Fruit dispersal syndromes in animal disseminated plants at Tinigua National Park, Colombia

Síndromes de dispersión en plantas dispersadas por animales en el Parque Nacional Tinigua, Colombia

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ABSTRACT

Fruit dispersal syndromes (groups of plants with similar fruit morphology, presumably adapted to dispersal by a particular set of vectors) have been described in a variety of tropical localities. In some cases the presence of different syndromes in each locality suggests independent evolution of fruit traits in response to selective pressures imposed by the particular animal community in each place. However, it is still unclear how general are fruit syndromes, and this is important to understand the evolution of mutualistic relationships. We compiled morphological information from about 500 fleshy fruited species at a lowland Neotropical forest in Tinigua National Park, Colombia, in an effort to test for the existence of fruit dispersal syndromes. We found that about two thirds of the plant genera analyzed could be classified in two different fruit types (large, protected, dull colored fruits, versus small, unprotected, bright colored fruits). These two syndromes correspond to the mammal and bird dispersal syndromes originally described at Cocha Cashu Biological Station, Peru. Two years of field observations on several fruiting plants revealed close associations between these fruit syndromes and the presumed animal dispersal vector. Our results support the idea that fruit dispersal syndromes are more general in Neotropical forests than previously inferred. However, we caution that similar syndromes found at Cocha Cashu and Tinigua may be a consequence of the floristic resemblance of both regions, and may not necessarily imply an independent case for the evolution of mammal and bird dispersal syndromes. Therefore, additional studies of fruit syndromes and biogeographical analyses would be necessary to assess how general are dispersal syndromes in the Neotropics.

Key words: fruit syndromes, fruit morphology, Neotropical forests, convergent evolution, frugivory.

RESUMEN

Los síndromes de dispersión de frutos han sido descritos para diferentes bosques tropicales. En algunos casos la presencia de diferentes síndromes de dispersión sugiere la evolución independiente de características morfológicas de los frutos como respuesta a presiones de selección particulares. Sin embargo, hasta el momento hay evidencias contrastantes sobre qué tan generales son estos síndromes. Este estudio reúne la información morfológica de aproximadamente 500 especies de plantas con frutos carnosos, en el Parque Nacional Tinigua, Colombia, en un esfuerzo por encontrar síndromes de dispersión de semillas. Alrededor de dos tercios de los géneros de plantas analizados se pueden agrupar en dos categorías: (frutos grandes, con protección y colores opacos; y frutos pequeños, sin protección y de colores llamativos), que corresponden a los síndromes de dispersión por mamíferos y aves descritos por Janson (1983) en Cocha Cashu, Perú. Nuestros resultados apoyan la idea que los síndromes de dispersión endozooócrlica son más generalizados de lo que se había planteado anteriormente. Consideramos que la similitud en los resultados obtenidos en este estudio y en el Perú no necesariamente implica evolución independiente de los síndromes de dispersión, porque las floras de estos lugares son bastante similares. Por lo tanto, más estudios de este tipo son necesarios para entender mejor qué tan generales son los síndromes de dispersión en bosques Neotropicales.

Palabras clave: síndromes de dispersión, morfología de frutos, bosques Neotropicales, evolución convergente, frugivoria.
INTRODUCTION

The process of seed dispersal by frugivores is a common interaction in almost every ecosystem and involves a large number of animal and plant species (Ridley 1930, Pijl 1972). For example, Neotropical rainforests animals disperse seeds of 50% to 90% of the plant species (Gentry 1988, Chapman 1995, Voss & Emmons 1996). The close ecological relationships that exist among some plant and animal species suggest that they have been subject to mutual selective pressures in the past (Janzen 1983). However, no specialized relationships, as required for species-to-species coevolution (Thompson 1994), have been convincingly documented in seed dispersal systems (Witmer & Cheke 1991).

Recent studies suggest that there are constraints on the evolution of fruit morphology (Howe 1984, Herrera 1985, 1986, Wheelwright 1988), and that dispersal systems have evolved mainly by diffuse coevolutionary processes (Janson 1983, Janzen 1983, Herrera 1985). First of all, different selective forces may act in every stage of a plant’s life cycle (Schupp 1995) and this complex web of potential forces may limit co-evolutionary trends between plants and frugivores. Furthermore, other studies have shown that fruit shape could be associated with phyllogenetic inertia and developmental constraints (Jordano 1995). Finally, some authors emphasize low heritability for the evolution of fruit traits (i.e., Obeso 1993). Consequently, diffuse coevolution is now considered as the main process affecting seed dispersal systems. This type of evolution might have produced different dispersal syndromes or associated morphological traits that could have evolved independently as adaptations for a particular seed disperser agent (Pijl 1972, Janson 1983).

Dispersal syndromes have been defined for groups of plant species with similar seed dispersal strategies, and the most general strategies involve completely different dispersal agents (Ridley 1930, Pijl 1972). For example, in a Peruvian rainforest, Janson (1983) found associations among three morphological fruit characters: size, color, and protection. Two-thirds of the fruits had one of two character complexes matching the morphological characteristics of mammals and birds. In particular, large, dull colored fruits (orange, yellow, brown or green) with a husk, were associated with primate dispersal, while small, bright colored fruits (red, black, white, blue, purple, or with mixed colors), without a husk, seemed suitable for bird dispersal. However, the generality of these two dispersal syndromes for tropical forests remains to be demonstrated.

Gauthier-Hion et al. (1984) found one syndrome for bird and primate fruits in an African forest and a second syndrome for seed dispersal by other mammal species. Fruits dispersed by birds and primates were associated with no pre-dispersal predation; yellow, orange, red or violet colors; less than 50 g, and succulent arils with soft or no protection. In contrast, fruits dispersed by ungulates, rodents, and elephants had pre-dispersal predation; green or brown colors; more than 50 g; fibrous or dry pulp and strong protection. Although, their results differ from Janson’s, they support the idea of a syndrome generated by interaction with frugivores that do not occur in the Neotropics. Fisher & Chapman (1993) compiled data on fruit dispersal syndromes from five different tropical sites and found few fruit character associations (i.e., between color and protection). They also found that the flora of New Guinea has a good representation of large, protected fruits, which elsewhere have been associated with primate dispersal, despite the lack of evidence of primate occupation of the island in the past. It is known that the largest fruits in New Guinea are consumed by cassowaries, hornbills, and flying foxes1, but without knowledge of their dispersal efficiency, it is difficult to predict which fruit syndromes might have evolved in the island and to validate New Guinea’s data as evidence of uncoupled diffuse coevolutionary paths. Interestingly, in a different region with a reduced number of seed dispersers, a particular mistletoe species in the Loranthaceae (a family characterized by colorful fruits dispersed by birds) has green fruits and is exclusively dispersed by a marsupial (Amico & Aizen 2000). This study again suggests that different fruit syndromes might evolve in response to particular dispersal agents.

Fruit syndromes have been analyzed using a variety of methods (i.e., Knight & Siegfried 1983, Dowsett-Lemaire 1986), which is an additional problem to assess how widespread are they. For example, Fisher & Chapman (1993), excluded fruits with mixed colors from their analyses and these methodological differences might explain some contrasts found among fruits with similar morphological characteristics.

when comparing fruit syndromes among tropical sites.

The main purpose of this work was to assess dispersal syndromes in the flora of Tinigua National Park, Colombia. Furthermore, we wanted to verify whether fruits classified in a particular morphological syndrome were actually visited preferentially by the same group of seed dispersers predicted to be associated with the syndrome. Although our results documented two main dispersal syndromes coincident with Janson (1983), we suggest that further studies are necessary to evaluate the general occurrence of these dispersal syndromes in Neotropical forests.

**MATERIAL AND METHODS**

**Study area**

This study was conducted at the CIEM (Centro de Investigaciones Ecológicas Macarena), a tropical rain forest in the northwestern Amazon, between the eastern Andes and Sierra de la Macarena, in the Departamento del Meta, Colombia. The CIEM is located on the right margin of Río Duda (2º 40’ N, 74º 10’ W; 350-400 m of altitude) about 13 km before it reaches the Río Guayabero, and it is part of Parque Nacional Tinigua (Stevenson et al. 1994). Mean annual temperature is around 26 ºC, and is relatively constant throughout the year. Precipitation varies between 2,600-2,800 mm annually, with a dry season between December and March and a rainy season between April and November; peak rainfall occurs in June and July (Kimura et al. 1995, Stevenson 2002). There are six basic vegetation types: mature terra firme forest, open canopy terra firme forest, two types of lowland seasonally flooded forest, secondary forest and riparian forest (Hirabuki 1990, Stevenson 2002).

A total of 445 bird species have been recorded at CIEM (Cadena et al. 2000). Many are frugivorous or eat fruits as part of their diet. Curassows, toucans, trogons, parrots, tanagers, manakins, woodpeckers, thrushes and other birds eat fruit regularly. There are seven primate species at the study site: Ateles belzebuth, Lagothrix lagotricha, Alouatta seniculus, Cebus apella, Saimiri sciureus, Callicebus cupreus and Aotus brumbacki (see Stevenson 2002). All of them eat fruits as part of their diets. There are several other fruit-eating mammals at the CIEM including tayras (Eira barbara), tapirs (Tapirus terrestris) and some of the 34 bat species reported at the site (Rojas 1997).

**Field protocols**

We classified fleshy fruits into bird and mammal-dispersed classes following Janson (1983). We selected the plants collected at the CIEM (Stevenson et al. 2000, Stevenson unpublished data) that have fleshy fruits, or can potentially offer a food source to frugivores. Morphological information was taken mainly from the fruit guide of the study site (Stevenson et al. 2000). We made additional fruit measurements in the field during the study period (November 1999-July 2001), and used information from a guide to the fruits of Guyana (Roosmalen 1985). For each plant species with fleshy fruits we recorded its fruit size, color, and protection. Fruit size was either small or large. Fruit size was considered as the smaller dimension between its width and length. Large fruits are those that have a larger dimension than the average fruit size of all the plant species in this study. For capsular fruits, because the capsule is not manipulated by frugivores, we only considered the size of the seeds and fleshy pulp.

We considered the following color categories: red, white, black, blue/purple, green, yellow, brown, orange and mixed colors. A mixed color fruit has at least two different colors when ripe, including its supporting structures. The third morphological character was the presence or absence of protection. Protected fruits were those that presented a distinct hard, non-nutritious layer as a barrier to feeding. Fruits with a soft, flexible skin covering at least 10 % of the external fruit dimension were also considered protected. Otherwise fruits were considered unprotected.

Some studies of the evolution seed dispersal and fruit morphology often focused on the species level, without considering its consequences (see Fischer & Chapman 1993). This may overestimate the number of evolutionary events that led from an ancestral to a derived character (Lord et al. 1995), because phylogenetically related species are not independent unities (Harvey & Pagel 1991). In our study, we used genera as the taxonomic unit to determine the existence of associations between fruit characters (Janson 1983, 1992). We distinguished monomorphic genera (those with only one combination of fruit characters) from polymorphic ones. Each monomorphic genus was considered a basic morphological unit (BMU), and each set of species within a polymorphic genus sharing the same fruit characters was also considered a BMU.
For monomorphic genera, we calculated the percentage of protected genera in each fruit color category. We tested heterogeneity and subset homogeneity (Sokal & Rohlf 1995) to group different color fruits according to their percentage of protection. Afterwards, we tested heterogeneity within each of the subgroups or types obtained. Polymorphic genera were assigned to color groups derived from monomorphic genera analysis. A $\chi^2$ test was used to determine association between fruit color and protection.

Color categories were the following: type A, low percentage of protection and bright colors (white, red, blue, black and mixed colors), and type B, high percentage of protected genera and dull colors (orange, green, yellow and brown). We used a Kolmogorov-Smirnov test to assess differences in fruit size between type A (n = 300) and type B (n = 191) fruits. We performed this test at the species level, because fruit size varies considerably between polymorphic and monomorphic genera.

All genera were classified dichotomously by size, color and protection which yielded eight possible combinations. We used a G-test of independence (Sokal & Rohlf 1995) to determine associations among fruit traits.

For the BMU having character complexes associated with fruit dispersal by mammals (large, type B color and protected) or birds (small, type A color and unprotected) (Pijl 1972, Janson 1983), we obtained information on visits by frugivores. This information was gathered from previous studies at the CIEM, especially for primates and birds (see Stevenson et al. 2000 and references therein). Observations on more than 75 plant species for more than 3,438 h were carried out to corroborate whether species with a particular syndrome were actually visited by the predicted seed dispersal vector. These observations were conducted mostly between 06:00 and 10:00 h and between 15:00 and 18:00, from a point of good visibility on the ground. Seed removal by nocturnal animals was checked only indirectly (using fruit traps) for a smaller set of plant species (n = 5).

**RESULTS**

We examined 491 plant species, corresponding to 80% of the fleshy-fruited plants found at the study site. Fruit characters are described in Appendix 1. We found an association between fruit protection and color (Fig. 1). We found heterogeneity in the percentage of protected monomorphic genera (n = 197) in each color category ($\chi^2_{(8)} = 51.5$, $P < 0.001$), but subgroups within each type were homogeneous [type A: $(\chi^2_{(4)} = 4.30$, $P > 0.05$; type B: $\chi^2_{(3)} = 3.93$, $P > 0.05$)]. Type A and type B color fruits showed differences in the proportion of protected genera ($G_H = 49.4$, $P < 0.001$). Because of the small number of polymorphic genera, we grouped them in type A and type B colors. Fifteen out of the 40 polymorphic genera were grouped in one color category. Of the remaining 25 polymorphic genera, 23 varied in color and two in protection. No genus varied in both traits. From the 23 polymorphic genera, five out of eight protected BMUs are of type B color and 22 out of the 53 unprotected BMUs are of type B color, yielding no statistical association ($\chi^2_{(1)} = 0.53$, $P > 0.05$). In the two genera that vary in protection, one of two protected BMU are type B color ($\chi^2_{(1)} = 0$, $P > 0.05$) and have no significant association between color and protection.

**Fig. 1:** Percentage of protected and unprotected fruits by different color categories in the flora of Parque Nacional Tinigua, Colombia. The number of monomorphic genera is shown in parenthesis.

Porcentaje de frutos protegidos y sin protección en las diferentes categorías de color, en la flora del Parque Nacional Tinigua, Colombia. Los números en paréntesis corresponden al número de géneros monomórficos.
We found differences in the size distribution between type A and type B fruits (Kolmogorov-Smirnov test $D = 0.507$, $n = 491$, $P < 0.001$) (Fig. 2). Average fruit size was 17.3 mm (range 1-200 mm, $n = 491$). Average size of type A fruits was 11.4 mm on average ($n = 300$), with 87% of them smaller than the average size of all the fruits analyzed, while type B were 27.2 mm on average ($n = 191$) and 62% were larger than the overall average. Almost 65% of all BMUs ($n = 299$) analyzed here belonged either to large, type B and protected or small, type A and unprotected fruits (Table 1). These two character complexes corresponded closely to the fruit morphology of primates and bird dispersal syndromes (Pijl 1972, Janson 1983). The hypothesis of independence between fruit traits was rejected for the three fruit traits considered in this study ($G(4) = 165.5$, $P < 0.001$) and for each combination any two characters: color and protection ($G(1) = 53.4$, $P < 0.001$); color and size ($G(1) = 70.1$, $P < 0.001$); size and protection ($G(1) = 80.6$, $P < 0.001$).

Out of 299 BMUs, 193 have fruit character complexes associated with either bird ($n = 150$) or primate dispersal ($n = 43$). We observed birds (excluding parrots) eating fruits of 84 BMUs; 76 of them corresponding to type A fruits. Primates were observed eating 83 BMUs; 53 of them corresponding to type B fruits. There was a significant association between the type of disperser (bird or primate) and fruit morphology (Aves: $\chi^2(1) = 7.2$, $P < 0.05$; Primates: $\chi^2(1) = 8.4$, $P < 0.05$).

![Fig. 2: Fruit size distribution for type A (non-protected and with bright colors) and type B fruits (protected and with dull colors) at Tinigua National Park. The dashed line represents type A fruits and the continuous line represents type B fruits.](image)

Distribución del tamaño de los frutos de tipo A (sin protección y con colores vistosos) y tipo B (protegidos y con colores opacos) en el Parque Tinigua. La línea punteada corresponde a los frutos de tipo A, mientras que la línea continua corresponde a los frutos de tipo B.
**DISCUSSION**

The main result of this study at Tinigua is that fruit traits such as color, size, and protection are associated with the previously described bird and mammal dispersal syndromes (Ridley 1930, Pijl 1972, Janson 1983). Further, this relationship partly agrees with the use of fruits by the corresponding frugivore vectors. We found that very few bird species (some parrots, curassows, corvids and icterids) consume fruits with the primate dispersal syndrome as the size and protection of these fruits acts as a barrier to access its pulp and seeds. Nevertheless, monkeys frequently consumed fruits with the bird syndrome, and for no plant species did we find good evidence of relying on only one frugivore species for its fruit removal and dispersal. The complex web of interactions between frugivores and plants, including interactions between phylogenetically unrelated taxa do not fit the models of species-to-species coevolutionary process (Thompson 1994). Therefore, diffuse coevolution seems the most likely path for the evolution of these systems, although other non-evolutionary fortuitous events may also have a place. For example, under certain circumstances plant-frugivore interactions can be ecologically strong in spite of the lack of evolutionary history. In particular, the artificial introduction of plant species to new habitats has revealed that local frugivores are able to consume fruits never seen before, resulting in strong plant-animal interactions without evolutionary history (Herrera 1985). Thus, in the absence of a fossil record that could confirm strong interactions in the past, we are limited to describing the products of evolution and speculating about their potential origins.

Reciprocal evolution between birds and type A fruits seem to be more difficult than that between primates and type B fruits. Because of morphological constraints, many birds in Neotropical rainforests are unable to eat fruits that are either large or have a husk (Wheelwright 1985, Peres & Roosmalen 2002). Only few guilds (i.e., parrots, crows, and icterids) have the ability to manipulate fruits with their feet, breaking up the fruit’s husk rather than swallowing the whole fruit. Thus, if the seeds are more efficiently dispersed by primates than by birds, it is likely that plants could evolve husks to limit bird access to the fruit pulp. On the other hand, primates do not have morphological limitations to exploit the majority of fruits in the forest and this seems to be the reason why they exploit both type A fruits and type B fruits. Therefore, even if primates are not very efficient dispersers compared to birds, it would be difficult for plants to evolve morphological adaptations to limit the access of primates. It is possible that plants have used other means to deter fruit consumption by primates, such as chemical composition of fruits. For example, it is known that some families (i.e., Solanaceae) that are predominantly dispersed by bats and birds contain high quantities of secondary compounds in the pulp (Chipollini & Levey 1997b). One of the hypotheses to explain the presence of these compounds in the pulp of fruits is the selection of particular seed dispersal agents (Chipollini & Levey 1997a), and we believe that the inclusion of nutritional analyses could reveal additional fruit dispersal syndromes.

**TABLE 1**

Distribution of BMUs (morphological basic units) into eight possible combinations of three fruit characters (fruit size, color, and protection) for animal dispersed plants at Tinigua National Park, Colombia. Type A and type B colors described in the text. Numbers in parenthesis are expected values assuming independence of characters.

<table>
<thead>
<tr>
<th>Size</th>
<th>Type A color</th>
<th></th>
<th>Type B color</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Protected</td>
<td>Unprotected</td>
<td>Protected</td>
<td>Unprotected</td>
</tr>
<tr>
<td>&gt; 17.3 mm</td>
<td>7 (12.5)</td>
<td>22 (49.7)</td>
<td>43 (7.8)</td>
<td>29 (31.0)</td>
</tr>
<tr>
<td>&lt; 17.3 mm</td>
<td>5 (24.4)</td>
<td>150 (97.4)</td>
<td>5 (15.3)</td>
<td>38 (60.4)</td>
</tr>
</tbody>
</table>
The results about the association of fruit character complexes with particular groups of frugivores, are very similar to those reported by Janson (1983) in the Peruvian rainforest at Cocha Cashu. Both studies found associations between the size, color and presence or absence of protection. At Tinigua and Cocha Cashu, respectively, 65% and 66% of the fleshy fruits analyzed are either small, type A colors without a husk; or large, type B colors with a husk. Further, at both sites associations were found between the fruit character complexes and the dispersal agents. Primates and birds tend to consume preferentially those fruits assigned to their particular dispersal syndromes (Pijl 1972, Janson 1983). These results suggest that the primate and bird dispersal syndromes are more general in Neotropical communities than previously inferred (see Fisher & Chapman 1993). However, one possible explanation for this finding could be the similarity in plant and animal assemblages between sites. At least 37% of the plant species present at Tinigua occur also at Cocha Cashu and this was the second highest percentage of similarity among 18 Neotropical localities compared with the Tinigua flora (Stevenson & Castellanos unpublished data). Animal composition is also very similar, especially birds and mammals. For example, frugivores represent a significant proportion of animal biomass, and primates, tapirs, and peccaries are the most important components at both sites (Terborgh 1983, Stevenson 1996, 2002). The avifauna is also very similar between these sites and the frugivore guild makes up a considerable fraction of avian biomass (Terborgh et al. 1990, Cadena et al. 2000), especially represented by a few families such as curassows, tinamous, toucans, trogons and others. This suggests that a great proportion of the avian biomass, at both sites, have fruits as an important item of their diets. Other families of avian frugivores are diverse at these sites, like tanagers and manakins (Terborgh et al. 1990, Cadena et al. 2000). These results confirm the general similarities reported previously for the fauna and flora of western Amazonian forests (Gentry 1988, Voss & Emmons 1996). In summary, at this point it is difficult to argue that the presence of primate and bird dispersal syndromes at both sites was either the result of similar evolutionary histories or of independent evolution driven by similar dispersers. For two Neotropical sites included in Fisher & Chapman’s (1993) study, only one showed a significant association of fruit characters corresponding to dispersal syndromes, therefore more studies of this type for a variety of vegetation types could help to clarify whether bird and primate dispersal syndromes are of general occurrence in Neotropical forests.

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LITERATURE CITED

GENTRY AH (1988) Changes in plant community diversity and floristic composition on
### APPENDIX 1

Animal dispersed plant species in Tinigua National Park, that were included in the analyses of dispersal syndromes. The columns show the morphological traits for each plant species. Fruit size refers to the largest dimension of the fruit (width or length).

<table>
<thead>
<tr>
<th>Species</th>
<th>Fruit size (mm)</th>
<th>Color</th>
<th>Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gnetum nodiflorum</td>
<td>27.5</td>
<td>Red</td>
<td>No</td>
</tr>
<tr>
<td>Anthurium clavigerum</td>
<td>4</td>
<td>Blue/purple</td>
<td>No</td>
</tr>
<tr>
<td>Anthurium eminens</td>
<td>7.5</td>
<td>Blue/purple</td>
<td>No</td>
</tr>
<tr>
<td>Anthurium fendleri</td>
<td>5</td>
<td>Blue/purple</td>
<td>No</td>
</tr>
<tr>
<td>Anthurium kunthii</td>
<td>5</td>
<td>Blue/purple</td>
<td>No</td>
</tr>
<tr>
<td>Anthurium cf. superbum</td>
<td>5</td>
<td>Blue/purple</td>
<td>No</td>
</tr>
<tr>
<td>Anthurium gracile</td>
<td>3</td>
<td>Red</td>
<td>No</td>
</tr>
<tr>
<td>Caladium bicolor</td>
<td>3</td>
<td>Yellow</td>
<td>No</td>
</tr>
<tr>
<td>Dieffenbachia longispatha</td>
<td>6.5</td>
<td>Red</td>
<td>No</td>
</tr>
<tr>
<td>Dieffenbachia cf. parlatoi</td>
<td>6.5</td>
<td>Red</td>
<td>No</td>
</tr>
<tr>
<td>Dacocotium sp.</td>
<td>6</td>
<td>Orange</td>
<td>No</td>
</tr>
<tr>
<td>Monstera adansoni</td>
<td>12.5</td>
<td>White</td>
<td>No</td>
</tr>
<tr>
<td>Monstera dilacerata</td>
<td>12.5</td>
<td>White</td>
<td>No</td>
</tr>
<tr>
<td>Monstera lechleriana</td>
<td>5.5</td>
<td>White</td>
<td>No</td>
</tr>
<tr>
<td>Monstera gracilis</td>
<td>6</td>
<td>Yellow</td>
<td>No</td>
</tr>
<tr>
<td>Philodendron sp.</td>
<td>3</td>
<td>Yellow</td>
<td>No</td>
</tr>
<tr>
<td>Philodendron divaricatum</td>
<td>3.5</td>
<td>Yellow</td>
<td>No</td>
</tr>
<tr>
<td>Philodendron ernestii</td>
<td>2.3</td>
<td>Yellow</td>
<td>No</td>
</tr>
<tr>
<td>Philodendron fragrantissimum</td>
<td>5.5</td>
<td>Red</td>
<td>No</td>
</tr>
<tr>
<td>Philodendron cf. cuneatum</td>
<td>2.5</td>
<td>White</td>
<td>No</td>
</tr>
<tr>
<td>Spathiphyllum cannaefolium</td>
<td>15.6</td>
<td>Green</td>
<td>No</td>
</tr>
<tr>
<td>Syngonium podophyllum</td>
<td>30</td>
<td>Yellow</td>
<td>Yes</td>
</tr>
<tr>
<td>Syngonium yurimaguense</td>
<td>34</td>
<td>Yellow</td>
<td>Yes</td>
</tr>
<tr>
<td>Aiphanes aculeata</td>
<td>22.5</td>
<td>Red</td>
<td>No</td>
</tr>
<tr>
<td>Attalea insignis</td>
<td>50</td>
<td>Brown</td>
<td>No</td>
</tr>
<tr>
<td>Astrocyrum chambira</td>
<td>47.5</td>
<td>Yellow</td>
<td>No</td>
</tr>
<tr>
<td>Bactris corossilla</td>
<td>20.5</td>
<td>Blue/purple</td>
<td>No</td>
</tr>
<tr>
<td>Bactris macana</td>
<td>24</td>
<td>Red</td>
<td>No</td>
</tr>
<tr>
<td>Bactris maraja</td>
<td>17.5</td>
<td>Black</td>
<td>No</td>
</tr>
<tr>
<td>Euterpe precatoria</td>
<td>11.5</td>
<td>Black</td>
<td>No</td>
</tr>
<tr>
<td>Geonoma macrostachya</td>
<td>8</td>
<td>Black</td>
<td>No</td>
</tr>
<tr>
<td>Geonoma interrupta</td>
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<td>3</td>
<td>Red</td>
<td>No</td>
</tr>
<tr>
<td>Trema micrantha</td>
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<td>Red</td>
<td>Yes</td>
</tr>
<tr>
<td>Ureia baccifera</td>
<td>3</td>
<td>Yellow</td>
<td>No</td>
</tr>
<tr>
<td>Ureia caracasana</td>
<td>8.5</td>
<td>White</td>
<td>No</td>
</tr>
<tr>
<td>Aegiphila guianensis</td>
<td>4.5</td>
<td>Blue/purple</td>
<td>No</td>
</tr>
<tr>
<td>Aegiphila integifolia</td>
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</tr>
<tr>
<td>Citharexylum spinosum</td>
<td>6.5</td>
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<td>No</td>
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<tr>
<td>Vitex compressa</td>
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</tr>
<tr>
<td>Vitex orinocensis</td>
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<tr>
<td>Leonia crassa</td>
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<tr>
<td>Leonia glycycarpa</td>
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<tr>
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<td>4</td>
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<tr>
<td>Cissus erosa</td>
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<tr>
<td>Cissus microcarpa</td>
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