Chapter 5

Advances in the Knowledge of the Vegetation of Hispaniola (Caribbean Central America)

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Additional information is available at the end of the chapter

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Abstract

The vegetation types and floristic diversity in the Dominican Republic are analysed, a territory with a tropical climate and ombrotypes that range from dry to humid-hyperhumid, due to the Atlantic winds and the phenomenon known as rain shadows. The presence of high mountains and different substrates have led to a rich flora, and as a result, a high diversity of habitats, among which two large forest types are particularly notable: (1) the dry forest with 81 endemic species, of which 10 are trees, 65 shrubs, 5 climbers and 1 herbaceous species, and an absence of epiphytes and (2) the cloud forest with 19 trees, 20 shrubs, 8 climbers, 4 epiphytes, and 6 herbaceous species. In all cases, these plant communities are regarded as endemic due to their high rate of endemic species. In spite of their importance for conservation, these habitats are highly deteriorated due to deforestation for agriculture, to obtain timber, and even to add to tourism infrastructures.

Keywords: endemics, conservation, deterioration, diversity, forest, structure

1. Introduction

The analysis of the vegetation of Hispaniola reveals different situations in terms of their state of conservation, the floristic diversity of the communities and habitat types. The process observed in the study territory resembles the reports by other authors for other countries: namely that agriculture and tourism are the primary factors affecting conservation. The island of Hispaniola has a wide floristic diversity with over 6000 endemic plants, and a high rate of plant communities. This is due to several factors such as orography, edaphology, and its strategic situation in the central Caribbean, which has meant that species have arrived through migratory routes from North and South America. The northernmost areas of the island, exposed to the Atlantic Ocean, are rainier than those in the Caribbean Sea (**Figure 1**).

Some works on vegetation published in the local journal of the Santo Domingo Botanical Garden (Moscoso) have been of assistance in this research. Deforestation changes the structure of the cloud forest [1] and gives rise to a "calimetal" of *Gleichenia bifia* (Willd.) Spreng. and *Dicranopteris flexuosa* (Schrad.) Underw., whose vigorous growth and dense coverage hinder the regeneration of the forest's own dynamic stages of deforestation in tropical areas.

The deterioration of the forests on the island of Hispaniola is exacerbated by the Caribbean hurricanes, which have a serious impact on their structure [2]. However, the mountains on the island are still home to a number of well-conserved areas, thanks to a close linear correlation between environmental factors and forest types [3], and to indigenous people who exploit the forests sustainably, using the wood to build houses and coal using knowledge acquired through tradition [4–6]. The presence of 28 climbing species in the cloud forest versus 44 in the dry forest is due to environmental factors, vegetation structure [7], and deforestation caused by human.

These forests are crucial to maintaining the biodiversity of this island—considered a biodiversity hotspot [8]—, and also for preserving the relation between forest stands and the water cycle, which is of such overriding importance to society [9–11].

The fundamental aim of this chapter is to explain the diversity of plant communities, their causes and their floristic diversity, and highlight their conservation status.

Figure 1. Ombroclimatic environments in the Dominican Republic.

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2. Materials and methods

A vegetation study was carried out on the island of Hispaniola, with particular reference to the forests in the Dominican Republic. Sixty-five ecologically and physiognomically homogeneous plots were selected, and the species present on the plots were noted and assigned a phytosociological abundance-dominance index; this index was subsequently converted to the Van der Maarel (1979) index [12]. We used our previous work as a basis for the bioclimatic and biogeographical classification of the territory [13, 14].

A statistical treatment was applied to obtain cluster and PCA. To separate the two major vegetation units (cloud forest and dry forest), we conducted a regression analysis (ANOVA) for the species *Magnolia hamorii* Howard (Maha), *Sideroxylon salicifolium* (L.) Sw. (Sisa), *Metopium toxiferum* (L.) Krug. & Urb. (Meto) and *Sideroxylon foetidissimum* Jacq. (Sifo); and a canonical correspondence analysis (CCA) between the Io (ombrothermic index) and ETP (potential evapotranspiration) of the 65 plots in the sample and the dominant species, located at altitudes below 1,200 m: *Hyeronima domingensis* Urb.(Hydo), *Magnolia hamorii* (Maha), *Magnolia pallescens* Urb. & Ekm.(Mapa) and *Pinus caribaea* Morelet. This last species forms mixed stands with the cloud forest and gives the name to the vegetation class *Byrsonimo-Pinetea caribaea* Samek and Borhidi in Borhidi et al. (1979), a native Caribbean species of subtropical and tropical areas [15]. Outside its distribution area (Central America), this tropical plant acts as an exotic, and is a well adapted in other tropical areas such as southern China [16].

3. Results

The results of the ANOVA regression analysis reveal the close correlation between the species present in the forests and the potential evapotranspiration and Io index. The species in the cloud forest are closely correlated with the ombroclimatic index, and in the dry forest with potential evapotranspiration, as shown in **Figures 2** and **3** where R2 always higher than 0.9.

The results of the regression analysis are Maha (*Magnolia hamorii*): $y = 0.08585x - 1.5$, $R^2 = -0951$; Sisa (*Sideroxylon salicifolium*): $y = 0.5799x - 0.4$, $R^2 = 0.9994$; Meto (*Metopium toxiferum*): $y = 0.4065x - 0.5$, $R^2 = 0.9979$; Sifo (*Sideroxylon foetidissimum*): $y = 0633x - 0.5$, $R^2 = 0.9708$; highlighting the clear correlation between the abundance values for these species and the values for Io and ETP (ANOVA) (**Figure 2**).

The CCA analysis shows two groups of inventories: R1-R39, representing the dry forest and dominated by *Bursera simaruba* (L.) Sarg., *Metopium toxiferum* (L.) Krug. & Urb., *Pilosocereus polygonus* (Lam.) B. & R., *Sideroxylon foetidissimum* Jacq., *Sideroxylon salicifolium* (L.) Sw., *Prosopis juliflora* L., *Lemaireocereus hystrix* Britt & Rose, and *Acacia macracantha* H. & B. Ex Willd.; and the group C40–C65 dominated by *Didymopanax tremulus* Krug. & Urb., *Hyeronima domingensis* Urb., *Magnolia hamorii* Howard, *Magnolia pallescens* Urb. & Ekm., *Prestoea montana* (Grah.) Nichol., *Alchornea latifolia* Sw., *Cyathea arborea* (L.) J.E. Smith, and *Cyathea furfuracea* Baker. (**Figure 3**).

The PCA analysis of 28 dominant species produces 2 groups such as A (cloud forest) and B (dry forest) (**Figure 4**). The two groups A and B in the PCA are maintained in the cluster.

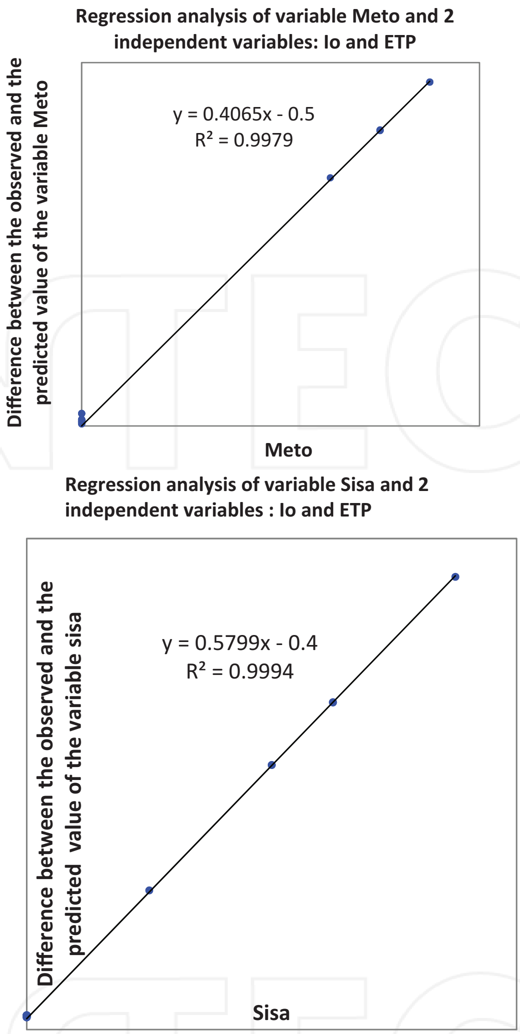

Figure 2. Regression analysis: Meto, Sisa and Io, ETP.

The forests in group B are separated into two subgroups such as G1 and G2. G1 (R1–R18) represents the communities described for the subhumid and humid territories in which the substrate takes prevalence and allows the entry of dry forest species. G2 (R19–R39) is classified into four plant communities.

Subgroup $G2_1$ includes the inventories R19–R48 taken in the Cibao Valley (Monte Cristi), in infratropical environments with a semiarid ombrotype on quaternary loans, with 17 endemic species, *Karwinskia coloneura* Urb. and *Justicia abeggii* Urb. & Ekm., exclusive to the territory. The subgroup is dominated by *Prosopis juliflora* L., *Lemaireocereus hystrix* Britt. & Rose, *Harrisia nashii* Britt. & Rose, *Consolea moniliformis* (L.) Haworth in Steud, and *Pilosocereus polygonus* (Lam.) B. & R.

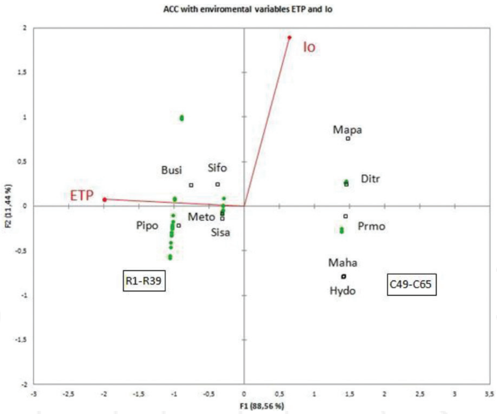

Figure 3. Canonical correspondence analysis (CCA).

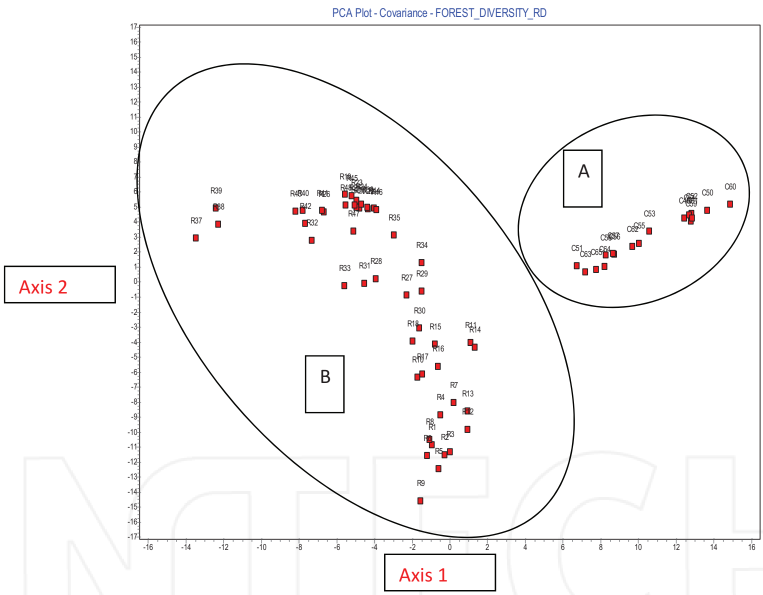

Figure 4. Principal component analysis (PCA) for dry and cloud forest.

Subgroup $G2_2$ includes the inventories R27–R33, a community that grows in the outlying areas of the Cibao Valley in the infra and dry thermotropical thermotype. This is an intricate forest dominated by *Erythroxylum rotundifolium* Lunan and *Maytenus buxifolia* (A. Rich.) Griseb., with 36 endemic plants, of which the following are exclusive to the territory: *Lantana leonardorum* Moldenke, *Lantana pauciflora* Urb., *Croton gonaivensis* Urb. & Ekm., *Lantana buchii* Urb., *Guettarda tortuensis* Urb. & Ekm., and *Galactia synandra* Urb. (**Figure 5**).

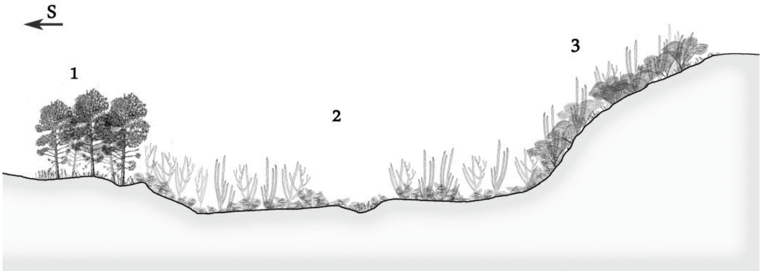

Figure 5. Profile of the vegetation of the dry forest of Cibao Valley. 1. *Leptogono buchii-Pinetum occidentalis*. 2. *Harrisio nashii-Prosopidetum juliflorae* 3. *Crotono poitaei-Erythroxyletum rotundifolii* [17].

Subgroup $G2_3$ (R40–R43) is located in areas of Ázua, Bani, San Juan, Enriquillo and Port au Prince (Haiti), which have a dry infratropical thermotype and are home to a spinescent forest growing on Miocene loams. In this forest, there is a predominance of *Guaiacum officinale* L., *Capparis cynophallophora* L., *Bourreria divaricata* (DC.) G. Don and *Cylindropuntia caribaea* (Britt. & Rose) Kunth; and 16 endemic plants, including particularly *Coccothrinax spissa* Bailey, and *Neoabbottia paniculata* (Lam.) Britt. & Rose.

$G2_4$ contains the inventories R37–R39 taken in the dry forest between Pedernales and Barahona. The territory has a semiarid infratropical thermotype and reef limestone substrates. This forest is rich in coarse and spiny plants such as *Cylindropuntia caribaea* (Britt. & Rose) Kunth, *Cameraria linearifolia* Urb., *Bursera simaruba* (L.) Sarg. and *Agave antillarum* Descourt.; and has 24 endemics, including particularly *Melocactus pedernalensis* M. Mejía & R. García, *Malpigina micropetala* Urb., *Thouinia domingensis* Urb. & Radlk., *Thouinidium inaequilaterum* Alain, and *Lonchocarpus pycnophyllus* Urb. These samples are clearly separated from the rest due to the fact that they constitute specific endemic habitats (**Figures 6** and **7** and **Photo 1**).

The type A forest group is located in the northern areas of the great mountains; Cordillera Central, Northern, Bahoruco, Oriental, Los Haitises, all of which have an ombrotype that oscillates between the subhumid and the hyperhumid, and a thermotropical to supratropical thermotype (**Photos 2–4**).

The territory of the Dominican Republic, including some small adjacent islands, covers 48,198 km^2 and accounts for over two-thirds of the territory of the island of Hispaniola, located between parallels 17 and 19°N, and part of the Greater Antilles. The main aim of this chapter is to determine the forest vegetation (cloud forest), floristic diversity, and state of conservation in areas with high rainfall in the Dominican Republic. Most of the botanical studies to date are floristic in nature, and include the studies on the Sierra de Bahoruco, which highlight the substantial rainfall of up to 4000 mm and the very high rate of endemic species. Studies by various authors in the central, northern, and eastern mountain ranges containing the cloud forest [18–24], and which together with our own previous studies, form the basis of this present work [25–35]. All the above-mentioned studies focus on the knowledge of the

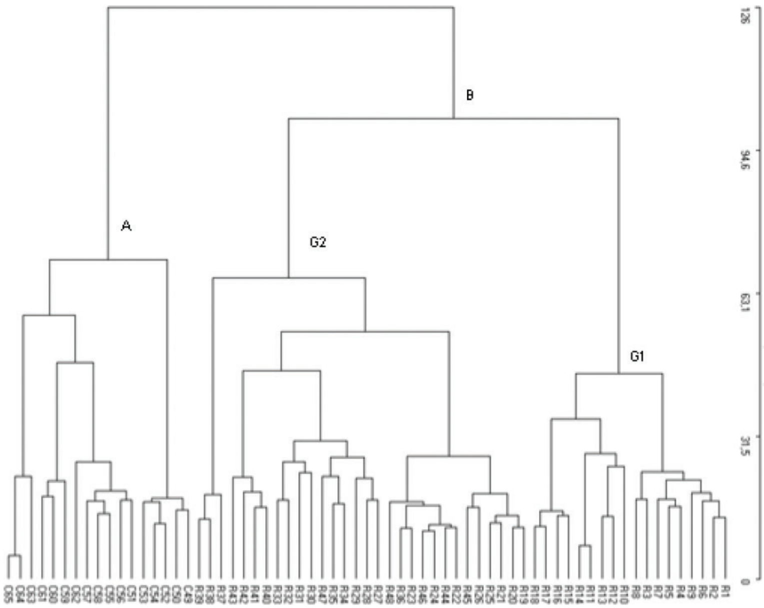

Figure 6. Cluster analysis. Diversity of forest types.

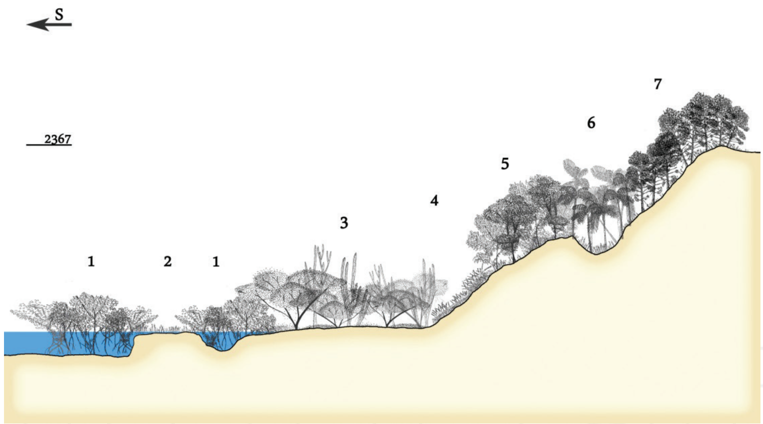

Figure 7. Profile of the vegetation of the cloud forest of Sierra Bahoruco-Barahona-Pedernales 1. *Rhabdadenia biflora-Laguncularietum racemosae* and *Lonchocarpo pycnophylli-Conocarpetum erecti*. 2. Salt marshes of *Batidi-Salicornietea*. 3. *Lonchocarpo pycnophylli-Cylindropundietum caribaeae*. 4. *Melocacto pedernalensis-Leptochloopsietum virgatae*. 5. Broad-leaved forest. 6. Cloud forest of *Prestoea montana* [17].

flora, with passing references to the vegetation; herein lies the interest of this work. The floristic approach is important as these are biodiversity hotspots [36], with a 33% rate of endemics compared to the total flora.

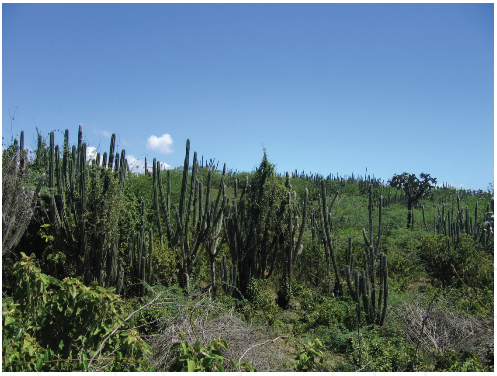

Photo 1. Dry forest of *Pilosocereus polygonus* (Cibao Valley, Dominican Republic).

Photo 2. Subtropical forests of *Pinus occidentalis* in the Cordillera Central, and the heath grass formation of *Danthonia domingensis*.

Photo 3. Meso and supratropical cloud forests in the Cordillera Central.

In the analysis of the diversity of the 2 forest types (dry and rain); in the dry forest, there are 61 tree species and 5 stipes, of which 10 are endemic; compared to 75 in the cloud forest and 4 stipes, of which 19 are endemic. There is more number of epiphytes in the cloud forest, with

Photo 4. Vegetation of Los Haitises (A6). 1. Latifoliate mahogany forest *Swietenia mahagoni*. 2. *Ormosia krugii* and *Prestoea montana* which is enriched on the summits with *Didymopanax morototoni*.

	Trees	Stipes	Shrubby	Succulents	Climbers	Epiphytes	Herbaceous	T. species
Dry forest	61	5	158	16	44	13	28	322
Rain forest	75	4	63	0	28	36	43	244

Table 1. Species diversity in dry and cloud forests in the Dominican Republic.

36 species, than in the dry forest, with 13 species (**Table 1**). Shannon's index gives values of 3384 and 3528 for the dry and cloud forest, respectively.

4. Discussion and conclusions

There are areas with dry forest plant cover in the Dominican Republic; these are located in the southwest of the island, specifically in Procurrente de Barahona, Azua-Valle de San Juan-Hoya Enriquillo and in its extension toward western Haiti, including Beata Island and the Cibao Valley, Monte Cristi. These territories have a high rate of endemics, therefore, the habitats where they grow should also be considered endemic. The cloud forest, however, is always found in the mountains as a consequence of the moisture-laden winds from the Atlantic. In both cases, the forest distribution responds to the environmental factors on the island, which has a high rate of endemics owing to the island phenomenon, making it a hotspot in the Caribbean.

The presence of two groups of forests due to the humidity gradient [37] in the Dominican Republic, which varies between semiarid and hyperhumid. This classification is based on the floristic composition and less on forest structure [38]. The cloud forest in Ebony Green (Cordillera Central) has suffered frequent fires, causing an invasion of *Gleichenia bifida* and *Dicranopteris pectinata*, which prevent the germination and development of primary forest species and in turn leads to a loss of seeds and intensification in the rate of invasive species. This situation requires rapid human intervention [39] (**Photo 5**), which should be aimed at reinforcing the seed bank of species of interest to conservation in botanical gardens in the Caribbean

Photo 5. Deforested area in the central range invaded by *Gleichenia bifida* (Dominican Republic).

Photo 6. Deforestation of the dry forest in the Cibao Valley (Dominican Republic).

[40]. The rain forests on the ridges and mountain ranges of Hispaniola are rich in *Cecropia schreberiana* Miq. [41] and species of the genera *Magnolia*, *Prestoea*, *Didymopanax*, *Cyathea*; the greatest botanical diversity is found in the oldest mountains, while the younger formations are less floristically diverse [42]. The diversity of trees and epiphytes is lower in the dry forest than in the cloud forest, but there are more succulents from the Cactaceae and Agavaceae family; we found no interactions between these families and parasitic elements in the Dominican Republic as occur in Puerto Rico. This type of dry forest dominated by succulent species has a low rate of epiphytes (4%) compared to 15% for the cloud forest. Epiphytes are renowned for their abundance in dry forests: *Tillandsia recurvata* (L.) L, *Broughtonia domingensis* (Lindl.) Rolf, *Tillandsia balbisiana* Schultes, *Tillandsia usneoides* (L.) L, and *Bromelia pinguin* L.

Deforestation caused by fire or heavy machinery is causing changes in the landscape, leading to the loss of species and plant cover (**Photo 6**) in areas where there is insufficient knowledge of the flora and vegetation, despite the fact that, so far, we have described nine phytosociological classes and more than 20 associations and plant communities on the island.

Global syntaxonomical checklist of the known vegetal diversity of Hispaniola (syntaxonomical approach to Hispaniola)

Number of classes, orders, alliances and associations recognized so far. Classes: 9; Orders: 11; Alliances: 13; Associations: 29

CHRYSOBALANO-ANNONETEA GLABRAE Borhidi & Muñiz in Borhidi, Muñiz & Del-Risco 1979

Tabebuio-Bucidetalia (Lvov 1967) Borhidi & Del-Risco in Borhidi, Muñiz & Del-Risco 1979

Marcgravio rubrae-Pterocarpion officinalis Cano, Velóz, Cano-Ortiz et Esteban Ruiz 2009

1-Roystoneo hispaniolanae-Pterocarpetum officinalis Cano, Velóz, Cano-Ortiz et Esteban Ruiz 2009

BYRSONIMO-PINETEA CARIBAE Samek and Borhid in Borhidi et al. 1979

Pinetalia occidentalis-maestrensis Knapp 1964 in Borhidi et al. 1979

Ilici tuerckheimi-Pinion occidentalis Cano, Velóz et Cano-Ortiz 2011

1-Dendropemon phycnophylli-Pinetum occidentalis Cano, Velóz et Cano-Ortiz 2011

2-Cocotrino scopari-Pinetum occidentalis Cano, Velóz et Cano-Ortiz 2011

RHIZOPHORO-AVICENNIETEA GERMINANTIS Knapp (1964) em. Borhidi & Del-Risco in Borhidi et al. 1979

Rhizophoretalia Cuatrecasas 1958

Al. Dalbergio-Rhizophorion manglis (Borhidi 1991) Cano, Cano-Ortiz, Velóz, Alatorre et Otero 2012

1-Machario lunati-Rhizophoretum manglis Cano, Cano-Ortiz & Velóz ex Cano, Cano-Ortiz, Velóz, Alatorre et Otero 2012

Avicennietalia germinantis Cuatrecasas 1958

Conocarpo-Laguncurion racemosae Cuatrecasas 1958

2-Batidi-Avicennietum germinantis Borhidi & Del-Risco & Borhidi 1991

(syn. As. Laguncurio racemosae-Avicennietum germinantis Reyes & Acosta 2003; As. Avicennietum germinantis Reyes & Acosta 2003)

3-Rhabdadenio biflorae-Laguncularietum racemosae Cano, Cano-Ortiz & Velóz ex Cano, Cano-Ortiz, Velóz, Alatorre et Otero 2012

4-Conocarpo erectae-Coccolobetum uviferae Reyes in Reyes & Acosta 2003

(syn. Conocarpetum erectae Reyes in Reyes & Acosta 2003)

5-Sthalio monospermae-Laguncularietum racemosae Cano, Cano-Ortiz & Velóz ex Cano, Cano-Ortiz, Velóz, Alatorre et Otero 2012

6-Lonchocarpo pycnifolii-Conocarpetum erecti Cano, Cano-Ortiz & Velóz ex Cano, Cano-Ortiz, Velóz, Alatorre et Otero 2012

TABEBUIO-BURSERETEA Knapp (1964) Borhidi 1991

Tabebuio-Burseretalia Knapp (1964) Borhidi 1991

Leptogono buchii-Tabebuion berterii Cano, Cano-Ortiz, del Río, Velóz et Esteban Ruíz 2014

1-Coccotrino argentei-Tabebuietum berterii Cano, Cano-Ortiz, del Río, Velóz et Esteban Ruíz 2014

2-Zombio antillari-Leptogonetum buchii Cano, Cano-Ortiz, del Río, Velóz et Esteban Ruíz 2014

Calliandro haematommae-Phyllanthion nummularioidis Cano, Cano-Ortiz, del Río, Velóz et Esteban Ruíz 2014

3-Garcinio glaucescentis-Phyllanthetum numularioidis Cano, Cano-Ortiz, del Río, Velóz et Esteban Ruíz 2014

4-Tabebuio ophiolithicae-Randietum aculeati Cano, Cano-Ortiz, del Río, Velóz et Esteban Ruíz 2014

PHYLLANTHO-NEOBRACETEA VALENZUELANAE Borhidi & Muñiz in Borhidi et al. 1979

Ariadno-Phyllanthetalia Borhidi & Muniz in Borhidi et al. 1979

Tetramicro canaliculatae-Leptochloopsion virgatae Cano, Velóz et Cano-Ortiz 2010

1-Leptogono buchii-Leptochloopsietum virgatae Cano, Velóz et Cano-Ortiz 2010

Rondeletio christii-Pinion occidentalis Cano, Cano-Ortiz, del Río, Velóz et Esteban Ruíz 2014

2-Leptogono buchii-Pinetum occidentalis Cano, Veloz & Cano Ortiz 2011

COCCOTHRINACETO-PLUMERIETEA Knapp in Boirhi 1991

Lantano-Cordietalia Borhidi in Borhidi et al. 1979

Crotono poitaei-Leptochloopsion virgatae Cano, Velóz et Cano-Ortiz 2010

1-Crotono astrophori-Leptochloopsietum virgatae Cano, Velóz et Cano-Ortiz 2010

2-Melocacto pedernalensis-Leoptochloopsietum virgatae Cano, Velóz et Cano-Ortiz 2010

3-Solano microphylli-Leptochloopsietum virgatae Cano, Velóz et Cano-Ortiz 2010

Eugenio-Metopietalia toxiferi Knapp (1942) Borhidi 1991

Eugenio-Capparidion Borhidi in Borhidi et al. 1959

4-Chrysophyllo oliviformi-Sideroxyletum salicifolii Cano & Velóz 2012

5-Zamio debilis-Metopietum toxiferi Cano & Velóz 2012

6-Coccotrino gracili-Burseretum simarubae Cano, Cano-Ortiz et Velóz 2015

CERCIDI-CEREETEA Borhidi 1996

Ritterocereetalia hystricis Borhidi 1996

Harrio nashii–Acacion skleroxylae Cano, Cano-Ortiz & Velóz ex Cano-Ortiz, Musarella, Spampinato, Velóz et Cano 2015

1-Harrisio nashii–Prosopidetum juliflorae Cano, Cano-Ortiz & Velóz ex Cano-Ortiz, Musarella, Spampinato, Velóz et Cano 2015

2-Crotono poitaei–Erythroxyletum rotundifolii Cano, Cano-Ortiz & Velóz ex Cano-Ortiz, Musarella, Spampinato, Velóz et Cano 2015

3-Lonchocarpo pycnophylli–Cylindropuntietum caribaeae Cano, Cano-Ortiz &Velóz ex Cano-Ortiz, Musarella, Spampinato, Velóz et Cano 2015

4-Neoabbottio paniculatae–Guaiacetum officinalis Cano, Cano-Ortiz & Velóz ex Cano-Ortiz, Musarella, Spampinato, Velóz et Cano 2015

WEINMANNIO-CYRILLETEA Knapp 1964

Weinmannio-Cyrilletalia Knapp 1964

1.-Community of Cyathea furfuracea and Prestoea motana

2.-Community of Ormosia krugii and Prestoea montana

OCOTEO-MAGNOLIETEA Borhidi and Muñiz in Borhdi et al. 1979

Ocoteo-Magnolietalia Muñiz in Borhdi et al. 1979

1.-Community of Hyeronima Montana and Magnoliea pallescens

2.-Community of Hyeronima dominguensis and Magnolia hamorii

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References

[1] Oliveras I, Malhi Y, Salinas N, Huaman V, Urquiaga-Flores E, Kala-Mamani J, Quintano-Loaiza JA, Cuba-Torres F, Lizarraga-Morales N, Roman-Cuesta RM. Changes in forest structure and composition after fire in tropical monatane cloud forests near the Andean treeline. Plant Ecology & Diversity. 2014;**7**(1-2):329-340

[2] Saito S. Effects of severe typhoon on forest dynamics in a warn-temperature evergreen broad-leaved forest in Southwestern Japan. Journal of Forestry Research. 2002;**7**: 137-143

[3] Phua M, Minowa M. Evaluation of environmental functions of tropical forest in Kinabalu Park, Sabah, Malaysia using GIS and remote sensing techniques: Implications to forest conservation planning. Journal of Forestry Research. 2000;**5**:123-131

[4] Berkes F. Indigenous ways of knowing and the study of environmental change. Journal of the Royal Society of New Zealand. 2009;**39**(4):151-156

[5] Agrawal A. Why indigenous knowledge? Journal of the Royal Society of New Zealand. 2009;**39**(4):157-158

[6] Robson JP, Miller AM, Idrobo CJ, Burlando C, Deutsch N, Kocho-Schellenberg JE, Pengelly D, Turner KL. Building communities of learning: Indigenous ways of knowing in contemporary natural resources and environmental management. Journal of the Royal Society of New Zealand. 2009;**39**(4):173-177

[7] Almeida de Oliveira E, Schwantes Marimon B, Feldpausch TR, Rinaldi Colli G, Marimon-Junior BH, Lloy J, Lenza E, Maracahipes L, Oliveira-Santos C, Oliver LP. Diversity, abundance and distribution of lianas of the cerrado-Amazonian Forest transition, Brazil. Plant Ecology & Diversity. 2014;**7**(1-2):231-240

[8] Maunder M, Leiva A, Santiago-Valentín E, Stevenson DW, Acevedo-Rodríguez P, Meerow AW, Mejía M, Clubbe C, Francisco-Ortega J. Plant conservation in the Caribbean Island biodiversity hotspot. Botanical Review. 2008;**74**:197-207

[9] Nakashizuka T. The role of biodiversity in Asian forests. Journal of Forestry Research. 2004;**9**:293-298

[10] Kaimowitz D. Forest and water: A polycy perspective. Journal of Forestry Research. 2004;**9**:289-291

[11] Uzawa H. Forest and social common capital. Journal of Forestry Research. 2004;**9**:283-288

[12] Van Der Maarel E. Transformation of cover-abundance values in phytosociology and its effects on community similarity. Vegetatio. 1979;**39**:97-114

[13] Cano E, Cano Ortiz A, Del Río S, Alatorre J, Veloz A. Bioclimatic map of the Dominican Republic. Plant Sociology. 2012;**49**:81-90

[14] Cano E, Cano Ortiz A. Establishment of Biogeographic Areas by Distributing Endemic Flora and Habitats (Dominican Republic, Haiti R.). In Global Advances in Biogeography. Croatia: Ed. Lawrence Stevens INTECH; 2012. pp. 99-118

[15] Nobis MP, Traiser C, Roth-Nebelsick A. Latitudinal variation in morphological traits of the genus Pinus and its relation to environmental and phylogenetic signals. Plant Ecology & Diversity. 2012;**5**(1):1-11

[16] Wei Y, Ouyang Z, Miao H, Zheng H. Exotic *Pinus caribaea* causes soil quality to deteriórate on former abandoned land compared to an indigenous *Podocarpus* plantation in the tropical forest area of southern China. Journal of Forestry Research. 2009;**14**:221-228

[17] Cano Ortiz A, Musarella CM, Cano E. Biogeografical areas of Hispaniola (Dominican Republic, Republic of Haiti) in Ecology. Intech Open Science. 2017:165-189

[18] May TH, Pequero B. Vegetación y flora de la Loma el Mogote, Jarabacoa, Cordillera Central, República Dominicana. Moscosoa. 2000;**11**:11-37

[19] Mejía M, García R, Jiménez F. Sub-región fitogeográfica Barbacoa-Casabito: riqueza florística y su importancia en la conservación de la flora de la Isla Española. Moscosoa. 2000;**11**:57-106

[20] May TH. Fases tempranas de la sucesión en un bosque nublado de Magnolia pallescens después de un incendio (Loma de Casabito, Reserva Científica Ébano Verde, Cordillera Central, República Dominicana). Moscosoa. 1997;**9**:117-144

[21] Zanoni T, Mejía M, Pimentel JD, García R. Flora y Vegetación de los Haitises República Dominicana. Moscosoa. 1990;**6**:46-98

[22] Mejía M, Jiménez F. Flora y Vegetación de la Loma Humeadora, Cordillera Central, República Dominicana. Moscosoa. 1998;**10**:10-46

[23] Hager J, Zanoni T. La vegetación natural de la República Dominicana. Una nueva clasificación. Moscosoa. 1993;**7**:39-81

[24] Höner D, Jímenez F. Flora vascular y vegetación de la Loma La Herradura (Cordillera Oriental, República Dominicana). Moscosoa. 1994;**8**:65-85

[25] Cano E, Veloz Ramírez A, Cano Ortiz A, Esteban FJ. Distribution of Central American Malastomataceae: Biogeographical Analysis of the Caribbean Islands. Acta Botanica Gallica. 2009;**156**(4):527-557

[26] Cano E, Veloz Ramírez A, Cano Ortiz A, Esteban FJ. Analysis of the Pterocarpus officinalis forests in the Gran Estero (Dominican Republic). Acta Botanica Gallica. 2009; **156**(4):559-570

[27] Cano E, Veloz A, Cano Ortiz A. Contribution to the biogeography of the Hispaniola (Dominican Republic, Haiti). Acta Botanica Gallica. 2010;**157**(4):581-598

[28] Cano E, Veloz A, Cano Ortiz A. The habitats of Leptochloopsis virgata in the Dominican Republic. Acta Botanica Gallica. 2010;**157**(4):645-658

[29] Cano E, Veloz Ramírez A, Cano Ortiz A. Phytosociological study of the *Pinus occidentalis* woods in the Dominican Republic. Plant Biosystems. 2011;**145**(2):286-297

[30] Cano E, Veloz A, Cano Ortiz A, Alatorre J, Otero R. Comparative analysis of the mangrove swamps of the Caribbean and those of the state of de Guerrero. Mexico. Plant Biosystems. 2012;**146**(suplemento 1):112-130

[31] Cano E, Cano Ortiz A, del Río S, Veloz A, Esteban Ruíz FJ. A phytosociological survey of some serpentine plant communities in the Dominican Republic. Plant Biosystems. 2013;**148**(2):200-212

[32] Cano E, Veloz A, Cano Ortiz A. Rain forests in subtropical mountains of Dominican Republic. American Journal of Plant Science. 2014;**5**:1459-1466

[33] Cano E, Cano Ortiz A, Veloz A. Contribution to the knowledge of the edaphoxerophilous communities of the Samana peninsula (Dominican Republic). Plant Sociology. 2015; **52**(1):3-8

[34] Cano Ortiz A, Musarella CM, Piñar JC, Veloz A, Cano E. The dry forest in the Dominican Republic. Plant Biosystems. 2015;**149**(3):451-472

[35] Cano Ortiz A, Musarella CM, Piñar Fuentes JC, Pinto Gomes CJ, Cano E. Forests and landscapes of Dominican Republic. British Journal of Applied Science & Technology. 2015;**9**(3):231-242

[36] Cano Ortiz A, Musarella CM, Piñar Fuentes JC, Pinto Gomes CJ, Cano E. Distribution patterns of endemic flora to define hotspots on Hispaniola. Systematics and Biodiversity. 2016;**14**(3):261-275

[37] Butt N, Malhi Y, New M, Macia MJ, Lewis SL, Lopez-Gonzalez G, Laurance WF, Laurance S, Luizao R, Andrade A, Baker TR, Almeida S, Oliver L. Shifting dynamics of climate-functional groups in old-growth Amazonian forests. Plant Ecology & Diversity. 2014;**7**(1-2):267-279

[38] Gardener MR, Bustamante RO, Herrera I, Durigan G, Pivello VR, Moro MF, Stoll A, Langdon B, Baruch Z, Rico A, Arredondo-Nuñez A, Flores S. Plant invasions research in Latin America: Fast track to a more focused agenda. Plant Ecology & Diversity. 2012; **5**(2):225-232

[39] Faggi A, da Costa ML, Pereira TS, Balcazar Sol T, Mejía M. Latin America and Caribbean botanic gardens: advances an challenges at national and regional levels. Plant Ecology & Diversity. 2012;**5**(2):259-263

[40] Sheil D, Padmanaba M. Innocent invaders? A preliminary assessment of Cecropia, an American tree, in Java. Plant Ecology & Diversity. 2011;**4**(2-3):279-288

[41] Spehn EM, Rudmann-Maurer K, Körner C. Mountain diversity transitions. Plant Ecology & Diversity. 2011;**6**(1):101-137

[42] Guerrero PC, Carvallo GO, Massar JM, Rojas-Samdoval J, Sanz V, Medel R. Ecology and evolution of negativa and positive interactions in Cactaceae: Lessons and pending tasks. Plant Ecology & Diversity. 2012;**5**(2):205-215

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