

Establishment of Biogeographic Areas by Distributing Endemic Flora and Habitats (Dominican Republic, Haiti R.)

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1. Introduction

Despite the large number of botanical studies conducted on the flora of the Island of Hispaniola, some of which adopted a floristic or physiognomical approach (e.g., Zanoni et al., 1990; Höner and Jiménez 1994; Guerrero et al., 1997; May, 1997, 2000, 2001; Mejía and Jiménez 1998; Rivas-Martínez et al. 1999; May and Peguero, 2000; Mejía et al., 2000; Slocum et al., 2000; García and Clase 2002; García et al. 2002; Peguero and Salazar 2002; Veloz and Pequero 2002); and Cano et al., 2009a, 2009b, 2010a, 2010b, 2011, 2012 with a phytosociological methodology, only few have adopted phytogeographical or phytosociological approaches. Here we present a biogeographic profile on the flora of the Island of Hispaniola.

2. Study area

Our study area is the Island of Hispaniola (Dominican Republic, Republic of Haiti); (Fig. 1). The island belongs to the so-called Greater Antilles (Cuba, Hispaniola, Jamaica and Puerto Rico), which are located approximately in the centre of the Antillean Arc. With an area of 76,484 km² Hispaniola is the second largest island of the group, second in size only to Cuba (110,861 km²). By comparison, the Bahamas (Grand Bahama, Andros, Mayaguana, Great Inagua and Grand Caicos) are a group of islands open to the Atlantic and extend from SE to NW. The arc of the Lesser Antilles, with the Virgin Islands, St Kitts Nevis, Antigua and Barbuda, Dominica, St Lucia, St Vincent and the Grenadines, Barbados, Grenada, Trinidad and Tobago, is located to the SE of Puerto Rico.

3. Methods

Our biogeographical approach for the vegetation of the Island of Hispaniola relies both on previous geological studies compiled by Liogier (2000), Mollat et al. (2004), Cano et al. (2009a, 2010a) and also on some geomorphological studies (A.R.N. 2004). We carried out a total of 300 vegetation relevés on the island. These samples, together with the numerous floristic studies used references, allowed us to plot the different biogeographical areas of the island. For an accurate mapping of the floristic differences in the territory, we first studied the endemic plants growing not only all over the island but also on restricted sites of it. We



Fig. 1. Location of Hispaniola in the Caribbean area (Cano et al., 2009a)

provide here the number of endemic species per sampling unit. The area of these sample units ranges from 500 to 2,000 m², depending on the vegetation unit involved in each case, either of herbaceous, scrub or forest species. To check that the units defined in this manner were suitable as far as the differences recorded in the flora and vegetation are concerned, we simultaneously applied our own Jaccard's and Pearson's numerical analyses already published. Our approach relies heavily on the bioclimatic and biogeographical analyses up to the rank of biogeographical sector, as conducted by us in previous studies (Cano et al. 2009a, 2010a). With the presentation of some bioclimatic charts representing the study area in this paper we further extend this approach. For that purpose we also made use of the globalbioclimatic.org website Rivas-Martínez (2009). Our biogeographical mapping is based on edaphological, bioclimatic, floristic, vegetational and historical criteria. Our analysis of the flora makes use of 1,582 endemic species recorded either in the references or in our field samples. We followed the taxonomy of Liogier (1996-2000) and Martín & Cremers (2007).

We determined the degree of kinship between each pair of 19 biogeographic areas (Fig. 2), and we consulted previous studies (Cano et al., 2010a). These references were further extended through application of the Jaccard's coefficient and the Pearson's index between the 19 areas according to the presence/absence of the species.

4. Results and discussion

4.1 Analysis of vegetation

Island of Hispaniola exhibits a wide altitudinal range, from 0 at sea level to 3,175 masl on Pico Duarte (Cordillera Central), a great variety of soils, and a rainfall gradient ranging from 400 to 4,600 mm. These three parameters, together with the isolation of the territories involved have been crucial for the emergence of the current vegetation.

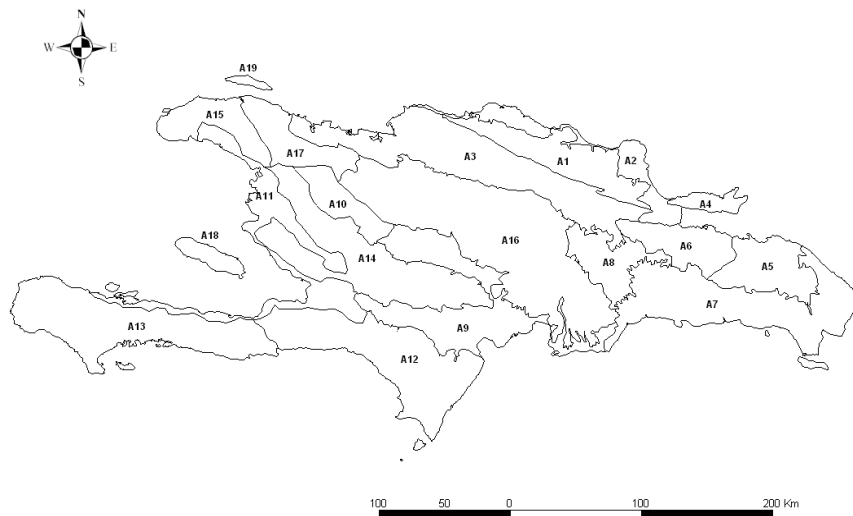


Fig. 2. Floristic areas on the Island of Hispaniola.

To study the vegetation we defined some large areas according to rainfall and temperature records. These areas include dry areas, subhumid areas, humid-hyperhumid areas and high mountain areas, as defined in Cano et al. (2009a, b).

Dry areas exhibit a tropical xeric macrobioclimate dominated by an infratropical semiarid and dry thermotype (Fig. 3 and 4). These areas also support a high richness of endemic species and correspond with our study areas A3, A9 and A12. From a physiognomical point of view, the vegetation is very similar in all the semiarid and dry areas, and is usually dominated by plants of the *Agavaceae* and *Cactaceae* families, among other, such as *Lemaireocereus hystrix* (Haw.) B.&R., *Cylindropuntia caribae* (B.&R.) Kunth, *Consolea moniliformis* (L.) Haw., *Leptochloopsis virgata* (Poir.) Griseb., *Pilosocereus polygonus* (Lam.) B.&R., *Opuntia dillenii* (Fer.-Gawl) Haw., *Leptocereus weingartianus* (Hartm.) Britt. & Rose, *Acacia skleroxyla* Tuss., *Agave antillarum* Descourt., *Pithecellobium unguis-cati* (L.) Mart.

In the southwest of the island (A12) we find the dry forest of Pedernales-Ceitillan (Procurrente de Barahona; Photograph 1), developed on limestone dog-tooth substrates. Several endemic species include *Melocactus pedernalensis* (Ait.) M. Mejía & R. García, *Galactia dictyophylla* Urb., *Coccoloba incrassata* Urb., *Caesalpinia domingensis* Urb., and *Guettarda stenophylla* Urb. However, the dry forest growing in the area A9, with an ombrothermic index value $O_i = 2.1$, presents a slightly lower level of endemism. Here the most species differentiating the dry forest of Pedernales are *Melocactus lemairei* (Monv.) Miq. *Neoabbottia paniculata* (Lam.) Britt. & Rose, *Coccoloba spissa* Bailey. Area A3, located in the northwest of the island supports a dry forest dissimilar to those previously mentioned in that it supports an endemic flora, including *Salvia montecristina* Urb. & Ekm., *Mosiera urbaniana* Borhidi, *Croton poitai* Urb., *Croton sidaefolius* Lam., *Guettarda tortuensis* Urb. & Ekm. and *Coccoloba buchii* Urb. The most representative plant communities growing in dry areas belong to the following endemic habitats: *Leptogono buchii-Leptochloopsisvirgatae* Cano, Velóz & Cano-Ortiz 2010, which is included in the endemic serpenticolous alliance *Tetramicro canaliculatae-*

Leptochloopsis virgatae Cano, Veloz & Cano-Ortiz 2010; *Crotono astrophori-Leptochloopsisium virgatae* Cano, Veloz & Cano-Ortiz 2010, *Melocacto pedenalensi-Leptochloopsisium virgatae* Cano, Veloz & Cano-Ortiz 2010, *Solano microphylli-Leptochloopsisium virgatae* Cano, Veloz & Cano-Ortiz 2010, which are included in the endemic alliance *Crotono poitaei-Leptochloopsisium virgatae* Cano, Veloz & Cano-Ortiz 2010; and the pine forests of *Leptogono buchii-Pinetum occidentalis* Cano, Veloz & Cano-Ortiz 2011 on serpentine substrates, which we include in the endemic alliance *Leptogono buchii-Pinion occidentalis* ined.

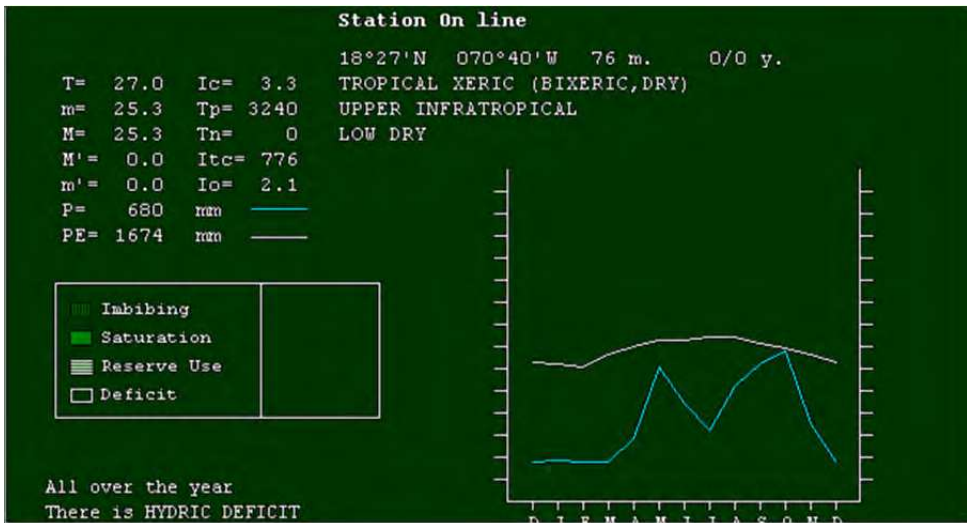


Fig. 3. Weather station of Azua: upper infratropical, lower dry bixeric, (A9).

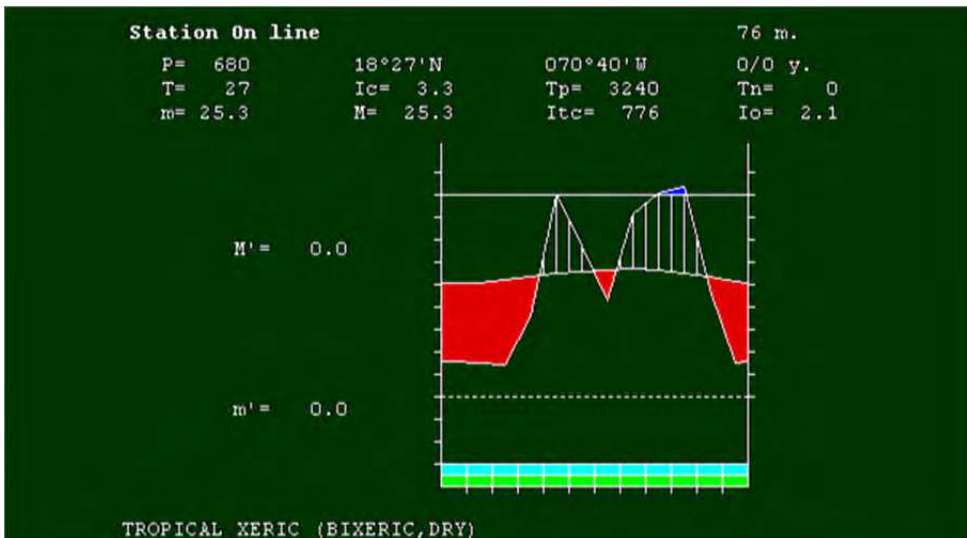


Fig. 4. Weather station of Azua: tropical xeric (bixeric), (A9).



Photo 1. Dry forest of *Consoula moniliformis* of Procurrence of Barahona. Dominican Republic.

Most of the territory of Hispaniola presents a tropical pluvisesonal macrobioclimate (Figs. 5, 6) and dominance of the subhumid ombrotype, with rainfall rates ranging from 1,000 to 2,000 mm and Oi values ranging from 3.7-4.3 (Parque Nacional del Este), Oi = 4 (El Seibo), Oi = 6.2 (Miches), Oi = 5.9 (Mayaguana), to Oi = 9.3 (Jarabacoa). The dominant vegetation in these areas is a subhumid, broad-leaved forest undergoing a dry season from December to April. As a result of the water stress, this flora includes tree-like, deciduous species. This is the case of *Bursera simaruba* (L.) Sarg., *Swietenia mahagoni* (L.) Jacq. and other species, such as *Metopium toxiferum* (L.) Krug & Urb., *Krugidendron ferreum* (Vahl) Urb., *Acacia macracantha* H. & B. ex Willd., *Coccoloba diversifolia* Jacq. and *Bucida buceras* L. These formations include important endemic taxa, such as the climbing plant *Aristolochia bilobata* L., the tree-like *Melicoccus jimenezii* (Alain) Acev. Rodr. and scrub-like plants, such as *Lonchocarpus neurophyllus* Benth. There also are other dominant scrub formations playing the role of dynamic substitution stages, such as *Zamia debilis* L., which occurs with the endemic taxa *Pereskia quisqueyana* Alain and *Goetzea ekmanii* O.E. Schulz.

If these subhumid forests are located on reef-perforated limestones, the territory adopts a dry profile as a result of the heavy water loss through the soil. Such settings include floristic elements such as *P. polygonus*, *P. unguis-cati*, *L. weingartianus* and *Hylocereus undatus* (Haw.) Britt. & Rose. The plant formations peculiar to A7 are associated with the dry forests of the southwest region of the island, with which they also share some physiognomical features. A similar situation occurs in the rocky escarpments of Samaná, where *B. simaruba*, *Coccoloba gracilis* Burret, *A. antillarum*, *L. weingartianum* and *O. dilleni* occur frequently. As a result of water stress, these habitats tend to exhibit deciduous species related to the

Chrysophyllo oliviformi-Sideroxyletum salicifolii Cano & Velóz 2011 and *Zamio debilis-Metopietum toxiferi* Cano & Velóz 2011 associations of Cano & Velóz (2012); (Photograph 2).

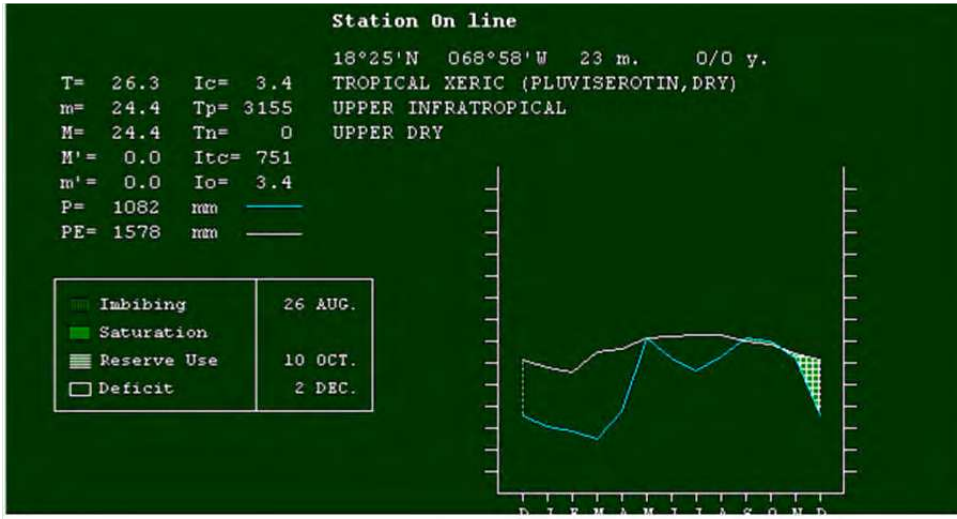


Fig. 5. Weather station of La Romana (40 years): upper infratropical, upper dry, (A7).

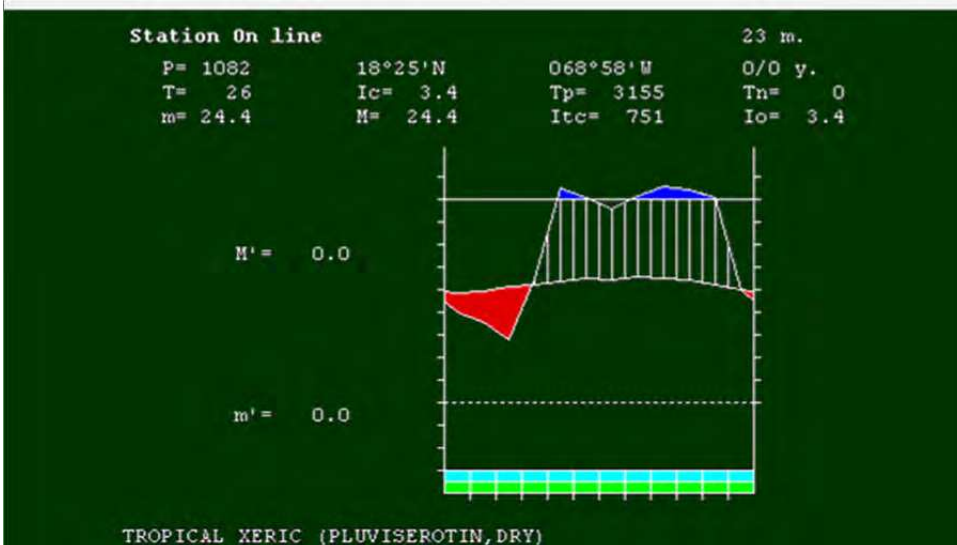


Fig. 6. Weather station of La Romana (40 years): tropical pluviseasonal, xeric, (A7).

Dry and subhumid areas with serpentinicolous vegetation belonging to the phytosociological classes of *Tabebuio-Bureserea* Knapp (1964) Borhidi 1991 and *Phyllantho-Neobracteeta valenzuelanae* Borhidi & Muñiz in Borhidi et al. (1979) are of great interest.

In humid areas the macrobioclimate is tropical pluvial (Figs. 7, 8) with no dry season. Actually, rainfall rates are higher than 2,000 mm. These humid areas tend to be located on mountain ranges, such as the Cordillera Septentrional, Cordillera Central, Sierra de



Photo 2. Dry, edaphoxerophilous forest (Parque Nacional del Este, Dominican Republic) in Area A7.

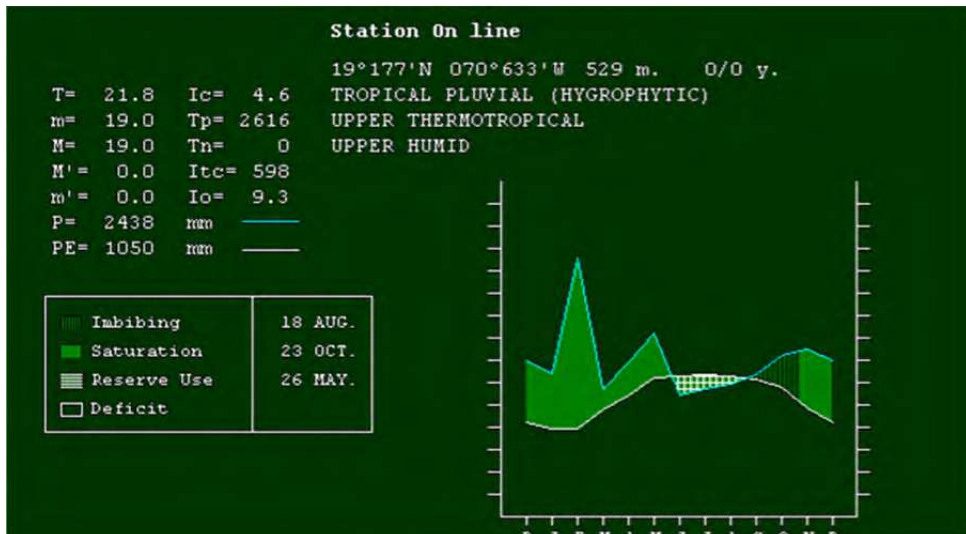


Fig. 7. Weather station of Jarabacoa (1931-2000): upper thermotropical, upper humid, (A16).

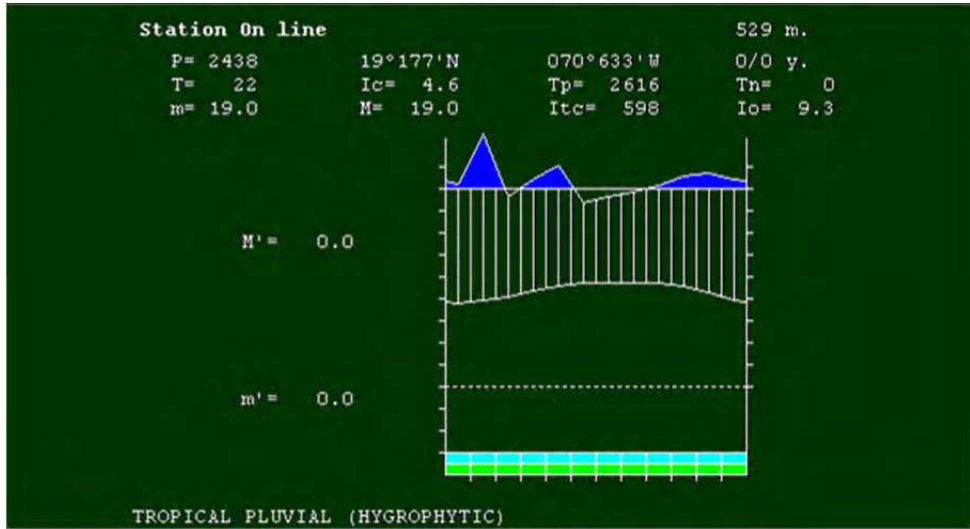


Fig. 8. Weather station of Jarabacoa (1931-2000): tropical pluvial, hygrophytic, (A16).



Photo 3. Humid-hyperhumid forest in Mogotes of Haitises. Dominican Republic, (A6).

Bahoruco, Cordillera Oriental, Los Haitises (Photograph 3), and the Samana Peninsula. In these sites, pluvial, humid plant formations and broad-leaved, ombrophilous forests are usually found. The physiognomical profile of these forests is variable. In the Loma la Herradura (Cordillera Oriental) the dominant plants are *Sloanea berteriana* Choisy, *Ormosia krugii* Urb., *Didymopanax morototoni* (Aubl.) Dcne. & Planch., and *Oreopanax capitatus* (Jacq.) Dcne. & Planch. In stream bottoms, the manacla forest or *manaclar* of *Prestoea montana* (Grah.) Nichol, exists, along with associated *Guarea guidonia* (L.) Sleumer, *D. morototoni*, *Alchornea latifolia* Sw., and *Eugenia domingensis* Berg (Honer & Jiménez, 1994).

On the Cordillera Central (A16), in the Ebano Verde Scientific Reserve (Photograph 4), the ombrophilous forest is dominated by species in the genus *Magnolia*, which are endemic to the island. These are *Magnolia pallescens* Urb. & Ekm. and *Magnolia domingensis* Urb., together with the wind tree *Didymopanax tremulus* Krug & Urb., *Ocotea leucoxydon* (Sw.) Lanessan, *Persea oblongifolia* Kopp, *Cyrilla racemiflora* L., *Cecropia schreberiana* Miq., *Dendropanax arboreus* (L.) Decne. & Planch., and other endemic species, such as *Myrsine nubicola* A. Liogier, *Odontadenia polyneura* (Urb.) Woods, *Marcgravia rubra* A. Liogier, *Pinguicula casabitoana* J. Jiménez, and *Tabebuia vinosa* A. Gentry. A similar situation is found in the Loma la Herradura with the *manaclar* or community of *P. montana*, which takes refuge in the most humid gullies. When these plant communities are altered and their cover decreased, the fern community or *calimetal* of *Dicranopteris pectinata* (Willd.) Underw. and *Gleichenia bifida* (Willd.) Spreng. (May, 2000) emerges immediately.



Photo 4. Humid forest of the Cordillera Central. Dominican Republic, (A16).

In the Loma Humeadora the wind tree cloud forest of *D. tremulus* is located at altitudes ranging from 1,100 to 1,315 m and occurs in combination with *Clusia clusioides* (Griseb.) D'Arcy, *C. racemiflora*, *Ocotea foeniculacea* Mez, *Lyonia alainii* W. Judd and *P. montana*. At lower altitudes, e.g. 850-1,100 m, in gullies and hillsides with slopes of 45-60 ° and a thick, water-retaining layer of fallen leaves, *P. montana* becomes dominant in association with *A. latifolia*, *O. leucoxydon*, *Bombacopsis emarginata* (A. Rich.) A. Robins., *S. berteriana*, *Mora abbottii* Rose & Leon., *Turpinia occidentalis* (Vent.) G. Don, *Bactris plumeriana* Mart., and *Ditta maestrensis* Borhidi (Mejía & Jiménez, 1998).

The relevés conducted both in the Cordillera Central and in Sierra de Bahoruco not only revealed different substrates but also clear dissimilarities in the broad-leaved forest. *M. pallescens* and *M. domingensis* are peculiar to the Cordillera Central, and *Magnolia hamorii* Howard only occurs in the Sierra de Bahoruco. The forests of *M. hamorii* and *D. tremulus* occur in combination with a large number of endemic species, such as *Lasianthus bahorucanus* Zanoni, *Psychotria guadalupensis* (DC.) Howard, *H. domingensis* Urb., *Mecranium ovatum* Cog. (a locally endemic plant), *Vriesea tuerckheimii* (Mez.) L.B. Smith, *Macroparpea domingensis* Urb., *Cestrum daphnoides* Griseb., *Hypolepis hispaniolica* Maxon, *Columnnea domingensis* (Urb.) Wiehler, and *Ilex tuerckheimii* Loes. Cano et al. (2009a) included this vegetation in the classes *Ocoteo-Magnolietea* Borhidi & Muñiz in Borhidi, Muñiz & Del Risco (1979) and *Weinmannio-Cyrilletea* Knapp (1964).



Photo 5. Cloud forest of Bahoruco. Dominican Republic, (A12).

Our study of high mountain areas was carried out in the Sierra de Bahoruco (A12) and the Cordillera Central (A16), which we crossed from Constanza to San José de Ocoa. The high mountain macrobioclimate is tropical pluviseasonal and mesophytic. From a physiognomical point of view, the plant formations sampled between 1,203 m (Sierra Bahoruco) and 2,383 m (Cordillera Central) are similar and are a pine forest of *Pinus occidentalis* Sw. In these territories precipitation rates are lower, as the sea of clouds carried by trade winds that supports broad-leaved forest at lower elevations never reaches these higher altitudes. Winter time temperatures can fall below 0 °C. Cold, xeric conditions in the high mountain support the *P. occidentalis* forest, which in the Cordillera Central is accompanied 8-10 endemic species per sampling relevé. A similar scenario has been observed in Sierra de Bahoruco (Photograph 5), where pine forest support an average record of 20 endemic plants per relevé. The high level of endemism in these two mountain ranges is likely attributable to a lengthy period of isolation.

In the Cordillera Central these forests develop on siliceous substrates and exhibit a large number of endemic species, such as *I. tuerckheimii*, *Ilex fuertesiana* (Loes.) Loes., *Garrya fadyenii* Hooker, *Mikania barahonensis* Urb., *Myrica picardae* Krug & Urb., *Rubus eggersii* Rydberb., *Tetrazygia urbaniana* (Cogn. in Urb.) Croizat ex Moscoso, and *Fuchsia pringsheimii* Urb. Endemic parasitic species, such as *Pinus occidentalis*, *Dendropemon pycnophyllus* Krug & Urb., and *Dendropemon constantiae* Krug & Urb. play an important role in these pine forests. Meanwhile, in the underbrush of this pine forest the Gramineae *Isachne rigidifolia* (Poir.) Urb. is abundant, but where the pine forest becomes sparse it is replaced by a formation of tufted Gramineae dominated by *Danthonia domingensis* Hack. & Pilg., which covers large areas above 1,800 m in the Cordillera Central.

By contrast, the pine forest of *P. occidentalis* develops on limestone soils in Sierra de Bahoruco and includes a different floristic composition. As particularly interesting plants, special mention must be made of the endemic species *Cocotrinax scoparia* Becc. *Agave intermixta* Trel., *Senecio barahonensis* Urb., *Cestrum brevifolium* Urb., *Eupatorium gabbii* Urb., *Lyonia truncatula* Urb., *Sideroxylon repens* (Urb. & Ekm.) T. Pennigton, *Cordia selleana* Urb., *Narvalina domingensis* Cass., and *Galactia rudolphiodes* (Griseb.) Benth. & Hook. var. *haitiensis* Urb., together with other endemic grasses, including *Pilea spathulifolia* Groult, *Tetramicra ekmanii* Mansf., *Artemisia domingensis* Urb., *Gnaphalium eggersii* Urban, and *Polygala crucianelloides* DC. In our opinion, high mountain pine forest habitats endemic to Hispaniola (Cano et al., 2011a) include *Dendropemon phycnophylli-Pinetum occidentalis* Cano, Velóz & Cano-Ortiz 2011 and *Cocotrinax scopari-Pinetum occidentalis* Cano, Velóz & Cano-Ortiz 2011 (Photograph 6).

4.2 Distribution analysis of endemic species

Endemic plant species are found in many of the 19 floristic areas of Hispaniola. The total number of endemic species of all 19 floristic areas combined is 2,094. Meanwhile, the total number of endemic taxa is 1,162. The difference of these two figures, 932 taxa, indicates that a large number of endemic species is widely distributed, occurring widely across the island. However, there are three areas that should be considered as hot spots of endemism, including areas A12, A16, A13 (Fig. 2). Second in levels of endemism, A4 and A9 exhibit endemism levels far above average, and are particularly interesting because of their endemic species exclusive to the territory. Also, in A18 and A19 are found endemic plant genera.



Photo 6. Community of *Pinus occidentalis* and *Coccolrinax scoparia*. Sierra de Bahoruco. Dominican Republic. As. *Coccolrinax scoparia*-*Pinetum occidentale* Cano, Velóz & Cano-Ortiz (2011), (A12).

4.3 Biogeographical analysis

The geological background of the island, the wide spectrum of bioclimatic thermotypes (which range from infratropical to supratropical standards) and ombrotypes (which range from semiarid to hyperhumid standards), the origin of the flora as a result of dispersal routes, and the intense isolation of *sierras* and mountains have generated a high level of endemic habitats and species. The island supports 1,284 plant genera, of which 31 are endemic, including: *Zombia*, *Leptogonum*, *Arcoa*, *Neobuchia*, *Fuertesia*, *Sarcopilea*, *Salcedoa*, *Eupatorina*, *Vegaea*, *Coeloneurum*, *Theophrasta*, *Haitia*, *Stevensia*, *Samuelssonnia*, *Hottea*, *Tortuella*, and *Anacaona*, among others. Some endemic genera are monotypic and have a fairly restricted distributional area. This is the case of *Vegaea pungens* Urb., *Zephyranthes ciceroana* M. Mejía & R. García, *Gautheria domingensis* Urb., *M. domingensis*, *Omphalea ekmanii* Alain, *Gonocalyx tetrapterus* A. Liogier, *G. ekmanii*, *Reinhardtia paiwonskiana* R.W. Read, T. Zanoni & M. Mejía, *Pseudophoenix ekmanii* Burret, and *Salcedoa mirabaliarum* F. Jiménez & L. Katinas. Others are endemic at a very local level, as is the case for *Pinguicola casabitoana*, *Fuertesia domingensis* Urb., *P. quisqueyana*, *M. jimenezii* Alain and *S. montecristina*.

According to Liogier (1996), the total richness of Hispaniola plants is 5,800 taxa, including islands Beata, Saona, Gonave and Tortuga. Subsequently, Mejía (2006) increased the figure to 6,000 vascular species encompassing 1,284 genera, including 2,050 endemic species (34.1% of all Hispaniola plant species). This high level of endemism makes Hispaniola one of the world's hot spots for the conservation of the flora, and is consistent with the high levels of endemism on other Caribbean islands. For example, Cuba supports a total of 6,500 species, approximately 50% of the species of which are endemic, and including 66 endemic genera. In comparison, Madagascar, in the Palaeotropical Kingdom, African Subkingdom supports a total of 12,000 plant species, 80% of which are endemic, and distributed among 12 families and 350 genera (Costa, 1997).

Our biogeographical description of island of Hispaniola includes 1,582 endemic species distributed in 19 floristic areas (Cano et al., 2010a). This high proportion of endemic taxa, together with the existence of peculiar vegetation catenae supports ascription of the rank of biogeographical province to Hispaniola. The Hispaniola Province supports 154 endemic species that are broadly distributed across the island (Table 1; Fig. 9). Of these widely distributed species, 114 are in the family *Melastomataceae* (Cano et al., 2010a).

Despite the presence of a relatively large number of widely distributed endemic species, Pearson analysis produced low pairwise correlations between floristic areas A12 and A16 ($r = 1.25$), A16 and A13 ($r = 1.17$), and A12 and A13 ($r = 1.23$). We attribute these low scores to differences in geological, edaphic, climatological, and land use factors. Low pairwise correlation. For example, in the latter case, both areas A12 and A13 have calcareous substrates, but A13 has sustained more intense human land use impacts. A16 and A17 are distinctively different floristically because the Massif du Nord (A17) is an extension of the Cordillera Central (A16). The common occurrence of calcareous outcrops in A17, and the high intensity of human use there increased the difference between these two areas, making A17 more similar to A15 (northwest of Haiti; Jaccard analysis revealed a dissimilarity distance of 0.9 between areas A12 and A16 a 10% match and a 90% difference; (Fig. 10). We obtained similar results in the comparison of A16 and A17, and this analysis confirmed that A17 was more similar to A15. Also, Jaccard analysis for areas A12 and A13 corroborated the Pearson analysis (Cano et al., 2010 a).

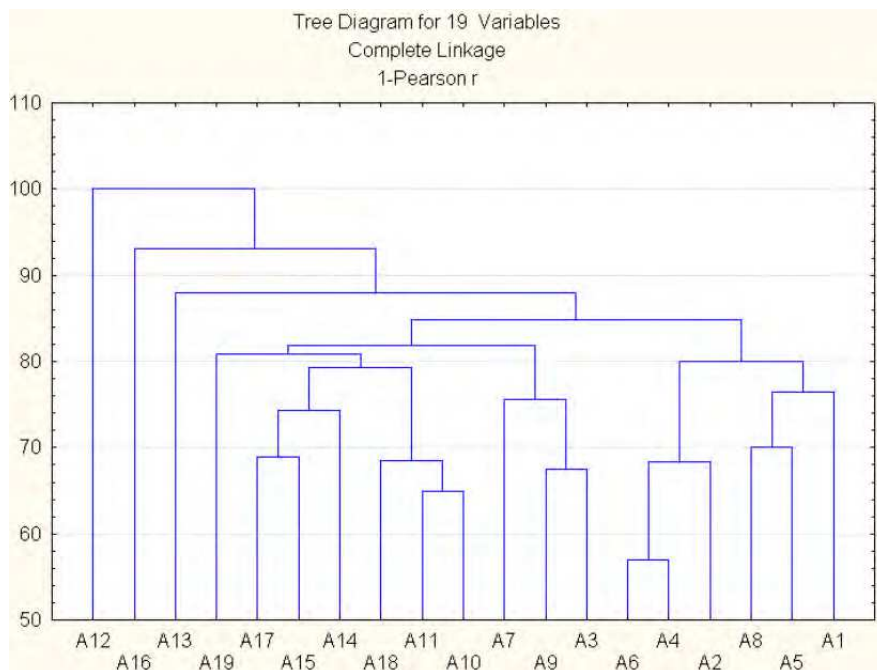


Fig. 9. Cluster diagram for 19 variables based on Pearson’s r. Correlation analysis of the 19 areas (X-axis) and the number and endemism per area (Y-axis).

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19
A1	0.00	0.99	0.95	0.93	0.96	1.00	1.03	0.95	0.99	0.96	1.02	1.13	1.06	0.99	1.01	1.05	1.03	0.95	0.97
A2	0.99	0.00	1.03	0.73	0.97	0.86	0.97	0.91	1.02	1.02	1.04	1.09	1.07	1.03	1.02	1.05	1.04	1.02	0.99
A3	0.95	1.03	0.00	0.99	1.02	1.04	0.95	0.97	0.85	0.97	0.96	1.09	1.04	0.96	0.98	1.09	0.95	1.00	1.02
A4	0.93	0.73	0.99	0.00	0.81	0.71	0.93	0.98	0.98	1.02	1.06	1.17	1.10	1.04	1.04	1.05	1.06	1.03	1.00
A5	0.96	0.97	1.02	0.81	0.00	0.91	1.02	0.88	0.98	1.01	1.02	1.03	1.03	1.01	1.02	0.93	1.02	1.01	1.01
A6	1.00	0.86	1.04	0.71	0.91	0.00	1.04	0.95	1.01	0.96	1.02	1.11	1.05	1.02	1.04	1.07	1.02	1.02	1.02
A7	1.03	0.97	0.95	0.93	1.02	1.04	0.00	1.01	0.92	0.97	1.01	1.03	1.06	1.00	1.03	1.12	1.01	1.02	1.02
A8	0.95	0.91	0.97	0.98	0.88	0.95	1.01	0.00	1.02	1.01	1.01	1.04	1.02	1.01	1.01	1.00	1.01	1.01	1.01
A9	0.99	1.02	0.85	0.98	0.98	1.01	0.92	1.02	0.00	0.91	0.97	1.00	1.08	0.99	1.02	1.09	1.02	1.00	0.99
A10	0.96	1.02	0.97	1.02	1.01	0.96	0.97	1.01	0.91	0.00	0.81	1.05	0.97	0.95	0.84	1.01	0.93	0.86	1.01
A11	1.02	1.04	0.96	1.06	1.02	1.02	1.01	1.01	0.97	0.81	0.00	1.11	0.92	0.92	0.89	1.09	0.97	0.83	0.99
A12	1.13	1.09	1.09	1.17	1.03	1.11	1.03	1.04	1.00	1.05	1.11	0.00	1.23	1.05	1.14	1.25	1.16	1.09	1.09
A13	1.06	1.07	1.04	1.10	1.03	1.05	1.96	1.02	1.08	0.97	0.92	1.23	0.00	1.02	1.04	1.17	1.01	1.02	1.03
A14	0.99	1.03	0.96	1.04	1.01	1.02	1.00	1.01	0.99	0.95	0.92	1.05	1.02	0.00	0.93	1.04	0.91	0.97	1.01
A15	1.01	1.02	0.98	1.04	1.02	1.04	1.03	1.01	1.02	0.84	0.89	1.14	1.04	0.93	0.00	1.07	0.86	0.94	0.89
A16	1.05	1.05	1.09	1.05	0.93	1.07	1.12	1.00	1.09	1.01	1.09	1.25	1.17	1.04	1.07	0.00	1.04	1.04	1.06
A17	1.03	1.04	0.95	1.06	1.02	1.02	1.01	1.01	1.02	0.93	0.97	1.16	1.01	0.91	0.86	1.04	0.00	0.99	0.99
A18	0.95	1.02	1.00	1.03	1.01	1.02	1.02	1.01	1.00	0.86	0.83	1.09	1.02	0.97	0.94	1.04	0.99	0.00	1.01
A19	0.97	0.99	1.02	1.00	1.01	1.02	1.02	1.01	0.99	1.01	0.99	1.09	1.03	1.01	0.89	1.06	0.99	1.01	0.00

Table 1. Results of the Pearson's pairwise.

Within the Hispaniola Province, we distinguished two subprovinces: the Central Subprovince and the Caribbean-Atlantic Subprovince, based on differences in their geological origins and bioclimatic, floristic, and vegetational profiles. Key elements from our previous work that supports this differentiation include: 1) the siliceous Central Subprovince, which includes only one sector containing one single area (A16). The Central subprovince (A16) includes only the central sector (1.1) Fig. 12; (Fig.9); and 2) the calcareous Caribbean-Atlantic Subprovince, with the following 5 biogeographical sectors 2.1.-Bahoruco-Hottense (A12, A13); 2.2.- Neiba-Matheux-Northwest (A14, A15, A17 and A19); 2.3.-Azua- San Juan-.Hoya Enriquillo-Port-au-Prince-Artiobonite-Gonaivès (A9, A10, A11 and A18); 2.4.-Caribeo-Cibense (A3, A7 and A8); and 2.5.-North (A1, A2, A4, A5 and A6), which comprises the other 18 areas (Fig. 11 and 12).

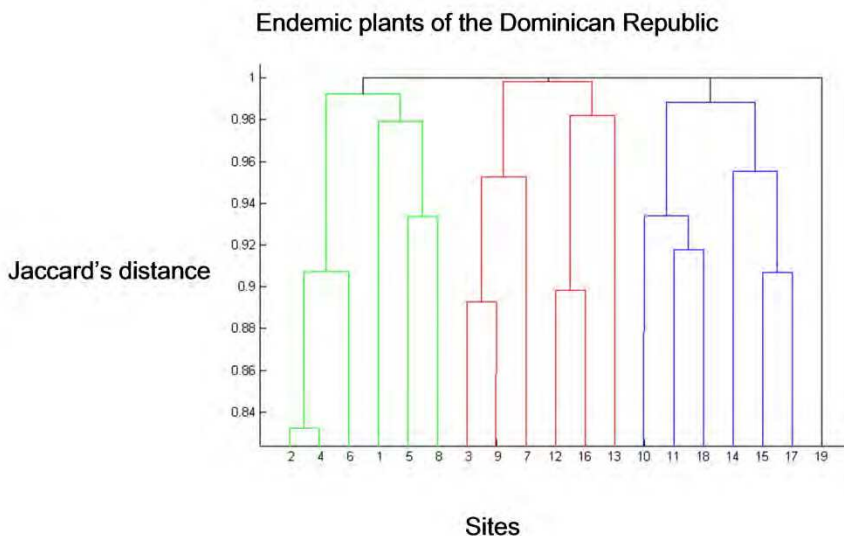


Fig. 10. Cluster analysis of the Jaccard's dissimilarity distances between study areas.
1.- Green group in northern areas with calcareous substrates domain and serpentines.
2.- The red areas are grouped with south central siliceous substrates and dry areas.
3.- Blue are grouped in areas of highly altered Republic of Haiti.
(Jaccard's analysis)

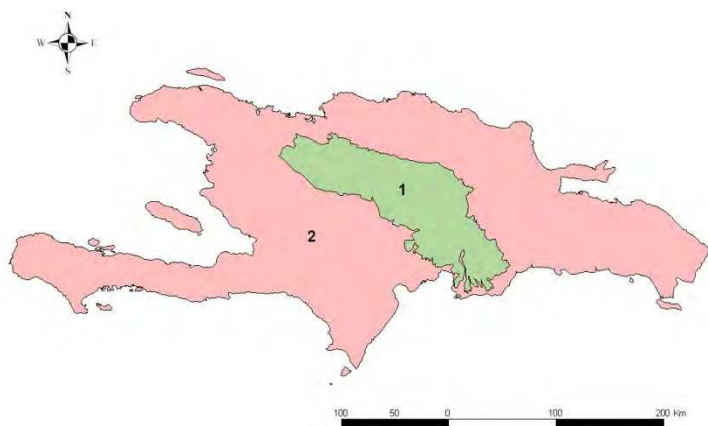


Fig. 11. Map of the biogeographical subprovinces of Hispaniola. from Cano et al. (2009a). 1.- Central (A16); 2.- Caribbean-Atlantic.

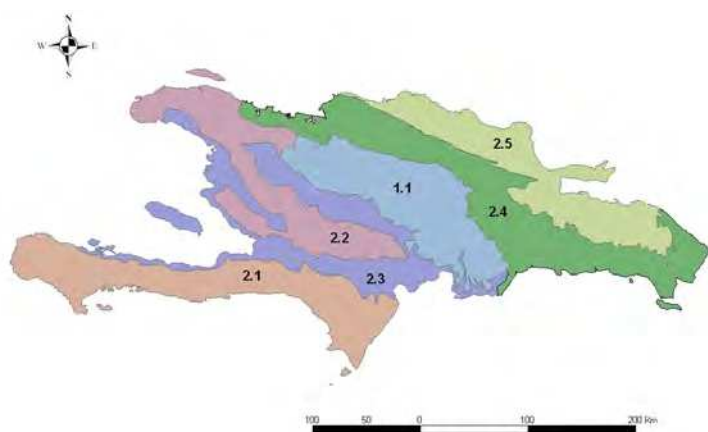


Fig. 12. Map of the biogeographical sectors of Hispaniola. 1.1.- Central (A16). 2.1 - Bahoruco-Hottense, 2.2.- Neiba-Matheux-Northwest, 2.3.-Azua - San Juan- Hoya Enriquillo-Port-au Prince-Artiobonite-Gonaivès, 2.4.-Caribeo-Cibense, 2.5.-North. Redrawn from Cano et al. (2009a).

5. Conclusions

5.1 Floristic biogeography

Hispaniola had been previously considered as a single biogeographical sector (Rivas-Martínez et al., 1999) and included in the province of Antilles. However, we recommend promoting Hispaniola to the rank of a biogeographical province (Cano et al., 2009a) and contend that the province of Antilles should be promoted to a superprovince, namely that of Central-Eastern Antilles, with the inclusion of the islands of Jamaica and Hispaniola. Hispaniola, together with a group of some small nearby islands -Beata, Saona, Gonave and Tortuga- make up the Hispaniola Province. Our biogeographical proposal for the Hispaniola Province encompasses 5 biogeographical sectors and 19 areas within the two countries of the Dominican Republic and the Republic of Haiti. We distinguish the following biogeographic hierarchy: The Caribbean-Mesoamerican Region. Central-Eastern Antilles Superprovince. Hispaniola Province. 1.- Central Subprovince. 1.1.- Central Sector. A16.- Central-Eastern Area. 2.- Caribbean-Atlantic Subprovince. 2.1.- Bahoruco-Hottense Sector. A12.- Bahoruco-La Selle Area. A13.- Hottense Area. 2.2.- Neiba-Matheux-Northwest Sector. A14.- Neiba-Matheux Area. A15.- Northwest Area. A17.- Centre-West Area. A19.- Tortuga Island Area. 2.3.- Azua-Sán Juan-Hoya Enriquillo-Port-au-Prince-Artiobonite-Gonaivès Sector. A9.- Azua-Sán Juan-Hoya Henriquillo Area. A10.- Central Plain Area. A11.- Port-au-Prince-Arbiobonite-Gonaivès Area. A18.- Gonave Island Area. 2.4.- Caribeo-Cibense Sector. A3.- Cibao Valley Area. A7.- Caribeo-Eastern Area. A8.- Yamasense Area. 2.5.-North. A1.- Cordillera Septentrional Area. A2.- Atlantic Coastal Area. A4.- Samanense Area. A5.- Eastern Area. A6.- Haitiense Area.

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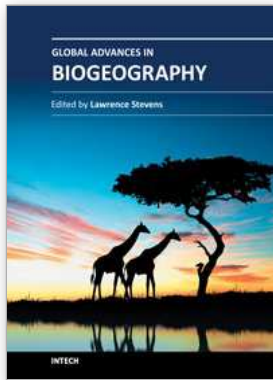
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