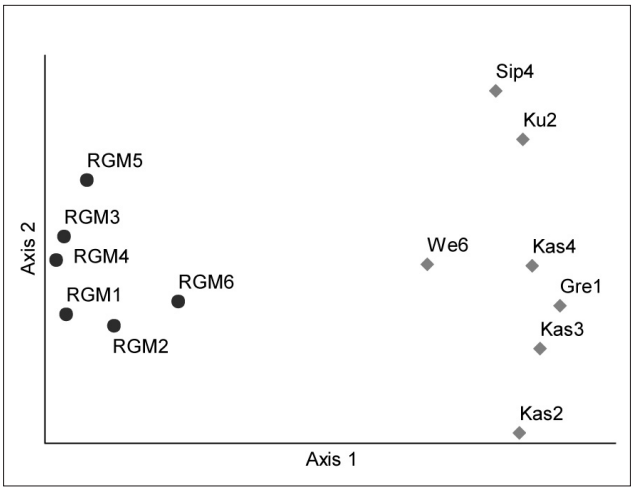

Figure 3.1. Non-metric multidimensional scaling (NMS) showing the floristic differences of the 0.1 ha plots of the South of Suriname, current study (Gre1, Kas2-4) combined with plot from the surroundings of Kwamalasamutu (Ku2, Si4, We6), and the 0.1 ha plots of Northern/Central Suriname (RGM 1-6). The NMS shown is the ordination based on all species with five or more individuals in the total plot data set of the South and North of Suriname. The first axis represented most variation in floristic differences (77%) separating the plots of the South of Suriname from the plots of the Northern/Central Suriname. The second axis represented 14% of the floristic variation, mostly showing the floristic differences between the plots of the current study and the plots from the surroundings of Kwamalasamutu.

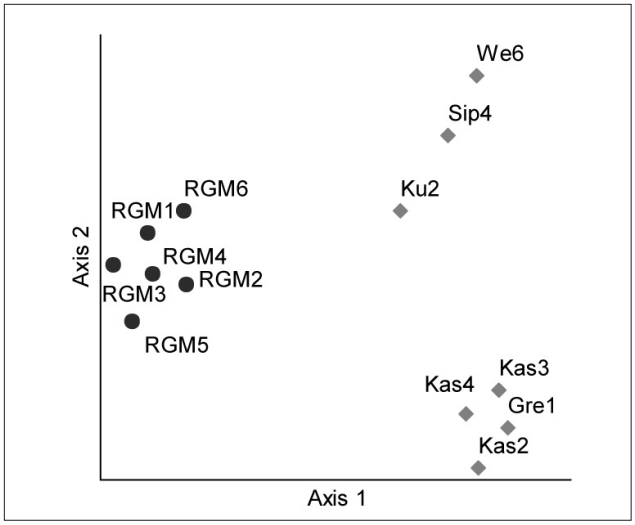

Figure 3.2. Non-metric multidimensional scaling (NMS) showing the floristic differences of the 0.1 ha plots of the South of Suriname, current study (Gre1, Kas2-4) combined with plot from the surroundings of Kwamalasamutu (Ku2, Si4, We6), and the 0.1 ha plots of Northern/Central Suriname (RGM 1-6). The NMS shown is the ordination based on all genera in the total plot data set of the South and North of Suriname. The first axis represented most variation in floristic differences (60%) separating the plots of the South of Suriname from the plots of the Northern/Central Suriname. The second axis represented 26% of the floristic variation, mostly showing the floristic differences between the plots of the current study and the plots from the surroundings of Kwamalasamutu.

Amazonian distribution, while six species have a Guianas or a Guiana Shield distribution, and one newly recorded species for Suriname has a Neotropical distribution. Of the total amount of 152 genera found during the expedition to the Grensgebergte and Kasikasima and identified so far, about 1% represent new records for Suriname. The genus *Tetrameranthus* has a Guianas distribution, while the genus *Tovomitopsis* has a Neotropical distribution. The geographical distribution of the new records for Suriname suggests that opposed to northern Suriname, southern Suriname could show more floristic affinity with the whole of Amazonia. Since many of the newly reported species are already known from other countries in the Guianas and the Guiana Shield, it could also show that the forests in the South of Suriname are little explored. We assessed the occurrence of the fifteen newly recorded species, and two genera from the best possible available digital information. It is however possible that valuable information about the occurrence of these species and two genera within Suriname has been missed, because the information is not digitally available. As several difficult plant families still require further identification, it is likely more new records or special species for Suriname will be found.

The new records for Suriname were found in four vegetation types, which are all dominant and floristically distinct for the South of Suriname. Five newly recorded species for Suriname were found in 'tall dryland tropical forest on laterite/granite hills', and four species on the edge of this forest type at the interchange to open rock vegetation. Five species were found in tall seasonally flooded forest along the Palumeu River, and one species was found in seasonally flooded palm swamp forest. Extensive areas of tall seasonally flooded forests were found along the Upper Palumeu River. The Upper Palumeu River is a meandering river that flows in valleys of a hilly landscape, and cuts through eroded sediment (loamy and sandy substrate). Because of the flat plains the water flows into the forests, just as was found in the surroundings of Kwamalasamutu (Bánki and Bhikhi 2011). Such extensive 'seasonally flooded forests' are less known from Northern parts of Suriname. Where the Upper Palumeu River starts to meander widely, vegetation types like palm swamps and 'tall herbaceous swamp vegetation and swamp wood' occurred frequently. These vegetation types resemble vegetation types in the coastal areas of Suriname, both in appearance and at times in species composition. Vegetation types like the 'tall dryland tropical forests on laterite/granite hills', 'savannah moss forest on granite rock' and 'open rock (Inselberg) vegetation, including rocky outcrops around rapids' are however dominant and exemplary for central (e.g. Raleigh Vallen) and southern Suriname. Between RAP Sites 1 and 4 there were some floristic differences in the composition of the 'tall dryland tropical forest on laterite/granite hills'. The open rock vegetation between the Grensgebergte (RAP Site 2) and the Kasikasima Mountains (RAP Site 4) had similar species composition. Interestingly, the rocky outcrops close to rapids along the Upper Palumeu River also had comparable species composition to the open rock vegetation on the Grensgebergte and the Kasikasima Mountains. On these rock outcrops as well as on the Grensgebergte wet micro habitats with carnivorous plants were also similar. Such vegetation types are relatively rare. Most orchids that were found on the Grensgebergte rock outcrop were recorded only a few times in Suriname (Werkhoven 1986).

Previous studies predict that tree alpha diversity increases from the North of the Guianas to the South, especially in Guyana and Suriname (ter Steege et al. 2003, 2006). Our findings based on real data from seven 0.1 ha plots from southern Suriname show that tree alpha diversity is not significantly higher in comparison to northern Suriname. Most of the seven 0.1 ha plots, from the current study and from the study in the surroundings of Kwamalasamutu, occur in 'tall dryland tropical forest on laterite/granite hills'. This forest type is standing on relatively nutrient poor and shallow soils because of the bedrock underneath. It is likely the overall tree alpha diversity in this forest type is constrained by these ecological conditions. As the landscape in southern Suriname is dominated by laterite/granite hills, the forest type of 'tall dryland tropical forest on laterite/granite hills' is also very dominant in these areas. These results do not support a view that tree alpha diversity is higher in southern Suriname. However, it is possible that in some forest types tree alpha diversity is higher in the South in comparison to the Northern part of Suriname. The only plot in tall lowland rainforest standing on top of a well-drained loamy to sandy soil along the Kutari River has one of the highest tree alpha diversity recorded for Suriname so far (Bánki and Bhikhi 2011). It is possible that the tall lowland rainforest in the South of Suriname has a high tree alpha diversity in general in comparison to the Northern part of Suriname. But we currently lack the data to firmly state this.

The forests in South Suriname differ substantially in floristic composition from the forests in the Northern part of Suriname that also occur on the Guiana Shield basement complex. The majority of the floristic variation in the total plot database of 13 0.1 ha plots, showed a clear separation between the plots of the South of Suriname with those from the North of Suriname. All the non-metric multidimensional scaling (NMS) analyses showed similar patterns in floristic variation between the plots of the South of Suriname and plots of the Northern part of Suriname. Moreover, there are specific and significant indicator species and genera for the South and the North of Suriname, as revealed by the Indicator Species Analyses. These results indicate that the 'tall dryland tropical forests on laterite/granite hills' found in most of the plots in southern Suriname, have floristic elements that do not occur in the plots of northern Suriname. A lot of identifications of especially the sterile tree species collections still have to be resolved both for the current study and for the plots in the surroundings of Kwamalasamutu. When these tree identifications will be included, we expect that the floristic differences between the plots in the Kwamalasamutu

surroundings and those of the current study will become smaller. Most likely, the completion of sterile tree collection identifications from the plots of the current study and for the plots in the surroundings of Kwamalasamutu will also lead to even sharper floristic differences between the forests of southern and northern Suriname. Our findings also do not support a view that the forests of the Guiana basement complex in Suriname all belong to one uniform forest type (see also Bánki and Bhikhi 2001). This is assumed by WWF's ecoregions, where most forests covering the Guianas are referred to as Guianan moist forest (see www.wwfguianas.org/about_guianas/ecoregions.cfm). Our findings rather support a view that the forests in southern Suriname have several unique floristic elements and are poorly explored. These floristic elements warrant protection of a wilderness area in the Southern Guianas as identified and proposed during the Guayana Shield Conservation Priority setting workshop in Suriname 2002 (Huber and Foster 2003).

CONSERVATION RECOMMENDATIONS

With regard to the plants and forest surveyed during the Grensgebergte and Kasikasima RAP expedition, some conservation recommendations can be made.

The Grensgebergte and the Kasikasima Mountains contain several vegetation types that are within Suriname dominant and floristically distinct for the central and southern parts of Suriname. Within these vegetation types, we recorded nearly all of the fifteen new plant species and two new genera for Suriname we found during this study. We also recorded several species with a restricted distribution in Suriname and/or in the Guianas, orchids listed on Appendices I and II of CITES, some carnivorous plants and three tree species that are listed on the IUCN Red List. Amongst these is a unique palm species *Syagrus stratincola* that is only know from ten localities in the Guianas, and is listed as Vulnerable on the IUCN Red List. We also found the tree species *Vouacapoua americana* that is listed as Critically Endangered on the IUCN Red List. As plant collections from several plant families still await identification, we expect to find more new records or noteworthy species for Suriname. These findings indicate the pristine status of the forests and vegetation types in southern Suriname, and the fact that these forests are still poorly explored.

Based on plot studies, we found distinct differences between the forests in the South from those examined in the North of Suriname. We also found some floristic differences between the forests in the South of Suriname of this study and from the rapid assessment in the surroundings of Kwamalasamutu. However, the floristic differences between plots in the South of Suriname were far less distinct, in comparison to the floristic differences between the plots of the South and the plots of the North of Suriname. Our findings contrasts current models in tree alpha diversity in the Guianas that predict tree alpha diversity ought to be higher in southern Suriname. Species composition of the forests in the South of Suriname was found to be different from the North, and a small set of significant indicator species and genera were found for the South of Suriname. All the plots used in this chapter were located on the Guiana Shield basement complex. We therefore conclude that the forests on the Guiana Shield basement complex are not one uniform forest type as being suggested by some. Some forest types like the tall dryland forests on laterite/granite hills are more dominant in the South of Suriname, and are floristically distinct.

In combination with those from the Kwamalasamutu surroundings, the results of the plant rapid assessment in the surroundings of the Grensgebergte and the Kasikasima Mountains clearly show the occurrence of several dominant vegetation types with distinct floristic elements for Suriname. We expect that further exploration of the South of Suriname will only further strengthen these findings. The floristic distinctiveness of the South of Suriname warrants protection of a wilderness area in the Southern Guianas.

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