Report on the rare plants of the Cordillera Jaicoa, in the municipalities of Isabela and Moca, Puerto Rico

By Marcos Caraballo and Eugenio Santiago[1]

Herbario, Jardin Botanico, Universidad de Puerto Rico
Apartado 36948, San Juan, Puerto Rico 00936-4980

Departamento de Biologia
Universidad de Puerto Rico, Recinto de Rio Piedras
Apartado 23360, San Juan, Puerto Rico 00931-3360

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We report the results of botanical explorations along the forested areas of the Cordillera Jaicoa, located in Northwestern Puerto Rico (Figure 1). The objective of the exploration was to find new populations of federally-listed plant species of Puerto Rico. The expeditions also recorded several native uncommon or rare plant species found along those forests. Reference plant specimens for all uncommon, rare and endangered species were collected and deposited in the Herbarium of the Botanical Garden of the University of Puerto Rico at Rio Piedras (Index Herbariorum "UPR"). A total of 150 specimens were collected along the 24 field visits performed.

The explored region comprises four Barrios: Barrio Centro (18°24'47.10"N, 67°06'29.27"W [GPS datum: WGS84]; ~200 m asl) and Rocha (18°24'08.30"N, 67°03'48.75"W ~250 m asl) in the municipality of Moca, and Barrio Galateo Alto (18°24'23.38"N, 66°59'25.17"W ~250 m asl) and Barrio Arenales Altos (18°25'27.15"N, 67°02'18.25"W ~250 m asl) in the municipality of Isabela (Figure 2).

1. Author for correspondence.

Barrio Centro (Moca) - Almost all parts of the forested areas of Barrio Centro in Moca are composed of secondary forests with active regeneration of native species (Figure 3). Active cattle lands and minor agricultural activities surround the forested areas of this region. The geography of Barrio Centro does not present typical limestone hills (gentle slopes as opposed to steep slopes) and is dominated by small hills and some depressions in the terrain. Many tree species present are typical of secondary forests in other areas of Puerto Rico, such as *Spathodea campanulata*, *Delonix regia* and *Adenanthera pavonina*. We found saplings of many native species in the forest understory, suggesting that active recolonization with local elements. Examples of such species are *Cupania americana*, *Prunus myrtifolia*, *Pouteria dyctioneura* and *Thespesia grandiflora*. The only rare species found in this region was an individual of *Stenostomum sintenisii* growing at the roadside. We did not found any endangered species in this area.

Figure 1. Map showing the location of the Cordillera Jaicoa in Northwestern Puerto Rico.

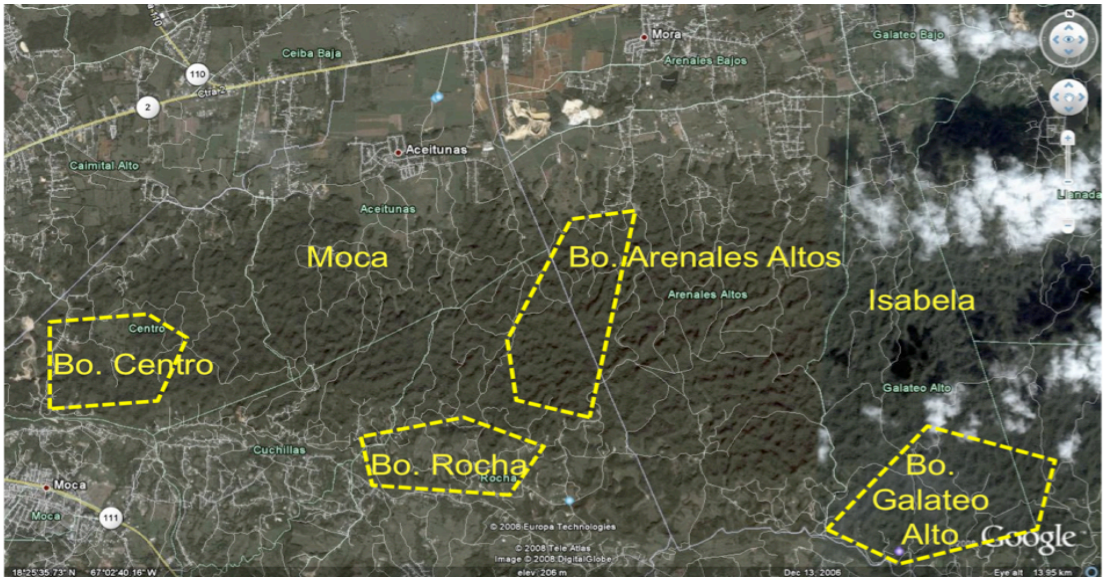

Figure 2. Map of the Cordillera Jaicoa showing the four explored Barrios in the municipalities of Moca and Isabela.

Figure 3. View of a disturbed area at Barrio Centro in Moca.

Barrio Rocha (Moca) - The Barrio Rocha of Moca exhibits a severely fragmented habitat with some forest remnants in the steep parts and rock walls (Figure 4). Forest remnants comprises several native species of limestone forests, such as *Cojoba arborea*, *Pimenta racemosa* var. *grisea*, *Guapira dominguensis*, *Tabebuia heterophylla, Coccoloba costata* and *Trinax morrisii*. Many places of this region were disturbed in the past by bulldozers to develop agricultural terrains and access to private properties. At present, many of those roads are covered with shrubs and other herbaceous vegetation. An interesting finding along those roads is a population of the endemic shrub *Poitea punicea*. Some other native plants grow along those roads, such as *Forsteronia portoricensis*, *Ernodea littoralis*, *Bletia patula*, *Coccoloba microstachya*, *Petitia dominguensis* and *Byrsonima lucida* (Figure 5). All parts explored were at the southern limit of the Cordillera Jaicoa, and no endangered species were found in this region.

Figure 4. Disturbed environment at Barrio Rocha, Moca.

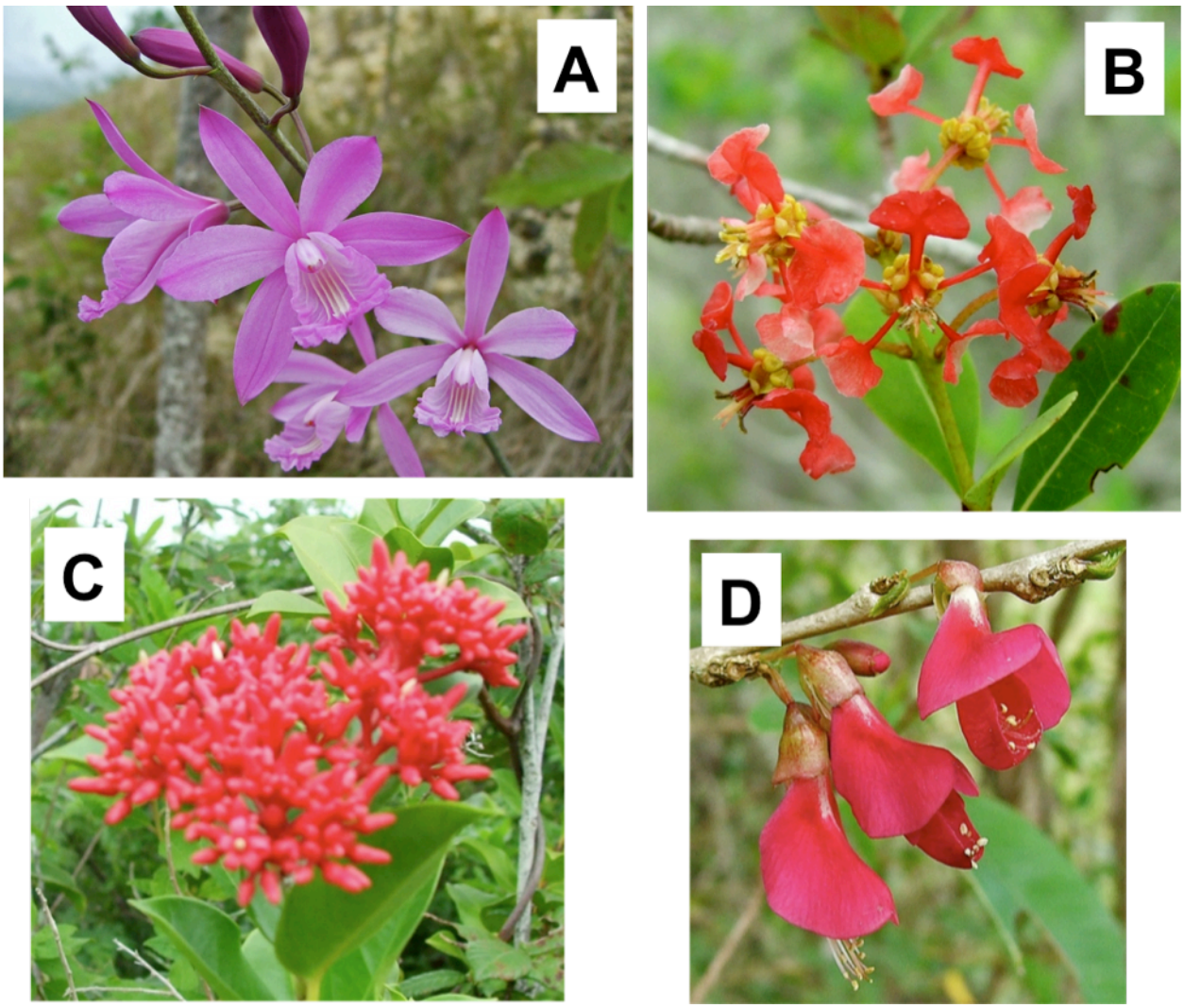

Figure 5. Examples of native plants found at Barrio Rocha, Moca: A. The terrestrial orchid *Bletia patula,* B. The small tree *Byrsonima lucida*, C. the vine *Forsteronia portoricensis* (endemic), and D. the shrub *Poitea punicea* (endemic).

Barrio Galateo Alto (Isabela) - We explored several forested areas at Barrio Galateo Alto in the municipality of Isabela, but no endangered species were found. This region is dominated by a rugged topography, consisting of a mosaic of limestone hills and sinkholes, and several farms and residences in the less rugged areas (Figure 6). Forests in this region are mature but with an evident past disturbance that have strongly influenced actual structure and species composition. Some limestone hills are dominated with disturbed herbaceous vegetation such as ferns (*Nephrolepis multiflora*, *Pteridium* sp.) and common tree species, such as *Calophyllum antillanum* and *Coccoloba diversifolia*. Sinkholes and small valleys are dominated by *Spathodea campanulata* and other past-cultivated species, such as *Erythrina poepiggiana*, *Musa* spp., *Mammea americana*, *Theobroma cacao*, *Coffea arabica* and *Dioscorea alata* (Figure 7). Also, there are other native species growing in the understory, such as *Quararibaea turbinata*, *Guarea guidonia*, *Urera baccifera*, *Ardisia obovata*, *Piper* spp., *Trichilia pallida* and *Casearia guianensis*. Predominant plants in the limestone hills consist of woody shrubs and trees such as *Coccoloba pubescens*, *Tabebuia heterophylla*, *Comocladia glabra*, *Tetrazygia elaeagnoides*, *Neolaugeria resinosa* and the endemics *Manilkara pleeana, Epidendrum boricuarum* and *Lonchocarpus glaucifolius* (Figure 8). The only rare species found in this area was the small tree *Sloanea amygdalina*.

Figure 6. Rugged karstic topography and dense woody forests at Barrio Galateo Alto, Isabela.

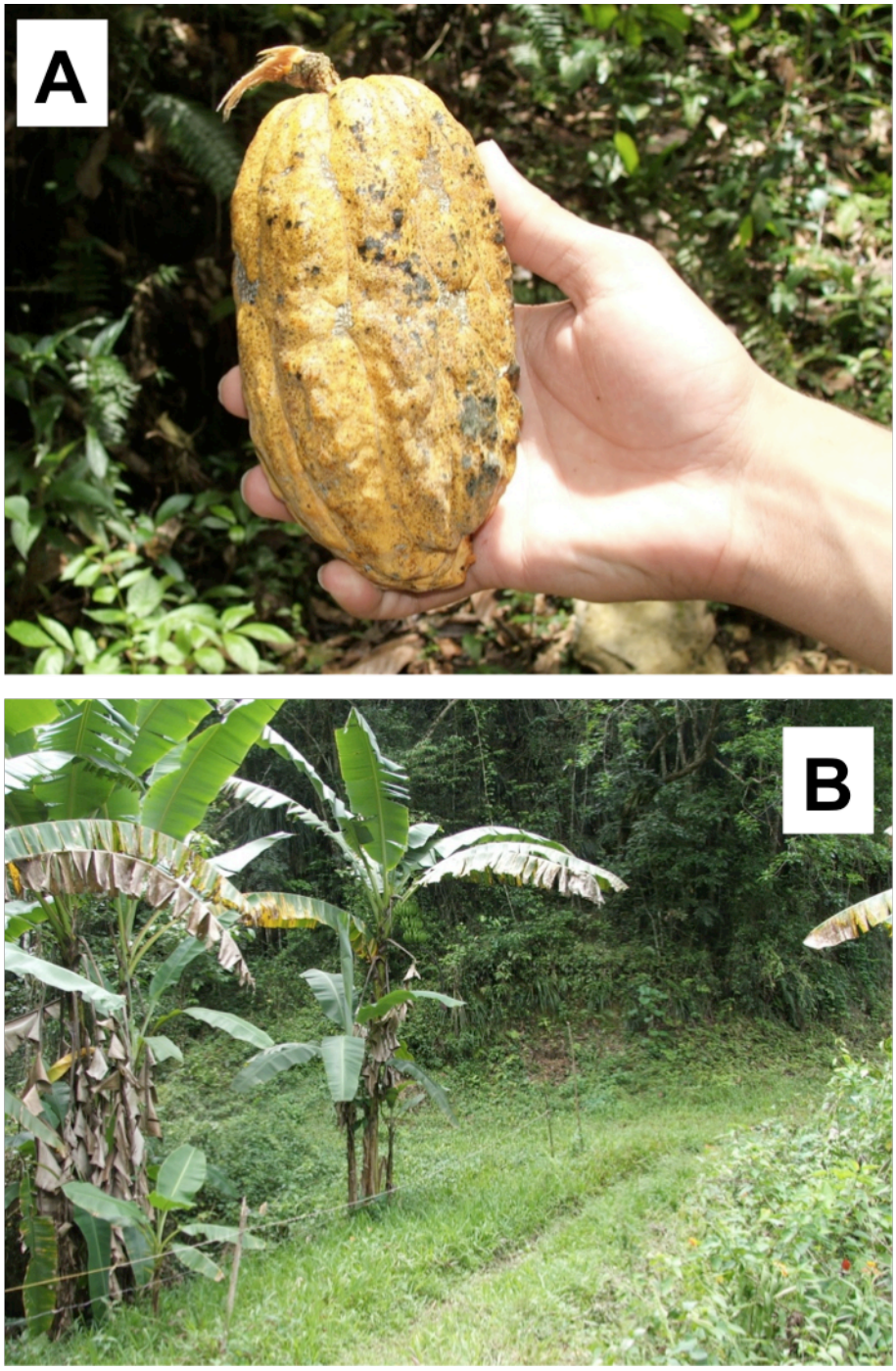

Figure 7. Examples of cultivated plants found at Barrio Galateo Alto, Isabela: A. The cocoa fruit *Theobroma cacao* and B. the banana plant *Musa* sp.

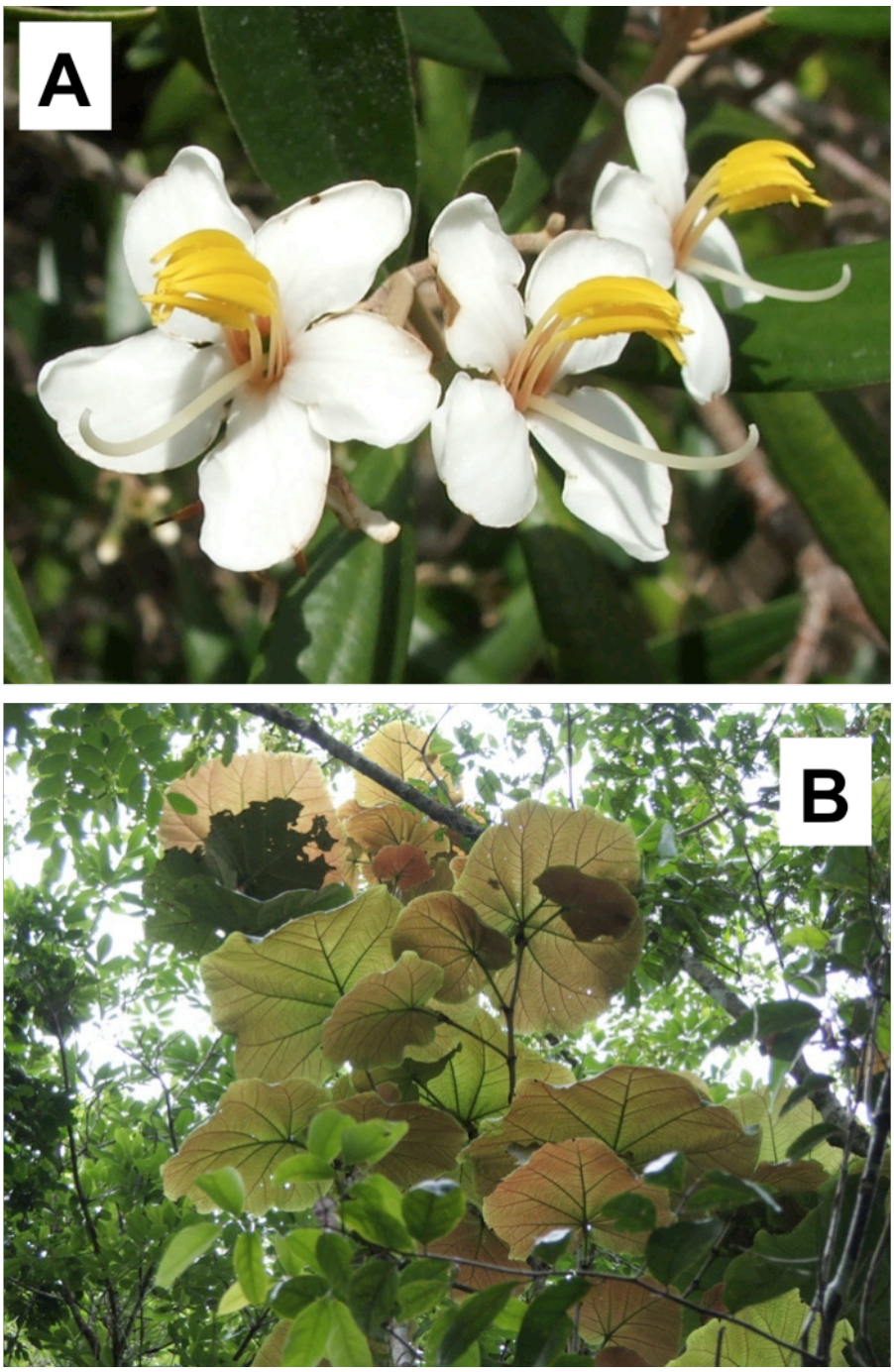

Figure 8. Native trees growing at Barrio Galateo Alto, Isabela: *Tetrazygia elaeagnoides* and B. *Coccoloba pubescens*.

Barrio Arenales Altos (Isabela) - The Barrio Arenales Altos in Isabela was the only place where an endangered species was observed: *Eugenia haematocarpa* (Figure 9). This is a solitary tree about 6 meters in height, growing in a shady slope of a steep limestone hill between sinkholes (~18°25'34.45"N, 67°02'12.09"W ~230 m asl). This individual was found with several mature fruits in November 2006. We carried out intensive search for the species in surrounding areas, but no other individuals were found. There are other nearby limestone hills that have not been explored yet, where possibly more individuals can be found.

Several other rare and endemic plant species were observed in the limestone hill region of the Barrio Arenales Altos. The geography of the region consists of dense limestone hills separated by narrow and humid sinkholes (Figure 10). There are many old trails that run through the limestone hills and sinkholes that are maintained by local pigeon hunters, and by local farmers who cut medium-sized trees for fence poles. We found several abandoned human settlements with evidence of a severe past disturbance. These areas are now covered with introduced and primary succession species such as *Adenanthera pavonina*, *Delonix regia*, *Spathodea campanulata*, *Cupania americana*, *Cecropia schreberiana*, *Hura crepitans* and *Cordia sulcata*. Cultivated ornamental species that persist in this area include *Pedilanthus titymaloides* subsp. *titymaloides*, *Furcraea tuberosa*, *Cocos nucifera* and *Sansevieria hyacinthoides*. The sinkholes vegetation consists mainly of tall trees and few shrubs in the understory. The trees present in sinkholes are a mixture of abandoned cultivated species and other forest species that have been established since farmers left the area. Some of the abandoned cultivated trees include *Erytrina poepigiana*, *Theobroma cacao*, *Musa* spp., *Syzigium jambos*, *Artocarpus altilis* and *Mammea americana*. Species established after agriculture was abandoned include *Spathodea campanulata*, *Cecropia schreberiana*, *Aiphanes acanthophylla*, *Ocotea*

floribunda, *Quararibaea turbinata*, *Roystonea borinquena*, *Ceiba pentandra*, *Coccoloba pubescens*, *Trophis racemosa*, *Pseudolmedia spuria*, *Manilkara pleeana*, and *Ocotea leucoxylon*. One the most common plants growing at sinkhole walls include the herb *Gesneria cuneifolia*. Common shrubs include *Urera baccifera*, *Faramea occidentalis*, *Parathesis crenulata*, and *Piper* spp., including the rare species *Piper swartzianum*. The following persistent species were observed in some limestone hills showing vegetation disturbance: *Dioscorea alata* and *Manihot esculenta*, mixed with native species such as *Cyathea arborea*, *Guarea guidonia* and *Heteropterys wydleriana*. Some of the explored top and slopes of limestone hills show many native species and mature forests that suffered few disturbances in the past. Examples of rare species found in those limestone hills are: *Diospyros sintenisii*, *Eugenia padronii*, *Buxus portoricensis*, *Tabebuia karsana*, *Plumeria obtusa*, *Encyclia cochleata*, *Pisonia woodburyana*, *Pisonia taina*, *Stenostomum sintenisii*, *Psidium amplexicaule*, *Reynosia krugii* and *Simarouba tulae* (Figures 11 and 12). Along the trails, we found some other native species such as *Buchenavia tetraphylla*, *Prunus myrtifolia*, *Chione venosa*, *Myrcia citrifolia* var. *imaryana*, *Myrcia citrifolia* var. *citrifolia*, *Coccoloba costata*, *Salmea scandens* and *Justicia mirabiloides*, some of them uncommon species and only found in mature or little disturbed forests.

In conclusion, although the Cordillera Jaicoa exhibits at present a dense vegetation coverage, many of those forests are secondary, with high recruitment of native species. In this study, the areas with most rare and uncommon species, including the only endangered plant found are the tops and slopes of limestone hills in Barrio Arenales Altos at Isabela. This could be due to the inaccessibility of the rugged limestone hills of the area. Most of the disturbance in Arenales Altos was observed in the sinkholes and small valleys among karst knolls (mogotes). Forest disturbance in the upper slopes and tops of the mogotes are of limited extension in relation

to the sinkholes and small valleys. This is inferred by the diversity of natives found, including individuals of some species of valuable wood with uncommonly large trunk sizes. There are some dense forested parts in Barrio Galateo Alto that were not explored in the expeditions, and should be a priority for the future. As these forested parts are located between the Guajataca Forest Reserve and the limestone hills of Barrio Arenales Altos, it is reasonable to expect the presence of listed and rare species in those forests. We also expect to find endangered species at Southwest of Barrio Arenales Altos and at North of Barrio Rocha, where several dense limestone hills seem to be potential to find rare plants.

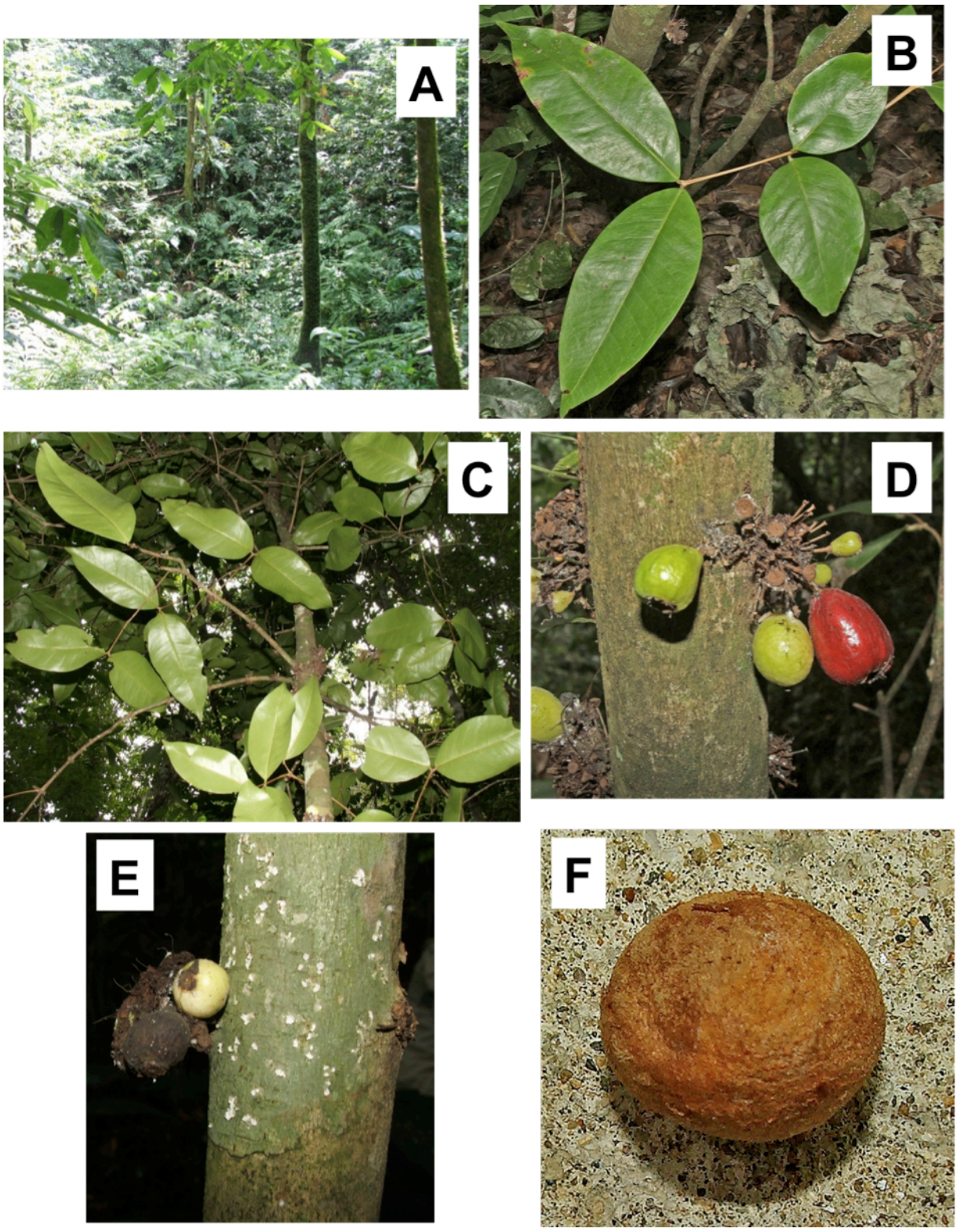

Figure 9. *Eugenia haemathocarpa* was the only listed species found in Barrio Arenales Altos at Isabela: A. Habitat where the species occur, B. leaves and stems, C. underneath leaves and branches, D. immature and mature fruits, E. bark and dry fruit, and F. cleaned seed showing shape and color.

Figure 10. Forested limestone hills at Barrio Arenales Altos, Isabela.

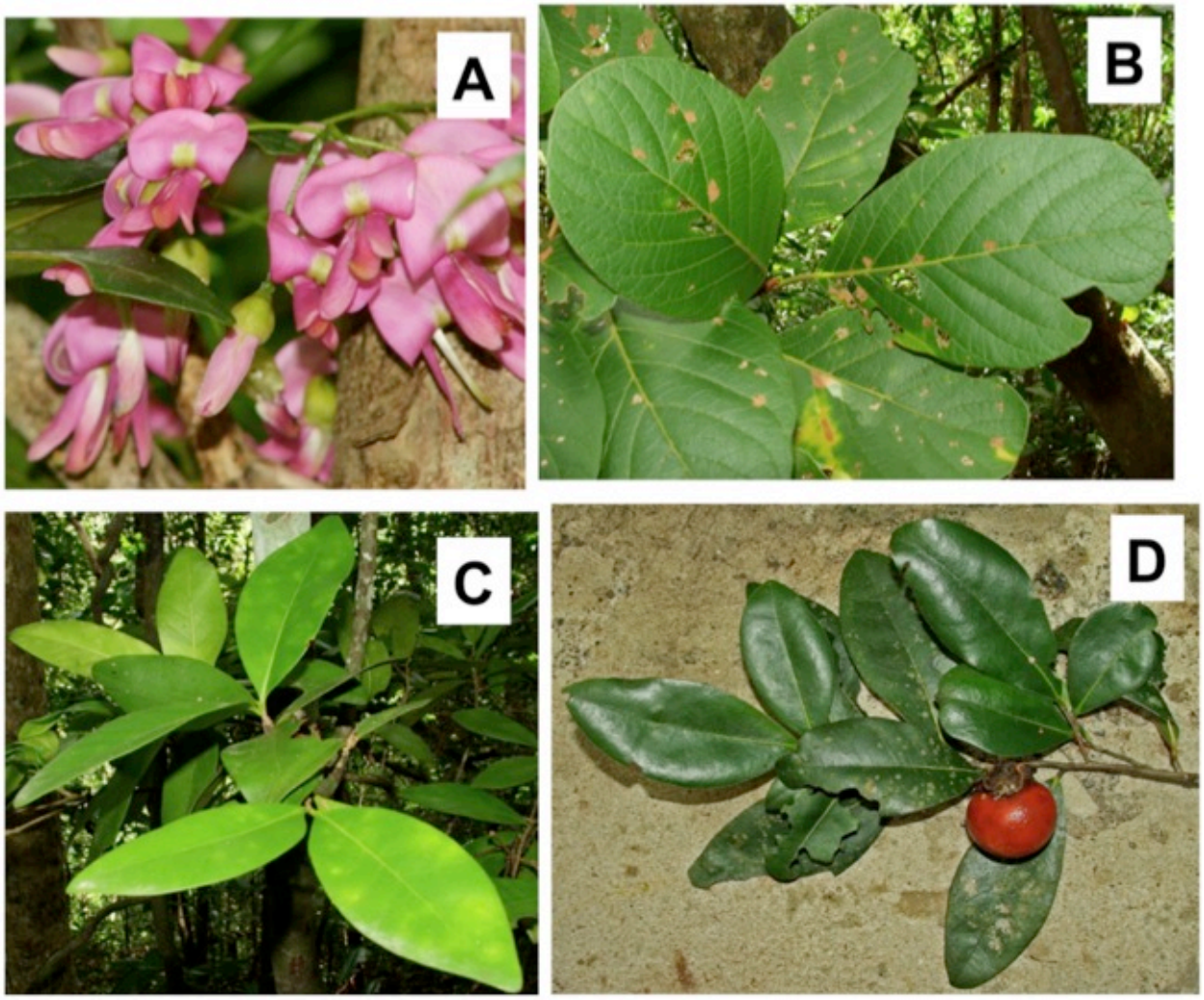

Figure 11. Endemic species found in limestone hills of Barrio Arenales Altos, Isabela: A. *Lonchocarpus glaucifolius*, B. *Pisonia taina*, C. *Stenostomum sintenisii*, and D. *Diospyros sintenisii*.

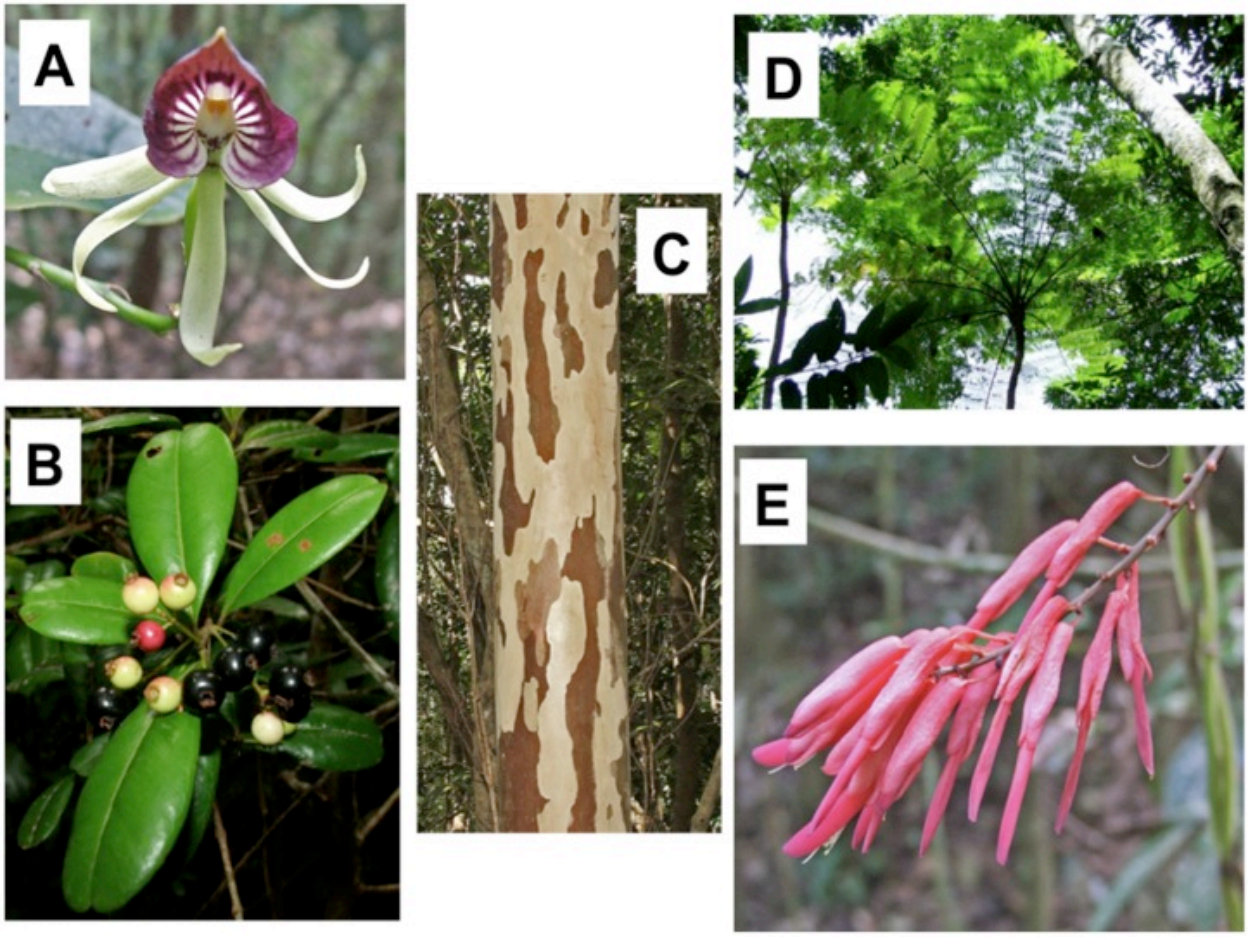

Figure 12. Other native species found at Barrio Arenales Altos, Isabela: A. the orchid *Encyclia cochleata,* B. the shrub *Myrcia citrifolia* var. *imrayana*, C. the tree *Psidium amplexicaule*, D. the tree fern *Cyathea arborea*, and E. the vine *Neorudolphia volubilis*, the only genus of the Plant Kingdom that is endemic to Puerto Rico.

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