

Some Considerations on the Uses of Rubiaceae Present in the Lesser Antilles (Caribbean)

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How to cite this paper: Claude, J.-P. (2025) Some Considerations on the Uses of Rubiaceae Present in the Lesser Antilles (Caribbean). *Natural Resources*, **16**, 454-471. <https://doi.org/10.4236/nr.2025.1613022>

Received: January 13, 2025

Accepted: December 26, 2025

Published: December 29, 2025

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Abstract

Rubiaceae is one of the most widespread families of flowering plants in the world, with about a hundred species recorded only in the Lesser Antilles archipelago located in the Caribbean. Although most of them have been introduced and naturalized, these plants have remarkably adapted to a wide variety of habitats, where they play an essential role in maintaining local ecosystems. They also enrich the region's ethnobotanical practices thanks to their exceptional chemical properties, which are the source of many bioactive compounds. These species are widely used in traditional and modern medicine throughout the world, while offering a multitude of other uses. However, the survival of these species and their habitats is threatened by the intensification of human activities and the impacts of current climate change. This article aims to highlight the diversity of potential uses of Rubiaceae in order to enhance this exceptional botanical heritage and to encourage or strengthen conservation initiatives. The uses reported here, resulting from a preliminary bibliographic research, however require rigorous validation by other scientific studies in phytochemistry and pharmacology to guarantee the veracity of these uses.

Keywords

Lesser Antilles, Rubiaceae, Uses, Conservation

1. Introduction

Rubiaceae, with more than 14,000 species divided into approximately 580 genera, constitute one of the largest families of flowering plants in the world [1]. It is the fifth largest family of plants in the Lesser Antilles archipelago located in the Caribbean, with approximately 129 species recorded [2]-[5]. These plants, mostly introduced and naturalized, occupy a wide range of habitats and show a remarkable

diversity of ecological and physiological adaptations [2]-[7]. They are found in all possible forms of life: tree, shrub, liana, herbaceous, epiphyte, etc., [2] [3] [6] [7]. They play a key ecological role, providing food resources to local fauna and participating in the plant succession of tropical island forests [4] [5].

The interest of Rubiaceae, however, goes beyond the ecological framework. These plants are also distinguished by their unique chemical properties [8]-[10]. They produce a multitude of bioactive compounds directly or through associated fungi, which give them various possibilities of uses by humans [11]-[15]. Traditionally, several Rubiaceae are used in folk medicine in the Lesser Antilles and for other types of uses, whether food, ornamental, craft or cultural and religious, but these uses are today threatened with oblivion [4] [16]-[22]. On a global scale, they are widely used in traditional medicines and are included in modern medicine, particularly for the development of drugs [10] [12] [23] [24].

Some species, such as coffee trees, are of major global economic importance, while others are valued for their ornamental qualities or their role in cultural rituals [4] [25]-[27]. Tropical America, including the Caribbean, is identified as a global biodiversity hotspot, thus reinforcing the urgency of studying these plants in these regions [28] [29]. The increasing anthropization of the Lesser Antilles islands is exerting significant pressure on local ecosystems, to which are added the effects of current global warming, threatening many plant species [30]-[36]. In this context, the valorization of Rubiaceae through their multiple uses cited in the literature could support additional and effective efforts for sustainable management of natural resources.

In the context of this research, it is necessary to specify that the approach adopted with respect to the literature was carried out with a certain critical restraint. The objective was not to conduct an in-depth and exhaustive analysis of all existing publications on Rubiaceae and their uses, nor to develop a detailed reflection on the limits of previous work. The main intention was to provide a non-exhaustive overview of the uses of this family of plants, highlighting preliminary information. It is therefore essential to consider that the data presented here, particularly concerning traditional uses, will have to be confirmed by additional investigations and rigorous empirical validations. However, this approach allows us to lay a first useful basis for future, more in-depth research.

2. Materials and Methods

2.1. Study Area

The Lesser Antilles archipelago comprises about twenty islands extending from the Virgin Islands to Trinidad and Tobago (**Figure 1**). These islands are the result of subduction between the North American and Caribbean plates [37]-[39]. The archipelago is divided into two main arcs: an ancient external arc, composed of limestone islands, and an active internal arc composed of volcanic islands, separated by an intermediate arc linked to underwater volcanic activities since the Miocene [37]-[39]. This complex and diverse geography, combined with the influ-

ence of the region's tropical climate, promotes exceptional biodiversity despite the modest surface areas of these islands [32] [34] [35].

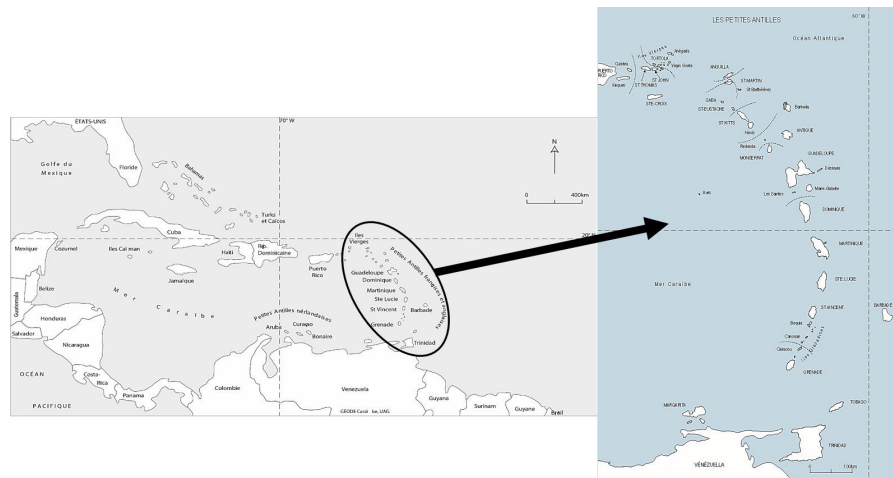


Figure 1. Location of the Lesser Antilles archipelago in the Caribbean.

However, volcanic islands are the majority and are characterized by mountain ranges that create a bioclimatic layering. This layering conditions the existence of multiple habitats and favors the installation of a diversity of species, adapted to local conditions and thus forming different forests (**Figure 2**) [32] [34] [35].

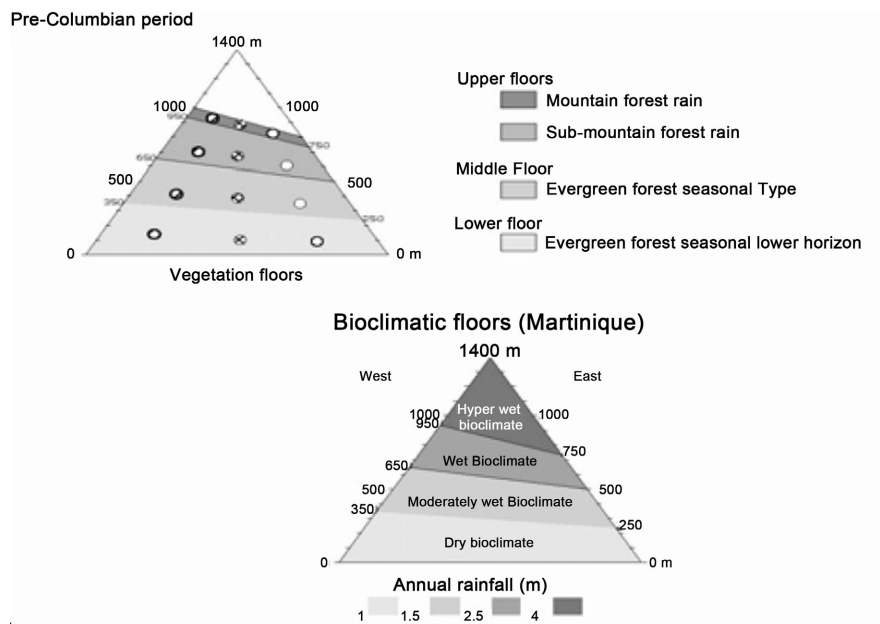


Figure 2. Ecosystem and bioclimatic potential of the mountainous Lesser Antilles [40].

The Lesser Antilles archipelago contributes to the ecological richness of the Caribbean: one of the hotspots of global biodiversity, notably for Rubiaceae (**Figure 3**) [32] [41].

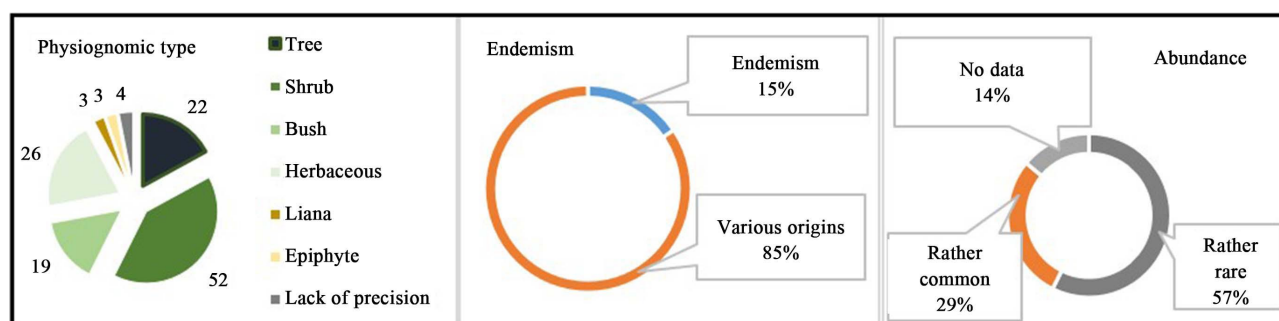


Figure 3. Some characteristics of Rubiaceae in the Lesser Antilles [2] [3].

Ethnobotanical practices in the Lesser Antilles demonstrate a diverse use of plants, deeply rooted in local traditions, influenced by various cultures (Amerindian, African, European, etc.) and having given rise, for example, to a unique, rich and varied traditional medicine [42]-[48]. The local pharmacopoeia includes both indigenous and introduced species, which are now cultivated in private or community gardens. This evolution is the result of a gradual transition from traditional collection in forest environments to more recent domestication [44] [49]-[53]. Creole gardens play a central role in the preservation of traditional knowledge and the sustainable management of plant resources by integrating medicinal, food and ornamental plants, witnesses to a syncretic cultural heritage [43] [44] [46] [51] [53]-[57].

However, increasing anthropogenic pressure (urbanization, introduction of invasive species, etc.) and new climatic constraints threaten the natural ecosystems and local biodiversity of these islands [32] [50] [58]. Despite the richness of the pharmacopoeia of the Lesser Antilles, few plants have been included in official pharmacopoeias, which limits their promotion on an international scale [53] [59]. Scientific research, particularly in the fields of phytochemistry and pharmacology, remains crucial to validate their therapeutic properties and guarantee safe use [53] [59]. The promotion of these species and their economic recognition could thus contribute to more effective preservation of local biodiversity [53].

2.2. Methods

The main potential uses of Rubiaceae present in the Lesser Antilles, whether specific or not specific to this region, were identified through a preliminary, non-exhaustive and non-in-depth bibliographic search, conducted on online platforms such as “Google Scholar”, “ResearchGate” or “Thèses.fr” or by using published works presenting the uses of plants in the Lesser Antilles.

This bibliographic search was based on keywords including the scientific names of the Rubiaceae listed in the archipelago, in accordance with the regional flora established by Jacques Fournet and Richard Alden Howard [2] [3], as well as the terms “uses” or “virtues”. By relying on around a hundred bibliographic references (articles, books or theses, etc.), we were able to identify numerous uses attributed to approximately 77 species of Rubiaceae present in the Lesser Antilles,

including one endemic species, *Exostema sanctae-luciae* (**Appendix**). The collected data were organized in a table using Excel software, allowing an analysis aimed at identifying and characterizing the main types of possible uses of these plants. In addition, multivariate statistical processing with XLSTAT software made it possible to carry out a factorial correspondence analysis (AFC) in order to illustrate the diversity of the use profiles of Rubiaceae by human populations.

3. Results and Discussion

3.1. The Diversity of Possible Uses of Rubiaceae

Many uses from various origins, whether traditional or contemporary, are attributed to the Rubiaceae present in the Lesser Antilles, the majority of which are introduced and naturalized (**Figure 4**).

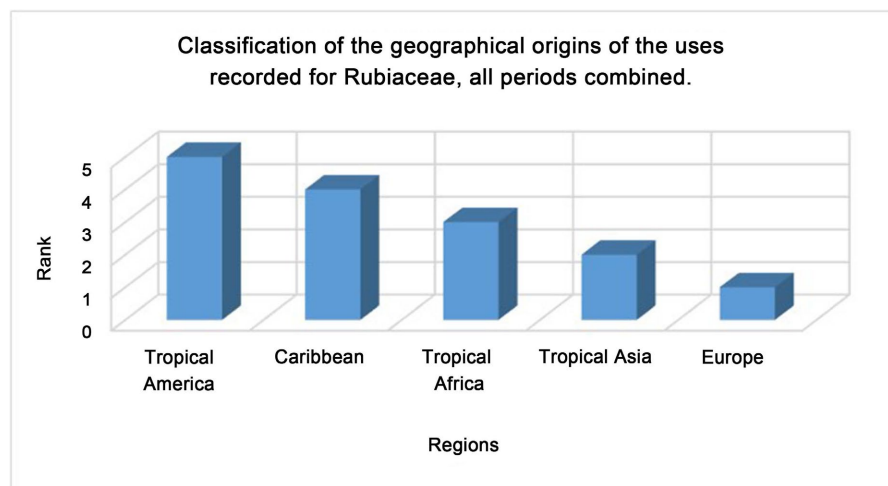


Figure 4. Diversity of geographical origins of uses recorded for Rubiaceae, all periods combined.

These various uses reflect both the importance of empirical knowledge acquired and transmitted locally depending on the regions of the world where these species are present and the applications resulting from contemporary scientific research. The Rubiaceae illustrate the richness and diversity of uses that humans can make of plants.

The main areas of use identified are distributed variably between the following categories: medicinal, ornamental, industrial and craft, cultural and spiritual, food, agricultural, scientific and technological (**Figure 5**). Data analysis reveals a predominance of medicinal and ornamental uses, while the other areas, although less represented, show promising potential (**Figure 5**).

Table 1 highlights the diversity of therapeutic approaches, notably through the different types of preparations or possible uses of Rubiaceae, which vary according to the knowledge acquired on the virtues of these plants according to the regions of the world.

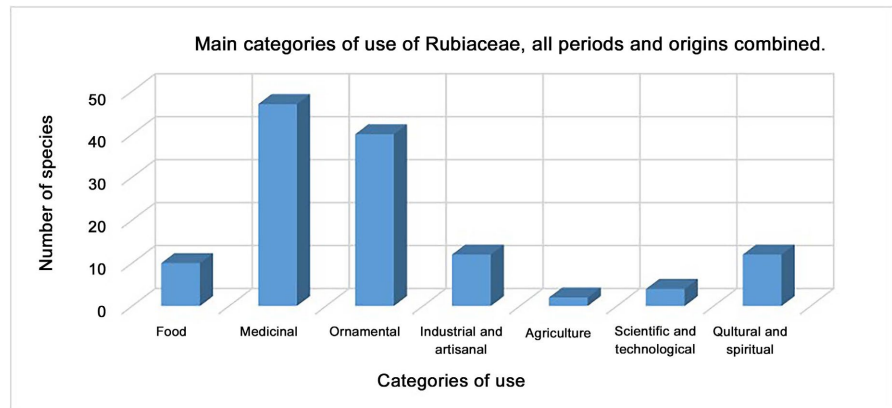


Figure 5. Classification of the main categories of use attributed to Rubiaceae, all periods and origins combined.

Table 1. Diversity of types of preparations or possible uses of Rubiaceae.

Types of preparation or use	
Infusion	Poultice
Decoction	Balms
Maceration	Ointments
Oil	Powders
Drinks (juice, alcohol, etc.)	Animal feed
Fresh juices	Cosmetics
Candies	Ornament
Jams/jellies	Wood
Baths	
Smoke inhalation	Tattoo ink
Tinctures	

Although all parts of plants are almost entirely exploited depending on the species and their chemical spectrum (leaves, flowers, fruits, bark, roots, etc.), trees and shrubs occupy a predominant place as shown in **Figure 6**.

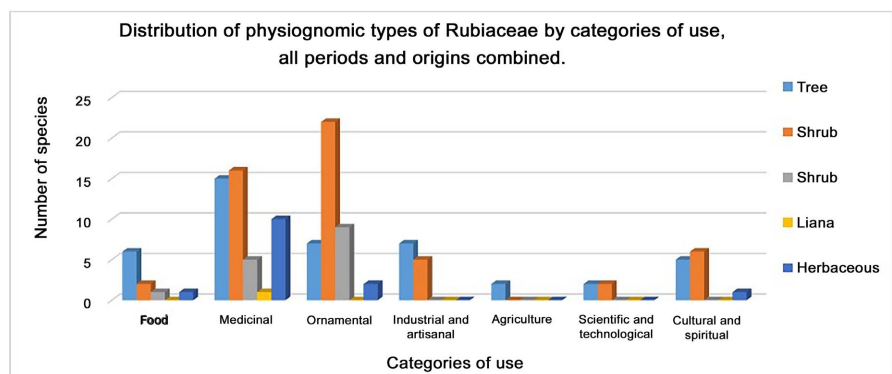


Figure 6. Distribution of physiognomic types by category of use, all periods and origins combined.

This factorial analysis clearly illustrates the diversity of potential uses of Rubiaceae by humans. It demonstrates the knowledge accumulated on their properties across different regions of the world and highlights their significant potential for application in various fields (**Figure 8, Appendix**). Although the majority of Rubiaceae exhibit a wide variety of use profiles, their therapeutic properties still largely require rigorous validation by scientific research in phytochemistry and pharmacology to ensure safe uses.

3.2. Some Examples of Traditional Uses of Rubiaceae within the Archipelago

We were unable to identify uses for 52 Rubiaceae, including approximately 16 species endemic to the archipelago or strictly endemic to certain islands of the archipelago according to regional flora [2] [3]. While many species still seem unknown from the point of view of their chemical composition and therapeutic potential, some Rubiaceae have documented uses.

- Medicinal uses

For example, Rubiaceae play an important role in the traditional medicine of the archipelago. *Chione venosa* is a tree used in particular on the island of Grenada, to produce the popular aphrodisiac “Bois Bande”, made from its stem bark and roots [60] [61]. The crushed seeds of *Coffea arabica* (Tree) are used in the French Antilles to treat eye conditions or as a wormer, and the juice or decoction of its roots is said to relieve scorpion stings [20]. *Morinda citrifolia* (Tree), is used to treat various conditions such as asthma, bronchitis, digestive disorders, urinary tract infections, or to soothe localized pain [18] [20] [62]. In Dominica, its leaves are applied as a poultice or infused as a tea to relieve rheumatism or stop bleeding on wounds [20].

It is also known that Amerindians, the first peoples to colonize the islands of the archipelago, used the resin of *Exostema caribaeum* (Tree) against conjunctivitis [7] [21], while the endemic species of the archipelago, *Exostema sanctae-luciae* (Tree), was traditionally used to relieve women after childbirth [21].

In Barbados and Dominica, *Chiococca alba*, a lianescent shrub, is said to have abortive and/or purgative properties. *Hedyotis corymbosa*, an herbaceous plant, is considered refreshing: its infusion is used against fever, flu, cough, asthma, as well as for liver and gastric ailments [21]. Furthermore, in Martinique, Dominica and Trinidad, decoctions or infusions of the herbaceous plant *Spermacoce verticillata* were used to treat flu, fever, bronchitis, colds, constipation and many other ailments [20]. Finally, the fruits and roots of *Genipa americana* were once exploited for their antibacterial properties in the treatment of venereal diseases, although these uses are now forgotten [20].

All these examples testify to the richness of the bioactive compounds produced by these Rubiaceae at the origin of the various medicinal applications, however the majority of these plants remain under-exploited in the region.

- Food uses

Several Rubiaceae are also used for their nutritional and cultural value. Marti-

nique has also become known throughout the world for its excellent coffee culture in the 18th century [63]. The fruits of several species are said to be edible and used in the Caribbean and particularly in the Antilles, such as *Alibertia edulis* (Shrub), *Genipa americana* (Tree), or *Randia nitida* (Tree), [7] [16]-[18] [20]. These uses come from an ancient domestication of Rubiaceae and an integration into the food and cultural practices of the archipelago.

- Ornamental uses

Some Rubiaceae are highly valued for their aesthetic value. Species of several genera including especially *Ixora*, *Gardenia*, *Mussaenda* are used as ornamental plants, especially for their flowers and perfumes [4] [3] [21] [32] [64].

These plants (shrubs, shrubs and trees) are easy to maintain and are adapted to tropical climates, which makes them popular for some in private gardens and public spaces [64]. They symbolize vitality and tropical exuberance, reinforcing their ornamental value [32].

- Industrial and artisanal uses

Some Rubiaceae are sought after for the quality and robustness of their wood.

Antirhea coriacea, *Chimarrhis cymosa* and *Exostema sanctae-luciae* are trees that produce a resistant wood, used in construction or furniture. These species are known for their durability, their resistance to rot, their ability to remain intact in water or their immunity to insects [7] [21] [32] [65]. In addition, the flammable resin of species of the genus *Erithalis* was once used by Amerindians to make torches, constituting an effective source of lighting [32] [66]. These uses demonstrate the practical importance of Rubiaceae in traditional ways of life, closely linked to indigenous knowledge and the oral transmission of knowledge [59].

- Cultural and religious uses

The spiritual practices of the Lesser Antilles also include certain Rubiaceae for their symbolism and ritualistic properties. The Amerindians attributed magical and ceremonial functions to certain Rubiaceae, including the emblematic species: *Genipa americana* (Tree), [20] [67]. This species is indeed associated with Amerindian ceremonies, because its fruit was used to produce, by oxidation, a blackish dye traditionally used in ritual tattoos. These practices show a fairly deep interconnection between nature and spirituality in the local cultures of the archipelago.

3.3. Environmental Challenges in the Lesser Antilles and the Sustainable Development of Potential Uses of Rubiaceae

The Lesser Antilles archipelago is characterized by exceptional wealth, whether physical, biological, ecosystemic or landscape, but whose preservation is endangered by the intensification of human activities since colonization [31] [32] [68] [69]. These tropical island territories, still characterized today by a varied biodiversity and unique ecosystems, are facing major challenges [2] [3] [32] [35] [68] [69]. The new climatic constraints of this century amplify and add to the varied and negative effects of anthropization: urbanization, massive agricultural exploitation, deforestation, water and soil pollution, introduction of invasive species,

further threatening the island ecosystems of the archipelago [32] [33] [36] [58] [68] [70] [71]. Unfortunately, cooperation in terms of natural resource management in the Lesser Antilles has long been limited by weak institutional coordination and significant socio-economic disparities between the islands, which complicated the implementation of integrated regional strategies [69] [72].

The application of sustainable development policies even at the island level has not proven to be more effective [73]. Faced with the many environmental challenges, the promotion of the uses of species present in the archipelago constitutes an essential strategy to strengthen cooperation initiatives in terms of conservation, but also to preserve traditional phytotherapeutic practices, while adapting this empirical knowledge to the contemporary requirements of medicine [16]-[21] [53] [59]. In this regard, the TRAMIL network constitutes a relevant example of regional cooperation for the integration of the uses of plants in the region into a sustainable cultural, heritage and economic approach; by scientifically validating traditional knowledge related to medicinal plants and integrating it into public health systems [17]-[19].

The various categories of uses recorded for species of the Rubiaceae family make this an example. These species are cited for their medicinal virtues to treat various ailments and produce traditional remedies [18] [20] [60]-[62]. They are also prized for their edible fruits, their ornamental qualities, their robust wood and their artisanal resins [7] [16]-[18] [20] [21] [32] [64] [66]. Finally, some species such as *Genipa americana* have a strong cultural and spiritual dimension linked to Native American ritual practices [20] [67]. The therapeutic properties indicated for these plants in the literature nevertheless require rigorous validation by scientific research in phytochemistry and pharmacology in order to ensure safe uses.

4. Conclusions

The Rubiaceae of the Lesser Antilles, whether native or introduced, constitute a remarkable wealth. Adapted to a variety of habitats and presenting a diversity of life forms, they are given a wide range of uses, notably in traditional medicine, but also in areas such as food, ornament, culture, industry, crafts, agriculture, as well as in scientific and technological advances. However, these plants are increasingly threatened by human activities and the impacts of climate change. It is therefore imperative to further promote their multiple virtues to encourage sustainable management of natural resources.

Scientific research, particularly in the fields of phytochemistry and pharmacology, is however of capital importance to validate the therapeutic benefits of these species and guarantee their safe use. The conservation and promotion of the plants of the Lesser Antilles are essential to preserve the ecological balance of the region while promoting sustainable cultural and economic practices.

Acknowledgements

Sincere thanks to the University Professor, head of the UMR ESPACE DEV-BI-

ORECA research group at the University of the Antilles, Mr. Philippe JOSEPH for proofreading the text.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Appendix: Main Categories of Potential Uses Recorded for 77 Rubiaceae Present in the Lesser Antilles, Regardless of Geographical Origin and Temporality

No.	Species	Acronym	Physiognomy	Categories of use
1	<i>Alibertia edulis</i>	Aled	Shrub	Food, Medicinal, Ornamental
2	<i>Antirhea acutata</i>	Anacut	Tree	Medicinal
3	<i>Antirhea coriacea</i>	Ancori	Tree	Medicinal, Industrial and artisanal
4	<i>Antirhea lucida</i>	Anluci	Tree	Industrial and artisanal
5	<i>Chimarrhis cymosa</i>	Chcy	Tree	Industrial and artisanal
6	<i>Chiococca alba</i>	Chalb	Shrub Lianascent	Medicinal, Cultural and spiritual
7	<i>Chione venosa</i>	Chvenosa	Tree	Medicinal, Cultural and spiritual
8	<i>Coffea arabica</i>	Coarabic	Tree	Alimentaire, Medicinal
9	<i>Coffea canephora</i>	Cocaneph	Tree	Medicinal, Cultural and spiritual
10	<i>Coffea liberica</i>	Coliberi	Tree	Alimentaire, Medicinal
11	<i>Coutarea hexandra</i>	Cohexa	Tree	Medicinal, Ornamental
12	<i>Diodia sarmentosa</i>	Disarmen	Liana	Médicinal
13	<i>Erithalis fruticosa</i>	Erfru	Shrub	Médicinal, Industrial and artisanal, Cultural and spiritual
14	<i>Erithalis odorifera</i>	Erodo	Shrub	Cultural and spiritual
15	<i>Ernodea littoralis</i>	Erlitto	Bush	Medicinal
16	<i>Exostema caribaeum</i>	Excari	Tree	Medicinal, Industrial and artisanal, Agriculture, Cultural and spiritual
17	<i>Exostema sanctae-luciae</i>	Exlu	Tree	Medicinal, Industrial and artisanal
18	<i>Faramea occidentalis</i>	Faoccid	Tree	Alimentaire, Ornamental, Industrial and artisanal
19	<i>Gardenia augusta</i>	Gaaugu	Shrub	Medicinal, Ornamental, Scientific and technological
20	<i>Gardenia taitensis</i>	Gatait	Shrub	Ornamental, Scientific and technological
21	<i>Genipa americana</i>	Geameric	Tree	Alimentaire, Medicinal, Industrial and artisanal, Agriculture, Scientific and technological, Cultural and spiritual
22	<i>Géophila repens</i>	Gérepe	Herbaceous	Alimentaire, Medicinal
23	<i>Guettarda crispiflora</i>	Gucri	Tree	Medicinal
24	<i>Guettarda odorata</i>	Guodo	Shrub	Medicinal, Industrial and artisanal
25	<i>Guettarda scabra</i>	Gusca	Shrub	Medicinal, Industrial and artisanal
26	<i>Hamelia axillaris</i>	Haaxill	Bush	Medicinal
27	<i>Hamelia patens</i>	Hapaten	Shrub	Alimentaire, Medicinal, Ornamental, Cultural and spiritual
28	<i>Hedyotis corymbosa</i>	Hecory	Herbaceous	Medicinal
29	<i>Isertia haenkeana</i>	Ishaenk	Shrub	Medicinal
30	<i>Ixora acuminata</i>	Ixacumina	Shrub	Ornamental
31	<i>Ixora casei</i>	Ixc	Shrub	Ornamental

Continued

32	<i>Ixora chinensis</i>	Ixchinens	Shrub	Ornamental, Cultural and spiritual
33	<i>Ixora coccinea</i>	Ixcoccin	Shrub	Medicinal, Ornamental
34	<i>Ixora ferrea</i>	Ixfe	Shrub	Ornamental, Industrial and artisanal
35	<i>Ixora finlaysoniana</i>	Ixfinlays	Shrub	Ornamental
36	<i>Ixora fulgens</i>	Ixfulgens	Bush	Ornamental
37	<i>Ixora hookeri</i>	Ixhookeri	Shrub	Ornamental
38	<i>Ixora javanica</i>	Ixjavanic	Bush	Alimentaire, Ornamental
39	<i>Ixora laxiflora</i>	Ixlaxiflo	Shrub	Ornamental
40	<i>Ixora longifolia</i>	Ixlongifo	Shrub	Ornamental
41	<i>Ixora pavetta</i>	Ixpavetta	Tree	Ornamental
42	<i>Leptactina mannii</i>	Lema	Shrub	Ornamental
43	<i>Mitracarpus hirtus</i>	Mih	Herbaceous	Medicinal
44	<i>Mitracarpus polycladus</i>	Mip	Herbaceous	Medicinal
45	<i>Morinda citrifolia</i>	Mocitri	Tree	Medicinal, Ornamental, Scientific and technological
46	<i>Mussaenda erythrophylla</i>	Muery	Shrub	Medicinal, Ornamental
47	<i>Mussaenda flava</i>	Mufla	Bush	Ornamental
48	<i>Mussaenda frondosa</i>	Mufro	Bush	Medicinal, Ornamental
49	<i>Mussaenda philippica</i>	Muphi	Bush	Ornamental
50	<i>Mussaenda pubescens</i>	Mupub	Bush	Ornamental
51	<i>Mussaenda treutleri</i>	Mutre	Shrub	Ornamental
52	<i>Mussaenda rosea</i>	Muros	Bush	Ornamental
53	<i>Neolamarckia cadamba</i>	Ne	Tree	Medicinal, Ornamental, Culturel er spirituel
54	<i>Neolaugeria resinosa</i>	Ner	Shrub	Ornamental
55	<i>Oxyanthus longiflorus</i>	Oxlon	Shrub	Ornamental
56	<i>Palicourea crocea</i>	Pacr	Shrub	Medicinal
57	<i>Pentas lanceolata</i>	Pelanceo	Bush	Ornamental
58	<i>Portlandia grandiflora</i>	Pogr	Shrub	Medicinal, Ornamental
59	<i>Posoqueria latifolia</i>	Pola	Shrub	Ornamental
60	<i>Psychotria gardenioides</i>	Psga	Herbaceous	Ornamental
61	<i>Psychotria mapourioides</i>	Psma	Shrub	Medicinal
62	<i>Psychotria nervosa</i>	Psne	Bush	Medicinal
63	<i>Psychotria tenuifolia</i>	Pste	Shrub	Medicinal

Continued

64	<i>Psychotria pubescens</i>	Pspu	Shrub	Medicinal
65	<i>Randia aculeata</i>	Raaculea	Shrub	Medicinal, Industrial and artisanal, Cultural and spiritual
66	<i>Randia dumetorum</i>	Radumeto	Bush	Medicinal, Ornamental
67	<i>Randia formosa</i>	Raformos	Shrub	Ornamental
68	<i>Randia nitida</i>	Ranitida	Tree	Alimentaire, Medicinal, Ornamental
69	<i>Rondeletia odorata</i>	Rood	Shrub	Ornamental
70	<i>Serissa foetida</i>	Sefoeti	Herbaceous	Medicinal, Ornamental
71	<i>Sipanea pratensis</i>	Siprate	Herbaceous	Medicinal
72	<i>Spermacoce assurgens</i>	Spas	Herbaceous	Medicinal
73	<i>Spermacoce confusa</i>	Spco	Herbaceous	Medicinal, Cultural and spiritual
74	<i>Spermacoce tetraquetra</i>	Spte	Herbaceous	Medicinal
75	<i>Spermacoce verticillata</i>	Spve	Herbaceous	Medicinal
76	<i>Thogsennia lindeniana</i>	Thli	Tree	Ornamental
77	<i>Vangueria madagascariensis</i>	Vama	Tree	Alimentaire, Medicinal