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# **Unique botanical value on Atacora Mountains: reasons for the creation of new conservation areas in Benin**

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Hounnankpon Yédomonhan, Monique Tossou, Peter Neuenschwander, Brice Sinsin

Running title: Measuring plant diversity for conservation on Atacora Mountains

Unique botanical value of the Atacora Mountains: reasons for the creation of new conservation areas in Benin

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## Abstract

**Background and aims** – The Atacora Mountains (AMs) are a geo-morphologically, ecologically and floristically important ecosystem in Benin. Unfortunately, nearly entire the area remains without official protection. Considering the high pressure on the flora and vegetation during last decades, identification of suitable conservation areas at finer scale is needed. This work present a checklist of plant species found in the six site covered by Atacora Mountains, assess distribution of the special plants (endemic, nearly endemic, exclusive and threatened) and identify diversity centres and priority conservation area.

**Material and methods** – Inventories were conducted in six sites covered by the AMs from August 2017 to March 2019. The phytosociological method of Braun-Blanquet was applied. A total of 129 plots of 900 m<sup>2</sup> for mature individuals, and subplots of 5 x 5 m for regenerations were performed. The map of AMs was digitised using ArcGIS 9.3 and grid cells based on mileage were used to assess the spatial patterns of special species.

**Key results** – In total, 827 plant species belonging to 464 genera and 105 families of which 55 special species were recorded. The highest numbers of the special species were distributed throughout the study area except in Toucountouna and Kérou sites. Using distribution and taxonomic richness in special taxa as model system, three biodiversity centers and one top conservation priority site (Boukoubé) were identified.

**Conclusion** – The identified areas of AMs can form the basis for defining habitats with priority conservation in this ecosystem. It is therefore important to preserve the remaining plant populations *in situ* to create an environment in which they can increase to levels beyond an imminent danger of extinction.

## Keywords

Atacora Mountains, conservation sites, plant diversity, special taxa

## INTRODUCTION

Worldwide, the number of species threatened with extinction is high and this trend risks to become rapidly worse (Lawton and May 1995; Myers 1996; Royal Society 2003); this being due to land cleaning for agriculture, habitat fragmentation, invasive species, overexploitation and urbanization (Tilman et al. 2017). Since the recognition of major human pressure on biodiversity and its habitat, the biodiversity conservation has become essential in sustainable development agenda which has been translated in a unified convention: the Convention on Biological Diversity (CBD) which has been ratified in 1992. Conservation of life on earth has therefore become much more than a side interest of a few scientists and is now part of mainstream international activity (Knapp 2011).

In the Republic of Benin, flora protection is better assured in the 46 classified forests, the two national parks (Pendjari and Niger river W) and their protected hunting zones, the botanical reserves (Pobè and Niaouli), the botanical gardens and to a lesser degree in sacred groves and community forests (Neuenschwander et al. 2011). According to Adomou (2005) and Neuenschwander et al. (2011), the number of protected sites in the country is very limited and their distribution is highly uneven. Indeed, the southern relict forests are poorly represented in this network of protected areas and some botanically interesting areas such as Atacora Mountains (AMs) are totally absent.

The Atacora chain is an important macro-ecosystem of the West African sub-region, extending from Ghana (Akwakpim Hills) to Togo (Mount Togo) and Republic of Benin (AMs). In the Republic of Benin, it covers six sites namely Tanguieta, Kouandé, Natitingou, Toucountouna, Kérou, and Boukoubmé. According to its geographical structure and its particular climate type, it acts as a geo-morphologically, ecologically and floristically important ecosystem for Benin (Adomou 2005; Wala 2010) and for all the Atacora range from including Ghana, Togo and Benin. Geo-morphologically, AMs encompassed three main structural units namely: synclitorium of Toucountouna, monoclonal zone of Natitingou and anticlinorium of Kotopounga (Affaton 1987). This would create special microclimate noticed on and around the AMs. As consequence of ecology expression, AMs acts as isolation unit and hosts about 467 plant species of which two out of three of Benin's endemic plant species namely *Thunbergia atacorensis* and *Ipomoea beninensis* (Adomou 2005; Neuenschwander et al. 2011). AMs harbours three genera that are endemic to the Sudanian region (*Vitellaria*, *Pseudocedrela* and *Haematostaphis*) (Akoègninou et al. 2006), and many other exclusive and endangered plant species (Natta 2003). Furthermore, AMs acts as a refugial habitat for rain forest species such as *Antiaris toxicaria*, *Milicia excelsa*, *Pentadesma butyracea*, *Lecaniodiscus cupanioides*, *Detarium senegalense*, and *Millettia thonningii*, which are abundant in some riparian forests (Wala 2005). All this makes AMs an important centre of local biodiversity. Unfortunately, only a tiny part, less than 1% of the site located within Biosphere Reserve of Pendjari, is under legal protection, partially due to a lack of financial resources, public policies and detailed knowledge regarding the spatial distribution of species within ecologically valuable regions notably rare, endemic, threatened and exclusive plants. For this, studies by Adomou (2005) placed AMs among priority sites for plant conservation in Benin.

Human population established their lifestyle, culture and their livelihood through the uses of resources of this unique biodiversity site. The main economic activities in the AMs are extensive agriculture, hunting, apiculture and firewood harvesting. Unfortunately, the large and increasing demand for plant resources of which non-timber forest products and the consequent increase in the rate of collection negatively affected the wild populations of many species in Benin, to the point that some species are now considered to be threatened with extinction when other are already extinct. We can cite *Khaya senegalensis* (Desr.) A.Juss., *Milicia excelsa* (Welw.) C.C.Berg and *Vitellaria paradoxa* C.F.Gaertn. (Vulnerable) and *Caesalpinia bonduc* (L.) Roxb. and *Garcinia kola* Heckel (extinct in the wild) (Neuenschwander et al. 2011). Considering this

high pressure on the flora and vegetation during the last decades in the AMs there is an urgent need to include these plant species in restoration and more sustainable conservation programmes. While human pressure is continuously increasing no scientific data concerning the possible conservation exists. Although some studies (e.g. Tenté 2002; Natta 2003; Wala 2005) have analysed the floristic diversity on the AMs, a particular focus on the rare, endemic, exclusive, and threatened plants species is still lacking, and probably not offering strong enough arguments to better engage stakeholders on the conservation of the AMs. Thus, we draft a checklist of plant species on AMs with a focus on special plants (endemic, nearly endemic, exclusive, and threatened) proving unique botanical value to the AMs, assess distribution of the special species, and identify diversity centres and priority conservation areas on the AMs. Additionally, detailed information is given on family, life form, and phytogeographical type for each species.

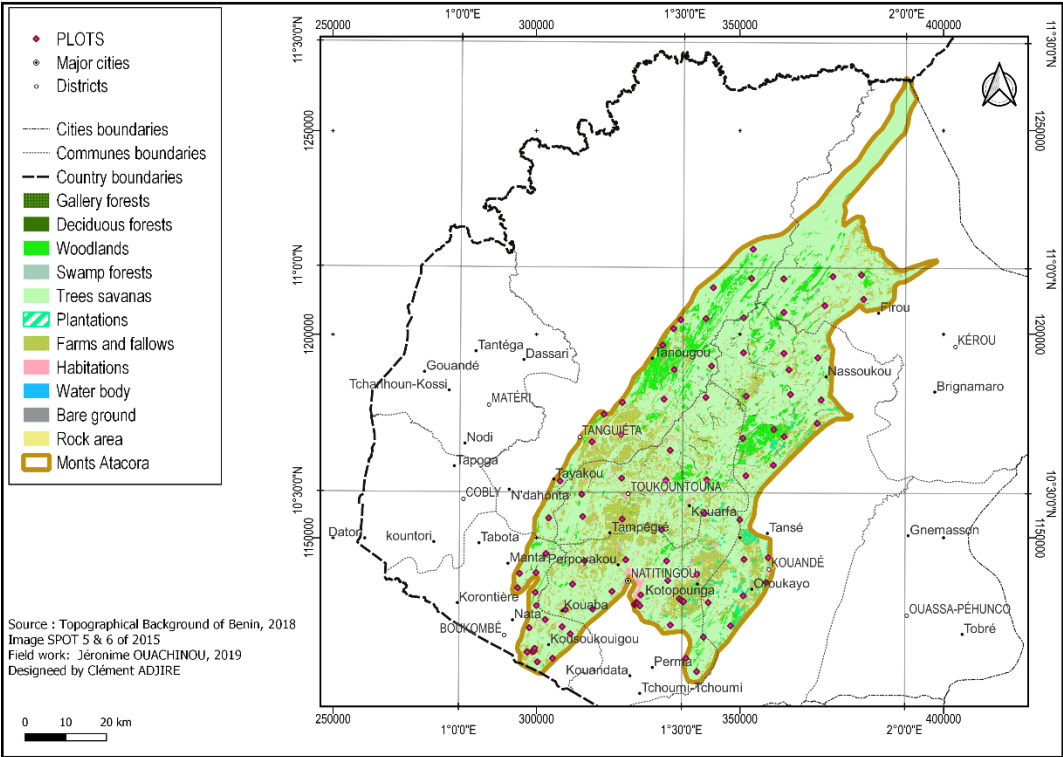
## MATERIAL AND METHODS

### Study site

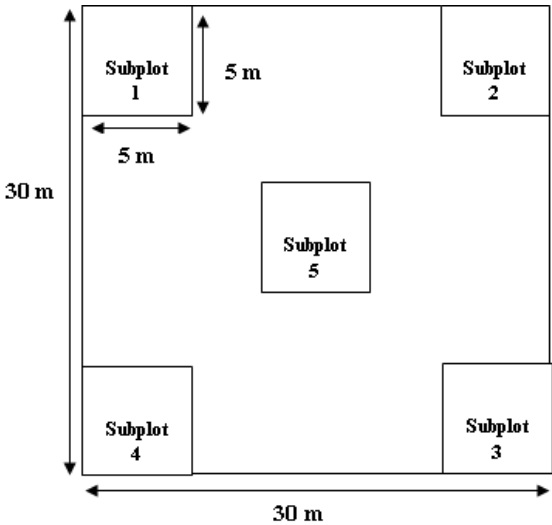
Pivot Spot Images for 2015, Digital Elevation Model ou DEM and contour lines were used for the exact delimitation (map) of the AMs (Fig. 1). The AMs in Benin Republic are situated between 9°45'N and 12°25'N (DDM) in the Sudanian region and cover six sites (Tanguieta, Kouandé, Natitingou, Toucountouna, Kérou and Boukoumbé) (Fig. 1). Mean altitude is 500 m and the annual rainfall is 1000–1200 mm. Soils are gravelous and only little developed. The AMs act as a physical and floristic discontinuity dividing the phyto-district Mékrou-Pendjari into western and eastern parts, which are floristically and ecologically similar (Adomou 2005). Natta (2003) showed that the species composition of the riparian forest at the foot of the AMs is unique in Benin, with many exclusive species such as *Eriocoelum kerstingii*, *Synsepalum passargei*, *Chrysobalanus icaco* subsp. *atacorensis*, and *Gardenia imperialis*. The exclusive presence of the Sudanian endemic genus *Haematostaphis* (White 1983) and Benin's endemic plant species *Thunbergia atcorensis* constitute the major biogeographical particularity of this phyto-district (Adomou 2005). Exploitation of granitic rock plates and timber as well as agriculture constitute the major human pressures on the vegetation of AMs.

### Data collection

The list of plant species found on Atacora Mounts was established through inventories conducted in six sites (Tanguieta, Kouandé, Natitingou, Toucountouna, Kérou, and Boukoumbé) from August 2017 to March 2019. Major vegetation types on the Atacora Mounts were identified using a vegetation map of Benin. Within each site, representative and homogeneous vegetations were selected according to the presence of dominant species and major environmental factors such as soil texture, outcrops, topography, vegetation structure, and tree cover. The phytosociological method of Braun-Blanquet (1932) was applied. A total of 129 plots of 900 m<sup>2</sup> (30 m x 30 m) were designed to record ecological data relating to all the species having at least 10 cm dbh (mature individuals). Within each plot, five square subplots (four in the angles and one in the centre) of 5 x 5 m (Fig. 2) were established to tag and sample the regenerations. The geographical coordinates and altitude of each plot were noted. Data were supplemented by specimen data from the National Herbarium of Benin and database of Global Biodiversity Information Facilities (GBIF) for a beter mapping of the threatened plant species distribution occurring on AMs. Some of the plants were identified in the field but most were identified at the National Herbarium by comparing to already identified herbarium specimens and using taxonomic keys notably Akoègninou et al. (2006) and Arbonnier (2009). Voucher specimens of recorded plants were collected from the study area and stored at the National Herbarium (BENIN). The World Flora Online (WFO) was used to obtain the current names of the plants collected.



**Figure 1 – Atacora Mountains showing the designed plots.**



**Figure 2 – Sample unit of forest inventory**

### Data analysis

Floristic diversity was assessed through taxonomic species, genera, and family richness. Biological and chorological types were assigned based on the life forms defined by Raunkiaer (1905) and the phytochoria defined by White (1983). The number of species per life form and chorological type were determined, and their relative frequency (%) was calculated and used for establishing the biological spectra. Identification of special species (endemic, nearly endemic, exclusive, and threatened species) occurring on the AMs was based on Adomou (2005) and Akoègninou et al. (2006) and the database of the National Herbarium of Benin. We used the following definitions: 1) endemic species: taxa restricted to Benin; 2) nearly endemic: taxa

restricted to Benin-Togo (locally restricted in West Africa); 3) exclusive species: species widely distributed in tropical Africa but in Benin only occurring on the Atacora Mountains; 4) threatened species: taxa classified as Endangered, Critically Endangered, or Vulnerable (IUCN 2008; Neuenschwander et al. 2011). Coordinates of the special species were distributed on the map of AMs, which was first digitized using ArcGIS 9.3. To a better analyse of the distribution species, map was divided in grid cells of 10 Km x 10 Km, which is large enough for local authorities to manage. Biodiversity centres were identified based on species richness and number of special species in each spatial unit for each site of the study area. These factor-variables were opposed to plant lists of state forest reserves in a gap analysis for identifying priority conservation areas on the Atacora Mountains.

## RESULTS

### Plant species composition

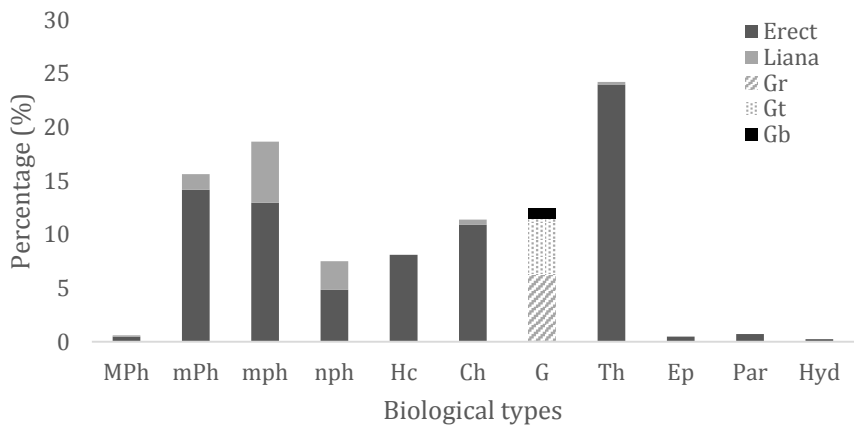
Eight hundred and twenty-seven plant species were recorded on the AMs (Supplementary file). They belong to 464 genera, 105 families and two clades: angiosperms (818 species, 98.91%) and Pteridophyta (9 species, 1.09%). Among angiosperms, dicotyledons accounted for 80.20% (656 species) of the total, monocotyledons for 19.80% (162 species). The most represented family by number of genera was Fabaceae with 69 genera (14.87%) and 152 species (18.38%); followed by Poaceae, 50 genera (10.77%) and 97 species (11.73%), Rubiaceae, 35 genera (7.54%) and 60 species (7.26%), Asteraceae, 30 genera (6.46%) and 46 species (5.56%), Malvaceae, 18 genera (3.88%) and 38 species (4.59%), Lamiaceae, 13 genera (2.80%) and 22 species (2.66%), and Acanthaceae, 13 genera (2.80%) and 19 species (2.30%), Apocynaceae, 12 genera (2.59%) and 15 species (1.81%), Euphorbiaceae, 11 genera (2.37%) and 16 species (1.93%). These families amount to 251 genera (54.09%) and 465 species (56.23%) of the flora.

Ten families encompass between 8 and 5 genera. There were: 1 family with 8 genera: Anacardiaceae (10 species); 3 families with 7 genera: Cyperaceae (20 species); Phyllanthaceae (12 species) and Arecaceae (9 species); 4 families with 6 genera: Asparagaceae (15 species), Amaranthaceae, Sapindaceae and Sapotaceae (8 species each); and 2 families with 5 genera: Convolvulaceae (16 species) and Meliaceae (5 species). They encompass 63 genera (13.58%) and 111 species (13.42%). Among the remaining 86 families, 8 contain each 4 genera; 10 have 3; 18 have 2, and 50 contain only 1 genus.

The ratio of the number of genera to the number of species was almost 1.78; meaning that each genus holds approximately two species. The genera holding the highest number of species were *Crotalaria*, *Ficus* and *Indigofera* (12 species each, 1.45% each of the total species). They were followed by four genera (*Combretum*, *Ipomoea*, *Tephrosia*) containing 10 species each (1.21% each). Three genera (*Dioscorea*, *Spermacoce* and *Vigna*) had 9 species each (1.09% each); 2 genera (*Cissus* and *Terminalia*) with 8 species each (0.97% each); 2 genera (*Cyperus*, *Scleria* and *Andropogon*) with 7 species (0.85% each); 5 genera (*Aspilia*, *Chlorophytum*, *Euphorbia*, *Grewia* and *Sida*) with 6 species each (0.73% each); 9 genera (*Bracharia*, *Eragrostis*, *Gardenia*, *Hyparrhenia*, *Panicum*, *Pennisetum*, *Senegalia*, *Senna* and *Triumfetta*) with 5 species each (0.60% each); 21 genera (*Albizia*, *Chamaecrista*, *Commelina*, *Corchorus*, *Ctenium*, *Cyphostemma*, *Digitaria*, *Dissotis*, *Eriosema*, *Eulophia*, *Loudetia*, *Ludwigia*, *Oldenlandia*, *Phyllanthus*, *Plectranthus*, *Polygala*, *Psychotria*, *Rhynchosia*, *Schizachyrium*, *Vachellia* and *Vernoniastrum*) with 4 species each (0.48% each); 26 genera (*Abrus*, *Acacia*, *Adenia*, *Alysicarpus*, *Amorphophallus*, *Asparagus*, *Bridelia*, *Cyanotis*, *Desmodium*, *Entada*, *Hibiscus*, *Hyptis*, *Keetia*, *Lantana*, *Lepidagathis*, *Ochna*, *Ocimum*, *Phaulopsis*, *Psorospermum*, *Sesbania*, *Sporobolus*, *Strychnos*, *Vangueria*, *Vernonia*, *Vitex* and *Ziziphus*) with 3 species each (0.36% each); 71 genera with 2 species each (0.24% each). The remaining 318 genera were monospecific.

**Life forms composition**

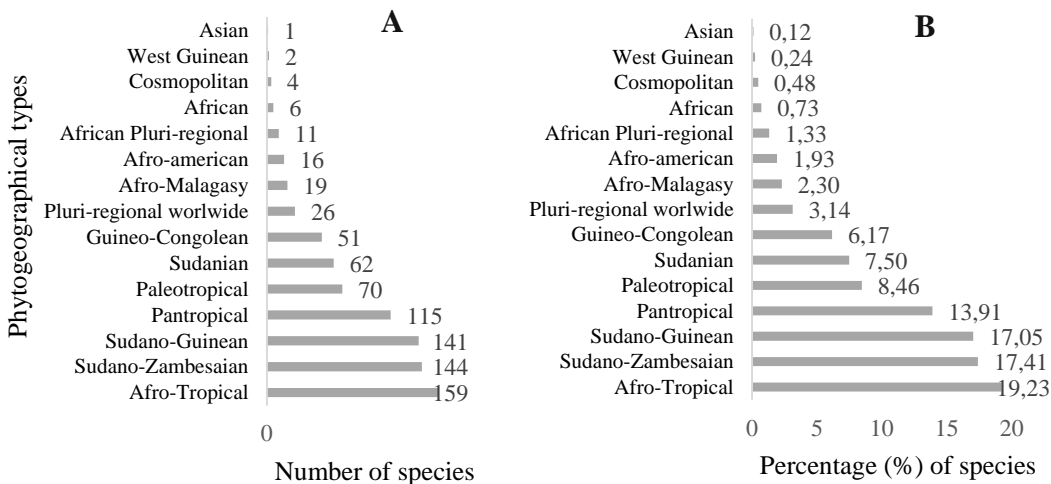
Analysis of life form category distribution (Fig. 3) showed phanerophytes were predominant representing 40.74% of the entire life form spectrum. This category includes megaphanerophytes (0.63%), mesophanerophytes (6.35%), microphanerophytes (26.02%), and nanophanerophytes (7.56%). These were followed by therophytes (29.25%), geophytes (13.04% of which Gb = 0.98%; Gr = 7.80%, and Gt = 4.26%), chamaephytes (9.39%), and hemicryptophytes (6.96%). The least represented life form groups were parasites and epiphytes (Fig. 3).



**Figure 3** – Life form spectrum of the species recorded on the AMs.

**Phytogeographical distribution**

AMs flora was assigned to 15 major distribution patterns (Fig. 4). It was dominated by Afro-tropical (159 species, 19.23% of the total), Sudano-Zambesian (144 species, 17.41%), Sudano-Guinean (141 species, 17.05%) and Pantropical elements (115 species, 13.91%) (Fig. 4). Paleotropical, Sudanian and Guineo-Congolese species respectively totalize 8.46, 7.50 and 6.17%. The other elements totalize 85 species. They include: Pluri-regional worldwide (26 species, 3.14%), Afro-Malagasy (19 species, 2.30%), Afro-American (16 species, 1.93%), African Pluri-regional (11 species, 1.33%), African (6 species, 0.73%), Cosmopolitan (4 species, 0.48%), West Guinean (2 species, 0.24%) and Asian (1 species, 0.12%) (Fig. 4). We found one Benin endemic species and another species nearly endemic to Benin but with some populations in Togo.

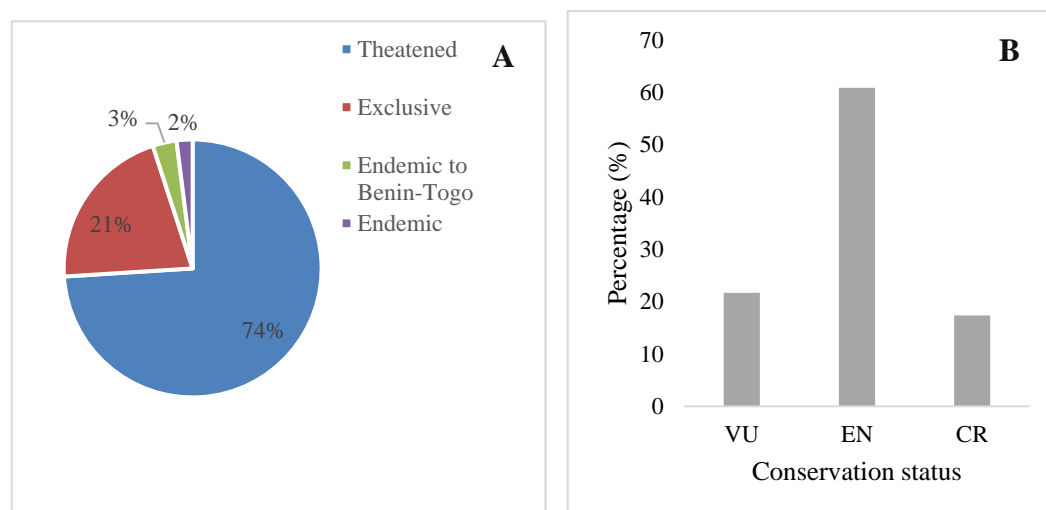


**Figure 4 – Chorological spectrum of AMs. A. Number of species. B. Percentage of species per phytogeographical type**

# **List of particular species giving a special botanical value to the AMs**

Investigations revealed a total of 55 special taxa distributed into four categories recorded on the AMs (Fig. 5A). Among them, the most common category was threatened species (46 species, 74%) followed by exclusive species (13 species, 21%) (Fig. 5A).

By considering the conservation status of the threatened species category, 60.90% of the species have been assessed as Endangered (EN) against 21.70% and 17.40% of them have been respectively characterised as Vulnerable (VU) and Critically endangered (CR) (Fig. 5B).



**Figure 5 – A. Percentage of special species per category. B. Percentage of the threatend species per conservation status.**

## **Endemic species**

Only one species among the three known as endemic to the country was recorded on the AMs.

***Ipomoea beninensis*** Akoègninou, Lisowski & Sinsin (Convolvulaceae)

**Distribution and habitat.** *Ipomoea beninensis* is known from a few localities within the phytogeographical districts of Bassila, AMs, and Borgou-Sud (Sudanian zone). It is therefore one of endemic species of the country. It occurs on ferruginous soils on crystalline rocks, or with concretions and breastplates or on poorly evolved and mineral soils in woodlands and savannah. Major parts of its habitats are unprotected.

**Material examined.** Akoègninou 2621; Lisowski D-777; HNB.

## **Narrow-distribution species**

We grouped the species presented in this part in two categories, namely Endemic to Benin-Togo species and exclusive species.

## **Endemic to Benin-Togo species**

***Thunbergia atcorensis*** Akoègninou & Lisowski (Acanthaceae)

**Distribution and habitat.** *Thunbergia atcorensis* is a species primarily found at Koussoukoingou (near Boukoumbé) on the AMs and previously considered as endemic plant of Benin. In fact, it is restricted to the gallery forests of the Atacora Chain (Benin and Togo) and of the Ouari-Marou Classified forest (Benin). Major parts of its habitats are unprotected.

288 **Material examined.** *Lisowski 990; Burg 1438; Sinsin 2907*; HNB.

289 ***Polygala atacorensis*** Jac.-Fél. (Polygalaceae)

290 **Distribution and habitat.** *Polygala atacorensis* is mainly distributed in the Atacora Mountains  
291 (Benin-Togo) but with a population in this area (Djougou) receiving microclimate created by the  
292 mountains. The species grows in savannah.

293 **Material examined.** *Sokpon 282; Pauwels 7917; Chevalier 24041*; HNB.

294 ***Exclusive species***

295 We recorded 14 species occurring exclusively on the AMs.

296 ***Actiniopteris radiata*** (Sw.) Link (Pteridaceae)

297 **Distribution and habitat.** *Actiniopteris radiata* is confined to the AMs and grows around dry  
298 rocks at an altitude above 600 m.

299 **Material examined.** *Sinsin 3963*; HNB.

300 ***Apodostigma pallens*** (Planch. ex Oliv.) R.Wilczek (Celastraceae)

301 **Distribution and habitat.** *Apodostigma pallens* grows in a variety of habitats ranging from  
302 riparian forests to dry woodlands across the phytogeographical district of AMs.

303 **Material examined.** *Akoègninou 2388; Akoègninou 2710; Sinsin 2528; Burg 1456*; HNB.

304 ***Commiphora pedunculata*** Engl. (Burseraceae)

305 **Distribution and habitat.** *C. pedunculata* is only known from the extreme north-western  
306 (phytogeographical districts of AMs and Mekrou-Pendjari) and it grows in the woodlands on  
307 poorly evolved and mineral soils.

308 **Material examined:** *Chevalier 23967; Hounnon 209a*; HNB.

309 ***Chrysobalanus icaco* L. subsp. *atacorensis*** (A.Chev.) F.White (Chrysobalanaceae)

310 **Distribution and habitat.** *C. icaco* is confined to the AMs, growing on poorly evolved and  
311 mineral soils with raw minerals (hydromorphic) in riparian forests.

312 **Material examined.** *Essou 2056; Akoègninou 6121; Chevalier 24175*; HNB.

313 ***Osmunda regalis*** L. (Osmundaceae)

314 **Distribution and habitat.** *O. regalis* is presently only known from Yéripao on the AMs,  
315 growing on hills and at edge of the river.

316 **Material examined.** *Akoègninou 2517; Maesen 7180*; HNB.

317 ***Eulophia guineensis*** Lindl (Orchidaceae)

318 **Distribution and habitat:** it is only known from the gallery forests of the Borgou-Sud and  
319 Bassila. It hold also some small populations found in the rocky and gallery forests at Tanguiéta,  
320 Tanougou, Kota, Pouya, Kotopounga on the AMs.

321 **Material examined.** *Burg 1489; Adjakidjè 2698*; HNB.

322 ***Gardenia imperialis* K.Schum. subsp. *imperialis*** (Rubiaceae)

323 **Distribution and habitat.** *G. imperialis* is confined to the AMs because it were recorded from  
324 only one locality (Yarpao). It grows in riparian forests on poorly evolved and mineral soils.

325 **Material examined.** *Maesen 7241*; HNB.

326 ***Ophrestia hedysaroides*** (Willd.) Verdc. (Fabaceae)

327 **Distribution and habitat.** Across Benin, *O. hedysaroides* grows only in the grassland with some  
328 small population in forest edges on the AMs.

329 **Material examined.** *Chevalier 24278*; HNB.

- 330 *Phaulopsis imbricata* Sweet. (Acanthaceae)  
 331 **Distribution and habitat.** *P. imbricata* is known from three localities on the AMs: Taneka  
 332 (grassland and gallery forest), Perma (river edge) and Kouaténa (gallery forest).  
 333 **Material examined.** Akoègninou 4257; HNB.
- 334 *Synsepalum passargei* (Engl.) T.D.Penn. (Sapotaceae)  
 335 **Distribution and habitat.** *S. passargei* is recorded at the foot of the Atacora Mounts in the  
 336 riparian forests. Important population of the species is found at Yarpao (Natitingou). It is native  
 337 to tropical Africa (Guinea, Sierra Leone, Ghana, Nigeria to DR Congo and East Africa).  
 338 **Material examined.** Sokpon 247; Sinsin 1433 ; HNB.
- 339 *Terminalia brownii* Fresen. (Combretaceae)  
 340 **Distribution and habitat.** *T. brownii* is known to be confined to only one unprotected site  
 341 (Tanguiéta) on Atacora Mount. It occurs in woodland and savannah woodland on poorly evolved  
 342 and mineral soils.  
 343 **Material examined.** Dassou 956; HNB.
- 344 *Bewsia biflora* (Hack.) Goossens (Poaceae)  
 345 **Distribution and habitat.** *B. biflora* is known from only two localities (Natitingou and  
 346 Tanguiéta) of the Mounts and it grows in riparian forest, dry forest, and woodland on poorly  
 347 evolved and mineral soils.  
 348 **Material examined.** Houngnon 3888; Sinsin 865; HNB.
- 349 *Haematostaphis barteri* Hook.f. (Anacardiaceae)  
 350 **Distribution and habitat.** *H. barteri* is confined to the savannah on rock hill with its principal  
 351 occurrence in Natitingou on the Atacora Mounts.  
 352 **Material examined.** Akoègninou 424; Essou 2087; HNB.
- 353 *Vigna stenophylla* Harms (Fabaceae)  
 354 **Distribution and habitat.** *Vigna stenophylla* grows in savannah with a distribution limited to the  
 355 Atacora Mounts between Natitingou and Kouandé.  
 356 **Material examined.** Akoègninou 3581; Chevalier 24234; HNB.  
 357
- 358 **Threatened species**  
 359 Forty-six species were identified to be threatened based on their proposed IUCN and IUCN-  
 360 Benin status.
- 361 *Belonophora coffeoides* Hook.f. (Rubiaceae)  
 362 **Distribution and habitat in Benin.** *B. coffeoides* is known from the gallery forests on the  
 363 Atacora Mounts, growing in exposed rocky areas. It is also found semi-deciduous and dry forests  
 364 of the Guineo-Congolian zone in Benin.  
 365 **Material examined.** Akoègninou 2497; Sokpon 353; Sinsin 3141; HNB.  
 366 **Benin Redlist:** CR
- 367 *Detarium senegalense* J.F.Gmel. (Fabaceae)  
 368 **Distribution and habitat in Benin.** *D. senegalense* occurs from the semi-deciduous forest in the  
 369 Pobè phytodistrict and from gallery forest of the Bassila and Borgou-Sud phytodistricts in  
 370 savanna area.  
 371 **Material examined.** Houngnon 268e; HNB.  
 372 **Benin Redlist:** VU
- 373 *Diplolophium africanum* Turcz. (Apiaceae)

- 374 **Distribution and habitat.** *D. africanum* is known from only one locality (Perma) on AMs. In  
375 Benin, its two other small populations were found at Tamarou and Daroukparou (Borgou-Sud). It  
376 grows in riparian forests on poorly evolved and mineral soils.  
377 **Material examined.** *Houngnon* 7207, *Lisowski* D-752, *Adjakidjè* 2830; HNB.  
378 **Benin Redlist:** EN
- 379 *Dissotis grandiflora* Benth. (Melastomataceae)  
380 **Distribution and habitat.** *D. Grandiflora* is known from Ouémé, Borgou-Sud and Atacora  
381 districts. It grows in savannah on hills and fallows.  
382 **Material examined.** *Adjakidjè* 1945; *Sinsin* 2901; *Pauwels* 8090; *Sokpon* 302; HNB.  
383 **Benin Redlist:** VU
- 384 *Andira inermis* (W. Wright) DC. (Fabaceae)  
385 **Distribution and habitat.** *A. inermis* is distributed in four phytogeographical districts namely:  
386 Zou, Borgou-Sud, Borgou-Nord and Atacora where it grows amongst savannahs and riparian  
387 forests.  
388 **Material examined.** *Essou* 1304; *Houngnon* 1495; *Akoègninou* 2338; *Essou* 2091; HNB.  
389 **Benin Redlist:** VU
- 390 *Xylopia aethiopica* A.Rich. (Annonaceae)  
391 **Distribution and habitat in Benin.** *X. aethiopica* is known from Côtier, Pobè, Ouémé, Plateau,  
392 Bassila phytogeographical districts and AMs. It is found growing in gallery and swamp forests,  
393 edge of the forests in savannah and specially near of streams.  
394 **Material examined.** *Paradis* 109a; *Houngnon* 109b; *Adjakidjè* 3256; *Sokpon* 1015; HNB.  
395 **Benin Redlist:** VU
- 396 *Borassus aethiopum* Mart. (Arecaceae)  
397 **Distribution and habitat.** *B. aethiopum* is distributed across whole national area where it grows  
398 in moist savannahs and Cleary forest. At the present time, it is cultivated and preserved in  
399 agroforestry systems.  
400 **Material examined.** *Houngnon* 4158; *Houngnon* 3546; HNB.  
401 **Benin Redlist:** VU
- 402 *Kigelia africana* (Lam.) Benth. (Bignoniaceae)  
403 **Distribution and habitat.** *K. africana* is known from Pobè, Plateau, Zou to Mekrou-Pendjari. It  
404 grows in a variety of habitats ranging dry forest and gallery forest to savannah and it is preserved  
405 around habitations and agroforestry systems.  
406 **Material examined.** *Paradis* 194a; *Adjakidjè* & *Akoègninou* 194d; *Maesen* 6475; HNB.  
407 **Benin Redlist:** VU
- 408 *Garcinia livingstonei* T.Anderson (Clusiaceae)  
409 **Distribution and habitat.** *G. livingstonei* is recorded from Ouémé, Borgou-Nord, Pendjari, W du  
410 Niger districts growing in moist area along Rivers, riparian forests and in woodlands.  
411 **Material examined.** *Houngnon* 6567; *Houngnon* 7708; *Maesen* 6715; HNB.  
412 **Benin Redlist:** CR
- 413 *Pentadesma butyracea* Sabine (Clusiaceae)  
414 **Distribution and habitat.** *P. butyracea* is found growing in gallery forests of Ouémé, Zou,  
415 Borgou-Sud, Borgou-Nord districts with an important population on AMs. It is partly preserved  
416 in the classified forest of Pénessoulou.  
417 **Material examined.** *Chevalier* 24169; *De Souza* 771a; *Maesen* 7175; *Akoègninou* 4607; HNB.

418 **Benin Redlist:** VU

419 *Afzelia africana* Pers. (Fabaceae)

420 **Distribution and habitat.** *A. africana* is found growing in semi-deciduous and dry forests,  
421 woodland of several districts (Pobè, Plateau, and Zou to Mekrou-Pendjari).

422 **Material examined.** *Houngnon 1624b*; *Adjakidjè 1560*; *Houngnon 241*; *Sinsin 2746*; HNB.

423 **Benin Redlist:** VU

424 *Sphenostylis schweinfurthii* Harms. (Fabaceae)

425 **Distribution and habitat.** It grows in woodlands of South-Borgou and Pendjari districts.

426 Countrywide, *S. schweinfurthii* is distributed across Benin, Centrafrica, Ethiopia and Soudan.

427 **Material examined.** *Sinsin 2652*; *Maesen 6983*; *Pauwels 8147*; HNB.

428 **Benin Redlist:** EN

429 *Parinari congensis* Didr. (Chrysobalanaceae)

430 **Distribution and habitat.** It is widespread across Benin, from Plateau, Borgou-Sud to Atacora  
431 Chain districts. *P. congensis* is recorded in riparian forest on Atacora Mounts.

432 **Material examined.** *Sokpon 465*; *Essou 2096*; HNB.

433 **Benin Redlist:** EN

434 *Pouchetia africana* A.Rich. ex DC. **var. africana** (Rubiaceae)

435 **Distribution and habitat.** *P. africana* is found in the semi-deciduous and gallery forest of the  
436 Borgou-Sud and Bassila districts. Along the Atacora Mounts (at Kouandé), it grows in the gallery  
437 forest.

438 **Material examined.** *Sinsin 2622*; *Akoègninou 2553*; HNB.

439 **Benin Redlist:** EN

440 *Pterocarpus erinaceus* Poir. (Fabaceae)

441 **Distribution and habitat.** *P. erinaceus* is widespread across Benin, from Pobè, Ouémé, Kouffo,  
442 Borgou-Sud districts. It found in the various forms of savannahs (savannah woodland, tree  
443 savannah, shrub savannah and grass savannah) and in the woodlands and gallery forests.

444 **Material examined.** *Lisowski D-534*; *Sokpon 1690*; *Akoègninou 2130*; HNB.

445 **Benin Redlist:** EN

446 *Afraegle paniculata* Engl. (Rutaceae)

447 **Distribution and habitat.** It is found in moist and dry deciduous forests of Plateau and Bassila  
448 districts.

449 **Material examined.** *Houngnon 7623*; *Sinsin 1911*; *Adjakidjè 1606*; HNB.

450 **Benin Redlist:** EN

451 *Albizia chevalieri* Harms (Fabaceae)

452 **Distribution and habitat.** *A. chevalieri* is known only of Mékrou-Pendjari district where it  
453 grows in the savannahs.

454 **Material examined.** *Houngnon 1248a*; HNB.

455 **Benin Redlist:** CR

456 *Chrysobalanus icaco* L. **subsp. atacorensis** (A.Chev.)F.White (Chrysobalanaceae)

457 **Distribution and habitat.** It has been described as exclusive species found on the Atacora  
458 Mounts.

459 **Material examined.** *Essou 2056*; *Akoègninou 6121*; HNB.

460 **Benin Redlist:** CR

461 *Commiphora pedunculata* Engl. (Burseraceae)

- 462 **Distribution and habitat.** *C. pedunculata* has been described as exclusive species found on the  
 463 Atacora Mounts.  
 464 **Material examined.** *Chevalier 23967; Houngnon 209a; HNB.*  
 465 **Benin Redlist:** EN
- 466 *Cordyla pinnata* (A.Rich.) Milne-Redh. (Fabaceae)  
 467 **Distribution and habitat.** *C. pinnata* grows in the dry semi-deciduous forests, savannah  
 468 woodlands and tree savannahs across Borgou-Sud and Borgou-Nord districts.  
 469 **Material examined.** *Adjakidjè 1798; Oumorou 1145; HNB.*  
 470 **Benin Redlist:** EN
- 471 *Diospyros abyssinica* (Hiern) F.White. (Ebenaceae)  
 472 **Distribution and habitat.** *D. abyssinica* is distributed across four phytogeographical districts  
 473 namely: Plateau, Bassila, Zou and Atacora where it grows in the moist forests and savannahs.  
 474 **Material examined.** *Houngnon 627b; Akoègninou 1560; Akoègninou 3286a; HNB.*  
 475 **Benin Redlist:** EN
- 476 *Dorstenia cuspidata* Hoscht. (Moraceae)  
 477 **Distribution and habitat.** *D. cuspidata* is collected in the woodlands or savannah woodlands  
 478 across Mékrou-Pendjari district with some small populations in Atacora Mounts.  
 479 **Material examined.** *Akoègninou 2844; Sinsin 1733; Burg 1315; HNB.*  
 480 **Benin Redlist:** EN
- 481 *Ekebergia capensis* Sparrm. (Meliaceae)  
 482 **Distribution and habitat.** *E. capensis* is widely distributed across Benin area notably in the  
 483 Plateau, Bassila, Borgou-Sud, Borgou-Nord and Atacora districts where it grows in the moist  
 484 forests and savannahs.  
 485 **Material examined.** *Chevalier 23133; Essou 1934; Maesen 7312; Burg 1327; HNB.*  
 486 **Benin Redlist:** EN
- 487 *Eriocoelum kerstingii* Gilg. ex Engl. (Sapindaceae)  
 488 **Distribution and habitat:** *E. kerstingii* is recorded in the riparian and gallery forests and  
 489 savannahs of Atacora district.  
 490 **Material examined.** *Houngnon 4428; Akoègninou 2464; Sinsin 840; Akoègninou 4614; HNB.*  
 491 **Benin Redlist:** EN
- 492 *Crateva monticola* (Gilg & Gilg-Ben.) Christenh. & Byng (Capparaceae)  
 493 **Distribution and habitat:** *C. monticola* is found growing in dry forests of districts (Pobè and  
 494 Plateau). On the Atacora Mounts, it is recorded in the dry forest at the bottom of west versant at  
 495 Batia.  
 496 **Material examined.** *De Souza & Paradis 223a; Houngnon 223; HNB.*  
 497 **Benin Redlist:** EN
- 498 *Eulophia angolensis* (Rchb.f.) Summerh. (Orchidaceae)  
 499 **Distribution and habitat.** This species is normally known from Côtier district but it has been  
 500 found growing within moist savannah at Atacora Mounts.  
 501 **Material examined.** *Adjakidjè 202; De Souza & Paradis s.n.; HNB.*  
 502 **Benin Redlist:** CR
- 503 *Gardenia imperialis* K.Schum. (Rubiaceae)  
 504 **Distribution and habitat.** *G. imperialis* is described as exclusive species found on the Atacora  
 505 Mounts.

506 **Material examined.** *Maesen* 7241; HNB.  
507 **Benin Redlist:** CR

508 *Campylospermum glaberrimum* (P.Beauv.) Farron (Ochnaceae)

509 **Distribution and habitat.** *C. glaberrimum* favours swamp savannahs and forests of Plateau and  
510 Ouémé districts.

511 **Material examined.** *Adjakidjè* 3204; *Essou* 2067; *Akoègninou* 1458; HNB.

512 **Benin Redlist:** EN

513 *Ipomoea beninensis* Akoègninou A. & Lisowski (Convolvulaceae)

514 **Distribution and habitat.** *I. beninensis* is described as endemic plant species.

515 **Material examined.** *Akoègninou* 2621; *Lisowski* D-777; *Sinsin* 2462; HNB.

516 **Benin Redlist:** EN

517 *Khaya senegalensis* A.Juss. (Meliaceae)

518 **Distribution and habitat.** *K. senegalensis* is known from all districts across Benin notably in  
519 Bassila, Zou, Borgou-Sud, Borgou-Nord, Atacora and Mékrou-Pendjari districts. It grows in the  
520 various habitats such as gallery forests, savannah woodlands and tree savannahs.

521 **Material examined.** *Burg* 1480; *Sinsin* 2436; HNB.

522 **IUCN :** VU ; **Benin Redlist:** EN

523 *Milicia excelsa* (Welw.) C.C.Berg (Moraceae)

524 **Distribution and habitat.** *M. excelsa* is spread across national area (except Mékrou-Pendjari  
525 district) where it grows in the semi-deciduous and gallery forests.

526 **Material examined.** *Chevalier* 23169; *Le Testu* 277; *Essou* 1476; HNB.

527 **IUCN:** NT; **Benin Redlist:** EN

528 *Mimusops andongensis* Hiern. (Sapotaceae)

529 **Distribution and habitat.** *M. andongensis* occurs in the semi-deciduous and gallery forests of  
530 Plateau, Bassila, Zou and Atacora districts.

531 **Material examined.** *Adomou* 1006; HNB.

532 **IUCN:** LC; **Benin Redlist:** EN

533 *Osmunda regalis* L. (Osmundaceae)

534 **Distribution and habitat.** This species is recorded as exclusive species occurring on Atacora  
535 Mounts.

536 **Material examined.** *Akoègninou* 2517; *Maesen* 7180; HNB.

537 **IUCN :** LC ; **Benin Redlist:** EN

538 *Phoenix reclinata* Jacq. (Arecaceae)

539 **Distribution and habitat.** *Phoenix reclinata* is a palm that grows in the gallery forests and  
540 savannah woodlands, and it is recorded in the Ouémé, Bassila, Zou, Borgou-Sud and Borgou-  
541 Nord districts.

542 **Material examined.** *Houngnon* 3628; *Adjakidjè* 3852; *Essou* 1015; *Houngnon* 4937; HNB.

543 **IUCN :** LC ; **Benin Redlist:** EN

544 *Psychotria obscura* Zoll. & Moritz (Rubiaceae)

545 **Distribution and habitat.** *P. obscura* is presently known from few localities of Atacora district.  
546 It grows in the dry and riparian forests.

547 **Material examined.** *Adomou* 1017; HNB.

548 **Benin Redlist:** VU

- 549 ***Raphia hookeri*** G.Mann & H.Wendl. (Arecaceae)  
 550 **Distribution and habitat.** This species is found in the swamp forests from Plateau and Ouémé  
 551 districts.  
 552 **Material examined.** *Paradis 1323a; Paradis 1323b; Adjakidjè 3904*; HNB.  
 553 **IUCN : LC ; Benin Redlist: EN**
- 554 ***Synsepalum dulcificum*** (Schumach. & Thonn.) Daniell. (Sapotaceae)  
 555 **Distribution and habitat.** *S. dulcificum* is distributed in the districts of Pobè, Plateau and Zou  
 556 where it grows in the swamp forests and agrosystem forest. Presently, it is cultivated in the home  
 557 gardens.  
 558 **Material examined.** *Yédomonhan 70; Adjakidjè 3363; Houngnon 5490*; HNB.  
 559 **IUCN : LC ; Benin Redlist: CR**
- 560 ***Synsepalum passargei*** (Engl.) T.D.Penn. (Sapotaceae)  
 561 **Distribution and habitat.** *S. passargei* is described as exclusive species found on the Atacora  
 562 Mounts.  
 563 **Material examined.** *Sokpon 386; Sinsin 732*; HNB.  
 564 **IUCN : LC ; Benin Redlist: CR**
- 565 ***Syzygium guineense*** DC. (Myrtaceae)  
 566 **Distribution and habitat.** *S. guineense* is known from six districts (Plateau, Bassila, Borgou-  
 567 Sud, Borgou-Nord, Atacora and Mekrou-Pendjari) where it has been recorded from woodland  
 568 savannahs, riparian and gallery forests.  
 569 **Material examined.** *De Souza 1003a; Essou 1949; Sinsin 3350; Houngnon 7713*; HNB.  
 570 **Benin Redlist: CR**
- 571 ***Terminalia brownii*** Fresen. (Combretaceae)  
 572 **Distribution and habitat.** It is distributed in the districts of Atacora and Mékrou-Pendjari where  
 573 it grows in the savannahs.  
 574 **Material examined.** *Adomou 1000*; HNB.  
 575 **Benin Redlist: EN**
- 576 ***Voacanga africana*** Stapf ex Scott Elliot (Apocynaceae)  
 577 **Distribution and habitat.** It is widely distributed in the semi-deciduous and gallery forests  
 578 across Benin from Côtier to Bassila districts with some populations in the riparian forest along  
 579 the Atacora chain (Toucoutouna and Kouarfa).  
 580 **Material examined.** *Adjakidjè 3200; Leeuwenberg 11924; Chevalier 23201*; HNB.  
 581 **Benin Redlist: EN**
- 582 ***Thunbergia atcorensis*** Akoègninou & Lisowski (Acanthaceae)  
 583 **Distribution and habitat.** This species has been recorded as endemic to Benin-Togo.  
 584 **Material examined.** *Lisowski 990; Essou 2079; Akoègninou 3563; Burg 1438*; HNB.  
 585 **Benin Redlist: EN**
- 586 ***Vitellaria paradoxa*** C.F.Gaertn. ssp. *paradoxa* (Sapotaceae)  
 587 **Distribution and habitat.** *V. paradoxa* is widely distributed across Benin from Zou to Atacora  
 588 and Mékrou-Pendjari districts where it grows in the woodlands, savannah woodland and tree  
 589 savannahs.  
 590 **Material examined.** *Zon 459; Essou 1253*; HNB.  
 591 **Benin Redlist: VU**
- 592 ***Zanha golungensis*** Hiern. (Sapindaceae)

**Distribution and habitat.** *Z. golungensis* is recorded in the districts of Zou, Bassila, Borgou-Sud, Borgou-Nord and of Atacora Mounts. It grows in a variety of habitats ranging from riparian and gallery forests to savannahs.

**Material examined.** *Houngnon 91a, Sinsin 261, Essou 2039*; HNB.

**Benin Redlist:** VU

***Zanthoxylum zanthoxyloides*** (Lam.) Zepernick & Timler. (Rutaceae)

**Distribution and habitat.** *Z. zanthoxyloides* is known from all phytogeographical districts, particularly in Côtier, Plateau, Bassila, Atacora and Mekrou-Pendjari districts, where it grows in a variety of habitats ranging from dry to moist forests. It is also found in the secondary forests and thickets.

**Material examined.** *Pauwels 8402; De Souza & Paradis 974a; Akoègninou 1599*; HNB.

**Benin Redlist:** EN

***Paliurus spina-christi*** Mill. (Rhamnaceae)

**Distribution and habitat.** This species is presently known from riparian forests of Mékrou-Pendjari district but it has been recorded in few localities of the Atacora Mounts.

**Material examined.** *Maesen 6597; Pauwels 840; Essou & Yédomonhan 1816*; HNB.

# **Spatial pattern, centres of diversity, and conservation priority sites on the AMs**

Boukoubé presented the highest species richness (779 species, 93.29% of the total flora of the Atacora Mounts) (Table 1). It was followed by Natitingou (757 species, 90.65%), Tanguiéta (649 species, 77.72%), Kouandé (459 species, 54.97%), Toucountouna (276 species, 33.05%) and Kérou (197 species, 23.59%). Of the 827 listed species, a total of 55 special species (endemic, nearly endemic, exclusive, and threatened) have been identified as occurring on the AMs. The largest numbers of special species were obtained for Boukoubé and Natitingou (Table 1). These sites do not host the endemic species *Ipomoea beninensis*. However, the Boukoubé site harbours the two near-endemic species (*Thunbergia atacorensis* and *Polygala atacorensis*) while the Natitingou site only hosts *P. atacorensis*.

**Table 1**– Overall and special specific richness for each prospected sites on the Atacora Mounts-TA: Tanguiéta; NA: Natitingou; BO: Boukoubé; KO: Kouandé; TO: Toucountouna; KE: Kérou

Parameters	TA	NA	BO	KO	TO	KE	Study site
Specific richness	643	750	772	455	276	197	827
Number of exclusive species	6	10	10	4	6	2	13
Number of threatened species	16	19	31	9	14	5	46
Number of endemic species	1	0	0	0	1	0	1
Number of nearly species	1	1	2	0	0	0	2

Across the 70 cells of the grid, there were 1195 occurrences for all the special species (Fig. 6) including 13, 37, 50, 448 and 647 respectively for the endemic, nearly endemic, exclusive, and threatened species. The mean number of special species in the cells was  $4.44 \pm 4.47$  species and cells with the highest numbers of species were distributed throughout the study area except Toucountouna and Kérou sites (Fig. 7). Sites of Natitingou and Tanguiéta (26 special species each) and Boukoubé (21 species) had the highest numbers of species (Fig. 6). The other sites (Toucountouna, Kouandé and Kérou) harbour 18, 13 and 7 special species, respectively. The

percentage (%) of grid cells supporting the special species was 86, 85, 62, 58, 56 and 51 for Boukoumbé, Natitingou, Toucountouna, Kouandé, Tanguiéta and Kérou sites, respectively. From this study, 3 biodiversity centers were identified notably Natitingou, Boukoumbé and Tanguiéta (Fig. 8). Combining the overall species richness (91.49% of the total flora of the AMs), the percentage of grid cells harboring the special species (86%) and the absence of classified forests, Boukoumbé was identified as the top conservation priority site on the AMs (Fig. 9).

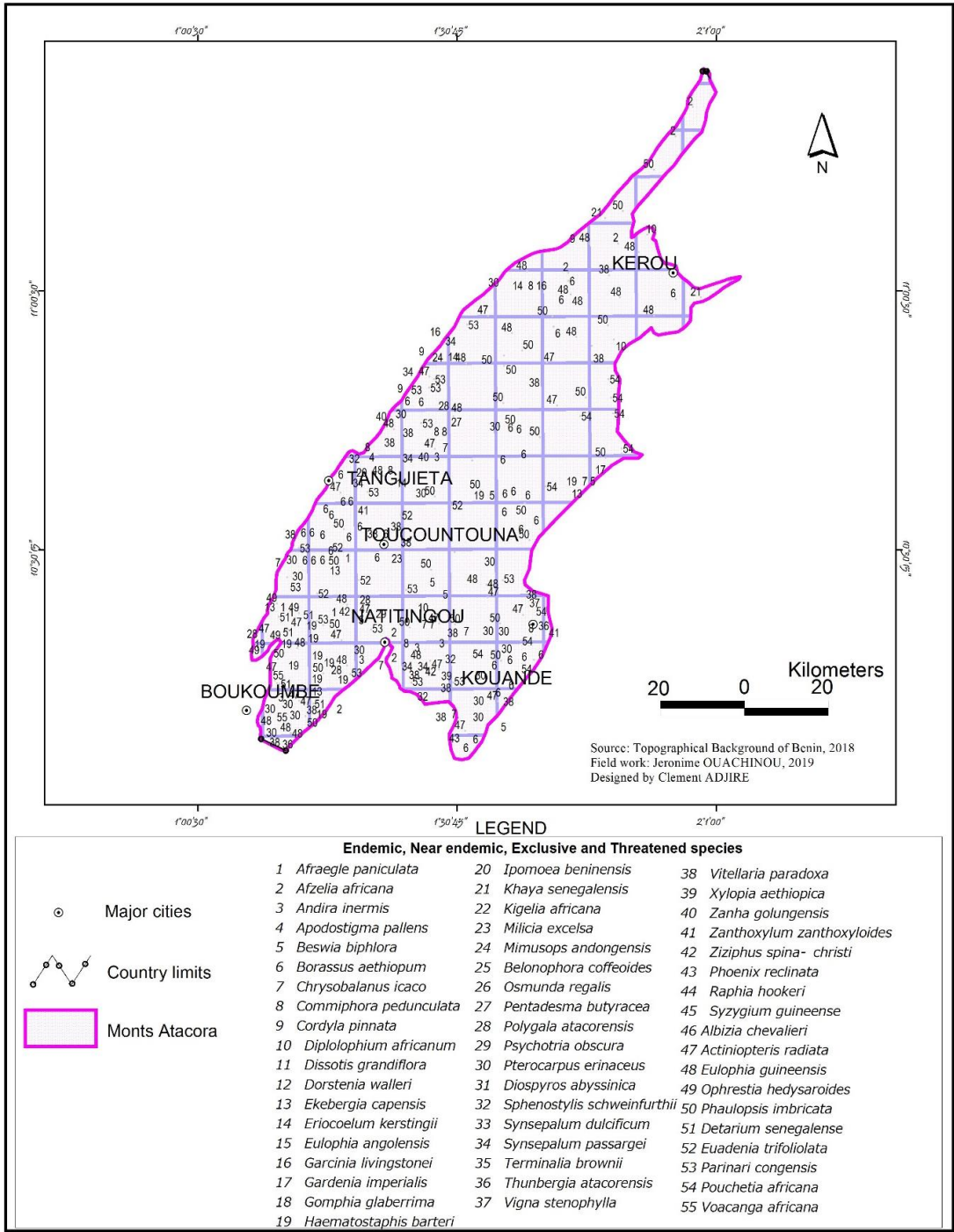
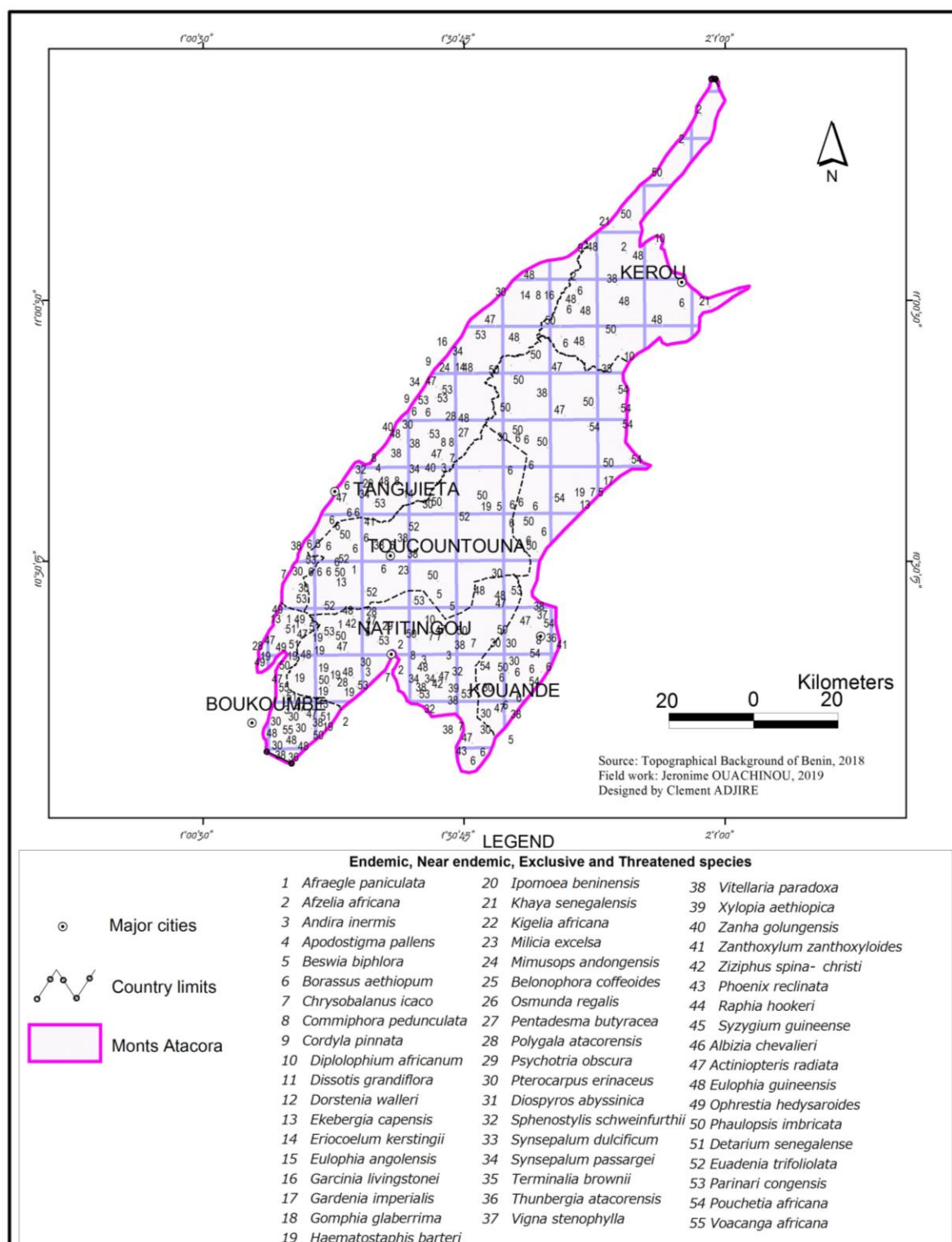


Figure 6 – Map showing the rate of special species per unit



**Figure 7** – Map showing the rate of special species per study site

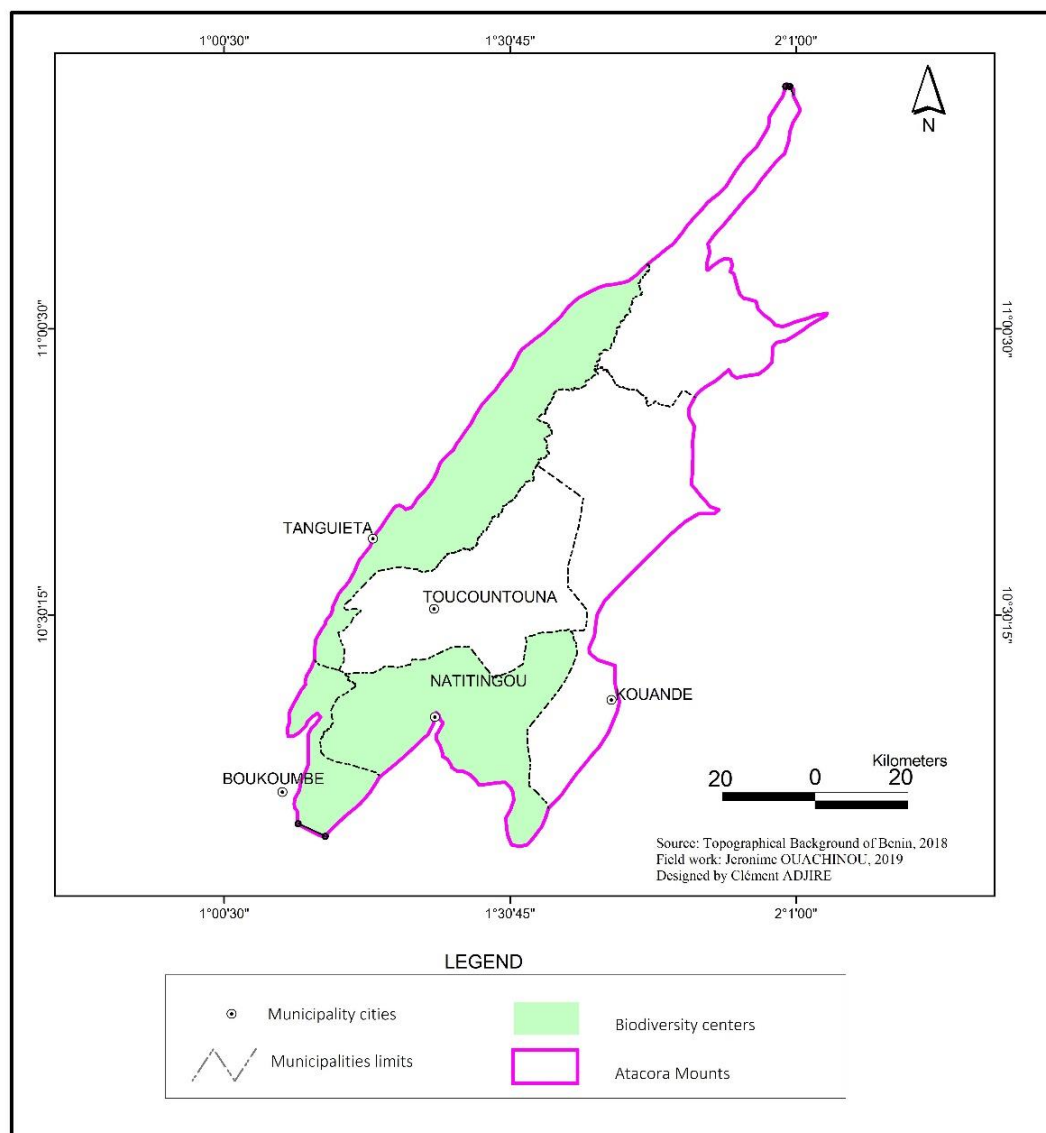


Figure 8 – Three centres of species in the Atacora Mountains

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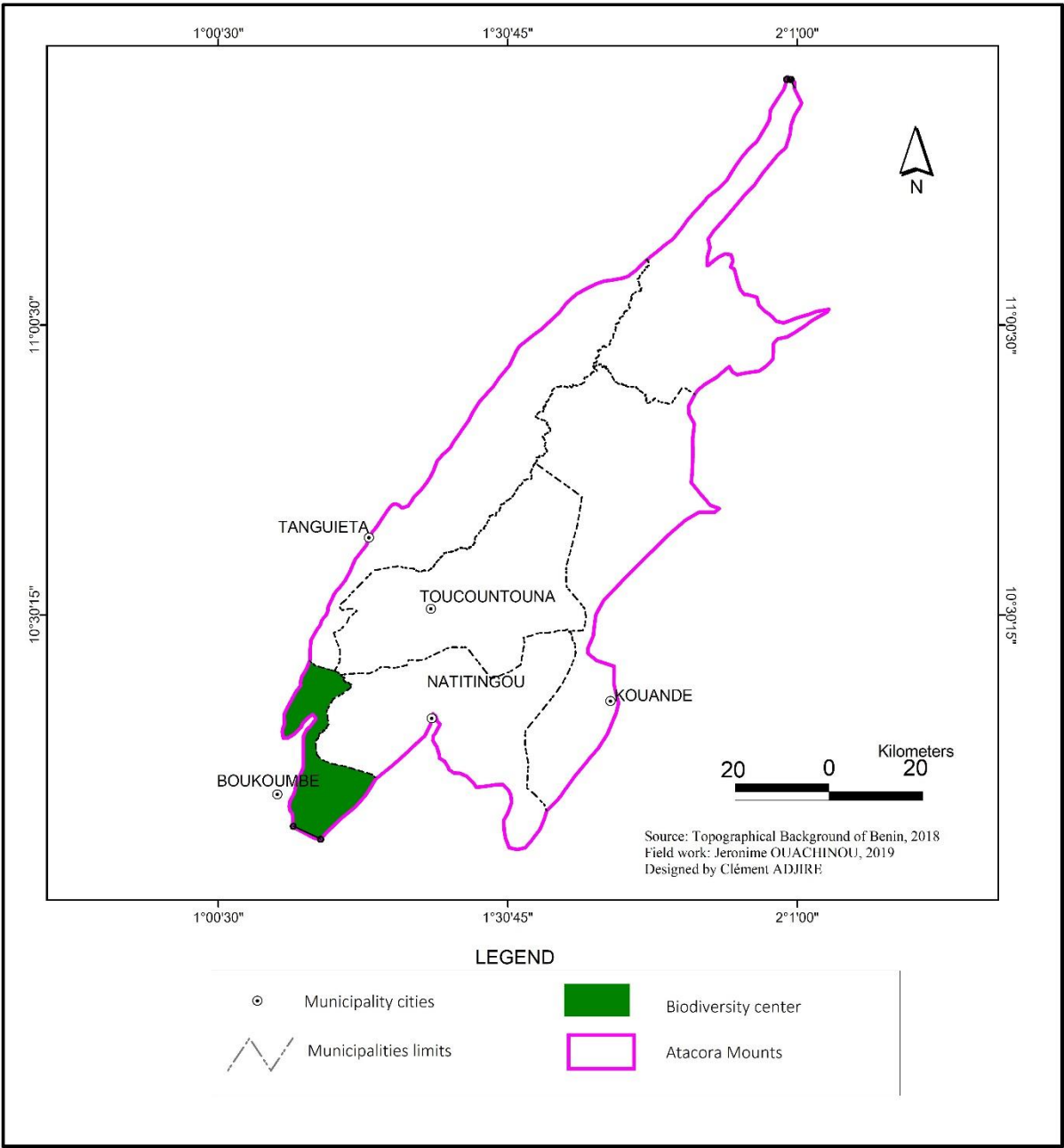


Figure 9 – Map showing the top priority conservation area identified (Boukoubé).

DISCUSSION

**The Atacora Mountains as centre of diversity**

We recorded a total of 827 plant species on the Atacora Mountains in Benin. This species richness was higher than 663 obtained by Wala (2010) on the whole AMs in Benin and 247 species by Tente (2002) on one sector (Perma-Toucuntouna) of the AMs in Benin. The difference in the diversity observed could be related to sampling effort. Indeed, in addition to our fieldwork, a documentary analysis was conducted for gathering the maximum of plants reported by several authors including Tente (2002), Adomou (2005), Akoègninou et al. (2006) and Wala (2010). Our study showed that AMs harbour considerable floristic diversity in terms of species as well as of genera and taxonomic families (462 genera, 105 families). Our species richness is also

higher than the 199 species recorded by Gebrehiwot et al. (2016) in Abune Yosef mountain range (Northern Ethiopia). However, the ratio of the number of species to the area of the field was almost 0.05 and 0.0004 respectively for the evergreen Afromontane vegetation of Ethiopia (3700 ha) and AMs (17 791 000 ha); meaning that per hectare of each ecosystem, there is no species. This confirms that diversity depends on size of the area. Species richness obtained corresponds to 29.46% of the total flora of Benin (Akoègninou et al. 2006), indicating that AMs is an important biodiversity center for Benin. About 435 plant species were expected to be found on the AMs if we considered total area estimated at 114 763 Km<sup>2</sup> (INSAE 2013) and species richness estimated at 2807 species (Akoègninou et al. 2006) of the country. Grid cells on whole national area cannot reveal one species per km<sup>2</sup> because of various types of soil occupation; this likely explains the additional number of species that we found (315 species). Adomou (2007) reported that AMs belong to Atacora Mountains Chain phyto-district flora which was estimated to 350 species. This species richness does not depart too much from the 435 expected for the site but it is very lower than 827 species that were actually obtained during our investigations. In addition, our species richness is higher compared to the 684 species recorded in the Biosphere Reserve of Pendjari (Assédé et al. 2012). This is supportive of the belief that mountain ecosystems usually have diverse biological communities globally due to their rapidly changing landscape, climate and geo-climatic history (Fosaa 2004). Examining chorological profile of the recorded species, we noticed that 56.15% of them were Sudano-Guinean and Sudano-Zambesian (Fig. 3). This high proportion of these species does support their relatedness to the Sudanian phytocoria.

### **Atacora Mounts as refuge for special species**

We identified 55 special species occurring on Atacora Mounts, about 6.65% of the total flora recorded. These species are much diversified ranging from exclusive species (13 species, 23.63% of the total of special species) and threatened species (46 species, 80 %) to the endemic (1 species, 1.81%) and nearly endemic (2 species, 3.63%) species. The threatened flora found on the Atacora Mountains corresponds to 16.42% of total threatened flora (280 plant species) (Adomou 2005), 50% of endemic (Akoègninou and Lisowski 2004), and 100% of nearly endemic plant species (Akoègninou et al. 2006) known for the country. All these features give to Atacora Mounts flora a unique position in national plant diversity. The presence of the special species can be explained by particular ecological conditions. For instance, Boukoumbé contains one important forest ecosystem namely typical riparian forest that harbours several exclusive species notably *Thunbergia atacorensis*, *Gardenia imperialis*, *Broenadia salicina*, *Synsepalum passargei*, *Eriocoelum kerstingii*, *Uvaria angolensis*, *Chrysobalanus icaco* subsp. *atacorensis*, *Garcinia ovalifolia*. In addition, this ecosystem acts as a refuge for rain forest species such as *Antiaris toxicaria*, *Milicia excelsa*, *Pentadesma butyracea*, *Lecaniodiscus cupanioides*, *Detarium senegalense*, and *Millettia thonningii* (Natta 2003; Adomou 2005; Wala 2005). We also found on the Atacora Mounts several other ecosystems such as dry forest, and woodland with exclusive species like *Haematostaphys barteri*, *Terminalia brownii*, *Erythrophleum africanum*, *Commiphora pedunculata*, *Bewsia biflora*, and *Trachypogon spicatus*. These floristic characteristics are certainly in relation with pedological and geomorphological profiles, defining a particular microclimate found on the mountains, which influences also surroundings spaces.

### **Implications for the creation of conservation area on the Atacora Mounts**

Although Atacora Mounts are close to the Biosphere Reserve of Pendjari, a protected zone, it is important to create complementary conservation areas on the Atacora Mounts. Indeed, exclusive species described are mostly confined to the Mounts, which encompass higher habitat diversity. Besides, the Atacora Mounts hold little similarity between the Biosphere Reserve of Pendjari (Assédé et al. 2012) in terms of special species. In addition, Atacora Mounts support refuges

species that were initially widespread across Benin area but that were less affected during quaternary climate changes (above all at Pleistocene and Holocene) and restricted some species in the special habitats. Future prevision could also affect these species. The Atacora Mounts support three Sudanian endemic genus *Pseudocedrela*, *Haematostaphis* and *Vitellaria* (White 1983). There are also high proportion of the threatened species. All this makes it a centre of local biodiversity whereas the entire Atacora Mounts area still remains without official protection. Considering the high pressure on the flora and vegetation during the last decades there is urgent need to include these plant species in restoration programmes and to preserve the remaining plant populations *in situ* to create an environment in which they can increase to levels beyond an imminent danger of extinction. To date, no conservation area exists in this ecosystem. The knowledge on the distribution of these species was helpful in the prioritization of conservation areas on the Atacora Mounts in order to future plan for its conservation. We identified gallery forests and some woodlands at Boukoubé, Natitingou and Tanguéta sites as suitable to support conservation units on the Atacora Mounts (Fig. 8). Boukoubé area was the top of priority sites (Fig. 9). Future studies on the AMs will focus on an interdisciplinary approach including for example insects, reptiles or mammals for a global conservation of biodiversity.

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