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Additive influences of soil and climate gradients drive tree community composition of Central African rainforests

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45

46 **Abstract:**

47 **Aim:** Examining tree species-environment association can offer insight into the drivers of
48 vegetation patterns and key information of practical relevance to forest management. Here,
49 we aim to quantify the contribution of climate and soil gradients to variation in tropical tree
50 species abundance and occurrence across the region in southern and eastern Cameroon.

51 **Location:** Rainforests of southern and eastern Cameroon.

52 **Methods:** We established 82 1-ha permanent plots across seven localities and censused all
53 trees ≥ 10 cm in diameter, representing a total of 37,733 trees and 455 species. In 60 of
54 those plots, we measured ten soil variables describing texture and nutrients levels and
55 extracted ten bioclimatic variables from global-gridded climate databases. We synthesized
56 the main environmental gradients by conducting principal component analyses on climate
57 and soil data respectively. We performed unconstrained and constrained non-symmetric

58 correspondence analyses to account for the individual and joint contributions of climate and
59 soil on species abundance and occurrence.

60 **Results:** Climate and soil contributed similarly to variances of species abundance and
61 occurrence (11–15 % variance for climate vs. 11–12 % variance for soil). Climate influence
62 mostly concerns some abundant species, while less abundant species were mainly driven by
63 soil. Fractions of species variances accounted for by climate and soil show strong correlation
64 when assessed from species occurrence and abundance data.

65 **Conclusion:** Variation in occurrence and abundance of tropical forest trees can be partly
66 shaped by both climate and soil gradients in Cameroon, which emphasizes the importance
67 to jointly considering soil and climate in species distribution modeling. Less abundant
68 species may express environmental influence differently than abundant species and convey
69 complementary information about community composition. Though showing congruent
70 patterns here, species abundance and occurrence reflect different interacting community
71 processes and both should be examined to better understand vegetation patterns.

72 **Keywords:** Cameroon, Climate gradient, Soil gradient, Species abundance, Species
73 occurrence, Tropical rainforests

74 **Nomenclature**

75 African Plant Database (version 3.4.0)

76

77 **Main text:**

78 **INTRODUCTION**

79 A central paradigm in plant ecology is that species distribution along environmental
80 gradients has the potential to inform on the dimensions of their realized niches (John et al.
81 2007; Toledo et al. 2012). For long-lived species such as trees, the presence and abundance
82 of mature individuals can reflect their tolerance and adaptation to local abiotic conditions
83 (Kraft et al. 2015). Tree distribution data thus represents an invaluable source of
84 information on species environmental requirements. For most tropical tree species a better
85 understanding of the drivers of their distribution has strong fundamental implications in

86 vegetation science and practical relevance in forest management and conservation (Swaine
87 1996; Potts et al. 2002; Toledo et al. 2011; Toledo et al. 2012; Amissah et al. 2014).

88 From a fundamental perspective, species turnover along broad-scale gradients can
89 provide insights on the strength of environmental filtering (Hardy & Sonké 2004; Soininen et
90 al. 2007; Kraft et al. 2011). These studies are still too scarce to allow grasping the variety of
91 species-environment patterns especially in diverse parts of the paleotropics. From an
92 applied perspective, determining the relative role of environmental factors such as climate
93 or soil in species distribution can help to classify and map vegetation types, habitats and
94 identify indicator species of a given environmental conditions (Hall & Swaine 1976;
95 Diekmann 2003). These outputs are important for conservation initiatives such as the sixth
96 category of the High Conservation Value (HCV) program dedicated to rare and threatened
97 habitats, developed and used by the Forest Stewardship Council (FSC) to support
98 sustainable forest management. Yet, there has been too few studies on species-
99 environment relationships at regional scale in tropical forests, most of them located in the
100 neotropics (Pyke et al. 2001; Duivenvoorden et al. 2002; Engelbrecht et al. 2007; Slik et al.
101 2009; Toledo et al. 2012; Condit et al. 2013) and even scarcer in Africa (but see Réjou-
102 Méchain et al. 2008; Amissah et al. 2014; Fayolle et al. 2014; Vleminckx et al. 2015) where
103 most studies were at a local scale.

104 Most studies analyzing plot taxonomic data along broad gradients concluded that
105 tropical tree species turnover is partly shaped by climate through rainfall, temperature and
106 seasonality gradients (e.g. Swaine 1996; Bongers et al. 1999; Pyke et al. 2001; Poorter et al.
107 2004; ter Steege et al. 2006; Engelbrecht et al. 2007; Parmentier et al. 2007; Toledo et al.
108 2011; Toledo et al. 2012; Amissah et al. 2014). A limited number of studies also integrated
109 information on soil, using either coarse geological proxies such as bedrock classes, bedrock-
110 derived dominant texture (Van Rompaey 1993; Réjou-Méchain et al. 2008; Fayolle et al.
111 2012; Guitet et al. 2015) or more accurate, continuous soil variables assessed from local soil
112 cores (Swaine 1996; Toledo et al. 2011; Toledo et al. 2012; Condit et al. 2013; Vleminckx et
113 al. 2015; Vleminckx et al. 2017). The former group of studies concluded on substantial
114 explanatory power of their substrate proxies, while the latter concluded on either strong
115 (e.g. Condit et al. 2013) or moderate (e.g. Toledo et al. 2012) influences of soil variables.
116 Another study described a confounding effect from correlated rainfall and soil fertility

117 gradients (e.g. Swaine 1996). Therefore, it remains unclear ~~what is the relative contribution~~
118 ~~of climate and soil gradients to~~ species turnover at regional scales in tropical rainforests.

119 To evaluate the contributions of climate and soil on species composition, datasets of
120 high botanical accuracy covering large spatial and ecological breadths are valuable. Such
121 sampling remains nevertheless challenging in tropical forests. Most regional-scale studies in
122 tropical forests were limited to a subset of tree species (but see Condit et al. 2013), often
123 focusing on the most reliably identified and abundant species in the field (e.g. Réjou-
124 Méchain et al. 2008; Toledo et al. 2012) or those which are frequent enough for statistical
125 analyses (e.g. Swaine 1996; Poorter 1999; Amissah et al. 2014). Thus, studying a subset of
126 the regional species pool may bias inferences drawn about climate and soil influences on
127 tropical forest tree species. Expanding sampling to the whole species pool is worthwhile
128 because it provides valuable information on rare and potentially threatened species but also
129 additional insights on processes shaping regional-scale floristic patterns. For instance, less
130 abundant species may respond differently to environmental gradients than more abundant
131 species (Keddy 1992). Taking into account less abundant and less frequent species is also
132 interesting because species occurrence (i.e. presence-absence in plots) and abundance data
133 may inform on different community assembly processes acting simultaneously (Toledo et al.
134 2012; Wilson 2012). Species presence in a local community can be viewed as the results of
135 filtering processes determining which species of the regional pool is able to establish and
136 persist (Kraft et al. 2015). Species abundance in a local community, on the other hand, may
137 be more influenced by other processes such as demographic stochasticity, historical
138 contingency and biotic interactions (Keddy 1992; Cingolani et al. 2009; Raevel et al. 2012;
139 Wilson 2012). If abundant species also tend to be frequent, this would thus suggest
140 pervasiveness of environmental filtering against other processes for explaining species
141 distribution. Hence, comparing patterns of species occurrence (presence-absence) and
142 abundance across communities can provide insights about the influence of environmental
143 gradients on community assembly (Toledo et al. 2012).

144 Here, we analyze an unpublished dataset of tropical trees sampled from 82 1-ha
145 plots within a large tropical region that simultaneously features broad climatic gradients and
146 soil variables along with thorough botanical identification at species level (91 % of the
147 trees). To our knowledge, this represents one of the most important data collection efforts
148 carried out to study variation in tree taxonomic composition with climate and soil along

149 non-orographic gradients in the paleotropics. More specifically, our sampling was carried
150 out along the southern and eastern Cameroonian plateau that is part of the continuous
151 forest block referred to as 'Congo Basin forests'. Although this region forms part of the
152 second most extended continuous forest area in the tropics, there is scarce evaluation of
153 species distributions along climate and soil gradients within this region. We aim to quantify
154 the effects of climate and soil in the variation of floristic composition in a region known to
155 display both evergreen and semi-deciduous forests (Letouzey 1985) and belonging to the
156 broad pantropical class of "moist forests" (Fayolle et al. 2014). More specifically, we address
157 the following questions: (i) what are the main clines of floristic variation and what is the
158 contribution of climate and soil? (ii) To what extent is the distribution of abundant vs. less
159 abundant species informative on climate and soil effects on the entire floristic composition?
160 (iii) Are species occurrence and abundance displaying congruent response to climate and
161 soil that would suggest strong environmental filtering?

162

163 **METHODS**

164 **Study area**

165 The study area spans *ca.* 110, 000 km² in southern and eastern parts of Cameroon and
166 encompasses dense lowland forests of different types along a gradient of climatic and
167 edaphic conditions (Figure 1; Appendix S1). The vegetation has been referred to as the
168 Cameroon-Congolese forest sector or dense moist Guineo-Congolese forest (Letouzey
169 1985), which is interspersed with savannas, evergreen and semi-deciduous forests. This
170 study area has been assigned to the Moist Central African floristic cluster by Fayolle et al.
171 (2014), but likely encompasses other vegetation types that still require finer
172 characterization. According to Letouzey (1985), for instance, the Mbam Djerem locality,
173 located towards the north of the study area, is occupied by a forest-savanna mosaic
174 (Appendix S1), composed of tall trees (average canopy height of 10–20 m) such as *Sterculia*
175 *rhinopetala* K.Schum., *Celtis zenkeri* Engl. and *Croton sylvaticus* Hochst. (Malvaceae ex
176 Sterculiaceae – Canabaceae ex Ulmaceae forest type). The localities of Deng-Deng and
177 Mindourou II are occupied by semi-deciduous forests and characterized by tall and large
178 buttressed.

179 The climate is equatorial, with two dry seasons (a long dry season from November to
180 March and a short dry season from June to July), and two wet seasons (a long wet season

181 August to October and a short wet season from April to May). The average number of wet
182 months receiving precipitation > 100 mm/month ranges from 6.6 – 8.2 months per year and
183 annual mean precipitation ranges from 1300 to 1900 mm (Hijmans et al. 2005; Fick &
184 Hijmans 2017). Annual mean temperature ranges between 20 and 25°C (Hijmans et al. 2005;
185 Fick & Hijmans 2017), these low values compared to other lowlands of Central Africa (Figure
186 1) are due to the moderately high elevation of the study area (between 500 and 800 m
187 above sea level).

188 The soils in the study area are generally 'ferralitic soils' (Ségalen 1967) , i.e. Ferralsols
189 (FAO-UNESCO 1977) showing medium to high levels of weathering and desaturation. This
190 area is also typical of Orthic, Xanthic, Rhodic and Plinthic Ferralsols with Dystric Gleysols
191 predominate in low-lying areas (FAO-UNESCO 1977). Though derived from different parent
192 materials such as granites and schists, they share common characteristics, among which a
193 strong dominance of clay content. The rocks which constitute the subsurface soil profile are
194 essentially acidic crystalline rocks (various granites, embrechites, etc.), considered to
195 originate from the lower Precambrian, though rocks of metamorphic origins have been
196 attributed to the middle and upper Precambrian (Curis et al. 1955; Martin & Ségalen 1966).

197

198 **Plot floristic inventory**

199 Permanent sampling plots (PSP) were established following a stratified design to represent
200 the main climatic regions within the study area. We established a total of 82 non-contiguous
201 1-ha PSP distributed in seven localities of the study area (Figure 1; Appendix S1): 4 in the
202 Mbam Djerem National Park; 15 in the Deng-Deng National Park; 21 in Mindourou II; 17 in
203 Mindourou I; 14 in Lomie; 3 in Ngoila and 8 in Somalomo. In each locality, we chose plot
204 locations to sample mesic soil conditions, avoiding seasonally waterlogged areas as well as
205 rocky or petroferric outcrops. We also avoided monodominant stands (e.g. *Gilbertiodendron*
206 *dewevrei*), young secondary forests and all vegetation dominated by short-lived pioneer
207 species (notably *Musanga cecropioides*). To establish a 1-ha PSP, we subdivided a 100 m²
208 area into 20 × 20 m² quadrats (Appendix S2). We set poles at each quadrat corner and at the
209 plot corners (Appendix S2). A total of 25 GPS points were recorded along the plot contour
210 using a high precision Trimble® Geo 7X. Within each 1-ha PSP, we measured all trees with
211 diameter at breast height (DBH) ≥ 10 cm. Large trees with buttresses or deformations were
212 measured at 30 cm below or above the deformations. Taxonomic identifications were first

213 conducted in the field at the time of tree measurement by observing leaves, flowers, trunk
214 slash, habit and other diagnostic characters. A second taxonomic identification was realized
215 at our mini herbarium of the Plant Systematics and Ecology laboratory and the Herbarium of
216 the Université Libre de Bruxelles. Herbarium acronym follow Thiers (2019) where voucher
217 specimens for each species are deposited. In total, we collected 2045 voucher specimens to
218 ensure correct, verifiable and homogenous identification. Nomenclature for families and
219 genera follows the APG IV (2016) classification while species names were corrected using
220 the African Plant Database (version 3.4.0) ([https://www.ville-
221 ge.ch/musinfo/bd/cjb/africa/recherche.php](https://www.ville-ge.ch/musinfo/bd/cjb/africa/recherche.php)).

222

223 **Plot soil variables**

224 Soil samples were analysed for a subset of 60 1-ha plots following standard
225 protocols. Samples from seven 1-ha plots in Somalomo and Mbam Djerem were analysed as
226 in Quesada et al. (2010) while for the other 53 1-ha plots are described below.

227 We collected soil samples at four locations along the right angle diagonal within each
228 1-ha PSP (Appendix S2). For each of these locations, we dug four soil cores (excluding litter)
229 at 10 cm intervals (0–10, 10–20, 20–30 and 30–40 cm) and air-dried separately. Equal
230 proportions from each core were taken and pooled to form one sample for analysis. In total,
231 four samples were analysed per 1-ha plots. Each pooled soil sample was ground to pass
232 through a 2 mm sieve. For Nitrogen and Carbon analyses, samples were further ground to
233 pass through a 0.5 mm sieve using a motorized – Retch RM200® grinder. Soil pH in water
234 was determined in a 1:2.5 (w/v) soil: water suspension. Total nitrogen ($\mu\text{g.g}^{-1}$) was
235 determined from a wet acid digest and analyzed by colorimetry (Buondonno et al. 1995;
236 Anderson, J. M. & Ingram 1998). Total phosphorus ($\mu\text{g.g}^{-1}$) was determined from wet acid
237 digest and also analyzed by colorimetry using the molybdate blue procedure described by
238 Murphy & Riley (1962). Available phosphorus ($\mu\text{g.g}^{-1}$) was extracted using Bray extractant
239 and the resulting extract analyzed using the molybdate blue procedure. Moisture content
240 (%) was determined by gravimetry using: $100 - (100 \times \text{weight of oven dried sample at } 105^\circ\text{C})$
241 \div weight of air dried sample). Organic carbon (%) was determined by chromic acid
242 digestion and spectrophotometric analysis using a Genesys 10S UV/Vis spectrophotometer.
243 Particle sizes (% Sand, % Silt, and % Clay) were determined by the Bouyoucos hydrometry

244 (Bouyoucos 1951; Day 1953). Soil analyses were conducted at the soil & plant laboratory of
245 the International Institute of Tropical Agriculture (IITA)-Yaoundé.

246 In total, we measured ten soil variables, which varied between localities (Appendix
247 S3). These soil variables confirm the main common characteristics of the reddish ferralitic
248 soils (Segalen 1967) with the exception of Mbam-Djerem that is largely dominated by clay
249 (40-60%), acidic pH (4 – 5), and low rates of organic carbon (1 – 2%) in spite of enduring
250 forest cover (Appendix S3). A Principal Component Analysis (PCA) was used to determine
251 the main dimensions of soil variables. We used the *Broken-stick* model (Jackson 1993) to
252 select the number of interpretable PCA axes and kept the plot scores to reflect soil
253 gradients.

254

255 **Plot climatic variables**

256 A set of eight climatic variables were selected after a preliminary screening (based on their
257 spatial patterns) from an initial 21 variables. We discarded variables that were spatially
258 overlapping and **strongly correlated**. Climatic variables were obtained at 30 arc-second (*ca.*
259 900 m) ground resolution from Climatologies at High Resolution for the Earth's Land Surface
260 Areas (CHELSA v1.2; <http://chelsa-climate.org/>), based on a quasi-mechanistical statistical
261 downscaling of the climatic reanalysis interim global circulation model (Karger et al. 2017).
262 To account for variation in the radiative budget, we retrieved two variables related to cloud
263 frequency (i.e. mean and yearly standard deviation) from Wilson and Jetz' EarthEnv dataset
264 (Wilson & Jetz 2016). The latter are derived from Moderate Resolution Imaging
265 Spectroradiometer (MODIS) satellite optical data over a 12-year period (2001-2013). In
266 total, we assembled ten climatic variables: Annual Mean Temperature, Temperature Annual
267 Range, Annual Precipitation, Precipitation Seasonality (coefficient of variation over months),
268 Mean Temperature of Warmest and Coldest Quarters, Precipitation of Wettest and Driest
269 Quarters, Mean cloud frequency and yearly standard deviation of cloud frequency.

270 A regional-level PCA was performed for the broader zone covered by broadleaved
271 evergreen and semi-deciduous forest for tropical Africa (zone determined in the Global Land
272 Cover Map for 2009; (Arino et al. 2012)). We extracted PCA scores using the GPS
273 coordinates (i.e. plot centroids) for each 1-ha PSP to reflect predictor variables for climate.

274

275 **Statistical analyses**

276 *Species abundance and occurrence*

277 For each species, we defined (i) regional abundance as the total number of individuals over
278 the plots, (ii) local abundance as the average number of individuals over the plots where the
279 species was present and (iii) occurrence as the number of plots in which the species was
280 present.

281

282 *Variance partitioning*

283 We partitioned variance in species abundance and occurrence across plots with soil and
284 climate variables (Couteron & Pélissier 2004). Variance partitioning relates to both
285 constrained ordination and diversity measurement involving classical indices. Hence, for a
286 given species j , the individual species variance corresponds to $f_{+j}(1 - f_{+j})$, where f_{+j}
287 denotes relative abundance (i.e. number of individuals belonging to species j relative to all
288 the individuals sampled). Individual variance translates from species abundance to species
289 occurrence by considering f_{+j} as the relative number of plots in which the species j is
290 present. In line with diversity indices, direct summing of individual variances of abundance
291 over species is the Simpson-Gini index (Hill 1973). Weighting species variances by the
292 inverse of individual species relative abundances brings increased sensitivity to scarce
293 species because the total weighted sum equates species richness minus one (Pélissier et al.
294 2003; Couteron & Pélissier 2004). In line with ordination methods, these two options
295 correspond to Non-Symmetric Correspondence Analysis (NSCA) and to classical
296 Correspondence Analysis (CA), respectively (Pélissier et al. 2003; Couteron & Ollier 2005).
297 The relationship also applies to their constrained versions, that is, Non-Symmetric
298 Correspondence Analysis with Instrumental Variables (NSCAIV; *sensu* Couteron et al. 2003),
299 which is a particular case of Redundancy Analysis and CCA (Ter Braak 1986). These
300 constrained analyses rely on the same multivariate linear models of apportioning inter-plot
301 variances (inertia) of individual species abundance with-respect-to environmental
302 descriptors (Couteron et al. 2003; Pélissier & Couteron 2007).

303 Here, we used unconstrained NSCA on our floristic table (82 1-ha plots, 455 tropical
304 tree species) to analyze variations of species abundance and occurrence across forest
305 communities (plots). We presented the results of NSCA but not CA because the latter
306 presented similar results for species abundance. We repeated the unconstrained analysis on
307 a reduced floristic table (60 1-ha plots, 416 species) corresponding to plots with both soil

308 and climate data. Preliminary analyses revealed no substantial changes in the main clines of
309 floristic variation when switching the floristic tables (see Appendix S4 and Figure 2 for
310 results with 82 and 60 plots, respectively). We further conducted the deriving constrained
311 analyses (NSCAIV) on the reduced floristic table via variance partitioning.

312 To assess the individual and joint influence of soil and climate on species abundance
313 and occurrence, we apportioned inter-plots variation with respect to soil gradients (S_{IV}),
314 climate gradients (C_{IV}) and their joint contributions ($S_{IV} + C_{IV}$). The variance apportioning
315 calculates the shares of individual species variances explained by climate, soil and both.
316 Further, we performed a partial ordination with respect to soil after factoring out the effects
317 of climate, and vice versa. The partial ordination allowed synthesizing multi-species floristic
318 gradients from the species abundance and occurrence tables. We calculated the proportion
319 of variance accounted for by climate when the effects of soil were factored out ($C_{IV} - S_{IV}$)
320 and the proportion of variance accounted for by soil when the effects of climate were
321 factored out ($S_{IV} - C_{IV}$). Finally, we tested the statistical significance of the variance
322 portions obtained at both individual and multi-species scales using Monte-Carlo
323 permutation tests (i.e. by randomizing the rows of the floristic table irrespective of the
324 values of the environmental gradients). This randomization aimed to break the relationship
325 between floristic composition and environmental variables. Each test was considered
326 statistically significant at a P value less than 0.05 after 1000 randomizations.

327 All statistical analyses were performed with the *R* statistical software version 3.5.2 (R
328 Core Team. 2019), using routine *R* functions and the *diversity.R* package (Pélissier 2013).

329

330 RESULTS

331 Floristic diversity

332 The 82 1-ha plots comprised 37,733 trees belonging to 455 species and 257 genera, grouped
333 in 61 families. The subset of 60 1-ha plots for which both soil and climate were available
334 contained 26,726 trees belonging to 416 species and 234 genera, grouped in 60 families.
335 The 60 1-ha plot data excluded 798 (2.7%) unidentified individuals and 1741 (5.9 %)
336 individuals identified at genus level only. The genus-level identified individuals represented
337 species that can be distinguished in the field while names cannot be attributed.

338

339 **Correlations between species regional abundance and occurrence**

340 We found a strong correlation between species regional abundance and occurrence across
341 the 60 1-ha plots ($r = 0.71$; $df = 414$; $t = 20.46$), but a weak correlation between species local
342 abundance and occurrence ($r = 0.23$; $df = 414$; $t = 4.91$). The results were similar for the 82
343 1-ha plots, that is, strong correlation for regional abundance and occurrence ($r = 0.72$; $df =$
344 453 ; $t = 22.38$) and weak correlation for local abundance and occurrence ($r = 0.21$; $df = 453$;
345 $t = 4.46$). Frequent species (i.e. present in more than 80 % of plots) such as
346 *Tabernaemontana crassa*, *Anonidium mannii* and *Greenwayodendron suaveolens* were also
347 highly abundant at regional scale (i.e. recorded from more than 1000 individuals each;
348 Appendices S5A, S6). Other species (e.g. *Plagiostyles africana*, *Baphia leptobotrys*, *Parkia*
349 *biglobosa*) were less frequent and, when present, showed high local abundance (Appendix
350 S5B).

351

352 **Patterns of floristic composition**

353 Both occurrence and abundance datasets reveal congruent patterns of localities according
354 to axes defined by species that were either regionally frequent or abundant, respectively
355 (Figure 2). NSCA on the species occurrence matrix for 60 1-ha plots revealed a first axis (8.65
356 % variance) mostly determined by regionally abundant species such as *Albizia adianthifolia*,
357 *Celtis adolfi-friderici* and *Mansonia altissima* with positive values and *Panda oleaosa*, *Carapa*
358 *procera* and *Cylicodiscus gabunensis* with negative values (Figure 2A). This first axis opposed
359 plots from the drier localities (Mbam-Djerem, Deng-Deng and Mindourou II) to plots from
360 wetter localities (Lomié, Mindourou I and Somalomo) (Figure 2B). The second axis (7.14 %
361 variances) was characterised by species such as *Celtis zenkeri* with negative score and
362 species such as *Drypetes leonensis* and *Phyllocosmus africanus* with positive scores (Figure
363 2A). This axis opposed plots from the Mbam Djerem (positive scores) against those of Lomie
364 (negative scores) localities.

365 NSCA on species abundance matrix for 60 1-ha plots revealed a first axis (12.17 % of
366 total variance) driven by regionally abundant species (Figure 2C) such as *Anonidium mannii*
367 (1253 individuals), *Greenwayodendron suaveolens* (1098 individuals), *Funtumia africana*
368 (495 individuals), *Plagiostyles africana* (459 individuals), *Uapaca guineensis* (452
369 individuals), *Heisteria parviflora* (346 individuals), *Strombosia grandifolia* (651 individuals).
370 This first axis represented a dry to wet gradient of localities including Lomie, Somalomo and

371 Deng-Deng. The second axis (9.95 % of total variance) featured species of young dry forests
372 (e.g. *Markhamia lutea* and *Parkia biglobosa*) in the Mbam Djerem locality and a blurring
373 effect of the pioneer *Musanga cecropioides* (417 individuals) in one plot of the Mindourou I
374 locality (Figure 2D).

375

376 **Gradients of soil and climate**

377 The main gradients in soil variables were summarized by the first three axes of the PCA that
378 together explained 64.5 % of variance. The first axis (27.6 % variance) corresponds to a
379 texture gradient, the second axis (22.3 % variance) to a fertility gradient and the third axis
380 (14.7 % variance) to an organic content gradient (Figure 3A & 3B).

381 PCA on climate variables was less interpretable in terms of single climatic factors
382 because of the patterns of covariation between climate variables. The climate variables
383 from the first three axes were reduced to a 3-dimensional space and this together explained
384 84.9 % of total variance (Figure 3C & 3D) while entailing: (1) seasonality (in temperature,
385 precipitation and cloud frequency); (2) mean annual temperature (with a weak link to
386 seasonality) and (3) precipitation (with a loose correlation between total, wet and dry
387 season precipitations).

388

389 **Variance partitioning of species local abundance and occurrence with respect to climate 390 and soil**

391 Partitioning variance in species abundance and occurrence with soil and climate, we
392 found comparable levels of explained variances (Table 1). Climate alone explained 15.2 %
393 species variance for abundance and 12.4 % for occurrence. Soil alone explained almost
394 equal fraction of variance of abundance and occurrence (11.6 % and 11.2%, respectively).
395 The joint effect of soil and climate accounted for 25.8 % of variance of the abundance
396 matrix and 23.0 % variance of the occurrence matrix (Table 1).

397 The proportion of unexplained variance once either soil or climate effects were
398 factored-out revealed that soil and climate gradients appeared fairly additive (i.e. small
399 fractions of shared explained variances) for species abundance and occurrence (Table 1).
400 Factoring out the effects of soil, climate explained 10.2–11.3 % variance and factoring out
401 the effects of climate, soil explained 8.2–9.1 % variance of species distribution.

402 Interaction between soil and climate based on pairwise multiplicative effects of
403 explanatory variables ($C_{IV} * S_{IV}$) was very low (i.e. < 2 % variance).

404 Monte Carlo permutation tests at P -value < 0.05 revealed that 26 % (108 out of
405 416) species associated with climate alone, 14.9 % (62 out of 416) species associated with
406 soil alone, and only 6.3 % (26 out of 416) species associated with both climate and soil
407 (Appendix S6) for species abundance. Larger proportions of sensitive species were
408 observed for species occurrence (i.e. 131, 110 and 96 out of 416, for climate alone, soil
409 alone and both climate and soil, respectively) (Appendix S6).

410 We found species-specific affinity to climate or soil gradients (Figure 4). For some
411 species, the variance in their abundance was well explained by climate but not soil (e.g.
412 *Stombosiopsis tetrandra*, *Desbordesia insignis*). For other species, the variance in
413 abundance was well explained by soil but not climate (e.g. *Dialium angolense*,
414 *Pentaclethra eetveldeana*, *Monodora myristica*). The former group of species tends to be
415 regionally abundant (fairly large circles in figure 4), while the latter encompasses less
416 abundant species (Figure 4). Few species (located along plot diagonal in Figure 4)
417 simultaneously displayed high levels of explained variances for both factors and were
418 mostly not abundant (e.g. *Khaya ivoriensis*, *Markhamia lutea*, and *Vitex doniana*).

419 We found positive relationships between explained variance in species abundance
420 and occurrence: $R^2 = 0.58$ for soil gradient (Figure 5B) and $R^2 = 0.53$ for climate gradient
421 (Figure 5A). Despite these strong relationships, several species deviated from the
422 regression trends. For example, for *Greenwayodendron suaveolens*, one of the most
423 abundant and frequent species of our dataset (Appendix S5), soil well explained variance
424 in its occurrence, but not its abundance. *Parkia biglobosa*, an infrequent species that
425 tends to be locally abundant within dry forests (Appendix S5B), exhibits the same pattern.
426 *Funtumia africana*, one of the regionally abundant and frequent species (Appendix S5A),
427 climate well explained its abundance but not its occurrence. Conversely, for *Panda oleosa*,
428 also regionally abundant (Appendix S6), climate well explained its occurrence but not its
429 abundance.

430

431

432 **DISCUSSION**

433 This study contributes to a better understanding of floristics turnover according to both soil
434 and climate which has ~~insofar~~ not been sufficiently addressed in the tropics (but see Swaine
435 1996; Toledo et al. 2012; Condit et al. 2013) and African rainforests in particular. Our
436 dataset encompasses high botanical accuracy and sampling of soil composition alongside
437 the main rainfall gradients (e.g. climate PCA axis 1; Figure 1), stretching over *ca.* 110, 000
438 km² of rainforests in the Congo Basin (Figure 1).

439

440 **Relative importance of climate and soil gradients**

441 Climate and soil explained similar proportions of variances of species abundance and
442 occurrence, with low shared explained variances (1 – 3 %), **suggesting that climate and soil**
443 **were non-redundant in explaining species distribution.** This result is in line with findings
444 from Condit et al. (2013) who reported that both rainfall and soil phosphorus shape the tree
445 community of Panamanian forest. The relative importance of soil and climate on biomass
446 and forest structure has also been highlighted for other African (Lewis et al. 2013) and
447 Amazonian (Quesada et al. 2012) forests.

448 Studies that emphasized stronger importance of climate over soil occur in drought-
449 sensitive regions, where water availability is a limiting factor (Toledo et al. 2011; Toledo et
450 al. 2012). Conversely, soil (or geology) can trump climate in areas of extreme soil conditions
451 (e.g. sandstone, alluvium) (Réjou-Méchain et al. 2008; Fayolle et al. 2012). Extreme soil
452 conditions may develop distinct textural (e.g. very sandy or clayey), chemical and structural
453 properties (e.g. ferruginous nodules and duricrust as in some forests: Gourlet-Fleury et al.
454 (2011)), and consequently have different levels of nutrients and water availability. Soil
455 conditions can also be a stronger driver of species distribution in regions of weak climatic
456 heterogeneity (Clark et al. 1999; Harms et al. 2001). However, in the present study,
457 precipitation and temperature gradients show substantial amplitude (Figure 1; Appendix
458 S3). We did not sample extreme soil conditions and drought-prone forests are not common
459 in the study area (apart from the Mbam-Djerem locality). These might indirectly contribute
460 to balanced effects of climate and soil on community composition.

461 Climate and soil left an apparently considerable unexplained fraction (74 – 77 %)
462 of variance of species abundance and occurrence in this study. But large shares of
463 unexplained variance is common in studies applying variance decomposition to species-
464 rich tropical forests (e.g. Réjou-Méchain et al. (2008); Guitet et al. (2016)). In addition to

465 community diversity itself, unexplained variances can result from unmeasured factors
466 (e.g. human and natural disturbances and biotic interactions) and stochastic processes
467 (e.g. dispersal limitation and demographic stochasticity). Bearing this in mind, we
468 concluded on rather high fractions of explained variances for a tropical forest dataset
469 that did not sample extreme conditions, and this pleads for considerable climate and soil
470 influences on forest composition in our region.

471 Forest gaps are legacies of past natural or human disturbances and are rapidly
472 colonized by light-demanding and short-lived pioneer species (Gourlet-Fleury et al. 2013).
473 Even though our sampling avoided recently disturbed forests, pioneers such as *Musanga*
474 *cecropiodes* (Figure 2C) and light-demanders like *Sterculia rhinopetala* and *Desbordesia*
475 *insignis* (Figure 2C) were noticeable. Hence, different degrees of disturbances across the
476 sampled forest are likely to be an influential factor we did not take into account.
477 Accounting for such effect may not be possible without historical records or long-term
478 observation of the forest dynamics. It is also likely that variation in forest composition
479 reflects to some extent historical events on long time-scale such as anthropogenic
480 disturbances during the last centuries. For instance, the upper strata of a large part of
481 forests in Cameroon are indeed dominated by long-lived, light-demanding species
482 without apparent regeneration, suggesting past large-scale disturbances (Vleminckx et al.
483 2014; Morin-Rivat et al. 2017).

484 Inter-site variation is a sound basis for assessing neutral-like migration limitation
485 (*sensu* Munoz et al. (2007); Munoz, Coueron & Ramesh (2008)), but it also explained
486 climate variation and both are thus difficult to disentangle. However, Hardy & Sonké
487 (2004) noted that though habitats explain species distribution in the Dja Biosphere Forest
488 Reserve (a section of Somalomo locality, Figure 1, Appendix S1), data strongly agree with
489 a model of limited dispersal. Studies detailing population genetics and dispersal ability of
490 species could also help reveal the role of neutral-like processes in these tropical forests.

491

492 **Insights from abundant and less abundant species**

493 It has been frequently observed that diverse tropical forests are dominated by a small suite
494 of species showing very high abundance, while the majority of other species are less
495 abundant or rare (Gaston et al. 2000; Pitman et al. 2001; ter Steege et al. 2013). Drivers of

496 this abundance pattern include habitat (ter Steege et al. 2013), demographic stochasticity
497 (Hubbell 2011), intra-specific competition, herbivory and other density-dependent mortality
498 (Janzen 1970; Comita et al. 2010). We show in this study that climate explained the variance
499 of mainly abundant species while soil explained the variance of mainly less abundant species
500 (Figure 4). In fact, climate well explained 108 species of which 38 % were abundant (> 100
501 individuals), representing 39 % of all stems. Also, soil explained 62 species of which 66 %
502 were less abundant (< 100 individuals) corresponding to only 4 % of all stems (Appendix S6)
503 and both climate and soil only explained 6 % (i.e. 26 species). These proportions in climate-
504 and soil-sensitive species follow the habitat- species associations that has been reported for
505 other tropical forest sites in Korup, Cameroon (Chuyong et al. 2011), Ecuador (Valencia et al.
506 2004) and Bolivia (Toledo et al. 2012). Our results therefore suggest climate fitness for the
507 abundant and soil fitness for the less abundant species.

508

509 **Informativeness of species occurrence versus local abundance across environments**

510 We found strong positive relationship between explained variance fractions of species
511 occurrence and abundance for climate and soil gradients. Species presence reflect primarily
512 the result of species environmental requirements and tolerance (Brown 1984; Kraft et al.
513 2015). In this study, species presence means its ability to overcome environmental filtering.
514 Species abundance, on its part, contains more quantitative component and incorporates
515 species presence. Species abundance can reflect diverse processes operating simultaneously
516 at the community level. However, the regression strength in our case means that species
517 abundance and occurrence provide overall congruent insight on species environment
518 relationship in our study area. This result has not been previously reported for rainforest
519 tree communities. But studies on desert annuals also found positive correlations between
520 occurrence and abundance (Boeken & Shachak 1998; Guo et al. 2000). Despite strong
521 agreements between occurrence and abundance, individual species deviated from the
522 average regression slopes, suggesting species with distinct phylogenetic relatedness
523 responding to climate and soil. For instance, species that respond to soil like *Anonidium*
524 *manni*, *Anickia affinis* and *Greenwayodendron suaveolens* (Figure 5B) are Annonaceae that
525 are widely distributed in wet old-growth forests in central Africa. In addition, *Celtis* spp, *Cola*
526 *lateritia* and *Sterculia rhinopetala* belong to former Ulmaceae (now Canabaceae) and former
527 Sterculiaceae (now Malvaceae) are sensitive to climate and widely distributed in dry forests

528 (Figure 5A). The deviating species maybe indicators of environmental response to forest
529 deciduousness (Ouédraogo et al. 2016). For instance, species that respond to climate such
530 as *Funtumia africana*, *Celtis* spp, *Cola lateritia* and *Sterculia rhinopetala* (Figure 5A) are
531 prominent long-lived pioneers of old-growth forests in Central and West Africa. These long-
532 lived pioneers regularly shade their leaves with the severity of the dry season (Ouédraogo et
533 al. 2016).

534 Practical information for positive species occurrence-abundance relationships
535 have been reviewed (Gaston et al. 2000; Wilson 2012) with major emphasis on cost
536 effectiveness of sampling effort in favor of presence/absence (Joseph et al. 2006). But,
537 practically, this is not so true in tropical forests since plots are to be large and it is not
538 possible to rapidly grasp the list of present species. Support for abundance sampling is
539 highlighted for analyzing conservation status for species with increasing extinction risk from
540 reductions in abundance (Lawton 1996). Sampling species abundance may also be
541 particularly important for multi-purpose collections and high quality data (e.g. biomass and
542 carbon stock assessment) for forest dynamics. However species presence/absence and
543 species abundance should be analyzed separately as they result from different but closely
544 related filtering processes (Cingolani et al. 2009).

545

546 **Conclusion**

547 Based on an exceptional dataset collected at regional scale in tropical rainforests in the
548 Congo Basin, we found that climate and soil strongly explain the variance in tree species
549 composition (abundance and occurrence). We showed that climate explains only slightly
550 higher fraction ($\approx 2.5\%$) of variance on species composition compared to soil, which
551 challenges the notion of strong climate hierarchy over soil for tropical rainforests in
552 Cameroon. Climate and soil jointly explain very small proportion of variance in species
553 composition, indicating that they have complementary and additive effects on species
554 composition. We equally noticed that climate-explained variance mainly concern species of
555 high abundance while soil-explained variance mainly concern species of less abundance.
556 Finally, we found that species abundance and occurrence show congruent patterns across
557 the soil and climate gradients although some species depart from the overall trend. Beyond
558 the fundamental implication of unraveling environmental processes that underlie tree
559 species abundance and occurrence, our results highlight that considering both climate and

560 soil in modeling species distribution can improve mapping species range and distribution for
561 tropical rainforests.

562

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579

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864 **Table with legend:**

865 **TABLE 1** Variance proportions of species abundance (i.e. relating to Simpson beta-diversity)
866 and occurrence apportioned with-respect-to soil and/or climate gradients.

	Total	Constrained ordination			Partial ordination		Residual ordination
		S_{IV}	C_{IV}	$S_{IV} + C_{IV}$	$C_{IV} - S_{IV}$	$S_{IV} - C_{IV}$	$total - (S_{IV} + C_{IV})$
Variance for species abundance (Simpson beta-diversity)	0.987	0.003**	0.001**	0.005**	0.0005**	0.003**	0.982*
Variance for species occurrence (Simpson beta-diversity)	0.995	0.0006**	0.0002**	0.0008**	0.0001**	0.0005**	0.994
Fractions for species abundance (%)	100	11.6	15.2	25.8	11.3	8.2	74.2
Fractions for species occurrence	100	11.2	12.4	23.0	10.2	9.1	77.0

(%)

867 Environmental descriptors (Instrumental variables (IV)) i.e. first three PCA axes for soil (S_{IV})
868 and climate (C_{IV}) are used to explain multi-species diversity (from species abundance and
869 occurrence) determined via Non-symmetric correspondence analysis (NSCA). Entries denote
870 values or fractions of Simpson-Gini diversity and species variance explained by soil (S_{IV}),
871 climate (C_{IV}), soil and climate ($C_{IV} + S_{IV}$), climate without soil ($C_{IV} - S_{IV}$), soil without climate
872 ($S_{IV} - C_{IV}$) and the residuals [$total - (S_{IV} + C_{IV})$]. Monte-Carlo permutation test of
873 significance (1000 repetitions) for each operation is denoted by * (* = $P < 0.05$, ** = $P <$
874 0.01).

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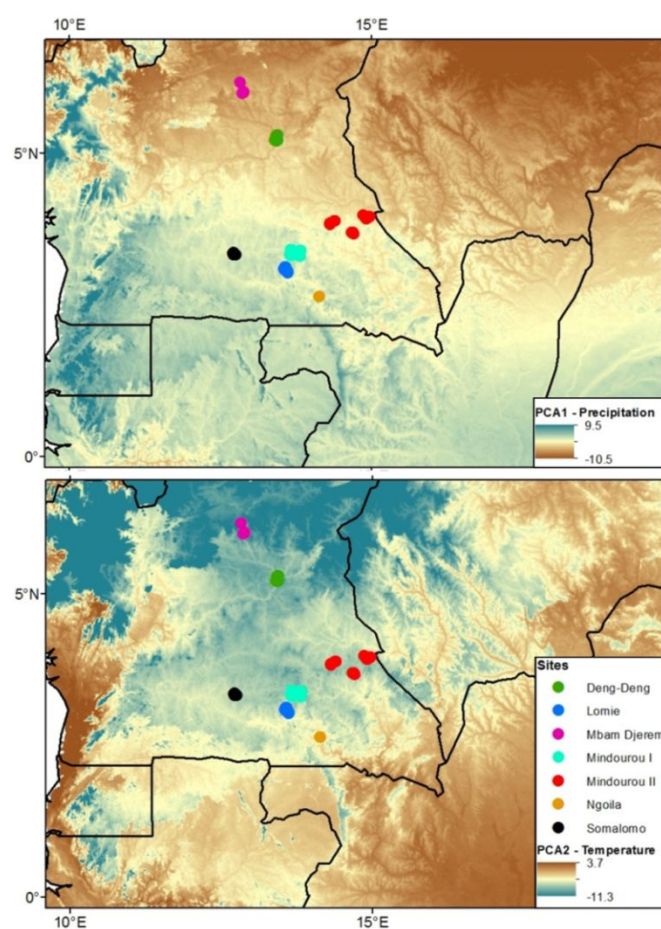
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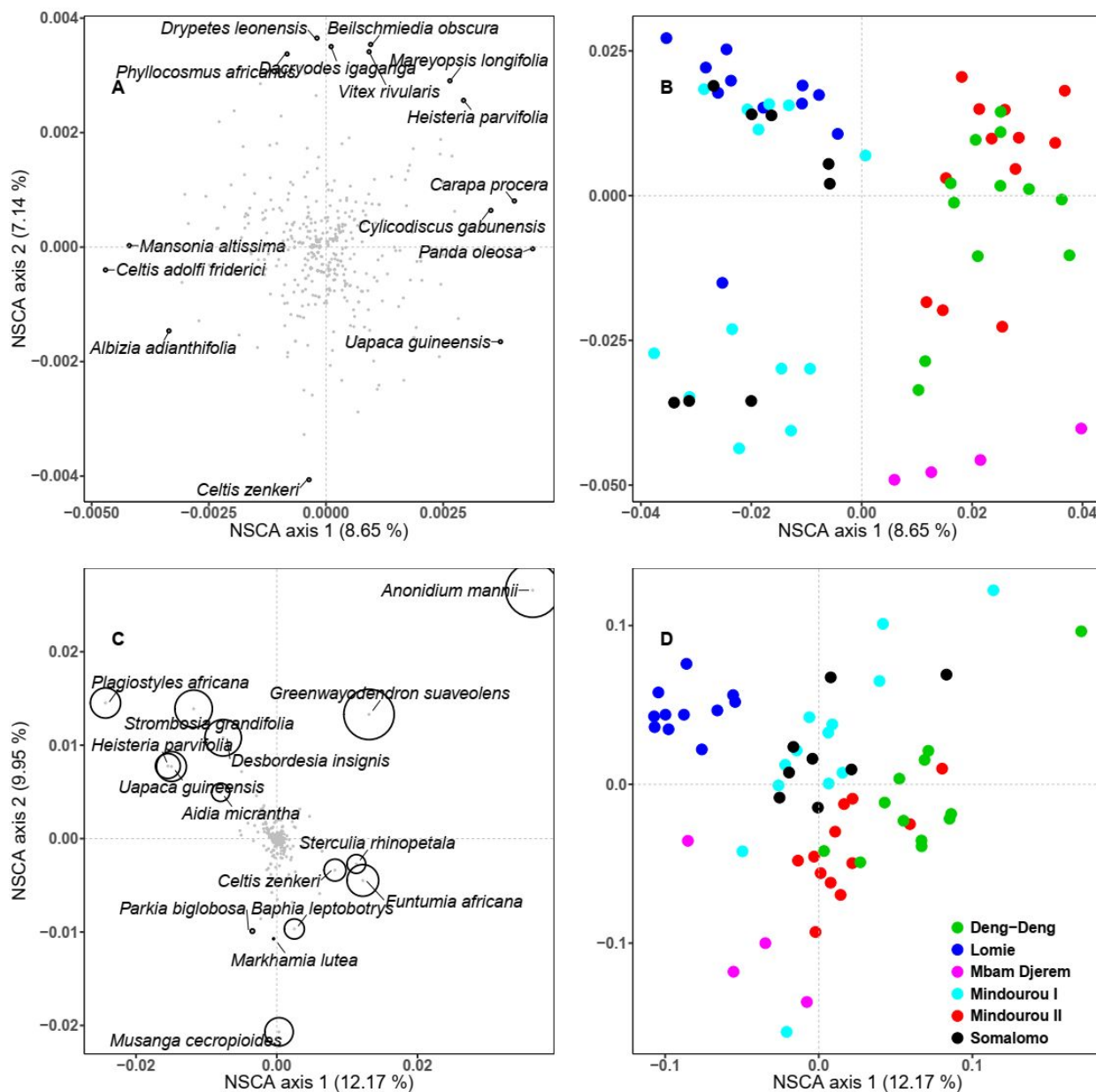
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Figures with legends:



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905 **Fig. 1.** Spatial distribution of 1-ha permanent sampling plots in the study area in Cameroon,
906 projected over regional climatic gradients. Dots of the same color denote plots within a
907 locality. Background rasters are precipitation (upper panel) and temperature (lower panel)
908 from Climatologies at High Resolution for the Earth's Land Surface Areas (CHELSA v1.2;
909 <http://chelsa-climate.org/>), gradients depicted by the first two axes of a Principal
910 Component Analysis on ten climatic variables across the study area.

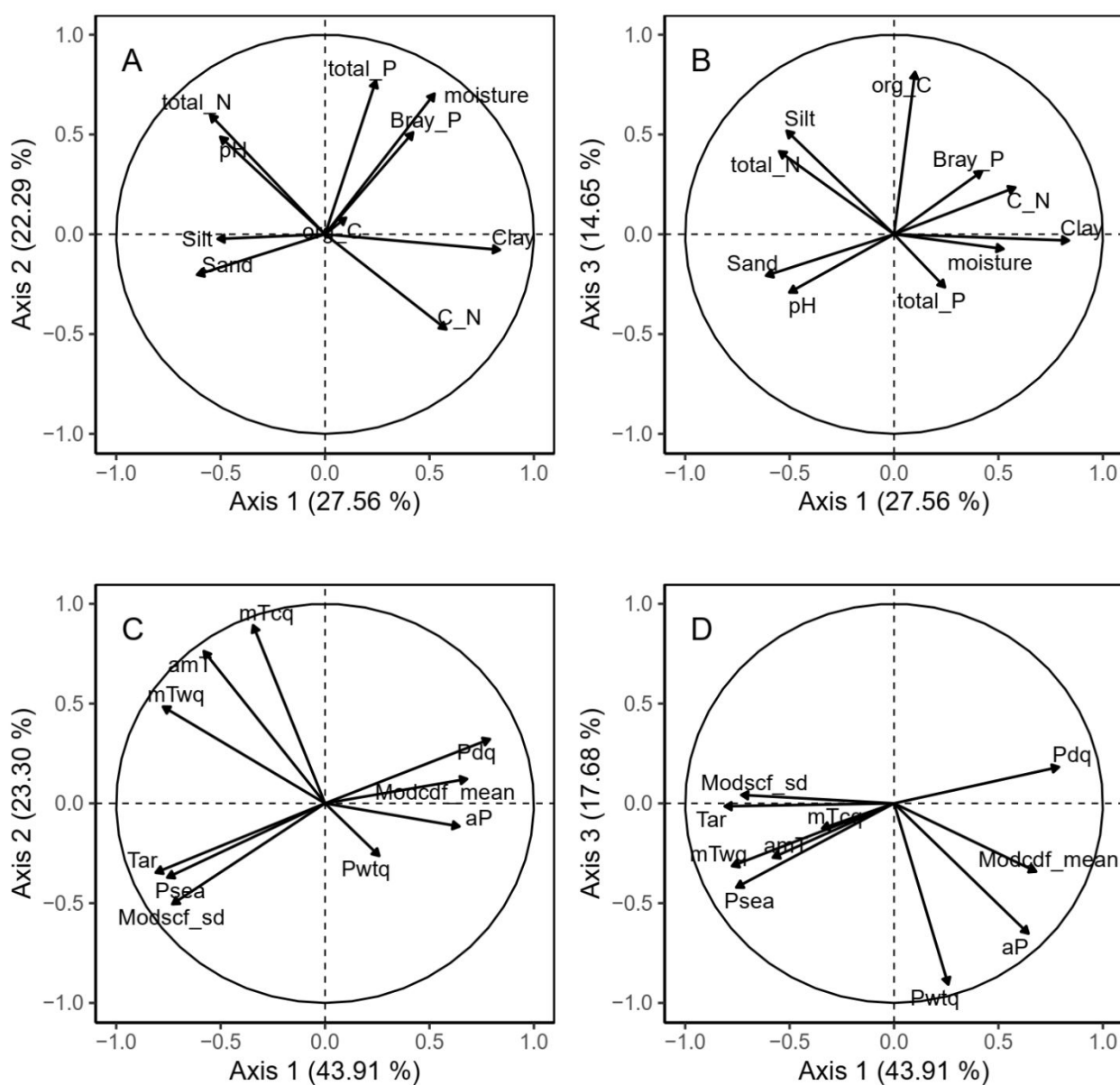
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913 **Fig. 2.** Variation in tree species composition in sixty 1-ha plots from southern and eastern
 914 Cameroon depicted by Non-symmetric Correspondence Analysis (NSCA). First two
 915 ordination axes based on species occurrence (A & B) and on species abundance data (C & D).
 916 Dots of the same color denote 1-ha plots within the same locality (B & D) and sizes of circles
 917 are proportional to species abundance for C. Only the 15 most discriminating species out of
 918 416 are labeled for B & D to improve legibility.

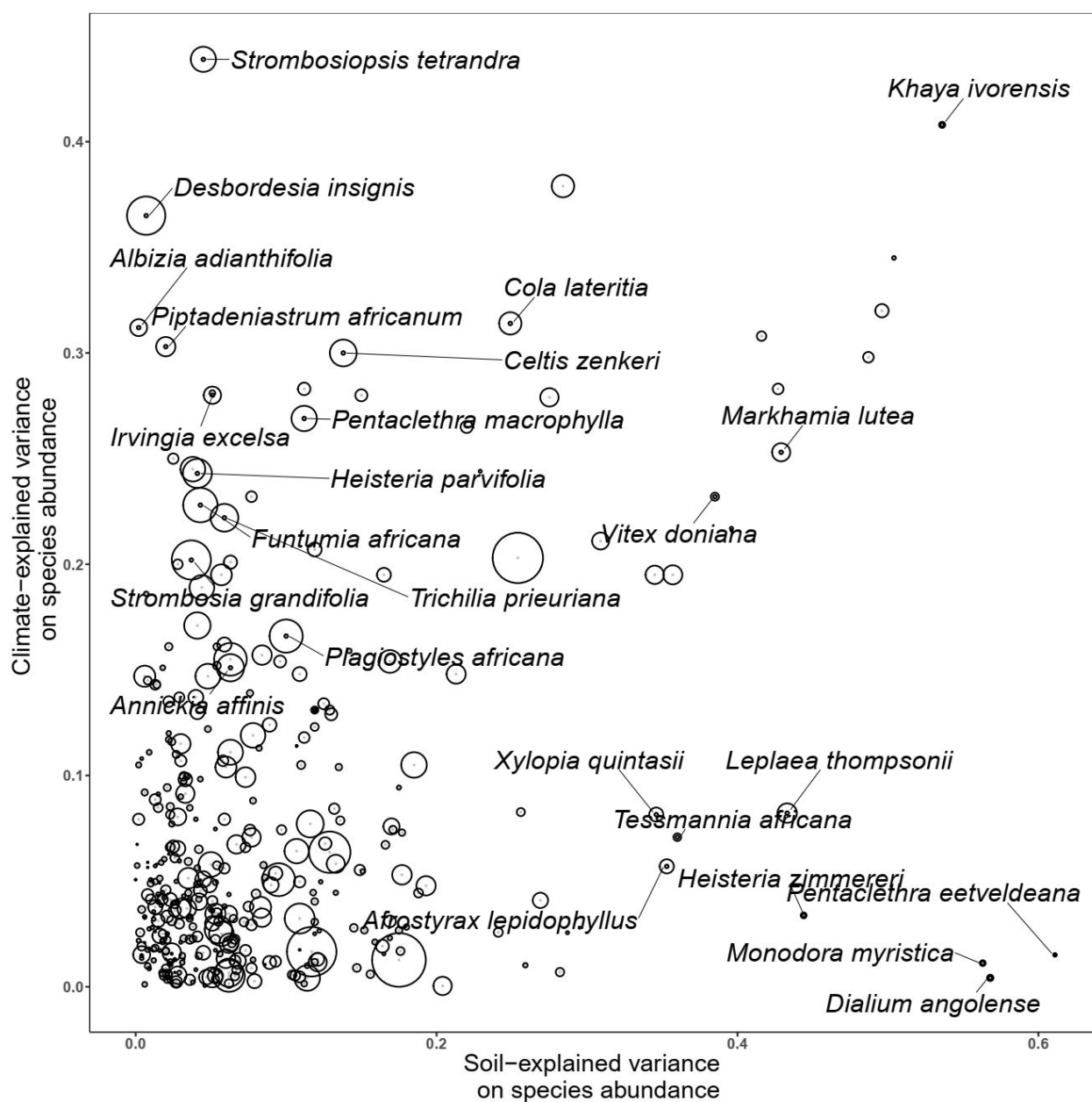
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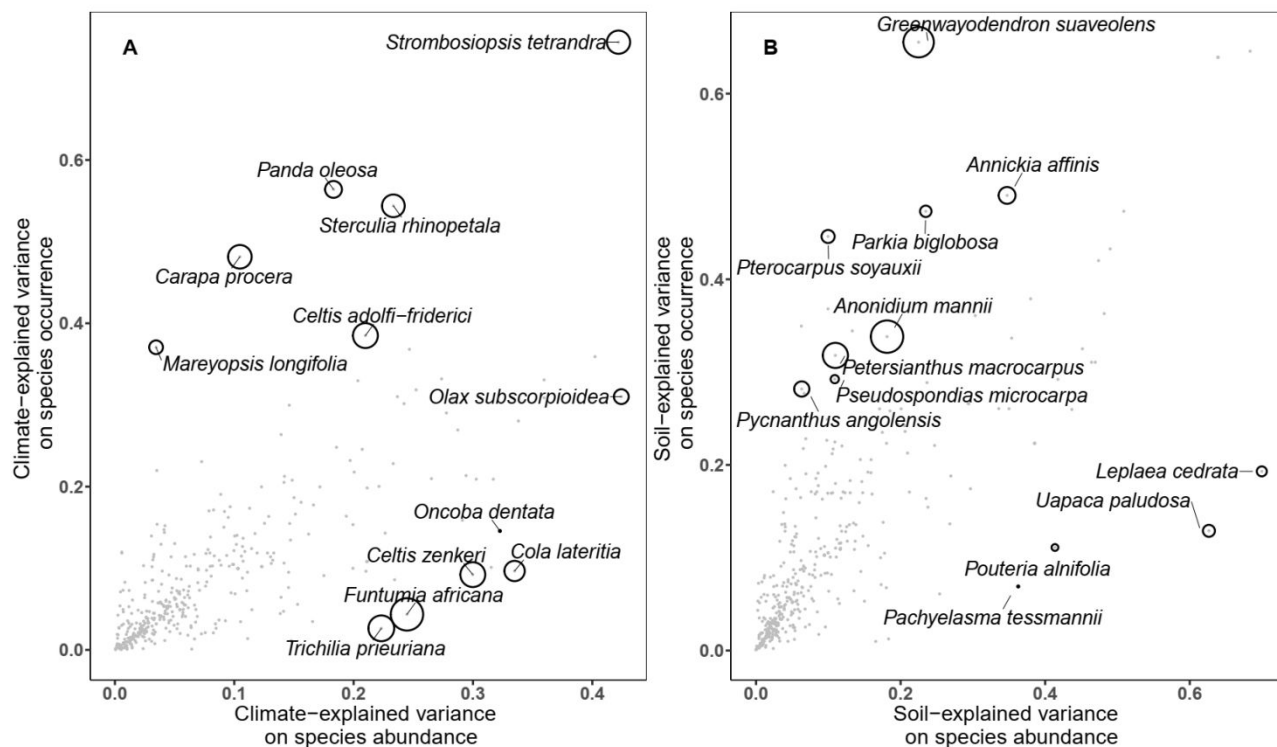


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921 **Fig. 3.** Correlation circles of Principal Component Analysis on soil composition and
 922 bioclimatic variables. Variables of first three axes for soil (A & B): *moisture* = Soil moisture
 923 content; *Org_C* = Organic carbon; *total_N* = Total nitrogen; *total_P* = Total phosphorus;
 924 *Bray_P* = Assimilable phosphorus; *C_N* = Carbon/nitrogen ratio; pH; Clay, Sand and Silt
 925 contents and for climate (C & D): *amT* = Annual Mean Temperature; *Tar* = Temperature
 926 Annual Range; *aP* = Annual Precipitation; *Psea* = Precipitation Seasonality; *mTwq* & *mTcq* =
 927 Mean Temperature of Warmest and Coldest Quarters; *Pwtq* & *Pdq* = Precipitation of
 928 Wettest and Driest Quarters. *Modscf_mean* = mean of cloud frequency; *Modscf_sd* =
 929 standard deviation of cloud frequency. A quarter is a period of three successive months, i.e.
 930 1/4 of the year.

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938 **Fig. 5.** Relationships of explained variances between species abundance and species
 939 occurrence. Climate-explained variance (A: regression slope = 0.53) and Soil-explained
 940 variance (B: regression slope = 0.58). To improve legibility, only species (12 out of 416)
 941 departing from main regression trend are labeled on both graphs and their circles are
 942 proportionate to abundance.

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953 **List of appendices with shortened captions**

954 **Appendix S1.** Location of eighty-two 1-ha permanent sampling plots projected over
955 different forest types of southern and eastern Cameroon. Dots of the same colors are plots
956 within the same locality. Forest types according to Letouzey (1985).

957 **Appendix S2.** Design of a 1-hectare (100-m x 100-m) permanent sampling plot for tree
958 census and soil sampling.

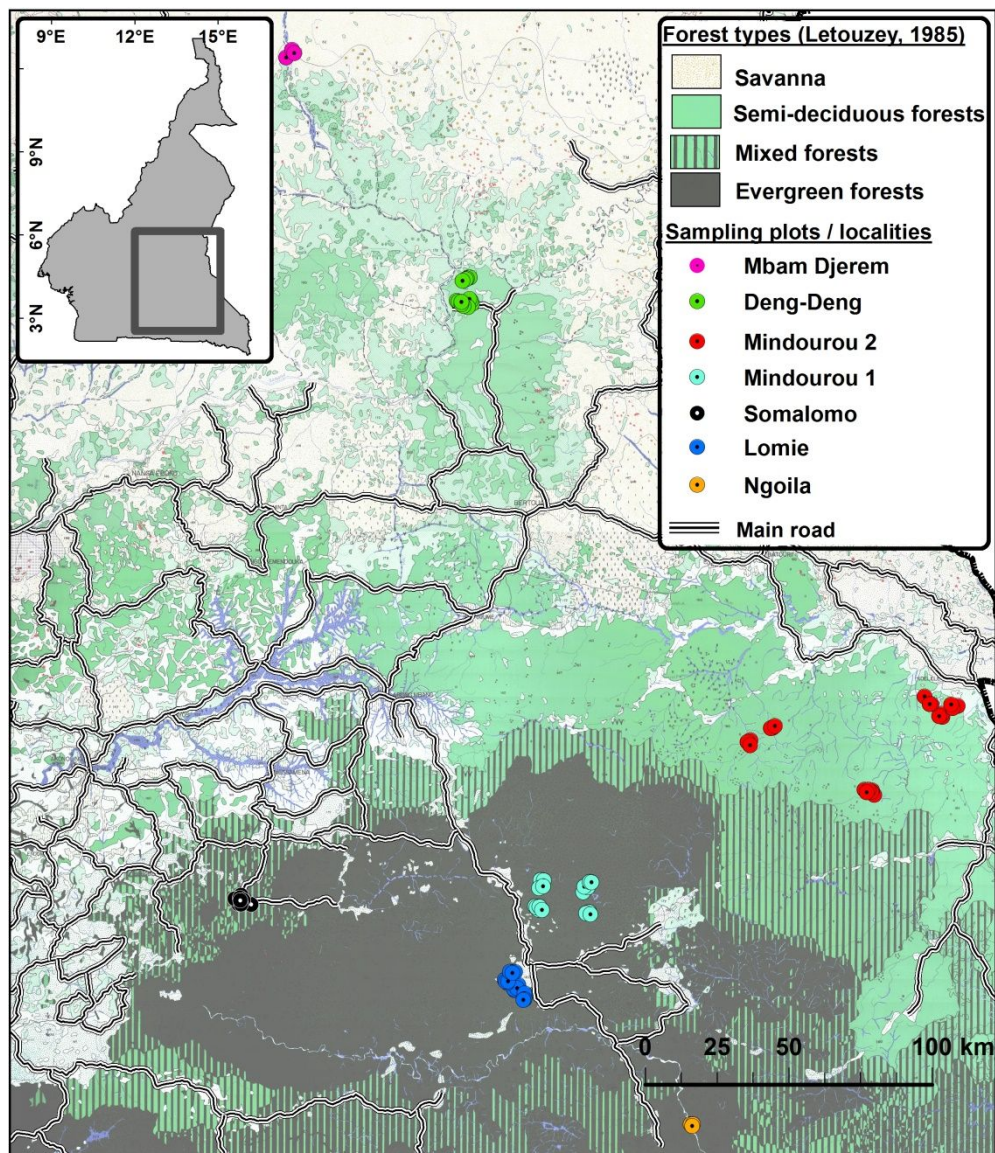
959 **Appendix S3.** Variation of individual soil and bioclimate variables between six localities in
960 southern and eastern Cameroon.

961 **Appendix S4.** Regional distribution in species abundance and occurrence depicted by Non-
962 symmetric Correspondence Analysis (NSCA; *sensu* Pélissier et al. (2003)) applied to 82 plots.
963 NSCA based on species abundance data (A & B) and on species occurrence data (C & D).

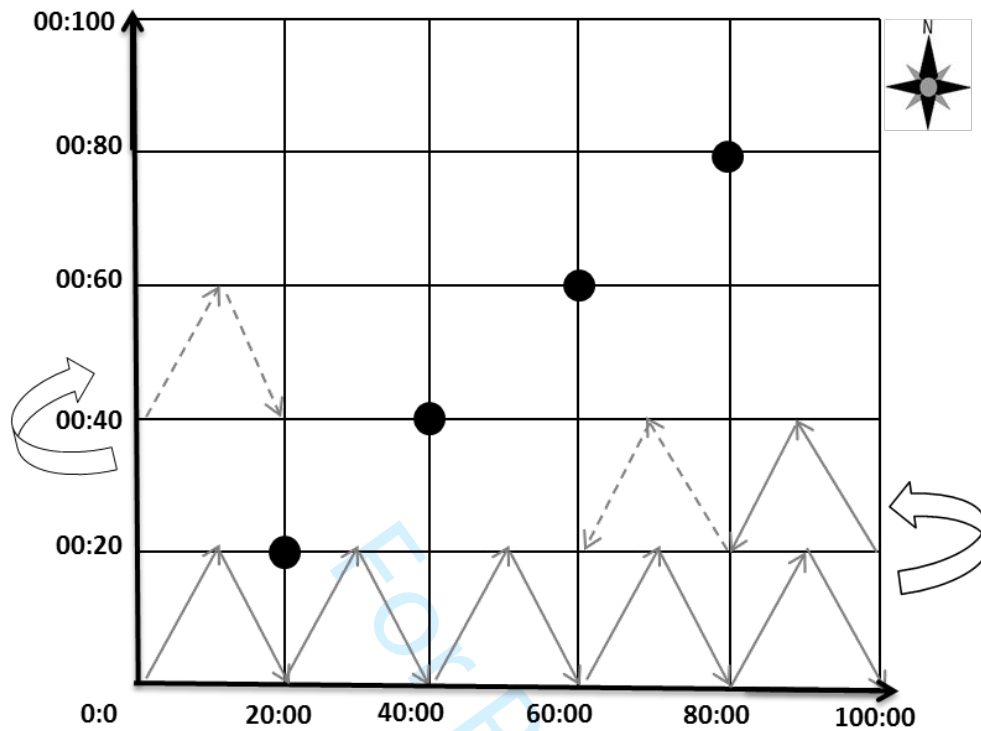
964 **Appendix S5.** Relationship between species abundance and frequency at regional (A) and
965 local (B) scales.

1 Appendices with legends:

- 2 Supporting information to the paper Libalah, M.B. et al. Additive influences of soil and
 3 climate gradients drive tree community composition of Central African moist rainforests.
 4 *Journal of Vegetation Science*



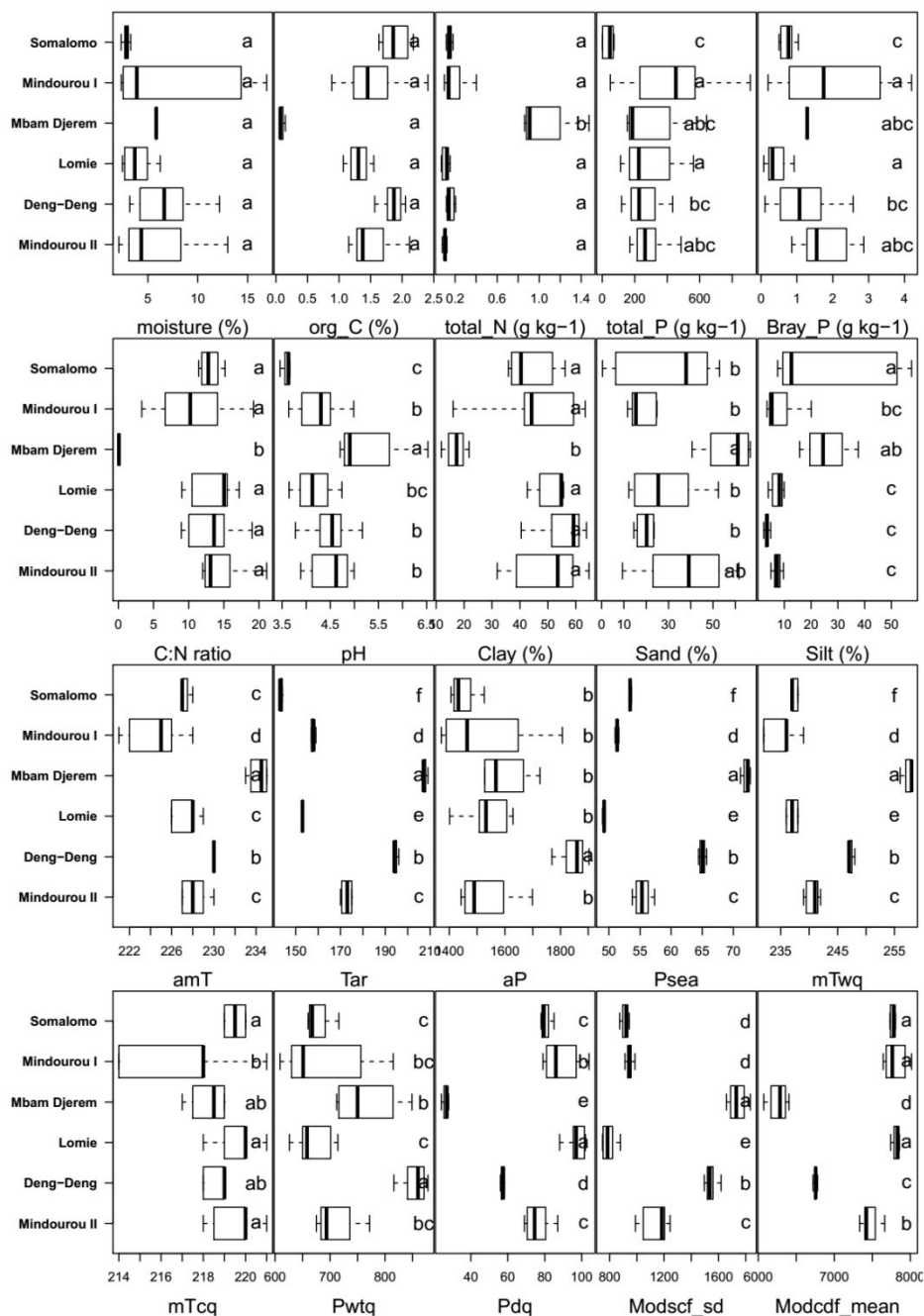
- 5
 6 **Appendix S1.** Location of eighty-two 1-ha permanent sampling plots projected over
 7 different forest types of southern and eastern Cameroon. Dots of the same colors are plots
 8 within the same locality. Forest types according to Letouzey (1985).



9

10 **Appendix S2.** Design of a 1-hectare (100-m x 100-m) permanent sampling plot for tree
 11 census and soil sampling. Trees are systematically sampled within quadrats (20-m x 20-m)
 12 and intra-quadrats displacement for tree sampling follows the grey full arrows and grey
 13 broken arrows are further continuation within the 1-ha plot; inter-quadrat transition follows
 14 the white arrows. Black dots are points of four soils sampling.

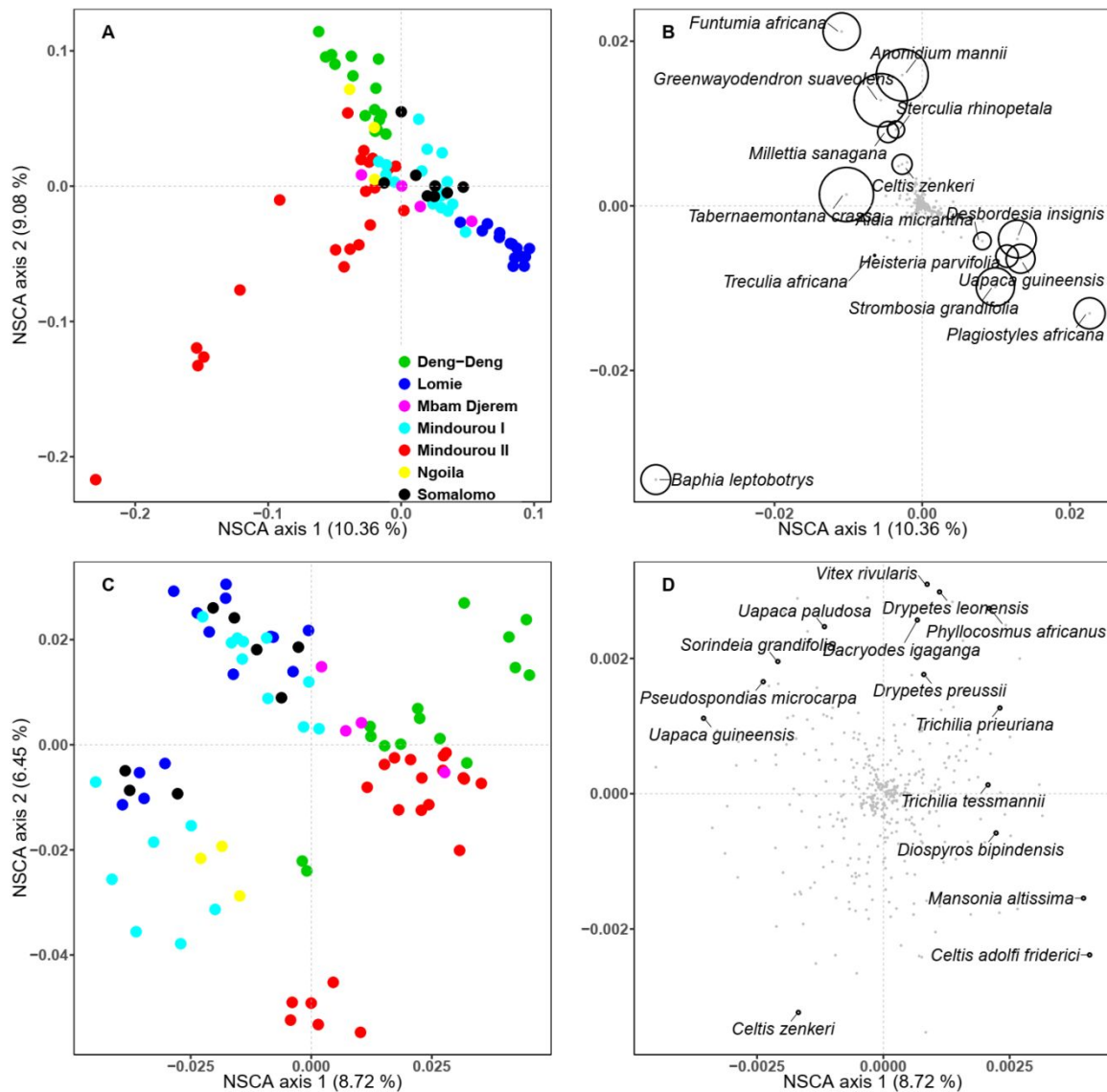
15



16

17 **Appendix S3.** Variation of individual soil and bioclimate variables between six localities in
 18 southern and eastern Cameroon. Least Significant Difference test with a Bonferroni-
 19 adjustment was applied on soil composition (upper two columns) and bioclimatic variables
 20 (lower two columns) collected from six localities for which both soil and climate data were
 21 available. Meaning of soil variables: moisture = Soil moisture content; Org_C = Organic
 22 carbon; total_N = Total nitrogen; total_P = Total phosphorus; Bray_P = Assimilable
 23 phosphorus; C_N = Carbon/nitrogen ratio; pH; Clay, Sand and Silt contents. Meaning of
 24 bioclimatic variables: amT = Annual Mean Temperature; Tar = Temperature Annual Range;

25 aP = Annual Precipitation; Psea = Precipitation Seasonality; mTwq & mTcq = Mean
 26 Temperature of Warmest and Coldest Quarters; Pwtq & Pdq = Precipitation of Wettest and
 27 Driest Quarters. Modscf_mean = mean of cloud frequency; Modscf_sd = standard deviation
 28 of cloud frequency. A quarter is a period of three successive months, i.e. 1/4 of the year.
 29



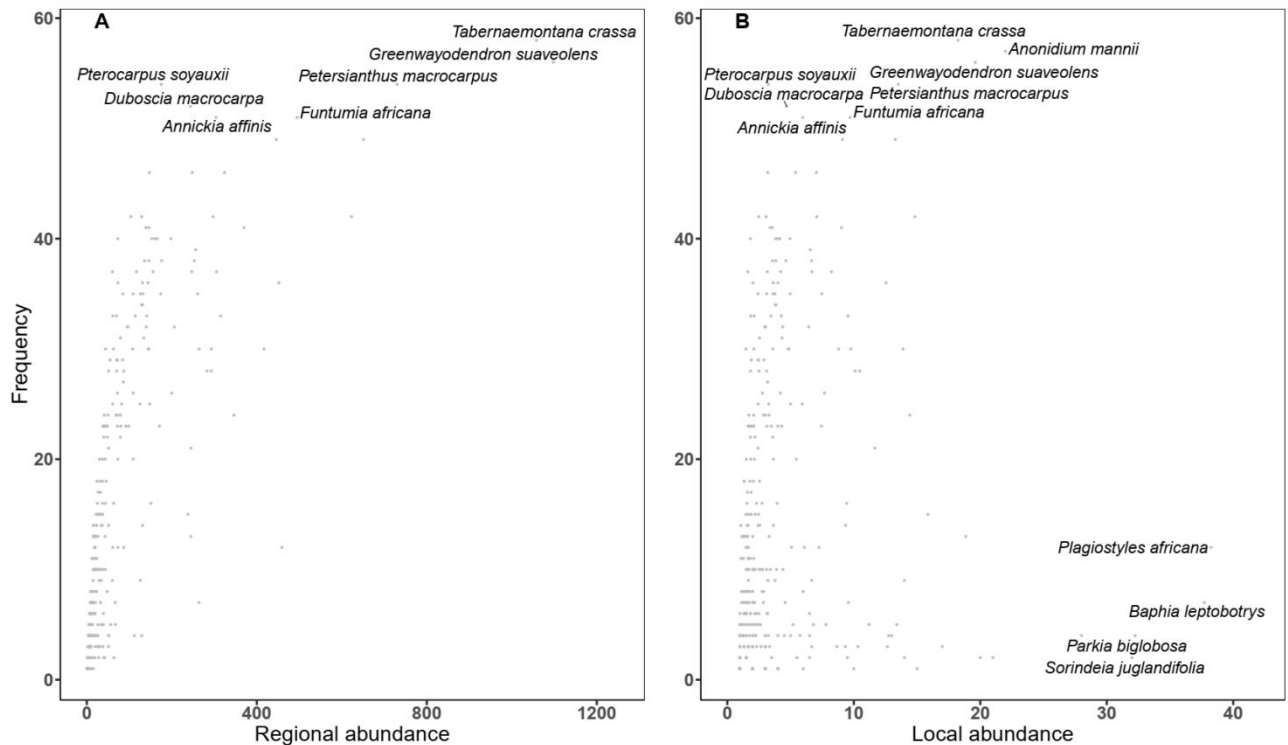
30
 31 **Appendix S4.** Regional distribution in species abundance and occurrence depicted by Non-
 32 symmetric Correspondence Analysis (NSCA; *sensu* Pélissier et al. (2003)) applied to 82 plots.
 33 NSCA based on species abundance data (A & B) and on species occurrence data (C & D).
 34 Dots of the same color denote 1-ha plots within the same locality (A & C) and sizes of circles
 35 are proportionate to species abundance for B. Only the 15 most discriminating species out
 36 of 455 are labeled for B & D to improve legibility.

37

38

39 **Floristic composition of 82 1-ha plots**

40 In total, 82 1-ha PSP were established within seven localities in center and eastern
 41 Cameroon (Figure 1 main text) hosting 39,942 trees with dbh \geq 10 cm. After excluding 1024
 42 (2.5 %) unidentified individuals and 2209 (5.5 %) individuals identified at genus level only,
 43 the final dataset comprised 37,733 trees belonging to 455 species and 257 genera, grouped
 44 in 61 families. The five most important species in terms of number of individuals were
 45 *Tabernaemontana crassa* Benth. (Apocynaceae; 1561 trees), *Greenwayodendron suaveolens*
 46 (*senso lato*) (Engl. & Diels) Verdc. (Annonaceae; 1508 trees), *Anonidium mannii* (Oliv.) Engl.
 47 & Diels (Annonaceae; 1442 trees), *Petersianthus macrocarpus* (P.Beauv.) Liben
 48 (Lecythidaceae; 870 trees) and *Strombosia grandifolia* Hook.f. ex Benth. (Olacaceae; 826
 49 trees); together representing 16.4 % of all individuals sampled. The three most diverse
 50 families were Fabaceae (77 species), Rubiaceae (40 species) and Malvaceae (38 species).
 51



52

53 **Appendix S5.** Relationship between species abundance and frequency at regional (A) and

54 local (B) scales. X-axes denote regional abundance (i.e. number of individuals of a species

55 across all plots (A)) and local abundance (i.e. average number of individuals of a species
56 across all plots (B)), and Y-axis denote species frequency defined as number of plots in
57 which the species is present (A and B). Only species with frequency more than 50 and
58 abundance more than 1000 (30 for local abundance) individuals are labeled to improve
59 legibility.
60

For Review Only

Supporting information to the paper

Libalah, M.B. et al. Additive influences of soil and climate gradients drives tree community composition of Central African rainforests. *Journal of Vegetation Science*

Appendix S6 Species variance partitioning test with-respect-to climate and soil gradients. Monte Carlo permutation test of significance ($P < 0.05$) are provided for each species. Species are arranged in alphabetical order and species nomenclature follows the African Plant Database (version 3.4.0) (<https://www.ville-ge.ch/musinfo/bd/cjb/africa/recherche.php>).

Species	Occurrence		Abundance		N°. individuals	Families
	Sig. test with Climate	Sig. test with Soil	Sig. test with Climate	Sig. test with Soil		
<i>Afrostryax lepidophyllus</i>	0.03	0.01	0.18	0	73	Huaceae
<i>Afzelia africana</i>	0.08	0.57	0.08	0.66	3	Fabaceae
<i>Afzelia bipindensis</i>	0.84	0.34	0.96	0.3	24	Fabaceae
<i>Afzelia pachyloba</i>	0.02	0.05	0.03	0.07	3	Fabaceae
<i>Aidia micrantha</i>	0.99	0.66	0.16	0.19	238	Rubiaceae
<i>Albizia adianthifolia</i>	0	0.31	0	0.84	108	Fabaceae
<i>Albizia ferruginea</i>	0.02	0.68	0.05	0.52	23	Fabaceae
<i>Albizia glaberrima</i>	0.04	0.24	0.02	0.31	82	Fabaceae
<i>Albizia gummifera</i>	0.01	0.79	0.01	0.66	6	Fabaceae
<i>Albizia zygia</i>	0.02	0.2	0.08	0.2	10	Fabaceae
<i>Alchornea cordifolia</i>	0.04	0.06	0.04	0.13	1	Euphorbiaceae
<i>Allanblackia floribunda</i>	0.37	0	0.41	0.02	51	Clusiaceae
<i>Allanblackia gabonensis</i>	0.84	0.34	0.83	0.32	1	Clusiaceae
<i>Allanblackia kisonghi</i>	0.34	0.11	0.33	0.18	32	Clusiaceae
<i>Allophylus africanus</i>	0.51	0.3	0.3	0.42	8	Sapindaceae
<i>Alstonia boonei</i>	0	0.23	0.37	0.44	104	Apocynaceae
<i>Amphimas ferrugineus</i>	0.89	0.99	0.96	0.97	6	Fabaceae

<i>Amphimas pterocarpoides</i>	0.17	0.74	0.31	0.8	60	Fabaceae
<i>Angylocalyx oligophyllus</i>	0.2	0.86	0.22	0.87	1	Fabaceae
<i>Angylocalyx pynaertii</i>	0.04	0.03	0.43	0.46	160	Fabaceae
<i>Angylocalyx talbotii</i>	0.36	0.02	0.35	0.02	1	Fabaceae
<i>Annickia affinis</i>	0.01	0	0.01	0.23	178	Annonaceae
<i>Annickia chlorantha</i>	0.47	0	0.09	0	126	Annonaceae
<i>Anonidium mannii</i>	0.16	0	0.7	0.04	1253	Annonaceae
<i>Anopyxis klaineana</i>	0.3	0.21	0.14	0.16	32	Rhizophoraceae
<i>Anthocleista schweinfurthii</i>	0.44	0	0.43	0	1	Gentianaceae
<i>Anthonotha cladantha</i>	0.02	0.22	0.11	0.06	19	Fabaceae
<i>Anthonotha ferruginea</i>	0.25	0.05	0.33	0.09	13	Fabaceae
<i>Anthonotha fragrans</i>	0.19	0.72	0.04	0.15	20	Fabaceae
<i>Anthonotha macrophylla</i>	0.33	0.7	0.3	0.39	166	Fabaceae
<i>Antiaris toxicaria</i>	0.66	0.48	0.64	0.87	5	Moraceae
<i>Antidesma laciniatum</i>	0.08	0.29	0.79	0.09	125	Phyllanthaceae
<i>Antidesma membranaceum</i>	0.02	0.77	0.87	0.34	79	Phyllanthaceae
<i>Antidesma vogelianum</i>	0.36	0.02	0.35	0.02	1	Phyllanthaceae
<i>Antrocaryon klaineanum</i>	0.97	0.16	0.59	0.27	28	Anacardiaceae
<i>Antrocaryon micraster</i>	0.11	0.77	0.12	0.8	1	Anacardiaceae
<i>Aoranthe cladantha</i>	0.48	0.61	0.54	0.48	23	Rubiaceae
<i>Aulacocalyx jasminiflora</i>	0.26	0.58	0.29	0.64	4	Rubiaceae
<i>Baikiaea insignis</i>	0.61	0.71	0.97	0.53	6	Fabaceae
<i>Baillonella toxisperma</i>	0.03	0.84	0.04	0.71	15	Sapotaceae
<i>Balanites wilsoniana</i>	0.08	0.36	0.05	0.23	4	Zygophyllaceae
<i>Baphia leptobotrys</i>	0.81	0.31	0.9	0.07	264	Fabaceae
<i>Baphia nitida</i>	0.66	0.24	0.66	0.24	1	Fabaceae
<i>Baphia pubescens</i>	0.15	0.16	0.08	0.37	131	Fabaceae
<i>Barteria fistulosa</i>	0.81	0.12	0.74	0.17	136	Passifloraceae
<i>Beilschmiedia anacardioides</i>	0.15	0.58	0.19	0.51	3	Lauraceae
<i>Beilschmiedia obscura</i>	0.01	0	0	0.06	55	Lauraceae
<i>Berlinia grandiflora</i>	0	0	0	0	38	Fabaceae

<i>Blighia sapida</i>	0.21	0.06	0.83	0.04	22	Sapindaceae
<i>Blighia welwitschii</i>	0.01	0.75	0.87	0.33	117	Sapindaceae
<i>Bobgunnia fistuloides</i>	0.48	0.29	0.45	0.3	22	Fabaceae
<i>Bombax brevicuspe</i>	0.03	0.27	0.37	0.98	20	Malvaceae
<i>Bombax buonopozense</i>	0.05	0.48	0.03	0.4	10	Malvaceae
<i>Borassus aethiopum</i>	0	0.03	0	0.04	2	Arecaceae
<i>Brenania brieyi</i>	0.63	0.19	0.6	0.27	20	Rubiaceae
<i>Bridelia grandis</i>	0.36	0.44	0.36	0.56	4	Phyllanthaceae
<i>Bridelia micrantha</i>	0.02	0.87	0	0.52	14	Phyllanthaceae
<i>Buchholzia coriacea</i>	0.17	0.96	0.19	0.99	1	Capparaceae
<i>Calpocalyx dinklagei</i>	0.2	0.45	0.27	0.14	25	Fabaceae
<i>Canarium schweinfurtii</i>	0.02	0.05	0.06	0.59	22	Burseraceae
<i>Canthium rheedei</i>	0.75	0.34	0.94	0.31	3	Rubiaceae
<i>Carapa grandiflora</i>	0.46	0.59	0.42	0.59	2	Meliaceae
<i>Carapa procera</i>	0	0.89	0.05	0.04	264	Meliaceae
<i>Casearia aculeata</i>	0.47	0.7	0.78	0.65	9	Salicaceae
<i>Cassia javanica</i>	0.01	0.49	0.02	0.54	5	Fabaceae
<i>Cavacoa quintasii</i>	0.27	0.46	0.32	0.49	3	Euphorbiaceae
<i>Ceiba pentandra</i>	0	0.98	0.01	0.92	19	Malvaceae
<i>Celtis adolfi-friderici</i>	0	0.18	0	0.71	293	Cannabaceae
<i>Celtis africana</i>	0.02	0.76	0.42	0.63	28	Cannabaceae
<i>Celtis conferta</i>	0.14	0.46	0.15	0.51	1	Cannabaceae
<i>Celtis gomphophylla</i>	0.66	0.64	0.65	0.63	2	Cannabaceae
<i>Celtis mildbraedii</i>	0.5	0.05	0.14	0.28	245	Cannabaceae
<i>Celtis philippensis</i>	0.07	0	0.21	0.13	67	Cannabaceae
<i>Celtis tessmannii</i>	0.31	0.12	0.07	0.02	153	Cannabaceae
<i>Celtis zenkeri</i>	0.06	0	0	0.08	293	Cannabaceae
<i>Centroplocus glaucinus</i>	0.01	0	0.01	0.12	146	Centroplocaceae
<i>Chrysophyllum africanum</i>	0.87	0.04	0.78	0.06	12	Sapotaceae
<i>Chrysophyllum beguei</i>	0.47	0.64	0.56	0.8	8	Sapotaceae
<i>Chrysophyllum boukokoense</i>	0	0	0	0.49	247	Sapotaceae

<i>Chrysophyllum giganteum</i>	0.68	0.24	0.67	0.25	2	Sapotaceae
<i>Chrysophyllum lacourtianum</i>	0.96	0	0.99	0.02	129	Sapotaceae
<i>Chrysophyllum perpulchrum</i>	0.92	0.85	0.85	0.87	3	Sapotaceae
<i>Chrysophyllum pruniforme</i>	0.21	0.36	0.23	0.25	12	Sapotaceae
<i>Chrysophyllum ubangiense</i>	0.47	0.94	0.55	0.93	1	Sapotaceae
<i>Citropsis articulata</i>	0.15	0.69	0.17	0.71	3	Rutaceae
<i>Cleistanthus itsoghensis</i>	0.02	0.45	0.06	0.53	67	Phyllanthaceae
<i>Cleistopholis glauca</i>	0.74	0	0.67	0	40	Annonaceae
<i>Cleistopholis patens</i>	0.8	0.98	0.96	0.86	48	Annonaceae
<i>Coelocaryon preussii</i>	0.04	0.69	0.43	0.39	370	Myristicaceae
<i>Cola acuminata</i>	0.35	0.01	0.43	0.12	40	Malvaceae
<i>Cola altissima</i>	0.21	0.03	0.21	0.12	10	Malvaceae
<i>Cola ballayi</i>	0.77	0.34	0.75	0.37	2	Malvaceae
<i>Cola chlamydantha</i>	0.41	0.87	0.82	0.64	14	Malvaceae
<i>Cola cordifolia</i>	0.01	0.2	0.05	0.28	9	Malvaceae
<i>Cola ficifolia</i>	0.05	0.96	0.07	0.97	2	Malvaceae
<i>Cola heterophylla</i>	0.53	0.05	0.51	0.06	1	Malvaceae
<i>Cola lateritia</i>	0.04	0.02	0	0.01	198	Malvaceae
<i>Cola nitida</i>	0.05	0.04	0.03	0.07	51	Malvaceae
<i>Cola reticulata</i>	0.04	0.06	0.04	0.13	1	Malvaceae
<i>Cola verticillata</i>	0.26	0.19	0.17	0.69	19	Malvaceae
<i>Cordia africana</i>	0	0.02	0	0.02	2	Boraginaceae
<i>Cordia aurantiaca</i>	0.77	0.34	0.73	0.37	1	Boraginaceae
<i>Cordia platythyrsa</i>	0.62	0.79	0.95	0.62	19	Boraginaceae
<i>Corynanthe pachyceras</i>	0.01	0	0.03	0.31	253	Rubiaceae
<i>Coula edulis</i>	0.96	0.31	0.95	0.31	1	Olacaceae
<i>Croton oligandrus</i>	0.01	0.93	0.04	0.86	6	Euphorbiaceae
<i>Croton sylvaticus</i>	0	0.77	0	0.92	5	Euphorbiaceae
<i>Cuviera longiflora</i>	0.02	0.05	0.03	0.07	2	Rubiaceae
<i>Cylicodiscus gabunensis</i>	0	0.32	0	0.61	37	Fabaceae
<i>Cyrtogonone argentea</i>	0.38	0.07	0.4	0.08	2	Euphorbiaceae

<i>Dacryodes buettneri</i>	0.27	0.86	0.3	0.87	1	Burseraceae
<i>Dacryodes edulis</i>	0.75	0	0.4	0	13	Burseraceae
<i>Dacryodes igaganga</i>	0.06	0	0	0.01	70	Burseraceae
<i>Dacryodes klaineana</i>	0	0.29	0	0.32	9	Burseraceae
<i>Daniellia ogea</i>	0.07	0.24	0.1	0.32	1	Fabaceae
<i>Desbordesia insignis</i>	0	0.83	0	0.85	623	Irvingiaceae
<i>Desplatsia dewevrei</i>	0.26	0	0.55	0.27	146	Malvaceae
<i>Desplatsia chrysochlamys</i>	0.53	0.02	0.54	0.06	5	Malvaceae
<i>Detarium macrocarpum</i>	0.82	0.75	0.2	0.32	30	Fabaceae
<i>Dialium angolense</i>	0.45	0.02	0.92	0.1	11	Fabaceae
<i>Dialium bipindense</i>	0.02	0.1	0.01	0.12	72	Fabaceae
<i>Dialium dinklagei</i>	0.63	0.49	0.43	0.49	7	Fabaceae
<i>Dialium guineense</i>	0.87	0.38	0.87	0.27	34	Fabaceae
<i>Dichrostachys cinerea</i>	0.2	0.66	0.23	0.68	2	Fabaceae
<i>Dictyandra arborescens</i>	0.01	0.85	0.3	0.97	15	Rubiaceae
<i>Diospyros bipindensis</i>	0.01	0.2	0.31	0.84	73	Ebenaceae
<i>Diospyros canaliculata</i>	0.02	0.05	0.03	0.07	15	Ebenaceae
<i>Diospyros cinnabarina</i>	0.19	0.58	0.22	0.82	9	Ebenaceae
<i>Diospyros conocarpa</i>	0.25	0.67	0.29	0.73	2	Ebenaceae
<i>Diospyros crassiflora</i>	0.42	0.01	0.44	0.03	18	Ebenaceae
<i>Diospyros dendo</i>	0.04	0.21	0.09	0.38	6	Ebenaceae
<i>Diospyros heudelotii</i>	0.59	0.8	0.63	0.83	1	Ebenaceae
<i>Diospyros hoyleana</i>	0.06	0.07	0.1	0.07	22	Ebenaceae
<i>Diospyros iturensis</i>	0.53	0.07	0.18	0.08	3	Ebenaceae
<i>Diospyros mannii</i>	0.25	0.17	0.27	0.18	3	Ebenaceae
<i>Diospyros monbuttensis</i>	0	0	0	0.01	3	Ebenaceae
<i>Diospyros preussii</i>	0.24	0.81	0.3	0.76	4	Ebenaceae
<i>Diospyros sanza-minika</i>	0	0.04	0	0.06	2	Ebenaceae
<i>Diospyros suaveolens</i>	0.06	0.58	0.14	0.6	52	Ebenaceae
<i>Diospyros zenkeri</i>	0.19	0.44	0.25	0.56	1	Ebenaceae
<i>Discoglyprena caloneura</i>	0.6	0.09	0.67	0.13	43	Euphorbiaceae

<i>Distemonanthus benthamianus</i>	0.1	0	0.39	0.06	48	Fabaceae
<i>Dovyalis zenkeri</i>	0.09	0.99	0.05	0.99	7	Salicaceae
<i>Dracaena arborea</i>	0.71	0.09	0.7	0.09	5	Asparagaceae
<i>Drypetes chevalieri</i>	0.94	0.66	0.81	0.96	3	Putranjivaceae
<i>Drypetes gossweileri</i>	0.95	0.71	0.9	0.77	28	Putranjivaceae
<i>Drypetes klainei</i>	0.11	0.2	0	0.15	39	Putranjivaceae
<i>Drypetes laciniata</i>	0.51	0.12	0.47	0.16	5	Putranjivaceae
<i>Drypetes leonensis</i>	0.37	0	0.13	0.23	131	Putranjivaceae
<i>Drypetes preussii</i>	0.15	0.01	0.5	0.53	79	Putranjivaceae
<i>Duboscia macrocarpa</i>	0.66	0	0.03	0.13	244	Malvaceae
<i>Duguetia staudtii</i>	0.36	0	0.01	0.34	73	Annonaceae
<i>Empogona crepiniana</i>	0.44	0	0.43	0	1	Rubiaceae
<i>Endodesmia calophylloides</i>	0.47	0.25	0.34	0.2	3	Calophyllaceae
<i>Entandrophragma angolense</i>	0.77	0.92	0.68	0.75	13	Meliaceae
<i>Entandrophragma candollei</i>	0.31	0.8	0.23	0.62	38	Meliaceae
<i>Entandrophragma congoense</i>	0.02	0.46	0.05	0.55	9	Meliaceae
<i>Entandrophragma cylindricum</i>	0.26	0.07	0.8	0.28	85	Meliaceae
<i>Entandrophragma utile</i>	0.17	0.64	0.26	0.7	3	Meliaceae
<i>Eribroma oblongum</i>	0.13	0.37	0.15	0.08	37	Malvaceae
<i>Eriocoelum macrocarpum</i>	0.72	0.05	0.5	0.03	26	Sapindaceae
<i>Eriocoelum oblongum</i>	0.59	0.46	0.55	0.56	13	Sapindaceae
<i>Erismadelphus exsul</i>	0.39	0.81	0.08	0.97	11	Vochysiaceae
<i>Erythrina excelsa</i>	0.2	0.29	0.26	0.88	9	Fabaceae
<i>Erythrophleum ivorense</i>	0.97	0.09	0.92	0.26	15	Fabaceae
<i>Erythrophleum suaveolens</i>	0.29	0.01	0.95	0.17	73	Fabaceae
<i>Erythroxyllum mannii</i>	0.02	0.1	0.04	0.14	8	Erythroxylaceae
<i>Euphorbia drupifera</i>	0.55	1	0.55	1	4	Euphorbiaceae
<i>Fernandoa adolfi-friderici</i>	0.02	0.02	0.19	0.53	46	Bignoniaceae
<i>Fernandoa ferdinandi</i>	0.4	0.24	0.38	0.33	5	Bignoniaceae
<i>Ficus exasperata</i>	0	0.09	0.02	0.13	11	Moraceae
<i>Ficus mucoso</i>	0.32	0.3	0.24	0.3	11	Moraceae

<i>Ficus variifolia</i>	0	0.02	0	0.02	1	Moraceae
<i>Fillaeopsis discophora</i>	0.15	0.69	0.17	0.71	1	Fabaceae
<i>Fleroya ledermannii</i>	0.63	0.33	0.65	0.39	1	Rubiaceae
<i>Funtumia africana</i>	0.22	0.03	0	0.31	495	Apocynaceae
<i>Funtumia elastica</i>	0.03	0.02	0.09	0.04	12	Apocynaceae
<i>Garcinia epunctata</i>	0.59	0.73	0.44	0.44	11	Clusiaceae
<i>Garcinia kola</i>	0.8	0.37	0.84	0.59	4	Clusiaceae
<i>Garcinia mannii</i>	0.9	0.06	0.92	0.07	43	Clusiaceae
<i>Garcinia ovalifolia</i>	0	0.02	0	0.02	1	Clusiaceae
<i>Garcinia staudtii</i>	0.27	0.86	0.3	0.87	1	Clusiaceae
<i>Gilbertiodendron brachystegioides</i>	0.7	0.94	0.73	0.94	1	Fabaceae
<i>Gilletiodendron pierreanum</i>	0.35	0.04	0.36	0.06	13	Fabaceae
<i>Glyphaea brevis</i>	0.05	0.35	0.01	0.8	33	Malvaceae
<i>Greenwayodendron suaveolens</i>	0	0	0	0	1098	Annonaceae
<i>Grewia coriacea</i>	0.99	0.89	0.81	0.75	5	Malvaceae
<i>Grossera macrantha</i>	0.07	0.24	0.1	0.32	10	Euphorbiaceae
<i>Harungana madagascariensis</i>	0.15	0.69	0.17	0.71	1	Hypericaceae
<i>Heisteria parvifolia</i>	0	0.06	0	0.4	346	Olacaceae
<i>Heisteria trillesiana</i>	0.29	0	0.27	0	26	Olacaceae
<i>Heisteria zimmereri</i>	0.32	0.14	0.31	0.2	9	Olacaceae
<i>Hexalobus crispiflorus</i>	0.04	0.76	0.19	0.86	84	Annonaceae
<i>Holoptelea grandis</i>	0.06	0.64	0.07	0.72	15	Ulmaceae
<i>Homalium laurentii</i>	0.24	0.26	0.26	0.28	1	Salicaceae
<i>Homalium le-testui</i>	0.03	0.02	0.38	0.17	72	Salicaceae
<i>Homalium longistylum</i>	0.17	0.61	0.19	0.6	6	Salicaceae
<i>Hylodendron gabunense</i>	0.41	0.24	0.89	0.5	324	Fabaceae
<i>Hymenocardia heudelotii</i>	0.09	0.35	0.11	0.45	3	Phyllanthaceae
<i>Hymenocardia lyrata</i>	0.93	0.22	0.81	0.91	9	Phyllanthaceae
<i>Irvingia excelsa</i>	0	0.85	0	0.84	114	Irvingiaceae
<i>Irvingia gabonensis</i>	0.57	0.02	0.42	0.04	8	Irvingiaceae
<i>Irvingia grandifolia</i>	0.02	0.82	0.05	0.96	44	Irvingiaceae

<i>Irvingia robur</i>	0.02	0.18	0.07	0.16	37	Irvingiaceae
<i>Irvingia smithii</i>	0.24	0.26	0.26	0.28	1	Irvingiaceae
<i>Isolona hexaloba</i>	0.26	0.98	0.17	0.99	6	Annonaceae
<i>Isolona thonneri</i>	0.2	0.65	0.23	0.68	2	Annonaceae
<i>Keayodendron bridelioides</i>	0.61	0.03	0.16	0.04	126	Phyllanthaceae
<i>Khaya anthotheca</i>	0.01	0.64	0.01	0.69	16	Meliaceae
<i>Khaya grandifoliola</i>	0.29	0.66	0.62	0.57	8	Meliaceae
<i>Khaya ivorensis</i>	0	0	0	0	10	Meliaceae
<i>Kigelia africana</i>	0.02	0.05	0.03	0.07	2	Bignoniaceae
<i>Klaineanthus gabonii</i>	0.03	0.01	0.07	0.03	20	Euphorbiaceae
<i>Klainedoxa gabonensis</i>	0.31	0.79	0.04	0.61	147	Irvingiaceae
<i>Laccodiscus pseudostipularis</i>	0.29	0.54	0.31	0.49	5	Sapindaceae
<i>Lannea welwitschii</i>	0.12	0.61	0.88	0.51	38	Anacardiaceae
<i>Lasiodiscus fasciculiflorus</i>	0.17	0.96	0.19	0.99	1	Rhamnaceae
<i>Lasiodiscus mannii</i>	0.06	0.16	0.17	0.08	44	Rhamnaceae
<i>Lasiodiscus marmoratus</i>	0.67	0.72	0.52	0.77	14	Rhamnaceae
<i>Lecaniodiscus cupanioides</i>	0.18	0.01	0.38	0.07	131	Sapindaceae
<i>Leonardoxa africana</i>	0.1	0.96	0.11	0.96	1	Fabaceae
<i>Lepidobotrys staudtii</i>	0	0	0.13	0.08	97	Lepidobotryaceae
<i>Leplaea cedrata</i>	0.41	0	0.21	0	95	Meliaceae
<i>Leplaea thompsonii</i>	0.53	0	0.09	0	146	Meliaceae
<i>Leptactina involucrata</i>	0.04	0.06	0.04	0.13	1	Rubiaceae
<i>Letestua durissima</i>	0.53	0.05	0.51	0.06	1	Sapotaceae
<i>Lovoa trichilioides</i>	0.29	0.36	0.03	0.31	72	Meliaceae
<i>Macaranga barteri</i>	0.18	0.33	0.67	0.69	134	Euphorbiaceae
<i>Macaranga hurifolia</i>	0.27	0.86	0.3	0.87	3	Euphorbiaceae
<i>Macaranga monandra</i>	0.7	0.04	0.23	0.08	9	Euphorbiaceae
<i>Macaranga spinosa</i>	0.7	0.18	0.02	0.94	176	Euphorbiaceae
<i>Maesobotrya griffoniana</i>	0.77	0.5	0.67	0.67	15	Phyllanthaceae
<i>Maesobotrya klaineana</i>	0	0.02	0	0.31	63	Phyllanthaceae
<i>Maesopsis eminii</i>	0.44	0.67	0.91	0.77	16	Rhamnaceae

<i>Majidea forsteri</i>	0	0.66	0	0.55	31	Sapindaceae
<i>Mallotus oppositifolius</i>	0.04	0.68	0.25	0.63	34	Euphorbiaceae
<i>Mammea africana</i>	0.04	1	0.2	0.61	25	Calophyllaceae
<i>Manilkara obovata</i>	0	0.04	0.04	0.11	40	Sapotaceae
<i>Mansonia altissima</i>	0	0.05	0	0.36	171	Malvaceae
<i>Maprounea membranacea</i>	0	0.04	0.03	0.06	42	Euphorbiaceae
<i>Maranthes chrysophylla</i>	0.12	0.55	0.16	0.55	5	Chrysobalanaceae
<i>Maranthes glabra</i>	0.01	0.18	0.03	0.13	69	Chrysobalanaceae
<i>Mareyopsis longifolia</i>	0	0.08	0.37	0.29	99	Euphorbiaceae
<i>Margaritaria discoidea</i>	0.08	0.43	0.23	0.97	48	Phyllanthaceae
<i>Markhamia lutea</i>	0	0	0	0.02	126	Bignoniaceae
<i>Markhamia tomentosa</i>	0.13	0.42	0.72	0.14	61	Bignoniaceae
<i>Massularia acuminata</i>	0.69	0.86	0.8	0.97	15	Rubiaceae
<i>Meiocarpidium lepidotum</i>	0.16	0.43	0.23	0.31	7	Annonaceae
<i>Memecylon aberrans</i>	0.32	0.84	0.39	0.81	3	Melastomataceae
<i>Memecylon amshoffae</i>	0.41	0.56	0.48	0.65	1	Melastomataceae
<i>Microdesmis puberula</i>	0.62	0.33	0.64	0.94	23	Pandaceae
<i>Mildbraediodendron excelsum</i>	0.26	0.58	0.29	0.64	1	Fabaceae
<i>Milicia excelsa</i>	0	0.01	0	0.04	51	Moraceae
<i>Millettia barteri</i>	0.7	0.15	0.66	0.16	12	Fabaceae
<i>Millettia laurentii</i>	0.85	0.38	0.84	0.37	2	Fabaceae
<i>Millettia mannii</i>	0.36	0.9	0.55	0.06	60	Fabaceae
<i>Millettia sanagana</i>	0.09	0.63	0.23	0.39	61	Fabaceae
<i>Monodora myristica</i>	0.57	0.51	0.76	0.55	9	Annonaceae
<i>Monodora tenuifolia</i>	0.04	0.24	0.54	0.47	36	Annonaceae
<i>Morinda lucida</i>	0.29	0.82	0.32	0.82	2	Rubiaceae
<i>Morus mesozygia</i>	0.13	0.33	0.24	0.42	3	Moraceae
<i>Musanga cecropioides</i>	0.19	0.11	0.9	0.18	417	Urticaceae
<i>Myrianthus arboreus</i>	0.18	0.43	0.29	0.53	139	Urticaceae
<i>Myrianthus preussii</i>	0.78	0.05	0.81	0.05	6	Urticaceae
<i>Nauclea diderrichii</i>	0.33	0.56	0.16	0.32	20	Rubiaceae

<i>Neoboutonia mannii</i>	0	0.02	0	0.02	1	Euphorbiaceae
<i>Nesogordonia kabingaensis</i>	0.55	0.01	0.49	0.17	87	Malvaceae
<i>Nesogordonia papaverifera</i>	0.02	0.05	0.03	0.07	1	Malvaceae
<i>Newtonia duparquetiana</i>	0.7	0.94	0.73	0.94	1	Fabaceae
<i>Newtonia glandulifera</i>	0.41	0.56	0.48	0.65	1	Fabaceae
<i>Newtonia griffoniana</i>	0.37	0.97	0.54	0.91	3	Fabaceae
<i>Ochna afzelii</i>	0.28	0.88	0.2	0.15	14	Ochnaceae
<i>Ochna calodendron</i>	0.25	0.53	0.15	0.69	6	Ochnaceae
<i>Octolobus spectabilis</i>	0.59	0.8	0.58	0.79	4	Malvaceae
<i>Olax subscorpioides</i>	0	0	0	0	112	Olacaceae
<i>Omphalocarpum elatum</i>	0.95	0.17	0.9	0.27	21	Sapotaceae
<i>Omphalocarpum procerum</i>	0.01	0.63	0.12	0.63	8	Sapotaceae
<i>Oncoba dentata</i>	0	0	0	0	29	Salicaceae
<i>Oncoba gilgiana</i>	0.2	0.66	0.23	0.68	1	Salicaceae
<i>Oncoba glauca</i>	0.28	0	0.11	0.01	148	Salicaceae
<i>Oncoba mannii</i>	0.07	0.24	0.1	0.32	1	Salicaceae
<i>Oncoba welwitschii</i>	0.38	0.33	0.65	0.34	9	Salicaceae
<i>Ongokea gore</i>	0	0.01	0	0.05	51	Olacaceae
<i>Oubanguia africana</i>	0.79	0.24	0.89	0.29	1	Lecythidaceae
<i>Pachyelasma tessmannii</i>	0.08	0.26	0.18	0.02	8	Fabaceae
<i>Pancovia laurentii</i>	0.07	0.04	0.01	0.46	283	Sapindaceae
<i>Pancovia pedicellaris</i>	0.86	0.13	0.85	0.13	1	Sapindaceae
<i>Panda oleosa</i>	0	0.05	0	0.12	140	Pandaceae
<i>Parinari excelsa</i>	0.01	0.36	0.07	0.6	43	Chrysobalanaceae
<i>Parkia bicolor</i>	0.94	0.13	0.98	0.1	9	Fabaceae
<i>Parkia biglobosa</i>	0	0	0	0.03	129	Fabaceae
<i>Parkia filicoidea</i>	0	0.82	0.02	0.8	15	Fabaceae
<i>Paropsia grewioides</i>	0.44	0	0.43	0	3	Passifloraceae
<i>Pauridiantha floribunda</i>	0.79	0.34	0.72	0.18	6	Rubiaceae
<i>Pausinystalia macroceras</i>	0	0.1	0.01	0.03	206	Rubiaceae
<i>Pentaclethra eetveldeana</i>	0.61	0.62	0.61	0.63	1	Fabaceae

<i>Pentaclethra macrophylla</i>	0	0.25	0	0.03	261	Fabaceae
<i>Persea americana</i>	0.36	0.68	0.4	0.71	3	Lauraceae
<i>Petersianthus macrocarpus</i>	0.06	0	0.17	0.1	730	Lecythidaceae
<i>Phoenix reclinata</i>	0	0	0.04	0.07	28	Arecaceae
<i>Phyllocosmus africanus</i>	0.12	0	0.05	0.23	174	Ixonanthaceae
<i>Phyllocosmus calothyrsus</i>	0.23	0.09	0.37	0.07	3	Ixonanthaceae
<i>Picalima nitida</i>	0.38	0.43	0.25	0.61	63	Apocynaceae
<i>Pierreodendron africanum</i>	0.02	0.05	0.03	0.07	3	Simaroubaceae
<i>Pinacopodium congolense</i>	0.27	0.86	0.3	0.87	1	Erythroxylaceae
<i>Piptadeniastrum africanum</i>	0.04	0.96	0	0.84	144	Fabaceae
<i>Piptocarpha riedelii</i>	0.25	0.18	0.25	0.21	1	Compositae
<i>Pittosporum viridiflorum</i>	0.08	0.06	0.11	0.11	4	Pittosporaceae
<i>Plagiostyles africana</i>	0	0.8	0.01	0.66	459	Euphorbiaceae
<i>Poga oleosa</i>	0.34	0.05	0.39	0.04	13	Anisophylleaceae
<i>Pouteria alnifolia</i>	0	0.08	0	0.02	39	Sapotaceae
<i>Pouteria altissima</i>	0.01	0.64	0.06	0.7	44	Sapotaceae
<i>Pouteria pierrei</i>	0.63	0.33	0.65	0.39	1	Sapotaceae
<i>Premna angolensis</i>	0.15	0.69	0.17	0.71	1	Lamiaceae
<i>Pseudospondias microcarpa</i>	0.71	0	0.72	0.1	61	Anacardiaceae
<i>Psydrax arnoldiana</i>	0.26	0.58	0.29	0.64	1	Rubiaceae
<i>Psydrax subcordata</i>	0.14	0.51	0.18	0.54	16	Rubiaceae
<i>Pteleopsis hylodendron</i>	0.06	0.52	0.11	0.32	48	Combretaceae
<i>Pterocarpus mildbraedii</i>	0.71	0.15	0.47	0.37	14	Fabaceae
<i>Pterocarpus soyauxii</i>	0.04	0	0.39	0.15	175	Fabaceae
<i>Pterygota bequaertii</i>	0.01	0.07	0.01	0.07	5	Malvaceae
<i>Pterygota macrocarpa</i>	0.66	0.54	0.57	0.51	14	Malvaceae
<i>Pycnanthus angolensis</i>	0.04	0	0.51	0.25	243	Myristicaceae
<i>Quassia gabonensis</i>	0.93	0.03	0.75	0.06	37	Simaroubaceae
<i>Quassia undulata</i>	0.04	0.06	0.04	0.13	1	Simaroubaceae
<i>Radlkofera calodendron</i>	0.63	0.33	0.65	0.39	1	Sapindaceae
<i>Rauvolfia caffra</i>	0.02	0.58	0.03	0.63	9	Apocynaceae

<i>Rauvolfia vomitoria</i>	0.26	0.3	0.46	0.26	27	Apocynaceae
<i>Ricinodendron heudelotii</i>	0.11	0.01	0.01	0.14	50	Euphorbiaceae
<i>Rinorea cuspa</i>	0.62	0.29	0.8	0.4	18	Violaceae
<i>Rinorea dentata</i>	0.94	0.26	0.84	0.15	23	Violaceae
<i>Rinorea grandifolia</i>	0.12	0.23	0.15	0.33	2	Violaceae
<i>Rinorea leiophylla</i>	0.24	0.03	0.33	0.14	26	Violaceae
<i>Rinorea oblongifolia</i>	0.96	0.38	0.75	0.99	109	Violaceae
<i>Rothmannia hispida</i>	0.94	0.32	0.82	0.3	5	Rubiaceae
<i>Rothmannia lujae</i>	0.43	0.07	0.15	0.02	132	Rubiaceae
<i>Rothmannia talbotii</i>	0.56	0.5	0.59	0.48	2	Rubiaceae
<i>Sacoglottis gabonensis</i>	0.18	0.08	0.24	0.06	5	Humiriaceae
<i>Santiria trimera</i>	0.01	0	0.01	0.28	446	Burseraceae
<i>Scottellia klaineana</i>	0.56	0.16	0.11	0.26	41	Achariaceae
<i>Shirakiopsis elliptica</i>	0.2	0.17	0.4	0.14	17	Euphorbiaceae
<i>Sloetiopsis usambarensis</i>	0.22	0.63	0.3	0.97	87	Moraceae
<i>Sorindeia africana</i>	0.36	0.02	0.35	0.02	1	Anacardiaceae
<i>Sorindeia grandifolia</i>	0.22	0.4	0.03	0.28	248	Anacardiaceae
<i>Sorindeia juglandifolia</i>	0	0	0	0.02	64	Anacardiaceae
<i>Spathodea campanulata</i>	1	0.22	0.99	0.26	2	Bignoniaceae
<i>Spondias cytherea</i>	0.08	0.06	0.11	0.11	1	Anacardiaceae
<i>Spondias mombin</i>	0	0.04	0.02	0.07	28	Anacardiaceae
<i>Staudtia kamerunensis</i>	0.03	0.03	0.13	0.6	297	Myristicaceae
<i>Sterculia micrantha</i>	0.34	0.92	0.19	0.76	11	Malvaceae
<i>Sterculia rhinopetala</i>	0	0.26	0.01	0.46	245	Malvaceae
<i>Sterculia tragacantha</i>	0.04	0	0	0.01	129	Malvaceae
<i>Strephonema pseudocola</i>	0.31	0.14	0.23	0.4	12	Combretaceae
<i>Strephonema sericeum</i>	0.49	0.6	0.5	0.68	1	Combretaceae
<i>Strombosia grandifolia</i>	0	0.04	0	0.42	651	Olacaceae
<i>Strombosia pustulata</i>	0.51	0.06	0.56	0.07	7	Olacaceae
<i>Strombosia scheffleri</i>	0.8	0.56	0.66	0.18	8	Olacaceae
<i>Strombosia zenkeri</i>	0.5	0.16	0.46	0.15	2	Olacaceae

<i>Strombosiopsis tetrandra</i>	0	0.54	0	0.38	256	Olacaceae
<i>Strychnos staudtii</i>	0.69	0.98	0.73	0.98	2	Loganiaceae
<i>Symphonia globulifera</i>	0.17	0.18	0.28	0.85	33	Clusiaceae
<i>Synsepalum dulcificum</i>	0.55	0.1	0.31	0.1	86	Sapotaceae
<i>Syzygium guineense</i>	0	0.04	0.04	0.09	19	Myrtaceae
<i>Syzygium rowlandii</i>	0.35	0.01	0.04	0.07	12	Myrtaceae
<i>Tabernaemontana crassa</i>	0.11	0	0.7	0.13	1058	Apocynaceae
<i>Terminalia superba</i>	0.1	0.44	0.83	0.28	156	Combretaceae
<i>Tessmannia africana</i>	0.14	0	0.1	0	18	Fabaceae
<i>Tessmannia anomala</i>	1	0.74	0.89	0.75	25	Fabaceae
<i>Tetrapleura tetraptera</i>	0.63	0.84	0.68	0.63	70	Fabaceae
<i>Tetrorchidium didymostemon</i>	0.91	0.33	0.79	0.06	19	Euphorbiaceae
<i>Tetrorchidium oppositifolium</i>	0.77	0.34	0.75	0.37	1	Euphorbiaceae
<i>Thomandersia hensii</i>	0.66	0.64	0.65	0.63	2	Thomandersiaceae
<i>Treculia africana</i>	0.36	0.73	0.77	0.14	92	Moraceae
<i>Treculia obovoidea</i>	0.08	0.55	0.3	0.55	51	Moraceae
<i>Trema orientalis</i>	0.16	0.64	0.21	0.54	3	Cannabaceae
<i>Tricalysia discolor</i>	0.72	0.05	0.7	0.06	2	Rubiaceae
<i>Tricalysia pangolina</i>	0.05	0.55	0.03	0.6	39	Rubiaceae
<i>Trichilia dregeana</i>	0.09	0.06	0.12	0.07	56	Meliaceae
<i>Trichilia prieuriana</i>	0.46	0.01	0	0.11	315	Meliaceae
<i>Trichilia rubescens</i>	0.01	0.24	0	0.03	109	Meliaceae
<i>Trichilia tessmannii</i>	0.58	0.01	0.1	0.43	109	Meliaceae
<i>Trichilia welwitschii</i>	0.01	0	0.49	0.11	305	Meliaceae
<i>Trichoscypha acuminata</i>	0	0.34	0.02	0.01	141	Anacardiaceae
<i>Trichoscypha arborea</i>	0.11	0	0.1	0.03	17	Anacardiaceae
<i>Trichoscypha oddonii</i>	0.01	0.61	0.1	0.88	26	Anacardiaceae
<i>Tridesmostemon omphalocarpoides</i>	0.69	0.64	0.17	0.66	27	Sapotaceae
<i>Trilepisium madagascariense</i>	0	0.01	0	0.01	200	Moraceae
<i>Triplochiton scleroxylon</i>	0.22	0.22	0.36	0.51	151	Malvaceae

<i>Turraeanthus africana</i>	0	0.8	0.02	0.9	34	Meliaceae
<i>Uapaca acuminata</i>	0.53	0.02	0.64	0.04	20	Phyllanthaceae
<i>Uapaca guineensis</i>	0.01	0.7	0.16	0.1	452	Phyllanthaceae
<i>Uapaca heudelotii</i>	0.11	0.54	0.27	0.61	31	Phyllanthaceae
<i>Uapaca paludosa</i>	0.35	0.04	0.23	0	144	Phyllanthaceae
<i>Uapaca staudtii</i>	0.02	0.12	0.28	0.29	34	Phyllanthaceae
<i>Uapaca vanhouttei</i>	0.16	0.11	0.5	0.05	20	Phyllanthaceae
<i>Usteria guineensis</i>	0.41	0.56	0.48	0.65	1	Loganiaceae
<i>Uvariastrum pierreanum</i>	0.51	0.01	0.75	0.15	43	Annonaceae
<i>Uvariastrum zenkeri</i>	0.24	0.27	0.02	0.23	18	Annonaceae
<i>Uvariopsis bakeriana</i>	0.02	0.05	0.03	0.07	1	Annonaceae
<i>Vepris louisii</i>	0.61	0.28	0.48	0.64	21	Rutaceae
<i>Vitex dentata</i>	0.08	0.06	0.11	0.11	2	Lamiaceae
<i>Vitex doniana</i>	0	0	0	0	20	Lamiaceae
<i>Vitex grandifolia</i>	0.92	0	0.87	0	18	Lamiaceae
<i>Vitex rivularis</i>	0.01	0	0.01	0.03	70	Lamiaceae
<i>Voacanga africana</i>	0	0.51	0.06	0.5	16	Apocynaceae
<i>Xylopi aethiopica</i>	0.44	0.64	0.06	0.12	80	Annonaceae
<i>Xylopi aurantiiodora</i>	0.06	0.1	0.03	0.17	39	Annonaceae
<i>Xylopi hypolampra</i>	0.12	0.2	0.36	0.27	32	Annonaceae
<i>Xylopi parviflora</i>	0	0.84	0.01	0.21	6	Annonaceae
<i>Xylopi quintasii</i>	0.02	0.89	0.08	0.34	72	Annonaceae
<i>Xylopi rubescens</i>	0.41	0.02	0.75	0.12	5	Annonaceae
<i>Xylopi staudtii</i>	0.87	0.04	0.89	0.07	24	Annonaceae
<i>Zanthoxylum gillettii</i>	0.25	0.38	0.43	0.28	79	Rutaceae
<i>Zanthoxylum heitzii</i>	0.73	0	0.75	0.01	5	Rutaceae
<i>Zanthoxylum leprieurii</i>	0.01	0.61	0.06	0.48	16	Rutaceae
<i>Zanthoxylum rubescens</i>	0.25	0.18	0.25	0.21	4	Rutaceae