Bioeconomical potential of Leguminosae from the Lower Negro River, Amazon, Brazil

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Amazônia is one of the megadiversidade areas of the planet, and has in its area geographical zones that stand out it goes the high biological variety, that represent an incalculable stock of genetic resources it goes current and future it uses. Leguminosae has distribution cosmopolitan, high number of species in the tropical and subtropical areas, representing an important group in Amazônia.

The archipelago of Anavilhanas has an area of 350.000 hectares and it is located in the bass Negro river, between the municipal districts of Manaus and New Airão (2º00'-3º02' S and 60º27'-61º07' W), where igapó vegetation prevails and it kills riverside. The archipelago is formed by hundreds of islands, besides countless lakes, in an area that extends for 90 km of length and 15 km of width, in its wider space (SEMA, 1977), have a distance of 50 km of Manaus.

Inside of the area, two bases serve as support to the researchers and visitors: the flotation base, located in the entrance of the Lake of the Plate and, the base of the firm earth, that allows the access to the riverside forests that border the Negro river. The forest of firm earth included in the Ecological Station has 250.000 km^2 of extension approximately.

It was made a rising of the species of Leguminosae of the archipelago of Anavilhanas, seeking a search to identify species with potential economic and/or agroforestry. For these works, six visits were accomplished to the place, being alternated the dry and rainy periods, in the months of April of 1987, February and August of 1988, October of 1989 and February and October of 1994.

Three systems ecological with its formations and sub-formations were considered: the igapó, vegetation type constantly flooded by the black waters of the Black river; the riverside forest, that border the channels and arms of the close smaller, located rivers to the Base of the earth-firm in areas adjacent to the archipelago and of flowing smaller than drain in the Negro river; and finally, the high forests of the earth-firm, close to the riverside forests, in places never reached by the annual cycles of flood.

During the collection works, the species were identified in the different vegetation types, being collected botanical material, fruits, peels, soil samples and of nodules, when presents. It was used in the field a standard of description record, that gathered information on the place of the collection, characteristics of the head office and characteristics of the botanical material. The botanical material was treated with commercial alcohol the stove to for 65ºC, in the laboratory. The identification of the species was driven in the herbarium of Botanical Department of INPA, for comparison with very identified material, of preference for specialists, and one sample of the botanical material were incorporate to the collection of the herbarium.

In this rising, they were identified 67 species distributed in the three sub-families, prevailing Papilionoideae (29 species, 43,3%), followed by Caesalpinioidea 21 species (31,3%) and Mimosoideae 17 species (25,4%), as presented in the Table 1.

As it can be verified, the Leguminosae is quite frequent and dominant in the landscape, and

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they present high diversity index, happening about 43 goods in the vegetation of the Ecological Station, fact that that can be associated to the annual cycles of flood of the Black river, since those areas, today subject to periodic floods, they were, formerly, forest of firm earth (Iron & Adis, 1979). In the vegetation of the igapó and in the riverside forests, the species present natural tolerance to the those changes you park of the level of the waters, that, in the Black river, they reach its pick more elevated the months of May and June. Between the genera found with larger number of species stand out: *Swartzia*, (eight species); *Dalbergia*, *Dioclea*, *Inga*, *Macrolobium* and *Ormosia*, (three species in each); and *Albizia*, *Macrosamanea*, *Parkia*, *Peltogyne*, *Pithecellobium*, *Senna* and *Tachigali*, with two species in each genera. Finally, 30 genera were registered with only a species.

In this work, they were striped species contained in 16 tribes of the Leguminosae, with larger frequency of the tribes Ingeae and Amherstieae (with 11 species), according to the Table 1. The species, classified in the tribes Cassieae, Dalbergieae, Sophoreae and Swartzieae, presented among five to nine individuals; in the tribe Sclerolobieae was found two species and, in Parkieae, three.

The habit of growth of the Leguminosae in the archipelago is mainly arboreal (53 species - 79,1%), so only varying with relationship to the individuals size, with small trees as the facarana (*Clitoria amazonum* Benth.) and the faveira (*Swartzia auriculata* Poepp.) and trees of medium and big load as the macucu (*Aldina heterophylla* Benth.), the arara-tucupi (*Parkia decussata* Ducke), the sucupira-do-igapó (*Diplotropis martiusii* Benth.), the arabá (*Swartzia polyphylla* DC.) and the pracuúba (*Mora paraensis* (Ducke) Ducke), among anothers.

Many works consider the hypothesis that the most primitive Leguminosae had origin in the tropical area and they presented, originally, growth habit almost exclusively arboreal (Tutim, 1958). This is an interesting, same verification because, now, more than 95% of the belonging species the sub-families Mimosoideae and Caesalpilionoideae, are woody, explaining the frequency and abundance of arboreal Leguminosae in the tropical forests.

With relationship to the lianas species, it is known that exist more species in the tropical forests than in the forests of the temperate areas (Gentry, 1984). In this rising, it was verified that liana Leguminosae is important components of the landscape of the archipelago, being verified the occurrence of 13 of them, what corresponds, until then, at 19,4% of the Leguminosae identified in the area. The woody lianas is defined as creeper, they be developed in height, being just used of a support for its growth. Among the families of arboreal vascular plants, many possess species lianescentes and, other, like Hippocrateaceae, Smilacaceae and Vitaceae they are constituted exclusively of lianas.

A lot of liana Leguminosae have nodules and they fasten nitrogen for the symbiosis between Rhizobia and the plants and, probably, the present liana in this vegetation of the archipelago can nodular, playing an important ecological part in the cycle of nutrients of the forest. The liana woody, for its properties, possesses cycle of smaller life than the trees, and they present it satisfies foliage that its take to the formation of a biomass with low relationship Carbon/Nitrogen, what it turns it of easy decomposition, due to the high present texts of nitrogen in its constitution (Souza *et al*., 1994).

It was observed that, of those liana species, some behave, great part of the times, as bushes in the juvenile phase of its development. Adaptation mechanisms in these lianas, as thorns, facilitate the development of these plants on the cup of the emergent vegetation or they allow that the species dominate the open areas, after the natural decadence of the trees, serving as support and/or sustentation for these plants creepers. In several points of the vegetation the liana woody, belonging to the genera *Dalbergia*, *Dioclea*, *Mucuna*, *Machaerium* and *Pithecellobium*, in fast and aggressive development, form, a lot of times, entangled dense of branches and foliage, in a process that can take to the death species of the inferior strata. In a posterior phase, the place comes as a great green scrub, with a lot of biomass production, sometimes stippled of flowers and/or good-looking fruits, standing out of the vegetation the feijão-bravo (*Dioclea bicolor* Benth.), with flowers erected, violet, that emerge in the

landscape or the veronica (*Dalbergia riedelii* (Raflk.) Sandw.) with fruits in form of dishes, brown, velvet, or same timbó-de-jacaré (*Deguelia scandens* Aubl.) and mosquiteiro-de-capivara (*Dalbergia riparia* (Mart.) Benth.), whose fruits also stand out among the foliage of the plants.

An only specie with load bush was found in the vegetation of the archipelago, the faveira-de-rosca (*Macrosamanea discolor* (Willd.) Brit. & Killip), that grows in the sandy banks of the margins of the small rivers and in the beaches, during the period of the water decay. The absence of herbaceous Leguminosae in the vegetation, is due, probably, to the small occurrence of open areas or you kill secondary, in the area of the Station.

The frequency of the species in the landscape was considered, settling down as parameter the following events: present, frequent and abundant. Under this approach, 37 species were considered presents (55,2%), 23 frequent species (34,3%) and 7 abundant species (10,5%). Between the abundant species in the vegetation of the igapó, stood out the lombrigueiro (*Crudia amazonica* Benth.), the tento-amarelo (*Ormosia excelsa* Benth.), the arapari (*Macrolobium acaciifolium* (Benth.) Benth.), the acapurana (*Campsiandra comosa* Benth.) and it had bico-de-arara it (*Parkia discolor* Benth.), trees these that vegetate commonly in the riverside forest. For these species, the main mechanism of dispersion of the fruits is the hidrocoria, that is to say, the dispersion for the water. According to Scarano (1996) the success of the propagation for seeds of species of the forests flooded it can be associated to an efficient aquatic dispersion of the fruits.

In the studies accomplished in flooded forests it has been verified that the diversity in species decreases in the topographical gradient, in direction to the areas submitted to a larger flood period (Aires, 1993).

The forests of igapó of the very old healthy Black river and they were formed along the time by the influence of the annual invasion of the riverside forests for the waters of the river, in places previously covered by firm, exposed earth forests, there are 1 million years before, to the annual pulses of flood (Iron & Adis, 1979). Generally, the flood of the igapó forest begins of March to April,extending until August and September.

Most of the collections in the archipelago was made in the vegetation of the igapó (35 species, 52,2%), proceeded by species sampled in the riverside forest (19 species, 28,4%), and, in the forest of earth-firm (13 species, 19,4%). The smallest number of collections made in areas didn't flood it’s due, basically, to the absence of trails in the forest of earth-firm of the Ecological Station. There are also species that happen so much in the igapó as in the riverside forests, or in another areas you flooded as the várzeas of the river Solimões, but this aspect was not explored in this study.

Bioeconomical potential of the species from Anavilhanas

Historically, the native species have been the initial source of raw material for countless products and by-products, as wood, medications, cellulose and paper, food for the fauna and for the man, fibers, oils and resins, gums, and other, existing an enormous investigation field the about of the economic potential of the species. Other species, besides products, they can also offer services as: shadow of cultivations, green fertilization, covering of the soil, biological fixation of nitrogen, forage, etc., indispensable for the continuous production, in systems of maintainable production. For ends of classification of the arboreal Leguminosae with relationship to its use, Duhoux & Dommergues (1985), they established three different groups: trees that produce wood and miscellany of by-products as firewood, oil, resin, tannin, coal and cellulose; trees forage and for human food; and, trees that aid the fertility of the soil.
The main economic product that the Leguminosae of Anavilhanas offers it is, without a doubt the wood, notedly the law wood used for noble ends, as: constructions of embarkations, civil construction, golf clubs, furniture, boards and others. In this group, the species are classified whose uses and mechanical properties were already investigated somehow by the wood technology, revealing its economic and industrial potential. Between they are the macucu (*Aldina heterophylla* Benth.), the jutaí-café (*Dialium guianense* (Aubl.) Sandw.), the angélica-do-Pará (*Dicorynia paraensis* Benth.), the sucupira-do-igapó (*Diplotropis martiusii* Benth.), the ingá-turi (*Inga alba* (Sw.) Willd.), the pracuúba (*Mora paraensis* (Ducke) Ducke), the arara-tucupi (*Parkia decussata* Ducke), the pau-roxo (*Peltogyne paniculata* Benth.), the angelim-rajado (*Marmaroxylon racemosum* (Ducke) Rec.), the saboarana (*Swartzia laevicarpa* Amshoff), the tachizeiro (*Sclerolobium hypoleucum* Benth.) and the fava-mutum (*Vatairea guianensis* Aubl.). most of these species already had its technological and anatomical properties of the studied wood, revealing its commercialization potential in the markets lumbermen, national and external (Laurel *et al.*, 1979; SUDAM/IPT, 1981).
On the other hand, there is also, readiness of species producing of wood for firewood, and that can be taken advantage of with energy ends or for less noble uses, as civil construction, compensated, box, etc., produced by species as the faveira-camuzé (*Stryphnodendron guianense* Benth.), the taboarana (*Acosmium nitens* (Vog.) Yakovl.), the faveira-do-igapó (*Albizia corymbosa* (Rich.) Lewis & Owen), the arapari (*Macrolobium acaciifolium* (Benth.) Benth.), the araparirana (*M. multijugum* (DC.) Benth.), the apeu (*M. angustifolium* (Benth.) Cowan), the paracaxi (*Pentaclethra racemosa* (Willd.) Kuntze), the lombrigueiro (Crudia *amazonica* Benth.), the arabá (*Swartzia polyphylla* DC.) and him cumaru-da-praia (*Taralea oppositifolia* Aubl.). it is evident, however, that that potential economic lumberman of the area won't be explored, for being of a conservation area. Even so, the readiness of germoplasm of the species that occupy those areas it cannot, in future, to have an important paper in programs of genetic improvement, that they include progeny studies and origins, to identify genetic resources of native species with potential of future use.
Between other uses, the found species still present varied use forms, as the pau-de-rolha (*Aeschynomene sensitiva* Sw.), whose roots, due to low density of its log, they are used in the cork production for bottle cork; the acapurana (*Campsiandra comosa* Benth.), that it is explored by the Indians from Venezuela, in time of little food readiness, in the production of products of such bakery as breads, cookies and „arepas“. The process for the production of these products starting from the seeds of *Campsiandra* was described by Barreiro *et al.*, (1984a,b).
The production of fruits can reveal economic value for some of the local species, as food for the man, as the ingá-mari-mari (*Cassia leiandra* Benth.), whose fruits possess seeds covered by a green, sweetened pulp, marketed in the markets of the area (Arkcoll, 1984) and the jatobá (*Hymenaea courbaril* L.), whose farinaceous pulp is, although in small scale, appreciated on the part of the population. Other species, produce fruits that are important for the feeding of the autochthonous fauna as the ingá xixica (*Inga nobilis* Willd.) and the ingaí

(*Inga leiocalycina* Benth.). However, the production of fruits can have wider application, as for the obtaining of another products as natural gums, produced by species of the genera *Parkia*, between they had beak-of-plowed it (*Parkia discolor* Benth.), abundant in the igapó vegetation. A lot of times, the potential of the fruits cannot be for direct use as food. Arkcoll (1984), it verified that the dry seeds of paracaxi (*Pentaclethra macroloba* (Willd.) Kuntze) they contain 45% of oil that it can be used in the kitchen and for illumination. After the extraction of the oil the remaining is used for animal feeding and the wood of this species is very used in the construction of canoes.

For the varnish production and lacquers, the highlighted species of the group is the jatobá (*Hymenaea courbaril* L.), whose well-known resin as „copal“ or „jutaicica“, is thoroughly taken advantage of in the industry of glues, lacquers and varnishes (Cavalcante, 1988).

In another situations, the intrinsic value of those species is as medicinal plant. For example: the lombrigueiro or orelha-de-cachorro (*Crudia amazonica* Benth.), whose peel is used as a powerful one vermifuge (Laurel *et al*. 1979); the fava-mutum, also known as fava-of-impinge (*Vatairea guianensis* Aubl.), whose seeds are used in the treatment of the impingem and the juice of the fruit against fever, that is to say you stain in the skin caused by the sun and other problems of human skin (Van den Berg, 1982), such as the „white cloth“; of the jatobá, (*Hymenaea courbaril* L.), the Indians extract of the sap a substance that is used in the treatment of illnesses of the breathing and urinary apparel (Benza, 1980).

Some of those species still produce seeds that are very used in the popular craft, as the tento-amarelo (*Ormosia excelsa* Benth.), with seeds with one color and the mulungu (*Ormosia macrocalyx* Ducke), that possesses bicolor seeds (black and red), used in the making of decorations, bracelets, necklaces, luminary, curtains, etc.

Finally, the ornamental aspects of the present Leguminosas in Anavilhanas deserve prominence, existing plants with good-looking flowers and with potential for use in landscape decoration, as the aiari (*Heterostemon mimosoides* Desf.), whose flowers are similar to orchids. Its also calls attention the ingá-de-sapo (*Pithecellobium inaequale* (Willd.) Benth.), that presents good-looking red-dark flowers in the trunk in its branches and the mututi (*Pterocarpus santalinoides* DC.), whose cup is filled of orange, exuberant flowers, standing out of the vegetation. The facarana individuals (*Clitoria amazonum* Benth.), they are small trees that produce bunches pendulums of flowers violet the white ones, quite good-looking in the areas along the river. Other species with ornamental potential, get attention for its fruits extremely colorings and vibrant, as the acapu-do-igapó (*Swartzia argentea* Benth.) that has orange fruits, the saboarana (*Swartzia sericea* Vog.), with voluminous, brown fruits, velvets, distributed in the open cup formed by big and attractive leaves, the arapari (*Macrolobium acaciifolium* (Ducke) Ducke), of yellow fruits and, the lombrigueiro (*Crudia amazonica* Benth.), that produces velvet oblong, brown favas. These species deserve a larger attention due to the potential ornamental that present.

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Table 1. Species of the family Leguminosae found in the Anavilhana's archipelago, lower Negro river, Brazil. Taxonomic category (sub-family, tribe, species), popular name habit, frequency, vegetation and registration number of collection and in the INPA herbarium.

Sub-family/Species	Tribe	Popular name (Brazil)	Habit	Frequency	Vegetation	Number of collection	N° of INPA herbarium
CAESALPINIOIDEAE							
Campsiandra comosa Benth.	Sclerolobieae	Acapurana	Tree	Abundant	Igapó	658	-
Cassia leiandra Benth.	Cassieae	Ingá mari mari	Tree	Present	Igapó	640	156.562
Chamaecrista negrensis Irwin & Barneby	Cassieae	Membi	Tree	Present	Igapó	634	156.556
Crudia amazonica Benth.	Amherstieae	Lombrigueiro	Tree	Frequent	Igapó	624	-
Cynometra spruceana Benth.	Cynometreae	Jutairana	Tree	Frequent	Igapó	648	156.570
Dialium guianensis (Aubl.) Sandw	Cassieae	Jutai café	Tree	Present	Firm earth	548	-
Dicorynia paraensis Benth.	Cassieae	Angélica do Pará	Tree	Present	Riverside	675	156.596
Elizabetha speciosa Ducke	Amherstieae	Arapari vermelho	Tree	Present	Igapó	646	156.568
Heterostemom mimosoides Desf.	Amherstieae	Aiari	Tree	Present	Firm earth	721	174.343
Hymenaea courbaril L.	Amherstieae	Jatobá	Tree	Present	Firm earth	502	-
Macrolobium acaciifolium (Benth.) Benth.	Amherstieae	Arapari	Tree	Abundant	Igapó	626	-
Macrolobium angustifolium (Benth.) Cowan	Amherstieae	Apeu	Tree	Frequent	Igapó	693	174.345
Macrolobium multijugum (DC) Benth.	Amherstieae	Araparirana	Tree	Frequent	Igapó	694	174.348
Mora paraensis (Ducke) Ducke	Dimorphandreae	Pracuúba	Tree	Present	Riverside	630	-
Peltogyne paniculata Benth.	Amherstieae	Mulateiro	Tree	Present	Riverside	590	156.622
Peltogyne venosa (Vahl.) Benth.	Amherstieae	Ipê roxo	Tree	Frequent	Igapó	664	156.585
Sclerolobium hypoleucum Benth.	Sclerolobieae	Tachizeiro	Tree	Present	Riverside	653	156.575
Senna reticulata (Willd.) Irwin & Barneby	Cassieae	Mata pasto	Tree	Present	Riverside	647	-
Senna silvestris (Vell. Conc.) Irwin & Barneby	Cassieae	Abotinha	Tree	Present	Firm earth	567	-
Tachigali myrmecophila (Ducke) Ducke	Amherstieae	Tachi preto	Tree	Present	Firm earth	637	156.591
Tachigali paniculata Aubl.	Amherstieae	Tachi branco	Tree	Frequent	Igapó	720	156.559

MIMOSOIDEAE							
Acacia polyphylla DC	Acacieae	Unha de gato	Liana	Present	Riverside	514	-
Albizia corymbosa (Rich.) Lewis & Owen	Ingeae	Faveira do igapó	Tree	Frequent	Riverside	535	156.597
Albizia polyantha (Spreng.) Lewis	Ingeae	Paricarana	Tree	Present	Igapó	721	148.576
Inga alba (Sw.) Willd.	Ingeae	Ingá turi	Tree	Present	Firm earth	562	148.574
Inga leiocalycina Benth.	Ingeae	Ingaí	Tree	Present	Igapó	642	156.579
Inga nobilis Willd.	Ingeae	Ingá xixica	Tree	Present	Riverside	533	-
Macrosamanea discolor (Willd.) Brit. & Killip	Ingeae	Faveira de rosca	Bush	Frequent	Igapó	722	156.588
Macrosamanea spruceana (Benth.) Rec.	Ingeae	Cipó ingarana	Liana	Present	Riverside	730	156.593
Marmaroxylon racemosum (Ducke) Rec.	Ingeae	Angelim rajado	Tree	Present	Firm earth	714	-
Mimosa spruceana Benth.	Eumimoseae	Unha de gato	Liana	Present	Riverside	580	156.589
Parkia decussata Ducke	Parkieae	Arara tucupi	Tree	Present	Firm earth	504	156.583
Parkia discolor Benth.	Parkieae	Bico de arara	Tree	Abundant	Igapó	560	156.569
Pentaclethra macroloba (Willd.) Kuntze	Parkieae	Paracaxi	Tree	Frequent	Igapó	622	-
Pithecellobium inaequale (Willd.) Benth.	Ingeae	Ingá de sapo	Tree	Frequent	Igapó	659	156.580
Pithecellobium marginatum Benth.	Ingeae	Saboeiro da várzea	Tree	Present	Igapó	652	156.574
Stryphnodendron guianense Benth.	Adenanthereae	Faveira camuzé	Tree	Present	Firm earth	561	-
Zygia cauliflora (Willd.) Killip	Ingeae	Jarandueua	Tree	Present	Igapó	651	156.673
PAPILIONOIDEAE							
Acosmium nitens (Vog.) Yakov.	Sophoreae	Taboarana	Tree	Abundant	Igapó	559	156.576
Aeschynomene sensitiva Sw.	Hedysareae	Pau de rolha	Liana	Present	Riverside	729	-
Aldina heterophylla Benth.	Swartzieae	Macucu	Tree	Present	Riverside	725	-
Chlathrotropis nitida (Benth.) Harms.	Sophoreae	Faveira branca	Tree	Frequent	Riverside	697	174.344
Clitoria amazonum Benth.	Phaseoleae	Facarana	Tree	Frequent	Igapó	625	-
Dalbergia inundata Benth.	Dalbergieae	Mosquiteiro	Liana	Frequent	Igapó	661	156.582
Dalbergia riedelii (Radlk.) Sandw.	Dalbergieae	Verônica	Liana	Abundant	Igapó	615	174.346
Dalbergia riparia (Mart.) Benth.	Dalbergieae	Rabo de guariba	Liana	Abundant	Igapó	638	156.560
Deguelia scandens Aubl.	Dalbergieae	Timbó de jacaré	Liana	Frequent	Igapó	635	156.557
Dioclea bicolor Benth.	Phaseoleae	Feijão bravo	Liana	Frequent	Igapó	639	156.561
Dioclea guianensis Benth.	Phaseoleae	Pé de pato	Liana	Present	Firm earth	728	-

Dioclea macrocarpa Huber	Phaseoleae	Olho de boi	Liana	Present	Igapó	663	156.584
Diplotropis martiusii Benth.	Sophoreae	Sucupira do igapó	Tree	Present	Igapó	731	-
Machaerium ferox (Benth.) Ducke	Dalbergieae	Juquiri preto	Liana	Frequent	Igapó	674	156.565
Mucuna urens (L.) Medikus	Phaseoleae	Pó de mico	Liana	Frequent	Igapó	649	156.571
Ormosia excelsa Benth.	Sophoreae	Tento amarelo	Tree	Abundant	Igapó	627	-
Ormosia macrocalyx Ducke	Sophoreae	Tento vermelho	Tree	Frequent	Igapó	636	156.558
Ormosia nobilis Tul. var. *nobilis*.	Sophoreae	Mulungu da mata	Tree	Present	Firm earth	655	156.577
Pterocarpus santalinoides DC	Dalbergieae	Mututi	Tree	Present	Igapó	650	156.572
Swartzia argentea Benth.	Swartzieae	Acapu do igapó	Tree	Frequent	Riverside	669	156.590
Swartzia auriculata Poepp.	Swartzieae	Faveira	Tree	Present	Firm earth	644	156.566
Swartzia cuspidata Benth.	Swartzieae	Coração	Tree	Present	Riverside	665	156.586
Swartzia laevicarpa Amshoff	Swartzieae	Saboarana	Tree	Frequent	Igapó	629	-
Swartzia macrocarpa Benth.	Swartzieae	Faveira	Tree	Frequent	Riverside	673	156.594
Swartzia polyphylla DC	Swartzieae	Arabá	Tree	Frequent	Riverside	656	156.567
Swartzia sericea Vog.	Swartzieae	Saboarana	Tree	Frequent	Riverside	696	174.347
Swartzia ulei Harms	Swartzieae	Girimum	Tree	Present	Firm earth	666	156.587
Taralea oppositifolia Aubl.	Galegeae	Cumaru da praia	Tree	Present	Igapó	732	-
Vatairea guianensis Aubl.	Dalbergieae	Fava mutum	Tree	Present	Riverside	692	-