Bulletin of the *Transilvania* University of Braşov
Series II: Forestry • Wood Industry • Agricultural Food Engineering • Vol. 12 (61) No. 1 – 2019
https://doi.org/10.31926/but.fwiafe.2019.12.61.1.3

KNOWN AND NEWLY DOCUMENTED USES OF RAINFOREST PLANT SPECIES IN THE PASTAZA REGION, ECUADOR

Alex V. GAVILANES MONTOYA[1,2] Danny D. CASTILLO VIZUETE[1,3] Carlos B. RICAURTE YEPEZ[3] Marina V. MARCU[1]

Abstract: *Knowing the uses of forest plant species is important for the conservation and sustainable use of forest ecosystem provisioning services. Based on an extensive literature survey, this paper reviews the uses of 540 rainforest species from the Pastaza region (Ecuador) and builds further the existing knowledge by field research that identified 39 new uses of local rainforest plants. Following a systematic categorization of the known and newly identified uses, it was found that the local plants are predominantly used as materials, medicines and foods (>80% of the sample), while the tree species dominate in various categories of local uses. The information given in this paper may help in building a local strategy for the sustainable use of plants and the conservation of endangered species, as well as in valuing the forest ecosystem provisioning services.*

Keywords: *tropical rainforest, plant uses, ethnobotany, ecosystem services, Amazon region.*

1. Introduction

Forests are able to provide a wide range of products and services [12, 14, 16, 18], contributing this way to human wellbeing [1]. In particular, tropical rainforests are characterized by the presence of a high number of plant species [7] that support increased biodiversity [7], [22] and provide many products to local communities and to several industrial sectors [9], [12], [17], [21], [26].

In Ecuador, for instance, tropical rainforests account for approximately 42.32% of the country's area [15] and the number of plant species that can be found

[1] Department of Forest Engineering, Forest Management Planning and Terrestrial Measurements, Faculty of Silviculture and Forest Engineering, *Transilvania* University of Braşov, Şirul Beethoven No. 1, Braşov 500123, Romania;
[2] Faculty of Sciences, Escuela Superior Politécnica de Chimborazo (ESPOCH), Panamericana Sur km 1½, Riobamba, EC060155, Ecuador;
[3] Faculty of Natural Resources, Escuela Superior Politécnica de Chimborazo (ESPOCH), Panamericana Sur km 1½, Riobamba, EC060155, Ecuador;
Correspondence: Marina V. Marcu; email: viorela.marcu@unitbv.ro.

in such forests is estimated at 7805 [11]. Products and other services provided by plants in such forests are locally used by many indigenous communities [11], [27]. Nevertheless, the sustainability of plant use depends largely on several factors among which the way that such plants are used is very important, especially in terms of frequency and amount of use [20, 27]. Therefore, a first step in understanding the dynamics of plant utilization is documenting the possible uses of plants [28] because it may help in understanding the sustainability of such activities and provide/offer an informed allocation of resources for the conservation of different plant species [3], [5], [25].

While a part of the Ecuadorian rainforest plant uses was previously documented [11], [27], this activity still needs refining to account for all the possible uses that are specific to the local, indigenous communities. In the absence of other approaches, one way to document potential new uses of plants is consulting experienced local people who have deep knowledge of such issues.

The aim of this study is to document and categorize the uses of more than 500 plant species from the tropical rainforest of Ecuador by (i) conducting a detailed literature survey and by (ii) additional documentation of plant uses with the assistance of experienced local people.

2. Materials and Methods

2.1. Literature Survey and Field Documentation

The tropical rainforest of Ecuador is spread across 5 provinces. One of the most representative regions in which the rain forests are located is the Pastaza region (Figure 1), which spreads across 2,952 million hectares and was selected for this study.

Fig. 1. *Map of Pastaza Province within Ecuador and South America*

Based on a literature survey, a total number of 540 plants were identified as having certain local uses. The plant uses were documented from 11 sources [2, 4, 6, 8, 10, 11, 13, 15, 19, 21, 28], covering scientific articles, books, manuals and encyclopedias.

An initial database was designed to contain the scientific and the common names of the plant species. The latter were extracted from available literature and included in the database in several indigenous languages. Habits of the plants as well as their origin (Figure 3) were extracted following the literature survey and added to the database. Plants were

grouped in 8 categories, based on the specifications of [27, 28]: parasite shrubs - PS, epiphytes - EF, ferns - F, hemiepiphytes - HE, lianas - L, herbs - H, shrubs – S, and trees – T (Figure 2). In a first phase, the known uses were documented for each plant, according to the literature survey. To this end, 11 categories were identified and used to categorize the known uses as shown in Table 1.

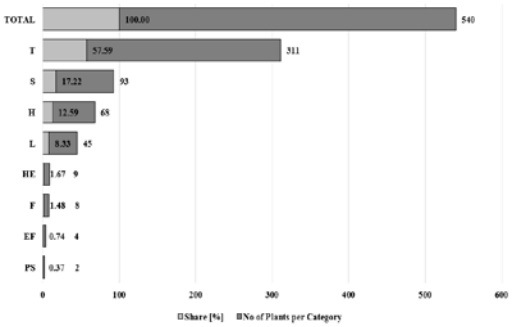

Fig. 2. *Number and proportion of plants per category*

Categories of Uses and their Description Table 1

Category of Use	Abbreviation	Description
Apiarian	AP	Plants that are used by bees during their activity.
Environmental	EN	Plants used for protection, improvement, and fertilization of soils; Plants used against invasive species; Plants used as live fence barriers; Plants used to control wildfires; Plants used to mitigate pollution; Plants used in the agroforestry systems.
Food	FO	Plants used for food; Plants used for production of beverages.
Food Additive	FA	Plants used as ingredients in the preparation of food and beverages to improve palatability.
Food for Invertebrates	FI	Plants used as food by invertebrates useful for man (*e.g.* edible beetle larvae and cochineal).
Food for Vertebrates	FV	Plants that are used as food by wild and domestic animals.
Fuel	FU	Plants directly used as firewood; Plants used for coal production; Plants used for production of petroleum substitutes; Plants used for production of combustible alcohols; Plants used for production of combustion initiators.
Materials	MA	Plants used as a source of material for buildings, bridges, crafts, tools and weapons; Plants used to produce (extract) fibres, reeds, waxes, gums, resins, oils, chemicals and their by-products.
Medicinal	ME	Plants used to heal, alleviate and combat human diseases; Plants used for veterinary purposes.
Social	SO	Plants used for social and cultural purposes.
Toxic	TO	Plants that contain poisonous agents for vertebrates (both accidental and intentional), particularly those used in fishing and hunting.

Following the detailed documentation of plant utilization, a list of plant common names and their documented uses was brought in the field to identify new

potential uses of the plants based on the experience and habits of the local indigenous people.

To this end, 5 well experienced local people were selected based on their informed consent to support this study.

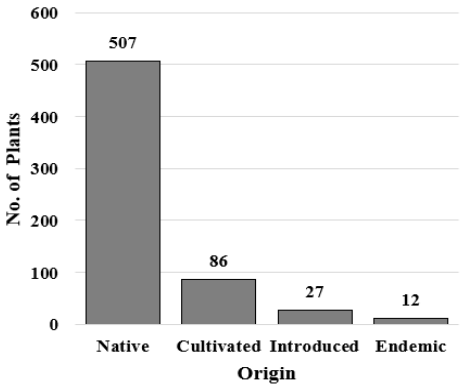

Fig. 3. *Number of plants and their origin*

Two of them were selected from the indigenous communities and 3 were selected from the local government. All of them belong to the "Shuar", ethnic group which is the dominant ethnic group with the greatest presence in the area, and had a deep knowledge of the utilization of the local forests. The locals were asked to take a look at the plant list and the documented uses. Then, for each plant contained in the list, they were asked to indicate whether they knew other uses. When they had difficulties in identifying a plant based solely on its common name, high-quality pictures were shown to help them identify the plant. Based on their responses, the database was updated with new uses which were attributed to the previously designed categories by checking a specified field in the database.

Following the above-mentioned steps, the database was used to compute the descriptive statistics of plant uses per category, number and the proportion of uses per category of utilization as well as to differentiate between plant categories and uses categories to be able to see which uses were the most common and which plants had these uses.

Statistical analysis, including the normality check whenever the case, was carried out in Microsoft Excel fitted with Real Statistics freeware plugin. Then, depending on the data type, the data was described by the commonly used descriptive statistics or as absolute and relative values.

3. Results and Discussions

3.1. Known and Newly Documented Plant Uses

A number of 39 new uses were identified following the field phase of documentation, representing approximately 3% of those documented in the final database. 23 of them belonged to the materials category (1 for epiphyte ferns, 7 for trees, 2 for herbs, 12 for shrubs and 1 for lianas), 8 were categorized as foods (4 for trees, 3 for herbs and 1 for shrubs), 4 were included in the medicinal use category (1 for epiphyte ferns, 2 for trees and 1 for shrubs), 3 were categorized as fuels (2 for trees and 1 for herbs) and a tree was included in the social use category.

3.2. Uses per Plant Category

Table 2 shows the descriptive statistics of the number of uses per plant category. The total number of documented uses in the aggregated database amounted to 1,450. As shown, both the total and the maximum number of uses was that characterizing the trees and shrubs, followed by herbs and lianas. For the

trees, there were cases in which no uses were identified, but also cases in which the same species had up to 8 different uses. This was also the case of shrubs. On average, lianas and herbs have 2 uses while shrubs and trees have 2-3 uses.

Descriptive statistics of plant uses per plant category Table 2

Plant Category	Descriptive Statistics of Uses					
	N	Min.	Max.	Range	Mean	Median
Parasite Shrubs (PS)*	4	2	2	0	2.00	2.00
Epiphytes (E)*	8	2	2	0	2.00	2.00
Ferns (F)*	15	1	3	2	1.87	1.50
Hemiepiphytes (HF)*	13	1	3	2	1.44	1.00
Lianas (L)*	99	0	7	7	2.20	2.00
Herbs (H)*	178	0	7	7	2.62	2.00
Shrubs (S)*	227	0	8	8	2.44	2.00
Trees (T)*	906	0	8	8	2.91	3.00

Note: * denotes data coming from non-normally distributed samples.

3.2. Number and Proportion of Uses per Utilization Category

Materials (MA=340), medicines (ME=285), food for vertebrates (FV=259), food (FO=251) and social (SO=137) were the predominant uses of the plants as shown in Table 3. These accounted for more than 85% of the documented uses in this study. For comparison purposes, the tree category is the one that includes the most useful species, even though the herbs and shrubs are more numerous in the total number of vascular plants in Ecuador [20]. Of the total number of plants described in the catalogue of vascular plants, 60% are medicinal, 55% are used for construction, 30% are edible, and 20% are used in religious rituals or similar practices [11]. As the sum of these percentages exceeds 100%, this means that part of the described species have multiple uses, but again, the utilization categories of the plants are quite similar in terms of ranking, to those found in the refined dataset of this study.

3.3. Number and Proportion of Uses per Plant and Utilization Category

Table 3 shows the number of plant uses by taking into account the plant and plant utilization categories. Most of the tree uses were those of material procurement, which is similar to other regions of the world [23]. Unlike other countries [23, 24], a significant number of tree species were identified to be useful for food and medicines. Shrubs were preponderant in the materials and medicinal categories, while herbs were more frequently used in the medicinal and food categories. Irrespective of the category of use, trees were dominant (Table 3), showing proportions between cca. 45% (medicinal) and 93% (food for invertebrates). Shrubs accounted for between cca. 4 (food additives) and 28% (toxic use) and herbs accounted for between 4 (toxic use) and cca. 36% (food additives). It has been shown that in the tropics at least 40,000 tropical tree species are documented, but it is still possible to have more than 53,000 species [29].

Number and proportion of uses per plant and utilization category Table 3

Plant category	Category of Use										
	EN	TO	SO	MA	FU	AP	FI	FV	FA	FO	ME
PS								2			2
EF			2					1		1	4
F			2	3				2			8
HE			2	3		1		3		1	3
L	2	8	7	14	2			13	3	23	27
H	2	1	27	27	1	1	1	22	10	29	10
S	5	7	29	49	4	2	1	37	1	35	57
T	31	9	68	244	33	11	28	179	14	162	127
PS [%]								0,77			0,70
EF [%]			1,46					0,39		0,40	1,40
F [%]			1,46	0,88				0,77			2,81
HE [%]			1,46	0,88		6,67		1,16		0,40	1,05
L [%]	5,00	32,00	5,11	4,12	5,00			5,02	10,71	9,16	9,47
H [%]	5,00	4,00	19,71	7,94	2,50	6,67	3,33	8,49	35,71	11,55	20,00
S [%]	12,50	28,00	21,17	14,41	10,00	13,33	3,33	14,29	3,57	13,94	20,00
T [%]	77,50	36,00	49,64	71,76	82,50	73,33	93,33	69,11	50,00	64,54	44,56
Number of uses	40	25	137	340	40	15	30	259	28	251	285
Proportion [%]	2,76	1,72	9,45	23,45	2,76	1,03	2,07	17,86	1,93	17,31	19,66

4. Conclusions

This study analysed the use of 540 rainforest species based on known and newly documented data. Compared to the existing literature, 39 more uses were identified for the analysed plants with most of such uses being categorized as materials, food and medicines. Materials, medicinal and food uses dominated in the case of the analysed plants. Among them, the trees dominated both in term of number of plants and number of uses, with most of their uses belonging to the same categories: materials, medicinal and food.

Acknowledgements

This study is a part of a doctoral thesis developed in the Doctoral School of the Transilvania University of Braşov. The authors would like to thank the aforementioned institution and the Escuela Superior Politécnica de Chimborazo for their technical help through the GIADE research group, Gabriela Román & Jenny Morocho (FNR). The authors are grateful to Daniel Feijoo and Hugo Cariajano (Estación experimental Pastaza ESPOCH), Simon Bolivar local government and Valquiria Cevallos (ESPOCH Faculty of Sciences) who helped to collect the data needed in this study.

References

1. Ahammad R., Stacey N., Eddy I.M.S. et al., 2019. Recent trends of forest cover change and ecosystem services in eastern upland region of

Bangladesh. Science of The Total Environment, vol. 647, pp. 379-389.
2. Barrantes G., Chaves H., Vinueza M., 2001. El Bosque en el Ecuador: Una visión transformada para el desarrollo y la conservación. Comafors, Quito, Ecuador, 79 p.
3. Bennett B.C., Baker M.A., Gómez Andrade P., 2002. Ethnobotany of the Shuar of eastern Ecuador. New York Botanical Garden Press, Bronx, USA, 299 p.
4. Betancourt B., 2006. Ethnobotany of the Huaorani communities in the Ecuadorian Northwest. Lyonia, vol. 10(2), pp. 7-17.
5. Caballero-Serano V., Onaindia M., Alday J.G. et al., 2016. Plant diversity and ecosystem services in Amazonian homegardens of Ecuador. Agriculture, Ecosystems & Environment, vol. 225, pp. 116-125.
6. Camacho R., 2008. Productos forestales no maderables: importancia e impacto de su aprovechamiento. Colombia Forestal, vol. 11(1), pp. 215-231.
7. Cevallos G.C., Sospedra R.S., Pérez M.V. et al., 2013. Strategies of conservation of the tropical natural forest of the commune «El Pital» Manabí, Ecuador. Revista Cubana de Ciencias Forestales, vol. 3(2), 16p.
8. Chandrasekharan C., Frisk T., Roasio J., 1996. Desarrollo de productos forestales no madereros en América Latina y el Caribe. Rome, Italy, Dirección de Productos Forestales. FAO, Serie forestal, no. 5, 70 p.
9. Comberti C., Thornton T., de Echeverria V. et al., 2015. Ecosystem services or services to ecosystems? Valuing cultivation and reciprocal relationships between humans and ecosystems. Global Environmental Change, vol. 34, pp. 247-262.
10. Cunningham A., 2014. Applied ethnobotany: people, wild plant use and conservation. London, UK, Taylor&Francis Press, 320 p.
11. De la Torre L., Navarrete H., Muriel P. et al., 2008. Enciclopedia de las Plantas Útiles del Ecuador. Herbario QCA & Herbario AAU, Quito&Aarhus, 322 p.
12. Ferraz S., Ferraz K., Cassiano C. et al., 2014. How good are tropical forest patches for ecosystem services provisioning? Landscape Ecology, vol. 29, pp. 187-200.
13. Fierro A., Fernández D., Quintana C., 2002. Usos de Melastomataceae en el Ecuador. SIDA, Contributions to Botany, vol. 20(1), pp. 233-260.
14. Foley J.A., Asner G.P., Costa M.H. et al., 2007. Amazonia revealed: forest degradation and loss of ecosystem goods and services in the Amazon Basin. Frontiers in Ecology and the Environment, vol. 5(1), pp. 25-32.
15. Garí J., 2001. Biodiversity and indigenous agroecology in Amazonia: the indigenous people of Pastaza. Etnoecologica, vol. 5(7), pp. 21-37.
16. Gray C., Bozigar M., Bilsborrow R., 2015. Declining use of wild resources by indigenous peoples of the Ecuadorian Amazon. Biological Conservation, vol. 182, pp. 270-277.
17. Guarrera P., Savo V., Caneva G., 2015. Traditional uses of plants in the Tolfa–Cerite–Manziate area (Central Italy). Ethnobiology Letters, vol. 6(1), pp. 119-161.
18. Hirons M., Comberti C., Dunford R., 2016. Valuing cultural ecosystem services. Annual Review of

Environment and Resources, vol. 41(1), pp. 545-574.
19. Jiménez González A., Pincay Alcivar F.A., Ramos Rodríguez M.P. et al., 2017. Utilización de productos forestales no madereros por pobladores que conviven en el bosque seco tropical. Revista Cubana de Ciencias Forestales, CFORES, vol. 5(3), pp. 270-286.
20. Jørgensen P., León S., González A. et al., 1999. Catalogue of the vascular plants of Ecuador. Missouri Botanical Garden Press, USA, 1181 p.
21. Macía M.J., Armesilla P.J., Cámara-Leret R. et al., 2011. Palm uses in northwestern South America: a quantitative review. The Botanical Review, vol. 77(4), pp. 462-570.
22. Mittermeier R.A., Mittermeier C.G., Brooks T.M. et al., 2003. Wilderness and biodiversity conservation. Proceedings of the National Academy of Sciences, vol. 100(18), pp. 10309-10313.
23. Moraes M., Ollgaard B., Kvist L. et al., 2006. Botánica económica de los Andes Centrales, Universidad Mayor de San Andrés, La Paz, 557 p.
24. Muñoz J., 2018. Regeneración Natural: Una revisión de los aspectos ecológicos en el bosque tropical de montaña del sur del Ecuador. Bosques Latitud Cero, vol. 7(2), pp. 130-142.
25. Reyers B., Biggs R., Cunning G.S. et al., 2013. Getting the measure of ecosystem services: a social–ecological approach. Frontiers in Ecology and the Environment, vol. 11(5), pp. 268-273.
26. Ríos M., De la Cruz R., Mora A., 2008. Conocimiento tradicional y plantas útiles del Ecuador: Saberes y Prácticas. Quito, Ecuador, IEPI y Ediciones Abya-Yala, 78 p.
27. Rios M., Koziol M., Pedersen H. et al. (Eds), 2007. Plantas útiles del Ecuador: aplicaciones, retos y perspectivas. (Useful plants of Ecuador: Applications, challenges, and perspectives). Quito, Ecuador, SIMBIOE, 652 p.
28. Ríos M., Pedersen H. (Eds), 1997. Uso y manejo de recursos vegetales. Quito, Ecuador, Abya-Yala, 426 p.
29. Slik J.W.F., Arroyo-Rodríguez V., Aiba S.I. et al., 2015. An estimate of the number of tropical tree species. Proceedings of the National Academy of Sciences of USA, vol. 112(24), pp. 7472-7477.