



Can a Use-based Taxonomy be Natural? An example from Aguaruna folk classification of trees

Kevin Jernigan

Research

Abstract

This work examines the classic utilitarian vs. intellectualist debate in cognitive ethnobiology from a new perspective. It challenges the notion that classifications based on utility are artificial, that is, necessarily constructed from a few special characteristics. The paper involves a new analysis of ethnographic data collected by the author over multiple field sessions from 2004 to 2010 in nine Aguaruna villages in Amazonas, Peru. In previous work, Aguaruna participants described uses, along with sensory and ecological characteristics of local tree species. They also stated which tree folk genera they consider related to each other as “companions,” typically placing taxa together in natural groupings. This new synthesis took the descriptions of uses and physical characteristics for a sample of 41 Aguaruna tree folk genera and subjected both to hierarchical cluster analysis to see which would better reproduce the folk classification. Use data performed nearly as well as sensory data in reproducing the natural groupings of trees. This makes sense considering that plant uses tend to be based on physical properties (including presence of secondary compounds) that related species will often share.

Introduction

Bases for classification

A classic and ongoing debate within the field of ethnobiology relates to the relative strengths of intellectualist, ecological, and utilitarian approaches to folk classification (Anderson 2000, 2010, Atran 1998, Berlin 1991, 1992, Hunn 1982, Posey 1984). Folk taxonomic systems typically give linguistic recognition to only a portion of the biological diversity in any given region (Berlin 1991, Hunn 1982). Some authors (Berlin 1991, 1992) maintain that the

most perceptually distinctive organisms have the greatest probability of being named. Others (Hunn 1982) have emphasized the importance of usefulness, arguing that cultural knowledge should be adaptive. Evidence (Berlin 1992, Posey 1984) suggests that ecological relationships also play an important role in classification.

Debate has focused not only on the factors motivating classification but also on the mechanics of how folk taxonomies are organized (Atran 1998, Berlin *et al.* 1974, Hunn 1982). An important aspect of these discussions concerns the naturalness of taxonomic schemes. Natural (or general purpose) schemes group together members based on many common shared characteristics (Berlin *et al.* 1966). Modern scientific classification is a good example. Conversely, artificial (or special) classification schemes use a small number of characteristics designed for a particular purpose. For instance, one might classify plants as “edible,” “medicinal” or “psychoactive.” Berlin (1991, 1992) argues that the widespread agreement between scientific and folk systems of classification provides good evidence

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that the latter are general purpose, based on observations of the morphological and behavioral qualities of organisms. Similarly, Atran maintains that folk taxonomies are general-purpose schemes that work “to maximize inductive potential relative to human interests” (1998:563). Hunn (1982) has suggested that folk classifications are based on an extensive natural core along with a periphery of artificial taxa based on utilitarian considerations. In any case, major contributors in this field (Berlin 1992, Ellen 2008, Hunn 1982) have largely discussed use-based classifications as being artificial rather than natural. The possibility that utility based classification schemes could be natural has largely not been explored. The present article examines this assumption through a detailed analysis of the Aguaruna life form category *númi* – “trees.” Specifically, it tests the hypothesis: When sensory and ecological characters listed by Aguaruna participants for local trees are subjected to a hierarchical cluster analysis, the resulting classification will be a natural one. However, a similar analysis based on use characters should fail to produce natural groupings.

Background

Study site

This study involves a new analysis of ethnographic data collected over multiple field sessions of the author and collaborators in nine Aguaruna villages from 2004 to 2010. The previous studies interviewed 30 adult Aguaruna participants, focusing on the process of tree identification (Jernigan 2006b, 2008), medical ethnobotany (Jernigan 2009), and knowledge of life histories of local birds and mammals (Jernigan 2006a, 2010, Jernigan & Dauphine 2008). The work involved researchers from the University of Georgia, the University of Alaska, Fairbanks, and the Universidad Nacional Mayor San Marcos in Lima, Peru.

All work took place on the upper Marañón river (see Figure 1), in the department of Amazonas, Peru, approximately 300 km northeast of the major Peruvian city of Chiclayo. This is an area of high species diversity of both flora and fauna (Jernigan & Dauphine 2008). These studies all

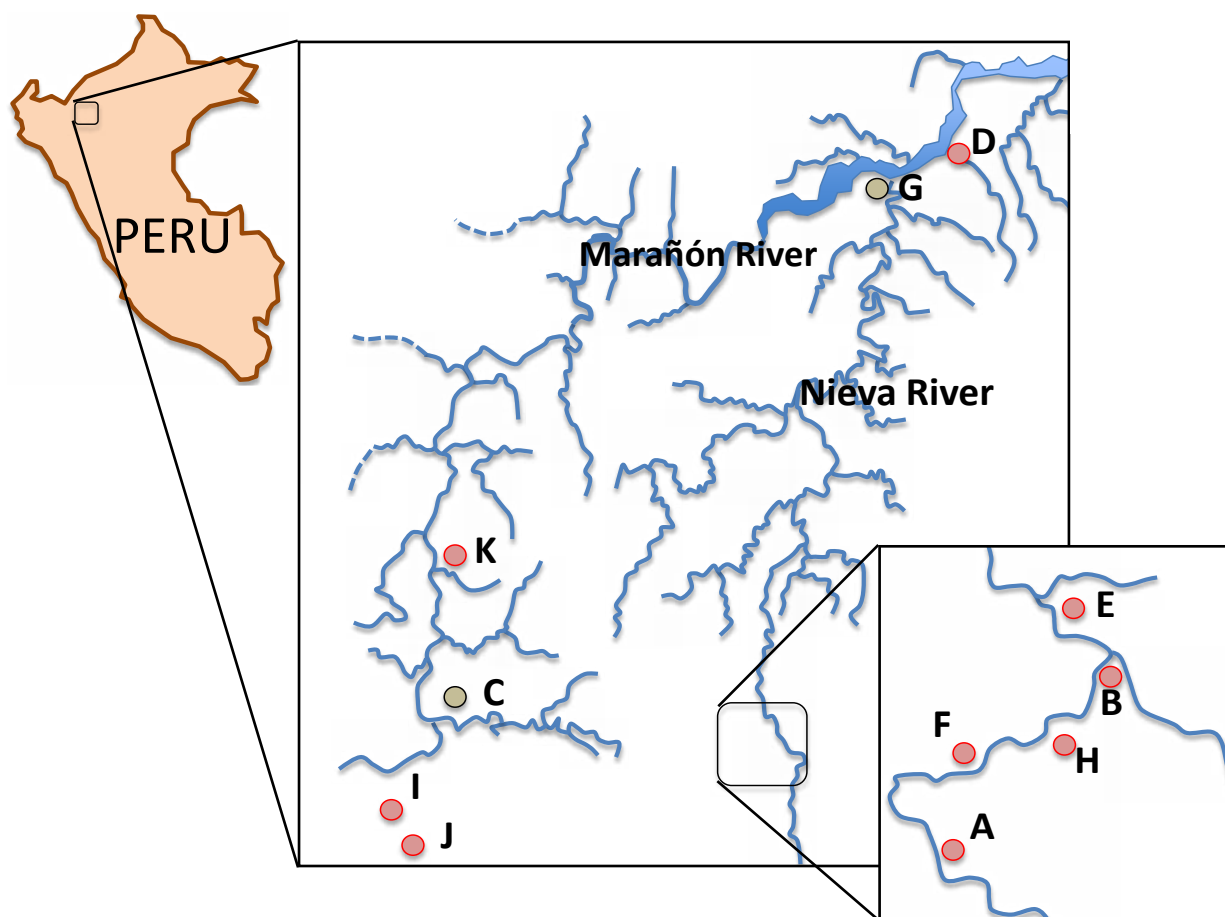


Figure 1. Study area on the upper Marañón river, Amazonas, Peru. Communities of **A**) Atash Shinukbau, **B**) Bajo Cachiaco, **C**) Chiriaco, **D**) Ciro Alegria, **E**) Kayamas, **F**) Pagki, **G**) Santa Maria de Nieva, **H**) Tunants, **I**) Wawas, **J**) Wichim, and **K**) Yangunga. Red denotes study communities, grey denotes other communities.

conformed to American Anthropological Association ethical guidelines (1998–2012). For all work, prior informed consent was obtained first at the community level, then from individual participants. Permission was also granted by the Peruvian Ministry of Agriculture for collecting botanical voucher specimens.

Approximately 40,000 people in this region identify ethnically as Aguaruna (Lewis *et al.* 2013). Local traditional subsistence practices focus on swidden agriculture, supplemented by wild plant foods and meat from livestock, wild game, and fish. Despite some expansion of market economies in recent years, local subsistence activities continue to dominate (Jernigan 2006b).

The present analysis relies on interviews from the native communities of Alto Pagki, Atash Shinukbau, Bajo Cachiaco, Ciro Alegria, Kayamas, Tunants, Wawas, Wichim, and Yangunga (Figure 1). All research participants are Aguaruna speakers, and interviews were carried out by the author and collaborators in that language. Villages range in elevation from 300–600 masl, corresponding to a transition zone between lowland and montane tropical evergreen forest.

Aguaruna folk taxonomy

The present discussion of Aguaruna folk taxonomy focuses on the life form category **númi**, which includes most of what falls under the English folk category “tree.” However, it excludes soft-wooded taxa such as *Carica papaya* L. (**papái**) and palms in general (Jernigan 2006b). For a wider treatment of Aguaruna folk classification see Berlin (1992) and Jernigan (2006b).

Aguaruna classification has a built-in mechanism for recognizing the relatedness of certain folk genera within a life form category. Such related taxa are called **kumpaji**

– “companions.” In previous research (Jernigan 2006a), the author asked Aguaruna participants to group folk genera of trees that they consider to be companions. For example, the majority of participants recognized the relatedness of trees in the genus *Cecropia* (Urticaceae), including **satik** (*Cecropia membranacea* Trécul) and **súu** (*Cecropia engleriana* Sneathl.). As with many of the companion groupings, this particular group can be justified in terms of both morphological similarities and similar uses. Both *Cecropia* species have palmate leaves with long petioles and clusters of oblong fruit. Both serve as firewood and have sap that treats hepatitis and anemia.

A majority of “companions” form natural groupings from the perspective of modern scientific taxonomy. However, occasionally trees that are not biologically closely related can also be considered **kumpaji**. For example, the species **shijig** (*Hevea guianensis* Aubl.), **tákae** (*Brosimum parinarioides* Ducke) and **barát** (*Chrysophyllum sanguinolentum* subsp. *balata* (Ducke) T.D. Penn.) are often placed together because they each have copious white sap that serves as a source of rubber.

Methods

In previous work (Jernigan 2006a, 2008, 2009, 2010), Aguaruna participants freelisted the following for local tree species: 1) their uses, 2) their physical characteristics (e.g. “the trunk is smooth” or “the sap is white”) and 3) their ecological relationships with animals (e.g., “the fruit is eaten by tapirs” or “stinging ants live in the trunk”).

The present analysis takes a sample of 41 Aguaruna tree folk genera of high salience in freelists that are widely agreed to form 15 distinct groups of related “companions” (Table 1) (Jernigan 2006a). Scientific names in this table are those accepted in the Tropicos database (Mis-

Table 1. Trees used for analysis of sensory, ecological, and use character hierarchical clusters in Amazonas, Peru. Voucher numbers preceded by J indicate Kevin Jernigan collections, which are deposited in the Universidad Nacional Mayor de San Marcos, herbarium (USM). Other letters indicate collections deposited at Missouri Botanical Garden, herbarium (MO): A = Ernesto Ancuash, H = Victor Huashikat, K = Rubio Kayap.

Grouping of Aguaruna taxa	Scientific taxa	Voucher
GROUP 1	APOCYNACEAE	
úchi dáum	<i>Couma macrocarpa</i> Barb.Rodr.	J188
úchi táuch	<i>Lacmellea oblongata</i> Markgr.	J199
GROUP 2	BURSERACEAE	
wáwa kunchái	<i>Dacryodes belemensis</i> Cuatrec.	J58
újuts	<i>Dacryodes uruts-kunchae</i> Daly, M.C.Martínez & D.A.Neill	J48
GROUP 3	BURSERACEAE	
shijikap	<i>Protium</i> sp.	J54
chípa	<i>Protium amazonicum</i> (Cuatrec.) Daly	J70
pantuí	<i>Protium grandifolium</i> Engl.	J49

Grouping of Aguaruna taxa	Scientific taxa	Voucher
shishi	<i>Protium spruceanum</i> (Benth.) Engl.	A427
GROUP 4	CLUSIACEAE	
wayámpainim	<i>Garcinia madruno</i> (Kunth) Hammel	J275
pegkáenum	<i>Garcinia macrophylla</i> Mart.	J119
GROUP 5	FABACEAE	
putsúu sámpi	<i>Inga</i> sp.	J60
wámpa	<i>Inga edulis</i> Mart.	J63
buabúa	<i>Inga</i> cf. <i>multinervis</i> T.D.Penn.	J71
sejempách	<i>Inga semialata</i> (Vell.) C.Mart.	J212
GROUP 6	FABACEAE	
samiknum	<i>Maclobium acaciifolium</i> (Benth.) Benth.	J82
wampishkunim	<i>Maclobium limbatum</i> Benth.	J56
GROUP 7	FABACEAE	
pandáij	<i>Ormosia</i> cf. <i>amazonica</i> Ducke	J114
tajép	<i>Ormosia</i> cf. <i>coccinea</i> (Aubl.) Jacks.	J72
GROUP 8	FABACEAE	
tigkishpinim	<i>Tachigali</i> sp.	J261
ugkuyá	<i>Tachigali formicarum</i> Harms	J264
wantsún	<i>Tachigali</i> cf. <i>bracteosa</i> (Harms) Zarucchi & Pipoly	J270
GROUP 9	LAURACEAE	
káwa tíncchi	<i>Nectandra olida</i> Rohwer	J268
káikua	<i>Licaria</i> sp.	J196
wampúsnum	cf. <i>Nectandra hihua</i> (Ruiz & Pav.) Rohw	J53
takák	<i>Ocotea gracilis</i> (Meisn.) Mez	J272
batút	<i>Ocotea floribunda</i> (Sw.) Mez	H483
káwa	<i>Ocotea floribunda</i> (Sw.) Mez	A170
GROUP 10	LECYTHIDACEAE	
kaáshnum	<i>Eschweilera gigantea</i> (R.Knuth) J.F.MacBr.	J102
shuwát	<i>Eschweilera</i> sp.	J217
GROUP 11	MALVACEAE	
wampúush	<i>Ceiba pentandra</i> (L.) Gaertn.	J266
ménte	not determined	J122
GROUP 12	MELASTOMATACEAE	
tseék	<i>Miconia ternatifolia</i> Triana	J75
ukuínmanch	<i>Miconia lourteigiana</i> Wurdack	J267
antumú chinchák	<i>Miconia</i> sp.	J216
chijáwe	<i>Miconia bubalina</i> (D.Don) Naudin	J112
GROUP 13	MELIACEAE	
yantsáu	<i>Guarea guidonia</i> (L.) Sleumer	K60
bíchauj	<i>Guarea macrophylla</i> ssp. <i>pendulispica</i> (C.DC.) T.D.Penn.	J74
GROUP 14	MYRISTICACEAE	
ejésh	<i>Iryanthera tricornis</i> Ducke	J80
úntuch tsémpu	<i>Iryanthera juruensis</i> Warb.	J55

Grouping of Aguaruna taxa	Scientific taxa	Voucher
GROUP 15	URTICACEAE	
satík	<i>Cecropia membranacea</i> Trécul	K805
súu	<i>Cecropia engleriana</i> Snethl.	J273

souri Botanical Garden 2014), corresponding to the APG III system of classification. Members of these 15 groupings belong to the same biological genus in 12 cases and same family in the remaining three. The sample only includes companion groupings that are also natural from a modern biological perspective, since the aim of this research is to investigate what kinds of reasoning can form the basis for natural classification.

Data analysis

The sensory, ecological, and use characters for the 41 study trees were subjected to separate hierarchical cluster analyses to see which results would correspond best with participants' statements about how these trees are related as "companions." This classificatory method takes data in the form of vectors and produces increasingly inclusive groups based on some measure of the distance between them (Bernard 1995:505). Here, each vector corresponds to one of the 41 study trees, and each element in it represents a particular sensory, ecological, or use character. The value of each element is the proportion of participants who mentioned that particular character state (e.g. white sap, fruit eaten by oilbirds) for a given tree. The furthest neighbor clustering method was chosen for these analyses because it tends to produce small, tight groupings, avoiding the tendency toward chaining found with single linkage methods (Rokach & Maimon 2005). Cosine distances were used because they take into account the similarity in overall pattern of the elements that make up the vectors (in this case the character states), without taking into account vector magnitudes (Diekhoff 1992).

The sensory, ecological, and utility characters used in the analyses can be found in Appendices 1–3. A total of 73 sensory characters (Appendix 1) includes 23 related to fruit, nine to the outer trunk appearance, eight for leaves, seven for cut bark, six for sap, five for growth habit, five for seeds, four for the inner trunk, four for flowers, one for roots, and one for branches.

Ecological characters (Appendix 2) include 65 categories of birds, 13 for mammals, and two for insects. To simplify the presentation of the data, the table headings are broad groupings such as "parrots" or "monkeys." Certainly many of these headings encompass multiple Aguaruna folk taxa. However, a complete listing would make for an overly extensive table, since some trees are said to be food for dozens of different animal species. The biological identity of Aguaruna bird names is based on research conducted by Boster *et al.* (1986), Jernigan (2006a), and

Jernigan and Dauphiné (2008). For mammal names, the work of Guallart (1962) and Berlin and Patton (1979) are referenced. Insect identifications are based on Guallart (1969).

Fifty-five use characters for the study trees are shown in Appendix 3. A full description of uses of all local woody flora is beyond the scope of this article, but see Jernigan (2006b) for a more detailed presentation. A few Aguaruna illness terms require further explanation, since the correspondence to biomedical categories is not always precise. **Jágku** is generally found in the elderly, and symptoms include pain and swelling of the joints (Brown 1984). It can be glossed as "rheumatism." The major symptom of **shíip** is bloody or mucousy diarrhea. It most likely corresponds to amebiasis. **Yunchít** is an illness whose primary symptoms are small mouth ulcers, irritation of the tongue, and hoarseness of the voice. It is sometimes associated with a bout of cold or flu and occurs most frequently in children (Brown 1984). Uwarai Yagkug *et al.* (1998) state that **yunchít** is equivalent to scurvy. The disease term **úgku** refers to a pus-filled boil and can be accompanied by a fever (Brown 1984). **Iyágbau** (Figure 2) refers to swelling caused by dislocations or fractures.

Results

The dendrograms for the hierarchical cluster analyses of the sensory, ecological, and use characters appear in Figures 3–5 respectively.



Figure 2. The author's swollen foot (**iyágbau**) being treated with hot pieces of **tájep** (*Ormosia cf. coccinea* (Aubl.) Jacks.), community of Bajo Cachiaco, Amazonas, Peru.

Figure 3. Dendrogram for hierarchical clustering of sensory characters of 41 study trees in Amazonas, Peru. *M. acaciifolium* = *Macrolobium acaciifolium* (Benth.) Benth.; *M. limbatum* = *Macrolobium limbatum* Benth.; *T. formicarum* = *Tachigali formicarum* Harms.

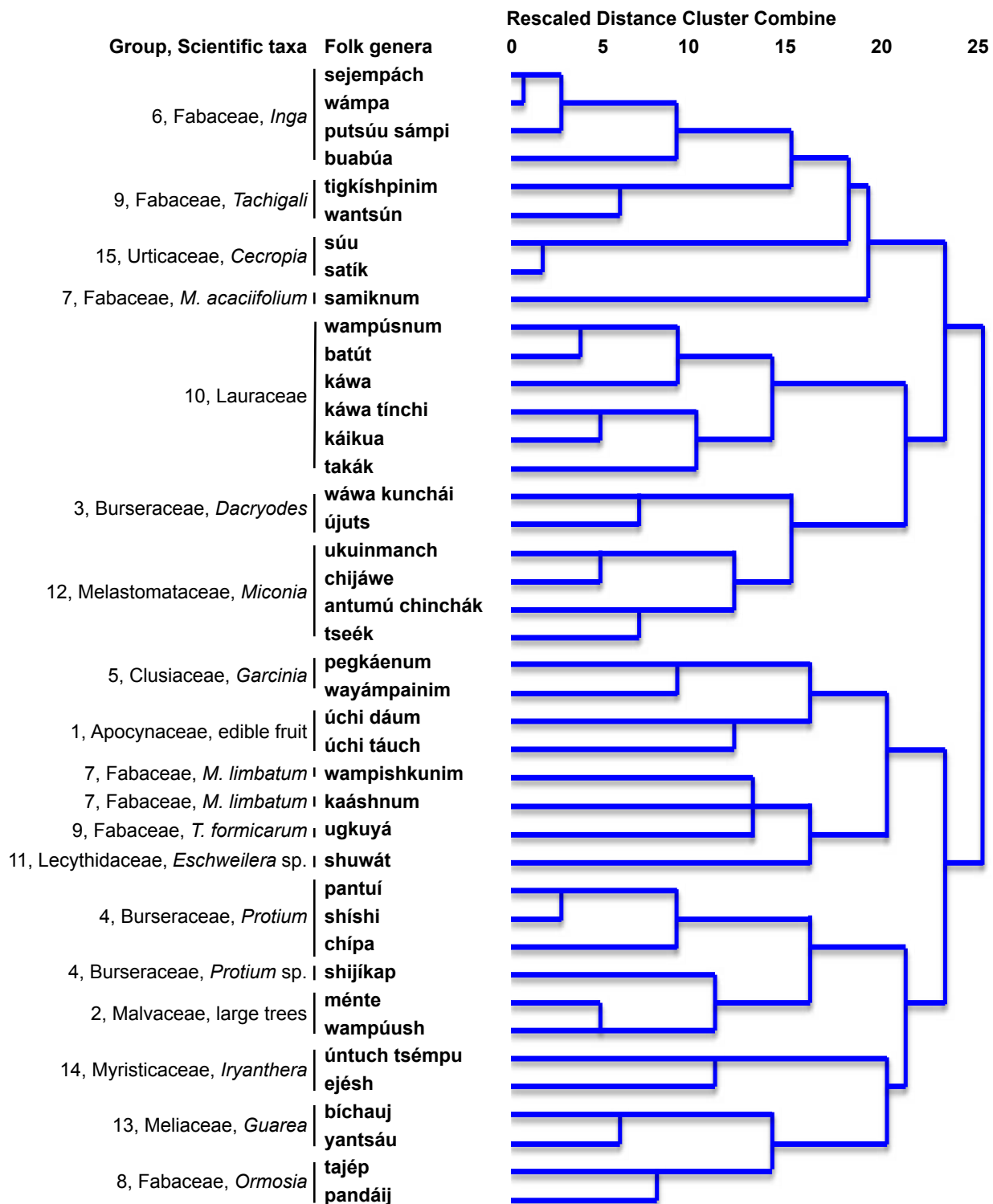


Figure 4. Dendrogram for hierarchical clustering of ecological characters of the 41 study trees in Amazonas, Peru. *C. macrocarpa* = *Couma macrocarpa* Barb.Rodr.; *D. kukachkana* = *Dacryodes kukachkana* L.O.Williams; *D. uruts-kunchae* = *Dacryodes uruts-kunchae* D.C. Daly & M.C.Martinez; *G. macrophylla* = *Garcinia macrophylla* Mart.; *G. madruno* = *Garcinia madruno* (Kunth) Hammel; *L. oblongata* = *Lacmellea oblongata* Markgr.; *N. hihua* = *Nectandra hihua* (Ruiz & Pav.) Rohwer; *P. spruceanum* = *Protium spruceanum* (Benth.) Engl.

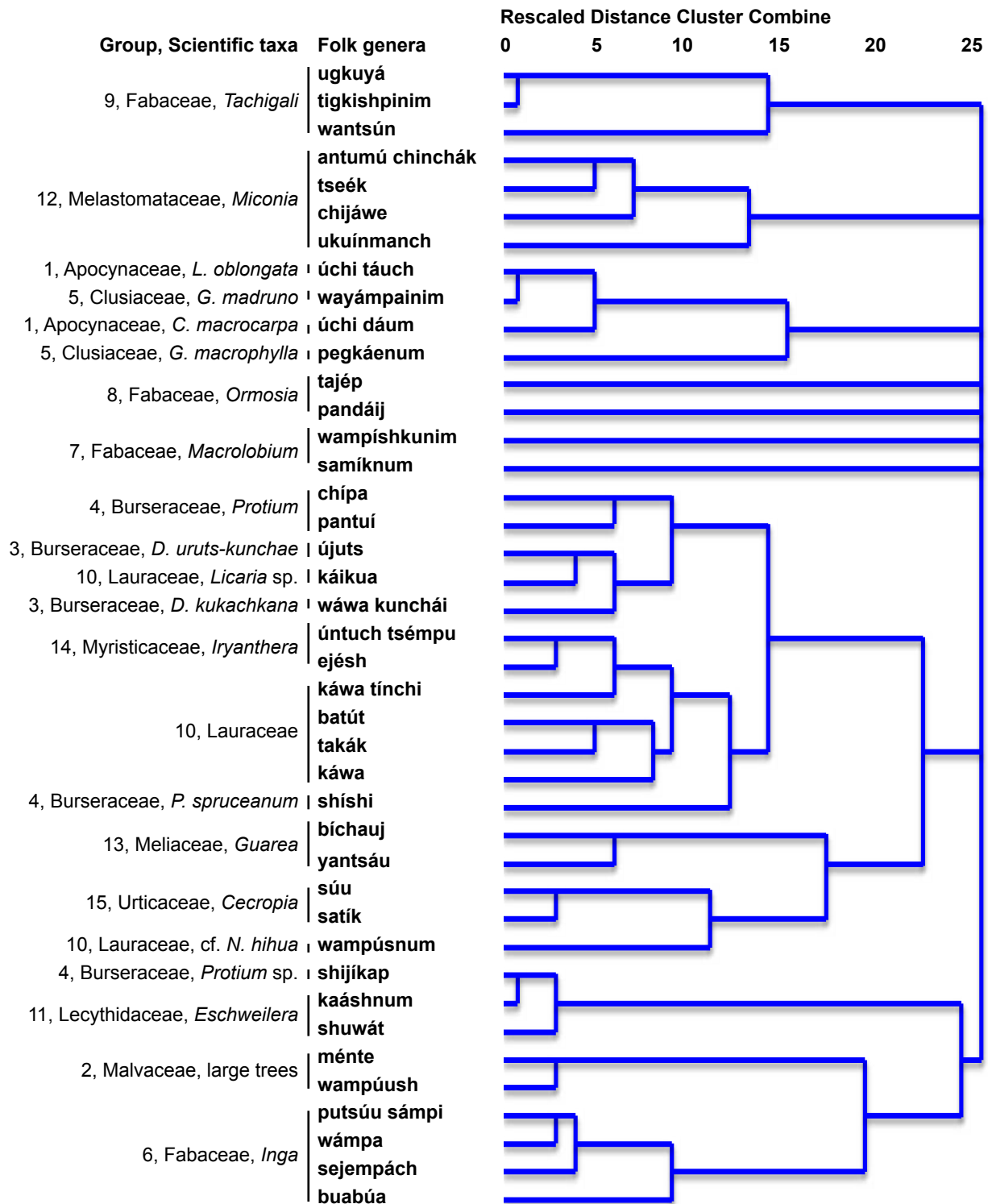
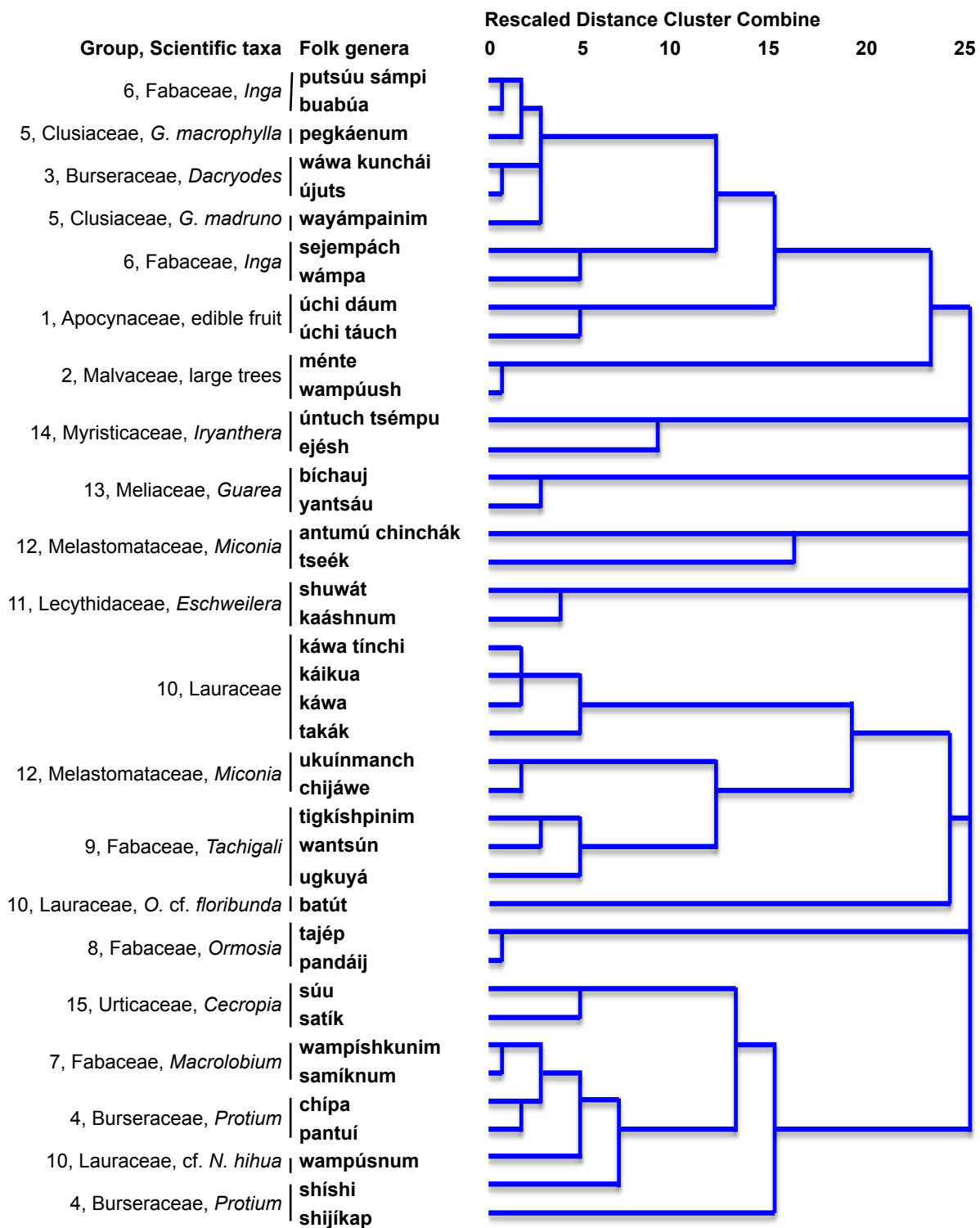


Figure 5. Dendrogram for hierarchical clustering of use characters of the 41 study trees in Amazonas, Peru. *G. macrophylla* = *Garcinia macrophylla* Mart.; *G. madruno* = *Garcinia madruno* (Kunth) Hammel; *N. hihua* = *Nectandra hihua* (Ruiz & Pav.) Rohwer; *O. cf. floribunda* = *Ocotea cf. floribunda* (Sw.) Mez



Discussion

Hierarchical clustering results

Sensory characters fully reproduced 11 of 15 (73%) of the original “companion” groups in the folk classification, while use characters reproduced ten (67%). The ecological analysis fared a bit worse, fully reconstructing only seven groupings (47%). One explanation for this last result is that participants did not mention any animal species associated with a few trees from the genera *Macrolobium* and *Ormosia* in the Fabaceae.

Reasons vary why certain “companion” groups were fully or partially unresolved under these analyses. For example, when ecological characters are considered, the Melastomataceae (group 12) hold together. Their fruit are all eaten by similar species of small birds such as tanagers and manakins. However, when usefulness is taken into account, the companions separate. Instead, there is a smaller grouping of the trees **ukuínmanch** (*Miconia lourteigiana* Wurdack) and **chijáwe** (*Miconia bubalina* Naudin), which have hard heartwood and serve as upright posts for house construction. The other members of this family lack those characters and cluster apart. To give another example, the Lauraceae (group 9) hold together based on the sensory analysis. They all possess a very characteristic aromatic odor in their leaves and bark. However, some Lauraceae fall off when looking at ecological characters. Since **wampúsnun** (cf. *Nectandra hihua* (Ruiz & Pav.) Rohwer) is found along the banks of rivers, participants said riverine birds such as icterids and tyrant flycatchers feed on its fruit. However, most Lauraceae are found on higher ground and therefore are associated with different birds. Only companion group 2 (genus *Protium*, Burseraceae) failed to resolve in any of the hierarchical clusters.

Twelve of the companion groups consist of trees in the same genus, while the remaining three are made up of trees in the same botanical family. One might expect to see a positive correlation between the taxonomic closeness of members of the companion groups and how well they were resolved under the hierarchical clustering. However, this does not appear to be the case. The three groups related only to the level of family (1, 9, and 11) are reproduced by an average of 2 out of the three clustering methods. The remaining groups representing a single biological genus are reproduced by an average of 1.9 out of the three methods. So taxonomic distance cannot explain any differences in how the companion groups are resolved.

Conclusions

Both use and sensory characters show similar potential in reproducing Aguaruna folk classification of trees. So the original hypothesis of this research is not supported. The

ability of use characters to reproduce a natural classification can be explained by noting that plant uses are often based on physical properties. These include some that are not readily observable at first glance that may provide information that could be helpful in making a natural classification. For example, Aguaruna use of the trees **yantsáu** (*Guarea guidonia* (L.) Sleumer) and **bíchauj** (*Guarea macrophylla* ssp. *pendulispica* (C.DC.) T.D.Penn.) in the Meliaceae to treat **shiip** – “watery diarrhea,” relying on the presence of secondary chemicals with antibiotic properties (Simoni *et al.* 1996). The use of resin from *Protium* species (Burseraceae) to make torches for illumination relies on the presence of flammable monoterpenes (Siani *et al.* 1999). Other uses of trees might reflect physical properties influencing durability and flammability of wood or the palatability and nutrition of fruit.

None of the character types were able to perfectly reproduce the folk classification. In the present hierarchical clustering analysis, all character states were given equal weight. However, academic taxonomists have found that not all characters are equally useful at a given level of taxonomic hierarchy (Stuessy 1990:33). Some characters tend to be more conservative over evolution than others. For example, within the mostly temperate genus *Quercus* (oaks), the character leaf shape is quite variable (see Brown & Kirkman 1990), but leaf arrangement is not, since all oaks have alternate leaves. Leaf shape, therefore, would be a useful feature for distinguishing between oak species, while leaf arrangement may be useful for distinguishing the genus *Quercus* from other genera. In fact, previously published evidence (Jernigan 2006a) hints that the Aguaruna may place greater emphasis on certain characters and less on others when deciding which tree folk genera are related as companions. When a small group of participants were asked to explicitly justify why they considered certain trees to be companions, the types of morphological characters they mentioned the most were: fruit color, sap color, fruit dehiscence, and bark odor. Future research would expand this line of questioning with regard to sensory, ecological, and use characters for the trees in question to test whether that would yield a hierarchical clustering result that is even closer to the Aguaruna folk classification.

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Appendix 1. Sensory characters of 41 study trees in Amazonas, Peru. Voucher evidence cited in Table 1.

Grouping of Aguaruna taxa	Scientific taxa	Most salient sensory characters
GROUP 1	APOCYNACEAE	
úchi dáum	<i>Couma macrocarpa</i> Barb.Rodr.	Tall tree; trunk dark colored, rough; copious, sticky white sap; leaves rounded; fruits large, yellow and round; reddish flowers.
úchi táuch	<i>Lacmellea oblongata</i> Markgr.	Short tree; trunk parted; copious, sticky, white sap; small, narrow leaves; clusters of round yellow sweet fruits; black seeds; white flowers.
GROUP 2	BURSERACEAE	
wáwa kunchái	<i>Dacryodes belemensis</i> Cuatrec.	A tall, thick tree; bark has aromatic odor; fruits oblong, black; flowers red.
újuts	<i>Dacryodes uruts-kunchae</i> Daly, M.C.Martínez & D.A.Neill	A small tree; trunk is grey; bark has aromatic odor; sap forms balls on the trunk; leaves small and rounded; fruits small, oblong, black.
GROUP 3	BURSERACEAE	
shijíkap	<i>Protium</i> sp.	A tall, thick tree with stilt roots; bark has aromatic odor; white sap forms balls on the trunk; leaves small; fruit round, dehiscent and white inside.
chípa	<i>Protium amazonicum</i> (Cuatrec.) Daly	A tall, straight tree; trunk is grey; bark has aromatic odor; leaves are long; the yellowish fruits are in clusters, break open, white inside.
pantuí	<i>Protium grandifolium</i> Engl.	A tall tree with stilt roots; bark has aromatic odor; leaves long, narrow and rounded; fruit round, breaks open, white inside.
shíshi	<i>Protium spruceanum</i> (Benth.) Engl.	Tree with stilt roots; trunk is grey; bark has aromatic odor; sap is white, sticky; leaves small, rounded; clusters of small round fruit that are dehiscent, white inside.
GROUP 4	CLUSIACEAE	
wáyámpainim	<i>Garcinia madruno</i> (Kunth) Hammel	A tall, straight tree; trunk is dark; sap is yellow; leaves small and rounded; fruit large, round, yellow.
pegkáenum	<i>Garcinia macrophylla</i> Mart.	A tall, thick tree, with dark trunk; sap is sticky and yellow; leaves long and narrow; fruit large, round, yellow; flowers reddish.
GROUP 5	FABACEAE	
putsúu sámpi	<i>Inga</i> sp.	A tall, straight tree; leaves small, narrow; fruit long, white and sweet inside; flowers white.
wámpa	<i>Inga edulis</i> Mart.	A medium sized tree; trunk is grey; leaves narrow, rounded, light when young; fruit is big, long, white and sweet inside; flowers white.
buabúa	<i>Inga</i> cf. <i>multinervis</i> T.D.Penn.	Short, thick tree; trunk grey; leaves long and wide; the long, wide, fruit is white and sweet inside; the seeds are large; flowers are white.
sejempách	<i>Inga semialata</i> (Vell.) C.Mart.	A medium sized tree; leaves are small, narrow, rounded; fruit long, white and sweet inside; flowers white.
GROUP 6	FABACEAE	
samíknum	<i>Macrobium acaciifolium</i> (Benth.) Benth.	A tall, straight tree; trunk grey and smooth; wood hard, heavy; leaves small; fruit is oblong flat and dehiscent; flowers white.

Grouping of Aguaruna taxa	Scientific taxa	Most salient sensory characters
wampíshkunim	<i>Macrobium limbatum</i> Benth.	A tall, straight tree; wood hard; leaves long, rounded; fruit is oblong, flat, dark and dehiscent; flowers white.
GROUP 7	FABACEAE	
pandáij	<i>Ormosia cf. amazonica</i> Ducke	A tall, thick, straight tree with buttressed roots; leaves oblong and slightly reddish on reverse; fruit in clusters, long, flat, brownish on outside and dehiscent; seeds red and black.
tajép	<i>Ormosia cf. coccinea</i> (Aubl.) Jacks.	A thick tree; trunk grey; leaves oblong and slightly reddish on reverse; fruit in clusters, long, brownish on outside and dehiscent; seeds red; flowers reddish.
GROUP 8	FABACEAE	
tigkíshpinim	<i>Tachigali</i> sp.	A thick, straight tree with buttressed roots; trunk yellowish and parted; leaves narrow and slightly yellowish; fruit long, flat, light colored and dehiscent; flowers whitish.
ugkuyá	<i>Tachigali formicarum</i> Harms	A tall, straight tree; trunk parted; leaves narrow; fruit long and light colored.
wantsún	<i>Tachigali cf. bracteosa</i> (Harms) Zarucchi & Pipoly	A tall, thick, straight tree with buttressed roots; leaves narrow and slightly yellowish; fruit long, flat, light colored and dehiscent.
GROUP 9	LAURACEAE	
káwa tínchi	<i>Nectandra olida</i> Rohwer	A tall, thick tree; bark has aromatic odor; wood yellowish inside; leaves small and rounded; fruit black when mature, with aromatic odor.
káikua	<i>Licaria</i> sp.	A tall tree; bark has aromatic odor and peels off; leaves small and narrow; fruit oblong, black when mature, with aromatic odor; flowers white.
wampúsnum	cf. <i>Nectandra hihua</i> (Ruiz & Pav.) Rohw	A short, thick tree with buttressed roots; trunk dark; bark has aromatic odor; leaves long; fruit small and black when mature, oblong, with aromatic odor; flowers white.
takák	<i>Ocotea gracilis</i> (Meisn.) Mez	A tall, straight tree with buttressed roots; trunk grey; bark has aromatic odor; wood yellowish inside; leaves long, narrow and slightly yellowish; oblong fruit is large, black when mature, with aromatic odor; flowers white.
batút	<i>Ocotea floribunda</i> (Sw.) Mez	A tall tree; trunk dark; bark has aromatic odor; leaves small and rounded; the round fruit is black when mature, has an aromatic odor; flowers white.
káwa	<i>Ocotea floribunda</i> (Sw.) Mez	A tall, thick, straight tree with buttressed roots; trunk dark and parted; bark has aromatic odor; wood yellowish inside; leaves small; fruit small, oblong and black when mature, with an aromatic odor; flowers white.
GROUP 10	LECYTHIDACEAE	
kaáshnum	<i>Eschweilera gigantea</i> (R.Knuth) J.F.MacBr.	A tall tree; trunk dark; bark rough; wood is hard; leaves narrow; fruit rounded, oblong, with operculate lid; flowers reddish white.
shuwát	<i>Eschweilera</i> sp.	A tall, thick tree with buttressed roots; bark rough; leaves narrow and rounded; fruit large, rounded and dehiscent; seeds wind dispersed; flowers reddish white.

Grouping of Aguaruna taxa	Scientific taxa	Most salient sensory characters
GROUP 11	MALVACEAE	
wampúush	<i>Ceiba pentandra</i> (L.) Gaertn.	A tall, thick tree with buttressed roots; thorny trunk, especially when young; leaves small and clustered; the large oblong fruit are dark on the outside, dehiscent with white cotton inside; seeds black; flower white.
ménte	not determined	A tall, thick tree with buttressed roots; thorny trunk, especially when young; leaves small and clustered; the large oblong fruit are yellowish on the outside, dehiscent and white inside; flower white or red.
GROUP 12	MELASTOMATACEAE	
tseék	<i>Miconia ternatifolia</i> Triana	A small tree; trunk grey; leaves long, narrow and rounded; has clusters of small, black fruit; flowers white.
ukuínmanch	<i>Miconia lourteigiana</i> Wurdack	A small, straight tree; trunk grey and parted; wood is hard; leaves narrow, reddish on the back; has clusters of small, black fruit.
antumú chinchák	<i>Miconia</i> sp.	A small tree; leaves rounded and reddish on the back; clusters of black fruit; flowers white.
chijáwe	<i>Miconia bubalina</i> (D.Don) Naudin	A small, straight tree; trunk parted; wood is hard; leaves narrow, rounded and reddish on the back; clusters of small black, round fruit; flowers white.
GROUP 13	MELIACEAE	
yantsáu	<i>Guarea guidonia</i> (L.) Sleumer	A thick tree with buttressed roots; trunk parted; bark has aromatic odor; leaves narrow and long; clusters of oblong, red, dehiscent fruits that are white inside; seeds red; flowers white.
bíchauj	<i>Guarea macrophylla</i> ssp. <i>pendulispica</i> (C.DC.) T.D.Penn.	A short tree; trunk dark; bark has aromatic odor; clusters of oblong, red, dehiscent fruits; seeds red; flowers white.
GROUP 14	MYRISTICACEAE	
ejésh	<i>Iryanthera tricornis</i> Ducke	A tall, thick, straight tree; trunk parted; sap light, reddish; leaves narrow; fruit oblong, dehiscent and red inside.
úntuch tsémpu	<i>Iryanthera juruensis</i> Warb.	A tall, thick, straight tree; trunk rough; sap sticky and red; leaves long and narrow; fruit oblong, dehiscent, red inside and cauliflorous.
GROUP 15	URTICACEAE	
satík	<i>Cecropia membranacea</i> Trécul	Has stilt roots; trunk grey; leaves wide, palmate, with long petiole; clusters of long, yellowish fruit.
súu	<i>Cecropia engleriana</i> Sneathl.	A tall tree with stilt roots; trunk grey; leaves wide, palmate with long, thick petiole; clusters of long, yellowish fruit.

Appendix 2. Ecological characters of 41 study trees in Amazonas, Peru. Voucher evidence cited in Table 1.

Grouping of Aguaruna taxa	Scientific taxa	Animal associations
GROUP 1	APOCYNACEAE	
úchi dáum	<i>Couma macrocarpa</i> Barb.Rodr.	monkeys, rodents, peccaries, deer, tapirs, kinkajou
úchi táuch	<i>Lacmellea oblongata</i> Markgr.	monkeys, rodents, peccaries, deer, kinkajou
GROUP 2	BURSERACEAE	
wáwa kunchái	<i>Dacryodes belemensis</i> Cuatrec.	toucans, cotingas, oilbird, parrots, tinamous, cracids, peccaries, tapirs, rodents, bears, deer
újuts	<i>Dacryodes uruts-kunchnae</i> Daly, M.C.Martínez & D.A.Neill	toucans, cotingas, oilbird, parrots, tinamous, cracids, peccaries, tapirs, rodents, bears
GROUP 3	BURSERACEAE	
shijíkap	<i>Protium</i> sp.	parrots, rodents
chípa	<i>Protium amazonicum</i> (Cuatrec.) Daly	toucans, cotingas, parrots, tinamous, doves, barbets, peccaries, rodents
pantuí	<i>Protium grandifolium</i> Engl.	toucans, cotingas, parrots, cracids, doves, thrushes, barbets, icterids peccaries, rodents
shíshi	<i>Protium spruceanum</i> (Benth.) Engl.	toucans, oilbird, tinamous, rodents
GROUP 4	CLUSIACEAE	
wayámpainim	<i>Garcinia madruno</i> (Kunth) Hammel	monkeys, kinkajou, deer
pegkáenum	<i>Garcinia macrophylla</i> Mart.	parrots, tanagers, thrushes, barbets, manakins, icterids, rodents, monkeys, kinkajou
GROUP 5	FABACEAE	
putsúu sámpi	<i>Inga</i> sp.	toucans, parrots, tinamous, cracids, doves, icterids, deer, peccaries, rodents, monkeys, kinkajou
wámpa	<i>Inga edulis</i> Mart.	toucans, parrots, tanagers, icterids, peccaries, rodents, monkeys, kinkajou
buabúa	<i>Inga</i> cf. <i>multinervis</i> T.D.Penn.	parrots, tinamous, peccaries, rodents, monkeys, kinkajou, deer
sejempách	<i>Inga semialata</i> (Vell.) C.Mart.	toucans, parrots, tinamous, cracids, doves, icterids, peccaries, rodents, monkeys, kinkajou, deer
GROUP 6	FABACEAE	
samíknum	<i>Macrolobium acaciifolium</i> (Benth.) Benth.	none
wampíshkunim	<i>Macrolobium limbatum</i> Benth.	none
GROUP 7	FABACEAE	
pandáij	<i>Ormosia</i> cf. <i>amazonica</i> Ducke	none
tajép	<i>Ormosia</i> cf. <i>coccinea</i> (Aubl.) Jacks.	tinamous
GROUP 8	FABACEAE	
tigkíshpinim	<i>Tachigali</i> sp.	ants
ugkuyá	<i>Tachigali formicarum</i> Harms	ants
wantsún	<i>Tachigali</i> cf. <i>bracteosa</i> (Harms) Zarucchi & Pipoly	ants, chiachia (unidentified insect sp.)
GROUP 9	LAURACEAE	
káwa tíncchi	<i>Nectandra olida</i> Rohwer	cotingas, oilbird, parrots, tinamous, cracids, doves, manakins, barbets, icterids, peccaries, rodents

Grouping of Aguaruna taxa	Scientific taxa	Animal associations
káikua	<i>Licaria</i> sp.	cotingas, oilbird, parrots, tinamous, cracids, doves, barbets, thrushes, peccaries, rodents, deer
wampúsnum	cf. <i>Nectandra hihua</i> (Ruiz & Pav.) Rohw	cotingas, oilbird, tinamous, cracids, doves, tanagers, saltators, tyrant flycatchers, thrushes, barbets, icterids
takák	<i>Ocotea gracilis</i> (Meisn.) Mez	cotingas, oilbird, tinamous, cracids, peccaries, rodents, ants
batút	<i>Ocotea floribunda</i> (Sw.) Mez	cotingas, oilbird, parrots, tinamous, cracids, doves, peccaries, rodents, bears, deer
káwa	<i>Ocotea floribunda</i> (Sw.) Mez	cotingas, oilbird, parrots, tinamous, cracids, doves, peccaries, rodents, deer
GROUP 10	LECYTHIDACEAE	
kaáshnum	<i>Eschweilera gigantea</i> (R.Knuth) J.F.MacBr.	parrots, rodents, deer
shuwát	<i>Eschweilera</i> sp.	parrots, tapirs, rodents, deer
GROUP 11	MALVACEAE	
wampúush	<i>Ceiba pentandra</i> (L.) Gaertn.	parrots
ménte	not determined	parrots, tinamous
GROUP 12	MELASTOMATACEAE	
tseék	<i>Miconia ternatifolia</i> Triana	toucans, cotingas, tinamous, cracids, tanagers, saltators, tyrant flycatchers, thrushes, manakins, barbets, icterids
ukuínmanch	<i>Miconia lourteigiana</i> Wurdack	doves, tanagers, manakins, monkeys
antumú chinchák	<i>Miconia</i> sp.	toucans, cotingas, parrots, tinamous, cracids, tanagers, saltators, tyrant flycatchers, thrushes, manakins, barbets, icterids
chijáwe	<i>Miconia bubalina</i> (D.Don) Naudin	toucans, cotingas, cracids, tanagers, thrushes, manakins, barbets, icterids
GROUP 13	MELIACEAE	
yantsáu	<i>Guarea guidonia</i> (L.) Sleumer	toucans, tinamous, cracids, tanagers, saltators, tyrant flycatchers, thrushes, manakins, barbets, icterids
bíchauj	<i>Guarea macrophylla</i> ssp. <i>pendulispica</i> (C.DC.) T.D.Penn.	toucans, parrots, tinamous, cracids, tanagers, saltators, tyrant flycatchers, thrushes, barbets, icterids, rodents
GROUP 14	MYRISTICACEAE	
ejésh	<i>Iryanthera tricornis</i> Ducke	toucans, cotingas, oilbird, tinamous, barbets, peccaries, tapirs, rodents, deer
úntuch tsémpu	<i>Iryanthera juruensis</i> Warb.	toucans, cotingas, parrots, tinamous, cracids, peccaries, rodents, deer
GROUP 15	URTICACEAE	
satík	<i>Cecropia membranacea</i> Trécul	toucans, parrots, tanagers, tyrant flycatchers, barbets, icterids, kinkajou, monkeys, ants
súu	<i>Cecropia engleriana</i> Sneathl.	toucans, parrots, tanagers, tyrant flycatchers, thrushes, barbets, icterids, kinkajou, ants

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Appendix 3. Use characters of 41 study trees in Amazonas, Peru. Voucher evidence cited in Table 1.

Grouping of Aguaruna taxa	Scientific taxa	Uses
GROUP 1	APOCYNACEAE	
úchi dáum	<i>Couma macrocarpa</i> Barb.Rodr.	Fruit and sap edible; sap used as pitch for waterproofing baskets, caulking canoes, firewood, treating the illnesses shíip, diarrhea, dysentery and hepatitis as well as for making rubber and decorating pottery
úchi táuch	<i>Lacmellea oblongata</i> Markgr.	Fruit edible; sap used as pitch for caulking canoes, treating the illness shíip and decorating pottery; wood serves for firewood.
GROUP 2	BURSERACEAE	
wáwa kunchái	<i>Dacryodes belemensis</i> Cuatrec.	Fruit edible; sap burned for illumination.
újuts	<i>Dacryodes uruts-kunchae</i> Daly, M.C.Martínez & D.A.Neill	Fruit edible; sap burned for illumination.
GROUP 3	BURSERACEAE	
shijikap	<i>Protium</i> sp.	Wood used for firewood and to treat scorpion and stingray stings; sap burned for illumination and for making tattoos.
chípa	<i>Protium amazonicum</i> (Cuatrec.) Daly	Wood used in house construction, firewood, sap used for decorating pottery.
pantuí	<i>Protium grandifolium</i> Engl.	Wood used in house construction, firewood, sap burned for illumination.
shishi	<i>Protium spruceanum</i> (Benth.) Engl.	Wood used in house construction, firewood, necklaces (seeds), sap burned for illumination.
GROUP 4	CLUSIACEAE	
wayápainim	<i>Garcinia madruno</i> (Kunth) Hammel	Fruit edible; sap used for decorating pottery.
pegkáenum	<i>Garcinia macrophylla</i> Mart.	Fruit edible; sap used to treat sores.
GROUP 5	FABACEAE	
putsúu sámpi	<i>Inga</i> sp.	Fruit edible; wood used for firewood.
wámpa	<i>Inga edulis</i> Mart.	Fruit edible; wood used for firewood; sap used to treat stomach aches and flu.
buabúa	<i>Inga</i> cf. <i>multinervis</i> T.D.Penn.	Fruit edible; wood used for firewood.
sejempách	<i>Inga semialata</i> (Vell.) C.Mart.	Fruit edible; wood used for firewood.
GROUP 6	FABACEAE	
samíknum	<i>Macrobium acaciifolium</i> (Benth.) Benth.	Wood used for house construction, firewood; bark used to help babies learn to walk.
wampíshkunim	<i>Macrobium limbatum</i> Benth.	Wood used for house construction and for firewood.
GROUP 7	FABACEAE	
pandáij	<i>Ormosia</i> cf. <i>amazonica</i> Ducke	Bark used to treat illnesses: iyágbau , jágku , and úgku ; seeds used to make necklaces.
tajép	<i>Ormosia</i> cf. <i>coccinea</i> (Aubl.) Jacks.	Bark used to treat illnesses: iyágbau , jágku , and úgku ; seeds used to make necklaces.
GROUP 8	FABACEAE	
tigkishpinim	<i>Tachigali</i> sp.	Wood used in construction of canoes and houses.
ugkuyá	<i>Tachigali formicarum</i> Harms	Wood used in construction of houses and also used to treat impotence.

Grouping of Aguaruna taxa	Scientific taxa	Uses
wantsún	<i>Tachigali cf. bracteosa</i> (Harms) Zarucchi & Pipoly	Wood used in construction of canoes and houses.
GROUP 9	LAURACEAE	
káwa tínchi	<i>Nectandra olida</i> Rohwer	Wood cut for lumber, making canoes and used in house construction.
káikua	<i>Licaria</i> sp.	Wood cut for lumber, making canoes, seats and in house construction.
wampúsnum	cf. <i>Nectandra hihua</i> (Ruiz & Pav.) Rohw	Wood used in house construction and for firewood.
takák	<i>Ocotea gracilis</i> (Meisn.) Mez	Wood cut for lumber, making canoes and in house construction.
batút	<i>Ocotea floribunda</i> (Sw.) Mez	Wood used in house construction; the fruit is used to treat jágku and anemia and also as perfume and as a charm against illness.
káwa	<i>Ocotea floribunda</i> (Sw.) Mez	Wood cut for lumber, making canoes and in house construction.
GROUP 10	LECYTHIDACEAE	
kaáshnum	<i>Eschweilera gigantea</i> (R.Knuth) J.F.MacBr.	The bark is used to make basket handles; wood used for firewood.
shuwát	<i>Eschweilera</i> sp.	The wood is used to make doors and is cut for lumber; the bark is used to make basket handles.
GROUP 11	MALVACEAE	
wampúush	<i>Ceiba pentandra</i> (L.) Gaertn.	Wood used for lumber; cotton used for dart fletching; seeds used in necklaces and to help children hunt birds better.
ménte	not determined	Wood used for lumber; cotton used for dart fletching; seeds used to help children hunt birds better.
GROUP 12	MELASTOMATACEAE	
tseék	<i>Miconia ternatifolia</i> Triana	The wood is used to make beds; the fibrous bark serves to make dog leashes; leaves used to dye clothing and paint ceramics.
ukuínmanch	<i>Miconia lourteigiana</i> Wurdack	The wood is used for house construction.
antumú chinchák	<i>Miconia</i> sp.	The wood is used to make beds.
chijáwe	<i>Miconia bubalina</i> (D.Don) Naudin	The wood is used for house construction.
GROUP 13	MELIACEAE	
yantsáu	<i>Guarea guidonia</i> (L.) Sleumer	The wood is used to make canoes, in house construction and for lumber; the bark treats shíip .
bíchauj	<i>Guarea macrophylla</i> ssp. <i>pendulispica</i> (C.DC.) T.D.Penn.	The bark treats shíip .
GROUP 14	MYRISTICACEAE	
ejésh	<i>Iryanthera tricornis</i> Ducke	The sap is used to treat skin sores.
úntuch tsémpu	<i>Iryanthera juruensis</i> Warb.	The wood is used in house construction, to make axe handles and for firewood; the sap is used to treat skin sores and the illness yunchít .

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Grouping of Aguaruna taxa	Scientific taxa	Uses
GROUP 15	URTICACEAE	
satík	<i>Cecropia membranacea</i> Trécul	Wood used for firewood; the sap is used to treat hepatitis and anemia.
súu	<i>Cecropia engleriana</i> Snethl.	Wood used for firewood; the sap is used to treat stomach ache, hepatitis and anemia; leaves and bark used to treat stingray sting.

