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Considerations on the ecology of Rubiaceae in Martinique (Lesser Antilles)

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ABSTRACT

The Rubiaceae family is an essential component of the flora of the Lesser Antilles archipelago located in the Caribbean. There are 129 species of Rubiaceae divided into 54 genera, including 20 endemic species. Martinique, a mountainous island occupying a central position in the archipelago, is home to 89 species of the family divided into 41 genera, including 2 endemic species. More than twenty species are grown or used as decorations, but the diversity of Rubiaceae found naturally in natural vegetation is significant, in terms of the number of species, genera or physiognomic types. As part of a doctoral thesis carried out in Martinique between 2015 and 2020, our knowledge about the ecology of this family has been enriched. In total, 120 floristic inventories were carried out in various natural plant formations. These data have undergone multivariate statistical processing, in particular using EXCEL and XLSTAT software. In total, 27 Rubiaceae species divided into 18 genera were observed (trees, shrubs, herbs, vines and epiphytes). Although the diversity and abundance of Rubiaceae vary according to the bioclimatic and therefore altitudinal gradient of the island, they are nevertheless rarely part of the dominant species assemblages. Due to the new climatic constraints of the 21st century, the current chorology of these species will evolve.

Key words: *Lesser Antilles, Martinique, Rubiaceae, Ecology, Global warming.*

Introduction

The "Neotropical" zone including the insular Caribbean is defined as one of the most important "hot spots" in the world for the Rubiaceae family (Davis, *et al*., 2009; Delprete, 2012). Taking into account all physiognomic types, the flora of the Lesser Antilles is composed of about 3200 plant species (Joseph, 2011). Among these species, according to the different flora published for the archipelago, more than a hundred belong to the Rubiaceae family (Fournet, 1978; Howard, 1989). The flora of the french botanist Jacques Fournet, indicates that the Rubiaceae form the fifth largest family of plant species in the Lesser Antilles after the Poaceae (216 species), the Fabaceae (180 species), the Asteraceae and the Orchidaceae (164 species), (Rubiaceae: 116 species), (Fournet, 1978). We consider that about 129 species of the family would have been identified in the archipelago, including 89 species in Martinique, by combining

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the censuses of the american botanist Richard Alden Howard and the french botanist Jacques Fournet (Table 1), (Fournet, 1978; Howard, 1989).

For the Lesser Antilles, there are approximately 22 trees, 52 shrubs, 19 bushes, 3 epiphytes, 3 vines, 26 herbaceous plants and some species without physiognomic features; while for Martinique, there are approximately 19 trees, 38 shrubs, 11 bushes, 3 epiphytes, 2 vines, 14 herbaceous plants and some species also without physiognomic features (Figure 1), (Fournet, 1978; Howard, 1989). The majority of the genera of the family are monospecific (Table 1) and more than twenty species are grown or used as decorations in public or private gardens (Fournet, 1978; Howard, 1989). The Rubiaceae found naturally in natural vegetation are, however, very numerous and occupy a wide range of habitats in the Lesser Antilles and Martinique. Several authors have stated that Rubiaceae occur in different bioclimates (from dry to humid), in various plant formations and at different stages of evolution (Fournet, 1978; Howard, 1989; Joseph, 1997, 2007, 2009, 2012, 2020; Rollet *et al*., 2010).

Some authors have stated that in tropical regions, Rubiaceae are highly sensitive to environmental disturbances and are rarely present in secondary forests (Davis, *et al.*, 2006; Davis, *et al*., 2009). However, these species are very often observed and identified in secondary forests in Martinique (Claude, *et al.*, 2017; Claude, 2020; Joseph, 2009; Joseph, *et al*., 2015;

Table 1. Total number of Rubiaceae identified in the Lesser Antilles and Martinique according to Howard (1989) and Fournet (1978)

Rubiaceae identified in the Leser Antilles				Rubiaceae identified in Martinique			
Genera	Number of species	Genera	Number of species	Genera	Number of species	Genera	Number of species
Alibertia	1	*Macrocnemum*	1	*Alibertia*	1	*Leptactina*	1
Antirhea	3	*Malanea*	1	*Antirhea*	1	*Machaonia*	1
Catesbaea	1	*Manettia*	1	*Chimorrhis*	1	*Manettia*	1
Chimarrhis	1	*Mitracarpus*	2	*Chiococca*	1	*Mitracarpus*	1
Chiococca	2	*Morinda*	1	*Chione*	1	*Morinda*	1
Chomelia	1	*Neolamorckia*	1	*Coutarea*	1	*Neolamarckia*	1
Coffea	3	*Neolaugeria*	1	*Diodia*	3	*Neolaugeria*	1
Coutarea	1	*Oxyanthus*	1	*Erithalis*	3	*Palicourea*	2
Diodia	3	*Policourea*	3	*Exostema*	2	*Pentas*	1
Erithalis	3	*Pentas*	1	*Faramea*	1	*Portlandia*	1
Ernodea	1	*Pentodon*	1	*Gardenia*	2	*Pasoqueria*	2
Exostema	2	*Portlandia*	1	*Genipa*	1	*Psychotria*	13
Faramea	1	*Posoqueria*	2	*Geophila*	1	*Randia*	4
Gardenia	2	*Psychotria*	16	*Gonzalagunia*	1	*Randeletia*	3
Genipa	1	*Randia*	4	*Guettarda*	3	*Radgea*	1
Geophila	1	*Relbunium*	1	*Hemelia*	2	*Schradera*	1
Gonzalagunia	1	*Rondeletia*	6	*Hedyotis*	2	*Spermacoce*	6
Guettarda	3	*Rudgea*	3	*Hillia*	1	*Thogsennia*	1
Hamelia	2	*Sabicea*	1	*Hoffmannia*	1	*Vangueria*	1
Hedyatis	3	*Schradera*	1	*txora*	12		
Hillia	1	*Serissa*	1				
Hoffmannia	2	*Sipanea*	1				
Isertia	1	*Spermacoce*	13				
Ixora	12	*Strumpfia*	1				
Leptactina	1	*Thogsennia*	1				
Machaonia	1	*Vangueria*	1				

	Lesser Autilles		Martinique		Endemism	
Total	Number of Genera	Number of Species	Number of Genera	Number of Species	Number in the Lesser Antilles	Number of in Martinique
	54	129	41	89	20	2

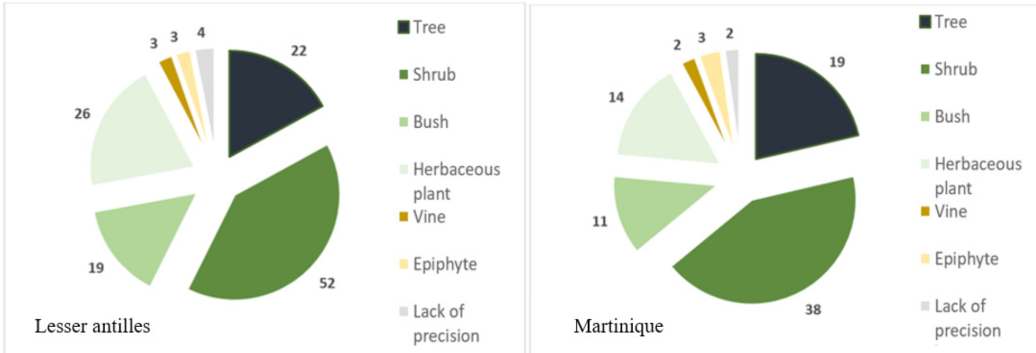


Fig. 1. Physiognomic types of Rubiaceae in the Lesser Antilles and Martinique, according to Howard (1989) and Fournet (1978).

Joseph, *et al.*, 2016; Joseph, *et al*., 2018; Joseph, *et al.*, 2020). Some ecological data about Rubiaceae therefore had to be verified or supplemented. In order to strengthen our knowledge of this family, we conducted our study in Martinique. We wanted to determine, what is the importance of the family in natural vegetation? What are the ecological profiles and temperaments of these species? What places do Rubiaceae occupy in the different successional stages of plant formations? Finally, what impact will the new climatic constraints of the 21st century have on their distribution and abundance? A hundred floristic inventories were thus carried out in various natural plant communities and multivariate statistical processing (HAC, FCA, PCA) made it possible to characterise and differentiate these phytocenoses. Then, using ecological indices and graphical or statistical representations, we attempted to define the ecology of Rubiaceae, their chorologies and their biodemographic importance, thus updating or supplementing existing data (Fournet, 1978; Howard, 1989; Joseph, 1997, 2009; Rollet *et al*., 2010).

Materials and Methods

Materials

The Lesser Antilles archipelago located in the Caribbean, resulting from intra-oceanic subduction between the North American plate and the Caribbean plate (Bouysse, 1984; Germa, 2008), consists of more than twenty islands stretching from north to south, from the US Virgin Islands to Trinidad and Tobago. The mountainous and volcanic island of Martinique occupies a central position (Figure 2). The highly contrasting topography of this island (chaotic and mountainous), the bioclimatic layering and the layering of plant formations linked to the altitudinal gradient of precipitation (Figures 3 and 4), the remarkable diversity of soil types or the effects of successive human societies are the source of numerous biotopes and the existence of a large number of life

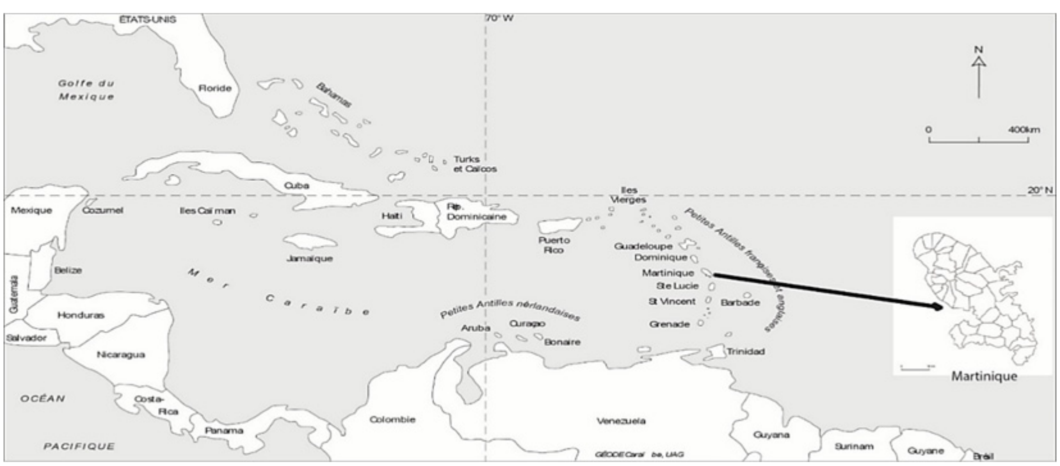


Fig. 2. Location of Martinique in the Lesser Antilles archipelago, Caribbean (Claude *et al.*, 2017).

forms (Joseph, 1997, 2009, 2012). In his work, Professor Philippe JOSEPH (Joseph, 1997, 2009, 2012), has also characterised the altitudinal layering of Martinique's bioclimates and the associated plant formations (Figure 4).

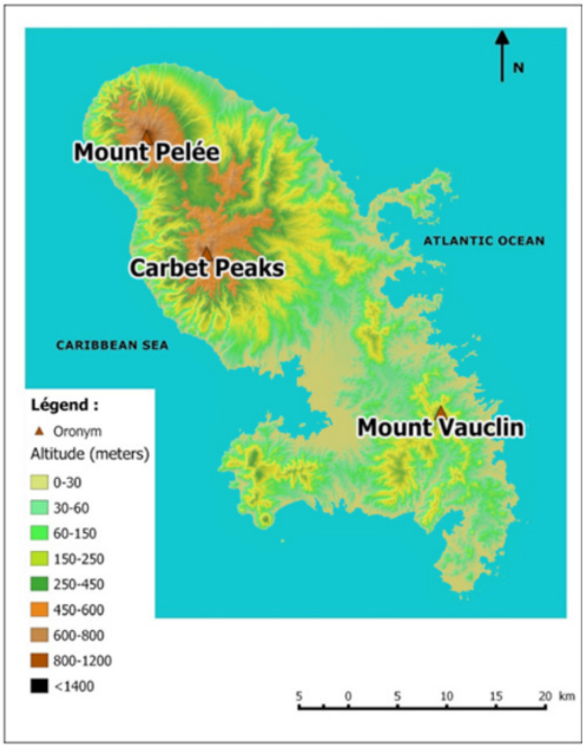


Fig. 3. Hypsometric map of Martinique (Claude, *et al.*, 2017), (Source: IGN and IRD).

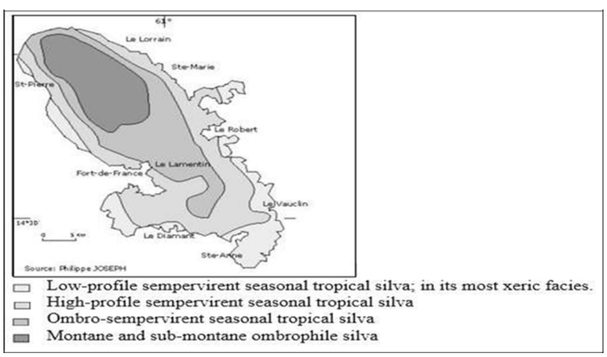


Fig. 4. Layering of the natural vegetation of Martinique (Source: JOSEPH, P., 2006).

There is a general distinction in ascending order: from 0 to 250 metres altitude, a dry sub-humid bioclimate with average annual precipitation of less than 1500 mm, which conditions the seasonal tropical evergreen forest of lower horizon and xeric facies (formerly xerophytic forest); from 250 to 500 metres, a humid sub-humid bioclimate with annual rainfall of between 1500 and 2500 mm, which influences the typical seasonal tropical evergreen forest (formerly mesophytic forest). Then from 500 metres to the highest peaks, a humid and hyper-humid bioclimate with precipitation ranging from 2500 to over 4000 mm. These last two bioclimatic stages are colonised respectively by tropical sub- montane rainforest (formerly hygrophilous forest) and tropical montane rainforest (formerly upper horizon of the hygrophilous forest), (Joseph, 1997, 2009, 2012).

Martinique is thus one of the components of one of the 24 global biodiversity hotspots, particularly for Rubiaceae: that of the Caribbean (Davis, *et al.*, 2009; Delprete, 2012; Joseph, 2009, 2011; Myers, *et al.*, 2000). The importance of the Rubiaceae family for ecological studies in tropical regions has already been demonstrated (Delprete, *et al.,* 2012). This family would effectively make it possible to highlight and compare the floristic compositions, dynamic stages and ecological profiles of tropical forests (Delprete, *et al.,* 2012). In Martinique, the Rubiaceae family is characterised by a great diversity of species but only two species are endemic: *Palicourea martinicensis* and *Rondeletia martinicensis* (Fournet, 1978; Howard, 1989). All life forms are nevertheless represented: trees, shrubs, bushes, herbaceous plants, vines and epiphytes (Fournet, 1978; Howard, 1989). The main botanical identification keys to easily recognise the representatives of this family are presented in Table 2. The chemical composition of these species is also remarkable. They have multiple properties and uses in the Lesser Antilles, while in the world they are used in the production of many medications, which places them in the field of useful plants (Germosén, 2007; Germosén, 2014; Lémus, *et al*., 2015; Martins, *et al.,* 2015; Claude, 2020).

Rubiaceae can be found in various habitat types ranging from coastlines to high peaks, from cliffs to sandy, rocky, swampy areas and even near rivers (Claude, *et al.,* 2017; Claude, 2020; Fournet, 1978; Howard, 1989; Joseph, 1997, 2009; Joseph, *et al.*, 2020; Rollet *et al.,* 2010). These species participate in several stages of plant succession and belong to the lower and middle strata of our tropical forests (forest undergrowth), very rarely to the upper strata (Joseph, 2009). Their ecological temperaments are most often: primary heliophilous, secondary heliophilous, sylvatic gap heliophilous or sciaphilous (Joseph, 2009). Moreover, the two main vectors of dissemination of their fruits are barochory and especially

Table 2. Main botanical characteristics of Rubiaceae, (Claude *et al.*, 2017).

Leaves	Simple, entire, opposite, opposite decussate, sometimes whorled (3 to 6 leaves per node) or pseudo-whorled. Undivided leaf blades and leaf margin always entire.
Stipules	Presence of interpetiolar or intrapetiolar stipules.
Flowers	Actinomorphic and rarely zygomorphic. Gamopetalous corolla. The number of stamens is often as many as the number of corolla lobes.
Fruits	Capsules, berries, drupes or schizocarps..

zoochory (Joseph, 2009). Indeed, the Rubiaceae form one of the main tropical plant families, providing most of the food resources for many zoocenoses (Bremer, *et al.,* 1992; Govaerts, *et al*., 2015; Leighton, M., 1983).

Methods

In order to decipher the ecology of Rubiaceae occurring naturally in natural vegetation in Martinique, the methodology applied is that which was developed by Professor Philippe JOSEPH in his work, which is based on macroecology (Blackburn, 2004; Claude, 2020; Joseph, 1997, 2009, 2011, 2012; Joseph, *et al*., 2016; Joseph, *et al*., 2020; Rangel, *et al*., 2010).

This methodology makes it possible to decipher the structural, architectural and functional dimensions of the surveyed phytocenoses, to highlight the diversity of the plant species that compose them and the types of associations they form, and to identify the dominant species assemblages (Joseph, 1997, 2009, 2012; Joseph, *et al.,* 2016; Joseph, *et al*., 2020). With the help of members of the UMR SPACE DEV – BIORECA laboratory of the University of the West Indies, 120 floristic inventories were carried out, thus representing the main means of data collection (Annex 1 and 2). These surveys were carried out at stations corresponding to different plant formations, at different stages of evolution and in different bioclimates (Figure 5).

The stations to be inventoried were chosen, taking into account sectors constituting homogeneous surfaces in terms of mesological conditions (topography, soil, climatic conditions, etc.) and in terms of the plant formation studied (physiognomy, structure and composition) (Claude, 2020; Joseph, 2009).

The overlay of an environmental data set in the GIS (Geographic Information System) software QGIS version 3.10 and the location of the main plant

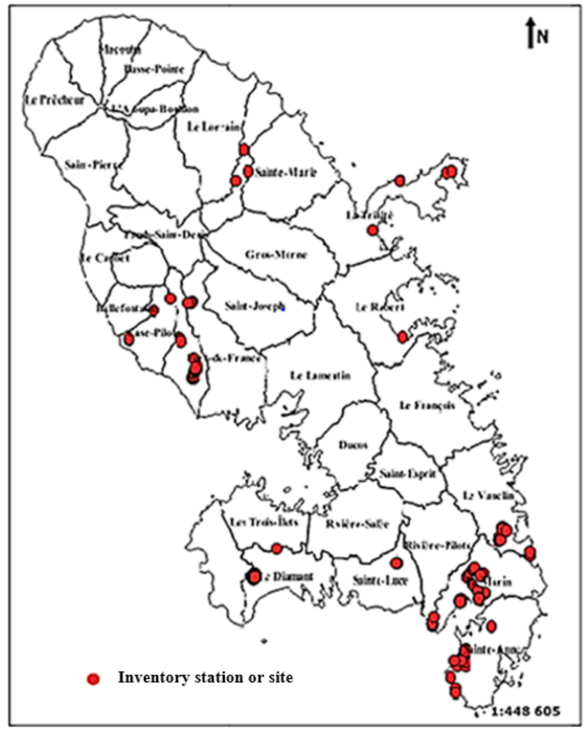


Fig. 5. Station locations.

formations in the literature facilitated our choices (Joseph, 2009, 2011, 2012). Each inventory consisted of a transect subdivided into quadrats (Figure 6). The transect surfaces (or minimum areas) varied according to the plant communities studied. Forest formations in the Lesser Antilles range on average from 200 metres² to more than 1000 metres², generally from a dry to humid bioclimate, due to a higher floristic richness in the forest formations in more humid bioclimates (Fiard, J., 1994; Joseph, 1997, 2009).

For each inventory we found several ecological and floristic descriptors, namely: the name of the species identified, the number of individuals per species (from regenerations to mature specimens), their diameters (sections measured at 1.33 m from the ground in accordance with international standards), their total height. For epiphytic and herbaceous Rubiaceae, we have simply indicated their presence and abundance (+ very low, ++ low, +++ medium, ++++ high, +++++ very high abundance), (Claude, 2020). To then process the inventories, they were entered into Excel software and several ecological indices or indicators were applied (Claude, 2020). However, the species richness (number of species but also genera) and the abundance of spe-

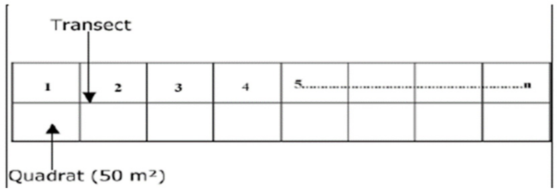


Fig. 6. Transect illustration (Joseph, *et al.*, 2015).

cies populations (number of individuals per species) were first counted and then expressed in absolute numbers and percentages (Claude, 2020; Faurie, *et al*., 2011; Marcon, 2015; Ramade, 2009).

Then, the indices that we applied come from the work of Philippe JOSEPH and allowed us to study the dominance relationships between species. These are frequency (presence of the species in the different quadrats), density (corresponding to the distribution of species populations in the station), distribution index (expressing the biodemographic importance and distribution of each species), basal area (expressing the phytomass or biovolume of each species and corresponding to the diameters of their individuals) and the dominance index (corresponding to the distribution index multiplied by the basal area, expressing the ability of the species to adapt and expand), (Joseph, 1997, 2009). Since Rubiaceae are ubiquitous and can be found in several types of habitat, we relied on Professor Philippe JOSEPH's qualitative representation model (Joseph, 2009). Using simple tables, it is indeed possible to better show the chorology, temperament and ecological profile as well as the biodemographic importance of each species (Claude, 2020; Joseph, 2009). However, we also used charts or maps to show the spatial distribution of species of the Rubiaceae family in Martinique.

Multivariate statistical processing was also carried out using the XLSTAT software, taking into account all the inventories carried out in order to highlight the heterogeneity of our stations. In this way, the validity of our sample as being representative of the plant mosaic which is observable today on the island is attested because different phytocenoses have been taken into account. A hierarchical ascending classification (HAC), principal component analysis (PCA) and a factorial correspondence analysis (FCA) were therefore carried out (Claude, 2020; Doré, *et al*., 2001; Ramade, 2009; Thorson, *et al*., 2015). Finally, we referred to the hypotheses formulated by Professor Philippe JOSEPH in his work, addressing the plausible ecosystem responses of Lesser Antillean forest ecosystems to the new climatic constraints of this century (Joseph, 2011, 2015) in order to formulate our hypothesis on the impact of global warming on the future chorology, diversity and abundance of Rubiaceae in Martinique (Claude, 2020).

Results and Discussion

Results

Spatial distribution and biodemographic importance of the Rubiaceae family in Martinique

At the end of our floristic inventory campaign, carried out from 2015 to 2020 on the island of Martinique (1128km^2), we counted 120 stations (or inventories) representing an area of 80985 metres^2, i.e. 8.1 hectares (Table 3, Annex 1). Approximately 75526 specimens were identified (excluding dead trees, regenerations and herbaceous plants), divided into 297 species, 191 genera and 71 families (Annex 2). The minimum areas of the transects vary from 240 to over 1000 metres 2 (Table 3). Various phytocenoses, at different stages of evolution and from several bioclimates, mainly from the lower and middle plant stages, were inventoried (Table 3, Annex 1), (Claude, 2020).

Species of the Rubiaceae family

Using the data obtained, we observe that the species richness (or number of species) of Rubiaceae, whatever the physiognomic type, increases from the coast to the high peaks, following the rainfall and altitudinal gradient of the island (Figure 7). Rubiaceae can represent up to 24% of the total number of species identified in the stations, all physiognomic types included. On the other hand, if only woody species are taken into account (excluding herbaceous plants and epiphytes), Rubiaceae can represent 14 to 20% of the total number of species identified, regardless of the type of plant cover considered. These species are much more numerous in absolute numbers (4-9 species) in typical tropical seasonal evergreen forests (mesophilous), tropical seasonal evergreen rainforests (mesohygrophilous) and tropical sub-montane rainforests (hygrophilous) (Figure 7). The stations with the fewest Rubiaceae species are therefore those made up of plant formations close to the coast and in the dry bioclimate (Claude, 2020).

Table 3. Summary table of the floristic inventories carried out (Annex 1).

	Lower plant level						Medium plant level			
	Mangrove	Back-mangrove	Backshore	F.S.S.T.F.X	F.T.X.M	F.S.S.T.T.	F.S.S.T.T.	F.O.S.S.T	F.O.S.M.T	Total
Number of inventories	5	9	11	55	10	17	1	5	7	120
Total area (m^{-2})	3150	10790	6065	31110	6610	12560	500	3950	6250	80985
Minimum inventory area (m^{-2})	400 to 950	420 to 2200	240 to 800	350 to 1000	500 to 1000	450 to 1000	500	600 to 1000	700 to 1050	240 to 2200
Number of inventories per commune in Martinique	(3) Trinite (1) Robert (1) Sainte-Anne	(9) Marin	(2) Trinite (2) Vauclin (3) Marin (4) Sainte-Anne	(2) Case Pilote, (3) Schoelcher, (12) Vauclin, (10) Diamant, (14) Marin, (14) Sainte-Anne	(2) Schoelcher (3) Diamant (5) Marin	(9) Schoelcher (3) Marin, (5) Vauclin	(1) Diamant	(1) Sainte-Marie, (2) Case Pilote, (3) Sainte-Luce. (1) Marin	(3) Sainte-Marine, (1) Case-Pilote, (3) Font-de-France	Missing area: the far north of the island
Inventory team	Numbers of the UMR S pace Dev – BIORECA laboratory									

F.S.S.T.F.X: Tropical seasonal evergreen and xeric facies plant formations (xerophilous), **F.T.X.M:** Transitional xero-mesophilous plant formations (tropical seasonal evergreen), **F.S.S.T.T:** Typical tropical seasonal evergreen plant formations (mesophilous), **F.O.S.S.T:** Tropical seasonal ombro-evergreen plant formations (mesohygrophilous), **F.O.S.M.T:** Tropical sub-montane rainforest plant formations (hygrophilous).

Genera of the Rubiaceae family

The number of genera, regardless of physiognomic type, also increases from the coast to the high peaks (Figure 8). Rubiaceae genera can represent up to 22% of the total number of genera identified in the stations, all physiognomic types combined. They are much more numerous in absolute numbers (6 to 7 genera) in typical tropical seasonal evergreen forests (mesophilic forests), tropical seasonal rainforests (meso-hygrophilous forests) and tropical sub-montane ombrophilous forests (hygrophilous forests). The stations with the fewest Rubiaceae genera are again those made up of plant formations close to the coast and in the dry bioclimate (Figure 8), (Claude, 2020).

Population abundances of woody Rubiaceae

Woody Rubiaceae (excluding herbaceous plants and epiphytes) can account for up to 35% of the total number of woody individuals (up to 400 individuals) identified in tropical seasonal evergreen and xeric facies forests (xerophytic forests), despite fewer species and genera. Woody Rubiaceae remain as abundant in terms of individuals in the more humid tropical forests (about 150 individuals) but they only represent 10 to almost 20% of the total. In other words, from the coast to the high peaks of the island, if the diversity of genera and species in the Rubiaceae family increases, by contrast, the number of individuals per species decreases along this alti-

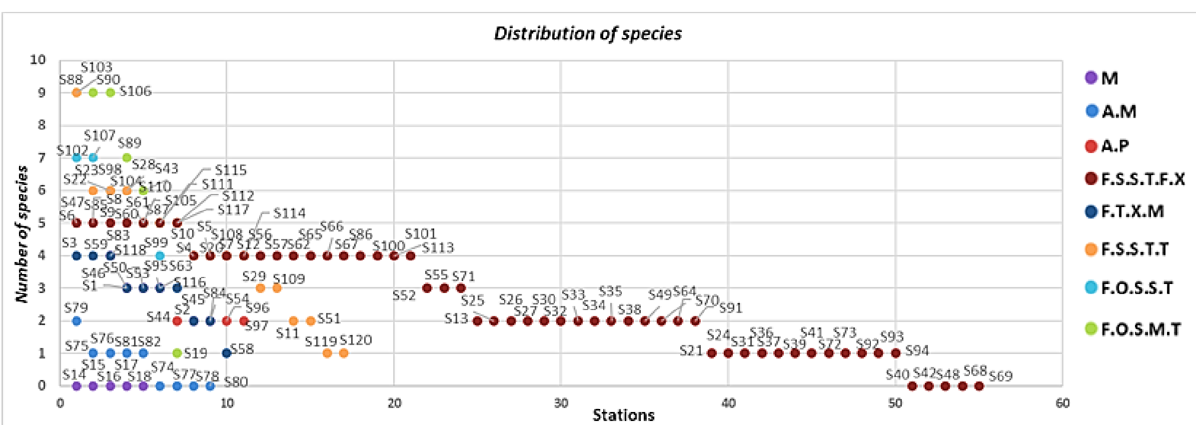


Fig. 7. Species richness of Rubiaceae by station and vegetation type (all physiognomic types included), (Annex 1).

M: Mangroves, **A.M:** Back-mangrove floristic units, **A.P:** Backshore floristic units, **F.S.S.T.F.X:** Tropical seasonal evergreen and xeric facies plant formations (xerophilous), **F.T.X.M:** Transitional xero-mesophilous plant formations (tropical seasonal evergreen), **F.S.S.T.T:** Typical tropical seasonal evergreen plant formations (mesophilous), **F.O.S.S.T:** Tropical seasonal ombro-evergreen plant formations (mesohygrophilous), **F.O.S.M.T:** Tropical sub-montane rainforest plant formations (hygrophilous).

tudinal gradient (Figure 9), (Claude, 2020).

Physiognomic types of Rubiaceae

We have also observed that Rubiaceae mostly have a shrubby physiognomic potential, regardless of the plant formation considered (Figure 10). However, trees, shrubs, epiphytes and herbaceous plants can nevertheless be found, especially among the Rubiaceae in more humid bioclimates (Figure 10). The physiognomic diversity of Rubiaceae therefore also seems to increase from the coast to the high peaks (Claude, 2020).

In summary, Rubiaceae are ubiquitous in Martinique because they occupy several types of natural habitat. Their diversity, in terms of number of species, genera and physiognomic types, increases mainly according to the bioclimatic gradient defined by precipitation. The species richness of Rubiaceae is higher in the more humid bioclimates but their population abundances are higher in the dry bioclimate, as shown in Figure 11 which we have developed. Thus precipitation is the most important factor affecting their spatial distribution and diversity.

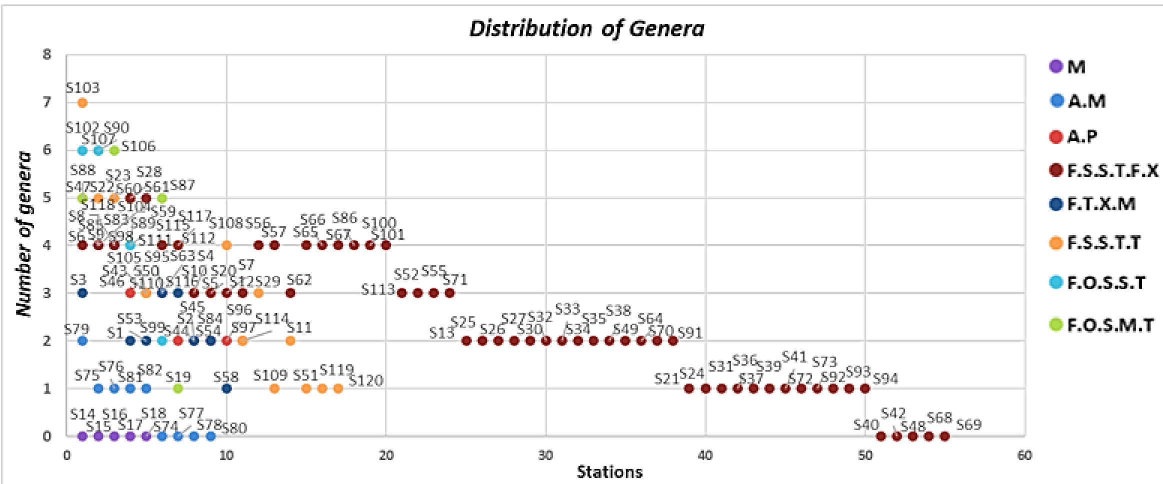
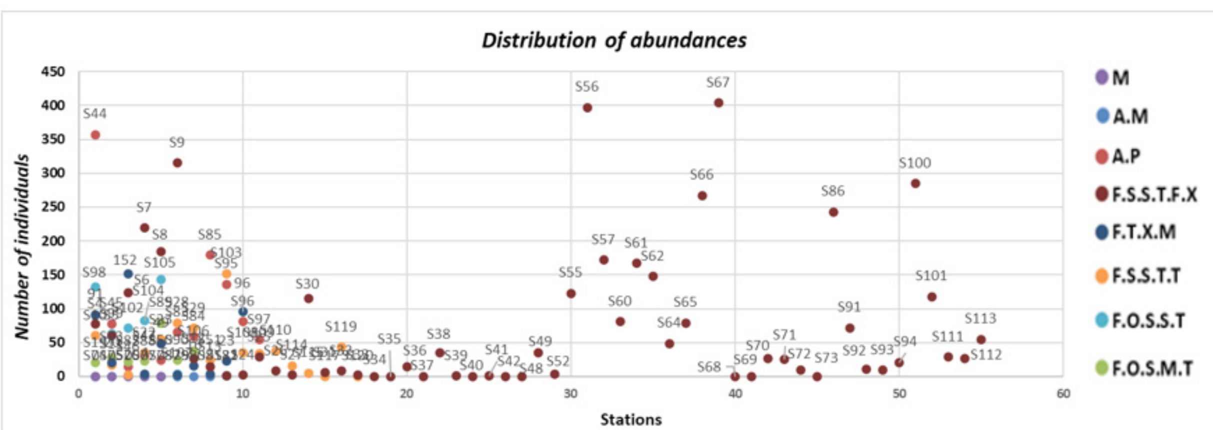


Fig. 8. Richness of Rubiaceae genera by station and vegetation type (all physiognomic types included), (Annex 1).

M: Mangroves, **A.M:** Back-mangrove floristic units, **A.P:** Backshore floristic units, **F.S.S.T.F.X:** Tropical seasonal evergreen and xeric facies plant formations (xerophilous), **F.T.X.M:** Transitional xero-mesophilous plant formations (tropical seasonal evergreen), **F.S.S.T.T:** Typical tropical seasonal evergreen plant formations (mesophilous), **F.O.S.S.T:** Tropical seasonal ombro-evergreen plant formations (mesohygrophilous), **F.O.S.M.T:** Tropical sub-montane rainforest plant formations (hygrophilous).



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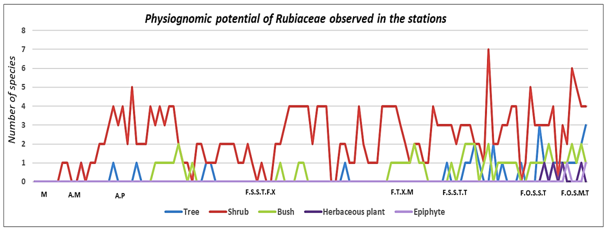

Fig. 10. Physiognomic potential of the Rubiaceae identified (maximum morphogenetic development that can be achieved by these species).

M: Mangroves, **A.M:** Back-mangrove floristic units, **A.P:** Backshore floristic units, **F.S.S.T.F.X:** Tropical seasonal evergreen and xeric facies plant formations (xerophilous), **F.T.X.M:** Transitional xero-mesophilous plant formations (tropical seasonal evergreen), **F.S.S.T.T:** Typical tropical seasonal evergreen plant formations (mesophilous), **F.O.S.S.T:** Tropical seasonal ombro-evergreen plant formations (mesohygrophilous), **F.O.S.M.T:** Tropical sub-montane rainforest plant formations (hygrophilous).

Ecological dominance of Rubiaceae

If we take into account the dominance index (DI) developed by Professor Philippe JOSEPH (Joseph, 1997 and Joseph, 2009), we find that, regardless of the type of plant cover, Rubiaceae make up the dominant species assemblages only in rare cases. Indeed, this index makes it possible to identify the dominant species by taking into account several parameters: the number of individuals (population abundance), the distribution and the basal area. However, differences are observed in various phytocenoses when separately considering the number of individuals, the distribution index (DI) and the basal area (phytomass index), (Figure 12), (Claude, 2020). Thus, in 31 stations out of 120, we can find among the dominant species by the number of individuals or only by the distribution index (DI) developed by Professor Philippe JOSEPH: *Chiococca alba*, *Coffea liberica*, *Erithalis fruticosa*, *Guettarda odorata*, *Guettarda scabra*, *Morinda citrifolia*, *Palicourea crocea*, *Psychotria microdon*, *Psychotria nervosa*, *Randia aculeata* (Figure 12).

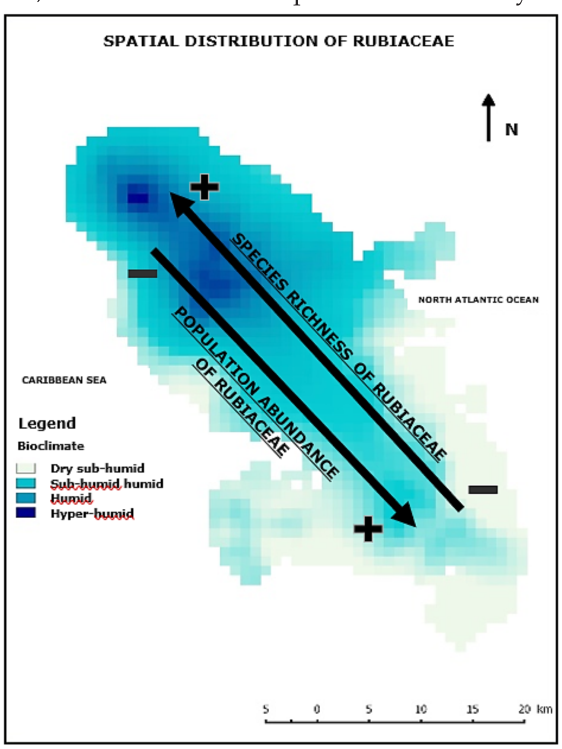

Fig. 11. Spatial distribution of Rubiaceae today (Claude, 2020).

In 12 stations, we can find among the dominant species this time only by the importance of the basal area (phytomass index): Chimarrhis cymosa, Erithalis fruticosa, Guettarda odorata, Guettarda scabra et Randia aculeata (Figure 12).

Ecology of the 27 Rubiaceae species identified in Martinique

Despite an intensive campaign of floristic inventories, only 27 species of the Rubiaceae family divided into 18 genera, growing naturally in natural vegetation (excluding cultivated and ornamental species), have been identified and described (Tables 4, 5 and 6). Their temperament, ecological profile and ecosystem affinity are established following the qualitative representation model of Professor Philippe JOSEPH (Joseph, 2009). Taking into account the professor's data, we tried to characterise the different types of ecological temperaments of Rubiaceae species: primary or secondary heliophilic, sylvatic gap heliophilic and hemisciaphilic (Table 4), (Joseph, 1997, 2009).

These species generally belong to the lower strata of our forests, although some may be part of the canopies such as: *Chimarrhis cymosa*, *Guettarda scabra* et *Morinda citrifolia* (Table 4). Rubiaceae are present and abundant in the extra-sylvatic and intra-sylvatic (early) stages of the island's plant dynamics (Joseph, 1997, 2009). They are also particularly abundant in secondary forests (Table 5). Their ecological dominance is nevertheless in the majority of cases extremely low, regardless of the environment considered (Table 6), (Claude, 2020). With the exception of *Chiococca alba* (lianoid shrub) which is extremely abundant in various phytocenoses, we could only note the presence of *Psychotria discolor* (herbaceous

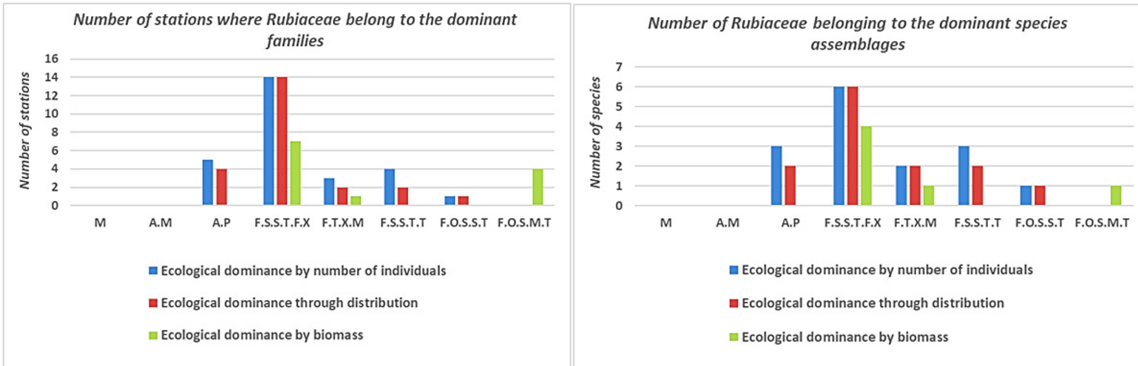

Fig. 12. Membership of Rubiaceae species in dominant woody species assemblages (ecological dominance (DI) by number of individuals, by distribution (DI) and by biomass).

M: Mangroves, **A.M:** Back-mangrove floristic units, **A.P:** Backshore floristic units, **F.S.S.T.F.X:** Tropical seasonal evergreen and xeric facies plant formations (xerophilous), **F.T.X.M:** Transitional xero-mesophilous plant formations (tropical seasonal evergreen), **F.S.S.T.T:** Typical tropical seasonal evergreen plant formations (mesophilous), **F.O.S.S.T:** Tropical seasonal ombro-evergreen plant formations (mesohygrophilous), **F.O.S.M.T:** Tropical sub-montane rainforest plant formations (hygrophilous).

plant), *Geophila repens* (herbaceous plant) and *Hillia parasitica* (epiphytic vine) in our stations (Tables 4, 5 and 6).

Anthirea coriacea (tree), *Exostemma sanctae-luciae* (tree) and *Randia nitida* (tree), considered rare and endangered in the French Antilles, have been identified in some stations (Tables 4, 5 and 6), (Bernard, *et al.*, 2014; Fiard, 1992). Their distribution indices, frequencies, densities, and consequently their ecological dominance indices taking all these param-

Table 4. Ecological temperament of the 27 Rubiaceae identified in the 120 stations, according to the qualitative representation model of Professor Philippe JOSEPH (Joseph, P., 2009).

Species	Physiognomy	pH	SH	SGH	HemSE	SPME	O
Antirhea coriacea	Tree			++		Middle	No
Chimarrhis cymosa	Tree			++		Middle add Upper	No
Chiococca alba	Lianoid shrub	++++	+++		+	Lower	No
Coffea liberica	Tree				++	Middle	No
Erithalis fruticosa	Shrub	+++	++			Lower and Middle	No
Exostema sanctaeluciae	Tree						
Faramea occidentalis	Tree				++	Lower	No
Genipa americana	Tree		+			Middle	No
Geophila repens	Herbaceous plant						No
Gonzalagunia hirsuta	Bush		+++		++	Lower	No
Guettarda odorata	Shrub	++++	+++			Lower and Middle	T
Guettarda scabra	Tree	++++	++	++		Middle add Upper	No
Hillia parasitica	Epiphyte						No
Ixora ferrea	Shrub				+	Lower	No
Morinda citrifolia	Tree	+	+++			Middle add Upper	No
Palicourea crocea	Shrub				+++	Lower	No
Psychotria berteriana	Shrub				++	Lower	No
Psychotria discolor	Herbaceous plant						No
Psychotria mapourioides	Shrub				++	Lower	No
Psychotria microdon	Shrub	++	++		+	Lower	No
Psychotria muscosa	Shrub				+++	Lower	No
Psychotria nervosa	Bush	+=	++		++	Lower	No
Psychotria tenuifolia	Shrub						No
Psychotria uliginosa	Bush				+	Lower	No
Randia aculeata	Shrub	+++	++		+	Lower	P
Randia nitida	Tree		+			Lower	P
Rudgea citrifolia	Tree				+	Lower	No

PH: Primary heliophile/**SH:** Secondary heliophile/**SGH:** Sylvatic gapheliophile/**HémSc:**Hemisciaphile/**SPME:** Stratigraphicposition atmaximum expansion/**O:** Obsolescence; (**T:** Total, **NO:**Notobsolete,**P:**Partial)/**(+)**:Significanceofdescriptor eters into account, are very low in the stations where they have been observed. This shows that they still seem to retain their status as rare and endangered species (Claude, 2020).

Global data analysis using HAC, FCA and PCA

Hierarchical Ascending Classification (HAC)

A hierarchical ascending classification (HAC) was carried out using an abundance table composed of 297 rows (species excluding regenerations and dead trees) and 120 columns (inventory stations). This table correlates the floristic composition with the population abundances of species per station (Claude, 2020). The Pearson coefficient and the "mean link" aggregation method represented the only possibility of grouping our stations into more or less coherent and similar groups (or classes) (Claude, 2020; Doré, *et al.*, 2001; Ramade, 2009; Thorson, *et al*., 2015). Indeed, the dendrograms obtained clearly show that it is difficult to identify coherent groups (or classes) among our stations, with a similarity rate higher than 20% (Figures 13 and 14, Table 7). Our stations differ enormously in their floristic compositions (multitude of possible associations of plant species and at various stages of evolution) and their biodemographic structures (population abundance of species), thus perfectly illustrating the observable plant mosaic in Martinique (Table 7).

Factorial Correspondence Analysis (FCA)

Factorial correspondence analyses (FCA) were carried out using the same abundance table, consisting of 297 rows (species excluding regenerations and dead trees) and 120 columns (inventory stations).

There is a link between the rows and columns as the calculated p-value (0.0001) is below the alpha significance level (0.05), (Claude, 2020; Doré, *et al*., 2001; Ramade, 2009; Thorson, *et al*.) Axes F1 and F2 of the first two factorial analyses that were carried out (Figures 15 and 16), show that several stations corresponding to mangrove and back- mangrove communities (Stations 14, 15, 16, 17, 18, 78, 80 and 81, Annex 1, Table 7) and to some tropical seasonal evergreen floristic units and xeric facies (Stations 31,

Table 5. Ecological profile of the 27 Rubiaceae identified in the 120 stations, according to the qualitative representation model of Professor Philippe JOSEPH (Joseph, 2009).

Species	Physiognomy	S.F	M.S.F	P.F	S.Y.S.F	S.S.F
Antirhea coriacea	Tree			++		
Chimarrhis cymosa	Tree			S	++	
Chiococca alba	Lianoid shrub	++++	++	+++	++	+
Coffea liberica	Tree					+++
Erithalis fruticosa	Shrub	++++	+++++	+++	+	
Exostema sanctae-luciae	Tree				S	
Faramea occidentalis	Tree			+	+	++
Genipa americana	Tree				+	
Geophila repens	Herbaceous plant				S	
Gonzalagunia hirsuta	Bush	S		+	+++	+
Guettarda odorata	Shrub	+++	++++	+++	+	
Guettarda scabra	Tree	+++	++++++	++++	++	S
Hillia parasitica	Epiphyte					S
Ixora ferrea	Shrub				+	+
Morinda citrifolia	Tree	S		++	+	
Palicourea crocea	Shrub				++++	+++
Psychotria berteriana	Shrub				++	+
Psychotria discolor	Herbaceous plant					S
Psychotria mapourioides	Shrub			+	++	++
Psychotria microdon	Shrub	+++	++	++	++	++
Psychotria muscosa	Shrub					+++
Psychotria nervosa	Bush	++	+	++	++	++
Psychotria tenuifolia	Shrub			S		
Psychotria uliginosa	Bush				S	+
Randia aculeata	Shrub	+++	+++	+	+	+
Randia nitida	Tree			+	+	
Rudgea citrifolia	Tree					+

(S.F): Shrub formation/**(M.S.F):** Mature shrub formation/**(P.F):** Presylvatic formation/**(S.Y.S.F):** Structured young sylvatic formation/**(S.S.F):** Secondary sylvatic formation/**S:** Seedling/(+): Significance of descriptor.

Table 6. Ecosystem affinity of the 27 Rubiaceae identified in the 120 stations, according to the qualitative representation model of Professor Philippe JOSEPH (Joseph, 2009).

	A.M			A.P			F.S.S.T.F.X			F.T.X.M			F.S.S.T.T			F.O.S.S.T			F.O.S.M.T		
Species	Ab	D	ED	Ab	D	ED	Ab	D	ED	Ab	D	ED	Ab	D	ED	Ab	D	ED	Ab	D	ED
Antirhea coriacea													++	VL							
Chimarrhis cymosa													S						+++	VL	Lo
Chiococca alba	+	EL	VL	+++	Lo	EL	+++	M	EL	++	Lo	EL	++	VL	EL	S					
Coffea liberica													++	Lo	VL						
Erithalis fruticosa				+++++	M	Lo	+++	M	Lo	+	EL	EL									
Exostema sanctae-luciae																S					
Faramea occidentalis										+	EL	EL	+	VL	EL	++	VL	EL	+	VL	EL
Genipa americana													+	EL	EL						
Geophila repens																S					
Gonzalagunia hirsuta							S			S			++	Lo	VL	++	VL	EL	S		
Guettarda odorata	S			S			+++	Lo	Lo	+	EL	EL	+	Lo	EL						
Guettarda scabra	+	EL	EF	+	Lo	EL	+++	Lo	Lo	++	M	M	+	VL	VL						
Hillia parasitica																			S		
Ixora ferrea													+	EL	EL	+	VL	EL	+	VL	EL
Morinda citrifolia	S			+++	M	M	+	EL	EL				+	Lo	VL						
Palicourea crocea													+++	La	VL	+++	M	EL	++	Lo	EL
Psychotria berteriana																++	Lo	VL	+	VL	EL
Psychotria discolor																S			S		
Psychotria mapourioides													++	Lo	EL	++	M	EL	+	VL	EL
Psychotria microdon				+	EL	EL	+++	Lo	EL	++	Lo	EL	+++	Lo	VL	+	EL	EL	+	VL	EL
Psychotria muscosa																+++	M	EL	++	Lo	EL
Psychotria nervosa							++	M	VL	++++	M	LO	++	VL	EL	+	EL	EL			
Psychotria tenuifolia													S								
Psychotria uliginosa																S			+	VL	EL
Randia aculeata				+++++	M	Lo	+++	Lo	VL	++	VL	EL	+	EL	EL						
Randia nitida							+	VL	EL				+	Lo	EL						
Rudgea citrifolia																			+	VL	EL

Ab: Abundance**/D:** distribution**/ED:** Ecological dominance/ **La:** Large, **M:** Medium, **Lo:** Low, **VL:** Very low, **EL:** Extremely low, **P**: Seedling/***A.M:*** *Back-mangrove floristic units,* ***A.P:*** *Backshore floristic units,* ***F.S.S.T.F.X:*** *Tropical seasonal evergreen and xeric facies plant formations,* ***F.T.X.M:*** *Transitional xero-mesophilous* plant formations, **F.S.S.T.T:** Typical tropical seasonal evergreen plant formations, **F.O.S.S.T:** Tropical seasonal ombro-evergreen plant formations, **F.O.S.M.T:** Tropical sub-montane rainforest plant formations.

32, 34 and 48, Annex 1, Table 7), focus the other stations (or inventories) practically at the starting point of these factorial axes. These few tropical seasonal

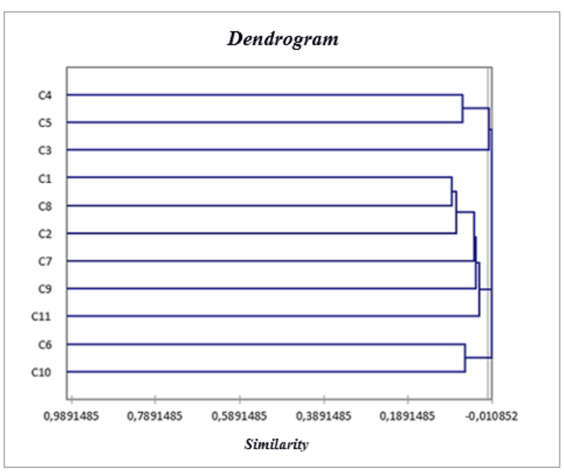

Fig. 13. Similarity dendrogram of the 120 stations grouped into classes (or groups).

evergreen floristic units and xeric facies (xerophilic phytocenoses) are distinguished by the population abundance of one or two species: *Gyminda latifolia* (Celastraceae) and/or *Eugenia axillaris* (Myrtaceae), forming almost monospecific plant formations; while the mangrove and back-mangrove stations are distinguished from the other stations by their floristic specificities.

By subtracting stations 14, 15, 16, 17, 18, 31, 32, 34, 48, 78, 80 and 81 from the data table, the new factorial correspondence analysis (Figure 17) makes it possible to better characterise all the other stations and to group them by type of biotope and floristic composition. Indeed, the variation of the population abundances of the species of our stations gives an indication on the biodemographic structure, the composition and the evolution dynamics of the inventoried phytocenoses, while the variation of the floristic compositions gives an indication on the biotope (Joseph, 1997, 2009, 2012). Thus in this Figure 17, the stations belonging to the extra-sylvatic stages are located on the left of the F1 axis, while all the others belonging to the intra-sylvatic stages are located on the right. The F2 axis must be related to the floristic specificities of the stations.

Principal component analysis (PCA)

Finally, a principal component analysis (PCA) was carried out, based on a cross-table of data corresponding to several environmental variables (Claude, 2020). This table is made up of 120 rows (stations) and 7 columns (ecoclimatic factors except soils), (Annex 1). The variables we took into account were: altitude (metres), annual rainfall (mm), average annual temperature (°C), average annual minimum temperature (°C), average annual maximum temperature (°C), annual evapotranspiration (mm), annual insolation (number of hours). This data was

Table 7. Typology of the stations according to their floristic compositions and biodemographic structures.

	Intra-class variance	Stations	Forest type	Population Structure
Class 1	58, 269,953	S1,S2,S3,S5,S6,S7,S8,S9,S10,S11, S12,S13,S20,S21,S22,S23,S24, S25,S26,S27,S29,S30,S33,S35, S36,S37,S38,S39,S40,S41,S42, S44,S45,S49,S50,S52,S54,S58, S59,S60,S61,S63,S68,S69,S	Very heterogeneous class: ackshore floristic unit, Tropical seasonal evergreen plant formation and xeric facies, Tropical seasonal evergreen plant formation (xero mesophilic).	Tendency towards low abundances of individuals per species and low stem density. or Relative numerical dominance of some species or Tendency for an even distribution of numbers between dominant species.
Class 2	185, 901,318	S4,S46,S47,S51,S53,S55,S5,S57, S62,S64,S65,S66,S7,S80,S86,S101, S103,S11, S112,S113,S116,S118	Very heterogeneous class: Tropical seasonal evergreen plant formation and xeric facies to Tropical seasonal evergreen plant formation (*xero mesophilic*).	More marked numerical dominance one species or of a group of two to four species. This grouping varies according to the station and without a higher stem density.
Class 3	0	S14	Mangrove swamp	Monospecific population Pterocarpus
Class 4	923	S15,S16,S17	Colluvial mangrove	Numerical dominance of *Rhizophora mangle*
Class 5	0	S18	Colluvial mangrove	Numerical dominance of *Avicennia germinans*
Class 6	22, 480, 524	S19,S43,S87,S88,S89, S90,S106	Tropical sub montane rainforest plant formation	Numerical dominance of a single species: *Tapura latifolia.* Exception: *Piper dilatatum* dominates in S43 and *Pouteria multiflora* in S19.
Class 7	28 205	S28,S109,S110,S114,S115,S117, S119,S120	Typical tropical seasonal evergreen plant formation	Numerical dominance of one to three species, variable according to the station. They often include: *Myrcia splendens*, Cordia sulcata, Piper amalago…
Class 8	219,350,500	S31,S32,S34,S48	Seasonal tropical evergreen xeric facies plant formation	A group of one or two species dominate numerically: *Gyminda latifolia* and/or *Eugenia axillaris*. Their numbers here numbers here are theare the highest compared to the total numbers of other species,all stations com bined.
Class 9	2, 444,482	S74,S75,S76,S77,S78,S79, S81,S82	Degraded back mangrove plant eco-units	Low total abundance of individuals per species. However, we note the numerical dominance of a species or a group of 3 to 4 species whose floristic composition varies according to the stations.
Class 10	85, 313,833	S98,S99,S102,S104,S105,S107	Tropical seasonal ombro evergreen plant formation	Numerical dominance of two species: generally *Odontonema nitidum* and/or *Myrcia fallax*. Their numbers can sometimes be very high, as in class 8. Exception: In S105, *Myrcia fallax* is part of a group of several dominant species.
Class 11	0	S 108	Typical tropical seasonal ever green formation	Numerical dominance of *Plinia pinnata*

collected from public bodies responsible for their production in Martinique (Albert and Spieser, 1999 ; Claude, 2020; Deal Martinique, 2012).

Figure 18 shows that precipitation is the main factor behind the heterogeneity of our stations in terms of biotopes and the plurality of phytocenoses studied, as Philippe JOSEPH has shown in his work (Joseph, 2009, 2011, 2012). More specifically, it is the alternation of periods of drought and rain associated with the topography of the island that constitute the most discriminating factors (Joseph, 2009, 2011, 2012).

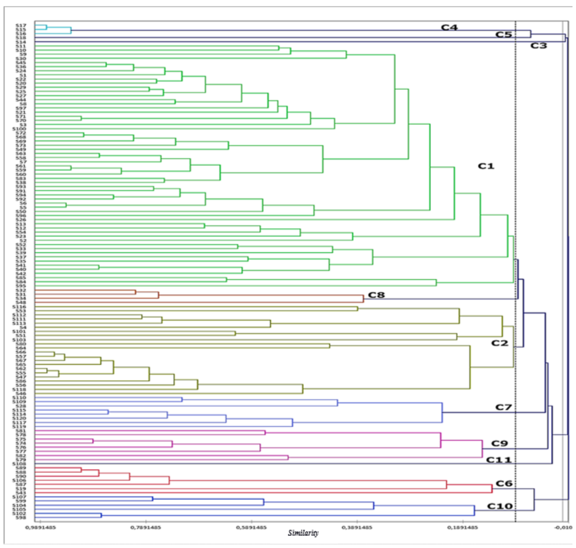

Fig. 14. Similarity dendrogram of the 120 stations, according to their floristic compositions and population structures (Annex 1).

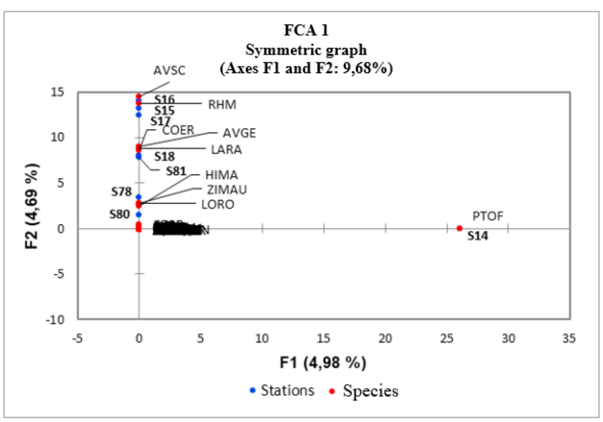

Fig. 15. Factorial correspondence analysis no. 1, carried out according to the floristic compositions and population abundances of the species in our stations (Annex 1 and 2).

Indeed, the topographic model of Martinique induces a strong rainfall gradient, favouring a bioclimatic layering of the land from dry to wet and consequently leading to a layering of the vegetation (Joseph Joseph, 2009, 2011, 2012). However, we know that on the site scale, the combination of other ecoclimatic factors such as temperatures, evapotranspiration, insolation and soil types will modify the modes of association of the species and partici-

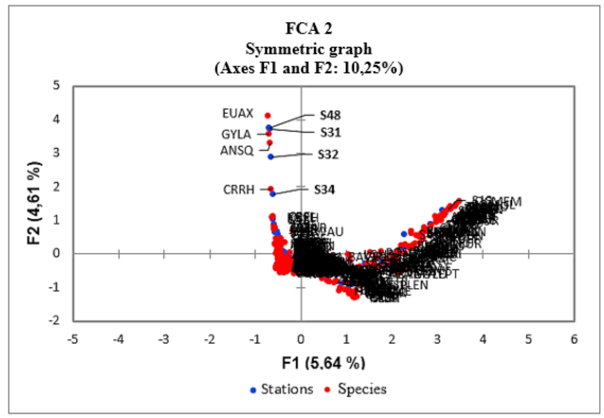

Fig. 16. Factorial correspondence analysis no. 2 (without mangrove and back-mangrove stations), carried out according to the floristic compositions and population abundances of the species in our stations (Annex 1 and 2).

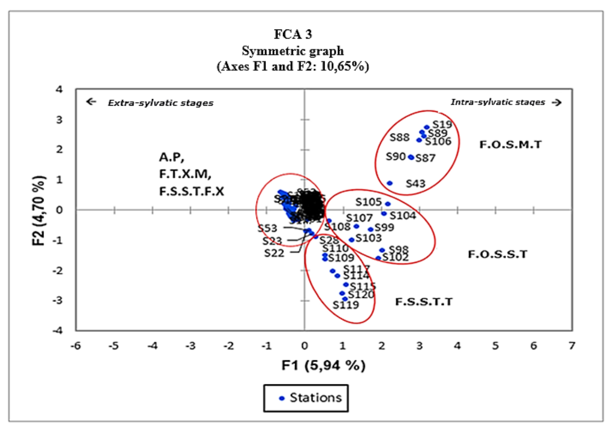

Fig. 17. Factorial correspondence analysis of no. 3 (without mangroves, back-mangroves and stations 31,32,34 and 48), (Annex 1 and 2).

A.P: *Backshore floristic units*, **F.S.S.T.F.X:** Tropical seasonal evergreen and xeric facies plant formations (xerophilous), **F.T.X.M:** Transitional xero-mesophilous plant formations (tropical seasonal evergreen), **F.S.S.T.T:** Typical tropical seasonal evergreen plant formations (mesophilous), **F.O.S.S.T:** Tropical seasonal ombro-evergreen plant formations (mesohygrophilous), **F.O.S.M.T:** Tropical sub-montane rainforest plant formations (hygrophilous).

Annex 1: List of 120 stations of floristic inventory

S = station **; SE** = Stage of evolution **; Tmin** = Minimum temperatures (°C) **; Tmax** = Maximum temperatures (°C) **; Taverage** = Average temperatures (°C) **; Rain** = Rainfall **; Eva** = Evapotranspiration **; Ins** = Insolation **; H** = Height **; SE =** Stage of evolution **: (S.F):** Shrub formation/**(M.S.F):** Mature shrub formation/**(P.F):** Presylvatic formation/**(S.Y.S.F):** Structured young sylvatic formation/**(S.S.F):** Secondary sylvatic formation/**(E.C.D) :** Degraded back-mangrove plant eco-unit/**(FVTD):** Very degraded plant formation.

S	SE	*Bioclimate or mesoclimate*	Tmin	Tmax	Taverage	Rain	Eva	Ins	H
1	SYSF	ecotone(xero-mesophile)	23,2	28,9	26,1	1854	1675	2800	51
2	SYSF	ecotone(xero	23,1	28,4	25,8	1853	1675	2800	64
3	SYSF	-mesophile)	23,1	28,4	25,8	1853	1675	2800	66
4	PF	subhumid dry	23,2	28,9	26,1	1854	1675	2800	45
5	PF	subhumid dry	23,2	28,9	26,1	1854	1675	2800	49
6	PF	subhumid dry	23,2	28,9	26,1	1854	1675	2800	82
7	PF	subhumid dry	22,4	27,9	25,2	1900	1675	2800	84
8	PF	subhumid dry	22,4	27,9	25,2	1900	1675	2800	69
9	PF	subhumid dry	22,4	27,9	25,2	1900	1675	2800	108
10	SYSF	subhumid dry	22,4	27,9	25,2	1900	1675	2800	56
11	SYSF	subhumid dry	22,4	27,9	25,2	1900	1675	2800	72
12	PF	subhumid dry	23,1	28,4	25,8	1853	1675	2800	69
13	MSF	subhumid dry	23,1	28,4	25,8	1853	1675	2800	71
14	Mangrove	subhumid dry	23,8	30,4	27,1	2093	1625	2700	3
15	Mangrove	subhumid dry	24,6	30	27,3	1572	1625	2700	1
16	Mangrove	subhumid dry	23,4	30,8	27,1	1783	1650	2700	5
17	Mangrove	subhumid dry	23,4	30,8	27,1	1783	1650	2700	1
18	Mangrove	subhumid dry	24	29,5	26,8	1393	1625	2900	3
19	SSF	humid	21	28,1	24,6	3870	1575	2400	252
20	SYSF	subhumidhumid	23,3	28,4	25,9	1575	1675	2700	152
21	SYSF	subhumid dry	23,3	28,4	25,9	1575	1675	2700	143
22	SYSF	subhumidhumid	23,3	28,4	25,9	1575	1675	2700	131
23	SYSF	subhumidhumid	23,3	28,4	25,9	1575	1675	2700	140
24	SYSF	subhumid dry	23,3	28,4	25,9	1575	1675	2700	130
25	SYSF	subhumid dry	23,3	28,4	25,9	1575	1675	2700	194
26	PF	subhumid dry	23,3	28,4	25,9	1575	1675	2700	182
27	SYSF	subhumid dry	23,3	28,4	25,9	1575	1675	2700	196
28	SYSF	subhumidehumid	23,3	28,4	25,9	1575	1675	2700	145
29	PF	subhumidhumide	23,3	28,4	25,9	1575	1675	2700	201
30	SYSF	subhumid dry	23,5	28,9	26,2	1489	1675	2700	166
31	PF	subhumid dry	24,2	29,7	27,0	1441	1625	2900	71
32	SYSF	subhumid dry	24,2	29,7	27,0	1441	1625	2900	65
33	SYSF	subhumid dry	23,9	29,3	26,6	1421	1625	2900	89
34	SYSF	subhumid dry	24,2	29,7	27,0	1441	1625	2900	80
35	SYSF	subhumid dry	23,9	29,3	26,6	1421	1625	2900	123
36	PF	subhumid dry	23,9	29,3	26,6	1421	1625	2900	30
37	SYSF	subhumid dry	23,9	29,3	26,6	1421	1625	2900	107
38	PF	subhumid dry	24,2	29,7	27,0	1441	1625	2900	38
39	PF	subhumid dry	24,2	29,7	27,0	1441	1625	2900	63
40	SYSF	subhumid dry	24,2	29,7	27,0	1441	1625	2900	51
41	SYSF	subhumid dry	24,6	29,9	27,3	1476	1625	2900	71
42	SYSF	subhumid dry	24,2	29,7	27,0	1441	1625	2900	82
43	SSF	humid	21,7	28,7	25,2	3123	1575	2400	177
44	SF	subhumid dry	24,3	29,6	27,0	1397	1625	2900	3
45	MSF	subhumid dry	24,3	29,6	27,0	1397	1625	2900	7
46	PF	subhumidhumid	23,9	30,8	27,4	1951	1625	2700	14
47	PF	subhumidhumid	23,9	30,8	27,4	1951	1625	2700	19
48	PF	subhumid dry	24,2	29,7	27,0	1441	1625	2900	54
49	SYSF	subhumid dry	23,6	28,9	26,3	1625	1675	2900	85
50	SYSF	subhumid dry	24,4	29,6	27,0	1438	1625	2900	13
51	SSF	subhumidhumid	23,2	28,6	25,9	1814	1625	2800	30
52	SYSF	subhumid dry	23,2	28,6	25,9	1814	1625	2800	30
53	SYSF	ecotone(xero-mesophile)	23,5	28,7	26,1	1810	1625	2800	80
54	SSF	ecotone(xero-mesophile)	23,5	28,7	26,1	1810	1625	2800	80
55	SF	subhumid dry	22,8	30,9	26,9	1609	1575	2700	108
56	MSF	subhumid dry	22,8	30,9	26,9	1609	1575	2700	136

Annex 1: *Continued ...*

S	SE	*Bioclimate or mesoclimate*	Tmin	Tmax	Taverage	Rain	Eva	Ins	H
57	SF	subhumid dry	22,8	30,9	26,9	1609	1575	2700	127
58	SYSF	ecotone(xero-mesophile)	22,8	30,9	26,9	1609	1575	2700	97
59	SYSF	ecotone(xero-mesophile)	22,8	30,9	26,9	1609	1575	2700	103
60	SF	subhumid dry	22,8	30,9	26,9	1609	1575	2700	130
61	PF	subhumid dry	22,8	30,9	26,9	1609	1575	2700	124
62	SF	subhumid dry	22,8	30,9	26,9	1609	1575	2700	108
63	SYSF	ecotone(xero-mesophile)	22,8	30,9	26,9	1609	1575	2700	103
64	SF	subhumid dry	22,8	30,9	26,9	1609	1575	2700	116
65	PF	subhumid dry	22,8	30,9	26,9	1609	1575	2700	108
66	SF	subhumid dry	22,8	30,9	26,9	1609	1575	2700	115
67	MSF	subhumid dry	22,8	30,9	26,9	1609	1575	2700	115
68	SF	subhumid dry	24	29	26,5	1393	1675	2700	33
69	SF	subhumid dry	24	29	26,5	1393	1675	2700	67
70	SF	subhumid dry	24	29	26,5	1393	1675	2700	79
71	PF	subhumid dry	24	29	26,5	1393	1675	2700	80
72	PF	subhumid dry	24	29	26,5	1393	1675	2700	61
73	PF	subhumid dry	24	29	26,5	1393	1675	2700	80
74	E.C.D	subhumidhumid	23,2	29,1	26,2	1751	1625	2800	4
75	E.C.D	subhumidhumid	23,2	29,1	26,2	1751	1625	2800	4
76	E.C.D	subhumidhumid	23,2	29,1	26,2	1751	1625	2800	4
77	E.C.D	subhumidhumid	23,2	29,1	26,2	1751	1625	2800	4
78	E.C.D	subhumidhumid	23,2	29,1	26,2	1751	1625	2800	4
79	E.C.D	subhumidhumid	23,2	29,1	26,2	1751	1625	2800	4
80	E.C.D	subhumidhumid	23,2	29,1	26,2	1751	1625	2800	4
81	E.C.D	subhumidhumid	23,2	29,1	26,2	1751	1625	2800	4
82	E.C.D	subhumidhumid	23,2	29,1	26,2	1751	1625	2800	4
83	PF	subhumid dry	23,4	29	26,2	1592	1625	2800	2
84	SF	subhumid dry	23,4	29	26,2	1592	1625	2800	2
85	PF	subhumid dry	23,4	29	26,2	1592	1625	2800	8
86	SF	subhumid dry	22,7	28,4	25,6	1698	1625	2800	26
87	SSF	Humid	20,2	26,7	23,5	2613	1650	2500	443
88	SSF	Humid	20,2	26,7	23,5	2613	1650	2500	387
89	SSF	Humid	20,2	26,7	23,5	2613	1650	2500	400
90	SSF	Humid	19,7	26,7	23,2	2479	1675	2500	592
91	SYSF	subhumid dry	23,8	28,7	26,3	1814	1650	2800	33
92	SYSF	subhumid dry	23,8	29,2	26,5	1741	1650	2800	37
93	PF	subhumid dry	23,8	29,2	26,5	1741	1650	2800	41
94	SYSF	subhumid dry	23,2	28,7	26,0	1814	1650	2800	27
95	SYSF	subhumid dry	24,2	29,2	26,7	1513	1700	2800	8
96	MSF	subhumid dry	24,2	29,2	26,7	1513	1700	2800	14
97	PF	subhumid dry	24,3	29,5	26,9	1387	1625	2900	2
98	SSF	ecotone(meso-hygrophilic)	22,3	28,3	25,3	1965	1600	2700	294
99	SSF	ecotone(meso-hygrophilic)	22,3	28,3	25,3	1965	1600	2700	257
100	SYSF	subhumid dry	23,4	31,5	27,5	1748	1775	2700	101
101	PF	subhumid dry	23,4	31,5	27,5	1748	1775	2700	62
102	SSF	subhumidhumid	21,3	29,1	25,2	1749	1725	2700	180
103	SSF	subhumidhumid	21,3	29,1	25,2	1749	1725	2700	130
104	SSF	ecotone(meso-hygrophilic)	20,7	28,3	24,5	2319	1675	2600	611
105	SSF	ecotone(meso-hygrophilic)	21	28,4	24,7	3443	1575	2400	447
106	SSF	Humid	19,6	26,6	23,1	2507	1650	2500	500
107	SYSF	ecotone(meso-hygrophilic)	22,7	28,4	25,6	1698	1625	2800	259
108	SSF	subhumidhumid	21,3	29	25,2	1757	1575	2700	363
109	SSF	subhumidhumid	23,4	30,7	27,1	1708	1750	2700	20
110	SSF	subhumidhumid	23,4	30,7	27,1	1708	1750	2700	21
111	SYSF	subhumid dry	23,4	30,7	27,1	1708	1750	2700	34
112	PF	subhumid dry	23,4	30,7	27,1	1708	1750	2700	42
113	PF	subhumid dry	23	30,2	26,6	1705	1750	2700	58
114	FVTD	subhumidhumid	23	30,2	26,6	1705	1750	2700	35
115	FVTD	subhumidhumid	23	30,2	26,6	1705	1750	2700	33

Annex 1: *Continued ...*

S	SE	*Bioclimate or mesoclimate*	Tmin	Tmax	Taverage	Rain	Eva	Ins	H
116	FVTD	ecotone(xero-mesophil)	23	30,2	26,6	1705	1750	2700	109
117	FVTD	subhumidhumid	23	30,2	26,6	1705	1750	2700	80
118	SYSF	ecotone(xero-mesophil)	22,4	29,7	26,1	1738	1750	2700	195
119	FVTD	subhumidhumid	23	30,2	26,6	1705	1750	2700	39
120	SSF	subhumidhumid	23	30,2	26,6	1705	1750	2700	45

pate secondarily in the establishment of a plurality of floristic communities (Joseph, 2009).

Discussion

The Rubiaceae family can be effectively considered among the families with the highest abundances of woody species in tropical rainforests, as reported in the literature (Weng, *et al.*, 2004; Davis, *et al.*, 2009). The diversity in terms of number of species and physiognomic types within this family is undeniable (Fournet, 1978; Govaerts, *et al*., 2015; Howard, 1989; Lecointre and Le Guyader, 2013; Robbrecht, 1988; Simpson, 2010). In the Lesser Antilles, several species of Rubiaceae are known for multiple uses linked to the first pre-Columbian peoples who occupied these territories up until our modern societies. There are many identified areas of use: magic-religious, wood production, food, medicine, decoration, perfumery, tattoos, textiles, etc. (Germosén, 2007; Germosén, 2014; Honychurch, 1986; Joseph, 2009; Mahabir, 1991; Quinlan, *et al*., 2007; Robard, I., 2004).

According to regional floras and floristic inventories carried out in the field, Rubiaceae do occupy a wide range of habitats in Martinique, ranging from dry sub-humid to humid bioclimates. These species are found, for example, in the undergrowth of structured or degraded forests, in transition forests or even in the climax of several forest types (Claude, *et al.,* 2017; Claude, 2020; Fiard, 1992; Fournet, 1978; Howard, 1989; Joseph, 2009; Joseph, *et al.*, 2020; Rollet *et al*., 2010). According to the scientific literature, in tropical regions Rubiaceae are known to be very sensitive to disturbances and changes in their environment (Davis *et al.,* 2006, 2009). However, our results show that Rubiaceae are not rarely present in secondary forests. On the contrary, they are very present and particularly abundant in these types of

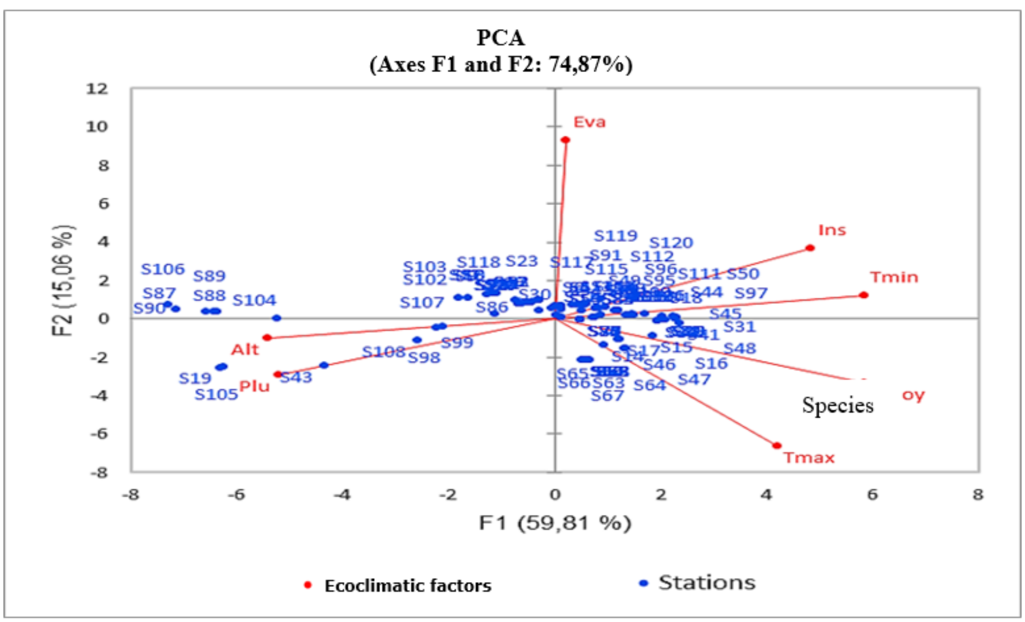

Fig. 18. Principal component analysis of the ecoclimatic factors matrix (Annex 1)
Alt *= Altitude,* ***Plu*** *= Pluviométrie (Rainfall),* ***Eva*** *= Evapotranspiration,* ***Ins*** *= Insolation,* ***Tmin*** *= Températures minimales (Minimum temperatures),*
Tmoy = Températures moyennes (Average temperatures), **Tmax** = Températures maximales (Maximum temperatures).

Annex 2. List of the 297 recorded species and its acronyms

Family	Nom of the Species	Acronym
Mimosaceae	*Acacia farnesiana*	ACFA
Mimosaceae	*Acacia muricata*	ACMU
Mimosaceae	*Acacia nilotica*	ACNI
Mimosaceae	*Acacia retusa*	ACRE
Mimosaceae	*Acacia sp*	ACSP
Mimosaceae	*Acacia tamarindifolia*	ACTA
Mimosaceae	*Acacia tenuifolia*	ACTEN
Mimosaceae	*Acacia tortuosa*	ACTO
Cactaceae	*Acanthocereustetragonus*	ACTET
Euphorbiaceae	*Actinostemoncaribaeus*	ACCA
Verbenaceae	*Aegiphilamartinicensis*	AEMA
Arecaceae	*Aiphanes minima*	AIMI
Arecaceae	*Aiphanessp.*	AISP
Sapindaceae	*Allophyllusracemosus*	ALRA
Rutaceae	*Amyris elemifera*	AMEL
Fabaceae	*Andira inermis*	ANIN
Lauraceae	*Anibabracteata*	ANBR
Annonaceae	*Annonamuricata*	ANMU
Annonaceae	*Annonareticulata*	ANRE
Annonaceae	*Annonasquamosa*	ANSQ
Rubiaceae	*Antirhea coriacea*	ANCO
Myrsinaceae	*Ardisiaobovata*	AROB
Euphorbiaceae	*Argythamniapolygama*	ARPO
Moraceae	*Artocarpus altilis*	ARAL
Cyclanthaceae	*Asplundiainsignis*	ASIN
Avicenniaceae	*Avicenniagerminans*	AVGE
Avicenniaceae	*Avicenniaschaueriana*	AVSC
Poaceae	*Bambusa multiplex*	BAMU
Poaceae	*Bambusa vulgaris*	BAVU
Euphorbiaceae	*Bernardiacorensis*	BECO
Gesneriaceae	*Beslerialutea*	BELU
Boraginaceae	*Bourreriasucculenta*	BOSU
Moraceae	*Brosimumalicastrum*	BRAL
Malpighiaceae	*Bunchosiaglandulosa*	BUGL
Burseraceae	*Bursera simaruba*	BUSI
Buxaceae	*Buxussubcolumnaris*	BUSU
Malpighiaceae	*Byrsonimaspicata*	BYSP
Caesalpiniaceae	*Caesalpinia bonduc*	CABO
Mimosaceae	*Calliandraslaneae*	CASL
Mimosaceae	*Calliandratergemina*	CATE
Clusiaceae	*Callophyllumcalaba*	CACA
Myrtaceae	*Calyptranthes elegans*	CAEL
Canellaceae	*Canellawinterana*	CAWI
Capparaceae	*Capparisbaducca*	CABA
Capparaceae	*Cappariscynophallophora*	CACY
Capparaceae	*Capparisflexuosa*	CAFL
Capparaceae	*Capparishastata*	CAHA
Capparaceae	*Capparisindica*	CAIN
Solanaceae	*Capsicum annicum*	CAAN
Solanaceae	*Capsicum frutescens*	CAFR
Caricaceae	*Caricapapaya*	CAPA
Flacourtiaceae	*Caseariadecandra*	CADE
Caesalpiniaceae	*Cassia sp*	CASP
Celastraceae	*Cassine xylocarpa*	CAXY
Rhizophoraceae	*Cassipoureaguianensis*	CAGU
Moraceae	*Cecropiaschreberiana*	CESC
Meliaceae	*Cedrela odorata*	CEOD
Bombacaceae	*Ceibapentandra*	CEPE
Solanaceae	*Cestrumlaurifolium*	CELA

Family	Nom of the Species	Acronym
Solanaceae	*Cestrummegalophyllum*	CEME
Solanaceae	*Cestrumsp*	CESP
Caesalpiniaceae	*Chamaecristanictitans*	CHNI
Rubiaceae	*Chimarrhiscymosa*	CHCY
Rubiaceae	*Chioccoca alba*	CHAL
Oleaceae	*Chionanthus compacta*	CHCO
Sapotaceae	*Chrysophyllumargenteum*	CHAR
Lauraceae	*Cinnamomum verum*	CIVE
Vitaceae	*Cissussicyoides*	CISI
Verbenaceae	*Citharexylum spinosum*	CISP
Melastomataceae	*Clidemiahirta*	CLHI
Melastomataceae	*Clidemiaumbrosa*	CLUM
Clusiaceae	*Clusia major*	CLMA
Polygonaceae	*Coccoloba caravellae*	COCA
Polygonaceae	*Coccoloba pubescens*	COPU
Polygonaceae	*Coccoloba swartzii*	COSW
Polygonaceae	*Coccoloba uvifera*	COUV
Arecaceae	*Coccothrinaxbarbadensis*	COBA
Rubiaceae	*Coffea liberica*	COLI
Combretaceae	*Conocarpus erectus*	COER
Melastomataceae	*Conostegiacalyptrata*	COCA
Melastomataceae	*Conostegiaicosandra*	COIC
Melastomataceae	*Conostegia montana*	COMO
Boraginaceae	*Cordiaalliodora*	COAL
Boraginaceae	*Cordiacollococca*	COCO
Boraginaceae	*Cordiamartinicensis*	COMA
Boraginaceae	*Cordianesophila*	CONE
Boraginaceae	*Cordiareticulata*	CORE
Boraginaceae	*Cordiasulcata*	COSU
Verbenaceae	*Cornutiapyramidata*	COPY
Costaceae	*Costus afer*	COAF
Capparaceae	*Crateviatapia*	CRTA
Bignoniaceae	*Crescentiacujete*	CRCU
Celastraceae	*Crossopetalum rhacoma*	CRRH
Fabaceae	*Crotalariasp.*	CRSP
Euphorbiaceae	*Croton bixoides*	CRBI
Euphorbiaceae	*Croton corylifolius*	CRCO
Euphorbiaceae	*Croton flavens*	CRFL
Euphorbiaceae	*Croton hircinus*	CRHIR
Euphorbiaceae	*Croton hirtus*	CRHI
Sapindaceae	*Cupania americana*	CUAM
Cyatheaceae	*Cyathearborea*	CYAR
Cyatheaceae	*Cyatheamuricata*	CYMU
Burseraceae	*Dacryodesexcelsa*	DAEX
Fabaceae	*Dalbergia monetaria*	DAMO
Thymeleaceae	*Daphnopsis americana*	DAAM
Mimosaceae	*Dichrostachys cinerea*	DICI
Rubiaceae	*Erithalisfructicosa*	ERFR
Erythroxylaceae	*Erythroxylonhavanense*	ERHA
Erythroxylaceae	*Erythroxylonsquamatum*	ERSQ
Myrtaceae	*Eugenia albicans*	EUAL
Myrtaceae	*Eugenia axillaris*	EUAX
Myrtaceae	*Eugenia confusa*	EUCON
Myrtaceae	*Eugenia cordata*	EUCOR
Myrtaceae	*Eugenia gregii*	EUGR
Myrtaceae	*Eugenia hodgei*	EUHO
Myrtaceae	*Eugenia ligustrina*	EULI
Myrtaceae	*Eugenia monticola*	EUMO
Myrtaceae	*Eugenia oerstedeana*	EUOE

Annex 2. *Continued ...*

Family	Nom of the Species	Acronym
Myrtaceae	Eugenia pseudopsidium	EUPS
Myrtaceae	Eugenia tapacumensis	EUTA
Myrtaceae	Eugenia trinervia	EUTR
Sapindaceae	Exotheapaniculata	EXPA
Rubiaceae	Faramea occidentalis	FAOC
Moraceae	Ficus citrifolia	FICI
Moraceae	Ficus nymphaeifolia	FINY
Moraceae	Ficus sp	FISP
Oleaceae	Forestierarhamnifolia	FORH
Apocynaceae	Funtumiaelastica	FUEL
Clusiaceae	Garcinia humilis	GAHU
Rubiaceae	Genipa americana	GEAM
Fabaceae	Gliricidiasepium	GLSE
Verbenaceae	Gmelinaarborea	GMAR
Rubiaceae	Gonzalaguniahirsuta	GOHI
Meliaceae	Guareaglabra	GUGL
Meliaceae	Guareamacrophylla	GUMA
Annonaceae	Guatteriacaribaea	GUCA
Sterculiaceae	Guazuma tomentosa	GUTO
Sterculiaceae	Guazuma ulmifolia	GUUL
Rubiaceae	Guettardaodorata	GUOD
Rubiaceae	Guettardascabra	GUSC
Celastraceae	Gymindalatifolia	GYLA
Caesalpiniaceae	Haematoxylon campechianum	HACA
Olacaceae	Heisteriacoccinea	HECO
Heliconiaceae	Heliconiabihai	HEBI
Heliconiaceae	Heliconiacaribaea	HECA
Heliconiaceae	Heliconiasp.	HESP
Euphorbiaceae	Hippomane mancinella	HIMA
Chrysobalanaceae	Hirtellatriandra	HITRI
Flacourtiaceae	Homaliumracemosum	HORAC
Caesalpiniaceae	Hymenaea courbaril	HYCOU
Aquifoliaceae	Ilexnitida	ILNI
Mimosaceae	Inga ingoides	ININ
Mimosaceae	Inga laurina	INLA
Rubiaceae	Ixora ferrea	IXFER
Theophrastaceae	Jacquiniaarmillaris	JAAR
Theophrastaceae	Jacquiniaaurantiaca	JAAU
Theophrastaceae	Jacquiniasp	JASP
Rhamnaceae	Krugiodendronferreum	KRFE
Flacourtiaceae	Laetiathamnia	LATH
Combretaceae	Laguncularia racemosa	LARA
Verbenaceae	Lantana involucrata	LAIN
Mimosaceae	Leucaenaleucocephala	LELEU
Chrysobalanaceae	Licaniaternatensis	LITERN
Fabaceae	Lonchocarpusheptaphyllus	LOHE
Fabaceae	Lonchocarpuspunctatus	LOPU
Fabaceae	Lonchocarpusroseus	LORO
Fabaceae	Lonchocarpussericeus	LOSE
Malpighiaceae	Malpighiaemarginata	MAEM
Malpighiaceae	Malpighiamartinicensis	MAMA
Malvaceae	Malvastrumcoromandelianum	MAC
Clusiaceae	Mammea americana	MAAME
Anacardiaceae	Mangiferaindica	MAIN
Sapotaceae	Manilkarabidentata	MABI
Sapotaceae	Manilkarazapota	MAZA
Euphorbiaceae	Margaritarianobilis	MANO
Clusiaceae	Marilaracemosa	MARA
Celastraceae	Maytenusguianensis	MAGUI
Celastraceae	Maytenuslaevigata	MALAE
Meliaceae	Melia azedarach	MEAZ
Sapindaceae	Melicoccusbijugatus	MEB
Melastomataceae	Miconialaevigata	MILA
Melastomataceae	Miconia mirabilis	MIMI
Melastomataceae	Miconiatrichotoma	MITRIC
Sapotaceae	Micropholisguyanensis	MIGU
Mimosaceae	Mimosa ceratonia	MICER
Mimosaceae	Mimosa pigra	MIPI
Mimosaceae	Mimosa pudica	MIPU
Rubiaceae	Morinda citrifolia	MOCI
Capparaceae	Morisonia americana	MOAM
Rutaceae	Murraya exotica	MUEX
Myrtaceae	Myrciacitrifolia	MYCIT
Myrtaceae	Myrciadeflexa	MYDEF
Myrtaceae	Myrciafallax	MYFAL
Myrtaceae	Myrcialeptoclada	MYLEPT
Myrtaceae	Myrciasplendens	
MYSPLEN		
Myrtaceae	Myrciariafloribunda	MYFL
Fabaceae	Myrospermumfrutescens	MYFR
Lauraceae	Ocoteacernua	OCCER
Lauraceae	Ocoteacoriacea	OCCOR
Lauraceae	Ocoteaeggersiana	OCEG
Lauraceae	Ocotealeucoxylon	OCLEUC
Lauraceae	Ocoteamembranacea	OCMEM
Lauraceae	Ocotea patens	OCPAT
Acanthaceae	Odontonemanitidum	ODNY
Fabaceae	Ormosiamonosperma	ORMO
Ochnaceae	Ourateaguildingii	OUGUIL
Oxalidaceae	Oxalis frutescens	OXFRU
Rubiaceae	Palicoureacrocea	PACR
Pandanaceae	Pandanus utilis	PAUTI
Passifloraceae	Passiflorasuberosa	PASU
Malvaceae	Pavonia spinifex	PASPIN
Simaroubaceae	Picramniapentandra	PIPE
Rutaceae	Pilocarpusracemosus	PIRAS
Cactaceae	Pilosocereusroyeni	PIRO
Myrtaceae	Pimenta racemosa	PIRACE
Piperaceae	Piper aduncum	PIADUN
Piperaceae	Piper aequale	PIAEQ
Piperaceae	Piper amalago	PIAMA
Piperaceae	Piper dilatatum	PIDIL
Piperaceae	Piper glabrescens	PIGLAB
Piperaceae	Piper reticulatum	PIRET
Nyctaginaceae	Pisoniafragans	PIFRAG
Nyctaginaceae	Pisoniasuborbiculata	PISUB
Mimosaceae	Pithecellobium unguis-cati	PITUN
Myrtaceae	Pliniapinnata	PLPIN
Apocynaceae	Plumeria alba	PLALB
Sapotaceae	Pouteriamultiflora	POMUL
Sapotaceae	Pouteriapallida	POPAL
Sapotaceae	Pouteriasemecarpefolia	POSEM
Arecaceae	Prestoea montana	PRMON
Rosaceae	Prunus pleuradeunia	RPLEUR
Rubiaceae	Psychotriaberteriana	PSB
Rubiaceae	Psychotriamapourioides	PSMA
Rubiaceae	Psychotriamicrodon	PSMI
Rubiaceae	Psychotriamuscosa	PSMU

Annex 2. *Continued ...*

Family	Nom of the Species	Acronym
Rubiaceae	***Psychotrianervosa***	PSNE
Rubiaceae	***Psychotriauliginosa***	PSUL
Fabaceae	***Pterocarpus officinalis***	PTOF
Bombacaceae	***Quararibeaturbinata***	QUTUR
Rubiaceae	***Randiaaculeata***	RAACU
Rubiaceae	***Randianitida***	RANIT
Apocynaceae	***Rauvolfia viridis***	RAVI
Rhizophoraceae	***Rhizophora mangle***	RHM
Phytolaccaceae	***Rivinia humilis***	RIHUM
Boraginaceae	***Rochefortiaspinosa***	RO
Rubiaceae	***Rudgeacitrifolia***	RUCIT
Mimosaceae	***Samaneasaman***	SASAM
Euphorbiaceae	***Sapiumcaribaeum***	SACAR
Piperaceae	***Sarcorhachis incurva***	SAIN
Celastraceae	***Schaefferiafrutescens***	SCFR
Olacaceae	***Schoepfiaschreberi***	SCSC
Polygalaceae	***Securidacadiversifolia***	SEDI
Caesalpiniaceae	***Senna alata***	SENAL
Caesalpiniaceae	***Senna bicapsularis***	SEBIC
Caesalpiniaceae	***Senna obtusifolia***	SEOBTU
Caesalpiniaceae	***Senna sp.***	SESP
Sapotaceae	***Sideroxylonfoetidissimum***	SIFO
Sapotaceae	***Sideroxylonobovatum***	SIOB
Simaroubaceae	***Simarouba amara***	SIAM
Elaeocarpaceae	***Sloaenasp.***	SLSP
Elaeocarpaceae	***Sloaneadentata***	SLDEN
Elaeocarpaceae	***Sloaneadussii***	SLDUS
Elaeocarpaceae	***Sloaneamassoni***	SLMAS
Solanaceae	***Solanum racemosum***	SORAC
Solanaceae	***Solanum torvum***	SOTOR
Solanaceae	***Solanum triste***	SOTR
Bignoniaceae	***Spathodeacampanulata***	SPCA
Anacardiaceae	***Spondias mombin***	SPMOM
Sterculiaceae	***Sterculiacaribaea***	STCAR
Myrsinaceae	***Stylogynecanaliculata***	STCAN
Meliaceae	***Swieteniaaubrevilleana***	SWAU
Meliaceae	***Swieteniamacrophylla***	SWMAC
Meliaceae	***Swietenia mahagoni***	SWMAH
Symplocaceae	***Symplocosmartinicensis***	SYMA
Bignoniaceae	***Tabebuiaheterophylla***	TAHET
Bignoniaceae	***Tabebuiamonophyllum***	TAMON
Apocynaceae	***Tabernaemontanacitrifolia***	TACI
Magnioliaceae	***Talaumadodecapetala***	TADO
Caesalpiniaceae	***Tamarindusindica***	TAI
Dichapetalaceae	***Tapuralatifolia***	TALAT
Combretaceae	***Terminaliacatappa***	TEC
Sterculiaceae	***Theobroma cacao***	THCA
Malvaceae	***Thespesiapopulnea***	THPO
Clusiaceae	***Tovomitaplumieri***	TOPLU
Meliaceae	***Trichiliapallida***	TRPA
Meliaceae	***Trichiliaseptentrionalis***	TRSE
Phytolaccaceae	***Trichostigmaoctandrum***	TROC
Rutaceae	***Triphasiatrifolia***	TRTR
Asteraceae	***Vernonia arborescens***	VEARB
Verbenaceae	***Vitex divaricata***	VIDIV
Asteraceae	***Wedeliacalycina***	WECAL
Flacourtiaceae	***Xylosmamartinicensis***	XYMAR
Rutaceae	***Zanthoxylumcaribaeum***	ZACA
Rutaceae	***Zanthoxylummonophyllum***	ZAMO
Rutaceae	***Zanthoxylumpunctatum***	ZAPU
Rutaceae	***Zanthoxylum spinifex***	ZASPIN
Rhamnaceae	***Ziziphus mauritiana***	ZIMAU

vegetation. They appear more as species structuring the undergrowth of our forests (Claude, 2020; Joseph, 2009; Joseph *et al*., 2015, 2016; Joseph *et al.,* 2018; Rollet *et al*., 2010). Alternating periods of drought and rain, associated with the island's topography, are the most discriminating factors affecting the spatial distribution, abundance and current richness of Rubiaceae in Martinique (Claude, 2020; Joseph, 2009, 2011).

The effects of temperature and precipitation variations on the spatial distribution, abundance and richness of several plant families are well known (Cantet *et al*., 2014; Joseph, 2015; Punyasena, *et al.,* 2008; Woodward, 1987). Temperatures affect the population abundance of species, while the number of species increases with precipitation (Punyasena *et al.,* 2008; Weng *et al.,* 2004). It is therefore understandable that we currently observe that the diversity of Rubiaceae (in terms of number of species, genera and physiognomic types), increases according to the bioclimatic and altitudinal gradient of the island, while the population abundance (number of individuals) of Rubiaceae decreases along this same gradient. The new climatic constraints of the 21st century, however, will lead to changes in temperature, pressure and precipitation, which are all factors whose key role for plant biodiversity in tropical forests has already been demonstrated (Leigh, *et al.,* 2004; Pachauri, *et al.,* 2007). The altitudinal layering of plant formations (boundaries of different forests), species chorology, the mode of association of plant species, ecosystem dynamics and population densities will thus be greatly disrupted (Buckley, *et al.,* 2007; Joseph, 2011; Maley, 1973).

Professor Philippe JOSEPH has indicated in his work that it is possible that in Martinique we are witnessing an "insularisation" of the flora of mesophilic and hygrophilic environments (flora of moderately humid and humid bioclimates) and a potentiation of species of the flora of xerophilic environments of the secondary dynamic stages (Joseph, 2011). However, the diversity of species in the Rubiaceae family is greater in these mesophilic and hygrophilic environments (Claude, *et al.,* 2017;

Claude, 2020). These species are therefore clearly endangered. We therefore hypothesise that there is a decrease in the species richness and abundance of Rubiaceae in these environments. On the other hand, there should be a potentiation of species of the Rubiaceae family found in dry environments near the coast. The Rubiaceae found in these dry bioclimate environments are already distinguished today by high population abundances and this should therefore increase (Claude, 2020).

Conclusion

At the end of a campaign of 120 floristic inventories carried out in Martinique, in various phytocenoses and corresponding to several bioclimates, it clearly appears that the Rubiaceae family is an important component of the flora of Martinique. The temperaments and ecological profiles, chorology and biodemographic importance of 27 species of the Rubiaceae family in 18 genera, found naturally in natural vegetation, were able to be defined or updated. Among these species there are ten trees, eleven shrubs, three bushes, two herbaceous plants and one vine (epiphyte). It is undeniable that our island plant formations are made up of a diversity of species belonging to the Rubiaceae family, but there are strong disparities. While the diversity of Rubiaceae (in terms of number of species, genera and physiognomic types) increases according to the bioclimatic and altitudinal gradient of the island, the population abundance (number of individuals) of Rubiaceae decreases. We also relied on the methodology and indices developed by Professor Philippe Joseph in his work to give another demonstration. The dominance index he developed, identifying dominant species by population abundance, distribution and basal area, regardless of the type of plant cover considered, helped us to show that Rubiaceae are rarely part of these assemblages according to these three criteria. On the other hand, if these three aspects are considered separately, several Rubiaceae can be part of these dominant assemblages in various phytocenoses. Alternating periods of drought and rain or the topography of the island are the most discriminating factors affecting the spatial distribution, abundance and richness of Rubiaceae. Facing new climatic constraints of the 21st century, the current chorology of these species will evolve: those in the humid bioclimates of the north of the island are endangered.

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Authors' contributions

All authors contributed to the study design, data collection and processing. The manuscript was written by Jean-Philippe CLAUDE, proofreading was carried out by Professor Philippe JOSEPH. All authors then read and approved the final manuscript.

Data Availability

The datasets generated during and/or analysed during the current study are available in the doctoral thesis available online on the website : "https://www.theses.fr/2020ANTI0548"

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