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Unveiling the Geographic Profile and Key Details of *Perebea tessmannii* (Moraceae): An Unconventional Amazonian Food Source

Francesca Salla[1*], Ildeu Soares Martins[2], José Marcio Rocha Faria[3], Rosana Cristo Martins[2], Bianca Cerqueira Martins[1] and Nicoll Andrea Gonzalez Escobar[4]

[1]*Federal University of Acre, Multidisciplinary Center, Floresta Campus, CEP: 69980-000, Cruzeiro do Sul, AC, Brazil*
[2]*University of Brasília, Faculty of Technology, Department of Forest Engineering, Darcy Ribeiro University Campus, Asa Norte, CEP: 70910-900, Brasília, DF, Brazil*
[3]*Federal University of Lavras, Department of Forest Sciences, CEP: 37200-900, Lavras, MG, Brazil*
[4]*Department of Plant Biology, Postgraduate Program in Plant Biology, Institute of Biology, State University of Campinas (UNICAMP), CEP: 13083-862, Campinas, SP, Brazil*
[*]For correspondence: francescasalla@gmail.com
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Abstract

Perebea tessmannii Mildbr., an unconventional food species, is widely recognized within traditional Amazonian communities but remains obscure in urban settings. Despite its delectable taste and potential antioxidant properties, this fruit has yet to undergo any form of comprehensive study, whether in terms of nutrition, chemistry, ecology, or technology. Hence, this study aimed to conduct a comprehensive review of the *P. tessmannii* species across the major virtual herbaria. The objective was to provide a detailed description of the plant's overall features, including seeds, fruits, habitat, and geographic distribution. Additionally, the study sought to establish connections with local investigations of the species in the Southwest Amazon. Trees of the species were mapped, and plant characteristics were measured. Fruits and seeds were also collected and studied for dendrometric characteristics and other variables. *P. tessmannii* has a record of occurrence in Brazil, Peru, Bolivia and Ecuador. In Brazil, it is found in Amazonas, Pará, Mato Grosso, Amapá and Acre. It can be found in terra firme environments, floodplains and low areas of poorly drained forests. The trees have, in a greater proportion, slightly tortuous trunks. Its fruits disperse by gravity, and the possibility of dispersion by animals is strongly indicated. The immature fruits are green, and when ripe they become reddish. They are characterized by being infructescence, covered in trichomes and emitting a striking sweet aroma. The moisture content of seed dispersion, measured at 39%, indicated a significant amount of water present. This high moisture level serves as a precursor, suggesting increased susceptibility to desiccation.

Keywords: Unconventional food plant; Amazon; Fruits; Seeds

Introduction

Within the Americas region, studies following sustainable development principles are focused on the exploration of more efficient models for land utilization. This directs multidisciplinary research in favor of food sovereignty and ecosystem resilience in the face of the challenges of climate change (Harwood 2009; Altieri 2015; Astier *et al.* 2015).

To promote the use of native fruits in popular food, it is imperative to integrate environmental, social, cultural and health dimensions, as well as the production and construction of knowledge accessible to the general public (Amorim *et al.* 2020). To comprehend the resilience of ecosystems in response to environmental impacts, it is essential, initially, to be acquainted with the species existing in the environment. However, numerous gaps persist concerning existing collections in the tropics, particularly in regions deemed priorities for conservation, harboring highly diverse and threatened flora (Breman *et al.* 2021).

In the Amazonian context, the sector related to regional fruits lacks technologies adapted to the local reality, particularly for extending the shelf life of fruits and ensuring their proper utilization. This is of great importance because adding value to regional fruits offers savings opportunities for small and medium-sized farmers. However, there are gaps in information even regarding the basic components of well-known native fruits (Aguiar and Souza 2020). Bezerra and de Brito (2020) also assert that many species do not have uses consistent with their food potential, mainly due to the population's lack of knowledge.

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Among the 27 native forest species traded by the Ashaninka people of the state of Acre, 11 are food species, and many still lack studies regarding the physiological classification of seeds, such as pama (*Pseudolmedia laevis*), sapota (*Matisia cordata*), and castanha-de-porco (*Caryodendron amazonicum*) (Rocha *et al*. 2021). These species are considered non-conventional food plants, and their study is very important to disseminate knowledge at regional and national level, in addition to allowing the population to expand the use of local diversity (Barbosa *et al*. 2021).

Brazil is the country with the most diverse flora known (Ulloa *et al.* 2017), and the virtual information system is imperative for planning and effective actions geared toward the conservation and/or preservation of this biodiversity. Highlights include Flora and Funga do Brasil and the Reflora Virtual Herbarium, which distribute important and reliable information to all sectors of society, shared on various platforms worldwide, and are accessed by researchers from different research areas (BFG 2018). Despite being called basic information (Ulloa *et al*. 2017), they contribute to knowledge about the Amazon flora, which is still largely unknown due to low number of collections (Cardoso *et al*. 2017).

Many plants are not prioritized for germplasm conservation. This often reflects limitations of knowledge related to their properties, use, and state of threat (Breman *et al.* 2021). As an example, the species *Perebea tessmannii* Mildbr., which belongs to the Moraceae family, occurs in the Amazon biome (Cardona–Peña *et al*. 2005). It is part of the animal diet (Araújo and da Silva 2000), including macaws, parakeets and parrots (Martinez and Ortiz 2011). In Brazil, it is known by various names such as “pama-mão-de-onça”, “pama-de-cacho”, “pama-vermelha” or “paima”; in Equador: “paparagua”, “pataca”, “puma huazus”; in Bolívia: “tedhushanui”; and in Peru, it is referred to as “chimicua”, “chimicua-de-hoja-ancha” and “mosquete-de-tigre” (Grandtner and Chevrette 2013). There is little information about the species in scientific articles, being cited only in Amazonian inventories (national and international) (Araújo and da Silva 2000; Miranda and Figueiredo 2001; Daly and Silveira 2008; Cerón and Reyes 2009; Machado 2016) and in the database of virtual herbaria available on the internet (Forzza *et al.* 2015; Pace *et al.* 2016; BFG 2018). There is a taxonomic study that examined the existing species in the genus *Perebea* and other genetically related taxons (Berg 1972).

Numerous plants acknowledged in digital databases lack comprehensive information, posing challenges for further exploration of their characteristics and distribution (Ulloa *et al*. 2017). Consequently, obtaining relevant details about plant features, seeds, fruits, propagation, among other factors, becomes crucial for delineating effective conservation strategies. Thus, this study aimed to conduct a comprehensive review of the *P. tessmannii* species within prominent virtual herbaria. It seeks to describe the general characteristics of the plant, seeds, and fruits while establishing connections with on-site investigations of the species in the Southwest Amazon.

Materials and Methods

Data collection in virtual herbaria

Virtual herbaria: The research on the species *P. tessmannii* was conducted on pages that have free access to virtual herbaria worldwide. Four different information systems were consulted to describe the characteristics of the species. They were: Global Biodiversity Information Facility (GBIF), which is an international network of open access to data about all types of life on earth; Tropicos.org; Reflora Virtual Herbarium; and The New York Botanical Garden Herbarium (NYBG).

Data collection: The research involved the search for the scientific name of the species. The locations of all occurrences recorded for the species *P. tessmannii* were identified and all information described by the researchers on the identification sheets was noted. All available images were analyzed to verify the botanical characteristics of the exsiccates. Records that were identified as *P. tessmannii*, that did not have characteristics similar to those found in other descriptions, were removed from the analysis. These records also did not have exsiccates for checking and comparing the morphology of leaves, fruits, and flowers. Additionally, exsiccates that were duplicates and that had only one herbarium of origin were removed from the analysis. Exsiccates collected in the Southwest of the Amazon were also analyzed according to their morphological aspects and the characteristics of the plants, leaves, fruits and seeds of the species were described.

In situ tree mapping, dendrometric and qualitative characterization

Nineteen *P. tessmannii* trees were mapped in the forests of the Rio Liberdade Extractive Reserve (07º49’17.29”S; 72º2’57.84”W) and the Rio Croa Sustainable Development Project (07º45’36.50”S; 72º34’04.18”W), in the municipality of Cruzeiro do Sul, State of Acre, Brazil. Information about the environment, dendrometric, qualitative and health characteristics was noted to compare and complement the information found on the websites. These individuals were mapped and visited starting in December 2021. In the Riozinho da Liberdade Extractive Reserve, the predominance is of Open Ombrophilous Forest, with some parts occupied by Dense Forests; while in the Croa Sustainable Development Project, Open Ombrophilous Forests are found, notably with the presence of palm (Moraes and Liesenfeld 2007; ICMBio 2020).

Biometric characterization, water content and germination of fruits and seeds

Biometric characterization: Two hundred fruits and two hundred seeds were used for biometric characterization. Thus, with the aid of a precision digital caliper, information about the length, thickness and width of both the fruits and seeds was computed. Information on the wet and dry weight of the seeds, obtained using a precision analytical balance, as well as the number of seeds per fruit was also measured. For this data collection, only healthy fruits were used. Fruits that were visually damaged or deformed were replaced from the samples. Information on the type of fruit, dispersion syndrome and color of fruits and seeds were also described, with fruit collections occurring at different stages of development: initial, intermediate and final.

Water content: To determine the water content of the seeds, four replications of 10 seeds were used. The seeds were placed in aluminum container and weighed on a precision scale. They were subsequently placed in an oven at 105 ± 3ºC for 72 h, during which time the weight remained constant. The formula for determining water content on a wet basis was used:

$$\text{Moisture content (\%)} = \frac{\text{Wet weight} - \text{Dry weight}}{\text{Wet weight}} \times 100$$

Germination: Germination tests were conducted in a germination chamber at 30ºC with constant light. The seeds were disinfected in 1% hypochlorite for 5 min, then placed in gerbox boxes containing two sheets of filter paper as substrate, four replications of 25 seeds were used. The seed coat was removed to conduct the germination tests.

Statistical analysis

The Shapiro-Wilk normality test and Principal Component Analysis (PCA) were performed for the statistical analyzes corresponding to the biometric characterization of seeds and fruits. To measure the degree of linear correlation between the variables, the Pearson correlation coefficients were derived.

Results

Virtual herbaria

Virtual herbaria: The Reflora Herbário Virtual (2023) had 12 records for the species, NYBG (2023) had 8, Tropicos.org (2023) has 64, and GBIF (2023) had the largest number of records, 193. The species *P. tessmannii* has been recorded as occurring in Peru (examined material NY196959), Bolivia (BG636), Ecuador (MIN911276), and Brazil. In Brazil, it is distributed in the states of Amazonas (K000947199), Pará (RB01485645), Amapá (UPCB00055306), Mato Grosso (K000579763), and Acre. In the state of Acre, it is registered in the municipalities of Cruzeiro do Sul (MG196503), Acrelândia (NY583600), Jordão (NY02736509), Manoel Urbano (NY476485), Feijó (RB00680628), Porto Acre (NY02688434) and Sena Madureira (RB01387592). This species has few collections of botanical material, recording around 15 samples for the state of Amazonas, 10 for the state of Acre and only one sample for Amapá, Mato Grosso and Pará.

Characteristics of the species and environment: The pama-mão-de-onça is a tree found in terra firme environments, floodplains and low areas of poorly drained forests, flooded periodically or permanently (NY02688434, NY476485, MG196503, NY02736509, MO695). In Brazil, it occurs between 150 and 465 m of altitude, reaching up to 40 m in height and 12.5 cm in diameter at breast height (DBH) (MO62463, RB01485645, QCNE8381, K000579763). The outer bark of the trunk appears brown, smooth, with thin shallow fissures, while the inner bark is characterized by a beige and fibrous texture (NY476485). Young female inflorescences exhibit yellow coloration, adorned with white, hanging flowers. Notably, green inflorescences have been documented in Pará, while observations from Amapá describe cream to reddish flowers at more mature stages (NY476485, RB01485645, UPCB00055306, NY02736509, NY02688434). The fruits display a green hue when immature, transitioning to a red coloration upon ripening (MO3699, NY02688434, NY02736509). When cut, the trunk revealed a latex color reminiscent of coffee with milk (MO695, NY476485, K000579763, MO62463). Certain exsiccates categorize the species as a potential food source (MO695, NY583600, MO3699).

In situ tree mapping, dendrometric and qualitative characterization

Characteristics of the mapped plants: All trees identified in this research were observed in open forest areas. Of the 19 mapped plants, 16 were located in the floodplain, directly affected by the proximity of the Croa River. In certain points, the water table was visible during the rainy season. In addition, 3 other plants were identified in areas of dry land within the Riozinho of Liberdade Extractive Reserve. Latex with a color similar to coffee with milk was also identified in the sampled trees. It was noticed that the species appears to have low density wood, often with regrowth appearing after damage to the crown.

Pama-mão-de-onça trees exhibited a higher proportion of slightly tortuous trunks (64.3%), 28.6% have straight trunks; and only 7.1% are tortuous. Additionally, sprouts occur in the crown when the branches are broken. All plants found had good characteristics in terms of crown quality (85.7%) and none of the plants had a malformed crown (Fig. 1). The mapped plants were in good health, without attack by pests and diseases, except for one plant, showing the presence of termites. The largest *P. tessmannii* tree, measuring 20 m, also had a larger circumference (112 cm).

Biometric characterization, water content and germination of fruits and seeds

Dispersal period and general characteristics: The fruit dispersion season occurs from December to February and may last, in some plants, until March. In the month of November, six individuals of *P. tessmannii* were observed that had fruits in the initial stage of development. Only one of these matrices had fruits at a more advanced stage; however, no plant had ripe fruits. In the other plants, fruiting events were not observed. The fruits disperse from the plant when ripe due to gravity. During the entire period, no leafless trees were observed.

The immature fruits display a green color that transitions to red when ripe, consistent with the observations documented in the exsiccates (Fig. 2). They are defined by their infructescence, enveloped in trichomes, emitting a distinctive sweet aroma. Moreover, the fruits are exceptionally delicate, with their integrity compromised upon contact with the ground, impacting both collection and consumption. This characteristic may be associated with the absence of any type of commercialization in the region. The seeds had a moisture content of 39% and the germination time was 52 days.

Biometric characterization: The fruits exhibited an average length of 22.43 mm, a thickness of 37.98 mm, a fresh weight of 19.1 g, and 17 seeds per bunch/infructescence. PCA concerning the biometric characterization of the fruits revealed that only the main component (PC 1) can account for 73.5% of the data variation, with thickness and wet weight showing the most powerful relationship between them. Combining PCs 1 and 2 provided insight into the relationship between variables, explaining a cumulative 88.72% of the sample variation (Table 1).

On the x-axis, the relationship between the variables thickness and weight of the fruits is observed; and on the y-axis, the length and quantity of fruits per bunch (Fig. 3). Thus, it was identified that fruit samples have a stronger relationship between thickness and weight. Therefore, thicker seeds generally have greater weight; however, the variables length and quantity of seeds per bunch also contribute significantly to the distribution of samples on the x-axis. It is observed that the length has an inverse relationship with the quantity of seeds per bunch/fruit, with a greater quantity of seeds in medium-length fruits.

The seeds were small with an average length, width and thickness of 8.05 mm, 5.5 mm and 4.41 mm, respectively. The average wet weight per seed was 0.15 g and dry weight was 0.09 g. The seed coat had a whitish outer film and, when removed, it is light brown in color. When removing the seed coat, the seed has a red film that surrounds the internal tissues (Fig. 4). The Shapiro-Wilk test results indicated that the length and width variables, the wet, dry weight and thickness variables did not show normality with a $P < 0.05$ (Table 2).

All variables showed a significant positive correlation, with the exception of the correlation between the variables thickness versus length and length versus width, which had a negligible and non-significant negative correlation. Wet and dry weight were highly correlated in this analysis, having a very strong positive correlation and a very small $P < 0.05$. The variables dry weight versus width, wet weight versus width, wet weight versus thickness and dry weight versus thickness, showed a moderate positive correlation. The variables dry weight versus length, width versus thickness and wet weight versus length have a weak but significant positive correlation (Table 3). The PCA also demonstrated that the wet weight and dry weight of the seeds are the descriptors that are most important in the distribution of variable data in PC1 and contribute significantly to explaining practically 53.86% of the relationship between the samples. PC 2 showed that length

Table 1: Values corresponding to the PCA of the variables of the infructescence studied

PC	Ev	V	Acc	L	T	W	NSI
1	2.943	73.569	73.57	0.447	0.523	0.553	0.470
2	0.606	15.153	88.72	0.741	0.088	-0.127	-0.653
3	0.325	8.113	96.84	0.489	-0.713	-0.133	0.484
4	0.127	3.165	100.00	0.109	0.459	-0.812	0.343

Description: Ev – eigenvalue; V – variance (%); Acc – accumulated variance (%); L - length; T- thickness (mm); W – weight (g); NSI - Number of seeds per infructescence (unit)

Table 2: Values corresponding to the Shapiro-Wilk test and p(normal) for the variables wet and dry weight, width, thickness and length of *P. tessmannii* seeds

Variables	Ww	L	W	T	Dw
Number of seeds	200	200	200	200	200
Shapiro-Wilk	0.9545	0.9902	0.9975	0.827	0.9682
p(normal)	5.30E-03	0.1929	0.9879	3.72E-11	0.000171

Description: Ww - Wet weight (g); L - Length (mm); W - Width (mm); T - Thickness (mm); Dw - Dry weight (g)

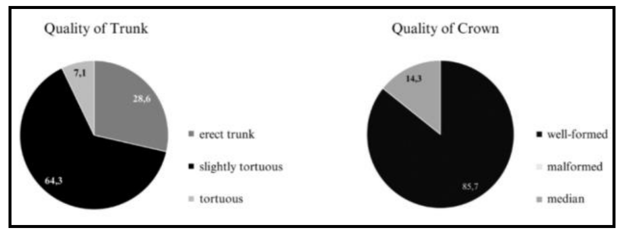

Fig. 1: Trunk and crown quality of *P. tessmannii* plants mapped in the Croa Sustainable Development Project and Riozinho da Liberdade Extractive Reserve

Fig. 2: Fruits of *P. tessmannii* at different stages of development and maturity (1, 2); mature fruits (3, 4)

Table 3: Values corresponding to linear correlations between the studied seed variables. Below in the table you will find the correlation values (r) and above the p-value, respectively

Variables	Wet weight	Length	Width	Thickness	Dry weight
Wet weight (g)	-	0.0022916	4.06E-12	1.03E-09	9.61E-60
Length (mm)	0.21447	-	0.52894	0.30565	9.55E-03
Width (mm)	0.53367	-0.04478	-	7.92E-02	5.09E-15
Thickness (mm)	0.47616	-0.072796	0.31002	-	1.67E-07
Dry weight (g)	0.87327	0.33837	0.57532	0.45284	-

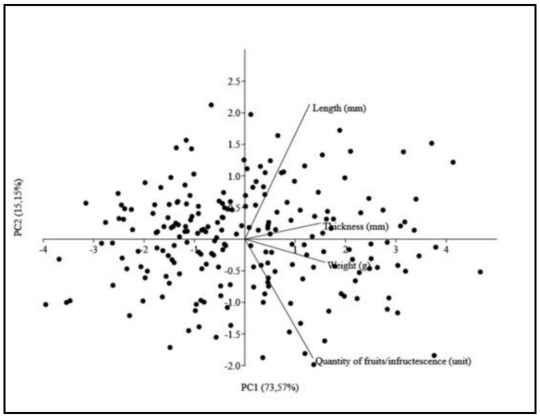

Fig. 3: Principal Component (PC) Analysis of *P. tessmannii* fruits using PC 1 and PC 2

Fig. 4: Whole seeds, with cracks in the outer skin, and with the seed coat removed (1); germinated seeds (2) and seedlings (3, 4) of the unconventional food species *P. tessmannii*

most explained the relationship between the samples. Therefore, only PC 1 and 2 can be used to understand the interaction between the variables, as together they explain 76.3% of the ratio (Table 4).

Fig. 5 shows the distribution of PC 1 (x axis) with the wet and dry weight, and the variables that are most related and PC 2 (y axis) with length and thickness corresponding to 22.44% of the ratio. Therefore, seeds that had a higher wet weight also had a higher dry weight, with these two variables being closer to thickness and width than to length. Thus, the seeds that were longer in length did not necessarily have greater thickness and width, assuming a more average length in most of the seed samples studied.

Discussion

The exsiccates found in Reflora and NYBG, together, are responsible for the vast majority of records identified for Brazil, thus demonstrating the importance of Brazilian sites

Table 4: Values corresponding to PCA of the studied seed variables

PC	Ev	V	Acc	Ww	L	W	T	Dw
1	2.69	53.86	53.86	0.559	0.157	0.436	0.383	0.571
2	1.12	22.44	76.30	0.056	0.871	-0.266	-0.376	0.162
3	0.69	13.83	90.13	0.001	0.136	-0.645	0.750	-0.048
4	0.38	7.65	97.78	-0.536	0.423	0.557	0.385	-0.275
5	0.11	2.22	100.00	0.630	0.143	0.110	0.020	-0.755

Description: Ev – eigenvalue; V – variance (%); Acc – accumulated variance (%); Ww - wet weight (g); L - length (mm); W - width (mm); T - thickness (mm); DW - dry weight (g)

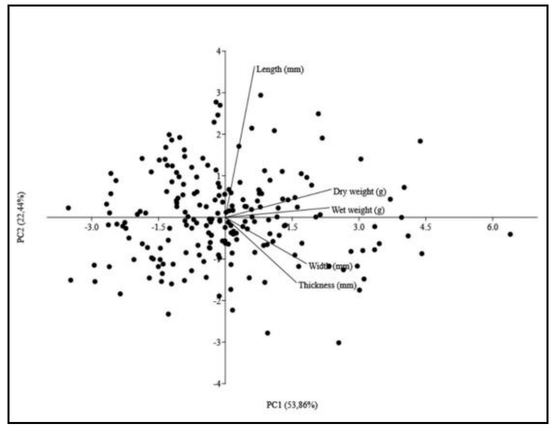

Fig. 5: Distribution of seed samples using component 1 and 2 of PCA

(BFG 2018), which accounted for 42% of the records found for the species. Thus, even observing the largest number of records in GBIF, they are not necessarily records of different exsiccates. This just demonstrates that the site has access to many platforms that use links from these same copies.

The geographic distribution of *P. Tessmannii* noted in this study is in accordance with the observations of Grandtner and Chevrette (2013) from South America and those of Daly and Silveira (2008) from Colombia. According to the analysis of this investigation, these records expand the distribution base of the species in Brazil, which was restricted only to the state of Acre and Amazonas (Daly and Silveira 2008; Grandtner and Chevrette 2013).

Due to the low sampling effort in the Amazon (Cardoso *et al.* 2017), this species may also occur in other regions of the biome, as well as in other regions of Acre. In the state of Mato Grosso, despite having only a limited record, lacking detailed information and unavailability for direct access to the exsiccate in the Royal Botanic Gardens herbarium, this record is supported by Borges *et al.* (2014). They identify it in the Amazon region of Mato Grosso, specifically, in the Dense Ombrophilous Forests, thus suggesting a wide distribution of this species.

The species *P. tessmannii* is included in a tribe of the Moraceae family (Olmideae), wherein the majority of member species are arboreal plants (rarely shrubby in the *Perebea* genus). These plants exhibit leaves and branches arranged in a distichous manner, and they also feature the presence of latex (Berg 1972). In addition to having fruits with food potential, due to the presence of fleshy fruit perianths, species in this taxonomic group, such as *Castilla ulei* Warb., popularly known as caucho, have become icons of the economic phase marked by latex (rubber) exploitation in the Amazon region.

In the State of Acre, at least eight species popularly known as pãma are known, which belong to five different genera (*Helicostylis, Naucleopsis*, *Perebea*, *Pseudolmedia, Sorocea*), all from the Moraceae family. There are also other varieties of pama, which are known by the names: pama-amarela, pama-branca, pama-caucho, pama-de-tamanho-médio, pama-de-trocha, pama-de-várzea, pama-ferro, pama-pequena, pama-preta, pama-vermelha and pama-mão-de-onça. The last two are popular names by which the species *P. tessmannii* is known in the Acre Amazon region (Daly and Silveira 2008). The fruits of *P. tessmannii* are a good taxonomic character to differentiate this from the other pamas of the Acre Amazon, as they have an apparently free fruiting perianth, while the other species have visibly connate fruiting perianths.

Generally, in addition to this characteristic, *P. tessmannii* can be recognized as a tree with leafy branches, elliptical to oblong leaves that are wider at the lower end, exhibiting a subcordate to deeply chordate base, and featuring an acuminate apex (Berg 1972). The species is of the evergreen type, which represents important specific characteristics that help predict issues related to productivity and forest functions (Qin *et al*. 2024). At reproductive stage, it often has its fruits on the lower side of the branches. Its fruits are consumed by many animals in the forest (Martinez and Ortiz 2011), which may indicate that the species may also has zoochory dispersal syndrome (Vidal and Vidal 2003) and not just barochory dispersal syndrome as observed in the forest (Oliveira 2012). Berg (1972) also comments that animals must have an important role in seed dispersal. However, this type of dispersion cannot be confirmed with on-site observations alone. An interesting characteristic is that the plant is not found in the species composition of fallow areas after burning and swidden agriculture in the Peruvian Amazon (Fujisaka *et al*. 2000).

The fruit dispersion season coincides with the highest rainfall in the region, usually between October and April (Silva *et al.* 2021). At the time of dispersal, seed moisture was 39%, indicating a high-water content. Both characteristics are predictors of seeds with desiccation sensitivity (Hong and Ellis 1998; Pritchard *et al.* 2004). Visually, in freshly collected and cut seeds, it was not possible to identify any tissue differentiation, and the embryo was not found. Furthermore, it was observed that the time required for germination to begin is quite long. In this sense, it is possible that the seeds have morphological dormancy, in which germination does not occur immediately after dispersion, due to the immaturity of the embryo. In some cases, it may also be undifferentiated (Carvalho and Nakagawa 2000; Hilhorst 2007). However, these studies are preliminary and new tests must be carried out to confirm these results.

Studies that describe the dendrometric characteristics of fruits and seeds are important for the recognition of the species in floristic surveys and its identification in seed banks (Araújo *et al.* 2004), including its importance for separating species of the same genus, with data relating to seeds are those indicated as most efficient for this separation (Cunha-Silva *et al.* 2012). These data also indicate genetic variability, in addition to serving as parameters for the selection of genetically superior specimens (Barroso *et al.* 2016).

The association between biometric characteristics of fruits and seeds, together with multivariate analyses, represented a crucial tool in the formation of germplasm banks, as well as in planning the collection and production of seedlings. They assist in *ex situ* conservation, identifying the variables that most contribute to the biometric characterization of species. Also, they are essential for identifying the most suitable locations for obtaining matrices, identifying variations that exist within and between locations (Bicalho *et al.* 2020). Biometric data also have the advantage of being easy to obtain and can help in conducting future studies on the ecology of the species covered (Cunha-Silva *et al.* 2012), especially in the Southwest Amazon where climatic extremes (Silva *et al.* 2023) can lead to unexpected scenarios for the region (Salla 2023).

Conclusion

P. tessmannii is widely distributed in the Amazon, present in both open and dense forests, with floodplain and terra firme environments. These pioneering studies were essential for acquiring information about this species and promoting urgent knowledge that may be lost in extreme climatic events, already documented for the Southwest Amazon. Such events can lead to unexpected scenarios for the region and the possibility of different forms of adaptability of the species present here.

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Author Contributions

ISM, JMRF and RCM guided this research through the planning, development, revision and conclusion stages; NAGE conducted the botanical characterization of the species and contributed to the write-up; BCM statistically analyzed the data, interpreted the results, and contributed to the write-up; FS participated in all stages.

Conflicts of Interest

All authors declare no conflict of interest.

Data Availability

Data presented in this study will be available on a fair request to the corresponding author.

Ethics Approval

Not applicable to this paper

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