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**Inventory**

# Floristic and structure of the arboreal community of an Ombrophilous Dense Forest at 800 m above sea level, in Ubatuba/SP, Brazil

*Ana Cláudia Oliveira de Souza*[1]*, *Luís Benacci*[2] & *Carlos Alfredo Joly*[3]

[1]*Universidade Estadual Paulista Júlio de Mesquita Filho, Departamento de Botânica, Campus de Rio Claro, Av. 24 A, 1515, 13506-900, Rio Claro, SP, Brasil*
[2]*Instituto Agronômico, 13020-902, Campinas, SP, Brasil*
[3]*Universidade de Campinas, Instituto de Biologia, Campinas, SP, Brasil*
**Corresponding author: Ana Cláudia Oliveira de Souza, e-mail: aco.souza@unesp.br*

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***Abstract:*** Undoubtedly, the publication of floristic lists and phytosociological studies are important tools for metadata generation, quantification and characterization of the megadiversity of Brazilian forests. In this sense, this work had the objective of describing the composition and the structure of the tree community of one hectare of Dense Atlantic Rainforest, at an altitude of 800 m. All individuals, including trees, palm trees, arborescent ferns and dead and standing stems, with a diameter at breast height (DBH) of ≥ 4.8 cm were sampled. After the identification of the botanical material, we proceeded to calculate the usual phytosociological parameters, besides the Shannon diversity index (H') and Pielou equability index (J). A total of 1.791 individuals were sampled, of which 1.729 were alive, belonging to 185 species, 100 genera and 46 families. The results obtained showed a strong similarity of structure and floristic composition with plots of both Montana and Sub Montana Ombrophilous Dense Forest studied in the same region. This reinforces the hypothesis that the transition between the phytophysiognomies of the Atlantic Ombrophylous Dense Forest is gradual, and that the boundaries between them cannot be clearly established.
***Keywords:*** *Biodiversity conservation, Megadiversity, Atlantic forest, Serra do Mar State Park, PELD/ILTER FGAF Site.*

# Florística e estrutura da comunidade arbórea de uma Floresta Ombrófila Densa a 800 m acima do nível do mar, em Ubatuba/SP, Brasil

***Resumo:*** Indiscutivelmente a publicação de listas florísticas e estudos fitossociológicos são importantes ferramentas para a geração de metadados, quantificação e caracterização da megadiversidade das florestas brasileiras. Neste sentido, o presente trabalho teve por objetivo descrever a composição e a estrutura da comunidade arbórea de um hectare de Floresta Ombrófila Densa Atlântica, na cota dos 800 m de altitude. Para tanto foram estabelecidas 100 subparcelas de 10 x 10 m, distribuídas em quatro blocos amostrais de 0,25 ha, onde foram amostrados todos os indivíduos arbóreos, incluindo palmeiras, fetos arborescentes e indivíduos mortos e em pé, com DAP (diâmetro à altura do peito) ≥ 4,8 cm. Após a identificação do material botânico e do cálculo dos parâmetros fitossociológicos usuais, foram calculados os índices de diversidade de Shannon (H') e de eqüabilidade de Pielou (J). Foram amostrados 1.791 indivíduos arbóreos, sendo 1.729 vivos pertencentes a 185 espécies, 100 gêneros e 46 famílias. Os resultados obtidos mostram forte similaridade de estrutura e composição florística com parcelas tanto de Floresta Ombrófila Densa Montana como Floresta Ombrófila Densa Submontana estudadas na mesma região, reforçando a hipótese que a transição entre as fitofisionomias da Floresta Ombrófila Densa Atlântica é gradual e que os limites entre elas não podem ser claramente estabelecidos.
***Palavras-chave:*** *Conservação da biodiversidade, Megadiversidade, Floresta Atlântica, Parque Estadual da Serra do Mar, Sítio PELD/ILTER FGAF.*

## Introduction

The Atlantic Forest, classified by Myers et al. (2000) among the five most threatened hotspots in the world, originally covered about 82% of the state of São Paulo (Joly et al. 1999), especially due to the coffee economic cycle, was reduced to about 5% of its original area (Kronka et al. 2005). This biome, which is classified as the second largest tropical rainforest on the American continent (Morellato & Haddad 2000), is composed of a mosaic of ecosystems with specific ecological processes (Campanili & Schaffer 2010).

The well-preserved stretches, which harbour great floristic diversity, are located mainly in the Serra do Mar region (SOS Mata Atlântica & INPE 2014), a set of scalloped escarpments that extend from

Rio de Janeiro to Santa Catarina (Almeida & Carneiro 1998). The largest continuous well-preserved stretch is protected by the Serra do Mar State Park (PESM).

During the last decade, the lack of large and intensive studies in the region of the north coast of São Paulo was greatly improved by work in the Picinguaba and Santa Virgínia Nucleus of the Serra do Mar State Park (Joly et al. 2012). However, between the elevations of 400 and 1000 m altitude, a large information gap persisted, because there was no floristic or phytosociological study with expressive representativeness of the arboreal vegetation in these intermediate levels.

Therefore, this work had the objective to describe the composition and structure of the tree community of one hectare of Montana Ombrophilous Dense Forest in the altitude of 800 m, an intermediate level between the altitudes of 400 and 1000 m. This proposal are of extreme importance for the generation of data that allow a better understanding of the full extent of the megadiversity of the forests that cover the Serra do Mar.

## Material and Methods

### *1. Location and characterization of the study area*

The Serra do Mar State Park (PESM) is about 332,000 ha, is predominantly covered by Ombrophilous Dense Forest (Veloso et al. 2012) and extends through 25 municipalities of São Paulo from sea level to around 1600 m altitude, including coastal plains, scarps and plateaus (Mattoso 2006). In the northern coastal region, in the plains area, the lowland forest presents a tropical climate without a dry season, with an average annual rainfall of 2200 mm, and even in the driest months (June to August) it is less than 60 mm (Setzer 1966, Rosado et al. 2012). However, the temperate tropical climate is present in the plateau, in the montane forest, with an average annual precipitation near 2000 mm and frequent occurrence of fogs that cover large areas of this forest (Rosado et al. 2010).

In the region, soils low in basic cations and rich in aluminum predominate in comparison to other tropical forests (Martins 2010, Joly et al. 2012). The study area (23º 21 '34-40 "S, 45º 06' 31-40" W) is located in the cliffs of the Serra do Mar, presenting relief with strong slopes (Forest Institute 2010) and is within the PELD/ILTER Functional Gradient of Atlantic Forest/FGAF site, established in 2010 (http://peld-biotagradiente.net/). This was the portion denominated as P, following the sequence of areas previously studied. Although the area studied was administratively part of Picinguaba Nucleus, due to its proximity and logistics, the Santa Virgínia Nucleus was used as an operational base.

### *2. Establishment of permanent plots and survey of vegetation*

In the studied area, 100 subplots of 10 x 10 m were established, distributed in four sample blocks of 0.25 ha (50 x 50 m) and a maximum distance between the blocks of around 40 m (Figure 1), between altitudes of 758 to 866 m (quota of 800 m). The allocation of subplots, georeferenced and delimited with PVC pipes of 1.5 m height and 5" diameter at the external vertices and 3/4" in the others, in order to allow long term studies and continuous monitoring in these areas was done by a team specialized in topography, as proposed by Joly et al. (2012).

The floristic survey was carried out from the collection of botanical material of the arboreal individuals, including palm trees, arborescent ferns and dead and standing individuals, with a diameter at breast height (DBH) of ≥ 4.8 cm. The collection trips were carried out from January 2011 to January 2012. The identifications were made with the aid of relevant literature and expert consultations, as well as comparisons with the IAC, UEC and HRCB herbarium collections. The species were grouped by families according to the classification system of Angiosperm Phylogeny Group (APG IV 2016) with indication of subfamilies in Fabaceae, according to the consensual proposal discussed by LPWG (2013). For the arborescent ferns, phylogenetic order was also followed (Christenhusz et al. 2011).

For the phytosociological analyses, the following parameters were represented: number of individuals; absolute frequency; absolute dominance and importance value, and the Shannon (H') diversity indexes, using the natural basis, and Pielou (J) equation (Brower & Zar 1984) were calculated. In the multivariate analyses, the FITOPAC 2.1 program (Shepherd 2010) was used, from a quantitative matrix (absolute density of all morphospecies, identified at least up to the family level), and a dendrogram was constructed using the UPGMA method, using the coefficient of Bray Curtis, to verify the similarity among the four sample blocks.

## Results

In the total area, 1.791 individuals were demarcated, of which 1.729 were alive, including 1610 trees (89.8% of individuals), 112 palm trees (6.2%) and 7 arborescent ferns (0.4%) belonging to 185 species, 100 genera and 46 families. Two individuals remained undetermined, not having been collected, due to the absence of branches and high height (Table 1). The individuals still dead and standing (62) represented 3.57% of the sample.

Myrtaceae was the richest family (48 species, 25.9%), followed by Rubiaceae (16 species, 8.6%), Fabaceae (11 species, 5.9% - being six Caesalpinioideae, three Faboideae and two Detarioideae), Lauraceae (9 species, 4.9%), Melastomataceae (8 species, 4.3%), Monimiaceae and Sapotaceae (7 species, 3.8% each), which together comprised 57.2% of the species found in the area. Four of these families were also among the most abundant: Rubiaceae (540 individuals.ha$^{-1}$, 31.3% of live trees), followed by Myrtaceae (233, 13.5%), Monimiaceae (122, 7.1%) and Melastomataceae (111, 6.4% – fifth position), together with Arecaceae (112, 6.5% – fourth position) and Nyctaginaceae (94, 5.4% – sixth position) added up to 70.2% of the live trees.

Most of the families that excelled in the richness and abundance parameters were eudicotiledonous, however, we also found representatives of magnoliids (Monimiaceae and Lauraceae) and monocotyledons (Arecaceae). Rubiaceae was the family with the highest

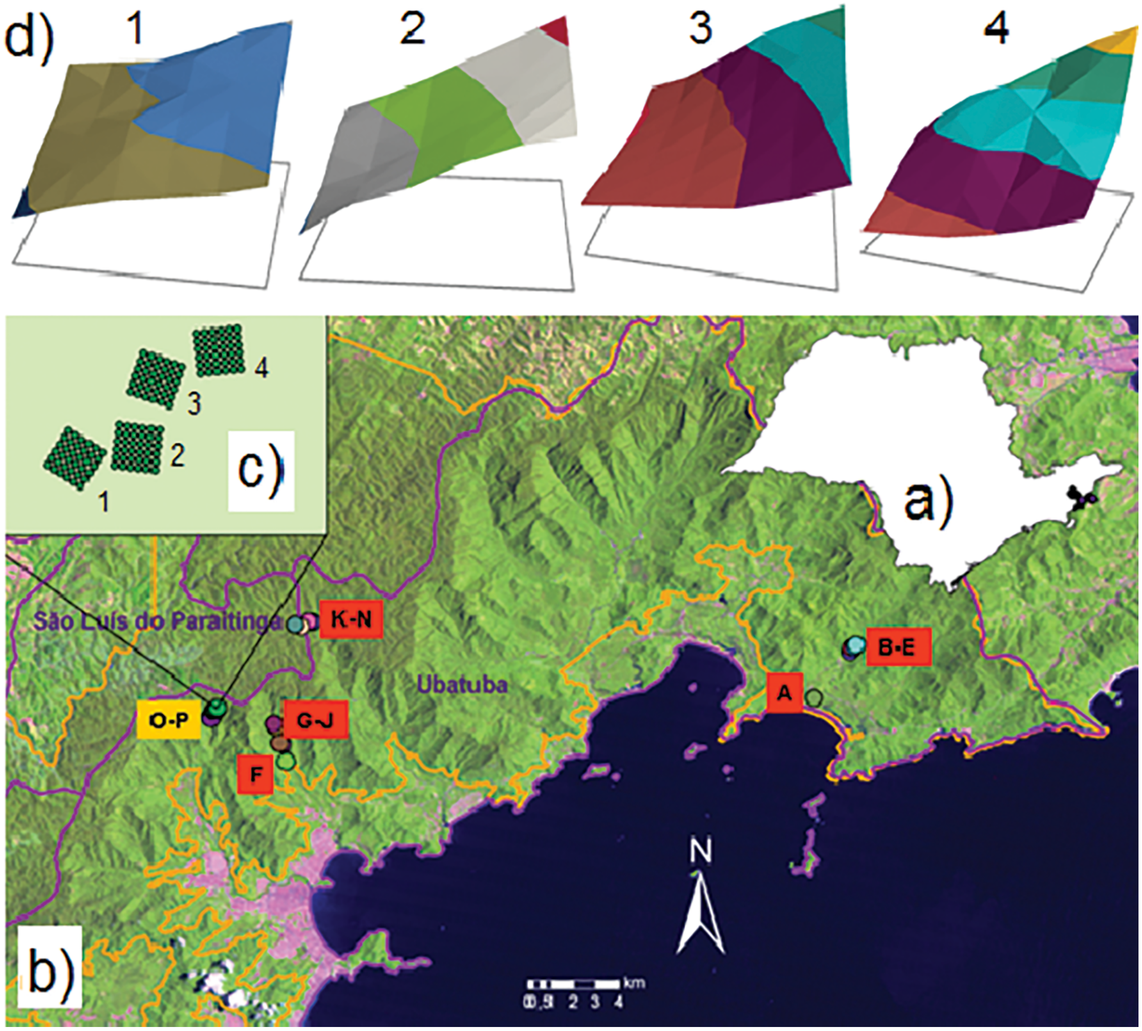


**Figure 1.** Location of the region and area of study. **a)** Núcleos Picinguaba and Santa Virgínia (PESM), in the region of the north coast (São Paulo - Brazil); **b)** Distribution of plots (1 ha each) with studies already carried out (A–J, 0–400 m; K–N 1000 m); **c)** Spatial arrangement of sample blocks of plot P (800 m); **d)** Topographic scheme in each sample block, where equal colour bands correspond to the same altitude (ranging from 758 m – block 1, to 866 m – block 4).

value of importance (60.9% of importance value index – IVI), followed by Myrtaceae (42.4%) and Monimiaceae (23.4%). In relation to genus, *Eugenia* (Myrtaceae) was the richest with 21 species (11.4% of the total), followed by *Mollinedia* (Monimiaceae) (seven species, 3.8%), *Marlierea* and *Myrcia* (Myrtaceae) and *Inga* (Fabaceae) (six species, 3.2% each), which added up to 24.8% of the species.

The estimated diversity of the community was H' = 4.3 and the equability was 0.82. *Rustia formosa* (151 individuals.ha$^{-1}$, 8.7% of live trees), *Euterpe edulis* (100, 5.8%), *Coussarea accedens* (89, 5.2%), *Psychotria suterella* and *Meriania calyptrata* (88, 5.1% each one of them), *Rudgea jasminoides* (75, 4.3%), *Ouratea multiflora* (55, 3.2%) and *Guapira opposita* (53, 3.1%) were the most abundant species (Table 2), accounting for 40.5% of living individuals.

With some variation of position, the eight most abundant species in the area were among the ten species with the highest IVI, standing out due to abundance and frequency. *Cryptocarya mandioccana* (24 individuals.ha$^{-1}$, 1.4% live individuals – eighth position) and *Mollinedia boracensis* (39, 2.3% – tenth position) completed the list of the ten species with the highest IVI, standing out due to dominance.

The majority (about 54.4%) of live trees (Figure 2) were 5-10 m in height. Emerging trees (≥ 20 m), which surpassed the regular forest canopy, included several species, such as *Copaifera trapezifolia*, *Syagrus pseudococos* and *Cryptocarya mandioccana*. Regarding the diameters, the majority of the individuals belonged to the class of 4.8 to 9.9 cm (Figure 3). The estimated basal area was 41.9 m$^2$ ha$^{-1}$.

The similarity analysis (Figure 4) that the floristic composition was similar between the blocks, with showed a high co-optic correlation (0.85) and grouped blocks 3 and 4 as the most similar (distance of 0.34). However, when we consider only the five species of the highest importance value per block (Figure 5), some differences between them stand out.

*Rustia formosa* (which had the highest IVI in the quota of 800 m) was the only species among the five species with the highest IVI in the four blocks. Other species that presented high IVI in more than one block were *Euterpe edulis* (blocks 1, 3 and 4), *Psychotria suterella* (blocks 1 and 3) and *Meriania calyptrata* (blocks 3 and 4). The other species stood out in only one of the blocks. *Coussarea meridionalis*, *Bathysia mendoncaei*, *Guapira hirsuta* and *Mollinedia argyrogyna* were

**Table 1.** Trees (in phylogenetic order by families and subfamilies and alphabetical by species) sampled in 1 ha of Montana Ombrophilous Dense Forest, at 800 m elevation, Serra do Mar State Park, Ubatuba – SP. Nº IAC = reference material in the herbarium of the Agronomic Institute; ①, ②, ③, ④ = sample blocks; X = occurrence of the species in the block and MS= material with specialist.

| **Family** | **Species** | **Nº IAC** | **Occurrence** | | | |
|---|---|---|---|---|---|---|
| | | | **1** | **2** | **3** | **4** |
| Ferns | | | | | | |
| CYATHEACEAE | *Alsophila sternbergii* (Sternb.) D.S.Conant | 56501 | X | | X | X |
| | *Cyathea dichromatolepis* (Fée) Domin | 56503 | | | X | X |
| | *Cyathea glaziovii* (Fée) Domin | 56502 | | X | | |
| Basal angiosperms | | | | | | |
| MYRISTICACEAE | *Virola bicuhyba* (Schott ex Spreng.) Warb. | 50545 | X | X | X | |
| ANNONACEAE | *Guatteria australis* A.St.Hil. | 50510 | | | X | |
| | *Guatteria* sp1 | 54021 | | | | X |
| | *Guatteria* sp2 | 53957 | | X | X | X |
| | *Annona dolabripetala* Raddi | 48948 | | | | X |
| SIPARUNACEAE | *Siparuna brasiliensis* (Spreng.) A.DC. | 49259 | | | | X |
| MONIMIACEAE | *Mollinedia argyrogyna* Perkins | 56476 | X | X | X | X |
| | *Mollinedia boracensis* Peixoto | 48995 | X | X | X | X |
| | *Mollinedia* aff. *oligantha* Perkins | 56475 | X | X | | |
| | *Mollinedia ovata* Ruiz & Pav. | 56494 | | X | | |
| | *Mollinedia schottiana* (Spreng.) Perkins | 50341 | X | X | X | X |
| | *Mollinedia triflora* (Spreng.) Tul. | 53991 | X | X | X | X |
| | *Mollinedia* sp1 | MS | | | X | X |
| LAURACEAE | *Cinnamomum triplinerve* (Ruiz & Pav.) Kosterm. | 56464 | | X | X | X |
| | *Cryptocarya mandioccana* Meisn. | 54073 | X | X | X | X |
| | *Cryptocarya saligna* Mez | 48981 | X | X | X | |
| | *Endlicheria paniculata* (Spreng.) J.F. Macbr. | 49790 | | X | | |
| | *Licaria armeniaca* (Nees) Kosterm. | 49789 | | X | X | |
| | *Ocotea dispersa* (Nees & Mart.) Mez | 50547 | X | X | | |
| | *Ocotea* cf. *divaricata* (Nees) Mez | | X | X | | |
| | *Ocotea frondosa* (Meisn.) Mez | 54019 | | | | X |
| | *Ocotea teleiandra* (Meisn.) Mez | 53933 | X | X | | |
| CHLORANTHACEAE | *Hedyosmum brasiliense* Miq. | 51161 | | | | X |
| Monocotyledon | | | | | | |
| ARECACEAE | *Astrocaryum aculeatissimum* (Schott) Burret | 51963 | X | X | | |
| | *Attalea exigua* Drude | 44109 | | X | | |
| | *Euterpe edulis* Mart. | 49271 | X | X | X | X |
| | *Syagrus pseudococos* (Raddi) Glassman | 49191 | X | X | X | X |
| Eudicots | | | | | | |
| PROTEACEAE | *Euplassa* cf. *cantareirae* Sleumer | 20054 | | | X | |
| | *Roupala montana* var. *brasiliensis* (Klotzsch) K.S.Edwards | 54007 | | X | | |
| | *Roupala paulensis* Sleumer | 53993 | | X | | |
| FABACEAE Detarioideae | *Copaifera trapezifolia* Hayne | 54009 | | X | | |
| | *Hymenaea courbaril* L. | 35618 | X | X | | |
| FABACEAE Caesalpinioideae | *Inga capitata* Desv. | 50313 | X | X | | X |
| | *Inga edulis* Mart. | 49311 | | | X | |
| | *Inga grazielae* (Vinha) T.D.Penn. | 49785 | | | | X |

**Continuation Table 1.**

| | | | | | | |
|---|---|---|---|---|---|---|
| | *Inga marginata* Willd. | 49339 | X | | | X |
| | *Inga schinifolia* Benth. | 54029 | X | | | X |
| | *Inga sessilis* (Vell.) Mart. | 48242 | | | X | |
| FABACEAE Faboideae | *Dahlstedtia pinnata* (Benth.) Malme | 54033 | X | | X | X |
| | *Zollernia ilicifolia* (Brongn.) Vogel | 49308 | X | | X | X |
| | Fabaceae-Faboideae sp1 | 54006 | X | X | | |
| ROSACEAE | *Prunus myrtifolia* (L.) Urb. | 49007 | | X | | |
| MORACEAE | *Brosimum guianense* (Aubl.) Huber | 56499 | X | | | |
| URTICACEAE | *Cecropia glaziovi* Snethl. | 49016 | X | | | X |
| | *Coussapoa microcarpa* (Schott) Rizzini | 49017 | X | X | X | X |
| CELASTRACEAE | *Maytenus* sp1 | 53958 | X | | X | |
| | Maytenus sp2 | 56500 | | | | X |
| ELAEOCARPACEAE | *Sloanea guianensis* (Aubl.) Benth. | 49778 | | X | | |
| | *Sloanea* cf. *hirsuta* (Schott) Planch. ex Benth. | 51299 | X | X | X | X |
| ERYTHROXYLACEAE | *Erythroxylum* cf. *cuspidifolium* Mart. | 54081 | | X | | |
| OCHNACEAE | *Ouratea multiflora* (Pohl) Engl. | 53932 | X | X | X | X |
| | *Quiina* aff. *magalano-gomesi* Schwacke | 56468 | X | X | X | X |
| CLUSIACEAE | *Garcinia gardneriana* (Planch. & Triana) Zappi | 49777 | X | X | X | X |
| MALPIGHIACEAE | *Bunchosia maritima* (Vell.) J.F.Macbr. | 54028 | | | X | |
| CHRYSOBALANACEAE | *Couepia venosa* Prance | 50297 | | X | | X |
| | *Hirtella hebeclada* Moric. ex DC. | 50298 | X | X | | X |
| | *Licania* cf. *hoehnei* Pilg. | 56471 | X | X | | |
| | *Licania* cf. *kunthiana* Hook.f. | 56470 | X | X | X | X |
| | *Parinari excelsa* Sabine | 56469 | | X | | X |
| HUMIRIACEAE | *Vantanea* sp1 | 54027 | X | X | | X |
| | Humiriaceae sp1 | 56493 | X | X | X | X |
| SALICACEAE | *Casearia decandra* Jacq. | 33938 | X | | X | |
| | *Casearia sylvestris* Sw. | 42118 | | X | | |
| EUPHORBIACEAE | *Alchornea glandulosa* Poepp. & Endl. | 49226 | X | | | X |
| | *Alchornea triplinervia* (Spreng.) Müll.Arg. | 48965 | X | | X | |
| | *Sapium glandulosum* (L.) Morong | 48967 | X | | | X |
| | *Sebastiania* sp1 | 54031 | | X | | |
| PHYLLANTHACEAE | *Hieronyma alchorneoides* Allemão | 54012 | X | X | X | X |
| MYRTACEAE | *Calyptranthes grandifolia* O.Berg | 56483 | | | | X |
| | *Calyptranthes lucida* Mart. ex DC. | 49145 | X | | | X |
| | *Calyptranthes rufa* O.Berg | 49047 | X | | | X |
| | *Calyptranthes strigipes* O.Berg | 49877 | X | X | X | |
| | *Campomanesia guaviroba* (DC.) Kiaersk. | 50617 | X | | | X |
| | *Campomanesia phaea* (O.Berg) Landrum | 43144 | X | | | |
| | *Eugenia acutata* Miq. | 49854 | | X | X | X |
| | *Eugenia batingabranca* Sobral | 49866 | X | X | | |
| | *Eugenia burkartiana* (D.Legrand) D.Legrand | 56675 | | | | X |
| | *Eugenia cerasiflora* Miq. | 49865 | | X | | |
| | *Eugenia cereja* D.Legrand | 56481 | X | X | X | |
| | *Eugenia copacabanensis* Kiaersk. | 45956 | X | | X | |
| | *Eugenia cuprea* (O.Berg) Nied. | 50363 | | | X | |

**Continuation Table 1.**

| | | | | | | |
|---|---|---|---|---|---|---|
| MYRTACEAE | *Eugenia dodonaeifolia* Cambess. | 51320 | | | | X |
| | *Eugenia flamingensis* O.Berg | 56489 | | | | X |
| | *Eugenia fusca* O.Berg | 50367 | X | | | |
| | *Eugenia involucrata* DC. | 50365 | X | | | |
| | *Eugenia melanogyna* (D.Legrand) Sobral | 50366 | | X | | X |
| | *Eugenia multicostata* D.Legrand | 56482 | X | X | X | |
| | *Eugenia neoverrucosa* Sobral | 49164 | | X | | |
| | *Eugenia oblongata* O.Berg | 53944 | | X | | X |
| | *Eugenia plicata* Nied. | 54004 | X | | X | X |
| | *Eugenia pruinosa* D.Legrand | 37912 | | X | | |
| | *Eugenia pruniformis* Cambess. | 49057 | X | X | | |
| | *Eugenia subavenia* O.Berg | 49058 | | | X | X |
| | *Eugenia verticillata* (Vell.) Angely | 56487 | X | X | | X |
| | *Eugenia* sp1 | MS | | X | | |
| | *Marlierea excoriata* Mart. | 46874 | | X | X | X |
| | *Marlierea glazioviana* Kiaersk. | 50371 | | X | | |
| | *Marlierea obscura* O.Berg | 54000 | | | X | X |
| | *Marlierea racemosa* (Vell.) Kiaersk. | 54070 | X | | X | X |
| | *Marlierea suaveolens* Cambess. | 56488 | X | X | | |
| | *Marlierea tomentosa* Cambess. | 49887 | X | X | | X |
| | *Myrceugenia* cf. *campestris* (DC.) D.Legrand & Kausel | 53947 | X | | | |
| | *Myrceugenia glaucescens* (Cambess.) D.Legrand & Kausel | 56477 | X | | X | |
| | *Myrceugenia* cf. *kleinii* D.Legrand & Kausel | 53930 | | | | X |
| | *Myrceugenia myrcioides* (Cambess.) O.Berg | 55770 | X | | X | X |
| | *Myrceugenia* sp1 | MS | X | | | X |
| | *Myrcia neoblanchetiana* E.Lucas & Sobral | MS | | | | X |
| | *Myrcia pubipetala* Miq. | 50374 | X | | X | X |
| | *Myrcia spectabilis* DC. | 53208 | X | X | | |
| | *Myrcia tenuivenosa* Kiaersk. | 56485 | | | X | |
| | *Myrcia tijucensis* Kiaersk. | 54458 | X | | | |
| | *Myrcia ubatubana* Mazine & Sobral | 53476 | X | X | | |
| | *Myrciaria floribunda* (H.West ex Willd.) O.Berg | 50377 | X | X | X | X |
| | *Myrciaria* cf. *pallida* O.Berg | 56498 | X | | | X |
| | *Neomitranthes glomerata* (D.Legrand) D.Legrand | 50515 | X | X | | |
| MELASTOMATACEAE | *Henriettea glabra* (Vell.) Penneys, F.A. Michelangeli, Judd et Almeda | 50383 | | | X | X |
| | *Leandra acutiflora* (Naudin) Cogn. | 54077 | | | X | |
| | *Meriania calyptrata* (Naudin) Triana | 53959 | | | X | X |
| | *Miconia atlantica* Caddah & R. Goldenb. | 54041 | | | X | X |
| | *Miconia calvescens* DC. | 54040 | | | | X |
| | *Miconia latecrenata* (DC.) Naudin | 54076 | X | X | | X |
| | *Miconia tristis* Spring | 56480 | | | | X |
| | *Mouriri chamissoana* Cogn. | 50381 | X | X | X | |

**Continuation Table 1.**

| | | | | | | |
|---|---|---|---|---|---|---|
| PICRAMNIACEAE | *Picramnia ciliata* Mart. | 50401 | X | X | | |
| BURSERACEAE | *Protium* sp1 | 54001 | X | | | |
| ANACARDIACEAE | *Tapirira guianensis* Aubl. | 37240 | X | | X | |
| SAPINDACEAE | *Allophylus edulis* (A.St.-Hil. et al.) Hieron. ex Niederl. | 56486 | | | X | |
| | *Allophylus* cf. *membranifolius* Radlk. | 56465 | X | | X | |
| | *Allophylus petiolulatus* Radlk. | 56467 | X | X | X | X |
| | *Cupania furfuracea* Radlk. | 54071 | X | X | | X |
| | *Cupania oblongifolia* Mart. | 50208 | X | | | |
| | *Matayba juglandifolia* (Cambess.) Radlk. | 50438 | X | | | |
| MELIACEAE | *Cabralea canjerana* (Vell.) Mart. | 48992 | X | | X | X |
| | *Guarea* cf. *guidonia* (L.) Sleumer | 49486 | X | | X | X |
| | *Guarea macrophylla* Vahl | 54035 | | | | X |
| | *Trichilia elegans* A.Juss. subsp.elegans | 48052 | X | | | |
| | *Trichilia silvatica* C.DC. | 56490 | X | X | | |
| THYMELAEACEAE | *Daphnopsis schwackeana* Taub. | 54075 | X | X | X | X |
| OLACACEAE | *Heisteria silvianii* Schwacke | 50396 | X | X | | |
| | *Tetrastylidium grandifolium* (Baill.) Sleumer | 54013 | X | X | | |
| OPILIACEAE | *Agonandra excelsa* Griseb. | 56496 | | | X | |
| NYCTAGINACEAE | *Guapira hirsuta* (Choisy) Lundell | 49894 | X | X | X | |
| | *Guapira nitida* (Mart. ex J.A.Schmidt) Lundell | 49002 | | X | X | |
| | *Guapira opposita* (Vell.) Reitz | 56479 | X | X | X | X |
| | *Guapira venosa* (Choisy) Lundell | 56484 | X | X | | X |
| SAPOTACEAE | *Chrysophyllum flexuosum* Mart. | 50440 | X | X | X | X |
| | *Chrysophyllum viride* Mart. & Eichler | 56474 | X | | | |
| | *Micropholis crassipedicellata* (Mart. & Eichler) Pierre | 55752 | X | X | | |
| | *Pouteria caimito* (Ruiz & Pav.) Radlk. | 49927 | | X | X | X |
| | *Pouteria psammophila* (Mart.) Radlk. | 56473 | | X | | |
| | *Pouteria venosa* (Mart.) Baehni | 50450 | X | | X | |
| | Sapotaceae sp1 | 54079 | | X | | |
| PRIMULACEAE | *Ardisia martiana* Miq. | 53956 | X | X | X | X |
| RUBIACEAE | *Alibertia myrciifolia* Spruce ex K.Schum. | 54030 | X | X | X | X |
| | *Amaioua intermedia* Mart. ex Schult. & Schult.f. | 51892 | | X | | |
| | *Bathysa mendoncaei* K.Schum. | 54037 | X | X | X | |
| | *Bathysa stipulata* (Vell.) C.Presl | 54076 | | | | X |
| | *Choemelia* cf. *pedunculosa* Benth. | 56472 | | | | X |
| | *Coussarea accedens* Müll.Arg. | 56495 | X | X | X | X |
| | *Coussarea* cf. *hydrangeifolia* (Benth.) Müll.Arg. | 54026 | | | X | X |
| | *Coussarea meridionalis* (Vell.) M.Gomes | 49942 | X | X | X | |
| | *Faramea hyacinthina* Mart. | 43943 | | X | | |
| | *Posoqueria latifolia* (Rudge) Schult. | 49907 | X | X | X | X |
| | *Psychotria leitana* C.M.Taylor | 50414 | | X | | |
| | *Psychotria pubigera* Schltdl. | 54038 | | X | | |
| | *Psychotria suterella* Müll. Arg. | 54022 | X | X | X | X |

**Continuation Table 1.**

| | | | | | | |
|---|---|---|---|---|---|---|
| | *Randia armata* (Sw.) DC. | 54645 | | X | | |
| | *Rudgea jasminoides* (Cham.) Müll. Arg. | 54024 | X | X | X | X |
| | *Rustia formosa* (Cham. & Schltdl. ex DC.) Klotzsch | 56478 | X | X | X | X |
| APOCYNACEAE | *Tabernaemontana* cf. *laeta* Mart. | 53734 | | X | | X |
| BORAGINACEAE | *Cordia sellowiana* Cham. | 54084 | | X | | |
| | *Cordia trichoclada* DC. | 50682 | X | | | |
| SOLANACEAE | *Cestrum schlechtendahlii* G.Don | 54083 | | | X | |
| | *Solanum pseudoquina* A.St.-Hil. | 48202 | X | | | |
| | *Solanum rufescens* Sendtn. | 54072 | | X | X | X |
| LAMIACEAE | *Aegiphila integrifolia* (Jacq.) Moldenke | 54036 | | X | X | |
| CARDIOPTERIDACEAE | *Citronella paniculata* (Mart.) R.A.Howard | 53934 | X | X | X | X |
| AQUIFOLIACEAE | *Ilex theezans* Mart. ex Reissek | 56497 | | X | | |
| ARALIACEAE | *Dendropanax denticulatus* Fiaschi | 54025 | X | | X | X |
| | *Dendropanax* sp1 | 53992 | X | X | | |
| | *Schefflera calva* (Cham.) Frodin & Fiaschi | 48950 | X | X | | |
| Undetermined | Undetermined sp1 | | | X | | |
| | Undetermined sp2 | | | | | X |

not among the 10 species with the highest IVI for the quota of 800 m, while *M. boracensis* was the only one among the 10 largest species with an IVI in the quota of 800 m that was not among the five species with the highest IVI per block (Figure 5).

## Discussion

Most of the families that excelled in the richness and abundance parameters were eudicotiledonous; however, we also found representatives of magnoliids (Monimiaceae and Lauraceae) and monocotyledons (Arecaceae). Sequentially, the three richest families at 800 m (Myrtaceae, Rubiaceae and Fabaceae) were the same as those observed by Ramos et al. (2011) and Gomes et al. (2011) in stretches of Sub Montana Ombrophilous Dense Forest, respective to those of 200 and 350 m of altitude, located in the same region. However, in another area of the same region (350 m of altitude), Lauraceae occupied the second position among the richest families (Rochelle et al. 2011), as in the Montana Ombrophilous Dense (Montane) Forest (Padgurschi et al. 2011 - 1000 m altitude).

In terms of families higher values of importance (IVI), the first two sites (Rubiaceae and Myrtaceae) are usually cited in works from the north coast of São Paulo (Gomes et al. 2011, Rochelle et al. 2011, Joly et al. 2012). However, we highlight the importance of the Monimiaceae (third major VI) in the altitudinal range that corresponds to the Montane stretch of this forest, a pattern already observed by Padgurschi et al. (2011) in an area denominated plot K in the altitudinal elevation of 1000 m.

At the gender level, although *Eugenia* (21 species at 800 m) was the richest in all altitudinal heights, with no evidence of strong anthropic impact, it presented greater wealth in Sub Montana Ombrophilous Dense (Submontane) Forest (from 19 to 28 species – Rochelle et al. 2011, Gomes et al. 2011), than in the Montane FOD (12 species - Padgurschi et al. 2011).

Among the species with the highest IVI in the 800 m, *Euterpe edulis*, “palmito-jussara” (second position) was considered a characteristic species and the only one with importance in other studies carried out in Submontane and Montane Forests (Scudeller et al. 2001).

*Rustia formosa* (first position of IVI) occupies intermediate positions of importance in the Submontane Forests in the region (Gomes et al. 2011, Campos 2008, Lacerda 2001) and in an area in the municipality of Imbé in the north of Rio de Janeiro (Moreno et al. 2003), representing between 0.26 (Ramos et al. 2011) and 19.0% (Gomes et al. 2011) of the IVI, but it was not observed in the Montane Forest (Padgurschi et al. 2011). While *Coussarea accedens* (third position) occurs, it does not present significant importance (between 0.7 and 1.1% of IVI), in the Submontane Forests and was not founded in the Montane Forest.

The high percentage of species represented by only one individual, as in this study, has already been observed in other studies carried out in Atlantic forests in southeastern Brazil (Melo & Mantovani 1993, Guedes-Bruni & Mantovani 1999, Gomes et al. 2011, Rochelle et al. 2011, Padgurschi et al. 2011). Thus, the present work contributed to increase the knowledge of this parameter, being that the great percentage of species represented by a single individual is considered a standard for to the Atlantic Forest (Martins 1991, Valencia et al. 1994).

The present work contributed to the publication of a newly described species, *Myrcia ubatubana* Mazine & Sobral, for which the holotype was represented by one of our herbarium collections (A.C.O. Souza et al. s/no., IAC 53476), reinforcing that the Atlantic Forest is one of the largest centers of biodiversity in the world (Campanili & Prochnow 2006, Tabarelli et al. 2010), with new species still being recognized and described in the present.

The values of the Shannon diversity index and Pielou equability index reflect the high diversity and equitability of the area, being among the richest in the region. The greatest diversity value found in one hectare continues was 4.48 (Rochelle et al. 2011) and, in general for this region, mature areas of this type of forest has an index higher than four (Campos

**Table 2.** Number of individuals (**NInd**) and importance value index (**IVI**) of the species that comprise 70% of the IVI by sampling area (**1–4**) and total (**T**), and absolute frequency (**AFr**) and dominance (**ADo**) in decreasing order of the total IVI, sampled in 1 ha of Montana Ombrophilous Dense Forest, at an altitude of 800 m, Serra do Mar State Park, Ubatuba – SP.

| **Species** | **NInd** | | | | | **AFr** | **ADo** | **IVI** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **T** | | | **1** | **2** | **3** | **4** | **T** |
| *Rustia formosa* | 35 | 17 | 55 | 44 | 151 | 67 | 4.6 | 23.2 | 10.4 | 44.8 | 25.7 | 25.1 |
| *Euterpe edulis* | 33 | 21 | 19 | 27 | 100 | 56 | 0.7 | 15.2 | 9.9 | 11.4 | 11.8 | 12.0 |
| *Coussarea accedens* | 19 | 12 | 39 | 19 | 89 | 48 | 0.8 | 9.3 | 5.1 | 21.4 | 9.6 | 10.9 |
| *Guapira opposita* | 12 | 23 | 3 | 15 | 53 | 38 | 1.8 | 9.2 | 17.1 | 2.2 | 11.7 | 10.5 |
| *Psychotria suterella* | 20 | 20 | 26 | 22 | 88 | 53 | 0.4 | 10.0 | 8.3 | 12.9 | 10.3 | 10.3 |
| *Rudgea jasminoides* | 12 | 22 | 13 | 28 | 75 | 47 | 0.3 | 6.7 | 8.9 | 7.4 | 11.8 | 8.8 |
| *Meriania calyptrata* | | | 42 | 46 | 88 | 31 | 0.3 | | | 17.9 | 16.4 | 8.4 |
| *Cryptocarya mandioccana* | 4 | 4 | 6 | 10 | 24 | 19 | 1.9 | 5.9 | 3.8 | 6.7 | 12.9 | 7.4 |
| *Ouratea multiflora* | 19 | 20 | 8 | 8 | 55 | 35 | 0.4 | 10 | 8.8 | 4.3 | 4.4 | 6.9 |
| *Mollinedia boracensis* | 10 | 1 | 14 | 14 | 39 | 32 | 0.6 | 7.4 | 0.6 | 9.5 | 8.7 | 6.4 |
| *Bathysa mendoncaei* | 1 | 45 | 1 | | 47 | 21 | 0.6 | 0.6 | 19.9 | 0.7 | | 5.7 |
| *Mollinedia* cf. *argyrogyna* | 7 | 13 | 4 | 2 | 26 | 20 | 1.0 | 5.6 | 10.8 | 3.6 | 2.0 | 5.6 |
| *Eugenia subavenia* | 10 | 9 | 8 | 2 | 29 | 23 | 0.5 | 5.9 | 3.9 | 8.3 | 1.1 | 4.6 |
| *Hirtella hebeclada* | 7 | 6 | 1 | 7 | 21 | 16 | 0.8 | 7.3 | 4.4 | 0.8 | 4.8 | 4.4 |
| *Cabralea canjerana* | 1 | | 3 | 7 | 11 | 10 | 1.1 | 3.3 | | 7.6 | 6.4 | 4.2 |
| *Licania* cf. *kunthiana* | 1 | 5 | 3 | 2 | 11 | 11 | 1.0 | 0.6 | 5.7 | 5.6 | 3.9 | 4.0 |
| *Guapira hirsuta* | 1 | 31 | 1 | | 33 | 12 | 0.4 | 1.1 | 12.8 | 0.7 | | 3.9 |
| *Hieronyma alchorneoides* | 2 | 3 | 2 | 9 | 16 | 12 | 0.8 | 3.3 | 1.7 | 1.4 | 8.3 | 3.8 |
| *Mollinedia triflora* | 1 | 1 | 4 | 6 | 12 | 10 | 1.0 | 0.7 | 3.3 | 3.9 | 6.9 | 3.8 |
| *Coussarea meridionalis* | 23 | 6 | 1 | | 30 | 18 | 0.2 | 10.9 | 3.1 | 0.7 | | 3.6 |
| *Coussapoa microcarpa* | 2 | 3 | 2 | 9 | 16 | 15 | 0.6 | 1.9 | 2.5 | 2.3 | 7.2 | 3.5 |
| *Humiriaceae* sp1 | 6 | 5 | 2 | 3 | 16 | 16 | 0.4 | 3.7 | 4.6 | 2.39 | 2.2 | 3.2 |
| *Citronella paniculata* | 9 | 1 | 2 | 3 | 15 | 13 | 0.5 | 7.9 | 0.6 | 2.61 | 2.1 | 3.1 |
| *Alibertia myrciifolia* | 2 | 8 | 2 | 10 | 22 | 18 | 0.1 | 1.2 | 3.8 | 1.33 | 5.1 | 2.9 |
| *Myrcia pubipetala* | 3 | | 7 | 2 | 12 | 9 | 0.6 | 1.9 | | 8.66 | 2.1 | 2.9 |
| *Chrysophyllum flexuosum* | 1 | 9 | 3 | 4 | 17 | 15 | 0.3 | 0.9 | 5.7 | 2.25 | 2.3 | 2.9 |
| *Calyptranthes lucida* | 5 | 4 | 2 | 2 | 13 | 13 | 0.4 | 4.4 | 3.2 | 2.9 | 1.2 | 2.8 |
| *Mollinedia schottiana* | 5 | 1 | 12 | 2 | 20 | 16 | 0.2 | 3.2 | 0.5 | 7.22 | 1.1 | 2.8 |
| *Campomanesia guaviroba* | 2 | | | 1 | 3 | 3 | 1.0 | 6.3 | | | 4.5 | 2.7 |
| *Alsophila sternbergii* | 3 | | 7 | 4 | 14 | 10 | 0.4 | 1.8 | | 5.53 | 3.5 | 2.6 |
| *Ocotea dispersa* | 1 | 2 | 4 | 2 | 9 | 9 | 0.6 | 1.7 | 4.3 | 2.97 | 1.3 | 2.0 |
| *Pouteria caimito* | | 4 | 1 | 3 | 8 | 8 | 0.6 | | 4.2 | 0.65 | 4.5 | 2.5 |
| *Eugenia cereja* | 7 | 4 | 2 | | 13 | 10 | 0.3 | 3.5 | 2.6 | 3.22 | | 2.2 |
| *Mollinedia* sp1 | | | 5 | 8 | 13 | 12 | 0.2 | | | 3.67 | 5.4 | 2.2 |
| *Daphnopsis schwackeana* | 5 | 2 | 5 | 1 | 13 | 11 | 0.2 | 3.4 | 1.2 | 3.43 | 0.6 | 2.0 |
| *Cupania furfuracea* | 2 | 2 | | 4 | 8 | 7 | 0.4 | 1.4 | 2.6 | | 3.6 | 2.0 |
| *Calyptranthes grandifolia* | 2 | 4 | 1 | 3 | 10 | 10 | 0.3 | 1.3 | 3.1 | 0.77 | 2.5 | 2.0 |
| *Eugenia fusca* | 1 | | | | 1 | 1 | 0.8 | 8.6 | | | | 2.0 |
| *Eugenia batingabranca* | 2 | 8 | | | 10 | 9 | 0.3 | 3.3 | 4.3 | | | 2.0 |
| *Coussarea* cf. *hydrangeifolia* | | | 9 | 6 | 15 | 11 | 0.1 | | | 5.58 | 2.5 | 1.9 |
| *Marlierea tomentosa* | 2 | 4 | | 2 | 8 | 8 | 0.3 | 2.9 | 2.3 | | 1.6 | 1.8 |
| *Myrciaria floribunda* | 4 | 2 | 1 | 4 | 11 | 11 | 0.1 | 2.7 | 1.1 | 0.78 | 2.6 | 1.8 |
| *Sloanea* cf. *hirsuta* | 1 | 2 | 2 | 4 | 9 | 9 | 0.2 | 0.6 | 1.5 | 1.61 | 3.3 | 1.8 |
| *Marlierea excoriata* | | 2 | 2 | 4 | 8 | 7 | 0.3 | | 1.2 | 1.15 | 4.5 | 1.8 |
| *Syagrus pseudococos* | 4 | 1 | 3 | 1 | 9 | 9 | 0.2 | 3.1 | 0.6 | 2.69 | 0.7 | 1.7 |
| Other 141 morphospecies | | | 438 | | | 405 | 13.4 | | | 89.9 | | |
| Total live trees | | | 1729 | | | 100 | 100 | | | 300 | | |

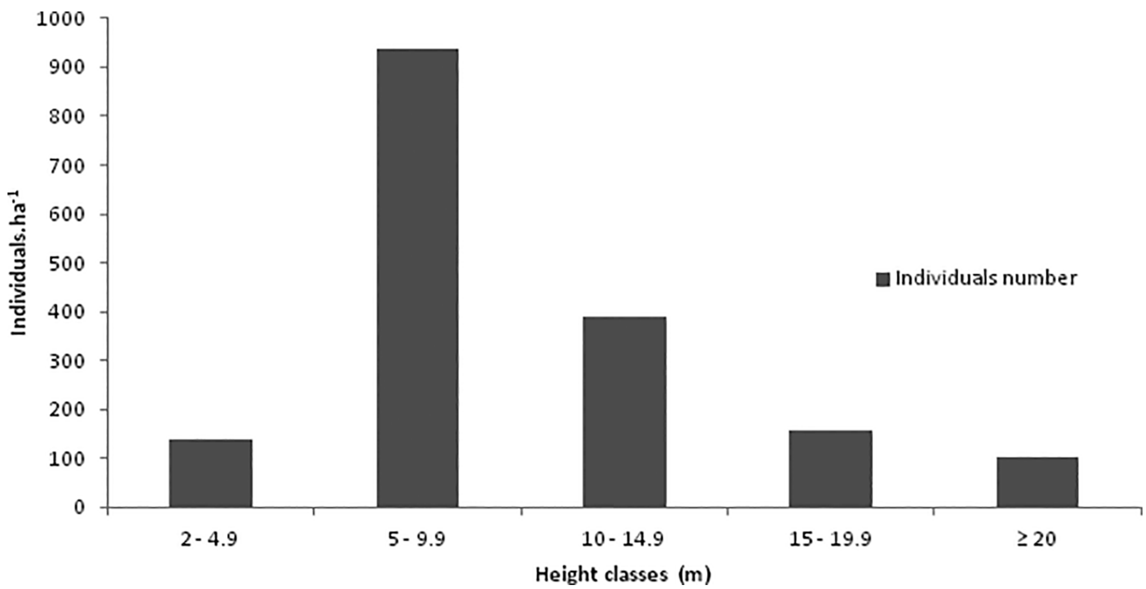


**Figure 2.** Distribution of the height classes of the tree component in 1 ha of the Ombrophilous Dense Montane Forest, at an altitude of 800 m, State Park of Serra do Mar, Ubatuba – SP.

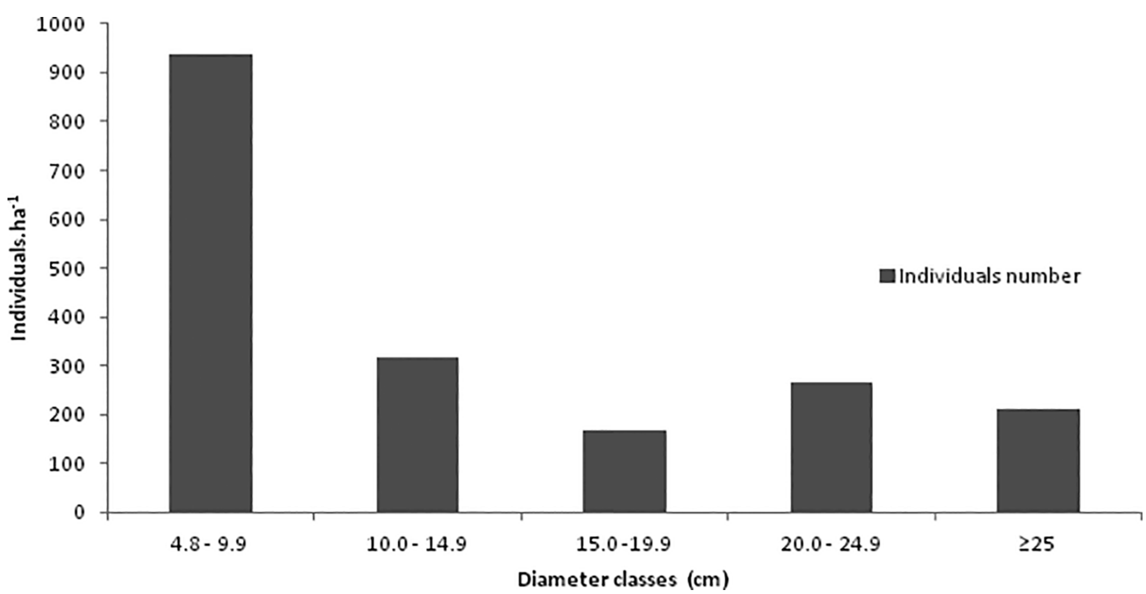


**Figure 3.** Distribution of the diameter classes of the tree component in 1 ha of Ombrophilous Dense Montane Forest, at an altitude of 800 m, State Park of Serra do Mar, Ubatuba – SP.

2008, Gomes et al. 2011, Padgurschi et al. 2011). With insufficient numbers of protected areas allied with other aggravating factors, the conservation of the Atlantic Forest is still insufficient (Tabarelli et al. 2005) and studies like this are fundamental to reinforce the need to preserve this biome and its valuable biodiversity.

It is widely known the proposed division of the Ombrophylous Dense Forest into phytophysiognomies that reflect the ecotypic variations of the altimetric bands and geomorphological situations (Veloso et al. 2012) however, recent studies have also highlighted the importance of local abiotic factors for floristic composition and structure of the vegetation (Joly et al. 2012). So although the proposed environmental continuum (Gleason 1926, Whittaker 1967) could consider this forest type as the only formation, there are peculiarities among the phytophysiognomies in the altitudinal gradient which are relevant and occur gradually.

Our results suggest that the 800 m altitude elevation is an environment of transition between the typical vegetation of the Submontane and Montane divisions of the Ombrophilous Dense Forest, already characterized by works carried out in the region. There are no abrupt transitions observed in this work, but it is noted that families of importance in the Montane areas begin to increase in the number of species and individuals (Monimiaceae). In this sense, the categorical division of altitude of the phytophysiognomies may not occur as proposed, and their limits are not clearly established.

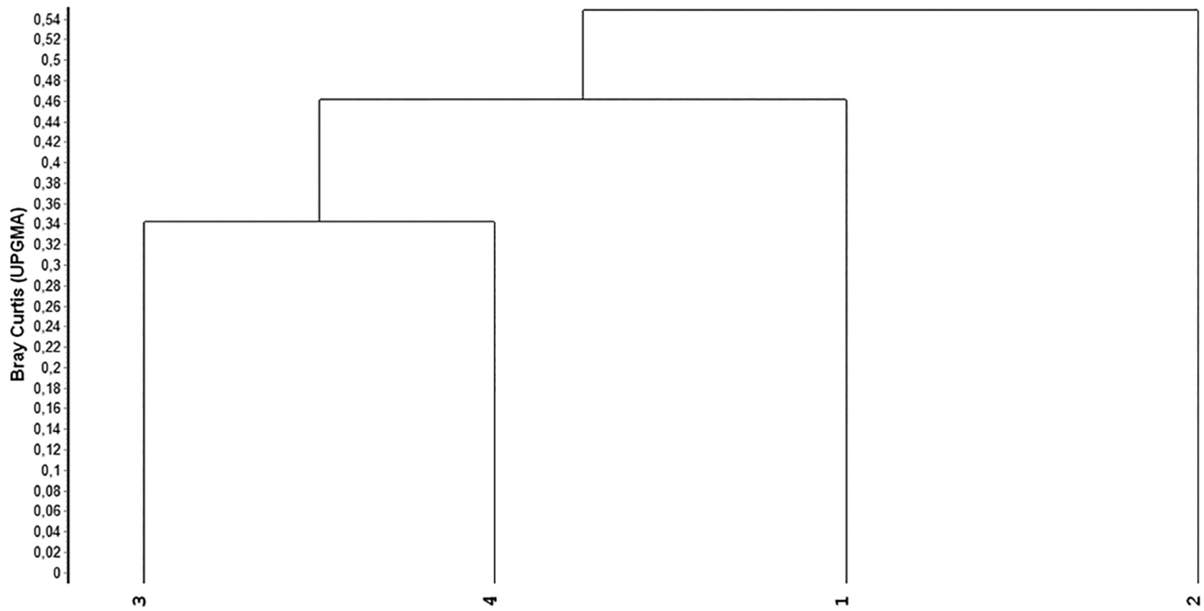


**Figure 4.** Dendrogram of similarity between the four sample blocks in 1 ha of Ombriphilous Dense Montane Forest, at 800 m elevation, Serra do Mar State Park, Ubatuba – SP.

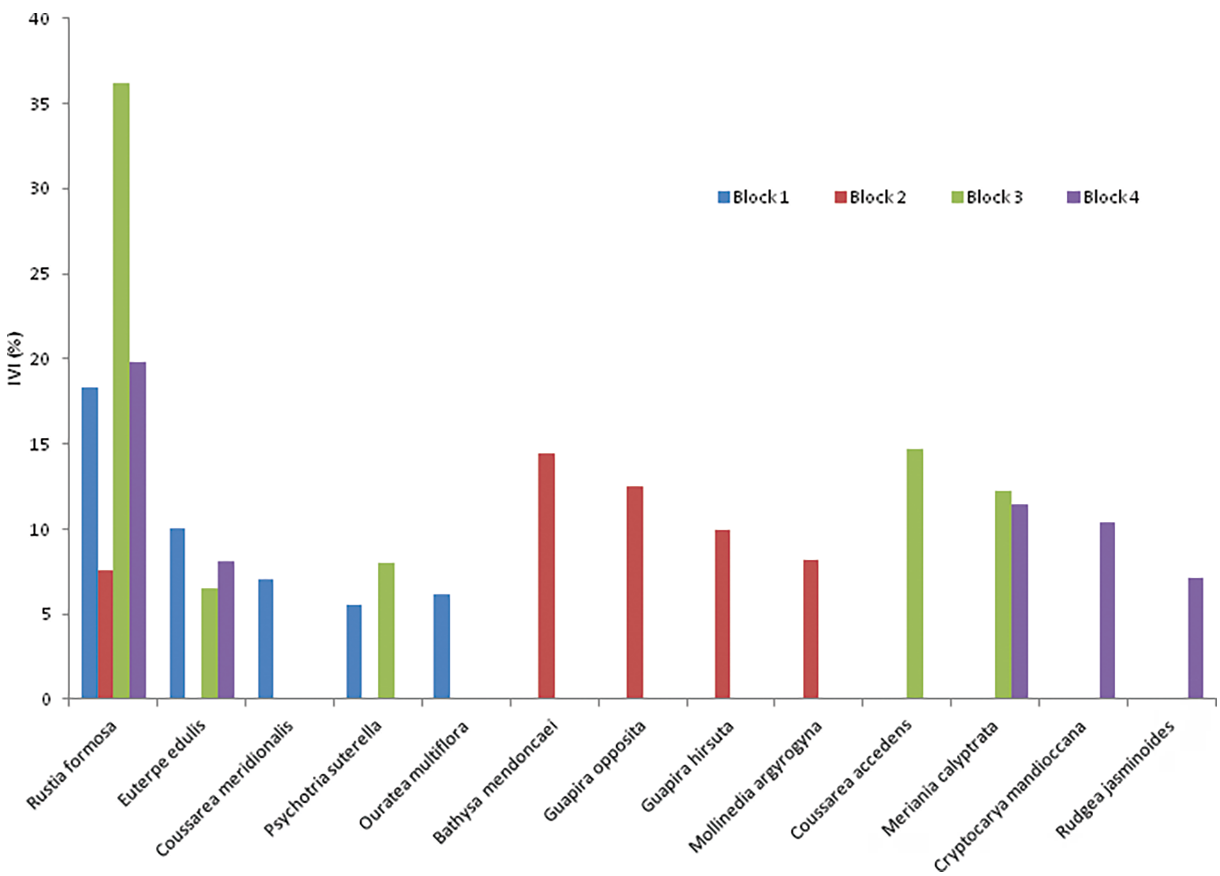


**Figure 5.** The five species that obtained the highest importance values per sampling area in 1 ha of Ombrophilous Dense Montane Forest, at an altitude of 800 m, Serra do Mar State Park, Ubatuba – SP.

In this way, these data corroborates with previous work which indicate that events of lower geographic scale, mainly related to the combination of relief and microclimate, could result in the phytophysiognomies stratification with smooth transitions (Scaramuzza et al. 2011, Joly et al. 2012). There are few vegetation studies developed in the Serra do Mar area at 800 m elevation, and therefore, the objective of describing the floristic composition and structure of this arborea community was essential to understanding the transition of this altitudinal gradient in the area, and new studies are desirable at the same quota altitudinal.

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## Author Contributions

Ana Cláudia Oliveira de Souza: Contribution to data collection, data analysis and interpretation. Contribution to manuscript preparation.

Luís Benacci: Substantial contribution in the concept and design of the study. Contribution to data collection, data analysis and interpretation. Contribution to manuscript preparation.

Carlos Alfredo Joly: Substantial contribution in the concept and design of the study. Contribution to manuscript preparation.

## Conflicts of interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

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