IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 10, Issue 8 Ver. II (Aug. 2016), PP 88-108
www.iosrjournals.org

The flower plants introduced in the Lesser Antilles: Martinique's example (general summary of the key data and ecosystem impacts

Philippe JOSEPH[1], Yelji ABATI[2]
[1] *Doctor And Professor Of Ecology, Botany And Biogeography. University Of The French Antilles (Martinique), Umr Espace Dev-Bioreca*
[2] *Doctoral Student In Ecology, Botany And Biogeography. University Of The French Antilles (Martinique), Umr Espace Dev-Bioreca*

Abstract: *The introduction of plants is not a new phenomenon and is consubstantial with the history of humanity. Travels and the conquest of new lands helped the spread of species from their place of domestication. The migration dynamics of some populations is closely linked to that of the plants necessary for their survival. The Native American saga in the Caribbean basin, which resulted in the introduction of many useful plant species, is an excellent example. In the Lesser Antilles, from the beginning of colonization to the present day, the exogenous species imported from tropical America were added various pantropical taxa. The successive introductions are mainly due to increased exchanges, in principal agricultural ones, the growing economic interests linked to horticultural products and the resurgence of the plant collections in botanical gardens, botanical conservatories and other green and landscaped spaces. The progressive anthropization of the planetary environments often resulted in the invasion of introduced species to the detriment of native taxa. Unlike some islands (Reunion, Mauritius and Tahiti) where the introduced plants caused a true ecological disaster, despite strong anthropization and plant importation, the Lesser Antilles appear to be currently protected from invasive plants. The alien species attempting installation in the natural environment are few in number and have a minor impact. We don't understand the determinism of this apparent ecosystem resistance. This synthesis article aims to lay the first foundations for an understanding of the existing relationship between the introduced species and the natural vegetation.*
Keywords: *anthropization, ecosystem, introduced species, invasive species. Martinique, vegetation*

I. Introduction

At planet scale the human contacts have been associated with the introduction of a large number of species, in principal plants [1-6]. In the West Indies, this phenomenon is and has been very active since the Native American era [7]. To these floristic exchanges within the new world we add contributions from the African and Asian tropical or subtropical regions [8-12]. If some floristic contributions were of great benefit to the autochthone and immigrant populations, other transfers were and are very negative, especially for the plant ecosystem [13-15]. Ultimately, the contacts due to the discovery of new territories led to an increase in species richness, at least on the floristic plan [9][16-18]. The Lesser Antilles are no exception to this rule or to this introducing process subsequent to travel and the connections created between various world populations [19-21] (Figure 1). The introduced species are used in all the activities of the island populations: ritual, dye, food, forest, ornamental and fodder plants [22]. Some introduced species have an undeniable importance and represent a strong axis of the Caribbean Islands economy (sugarcane, banana).

On the other hand, a significant group of introduced taxons exhibits a certain degree of colonisation towards the natural vegetation. The chorology of these species is logically dependent on the ecosystem characteristics of the receiving environment. We will see that, depending on their manner of expression, the human impacts have a potentiating role in the degree of colonization of these plants [23]. Not all the introduced plants find opportunities for installation in the natural vegetation. This fact allows us to classify them into several families[1] in the various phenological stages (phases of the life cycle) corresponding to the regeneration modes that can be sexual or vegetative (asexual). We will discuss a few significant allochthonous taxa in order to determine their positive or negative behaviour with regard to the island plant ecosystem [21]. We chose the case of Martinique, but our remarks are applicable to the entire Lesser Antilles.

[1]Depending on the types of anthropogenic intervention.

Figure 1: The Lesser Antilles in the Caribbean

II. General Method

The recent floristic studies and those of the twentieth century regarding the chorology of the species and the associations they form, the architecture and structure of the phytocenoses as well as the plant succession have been essential for understanding the process of ecosystem changes. Information from documents of the discoverers, chroniclers and the 17th, 18th and 19th century naturalist travellers were also used. They all allowed us to trace the important trends of the space-time dynamics as well as the indigenous and non-indigenous species.

III. General data on the native flora of the Lesser Antilles

The island flora is complex both in its origins and in its specific, observable expressions within each island. In general, this original floristic potential of the archipelago is formed by contributions from tropical America via the Greater Antilles, due to multiple vectors: wind, animals, ocean [24-27]. It is this reality which explains their great phylogenetic similarity, in particular in what concerns families and genera. This occurs despite a level of endemism which is significantly high for some islands, specifically Martinique [28][29]. From a biogeographical point of view the Lesser Antilles belong to the Neotropical realm. This geographical area exhibits specific factorial arrangements affecting the vegetation stock. Several biogeographic factors (abiotic and biotic) determine the species stock, particularly the dissemination vectors which often represent limiting factors. Some elements of the high "flexibility" floristic potential have a chorology known as the Caribbean circum.

The taxa are distributed in the greater and Lesser Antilles on the basis of their ecology, but also within the northern part of South America incorporating the Trinidad and Tobago area [19][30][31]. It is a genuine floristic region where the endemism is expressed at the scale of families and genera. The northern and southern influences are significant and are specific respectively for species present in an area comprising the Greater Antilles, whose lower latitudinal limit would be the Guadeloupe and an area including the South America and the Lesser Antilles. Within the meaning of the biogeographical nomenclature these above mentioned different geographical units can be likened to floristic sectors and districts where the endemism is recognizable at species scale. The eco-climatic determinism specific to each of the Lesser Antilles islands results in intra and inter-island differentiation in the reception of the representatives of the global plant stock. Obviously, these islands represent ecosystem regions characterized by unique floral expressions.

On these relatively small territories, the multiplicity of the factor networks or factorial spaces is matched by the multiplicity of possibilities for plant installation. As a result, there are as many factorial constraints as there are island systems. To this fact we add the intra-island complexity that can still generate subdivisions (in terms of factorial sub-spaces) defining the large potential floristic, physiognomic and landscape groups, repeatedly described in the literature [32-40].

The Antilles are excellent receptacles for a non-negligible number of exogenous tropical species, particularly those from the old world tropics. There are geographical, ecological and dissemination barriers affecting the progress of a species in the circumtropical space from its original environment (Figure2). With regard to the various reception environments, the phenological phases linked to the dynamic and ecological profiles represent primary distribution factors of the allochthonous taxa. As elsewhere in the tropics, the metastable nature of the "West Indian plant world" hyper-organism, characterised by a plurality of combinations, is represented by an infinitely complex floristic plasticity [41]. In fact, we can see all the dynamic profiles and temperaments in relation to the environmental factors, offering answers, formations or reorganisations for any progressive (progressive succession) or regressive (regressive succession) evolution event. This operating mode is active in all the spatial subdivisions of the plant cover of the island vegetation floors. The mountainous islands, like Martinique, are singularly composed of three plant floors corresponding to three strict bioclimatic domains. Naturally, depending on their biological cycles, the alien species will have a more or less marked colonizing power.

Overall, in a same floristic realm, the species belonging to the same floristic region have a greater likelihood of installation than those of other regions [42-45]. Conversely, the transfers within the territorial extension of a floristic empire to another have some limitations; especially when the eco-climatic conditions are affected by significant differences. Ultimately, the human vector, despite the natural barriers set by the anthropogenic processes they generated represent a key element in the increase in the species distributions areas (marginal areas) from their main areas.

Environment changes and the extinction of natives taxa (plant species) helped the establishment of exogenous species, often pantropical ones, forming a specific group we have named "floristic introduction potential" species, out of which some exhibit a regularly increasing colonizing power (Figure 2, Annex 1). These species probably occupy new functions or the functions once specific to the original extinct species or endangered ones. Accordingly, we can distinguish among these introduced plants all the existing morphotypes and usage types: naturalized species previously anthropophytes and those which are purely anthropophytes, fully requiring human intervention to ensure their phenological cycles.

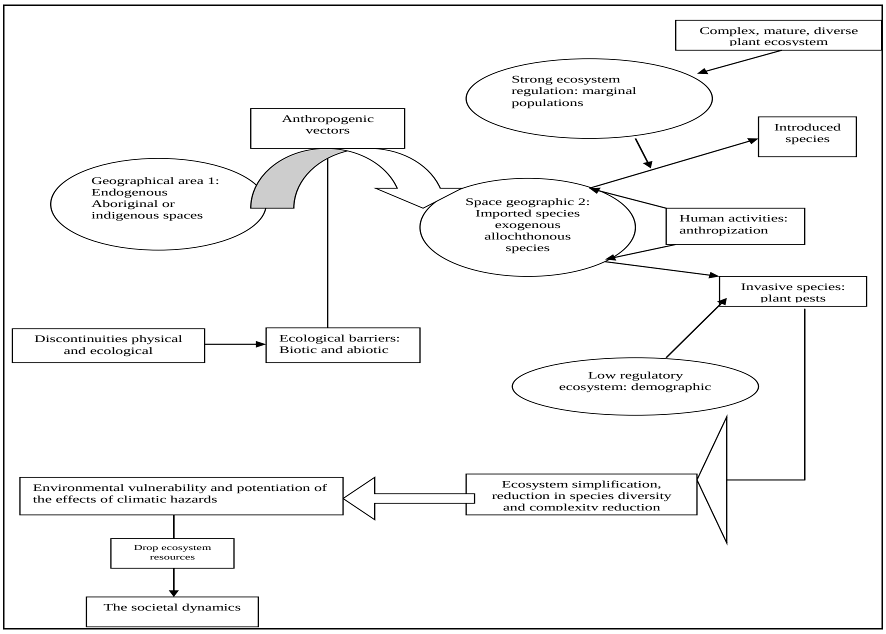

Figure 2: The potentiation process of allochthonous species

IV. The current state of the floristic potential of the French West Indies

If we consider only the seed plants, Martinique's floristic potential contains circa 3200 species. This number regards only the data contained in the recent flores [46][47]. This species stock is important if we take into account the island's size. The direct result is a strong specific and phytocenotic biodiversity. For example the forest trees are approximately six hundred. This figure could be increased substantially if we take into account the alien species. The great phyllums are present: Prephanerogames, Gymnosperms, Angiosperms, Pteridophytes. Martinique's floristic potential is divided into several classes linked to the indigenous, naturalized or cultivated nature of the different species. Naturally, with the exception of purely indigenous species, the others exhibit an ecologically complex behaviour.

They can be completely naturalized, ongoing naturalization, quasi-spontaneous or even originating from crops. Without being too much in the wrong, we may consider that 60% of the species are native, the others are distributed as follows: 5.4% are completely naturalized, 7.5% are ongoing naturalization, 23.6% are primarily cultivated, and 3.5% are cited and not currently found [46]). It is highly plausible that a number of species difficult to assess have disappeared during the colonization process. The introduction sub-potential is formed through exchanges between the old and the new worlds within the intertropical zone (Figure 3). Despite the reduced dimensions of the Caribbean Islands compared to the tropical continental lands, the introductions followed the land uses. We must assess this fact in the light of the taxonomic differences within the floristic introduction potentials of these islands (Annex 1).

Since 1635 the floristic structure of the plant cover has significantly changed, particularly regarding the dynamic profiles and the physiognomic types of the taxa. Plants belonging to the regressive extra-forest[2] stages mainly shrubs, herbaceous and pre-forest plants supplanted those which formed the spatially dominant climax and homeostatic forests of the pre-Columbian era [30]. The taxa expression within each great phyllum has undergone notable transformations. This fact is attested by the prevalence of primary and secondary heliophilous species, in general within the early successional stages. By altering Martinique's ecosystem characteristics, as throughout the Caribbean, the anthropization has generated conditions conducive to the establishment of exogenous anthropophilic species, some of which are very aggressive in inter-species competition (Figure 3).

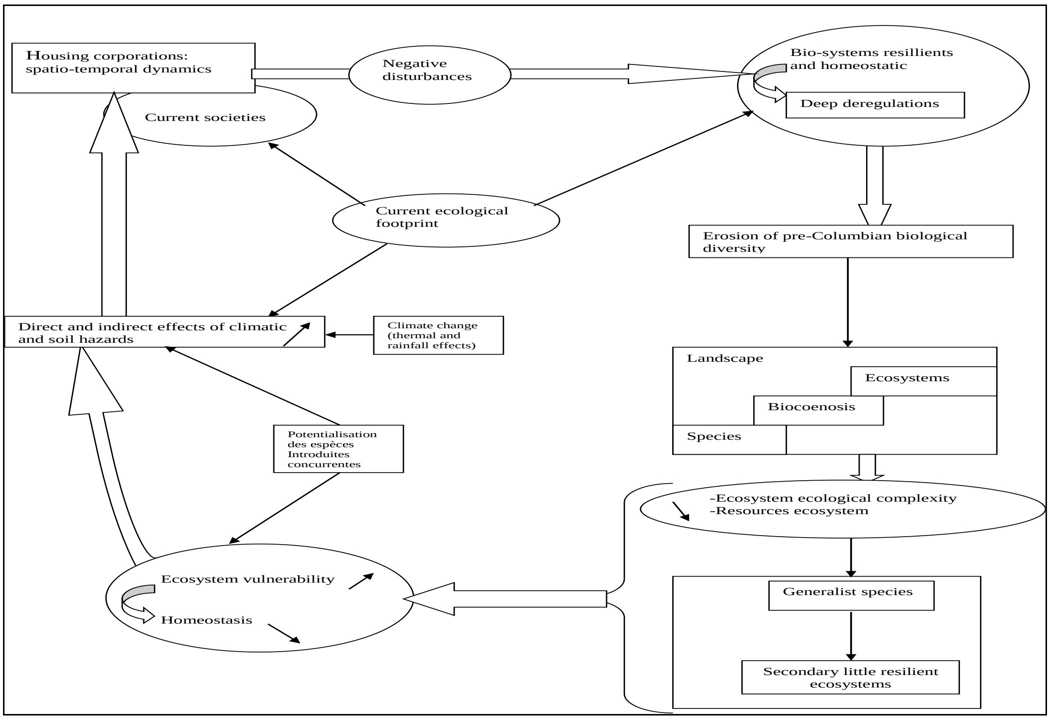

Figure 3: The effects of anthropization on small island systems

The stock of anthropophyte species distinctively consists of Amerindian introduction species and the contributions linked to the multiple colonization phases since 1635. On taking possession of the island, the subsistence crops and the implementation of large monospecific plantations have strongly influenced the introduction of species for food and industrial production: food, fruit, medicinal species, cocoa, coffee, sugar cane, etc. Chronologically, the first cultures could be found on the fertile lands of the lower floors, naturally on shallow slopes. The lower and middle third of the slopes essentially housed the large dwellings of the often monotypic plantations (sugar cane), while the top third usually covered in trees housed the small settlers cultivating subsistence crops and after 1848 the populations of newly free slaves. The exception was the South of the island where the local climates resulted in some monospecific crops, in principal cocoa, in areas corresponding to the middle floors (moderately wet bioclimate), for example the Vauclin mountain and the bottoms of the valley whose contained nature lead to the existence of a relatively high water resource (topographic corrections or eco-climatic inversion phenomena, [35]). For the cultivation of cocoa, just like for the coffee trees, they used species supplying natural shade, in principal the rain tree or Zamana (*Samanea saman*: Mimosacees). Ancient documents such as Moreau du Temple's map bear witness to this reality and give us a good idea of the land occupation situation at this time (Figure 4).

[2] The successional phases expressed before the establishment of the forest.

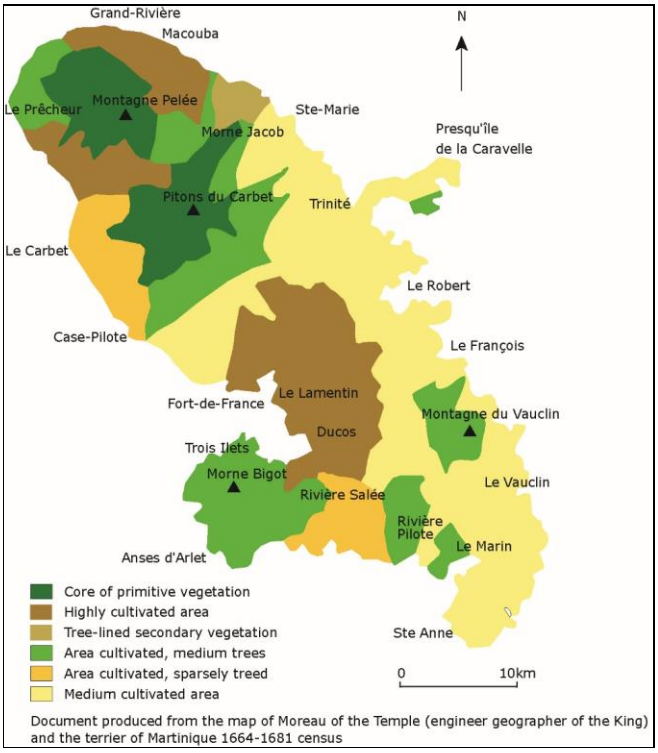

Figure 4: Status of the plant cover and the structuring of the space around 1770 (Martinique)

During the agricultural development, today’s commercial species which have become pantropical increased the biodiversity of the Antilles island systems. To these species vital for profit-generating crops and the survival of populations much later we add species having other functions and virtues especially ornamental ones (Annex 1). They constitute the bulk of the introductions in all the islands. Man is the primary vector, to whom we must add the domestic animals or those intended for the production of meat such as cattle, sheep and goats. The creole subsistence gardens of the post-colonial era, incorporating the traditional pharmacopoeia, are replaced with ornamental and pleasure gardens whose organisation and richness generally depend on the social class of owners. If the presence of landscaped spaces and ornamental gardens is an almost vital need in the cities to improve the quality of life, it is not less so in the peri-urban and rural areas, the ornamental species are very common[3]. Their architecture and phenology contrast starkly with the natural vegetation irrespective of its characteristics.

The resurgence of nurseries and the development of the horticultural trade in Martinique in the last decennia is a strong indication of this growing craze for foreign ornamental plants. All the areas are affected and receive a specific floristic treatment essentially incorporating ornamental plants: urban (green and landscaped areas, cemeteries, public buildings), roads (roundabouts, slopes, retaining walls). The means of area structuring[4] have been and remain a major cause of the spreading of ornamental plant species from the tropics of the old and new world. The current inventory does not allow us to specify the exact number of introduced plant species, because they are not all listed in the main flora of the Lesser Antilles. It is quite likely that one to two hundred taxonomic families had been introduced into the plant systems of small islands in the West Indies. Irrespective of the modes of introduction or transfer, the majority of tropical plants with commercial value from Asia, America and Africa, naturally according to their ecologies, are part of everyday life and the ornamentations of the Caribbean Islands inhabitants. The island populations of this region, in principal those of the cities where the natural habitats have completely disappeared, have culturally appropriated these ornamental foreign species at the expense of indigenous plant species, for which three hundred years of history had resulted in a high degree of tameness and the creation of an imagination fund rich in myths and representations.

This reality has resulted in the efficient and controlled use of the plant world which formed the basis for their survival. Finally the appropriation of the introduced flora is limited only to the services it offers: colours, shapes, flowers, perfumes, landscape features, architecture, phyllotaxis etc. In fact, the bulk of the introduced plant representatives have no common names. Often the genus name is used as the vernacular name.

[3] In principal around private houses.
[4]Environmental interventions of municipalities, Moderate Rent Housing companies (HLM), Mixed-Economy corporations (SEM) and communities of communes.

Ultimately, we can state that currently, in contrast to rural areas, the urban areas (strongly mineralized) are characterised by an exogenous ornamental vegetation (pantropical). All the physiognomic types are represented, from grasses to trees through bushes and shrubs. The growing trend of green plants and flower pots has also resulted in an increase in local production and imports. Logically the imports follow a legal circuit characterised by standards and principles governed by international laws. Nevertheless, despite the vigilance of customs and plant protection services, illegal and accidental introductions of entire or part of plants are frequent (import animals, passengers, careless collectors and lovers of exotic plants).

Notwithstanding this regular border monitoring, the legislation in force deals with infectious disease problems (due to bacteria, viruses and fungi) and not with ecological ones, notably the imbalances caused by introduced species which are harmful for the island plant ecosystem. All the plant species introductions are made without prior assessment with regard to their environmental profiles. Given their large number, approximately several hundred, on-site ecological studies in the host country and within reference stations would be time-consuming and expensive. On the other hand, it is essential to know the functional status of these alien species in their original communities, in terms of phenology, colonization capacity and ecosystem plasticity, naturally, in relation to the eco-climatic conditions. Here, in the context of ecological vigilance, the precautionary principle should apply perfectly, because the accidental or intentional introductions of ubiquitous plants (or plants of over-expressed ubiquity due to the anthropogenic nature of the receiving vegetation cover) have resulted in the collapse of plant ecosystems.

Many current, urban and rural landscapes are based on exotic circumtropical species. In this case, the loss of balance (homeostasis) resulting from deforestation is a critical factor in the more or less strong progression of some introduced species. Logically their ecological and dynamic profiles which ultimately influence their integration into the various island plant biosystems should be clearly defined and provide an analysis context for any introduction. The classification of the multiple introduced species, according to their ornamental or horticultural value, would not be sufficient since it is extremely difficult to predict their modes of behaviour within the new biotopes. If the behaviour of the individuals of these allochthonous species can be understood (autecology), their plant combinations (synecology) with the autochthone species are unpredictable. The characteristics of the new plant arrangements are fundamental parameters affecting the colonizing power and therefore the distribution (biogeography) of the plants introduced in the receiving ecosystems: "the host space". We differentiate between two situations: naturalization with variable negative or positive effects and the inability to assume an ecological function, therefore to become part of the biocenotic means (eco-systemic) typical for the implantation environment. In the second case the anthropogenic intervention is vital for their reproduction, which is often vegetative (cuttings, offshoots, layering, etc.). In fact, the classical cloning is the main propagation method; only certain species with notable economic value and purely anthropic nature benefit from modern techniques such as in vitro cultivation (banana). Irrespective of the case, the ornamental plants find installation sites outside the production areas and the gardens.

V. The impact of the introduced plants on the current landscapes

Their existence in built areas (urban), sometimes peri-urban and more rarely rural with a strongly ornamental anthropophilic vegetation is one of the constants of today's Lesser Antilles. This vegetation is very diverse, from a taxonomic, phenological (flowering, fruiting, etc.) as well as a physiognomic point of view. It is discontinuous and heterogeneous, characterized by ecologically atypical associations or groups under human control. It is in fact represented by private gardens (individual and collective) and public ones, by the landscaping of places of worship (cemeteries, churches) and of the national, departmental and communal road network (alignment trees, landscape treatment of roundabouts and slopes[5]). Unlike the ecological characteristics, only the chromatic, physiognomic and olfactory considerations are significant elements in the choice of plants and partly guarantee their commercial success.

Traditional and community-oriented, especially before and after 1848, today's Martinique has become a highly individualistic society where in some respects, the minerals, metals and plants are used for the protection of the houses against a large number of hazards linked to modernity and the new modalities of spatial organisation. The island's inextensible nature, the limited land availability compared to the multiple risks (climate and soil), galloping demography, the cult of owning your own house are all elements that led to the strong development of private gardens, mainly for purposes of protection and quality of life.

The floral art is secondary, its sole objective is the protection (blocking people's view, "camouflage plant", against the noise and pollution) and the creation of a pleasant life in the urban and peri-urban areas. The crucial lack of housing for people with small and average incomes has increasingly defined the rural area as the new population sector. As a result, we realize that the attraction for ornamental species is part of a dynamic similar to that of cities, despite the existence of preponderant forested landscapes. To a dispersed and illegal,

[5] Particularly in the French West Indies.

non-integrated, true "ecological pathology" subsequent to the demographic evolution phases associated with different economic changes we add the HLM collective housing (Moderate Rent Houses) which, despite their illegal character are built anarchically as well. These HLM whose number is increasing at a worrying pace and which constitute one of the main current approaches of Martinique's municipal housing policy are significantly involved in the destructuring of the rural landscape. In general, in order to maintain a minimum of landscaping balance the environmental concerns are not part of the general development context. The floristic treatment of these housing complexes is based on species identical to those used in urban areas, in the same manner and often fully opposite to the indigenous taxa.

Like the other islands of the Lesser Antilles, Martinique is rich in foreign species, mostly anthropophilic ones. Taking into account the great biotopes diversity, due to eco-climatic, edaphic as well as geomorphological constraints, the few naturalized species that can ensure their biological cycle in new environments without human intervention is surprisingly low. This phenomenon is all the more unusual because in many of the tropical island systems the species introductions were catastrophic and sometimes resulted in true ecological crises [2]. In general, irrespective of the degree of ecosystem complexity of the plant cover, the introduced species have low colonizing capacity in the Lesser Antilles.

We notice the same phenomena from the island of Saint-Martin to the Grenadines, the Saint Vincent dependencies. Irrespective of their morphotypes, both the agricultural and ornamental anthropophilic species are little represented in the natural vegetation. However, from a taxonomic perspective, a large number of introduced taxa belongs to families or genera of the local flora. Their mainly heliophilous and semi-heliophilous temperament, rarely semi-sciaphilous and sciaphilous allows them to colonize fully open environments. With regard to water resources, they have broad adaptation capacity, matching all the bioclimatic types existing in the small Caribbean Islands, be they mountainous, low altitude or low areas. The ecological profile of these foreign species, although specific to open biotopes, would potentially fit into the typical dynamic stages of the Lesser Antilles plant formations [35].

As a result, the low presence of these species in the natural formations, either in groups or isolated, seems paradoxical. The reasons for this ecological inefficiency are probably to be found in their biological cycles, in particular their reproductive modes. Actually, the floristic introduction potential is mostly composed of elements which are unable to ensure their sexual reproduction without human intervention. The propagation is almost exclusively vegetative (asexual) and corresponds to the conventional horticultural techniques (cloning). In the rare cases where the reproduction takes place through the sexual organs, the diaspores (seeds) are inefficient[6] in the natural environment. With the exception of the anemochorous species, the dissemination vectors seem inefficient. In reality, an entire range of factors associated with the phenology limit the installation and development of these exogenous species as well as their possible effectiveness in relation to interspecific competition.

Finally, the understanding of this particular phenomenon will require the establishment of a multidisciplinary research program to highlight the ecological incompatibility between many introduced species and their receiving environments: in Martinique and elsewhere in the Caribbean. These few elements proposed above are derived from field observations, nevertheless, the causes of this relative ecosystem resistance to introduced species are complex and difficult to identify. Only studies throughout the stages of their life cycle will allow us to identify the limiting factors. They are probably linked to their edaphic characteristics, the dissemination vectors, to the different bioclimates, to the germination means and the interspecific competition. Theoretically, there are numerous interlinked ecological factors opposing the total expression of multiple phenological phases (stages of life) of these introduction potential species.

VI. Hypotheses regarding Martinique's apparent "ecosystem resistance" to introduced species

Despite the quantitative importance of the introduction potential, the natural plant landscapes of today's Martinique, just like those of the Caribbean Islands, irrespective of the scope of human impacts, consist almost exclusively of the local flora. Since the first botanical inventory of the island, no significant expansion of alien species has been observed, with the exception of marginal installations dependent on favourable microclimatic conditions: the vegetative propagation in this case is their main reproductive policy and refers to specific species. Unlike other island systems in the circumtropical area, to be specific Mauritius, Tahiti and the island of Réunion, the Lesser Antilles, which are heavily anthropized as well, seem to be able to oppose the colonization of introduced flora. We can therefore speak of the "ecosystem-based immunity" of the plant formations of the Lesser Antilles natural environment.

Irrespective of the vegetation floor and the dynamic stage, therefore the relevant successional stage, the phenomenon is the same: the plant landscapes are dominated by the indigenous species. Yet all the regression stages, deriving from the original highly complex and structured forests, can be observed within Martinique's

[6] From the point of view of germination

vegetation cover just like in the other archipelago components. Open areas specific for the installation of light-loving species (heliophilous species) are numerous and diverse, nevertheless, the progressivity of the introduced plants is surprisingly low. This is diametrically opposed to the ecological fragility of Tahiti's plant communities which is going through an ecological quasi-crisis due to the aggression and the rapid expansion of a South American species of the Melastomataceae family whose horticultural name is *Miconia magnifica*. This species has undeniable ornamental value which explains its great horticultural interest. With a heliophilous temperament and purely hygrophilous, the *Miconia magnifica* seems to have significant affinity for the large gaps in the rainforests.

Like the pioneer species, this plant can be considered a brief cicatrisation plant. Normally, the large gaps (single or multiple chablis) of the Tahitian rainforest subsequent to the fall of trees or steep landslides (natural mortality, climatic hazards) are invaded, under certain conditions, by tree ferns. After a few years these ferns which require open spaces are replaced by tree and shrub species constituting the first wave of the forest colonization. It follows, theoretically at the time, a whole substitution of increasingly specialized plants to the more complex stage plant processions: the climax phase. In the case of the island of Tahiti, this Melastomatacee settles and develops in some gaps (chablis). Unlike the natural process we briefly mentioned above, the monotypic or monospecific newly formed *Miconia magnifica* tree associations do not allow the start of the subsequent dynamic stages.

This phenomenon translates into a blocking of the plant succession, because the ecological conditions created by these exogenous plant communities do not correspond to the ecological profiles of the indigenous plants normally involved in the forest dynamic phases. Apart from the diaspores of the foreign species (*Miconia magnifica*) which forms a dense floral cover, a genuine impenetrable barrier, the indigenous forest pioneer species cannot find installation and expansion sites [35]. In these circumstances this Melastomatacee indefinitely reproduces itself through successive populations. The forest gaps being sylvigenesis engines, when they no longer ensure the renewal of forest unit, they regress, collapse, are depleted from a floristic therefore ecosystem point of view. Without exhaustive explanations, we present the likely hazards associated with anthropic exchanges, because by eliminating the natural ecological barriers for certain plants, we increased their spatial expansion capacity. The ecological success of these plants currently depends on their biological functioning and the characteristics of the receiving biotopes.

The almost general anthropization, signified by the deregulation of plant ecosystems, generated numerous new environments. Therefore, the introduction of species and the disappearance of the native ones are all elements that will shape the future interspecific competitions and floral combinations. Within the plant communities, both in space and time, each species candidate for the floristic composition corresponds to an ecological function and therefore represents an interactive element which can be limiting for others. Logically, within the floristic entity, when the species change both in quantitative and qualitative terms, their modes of associations as well as their ecological regulatory functions also change. In the light of the "ecological identity" of the introduced species, in general heliophilous, the anthropic landscapes they structure are the direct expression of simplified regressive ecosystems characterised by low diversity due to the disappearance or elimination of indigenous plant species. Often the deregulating energy represented by human activity "insularized" the biosystems, in principal the original or highly organized forest ones, with a sharp decline in the number of highly specialised species, specific to the secondary advanced, pre-climax and climax stages.

When the floristic relays are inefficient in terms of dissemination, in principal the highly specialized species of the terminal stages, the vegetation is dominated by generalist species typical of secondary or regressive or pioneer plant units. Logically and regarding their level of anthropization, the plant ecosystems of the Lesser Antilles, just like those of some islands of the intertropical area, should incorporate a significant number of foreign plants in their organisation. The low colonizing ability of the latter, particularly within Martinique's plant world is a singular or "atypical" phenomenon. The seniority of these species was insufficient for their naturalization and their spatial expansion.

In fact, their resistance to exogenous plants is not total since we observed the tentative settlement of a small number of import plants, in some environments of the lower and middle floors. Without shaping the identity of Martinique's different natural landscapes, these introduction potential representatives may play a positive role (dynamic activator) or a negative one (dynamic inhibitor: invasive plants like *Miconia magnifica* in Tahiti). The existence of invasive plants shows that the apparent "ecosystem immunity" of the small islands of the West Indies is likely transient and that the constant anthropic degradation which renews the ecosystems will result in a true invasion of the introduced plants and likely in the long term change in landscape and impacts on biodiversity.

VII. A few tree species introduced under supervision

The resistance of Martinique's vegetation is not complete because certain introduced plants timidly colonize some plant ecosystems, particularly those on the lower and middle floors. The dry and medium wet environments are affected. The installation modes are variable and depend on their various ecological profiles. Obviously the latter will confer to these taxa an invasion power, which is uneven as well. The formations of naturalized alien species or those ongoing naturalization can generally be divided into three subgroups: the "inhibitors" (invasive plants, Figure 5), the "activators" (successional activators, Figure 6) to which we add the so-called "passive" species. The latter's insertion in the indigenous phytocenoses results in the redevelopment of the population numbers. It is obvious that due to unsustainable management the announced intense anthropogenic degradation could result in the quantitative emergence of this exogenous flora. In addition, these are ecosystem dysfunctions associated with the regression of biotopes and plant species as well as the disappearance of their dissemination vectors that free the colonization sites.

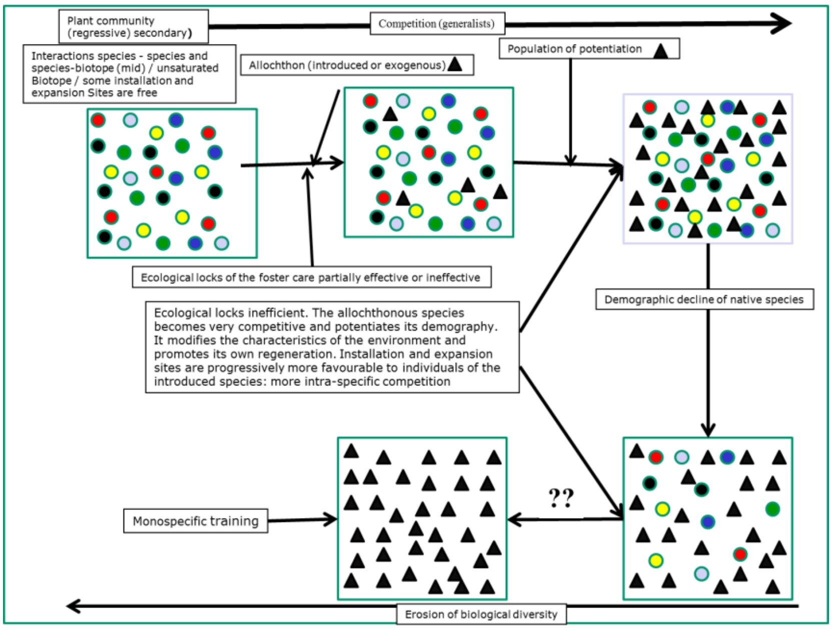

Figure 5: Potentiation of allochthonous species in anthropogenic habitats

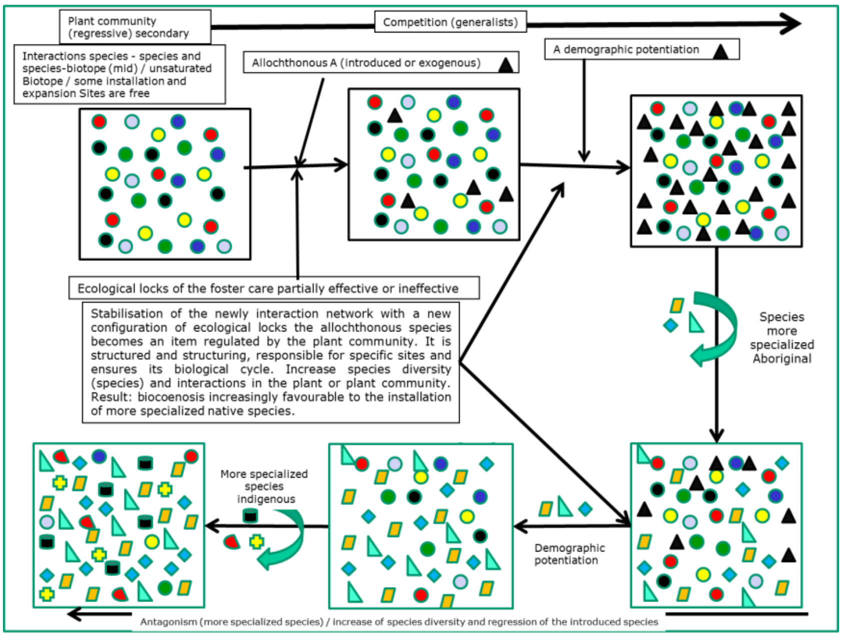

Figure 6: Theoretic process of the successional activators of allochthonous species

In other words, the loss of floristic relays (of dynamic stages taxa), the impossibility of new resistant formations originating from the stock of native plant species are important parameters that will define the degree of aggressiveness of the introduced species and therefore their competitiveness. Unlike the pre-Columbian period of great floristic complexity, today's plant dominance is due to open space species, dependent on light energy in varying degrees. The existing biotopes, just like those of the future, are favouring and will continue to favour the establishment of imported tropical plants, since their behaviour towards light falls within almost the entire range of the heliophilous temperaments. Unlike the highly specialised indigenous species of the Amerindian past, today's species are mostly generalists. Accordingly, the end of anthropization, in some areas, in the long term and at the end of the succession will lead to a complexity para-climax well below the supposed climax of pre-colonial times.

Beyond reasons linked to the invasion of plant species, this reality highlights other issues linked to the increasingly vulnerable character of the plant ecosystems, in principal their soil components whose mechanical protection is increasingly efficient. As a result, the effects of climatic disturbances such as geotechnical and hydrologic phenomena are significantly increased. These environmental problems occur due to the mere anthropization of the plant ecosystems. In reality, in the small mountainous islands like Martinique, such loss of a minimal ecosystem balance due to human activities has serious and permanent consequences. If to the already alarming existing situation we add the expansion of alien species. Especially those which are able to inhibit or modify the succession mechanisms and whose result is a simplified ecosystem structure and operation, they lead to environmental dysfunctionalities affecting the entire human society even more.

VIII. Potential invasive plants

The species ongoing naturalization can be detrimental from an auto-ecological point of view as well as from a synecological one. By disrupting the phenology of many local species, they change the specific interactions. Ultimately they are, theoretically, able to alter the functional relationships among species. This is extremely difficult to prove, nevertheless field observations and overall knowledge of the plant succession mechanisms of small island systems in the Caribbean allow us to roughly decrypt the functioning modalities of these introduced plants. Depending on the mode of dissemination there are many cases to be considered (Table 1).

Table 1: Potentially invasive plant species

Scientific names / families	Vernacular names	Origin	Physiognomic types	Bioclimates	Dynamic stages (biocenotic affinities)	Dissemination
Spathodea campanulata/ Bignoniaceae	Tulipier du Gabon	Tropical Africa	Tree	Wet, moderately wet	pre-forest, young Forest, gaps in the advanced secondary forests	Anemochorous
Funtumia elastica / Apocynaceae	Goma, Caoutchouc	Tropical Africa	Tree	Wet and hyper-wet	secondary forest	Anemochorous Barochoric?
Dichrostachys cinerea/ Mimosaceae	Acacia, Fausse monnaie	Tropical Africa	Shrub	Dry	Herbaceous, shrub	Barochoric
Mimosa malacocentra/ Mimosaceae		Brazil	Shrub	Dry	Herbaceous, shrub	Barochoric
Bambusa vulgaris/ Poaceae	Bambou	Tropical Asia	Large herbaceous plant	Wet, moderately wet	Herbaceous, shrubby chablis	Anemochorous
Triphasia trifolia/ Rutaceae	Petite citronnelle	South East Asia	Shrub	Moderately wet and dry	Pre-forest, young forest	Zoochoric?, Barochoric
Castilla elastica / Moraceae	Panama rubber tree	Tropical America	Tree	Wet, moderately wet	Pre-forest, young forester, forest gaps	Zoochoric?
Thunbergia grandiflora/ Acanthaceae	Liane de Chine	India	Vine	Wet, moderately wet	Shrub, pre-forest, secondary forest, large gaps of mesophilic and hygrophilous forests	Zoochoric?

8.1. Tulipier du Gabon (*Spathodea campanulata*: Bignoniaceae)

This is a good example of anemochorous species (spread by the wind). Introduced for the ornamentation of public or private parks and gardens, in a few decades, the Tulipier du Gabon settled timidly in damaged areas[7] of the dynamic shrub, pre-forest or young and secondary forest stages. This species is characterised by a heliophilous temperament, low density, and rapid growth. Due to its ecology, we can classify it as a cicatricial plant. This status gives it great flexibility with regard to the anthropized environments of the

[7]These damaged areas originate from the mesophilic forests (evergreen seasonal tropical forests) and hygrophilous ones (tropical submontane ombrophile rainforest).

lower and medium plant floors, or even the higher ones. From private and public gardens (seed plant parks) the Tulipier du Gabon colonizes vegetation formations of unequal complexity in isolation and more rarely in groups especially on the outskirts of urban and rural areas. Exceptionally, we seen it in gaps of the hygrophilous forest eco-units (tropical montane rainforest). Due to the edge effect, it can settle along forest roads (example: Fond Baron, the forest district of Fort-de-France). The dissemination core seems to be the old forest and ornamental nursery of the Office National des Forêts (ONF) in the place called "La DONIS").

In general, the populations are very low in the natural environment, however its escalation seems to be growing inexorably. Due to its high ecological tolerance (heliophilous growth) to which we add a significant anthropogenic seed plant park, these taxa is a good candidate to become an invasive plant. Despite its excellent competitive level, the Tulipier du Gabon's community success is currently particularly mediocre. This proves that Martinique's vegetation canopy, even modified, possesses some resistance due to limiting ecological factors whose characteristics are not easy to define.

In Puerto Rico in the Greater Antilles, its "invasive plant" name is legitimate since the forest environment significantly colonized by this tree (the Tulipier du Gabon) underwent deep transformations. In this case, a substitution phenomenon occurred because this species replaces other floristic representatives (other floristic relays), logically with a close dynamic profile and lower competitiveness. Regarding the example of Puerto Rico, it seems that this installation is accompanied by significant changes: ecosystem simplification at the expense of the local forest tree species. Facing this danger that may ultimately affect the complexity of the Puerto Rican forests, only an eradication programme will reduce the harmful effects of this invasive plant. Naturally the situation is less dramatic in Martinique and the mountainous islands of the Lesser Antilles, however, we must remain extremely vigilant.

8.2. *Funtumia elastica* (Apocynaceae**)**

This native species of tropical Africa and little-known in the French West Indies, was introduced between 1896 and 1897. It was a potential source of rubber, and was cultivated in some English islands such as Antigua, Saint Kitts, Montserrat, Saint Lucia, Saint Vincent and Grenada. The recent flores like those of R. Howard (1979-1989) specify that the island of Dominica is the unique naturalization station. As a result, having not been cultivated in Martinique, just like a large number of Apocynaceae, its presence is probably due to its ornamental value: physiognomic type, architecture (phyllotaxis), colour of the leaves and flowers and inflorescence. Notwithstanding the little information we have on this plant, we were able to outline some general features of its ecology through our field observations.

The known stations are all located in areas influenced by wet and moderately wet bioclimates resulting in hygrophilous (tropical submontane rainforest of the lower floors) and mesophilic (evergreen seasonal tropical) forest potentialities, as well as their hygro-mesophilic (evergreen seasonal tropical rainforest) interface (ecotone). *Funtumia elastica* can also colonize confined areas as the bottom of valleys and the stream banks, even within the lower plant floor (between 0 and 250 m on average) part of the dry bioclimate. This tree can reach 20 to 25 meters in height [47], it appears to require a secondary or regressive forest structure for its installation and expansion before the maturity phase. Only an in-depth ecological study may reveal the ecosystem functioning of this taxon, however it is quite likely that it may become a significant floristic competitor. Under any circumstances, the ecological characteristics of this species render it a factor that could significantly disrupt the successional pattern of certain aspects of the wet and moderately wet environments.

8.3. *Dichrostachys cinerea* (Acacia de Saint Dominic, fausse monnaie), *Mimosa malacocentra*

These species of shrub morphotypes belonging to the mimosacees family (under the legume family) originate respectively from Africa and tropical America (Brazil). They were introduced in the Lesser Antilles after they colonized certain islands of the Greater Antilles. It is almost impossible to know the reasons for these introductions since the literature dealing with this topic supplies imprecise and sometimes contradictory information. Obviously, with regard to their ecological functioning, they can be regarded as dynamic inhibitors. These shrubs colonize the sites affected by strong ecosystem damage, in principal soil damage: the old abandoned agricultural plots of the dry bioclimate. Their cultural history seems to constitute a critical element in their colonizing effectiveness, specifically plots of land that have undergone successive ploughing and land once used for sugarcane plantations. In general, all the strongly anthropized areas with soils unstructured by the agriculture of the South and the northern Caribbean littoral fringe of Martinique are suitable for the installation of these mimosacees. A priori they are xerophytic shrubs forming monotypic or monospecific, dense, impenetrable units that only allow the implementing of their own regeneration when mature. Thus, these species continually reinitiate their populations and block plant succession. Currently, in relation to the rest of the vegetation, the groups they form occupy very marginal areas which are potential expansion sites. In the light of the anthropogenic pressure evolution, it is likely that these plants will assume an increasingly important role in the ecosystems and landscapes of Martinique's dry bioclimate areas, with significant environmental consequences: for example the inhibition of successional mechanisms for a fairly long period of time.

8.4. *Bambusa vulgaris* (Bamboo**: Poaceae)**

The Bambou can also be classified as an invasive plant. In fact, this tall great herb (monocotyledonate) from tropical Asia grows mainly in wet environments. Strongly naturalized, the bamboo was once used in many domestic activities, prefers the forest edges, but also the damaged riparian forest units. Unstable slope areas where the soil is frequently modified, the anthropogenic damage deep within the forest canopy, the large gaps or natural chablis allow the bamboo to settle. Two modes of reproduction characterize the notable colonizing ability of this species: sexual reproduction characterised by dense little frequent fruiting (several decades) associated with anemochorous dissemination [the diaspores (seeds) are transported by the wind] and the vegetative reproduction (asexual).

These reproduction mechanisms grant it excellent competitiveness. Great seed production and the effectiveness of the wind dissemination cover from the point of emission and important spaces significantly offset the very low temporal frequency of its sexual reproduction. After the seeds are planted in sites where the ecological conditions are favourable, the development of individuals is followed by the vegetative propagation resulting in the end in monospecific formations which oppose the installation of the spontaneous vegetation. The result is to some extent a "hibernation" of the colonized plots for several years. This phenomenon can be noted in the wet and moderately wet forest formations of Martinique and other mountainous islands of the Lesser Antilles. In the great majority of cases, the past and present human activity is the main contributor to the spatial distribution of this introduced plant, which modifies the means of plant succession when it occupies many natural or anthropic chablis of the forest entities.

The field observations show that it is likely that this gap modification (primordial sylvigenesis elements) is directly translated into the low efficiency of progressive vegetation dynamics defined by the replacements in time of the formations of environmentally increasingly specialized species resulting in the "hibernation" concept. Notwithstanding this reality, it seems that the man-made forest formations, the so-called secondary formations which avoided man's influence arrive, at the end of a progressive change[8]to regulate the bamboo's community development. When the damaged forests become mature (advanced or delayed secondary forests) they incorporate groups of *Bambousa vulgaris* which colonize old large gaps, often becoming senescent and launching a process of elimination: we call this phenomenon the bamboo ecosystem regulation.

8.5. *Triphasia trifolia* (Petite citronnelle)

This Rutacee of the Citrus family, native to India was widely cultivated in the tropical zone and became an ornamental plant due to its aspect, its leaves (its phyllotaxy) and fruits. Used in gardens, in groups or on edges (trimmed hedges), from where it probably escaped, it forms monospecific associations in some sectors of the coastline. Despite its apparent ubiquity due to cultivation techniques and a broad climatic tolerance, this taxon seems to have more affinity for dry environments. Without a thorough study, a few known stations of *Triphasia trifolia*, give us information on its ecological potential, similar to that of xerophytic species of the undergrowth. In the light of the field observations, our inventories data and the characteristics of the typical successional processes of the lower floor, this taxon appears to be able to settle from the mature shrub stage.

A priori the eco-climatic pre-forest and forest conditions are the most favourable. In fact, the formations are much more significant in secondary forest communities which are structurally and architecturally varied. Within the forest organisation, the isles of *Triphasia trifolia* of various dimensions, occupy the lowest forest stratum not far from the grasses stratum (usually grasses). In the forest communities of the anthropized southern environments, it is its understory nature, its semi-heliophilous or sometimes semi-sciaphilous temperament and its means of community operation that give it all the potentiality that can turn it into an invasive plant in the future. The spatial progression of this plant species has been slow but steady for more than a decade and appears to be in covariance with the regression, the collapse or the drop in complexity of the remaining forest of the lower region whose causes are purely anthropic. In some forest groups, it (*Triphasia trifolia*) typically forms discontinuous, but dense and impenetrable units, real barriers which completely or partially oppose the installation of part of the diaspores (seeds) scattered by the wind, birds and more rarely by other animal vectors.

Overall, in these damaged forests, the anemochorous and zoochoric seeds are mostly small and often of insignificant weight. Finally, the *Triphasia trifolia* islets of significantly high density represent gravity filters, selecting seeds with advective seminal potential based on their weight and shape. Logically, this phenomenon should lead to a deficit and the spatial seeding heterogeneity of the edaphic (soil) system resulting in the expression of the floristic potential through the main plant formations. It is extremely difficult to accurately

[8]A reconstruction to a stage of greater complexity.

predict the future behaviour of this species, which in addition depends on interspecific competition. The collected field information is sufficient to predict an increased extension correlated with the increase in human pressure due to demography, development and lack of land resources.

To these species we must add *Castilla elastica* (Trees, Moraceae) and *Thunbergia grandiflora* (Vine, Acanthaceae) two introduced species in progression in the indigenous plant formations preferring the moderately wet and wet bioclimates. Our field observations indicate that *Castilla elastica* seems to be developing at the pre-forest stage of succession and perpetuates itself by increasing its numbers in the later evolution stages. In some listed damaged floristic units where the *Thumbergia grandiflora* species is present, it develops a dense and impenetrable curtain catching a high percentage of the incident light. One of the consequences is the trees' inability to complete all of their morphological development. There is also the risk that this process will result in a specific selection that could lead to new plant combinations and thus to new population dominance.

In the context of management of the local plant resources of the Lesser Antilles, and despite the sparse data we obtained, these examples show the need to take into account these naturalization phenomena of more competing species that can create long-term significant ecosystem and landscaped dysfunctions. It is all the more worrying as the species of the advanced forest stages which ensure a minimal balance, in particular the mechanical soil protection, are scarce due to low seed populations and non-existent or ineffective dissemination vectors: for example *Hymenaea courbaril*[9] (the courbaril) whose supposed disseminator, the Agouti, disappeared from Martinique.

IX. The "Dynamic activators" (Table 2)

In contrast to the previous plants, a subgroup of species with introduction floristic potential would undergo its colonization phases to facilitate progressive vegetation dynamics, during restructuration following an anthropic disturbance. Just like the potential invasive plants described above, these "dynamic facilitator" plants are usually heliophilous, semi-heliophilous and additionally semi-sciaphilous. They have a strong preference for open areas. In this group of exogenous plants the specific dominance will depend on the relevant species and the environmental conditions. Here we classify the most significant taxa for the plant succession facilitation phenomenon observed in the field.

Certainly, from an auto-ecologic point of view, our knowledge is fragmentary, however many observations allow us to outline the main lines of this particular mechanism, in some ways beneficial to Martinique's plant cover (Figure 6). Compared to the purely local species, the populations of introduced naturalized species or species ongoing naturalization involved in this process have a relatively low quantitative importance, except in some sites where their density can be extremely high. Naturally, in the plant ecosystems of the island, these alien species have low installation probability and it is due to specific site conditions that they can develop by forming frequently monotypic stands. The profound environment damages marked by edaphic and biocenotic regression represent a major element in the initiation of this phenomenon. In reality, this activation is limited to the recolonization of areas environmentally ruined by agricultural practices (southern and north Caribbean coast of Martinique) where the local (endogenous) species are little competitive. In these areas deeply modified by humans, the breakdown of the ecosystem balance causes the higher prevalence of these introduced species. This situation should be compared to environmental conditions that allow, even in the event of disturbances, the expression of all the temporal events of the vegetation dynamics.[10]

The highly anthropized areas, in principal those of the plant understorey are characterised by a preponderance of herbaceous and shrub morphotypes species which create, in various modes of association, a vegetation cover whose continuity depends on the site's eco-climatic conditions. Sometimes the vegetation is almost absent and is reduced to small marginal clumps of shrubs and grasses on unstructured and rocky soils. These biotopes affected by deep dysfunctions appear to be stationary. They change little in terms of physiognomic and floristic evolution. Frequently, the phenological cycles are provided by the same species in an almost permanent movement of initiation (regeneration) and collapse (senescence). This phenomenon is typical for low fertility xeric environments, damaged by an intense and pluri-form anthropization (agriculture) (southern and north Caribbean coast of the island).

This system guarantees the regeneration of the species already in place, excluding any floristic seeding, especially linked to the more specialized taxa of later stages. The blocking of the successional process results from the inability of the advective seminal potential representatives[11] to find installation opportunities, due to the unfavourable environmental conditions and the lack of subsequent interspecific competition. The "dynamic activators" will finally break this mechanism that favours the development of one or two species.

[9]Of the Caesalpiniaceae family

[10] All the successional stages that are specified by the native species formations.

[11] Anemochorous and zoochoric seeds.

The facilitating taxa which sometimes speed up the vegetation succession during their colonization use the same means defined in three stages: the initiation stage, the expansion stage, the maturity stage [35]. Their community operation differs due to its goals characterised, precisely in the maturity phase, by the creation of ecosystem conditions necessary for the floristic and physiognomic expression of the dynamic upper stage or stages (most complex): for example, the transition from herbaceous to shrubby and pre-forest stages. Depending on the site situations, to be specific on the existing microsites, the installation dynamics of the "dynamic activators" varies: it can be random, by scattered groups or isolated individuals.

Table 2: The "activators" of vegetation dynamics

Scientific names / families	Vernacular names	Origin	Physiognomic types	Dynamic stages (biocenotic affinities)	Dissemination
Delonix régia/ Césalpiniacées	the Flamboyant	Madagascar	tree	herbaceous, shrub, pre-forest young forest	barochoric
Haematoxylon campechianum/ Césalpiniacées	Campeche	Tropical America	tree	herbaceous, shrub, pre-forest.	barochoric?
Swietenia mahagoni/ Méliacées	The small leaves Mahogany	Tropical America	tree	shrub, pre-forest, young forest	anemochorous
Sweatenia macrophylla/ Méliacées	The Bigleaf Mahogany	Tropical America	tree	pre-forest, young forest	anemochorous
Mimosa pigra/ Mimosacées	L'Amourette	Tropical Africa	shrub	herbaceous	barochoric?
Gliricidia sépium/ Fabacées	The Gliciridia	South America	tree	herbaceous, shrub	barochoric?
Samanea saman/ Mimosacées	Zamana, rain tree	Tropical America	tree	forest, additionally herbaceous, shrub and pre-forest	zoochoric?, barochoric
Manilkara zapota/ Sapotacées	The Sapodilla	Central America	tree	pre-forest, forest	zoochoric barochoric
Spondias mombin/ Anacardiacées	The Mombin	Tropical America	tree	forest, additionally pre-forest	zoochoric, barochoric
Heliocarpus Donnell-Smithii/ Tiliacées	The Blessed Sacrament (formerly cultivated in the St. Peter Botanical Garden)	Central America	tree	shrub, pre-forest, young forest	anemochorous, barochoric

9.1. *Delonix regia* (the Flamboyant: Caesalpinioideae)

Despite the lack of dissemination vectors, this naturalized species native to Madagascar can present significant local development (a strong progression). Actually, in damaged sites the elastic dehiscence of its huge seedpods containing several seeds contributes to the installation of a large population. From a seed or seed island, this barochoric dispersion space extends spatially and can become dominant. Its ability to find installation opportunities both in shrub communities and in the young forest eco-units of the southern part of the island as well as its high growth speed turn it into a powerful agent of plant recovery. Due to these phenological means, in a few years (one or two decades) the Flamboyant can induce significant ecosystem changes by making the vegetation cover pass from the shrub stage to a forest stage that opposes its own regeneration.

Finally, the *Delonix regia* tree groups, naturally according to the constraints they impose (architecture, structure, biomass) will foster the establishment and expansion of tree species of the natural flora. From a behavioural perspective, the Mahogany (*Swietenia mahagoni*: Meliaceae, native to tropical America), species of Martinique's wood industry which is little competitive within the spontaneous flora species, appears to be identical. Except that its growth rate is much lower and the produced biomass can be used in the wood industry (half mature age 40 years). In situations of strong environment damage characterized in principal by intense soil erosion, we can observe particularly dense regeneration (the Southern part of the Island) from a relatively small number of seeds (Mahogany) and on small surfaces.

9.2. *Haemotoxylon campechianum* (Campeche: Caesalpinioideae)

The Campeche is a good candidate for the restructuring of xeric biotopes. On land where erosion is extreme, especially those once used for agricultural productions, this taxon has an amazing colonization ability. The worked and depleted soils of the old cultivated lots that have undergone significant erosion seem better able to promote the Campeche's regeneration compared to areas with deeply eroded soils which have not been modified by agriculture and which preferentially receive secondary or regressive species of the indigenous flora. Like the Flamboyant and the Mahogany, the Campeche, where density and maturity are sufficient, forms groups where their internal structures allow the initiation of more complex successional phases by the establishment of environmentally more specialized taxa such for example *Cassine xylocarpa* (Prune bord-de-mer) precisely on the southern xeric coast. In this specific case, this is truly a dynamic jump since this species *(Cassine xylocarpa)* which usually requires a forest tree limit, is considered an effective climax element of this area.

9.3. *Mimosa pigra (*Mimosacee) and *Gliricidia sepium* (Fabacee)

Mimosa pigra (Amourette Rivière), probably originating from the old tropical world as well as *Gliricidia sepium* (Gliricidia) native to South America are two species that can also be classified in the family of dynamic activators. With totally opposed ecological profiles, they are able to initiate the tree phase very rapidly through different modalities. In fact, the Amourette Rivière preferentially grows in moderately moist grasslands which were formerly grazed where the ground has been transformed by compaction. It spreads rapidly from the initiation points (installation places of the first seeds in the seed matrix) according to modes of dissemination which remain unknown. However, the plausible elastic dehiscence allows us to envisage a particular type of dissemination: many mature pods, opening elastically, project the seeds which fall on the ground due to gravity and germinate in suitable sites. As the population of this species increases in density and biomass, the grass cover regresses to disappear entirely. This process results in a *Mimosa Pigra* monospecific community of the shrub morphotype which can reproduce favouring its own regeneration over a relatively short period of time like the invasive plants before the higher chrono-sequences (stages) species can settle on the site.

As regards Gliricidia, the differences from the plant described above, with regard to its operation in the natural vegetation, lie primarily at the level of its environmental specificities regarding much more xeric soil of deeply unstructured environments. In this case the spatial progression is infinitely slower for a number of phenological reasons. It too has dehiscent elastic pods, from environmentally ruined stations this species can form pure units or participate in pluri-specific tree groups. For the highly localized recolonizations of highly eroded sites, this taxon very rapidly results in a tree vegetation that can represent the start of a specific dynamic path.

To these mechanisms we add the "successional activation" where we note the gradual implementation of populations, modes of colonization starting from a single individual which reaches maturity (age of full expansion) and favours the regeneration of other taxa. This colonization front thus created will conquer larger surfaces step by step. Logically if and only if the eco-climatic conditions are favourable. Despite its slowness this modality is common and does not always reach its end, however, in the case of extreme de-structuration, in certain blockage situations it (this modality) is likely to stimulate a colonization resulting in long-term floristic and physiognomic changes.

In the absence of anthropization or zoo-anthropization, in the dry savannas of the South[12] of Martinique, this mechanism allows the invasion of trees with varied physiognomies. The Zamana or the rain tree (*Samanea saman*: Mimosacee, introduced from tropical America) exhibits this functional mode regarding the dynamics of tree implementation, precisely where the ecological deregulations are accentuated: strong anthropic regression of the original forest ecosystem up to the installation of a self-perpetuating herbaceous grass stage. From the point of colonization initiation represented by one mature *Samanea saman*, it creates a microclimate under its crown receiving spontaneous flora species. These form a pioneer front which advances step by step and through the same mechanisms: we call this phenomenon "creep colonization.

Finally, there are a series of introduced, little competitive plants, whose behaviour is not clearly defined in the light of recent field observations. We can classify them in two categories, the positive (potential dynamic activators), the passive ones involved in floristic associations when the sites do exist: *Adenanthera pavoninia* (passive) *Malnikara zapota* (dynamic activator) *Debbie thamnia* (passive) *Spondias mombin* (dynamic activator) *Anacardium found* (passive) *Heliocarpus donelmitii* (dynamic activator) *Hamelia patens* (passive) *Cassia fistula* (passive). The behavioural types proposed above are not definitively irrefutable because behavioural changes are plausible and depend on the ecosystem evolution, therefore on the landscape evolution, which is linked to the human-environment relationship.

X. Discussion

These non-exhaustive descriptions which allowed us to present the broad outlines of the operation of introduced naturalized species or species ongoing naturalization, show the extent of the floristic substitution phenomenon in connection with future anthropization. The inevitable weakening of plant groupings in favour of a multiple and complex space occupation, for reasons of infrastructural and economic development necessary due to the demography and the small size of the island, will cause deep environmental crises.

Just like any negative impulse towards the natural environment, irrespective of its degree of organisation, the answer regarding the plant formations is greatly delayed in time and the mandatory development activities paradoxically represent the main deregulation factors. In the light of these findings and

[12] Actually the prairies incorrectly named savanna which are tall grass structures.

taking into account the necessary and urgent balance to be implemented to achieve the present objectives, universally defined in the management of space and its material and immaterial resources, the specific policies, particularly regarding the introduction of living plant organisms must fall within a global context of controlled environment treatment.

Theoretically, the anthropic transformation of biotopes by changing certain parameters, singularly within the plant ecosystem translates into floristic changes (and therefore ecosystem changes) notable in the sense of a regression or secondarisation or even resulting in extinctions [48]. The subsequent decrease in biocenotic complexity after this regression corresponds to a decrease of certain functions of the forest plant cover in principal the mechanical protection of the soil and the efficient management of rainwater (runoff, percolation, movement of terrigenous material). In the future, increasing populations of invasive plants in different plant covers will have damaging consequences in terms of (Figures 7 & 8):

1. ecosystem vulnerability to climatic shocks (cyclones, storms, induced geotechnical phenomena),
2. The biodiversity of the original plant species in principal those of the terminal stages.
3. The diversity of landscapes,
4. The successional process which can be blocked in regressive chrono-sequences (herbaceous and shrub stages),
5. wildlife diversity and by implication the diversity of the diaspores dispersion vectors;
6. the decrease in ecosystem, material and immaterial resources that can be recovered from a touristic point of view.

The species with natural potential for floristic introduction able to develop in the spontaneous vegetation are currently scarce due to the resistance of the floristic eco-units of the various plant floors (upper, middle and lower) linked to the various bioclimates.

Martinique's current eco-systemic immunity to alien species, despite its significant character, is fleeting and will decrease with the disappearance of the balance, increasingly significant, due to the decrease in the complexity of ecosystems which grow progressively artificial. Taxa which today seem to be little competitive ecologically could in the medium term, with the modification of environments, prove to be very aggressive acquiring significant colonizing ability. The image that emerges despite the lack of statistical data is quite dark and has some relevance when we study the reality in the field. The opinions we presented above are fuelled by our recent observations as well as by our experience of more than ten years in what regards floristic and botanical inventories. Regarding the small Caribbean Islands, the literature on the dynamics of introduced plants is almost non-existent irrespective of the relevant discipline. And this fact renders the issue interesting by placing it within the scope of a multidisciplinary research.

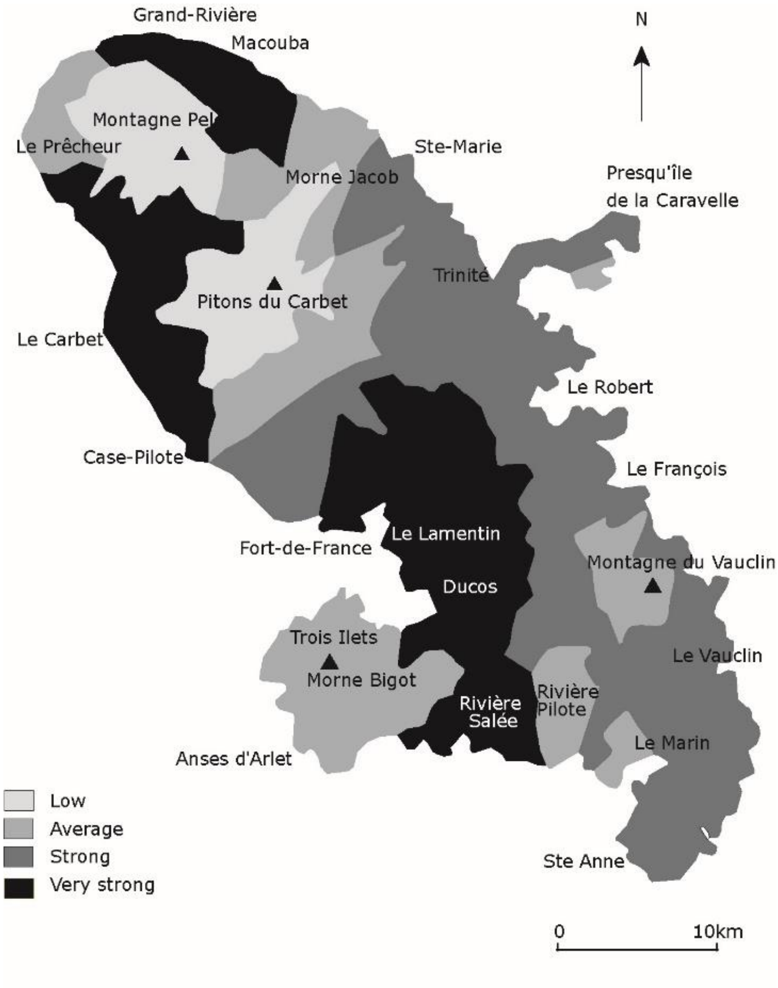

Figure 7: Martinique's ecosystem vulnerability

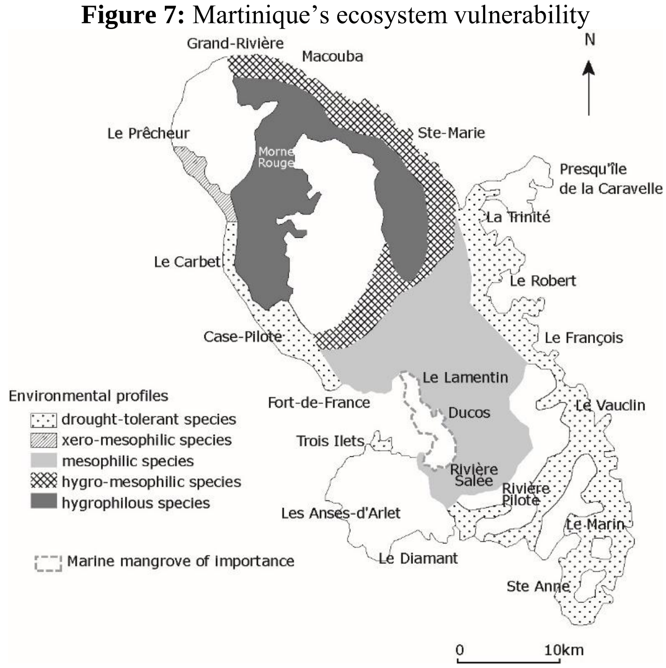

Figure 8: Possible area for the extension of alien species

XI. Conclusion

In the immediate future, the application of the precautionary principle in a wide protection programme of remaining floristic and landscape quality areas, but also of forest restructuration of damaged areas unfit for any human activity is paramount. It is extremely difficult to undertake this approach, due to the classic operation of the state services (especially those with jurisdiction in controlling the importation of living plant material) and the special relationship of the population with the vegetation, considering it inexhaustible and capable of all possible restorations. Through this reality and despite the pervasiveness of the plant cover, we can easily see a certain break between the people living on this island territory today and the plant world due to a lack of ecological, landscape and floristic culture, even in the rural world. This reality is in total contradiction with a resurgence of interest in plants (especially those from other tropical countries) based on their beauty, their blooms (inflorescences) and their fruit (infructescences).

As for indigenous plants, they are only valued for their rarity and are sought after by collectors from here and elsewhere. The increased enthusiasm for horticultural crops, irrespective of their physiognomic types is even more meaningful in structuring landscapes which form part of the quality of life. Particularly in urban agglomerations since all of the plant species used are foreign and pantropical. These activities are carried out at the expense of their ecology which is not always in phase with the factorial conditions of the planned landscape areas.

Ultimately, the many issues of undeniable urgency affecting the system- Martinique in terms of social, economic and cultural development, overshadow the problem of introduced species whose treatment falls within the scope of a global environmental management action. The short term consequences are minimal, however the process is insidiously continuing with regard to the first observed cases. The eradication of already installed invasive plants and the knowledge of the ecology of introduced plants and their function in the original environment are consubstantial elements which will allow us a better control in the protection of Martinique's plant cover against invasive species.

References

[1]. R.J. Hobbs, (Ed.), Invasive species in a changing world, in Island Press (*Cambridge University Press, London*, 2000) 154-178.

[2]. D. Simberloff, Eradication of island invasives: practical actions and results achieved, *Trends in Ecology & Evolution*, *16*(6), 2001, 273-274.

[3]. J. Gurevitch and D.K.Padilla, Are invasive species a major cause of extinctions?, *Trends in Ecology & Evolution*, *19*(9), 2004, 470-474.

[4]. D.M. Richardson and M. Rejmánek, Trees and shrubs as invasive alien species–a global review, *Diversity and Distributions*, *17*(5), 2011, 788-809.

[5]. R.T. Corlett, Invasive aliens on tropical East Asian islands, *Biodiversity and Conservation*, *19*(2), 2010, 411-423.

[6]. P.V. Fine, The invasibility of tropical forests by exotic plants, *Journal of Tropical Ecology*, *18*(05), 2002, 687-705.

[7]. E. Santiago-Valentin and R.G. Olmstead, Historical biogeography of Caribbean plants: introduction to current knowledge and possibilities from a phylogenetic perspective, *Taxon*, 2004, 299-319.

[8]. B.C. Bennett and G.T. Prance, Introduced plants in the indigenous pharmacopoeia of Northern South America, *Economic Botany*, *54*(1), 2000, 90-102.

[9]. J.C. Kricher, *A neotropical companion: an introduction to the animals, plants, and ecosystems of the New World tropics* (Princeton University Press, 1999).

[10]. C.C. Daehler, P. Pyšek, Z. Kaplan and D.M. Richardson, Invasibility of tropical islands by introduced plants: partitioning the influence of isolation and propagule pressure, *Preslia*, *78*(4), 2006, 389-404.

[11]. H.O. Spielmann, L'agriculture et l'espace agricole de l'Amérique centrale: Développement, structure, problèmes, *Bulletin de la Societé Géographique de Liége,(33)*, 1997, 119-128.

[12]. M. Hoff, and G. Cremers, Le Jardin Guyanais: Inventaire des plantes cultivées et des adventices des jardins de Guyane française, *Journal Botanique de la Société Botanique de France*, *29*, 2005, 3-40.

[13]. C. Delnatte and J.Y. Meyer, Plant introduction, naturalization, and invasion in French Guiana (South America), *Biological Invasions*, *14*(5), 2012, 915-927.

[14]. D. Wood, Introduced crops in developing countries: A sustainable agriculture?, *Food policy*, *13*(2), 1988, 167-177.

[15]. X. Giam, C.J. Bradshaw, H.T. Tan and N.S. Sodhi, Future habitat loss and the conservation of plant biodiversity. *Biological Conservation*, *143*(7), 2010, 1594-1602.

[16]. P. Birnbaum, Histoire de l'invasion d'une plante introduite, Miconia calvescens, dans une île polynésienne, *Bota. Appl., Vol XXXVI*(2), 1994, 283-295.

[17]. F. Breton, M. Cheylan, M. Lonsdale, J. Maillet, M. Pascal and P. Vernon, Les invasions biologiques, *le Courrier de l'Environnement n°32*, site www.inra.fr/dpenv/bretoc 32.hrtm, 1997, 17 p.

[18]. M. Rejmánek, Species richness and resistance to invasions. In *Biodiversity and ecosystem processes in tropical forests* (Springer Berlin Heidelberg, 1996)153-172.

[19]. M. Maunder, M. Abdo, R. Berazain, C. Clubbe, F. Jiménez, A. Leiva... And J. Francisco-Ortega, *The plants of the Caribbean islands: a review of the biogeography, diversity and conservation of a storm-battered biodiversity hotspot* (The Biology of island floras, 2011).

[20]. J. de Freitas, A.O. Debrot and L.A.P. Lotz, *Naturalised and invasive alien plant species in the Caribbean Netherlands: status, distribution, threats, priorities and recommendations: report of a joint Imares/Carmabi/PRI project financed by the Dutch Ministry of Economic Affairs, Agriculture & Innovation*, (Plant Research International-Business Unit Agrosystems Research, 2012).

[21]. P. Joseph, Les Petites Antilles face aux risques d'invasion par les espèces végétales introduites. L'exemple de la Martinique, *Revue d'écologie*,*61*(3), 2006, 209-224.

[22]. J.R. Pagán-Jiménez, *Human plant dynamics in the precolonial Antilles* (The Oxford Handbook of Caribbean Archaeology, 2013).

[23]. R.J. Morris, Anthropogenic impacts on tropical forest biodiversity: a network structure and ecosystem functioning perspective, *Philosophical Transactions of the Royal Society of London B: Biological Sciences*,*365*(1558), 2010, 3709-3718.

[24]. E. Cano, A.V. Ramirez, A. Cano-Ortiz and F.J. Esteban Ruiz, Distribution of Central American Melastomataceae: biogeographical analysis of the Caribbean islands, *Acta Botanica Gallica*, *156*(4), 2009, 527-557.

[25]. A. Graham, *A natural history of the New World: the ecology and evolution of plants in the Americas* (University of Chicago Press, 2010).

[26]. S. Martén-Rodríguez, C.B. Fenster, I. Agnarsson, L.E. Skog and E.A. Zimmer, Evolutionary breakdown of pollination specialization in a Caribbean plant radiation, *New Phytologist*, *188*(2), 2010, 403-417.

[27]. N.G. Swenson and M.N. Umaña, Phylofloristics: an example from the Lesser Antilles, *Journal of Plant Ecology*, *7*(2), 2014, 166-175.

[28]. S.A. Graham, Biogeographic patterns of Antillean Lythraceae, *Systematic botany*, *28*(2), 2003, 410-420.

[29]. V. Negrón-Ortiz and L.E. Watson, Hypotheses for the colonization of the Caribbean basin by two genera of the Rubiaceae: Erithalis and Ernodea, *Systematic Botany*, *28*(2), 2003, 442-451.
[30]. P. Joseph, *La végétation forestière des Petites Antilles: synthèse biogéographique et écologique, bilan et perspectives* (KARTHALA Editions-Paris, 2009).
[31]. A.H entry, Neotropical floristic diversity: phytogeographical connections between Central and South America, Pleistocene climatic fluctuations, or an accident of the Andean orogeny?, *Annals of the Missouri Botanical Garden*, *69*(3), 1982, 557-593.
[32]. J.S. Beard, *The natural vegetation of Windward and Leeward Islands* (Oxford Forestry Mem, 1949).
[33]. J. Portecop, *Phytogéographie, cartographie écologique et aménagement dans une île tropicale : le cas de la Martinique*, thèse de IIIe cycle, Université de Montpellier (France), 1978.
[34]. J.P. Fiard, *Les forêts du nord de la Montagne Pelée et des édifices secondaires volcaniques du Piton Mont-Conil et du Morne Sibérie*, Diplôme universitaire de phyto-écologie tropicale et aménagement insulaire, Université des Antilles et de la Guyane, 1994.
[35]. P. Joseph, *Dynamique, écophysiologie végétales en bioclimat sec à la Martinique*, Thèse de doctorat, Université des Antilles et de la Guyane, 1997.
[36]. D. Imbert, I. Bonhême, I., E. Saur and C. Bouchon, Floristics and structure of the Pterocarpus officinalis swamp forest in Guadeloupe, Lesser Antilles, *Journal of Tropical ecology*, *16*(01), 2000, 55-68.
[37]. A. Rousteau, Structures, flores, dynamiques : réponses des forêts pluviales des Petites Antilles aux milieux montagnards. *Phytogeographie tropicale : realites et perspectives, ORSTOM editions, Paris*, 1996, 308-321.
[38]. B. Dalsgaard, A.M. Martín González, J.M. Olesen, A. Timmermann, L.H. Andersen and J. Ollerton, Pollination networks and functional specialization: a test using Lesser Antillean plant–hummingbird assemblages, *Oikos*, *117*(5), 2008, 789-793.
[39]. R. Ricklefs & E. Bermingham, The West Indies as a laboratory of biogeography and evolution, *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, *363*(1502), 2008, 2393-2413.
[40]. A. Echeverry and J.J Morrone, Parsimony analysis of endemicity as a panbiogeographical tool: an analysis of Caribbean plant taxa, *Biological Journal of the Linnean Society*, *101*(4), 2010, 961-976.
[41]. P. Joseph, Trial to comprehend the functioning of the vegetation of the lesser Antilles in the light of the general understanding of vegetation dynamics, *Int. J. of Adv. Res. 4(3)*, 2016, 1786-1806.
[42]. C.B. Cox, The biogeographic regions reconsidered, *Journal of Biogeography*, *28*(4), 2001, 511-523.
[43]. P. Acevedo-Rodríguez and M.T. Strong, Floristic richness and affinities in the West Indies, *The Botanical Review*, *74*(1), 2008, 5-36.
[44]. J.J. Morrone, Cladistic biogeography of the Neotropical region: identifying the main events in the diversification of the terrestrial biota, *Cladistics*, *30*(2), 2014, 202-214.
[45]. P. Pyšek and D.M. Richardson, The biogeography of naturalization in alien plants, *Journal of Biogeography*, *33*(12), 2006, 2040-2050.
[46]. J. Fournet, *Flore illustrée des phanérogames de la Guadeloupe et de la Martinique : nouvelle édition augmentée* (CIRAD & GONDWANA EDITIONS, 2002)
[47]. R.A. Howard, *Flora of Lesser Antilles, Leeward and Windward Islands, Monocotyledoneae (Vol.3), Dicotyledoneae (Vol.4*: part. 1,2,3) (Arnold Arboretum, Havard University, Jamaica Plain, Massachussetts, 1979-1989)
[48]. S.J. Wright, H.C. Muller-Landau and J.A.N. Schipper, The future of tropical species on a warmer planet, *Conservation biology*, *23*(6), 2009, 1418-1426.

Annex 1: Lists of cultivated specimens escaped from cultures, sub-spontanous; sometimes going through a naturalization process, or instead weeds (plants introduced accidentally or non-accidentally, we do not currently know)	
ACANTHACEAE	*Barleria prionitis / Blechum pyramidatum / Diflugossa colorata / Hemigraphis alternate / Justicia secunda / Thunbergia alata / Thunbergia erecta / Thunbergia fragrans*
AGAVACEAE	*Agave Americana / Yucca aloifolia*
AMARANTHACEAE	*Amaranthus crassipes / Amaranthus cruentus / Amaranthus dubius / Gomphrena globosa / Iresine argentata*
AMARYLLIDACEAE	*Crinum amabile / Crinum asiaticum / Crinum bulbispermum / Crinum erubescens / Crinum latifolium*
ANACARDIACEAE	*Anacardium occidentale / Mangifera indica / Spondias cytherea / Spondias purpurea*
ANNONACEAE	*Annona cherimola*
APOCYNACEAE	*Catharanthus roseus / Funtumia elastica / Nerium oleander*
ARACEAE	*Alocasia cucullata / Alocasia macrorrhiza / Caladium esculenta / Syngonium podophyllum / Xanthosoma brasiliense*
ARECACEAE	*Raphia farinifera*
ARISTOLOCHIACEAE	*Aristolochia anguicida / Aristolochia littoralis / Aristolochia ringens*
ASCLEPIADACEAE	*Asclepias physocarpa*
ASTERACEAE	*Acanthospermum hispidum / Artemisia vulgaris / Cosmos sulphureus / Erechtites hieracifolia / Erechtites valerianifolia / Erigeron sp. / Eupatorium odoratum / Pseudelephantopus spicatus / Senecio vulgaris / Synedrella nodiflora / Tagetes erecta / Tagetes patula / Tithonia rotundifolia / Zinnia elegans / Zinnia peruviana*
BIGNONIACEAE	*Crescentia cujete / Distictis lactiflora / Spathodea campanulata*
BORAGINACEAE	*Cordia obliqua / Cordia sebestana*
BRASSICACEAE	*Sinapis alba*
CACTACEAE	*Opuntia ficus-indica / Pereskia aculeata*
CAESALPINIACEAE	*Bauhinia monandra / Caesalpinia decapetala / Senna bacillaris var. bacillaris / Senna bicapsularis var. bicapsularis / Senna multijuga var multijuga / Senna spectabilis*
CAPRIFOLIACEAE	*Sambucus canadensis*
CARICACEAE	*Carica papaya*
CASUARINACEAE	*Casuarina equisetifolia*
COMMELINACEAE	*Cyanotis cristata / Tradescandia pallida*
CONVOLVULACEAE	*Ipomoea batatas / Ipomoea hederifolia / Merremia dissecta / Turbina corymbosa*
COSTACEAE	*Costus afer*
CRASSULACEAE	*Kalanchoe pinnata / Kalanchoe rosei*

CUCURBITACEAE	*Luffa aegyptiaca / Sechium edule*
CYPERACEAE	*Carex sp. / Cyperus sphacelatus / Fimbristylis miliacea / Kyllinga erecta var. polyphylla*
DIOSCORIACEAE	*Dioscore bulbifera*
DRACAENACEAE	*Dracaena fragrans / Sansevieria cylindrica*
EUPHORBIACEAE	*Acalypha poiretii / Aleurites moluccana / Euphorbia graminea / Euphorbia tirucalli / Garcia nutans / Jatropha multifida / Mercurialis annua / Phyllanthus acidus*
FABACEAE	*Calopogonium mucunoides / Centrosema virginianum / Clitoria falcata var. glabrescens / Crotalaria mysorensis / Crotalaria paulina / Crotalaria pilosa / Crotalaria spectabilis / Crotalaria vitellina / Desmodium gyroides / Desmodium procumbens / Erythrina fusca / Erythina velutina / Indigofera disperma / Indigofera hirsuta / Indigofera subulata var. scabra / Sesbania bispinosa / Sesbania sesban / Stylosanthes guianensis / Tephrosia candida / Tephrosia noctiflora*
FAGACEAE	*Quercus alba*
GESNERIACEAE	*Achimenes longiflora / Kohleria amabilis var. bogotensis / Saintpaulia ionantha*
HYPOXIDACEAE	*Curculigo capitulata*
JUNCACEAE	*Juncus effusus*
LAMIACEAE	*Plectranthus amboinicus / Salvia coccinea / Satureja viminea*
LAURACEAE	*Persea americana*
LOBELIACEAE	*Hippobroma longiflora*
LYTHRACEAE	*Ammania coccinea / Cuphea carthagenensis*
MALPIGHIACEAE	*Stigmaphyllon convolvulifolium*
MALVACEAE	*Abutilon grandifolium / Abutilon indicum / Herissantia crispa / Hibiscus radiatus*
MARANTHACEAE	*Ischnosiphon obliqua / Maranta arundinacea*
MELIACEAE	*Azadirachta indica*
MENISPERMACEAE	*Tinospora crispa*
MIMOSACEAE	*Acacia cornigera / Acacia nilotica / Acacia sundra / Samanea leptocarpa*
MOLLUGINACEAE	*Mollugo verticillata*
MORACEAE	*Castilla elastica / Dorstenia contrajerva*
MORINGACEAE	*Moringa oleifera*
MYRTACEAE	*Myrcia leptoclada*
NYCTAGINACEAE	*Mirabilis jalapa*
ORCHIDACEAE	*Arundina graminifolia / Bletia purpurea / Dendrobium crumenatum / Epidendrum nutans / Epidendrum paniculatum / Maxillaria camaridii / Oncidium ornithorrhynchum*
PHYTOLACCACEAE	*Phytolacca icosandra*
PINACEAE	*Pinus caribaea*
PIPERACEAE	*Piper betle / Piper nigrum / Piper retrofractum*
POACEAE	*Bothriochloa bladhii / Bothriochloa pertusa / Brachiaria decumbens / Brachiaria pupurascens / Brachiaria reptans / Cenchrus brownie / Cymbopogon citratus / Dactyloctenium aegyptium / Dichantium aristatum / Digitaria ciliaris / Digitaria insularis / Digitaria longiflora / Echinochloa crusgalli / Eleusine indica / Eragrostis ciliaris / Homolepis aturensis / Hyparrhenia rufa / Imperata contracta / Ischaemum geniculatum / Ixophorus unisetus / Oryza sativa / Paspalum densum / Rottbœllia cochinchinensis / Sacciolepis indica / Setaria barbata / Setaria paniculifera / Setaria rariflora / Setaria setosa var. setosa / Setaria sphacelata / Stenotaphrum secundatum / Themeda quadrivalvis / Lolium perenne*
POLYGONACEAE	*Antigonon guatemalense / Antigonon leptopus*
PORTULACEAE	*Portulaca grandiflora*
ROSACEAE	*Rubus rosifolius*
RUBIACEAE	*Diodia samentosa / Mussaenda philippica / Mussaenda x rosea / Neolamarckia cadamba / Randia formosa / Thogsennia lindeniana / Vangueria madagascariensis*
SAPOTACEAE	*Chrysophyllum cainito / Manilkara zapota / Mimusops elengi*
SCROPHULARIACEAE	*Angelonia angustifolia / Kickxia elatine*
SIMAROUBACEAE	*Quassia amara*
SOLANACEAE	*Browallia Americana / Brugmansia suaveolens / Datura inoxia*
STERCULIACEAE	*Guazuma ulmifolia / Melochia pyramidata / Theobroma cacao*
URTICACEAE	*Boehmeria nivea / Pilea fasciata*
ZINGIBERACEAE	*Globba marantina*

Annexe 2: Lists of specimens perfectly naturalized, behaving practically in indigenous	
ACANTHACEAE	*Barleria lupulina / Pachystachys spicata / Thunbergia grandifolia*
AGAVACEAE	*Agave antillarum*
AMARANTHACEAE	*Alternanthera flavascens / Amaranthus caudatus / Celosia argentea / Iresine herbstii*
AMARYLLIDACEAE	*Hippeastrum puniceum / Zephyranthes grandiflora / Zephyranthes puertoricensis / Zephyranthes rosea*
ANACARDIACEAE	*Spondias mombin*
ANNONACEAE	*Cananga odorata*
ARACEAE	*Caladium bicolor / Epipremnum aureum*
ARECACEAE	*Elaeis guineensis*
ARISTOLOCHIACEAE	*Aristolochia grandiflora*
ASCLEPIADACEAE	*Asclepias curassavica / Calotropis procera*
ASTERACEAE	*Acanthospermum austral / Ambrosia hispida / Artemisia verlotorum / Aster novi-belgii / Aster squamatus / Centhatherum punctatum / Emilia coccinea / Emilia fodsbergii / Epaltes brasiliensis Erigeron karwinskianus / Lagascea mollis / Mikania micrantha / Parthenium hysterophorus*

	Pluchea carolinensis / Solidago gigantea subsp. Serotina / Tithonia diversifolia / Youngia japonica
BALSAMINACEAE	*Impatiens balsamina*
BEGONIACEAE	*Begonia hirtella*
BOMBACACEAE	*Ceiba pentandra / Pachira insignis*
BRASSICACEAE	*Armoracia rusticana / Brassica juncea / Coronopus didymus / Lepidium virginicum / Nasturtium officinale / Sisymbrium officinale*
CAESALPINIACEAE	*Cassia fistula / Chamaecrista nictitans var. glabrata / Senna hirsuta var. hirsuta / Senna septemtrionalis / Senna sulfurea / Tamarindus indica*
CANNACEAE	*Canna indica*
CAPPARACEAE	*Cleome gynandra / Cleome rutidosperma / Cleome speciose / Cleome viscosa*
CARYOPHYLLACEAE	*Stellaria media*
COMBRETACEAE	*Terminalia catappa / Terminalia latifolia*
COMMELINACEAE	*Commelina benghalensis / Zebrina pendula*
CONVOLVULACEAE	*Ipomoea alba / Ipomoea aquatic / Merremia tuberosa*
COSTACEAE	*Costus lucanusianus / Costus speciosus*
CUCURBITACEAE	*Cucumis anguria / Luffa acutangula*
CYPERACEAE	*Cyperus rotundus / Isolepis sepulcralis*
EUPHORBIACEAE	*Acalypha alopecuroidea / Acalypha indica / Breynia disticha / Cnidoscolus aconitifolius / Croton lobatus / Euphorbia heterophylla / Euphorbia lactea / Jatropha curcas / Phyllanthus debilis / Phyllanthus tenellus / Ricinus communis*
FABACEAE	*Alysicarpus vaginalis / Canavalia gladiata / Christia vespertilionis / Clitoria arborescens / Clitoria laurifolia f. laurifolia / Clitoria ternatea var. pleniflora / Clitoria ternatea var. ternatea f. ternatea / Crotalaria incana / Crotalaria micans / Crotalaria pallida / Crotalaria verrucosa / Crotalaria zanzibarica / Desmodium heterocarpum var. heterocarpum / Desmodium scorpiurus / Desmodium velutinum / Erythrina pœppigiana / Erythrina variegata var. orientalis / Flemingia strobilifera / Indigofera spicata / Indigofera tinctoria / Lablab purpureus / Neonotonia wightii / Pachryrrhizus erosus / Phaseolus lunatus / Pueraria phaseoloides / Sesbania grandiflora / Vigna hosei / Vigna luteola*
FLACOURTIACEAE	*Flacourtia jangomas / Samyda dodecandra*
GESNERIACEAE	*Achimenes erecta*
HELICONIACEAE	*Heliconia psittacorum*
HYDROCHARITACEAE	*Egeria densa / Elodea callitrichoides*
JUNCACEAE	*Juncus bufonius*
LAMIACEAE	*Hyptis capitata / Hyptis suaveolens / Hyptis verticillata / Leonurus sibiricus / Leucas martinicensis / Ocinum gratissimum / Scutellaria ventenatii*
LAURACEAE	*Cinnamomum verum*
LYTHRACEAE	*Ammania baccifera / Ammania robusta / Lawsonia inermis*
MALPIGHIACEAE	*Bunchosia glandulifera*
MALVACEAE	*Abutilon hirtum / Anoda acerifolia / Fioria vitifolia / Hibiscus calyphyllus / Hibiscus phœniceus / Malachra fasciata*
MELASTOMATACEAE	*Aciotis aequatorialis / Bellucia grossularioides*
MELIACEAE	*Carapa guianensis / Melia azedarach*
MIMOSACEAE	*Adenanthera pavonina / Calliandra surinamensis / Dichrostachys cinerea / Enterolobium cyclocarpum / Leucaena brachycarpa / Leucaena leucocephala / Mimosa malocentra / Mimosa pigra / Pithecellobium dulce*
MOLLUGINACEAE	*Mollugo verticillata*
MYRISTICACEAE	*Myristica fragrans*
MYRTACEAE	*Psidium cattleianum / Sizygium cumini / Sizygium jambos*
ORCHIDACEAE	*Prosthechea cochleata / Spathoglottis plicata*
OXALIDACEAE	*Oxalis debilis*
PASSIFLORACEAE	*Passiflora quadriglandulosa*
PLANTAGINACEAE	*Plantago lanceolata / Plantago major*
POACEAE	*Axonopus compressus / Bambusa vulgaris / Bothriochloa ischaemum / Brachiaria erucaeformis / Cendrus echinatus / Cendrus incertus / Dichantium annulatum / Eragrostis cilianensis / Eremochloa ophiuroides* *Hemarthria altissima / Paspalum urvillei / Pennisetum purpureum / Poa annua / Rhynchelytrum repens / Tragus berteronianus*
PONTEDERIACEAE	*Eichhornia crassipes*
RHAMNACEAE	*Colubrina elliptica*
RUBIACEAE	*Hedyotis lancifolia / Ixora finlaysoniana / Pentodon pentandrus / Spermacoce assurgens*
RUTACEAE	*Citrus aurantifolia / Triphasia trifolia*
SALICACEAE	*Salix chilensis*
SOLANACEAE	*Solanum erianthum / Solanum seaforthianum / Solanum torvum*
TILIACEAE	*Heliocarpus donnellsmithii*
URTICACEAE	*Phenax sonneratii / Pilea hyalina*
VERBENACEAE	*Clerodendrum chinense / Clerodendrum indicum / Cleodendrum speciosissimum / Stachytarpheta cayennensis / Stachytarpheta mutabilis*
ZINGIBERACEAE	*Hedychium coronarium*