Sustainable Forestry (2022) Volume 5 Issue 1
doi:10.24294/sf.v5i1.1621

ORIGINAL RESEARCH ARTICLE

Composition, structure and ecological importance of Moraceae in a residual forest of Ucayali, Peru

Fred C. Ramírez[1*], Gumercindo A. Castillo[1], Ymber Flores[2], Octavio F. Galván[1], Luisa Riveros[1], Lyanna H. Sáenz[3]

[1] *Universidad Nacional Intercultural de la Amazonía (UNIA), Pucallpa, Peru. E-mail: fredc.ramirez.g@gmail.com*

[2] *Instituto Nacional de Innovación Agraria (INIA), Pucallpa, Peru.*

[3] *Universidade do Estado do Amazonas (UEA), Manaus, Brazil.*

ABSTRACT

Species of the Moraceae family are of great economic, medicinal and ecological importance in Amazonia. However, there are few studies on their diversity and population dynamics in residual forests. The objective was to determine the composition, structure and ecological importance of Moraceae in a residual forest. The applied method was descriptive and consisted of establishing 16 plots of 20 m × 50 m (0.10 ha), in a residual forest of the Alexánder von Humboldt substation of the National Institute of Agrarian Innovation-INIA, Pucallpa, department of Ucayali, where individuals of arboreal or hemi-epiphytic habit, with DBH ≥ 2.50 cm, were evaluated. The floristic composition was represented by 33 species, distributed in 12 genera; five species not recorded for Ucayali were found. Structurally, the family was represented by 138 individuals/ha with a horizontal distribution similar to an irregular inverted "J". However, there were different horizontal structures among species. It was determined that 85% of the species were in diameter class I (2.50 to 9.99 cm), being the most abundant *Pseudolmedia laevis* (Ruiz & Pav.) J.F. Macbr. (41.88 individuals/ha); and the most dominant were *Brosimum utile* (Kunth) Oken (1.71 m^2/ha) and *Brosimum alicastrum* subsp. *bolivarense* (Pittier) C.C.Berg (0.90 m^2/ha). Likewise, P. *laevis* and B. *utile* were the most ecologically important. The information from the present research will allow the establishment of a baseline, which can be used to propose the management of Moraceae in residual forests in the same study area.

Keywords: Residual Forest; Abundance; Dominance; IVI; New Records

ARTICLE INFO

Received: 4 April 2022
Accepted: 22 May 2022
Available online: 1 June 2022

1. Introduction

Peru has an arboreal richness of 4,618 species, grouped in 148 families[1], which represents an incomparable opportunity and an urgent priority for floristic research. In addition, it is considered one of the most biologically diverse countries in the world[2]. However, large forest areas remain unexplored[3], and records are still incomplete and fragmented[1,4]. Moraceae presents considerable abundance and species richness[5-7], which influences it to be considered ecologically important in the different forests of Amazonia[8-13]. Recent studies found that *Brosimum utile* (Kunth) Oken is the species with the greatest ecological weight, at 107 masl in Colombia[13]; while, in Ecuador, *Ficus cuatracasana* Dugand dominates the horizontal space, between 601 to 1,000 masl[14]. In Peru, the Moraceae family is represented by 19 genera, 128 species, with the genus Ficus being the most diverse with 102 species and 20 subspecies[1,15-17], which has been complemented by the discovery of new species and new reports for the Peruvian flora[18,19], which together group all the names recognized to date; while, for the Ucayali region there are a total of 58 species and 6 subspecies[4].

The Moraceae are of economic importance mainly for the value of their wood[3,20,21], being the most used species, in primary processing, *Brosimum utile* subsp. ovatifolium (Ducke) C.C. Berg "Panguana", Maquira coriacea (H. Karst.) C.C. Berg "Capinurí" and Clarisia racemosa Ruiz & Pav. "Mashonaste, Tulpay"[22]. In addition, there are species with medicinal[20,23,24] and food use[25]. The fruits produced by several species are indispensable for numerous species of vertebrate frugivores, which significantly influences forest dynamics[26-28]. Other authors mention that Moraceae are among the top ten families, in terms of number of tree species[1], with *Pseudolmedia laevis* (Ruiz & Pav.) J.F. Macbr. being the fourth most abundant species in the Amazon[29]; however, Licona *et al*.[30] indicate that there are not many studies on the dynamics of Amazonian forests and the ecology of their species. Likewise, Calvi[6] points out that one of the main factors affecting the distribution and species richness of the Moraceae family in the Madidi National Park in Bolivia is the conservation status of the forests.

The objective of this study was to know the composition, structure and ecological importance of Moraceae in a residual forest of the Alexander von Humbolt substation of the National Institute of Agrarian Innovation Ucayali (Peru).

2. Materials and methods

2.1 Study area

The work was developed in a residual primary forest at the Alexander von Humboldt substation of INIA, Von Humboldt district, in the province of Padre Abad, department of Ucayali (Peru), between 8°49′31.7″S and 75°3′19.5″W. The study sector belongs to the lowland rainforest Ecozone[31] and is physiographically undulating (profile with regular waves of 5 to 10 m in height) with good drainage[32]. It has an estimated precipitation of 3,600 mm and the average temperature is 26 °C[33].

2.2 Species inventory

Based on topographic charts, the study area was preliminarily defined where, due to the degree of forest fragmentation, 16 sampling units of 0.10 ha (20 m × 50 m) were selectively located in an altitudinal range from 211 to 286 m following the methodology of Calvi[6] (**Figure 1**). Each woody individual of arboreal or hemi-epiphytic habit, belonging to the Moraceae family, with diameter at breast height (DBH) ≥ 2.50 cm was evaluated. The herborization protocol of Bridson and Forman[34] was used to collect and transfer the samples.

2.3 Taxonomic identification

A review was made of the Moraceae collections from the Alexander von Humboldt Experimental Annex, located in the Forest Herbarium of INIA-Pucallpa, as well as virtual catalogs, specialized bibliography and databases: The Plant List (http://www.theplantlist.org), Missouri Botanical Garden (http://www.tropicos.org), Global Biodiversity Information Facility-GBIF (https://www.gbif.org), NYBG Steere Herbarium (http://sweetgum.nybg.org) and the Field Museum (https://plantidtools.fieldmuseum.org). Subsequently, the identification was corroborated at the Herbarium Selva Central Oxapampa (HOXA), biological station of the Missouri Botanical Garden, located in Oxapampa. Finally, the exsiccatae were deposited in the Biological Depository of INIA-Pucallpa.

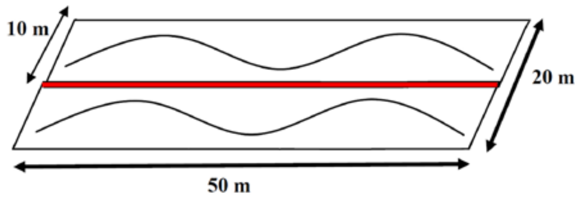

Figure 1. Diagram of the plot used for the study of Moraceae in a residual forest.

2.4 Data analysis

To represent the floristic composition, the species existing at the site were considered[35-37]. To calculate sampling efficiency, a species accumulation curve was elaborated using the non-parametric CHAO 2 estimator[38], which considers the distribution of species by sampling[39]. The analysis was performed using Estimates v.9.1.0[40].

The horizontal structure for the 16 plots (1.6 ha) was represented by the number of individuals per diameter class and the abundance of species; basal area was also calculated to know the distribution of the family and species dominance[36,37,41]. The data were grouped into the following diameter classes: I (2.50 to 9.99 cm), II (10 to 19.99 cm), III (20 to 29.99 cm), IV (30 to 39.99 cm), V (40 to 49.99 cm), VI (50 to 59.9 cm), VII (60 to 69.99 cm), VIII (70 to 79.99 cm), IX (80 to 89.99 cm), X (90 to 99.99 cm), XI (100 to 109.99 cm), XII (110 to 119.99 cm), XIII (120 to 120.99 cm) and XIV (130 to 139.99 cm).

Ecological importance was determined by calculating the species Importance Value Index (IVI) expressed as a percentage[42], the formula is shown below:

$$IVI = IVI_j = AbR_j + FR_j + DoR_j$$

Where:

Relative abundance: $AbR_j = 100 \times Ab_j / \Sigma Ab_j$

Relative Frequency: $FR_j = 100 \times F_j / \Sigma F_j$

Relative dominance: $DoR_j = 100 \times Do_j / \Sigma Do_j$

Being:

Ab_j: Total number of individuals of species j in all plots.

F_j: Number of plots where species j is present.

Do_j: Total basal area of species j in all plots.

3. Results

3.1 Floristic composition of the family Moraceae

In the 16 sampling plots (1.6 ha), 33 species were identified, while according to CHAO 2 the expected species were 44 (**Figure 2**). Accordingly, the richness (S) observed represented 75% of the species that constitute the residual forest.

The species composition was distributed in 12 genera: *Batocarpus*, *Brosimum*, *Clarisia*, *Ficus*, *Helicostylis*, *Maquira*, *Naucleopsis*, *Perebea*, *Poulsenia*, *Pseudolmedia*, *Sorocea* and *Trophis*. Three genera presented the highest richness: *Ficus* (8 species), *Brosimum* (6 species) and *Perebea* (4 species), grouping 54.55% of the total number of species (**Figure 3**).

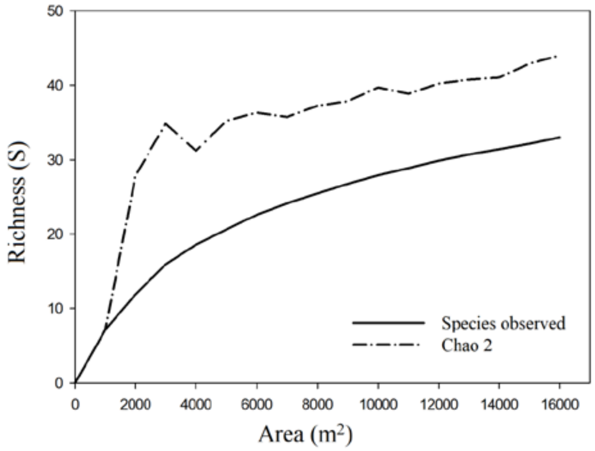

Figure 2. Accumulation curve of observed and expected species of the Moraceae family in a residual forest.

Five species are new records for the Ucayali region: *Ficus americana* subsp. *guianensis* (Desv. ex Ham.) C.C. Berg, *Ficus schultesii* Dugand, *Ficus ursina* Standl., *Ficus tonduzii* Standl. vel. sp. afí, and *Perebea guianensis* subsp. *hirsuta* C.C. Berg.

3.2 Horizontal structure of the family Moraceae

In 1.6 ha, 221 individuals were recorded and evaluated, 138 individuals/ha from 2.50 cm DBH; while from 10 cm DBH the density was 41.25 individuals/ha. The average DBH was 13.32 cm and the maximum was 136 cm. The individuals were grouped in 11 of the 14 diameter classes considered for the structural analysis, showing an irregular discetaneous diameter distribution similar to an inverted "J" (**Figure 4**).

Species with complete discetal structures were *Pseudolmedia laevis* (Ruiz & Pav.) J.F. Macbr. and *Poulsenia armata* (Miq.) Standl.; while *Brosimum lactescens* (S. Moore) C.C. Berg, *Clarisia biflora* Ruiz & Pav, *Clarisia racemosa* Ruiz & Pav., *Brosimum acutifolium* subsp. *obovatum* (Ducke) C.C. Berg, *Brosimum multinervium* C.C. Berg and *Brosimum utile* (Kunth) Oken showed irregular discetal structures. On the other hand, *Ficus maxima* Mill. vel. sp. aff., *F. americana* sbsp. *guianensis*, *Pseudolmedia macrophylla* Trécul, *Brosimum alicastrum* subsp. *bolivarense* (Pittier) C.C. Berg and *Perebea mollis* subsp. *mollis* showed bimodal structures (**Figure 5**).

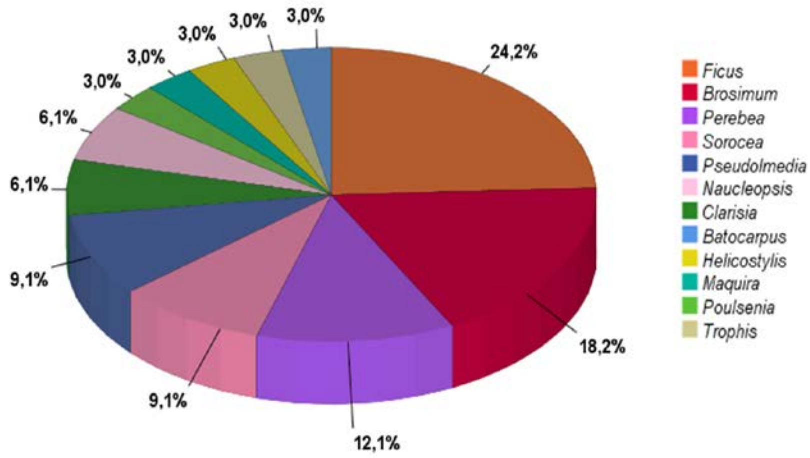

Figure 3. Richness of genera of the Moraceae family in a residual forest.

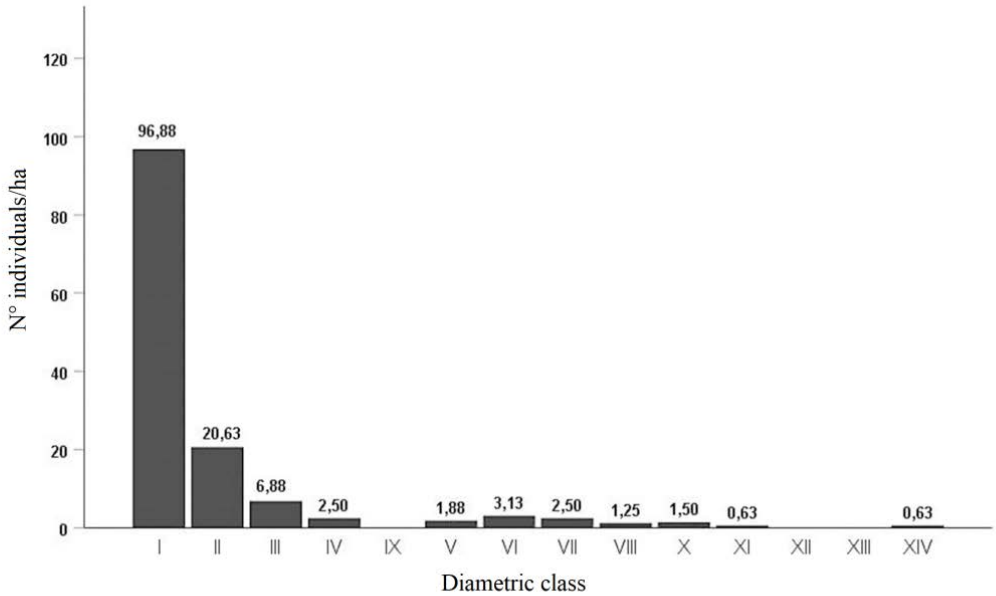

Figure 4. Irregular inverted horizontal structure of species of the Moraceae family in a residual forest.

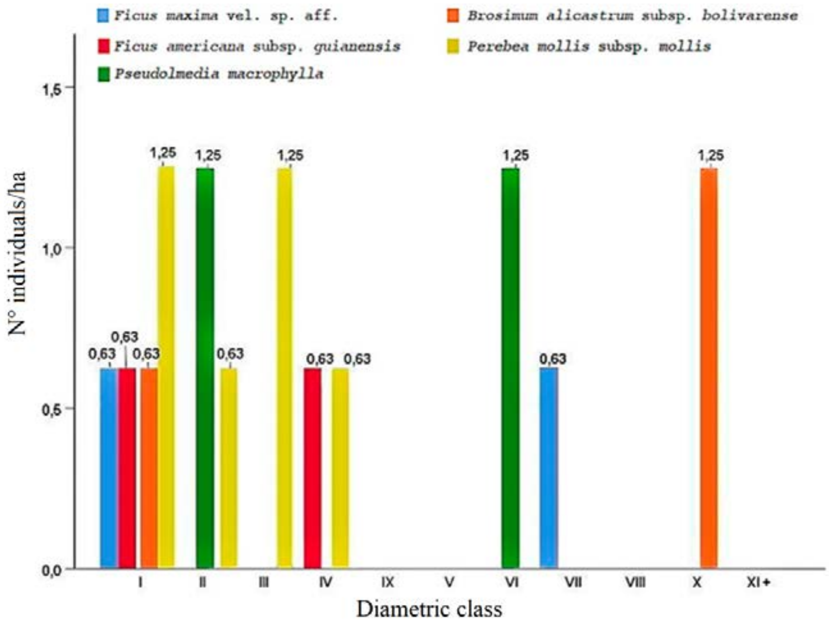

Figure 5. Species of the Moraceae family with bimodal horizontal structures in a residual forest.

Another group of species were distributed only in classes I and II. *Helicostylis tomentosa* (Poepp. & Endl.) Rusby, *Perebea angustifolia* (Poepp. & Endl.) C.C. Berg and *Pseudolmedia laevigata* Trécul presented horizontal structures of discetaneous appearances; while, *Brosimum guianense* (Aubl.) *Huber* and *Batocarpus costaricensis* Standl. & L.O. Williams showed horizontal structures with bimodal appearances.

3.3 Abundance of species

The six most abundant species were: *Pseudolmedia laevis* (41.88 individuals/ha), *Brosimum utile* (11.25 individuals/ha), *Clarisia biflora* (8.75 individuals/ha), *Poulsenia armata* (8.75 individuals/ha) and *C. racemosa* (6.25 individuals/ha), representing 55.7% of the total number of individuals.

The species that were present only in class I and were represented by only one individual (0.63 individual/ha) were: *Ficus tonduzii* vel. sp. aff., *Ficus paraensis* (Miq.) Miq, *Perebea guianensis* subsp. *hirsuta*, *Naucleopsis glabra* Spruce ex Pittier and *Sorocea briquetii* J.F. Macbr. While *Perebea longipedunculata* C.C. Berg, *Sorocea steinbachii* C.C. Berg, *Naucleopsis ulei* (Warb.) Ducke and *Maquira calophylla* (Poepp. & Endl.) C.C. Berg presented 1.88, 2.50, 4.38 and 5.63 individuals/ha in class I, respectively. On the other hand, *F. ursina* and *F. schultesii* were distributed in classes III and VI, with 0.63 individuals/ha each; on the other hand, *Ficus insipida* subsp. *insipida* and *Ficus popenoei* Standl. presented 0.63 individuals/ha each in class VII.

3.4 Basal area

The total basal area of the species evaluated was 5.81 m^2/ha. The distribution, by diameter class of the species, showed a discontinuous increase in the last classes (**Figure 6**). The genus *Brosimum* represented 61.1% of the total basal area (3.55 m^2/ha). A co-dominance of species was found, the first was *Brosimum utile* with 1.71 m^2/ha and the second was *B. alicastrum* subsp. *bolivarense* with 0.89 m^2/ha, despite being represented by only one individual in class I and another in class X. Both species represented 44.80% of the total basal area.

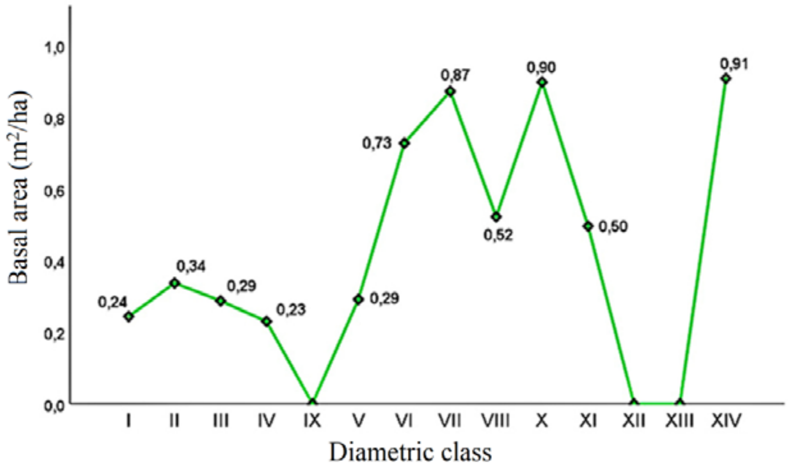

Figure 6. Cumulative distribution of basal areas by diameter class of the Moraceae family in a residual forest.

Table 1. Ecological importance of species of the Moraceae family in a residual forest

Species	AbA	AbR	FA	FR	DoA	DoR	IV (300%)	IVI (100%)
Pseudolmedia laevis (Ruiz & Pav.) J.F. Macbr.	67	30.32	0.88	12.50	0.71	7.62	50.44	16.81
Brosimum utile (Kunth) Oken	18	8.14	0.63	8.93	2.73	29.34	46.42	15.47
Brosimum alicastrum subsp *bolivarense* (Pittier) C.C. Berg	3	1.36	0.19	2.68	1.45	15.47	19.51	6.50
Brosimum acutifolium subsp. *obovatum* (Ducke) C.C. Berg	6	2.71	0.38	5.36	0.66	7.11	15.19	5.06
Clarisia racemosa Ruiz & Pav.	10	4.52	0.50	7.14	0.26	2.84	14.51	4.84
Ciarisia biflora Ruiz & Pav.	14	6.33	0.44	6.25	0.17	1.84	14.42	4.81

Table 1. (*Continued*)

Species	AbA	AbR	FA	FR	DoA	DoR	IV (300%)	IVI (100%)
Brosimum multinervium C.C. Berg	7	3.17	0.19	2.68	0.61	6.59	12.44	4.15
Poulsenia armata (Miq.) Standl.	14	6.33	0.31	4.46	0.12	1.32	12.12	4.04
Pseudolmedia macrophylla Trécul	4	1.81	0.19	2.68	0.51	5.44	9.92	3.31
Perebea mollis (Poepp. & Endl.) Huber subsp. *mollis*	6	2.71	0.31	4.46	0.19	2.02	9.20	3.07
Maquira calophylla (Poepp. & Endl.) C.C. Berg	9	4.07	0.31	4.46	0.03	0.34	8.88	2.96
Brosimum lactescens (S. Moore) C.C. Berg	6	2.71	0.25	3.57	0.20	2.13	8.41	2.80
Naucleopsis ulei (Warb.) Ducke	7	3.17	0.31	4.46	0.01	0.09	7.72	2.57
Helicostylis tomentosa (Poepp. & Endl.) Rusby	7	3.17	0.25	3.57	0.05	0.57	7.31	2.44
Ficus maxima Mill. vel. sp. aff.	2	0.90	0.13	1.79	0.34	3.66	6.35	2.12
Ficus insipida Willd. subsp. *insipida*	11	0.45	0.06	0.89	0.38	4.12	5.47	1.82
Perebea angustifolia (Poepp. & Endl.) C.C. Berg	55	2.26	0.19	2.68	0.05	0.51	5.45	1.82
Trophis cancana (Pittier) C.C. Berg	9	4.07	0.06	0.89	0.02	0.22	5.18	1.73
Ficus popenoei Standl.	1	0.45	0.06	0.89	0.32	3.48	4.83	1.61
Sorocea steinbachii C.C. Berg	4	1.81	0.19	2.68	0.01	0.08	4.57	1.52
Pseudolmedia laevigata Trécul	3	1.36	0.19	2.68	0.01	0.12	4.16	1.39
Ficus americana subsp. guianensis (Desv. ex Ham.) C.C. Berg	2	0.90	0.13	1.79	0.12	1.32	4.01	1.34
Ficus schultesii Dugand	1	0.45	0.06	0.89	0.21	2.31	3.66	1.22
Perebea longipedunculata C.C. Berg	3	1.36	0.13	1.79	0.00	0.02	3.17	1.06
Brosimum guianense (Aubl.) Huber	2	0.90	0.13	1.79	0.03	0.37	3.06	1.02
Batocarpus costaricensis Standl. & L.O. Williams	2	0.90	0.13	1.79	0.01	0.15	2.84	0.95
Sorocea guilleminiana Gaudich.	2	0.90	0.06	0.89	0.03	0.31	2.11	0.70
Ficus ursina Standl.	1	0.45	0.06	0.89	0.03	0.37	1.72	0.57
Perebea guianensis Aubl. subsp. *hirsuta*	1	0.45	0.06	0.89	0.01	0.08	1.42	0.47
Naucleopsis glabra Spruce ex Pittier	1	0.45	0.06	0.89	0.00	0.04	1.39	0.46
Ficus tonduzii Standl. vel. sp. aff.	1	0.45	0.06	0.89	0.00	0.04	1.38	0.46
Sorocea briquette J.F. Macbr.	1	0.45	0.06	0.89	0.00	0.04	1.38	0.46
Ficus paraensis (Miq.) Miq.	1	0.45	0.06	0.89	0.00	0.03	1.38	0.46
Total	221	100.00	7.00	100.00	9.31	100.00	300.00	100.00

Note: AbA (Absolute abundance), AbR (Relative abundance), FA (Absolute frequency), FR (Relative frequency), DoA (Absolute dominance), DoR (Relative dominance), IVI (Importance Value Index = AbR + FR + DoR).

3.5 Ecological importance of the species of the Moraceae family

The ecological weight of the first six species represented 53.49% of the IVI. The most important were *Pseudolmedia laevis* and *Brosimum utile*, the former due to its abundance (30.32) and frequency (12.50); while, the latter due to its abundance (8.14) and dominance (29.34). The species *B. alicastrum* subsp. *bolivarense* and *B. acutifolium* subsp. *obovatum* were also important, but due to their dominance (15.47) and (7.11), respectively; while *Clarisia racemosa* and *C. biflora* were important due to their abundance (4.52) and frequency (6.25) (**Table 1**).

4. Discussion

4.1 Floristic composition

When studying the composition of Moraceae, in the Madidi forest in Bolivia, between 100 to 250 m altitude, using plots of 20 m × 50 m and 10 m × 100 m, with a sampling area of 4.9 ha, 24 species and 11 genera were found[6], being this richness lower than that obtained in the present study, 33 species and 12 genera in 1.6 ha in a residual primary forest. As in the investigations of Calvi[6] and Marcelo-Peña and Reynel[12], Ficus was the genus that reported the highest floristic richness.

4.2 Horizontal structure

According to Louman *et al*.[41], this occurs because some diameter classes have few or many individuals. However, this type of distribution showed that the forest has a good reserve of small individuals, at the family level, in class I, 70% of the total number of individuals and 85% of the species, which is abundant enough to replace large individuals. Lam-Precht[35] mentions that the aforementioned distribution guarantees the sustainable yield of humid tropical forests, so it can be affirmed that the harvesting of all or most of the species of the Moraceae family in the forest under study could be carried out in compliance with the ecological dimension of sustainable forest management. *Pseudolmedia laevis* was the most abundant species, thus agreeing with ter Steege *et al*.[29].

The complete discetaneous structures of *Pseudolmedia laevis* and *Poulsenia armata* indicate that these species will not present problems to regenerate; whereas, species with irregular discetaneous structures (such as *Brosimum lactescens*, *Clarisia biflora*, *C. racemosa*, *B. acutifolium* subsp. *obovatum*, *B. multinervium* and *B. utile*) and with bimodal structures (such as *Ficus maxima* vel. sp. afí, *F. americana* sbsp. *guianensis*, *Pseudolmedia macrophylla*, *Brosimum alicastrum* subsp. *bolivarense* and *Perebea mollis* subsp. *mollis*) will need large clearings to regenerate[41].

The discontinuous increase in the basal area of Moraceae in the last classes reflects the degree of intervention in the study area. According to Louman *et al*.[41], undisturbed forests generally show an accumulation of basal area in the last class. Orozco and Brumér[43] explain that if a species has the largest basal area of a site, it is dominating, even if it is not abundant, as was the case of *Brosimum utile* and *B. alicastrum* subsp. *bolivarense*.

4.3 Ecological importance

Brosimum utile was the second species with the greatest ecological weight, after *Pseudolmedia laevis*, obtaining a similar result to the study conducted by Mena-Mosquera *et al*.[13]. Licona *et al*.[30] point out that there is not much information on the dynamics of Amazonian forests and the ecology of their species. On the other hand, we do not know other biological processes associated with richness and diversity, such as the effects caused by dispersers and competition between plants, which could help to understand many concepts.

5. Conclusions

The residual forest of the Alexander von Humboldt substation of INIA harbors an important richness of species of the Moraceae family, with five new reports for Ucayali.

There are different horizontal structures between species belonging to the same family, with notorious implications for the identification and planning of silvicultural interventions; suggesting for this type of forest, that management be diversified (or multiple use) in terms of species utilization and the generation of timber and non-timber goods.

The differences in structure and ecological importance are a manifestation of the individuality of each species; however, *Pseudolmedia laevis* and *Brosimum utile* are noteworthy because they presented the highest ecological weights.

Conflict of interest

The authors declared no conflict of interest.

References

1. Vásquez R, Rojas R, Monteagudo A, *et al*. Catalog of Peruvian trees. Revista Queña 2018; 9(1): 1–167.
2. MINAM (Ministerio del Ambiente, Perú). Plan/Estrategia: Estrategia Nacional de Diversidad Biológica al 2021 (Plan de Acción 2014–2018)

(Spanish) [Plan/Strategy: National Biodiversity Strategy to 2021 (Action Plan 2014–2018)]. Lima, Peru: Ministerio del Ambiente; 2014. p. 114.

3. Honorio E, Reynel C. Vacíos en la colección de la flora de los bosques húmedos del Perú (Spanish) [Gaps in the collection of the flora of Peruvian rainforests]. Lima: Universidad Nacional Agraria la Molina, Herbario de la Facultad de Ciencias Forestales; 2003. p. 87.
4. Flores Y. Árboles nativos de la region Ucayali, Perú (Spanish) [Native trees of the Ucayali region, Peru]. 1st ed. Pucallpa, Peru: Instituto Nacional de Innovación Agraria; 2018. p. 354.
5. Mostacedo B; Balcazar J, Montero JC. Tipos de bosque, diversidad y composición florística en la Amazonia sudoeste de Bolivia (Spanish) [Forest types, diversity and floristic composition in the southwestern Amazon of Bolivia]. Ecología en Bolivia 2006; 41(2): 99–116.
6. Calvi SP. Diversidad y distribución de la familia Moraceae en los bosques de la Región Madidi, La Paz, Bolivia (Spanish) [Diversity and distribution of the Moraceae family in the forests of the Madidi Region, La Paz, Bolivia] [PhD thesis]. La Paz: Universidad Mayor de San Andrés; 2013. p. 67.
7. García C, Marín H, Moriones D, *et al*. Structure, composition and diversity of the natural forests of Smurfit kappa cardboard of Colombia: Popayán and cajibío. Biotecnología en el Sector Agropecuario y Agroindustrial 2014; 12(1): 10–19.
8. Neill D, Killeen T. Curso de dendrología tropical en la Amazonía Boliviana, Valle de Sacta (Spanish) [Tropical dendrology course in the Bolivian Amazon, Sacta Valley]. La Paz: Herbario Nacional de Bolivia; 1991. p. 60.
9. Nebel G, Dragsted J, Vanclay JK. Estructura y composición florística del bosque de la llanura aluvial inundable de la Amazonía Peruana: II El sotobosque de la resting (Spanish) [Structure and floristic composition of the alluvial floodplain forest of the Peruvian Amazon: II The understory of the resting forest]. Folia Amazónica 2000; 10(1–2): 151–181. doi: 10.24841/fa.v10i1-2.246.
10. Cardona V, Fuentes A; Cayola L. Las moráceas de la región de Madidi, Bolivia (Spanish) [The moraceae of the Madidi region, Bolivia]. Ecología en Bolivia 2005; 40(3): 212–264.
11. Araujo-Murakami A, Bascopé F, Cardona V, *et al*. Composición florística y estructura del bosque amazónico preandino en el sector del Arroyo Negro, Parque Nacional Madidi, Bolivia (Spanish) [Floristic composition and structure of the pre-Andean Amazonian forest in the Arroyo Negro sector, Madidi National Park, Bolivia]. Ecología en Bolivia 2005; 40(3): 281–303.
12. Marcelo-Peña JL, Reynel C. Diversity patterns and floristic composition of permanent evaluative plots in the peruvian central forest. Rodriguésia 2014; 65(1): 35–47. doi: 10.1590/S2175-78602014000100003.
13. Mena-Mosquera VE, Andrade HJ, TorresTorre JJ. Floristic composition, structure and diversity of the tropical pluvial forest of the sub-basin of the Munguidó River, Quibdó, Chocó, Colombia. Entramado 2020; 16(1): 204–215. doi: 10.18041/1900-3803/entramado.1.6109.
14. Torres Navarrete B, Garcia WO. Composición florística de la familia Moraceae, como fuente de carbon aéreo en la gradiente altitudinal de un bosque siempreverde, piemontano de la Amazonia Ecuatoriana, año 2018 (Spanish) [Floristic composition of the Moraceae family, as a source of aerial carbon in the altitudinal gradient of an evergreen, piedmont forest of the Ecuadorian Amazon, year 2018] [Master's thesis]. Quevedo, Ecuador: Universidad Tecnica Estatal de Quevedo; 2019. p. 95.
15. Brako L, Zarucchi JL. Catálogo de las Angiospermas y Gimnospermas del Perú (Spanish) [Catalog of the Angiosperms and Gymnosperms of Peru]. Missouri: Missouri Botanical Garden; 1993. p. 1–1286.
16. Ulloa Ulloa C, Zarucchi JL, León B. Diez años de Adiciones a la Flora del Perú: 1993–2003 (Spanish) [Ten Years of Additions to the Flora of Peru: 1993–2003]. Arnaldoa 2004; Sp. Ed.: 1–242.
17. Ulloa Ulloa C, Acevedo-Rodríguez P, Beck S, *et al*. 2017. An integrated assessment of the Vascular plant species of the Americas. Science 2017; 358(6370): 1614–1617. doi: 10.1126/science.aao0398.
18. Berg C, Homeier J. Three new species of South American Moraceae. Blumea-biodiversity, evolution and biogeography of plants 2010; 55(2): 196–200. doi: 10.3767/000651910X527707.
19. Mitidieri N, Cardoso L, Damián A, *et al*. A new species and a new record of Ficus sect. Pharmacosycea (Moraceae) from Peru. Systematic Botany 2020; 45(1): 91–95. doi: 10.1600/0363636464420X15801369352342.
20. Reynel C, Pennington TD, Pennington RT, *et al*. Árboles del Perú (Spanish) [Trees of Peru]. Lima: Jesús Bellido M.; 2016. p. 1047.
21. SERFOR (Servicio Nacional Forestal y de Fauna Silvestre, Perú). Anuario forestal y de fauna silvestre 2019 (Spanish) [Forestry and wildlife yearbook 2019]. Lima: SERFOR; 2000. p. 132.
22. FAO (Organización de las Naciones Unidas para la Alimentación y la Agricultura). La Industria de la Madera en el Perú: Identificación de las barreras y oportunidades para el comercio interno de productos responsables de madera, provenientes de fuentes sostenibles y legales, en las MIPYMEs del Perú (Spanish) [The timber industry in Peru: Identification of barriers and opportunities for domestic trade of responsible wood products from sustainable and legal sources in Peruvian MSMEs]. Lima: FAO; 2018. p. 178.
23. Mejía K, Rengifo E. Plantas medicinales de uso popular en la Amazonía peruana (Spanish) [Medicinal plants for popular use in the Peruvian Amazon]. 2nd ed. Lima, Peru: IIAP (Instituto de Investi-

gaciones de la Amazonía Peruana); 2000. p. 286.
24. Mass W, Campera M. Árboles medicinales: Conocimientos y usos en la cuenca baja del río Marañón, zona de amortiguamiento de la Reserva Nacional Pacaya Samiria (Spanish) [Medicinal trees: Knowledge and uses in the lower basin of the Marañón River, buffer zone of the Pacaya Samiria National Reserve]. Iquitos: MINAM; 2011. p. 81.
25. Spichiger R, Méroz J, Loizeau P, *et al*. Contribución a la flora en la Amazonía peruana: Los árboles del Arboretum de Jenaro Herrera. Volumen II: Linaceae a Palmae (Spanish) [Contribution to the flora in the Peruvian Amazon: The trees of the Jenaro Herrera Arboretum. Volume II: Linaceae to Palmae]. Geneva, Switzerland: IIAP (Instituto de Investigaciones de la Amazonía Peruana); 1990. p. 359.
26. Shanahan M, Samson SO, Estephen SG, *et al*. Fig-eating by vertebrate frugivores: A global review. Biological Reviews 2001; 76(4): 529–572. doi: 10.1017/S146479310100576010.
27. Kanashiro LJ. Etología de Forrajeo de Ateles belzebuth chamek (Atelidae: Atelinae) en el Parque Nacional del Manu durante la temporada seca 2005 (Spanish) [Foraging ethology of Ateles belzebuth chamek (Atelidae: Atelinae) in Manu National Park during the 2005 dry season.] [PhD thesis]. Lima: Universidad Nacional Agraria La Molina; 2009.
28. Alegria DO. Influencia de la disponibilidad de frutos (familia Moraceae) en las dinámicas de fisión-fusión de Ateles chamek (Humboldt, 1812) en el Parque Nacional de Manu (Spanish) [Influence of fruit availability (Moraceae family) on fission-fusion dynamics of Ateles chamek (Humboldt, 1812) in Manu National Park] [PhD thesis]. Lima: Universidad Nacional Agraria La Molina; 2019. p. 75.
29. ter Steege H, Pitman N, Sabatier D, *et al*. 2013. Hyperdominance in the Amazonian tree flora. Science 2013; 342(6156): 245–337. doi: 10.1126/science.1243092.
30. Licona JC, Peña M, Mostacedo B. Composición florística, estructura y dinámica de un bosque amazónico aprovechado a diferentes intensidades en Pando, Bolivia (Spanish) [Floristic composition, structure and dynamics of an Amazonian forest harvested at different intensities in Pando, Bolivia]. Santa Cruz, Bolivia: Instituto Boliviano de Investigación Forestal; 2007. p. 60.
31. FAO (Naciones Unidas para la Alimentación y la Agricultura, Italia); SERFOR (Servicio Nacional Forestal y de Fauna Silvestre, Perú). Nuestros bosques en números: Primer reporte del Inventario Nacional Forestal y de Fauna Silvestre (Spanish) [Our forests in numbers: First report of the National Forest and Wildlife Inventory] [Internet]. Lima: FAO, SERFOR; 2017. Available from: https://sinia.minam.gob.pe/documentos/nuestros-bosques-numeros.
32. Vidaurre HE. Balance of silvicultural experience with cedrelinga catenaeformis Ducke in the Pucallpa region in the Peruvian Amazone [Master's thesis]. Turrialba, Costa Rica: CATIE; 1994. p. 165.
33. Angulo W, Fasabi H. Fenología de 10 especies forestales para determinar la influencia del cambio climático por efecto del calentamiento global: cinco años de estudio (2012–2016) (Spanish) [Phenology of 10 forest species to determine the influence of climate change due to the effect of global warming: Five years of study (2012–2016)]. Pucallpa: INIA; 2016. p. 31.
34. Bridson D, Forman L. The herbarium handbook. Kew: Royal Botanic Gardens; 1992. p. 93.
35. Lamprecht H. Silvicultura en los trópicos. Los ecosistemas forestales en los bosques tropicales y sus especies arbóreas. Posibilidades para un aprovechamiento sostenido (Spanish) [Silviculture in the tropics. Forest ecosystems in tropical forests and their tree species. Possibilities for a sustainable use]. Carrillo A (translator). Eschborn, Federal Republic of Germany: GTZ; 1990. p. 335.
36. Finegan B. El potencial de manejo de los bosques húmedos secundarios neotropicales de las tierras bajas (Spanish) [The management potential of lowland neotropical secondary moist forests]. Luján R (translator). Turrialba: CATIE; 1992. p. 37.
37. Mostacedo B, Fredericksen T. Manual de métodos básicos de muestreo y análisis en ecología vegetal (Spanish) [Manual of basic methods of sampling and analysis in plant ecology]. Santa Cruz de la Sierra: BOLFOR; 2000. p. 87.
38. Colwell RK, Chang XM, Jing C. Interpolando, extrapolando y comparando las curvas de acumulación de especies basadas en su incidencia (Spanish) [Interpolating, extrapolating and comparing species accumulation curves based on their occurrence]. Ecology 2005; 85(10): 2717–2727.
39. Magurran EA. Measuring biological diversity. Oxford: Blackwell Publishing; 2004. p. 256.
40. Colwell RK. Estimates 9.1.0 user's guide: Statistical estimation of species richness and shared species from samples. Connectitut: University of Connecticut; 2013.
41. Louman B, Quirós D, Nilsson M. Silvicultura de bosques latifoliados húmedos con énfasis en América Central (Spanish) [Silviculture of moist broadleaf forests with emphasis on Central America]. Turrialba: CaTIE; 2001. p. 265.
42. Curtis JT, McIntosh RP. An upland forest continuum in the prairieforest border region of Wisconsin. Ecological Society of America 1951; 32(3): 476–496. doi: 10.2307/1931725.
43. Orozco L, Brumér L. Inventarios forestales para bosques latifoliados en América Central (Spanish) [Forest inventories for broadleaved forests in Central America]. Turrialba: CATIE; 2002. p. 264.