# Report on a short study of the dry season feeding ecology and habitat preferences of the golden-backed uacari or bicó, *Cacajao melanocephalus ouakary* (Cebidae: Pitheciinae), on the lower Rio Jaú, Amazonas, Brazil.

No. 2 of the Igapó Study Project Report Series

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# REPORT ON A SHORT STUDY OF THE DRY SEASON FEEDING ECOLOGY AND HABITAT PREFERENCES OF THE GOLDEN-BACKED UACARI OR BICO, *Cacajao melanocephalus ouakary* (CEBIDAE:PITHECIINAE), ON THE LOWER RIO JAÚ, AMAZÔNAS, BRAZIL.

ADRIAN A. BARNETT & CAROL V. de CASTILHO


## *Abstract*

Golden-backed uacaris *Cacajao melanocephalus ouakary* were studied in the forests of Jaú National Park, Amazônas, Brazil, for 17 days in late October/early November 2000, the mid-dry season. Studies complimented our previous studies in the wet season of 1999 (Barnett et al., 2000). Eight uacari groups were seen and seven more were heard. Group sizes ranged from 1-100+. Uacaris were recorded in igapó, campina and terra firme forest types. Information was obtained from local informants on seasonal use of these forest types and of other, smaller, more spatially patchy habitat types, with high temporal patchyness in fruit availability (e.g. buritzal). Foods were recorded directly for animals in igapó and terra firme, and indirectly for all three forest types. A total of 64 food plant species were recorded. These included hard fruits, soft fruits and leaves. The physical dimensions and hardness of fruits was recorded for 34 of these species. Together, young leaves of three tree species (*Buchenavia oxicarpa* Combretaceae, *Eschweilera tenuifolia* Lecythidaceae and *Mabea taquari* Euphorbiaceae) appeared to form a substantial dietary component. This is the first record of substantial folivory for this primate. Quantitative transects showed fruit and flower availability to be low in all habitats. Leaves may thus be a refuge food. At Jaú there appears to be considerable overlap in the uacari's diet with that of *Cebus* spp. and *Saimiri*, but only for soft fruits. *Alouatta* was not seen eating the leaves consumed by the uacari. Evidence was obtained that some key wet-season diet components (e.g. *Eschweilera* seeds) were also consumed by macaws and parrots. For golden-backed uacaris the seasonal use patterns for habitats and the food resources within them may be more complex than previously realized.

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## *Introduction*

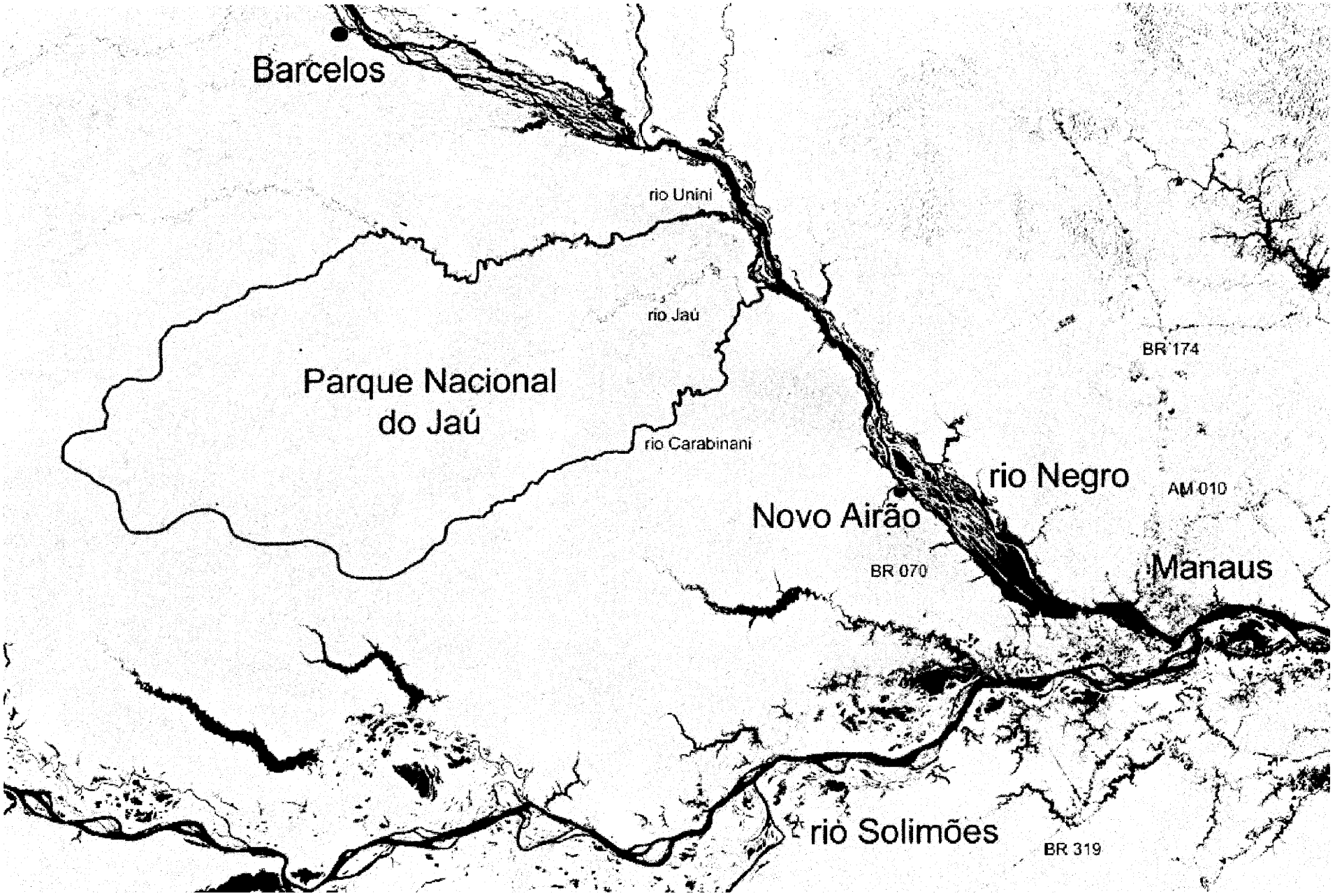
The Cebid sub-family Pitheciinae comprises of three closely related genera (*Pithecia, Chiropotes* and *Cacajao*), all of which are, to varying degrees, predators on hard, unripe seeds. This specialization is extremely unusual in primates and is accompanied by a number of marked modifications of the cranium, dentition, cranial musculature and viscera. These are most strongly developed in the genus *Cacajao*.

Ecologically both *Pithecia* (sakis) and *Chiropotes* (bearded sakis) are quite well known, having been the subject of a number of studies (e.g. Ayres, 1981, 1988; Ferrari, 1985; Frazao, 1992; Happel, 1982; Johns, 1985; Peres, 1993). Uacaris (genus *Cacajao*) are much less well known. Of the five taxa recognised by Hershkovitz (1987) as occurring in Brazil, only two have been the subject of long-term investigations: *C. calvus calvus* studied by Marcio Ayres (Ayres, 1986) and *C. m. melanocephalus* studied by Jean-Philippe Boubli (Boubli, 1997). Neither of these studies bears directly on the golden-backed uacari, the taxon present in Jaú National Park. In Jaú, as elsewhere, *C. m. ouakary* exhibits a strong preference for seasonally inundated black-water flooded forest ('*igapó*') (Prance, 1979). On the other hand, *C. c. calvus* inhabits whitewater flooded forests (*várzea*) which have a floristic composition and inundation rhythm that is distinct from that of igapó. Boubli's studies of *C. m. melanocephalus* occurred in terra firme, caatinga and chascavel, vegetation types that, unlike igapó, are not seasonally flooded. *C. m. ouakary* has not yet been the subject of any detailed studies. To date only two, short, studies have been made (Barnett & da Cunha, 1991; Barnett et al., 2000). Hence, the ecology, natural history and conservation requirements of the golden-backed uacari are poorly known, and are currently insufficient for the effective conservation of this interesting, yet enigmatic, primate (Barnett & Brandon-Jones, 1997).

The golden-backed uacari is one of nine species of primate recorded from Jaú (*Alouatta, Aotus, Callicebus, Cebus spp., Pithecia, Saguinus, Saimiri*: Neri & Borges, 1998; Barnett et al., in prep.). Studies of primates are a management plan priority for the park (FVA-IBAMA, 1998). As part of studies for a doctoral thesis in Primatology, a short field study of the diet and habitat preferences of the golden-backed uacari was undertaken in Jaú National Park between 21 October and 8 November 2000. This constitutes part of the dry season in the region (Ferreira, 1997), and compliments a study conducted in 1999 between 19 and 26 August 1999 (late wet season) (see Barnett, 1999; Barnett et al., 2000). Both are preliminary studies for a long-term study scheduled to start in 2001.

The aims of the current study were:

- To establish extended and repeated contact with a group of uacaris sufficient to habituate them to human presence
- record dry season habitat preferences of uacaris in Jaú
- record their dry season diet
- contrast this with the wet season diet and obtain additional information on wet season diet
- quantify thickness and hardness of diet items and non-diet items
- quantify abundance of diet items and non-diet items
- record dry season group sizes
- record instances of diet item competition with other animals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## *Methods*

Research was conducted from the FVA-IBAMA floating research base (01° 53.568"S 61° 41.842"W) above the Cachoeira do Jaú (20 – 27 October and 4 –6 November 2000) and from 30 October – 2 and 7 November 2000 at the FVA-IBAMA base at Seringalzinho (01° 50.452"S 61°35.595" W). In addition to the fieldwork, four informal interviews on uacari ecology were conducted with regional inhabitants (ages 12, 16, 35 and 70+). Research was conducted in terra firme, *igapó alto* (canopy exceeds 10m, *Leopoldinia pulchra* palms forms a light understory), *igapó baixo* (canopy less than 9m, *Leopoldinia* palms infrequent or absent in most areas). Aningal, buritzal, campina, campinerana vegetation types were also visited.

***monkeys:***

Uacaris were searched for in both igapó and terra firme forest, in the company of Antenor , an experienced forest guide. None of the igapó alto was flooded at the time of our visit, though some areas of igapó baixo remained flooded to a depth of 0.5-2m. Such areas were surveyed by paddled canoe. Trails were mostly absent and we simply walked or paddled until uacaris were located. This was normally first by sound of moving vegetation or by their distinctive contact calls (which resembles an abrupt kissing noise made while using the cupped hands in front of the mouth as an echo chamber). Thick canopy frequently prevented continuous GPS points from being obtained, so expended effort is shown as hours spent searching rather than the distance walked. Daily searches began at dawn (5.30) and continued until 10.30 or 11.00. Searches were also made in the afternoon between 16.00 and 18.00. Afternoons were spent identifying collected food plants.

Upon contact, group size and group spread was estimated as well as their height and distance from observer. Animals were then followed and additional *ad hoc* data gathered as the nature of the contact allowed. GPS points were taken as close to the initial contact point as canopy cover permitted.

***food items:***

Collections were made of any material that the uacaris were observed to eat (direct). This was supplemented with indirect records from material that bore the distinctive tooth marks of uacaris (see photographs in Heymann, 1990) and with samples of those species identified by Antenor and Eduardo de Souza (interview) as being eaten by the uacari . In each case, an effort was made to collect samples of fruit, leaves attached to stem, and slivers of bark or wood. These were stored separately in zip-lock bags, tagged with the local name. Since it was not possible to take material out of the park for identification back in Manaus, material was identified at the research base. Identifications were primarily carried out by CVC and used keys and descriptions in Roosemalen (1985a), Davis & Cullen (1989), Gentry (1993), Ribeiro et al. (1999) and checked against identifications in Ferreira (1997, 2000) and in Ferreira & Stohlgren (1999).

AAB quantified samples, measuring seed dimensions and weight, and thickness of material surrounding the seed. Using a penetrometer, the quantitative methodology of Kinzey & Norconk (1990) was initially attempted, but was soon rejected as inappropriate. A qualitative division was adopted of 'soft' (strawberry to apple resistivity), 'tough' (avocado to melon) and 'hard' (sclerocarpic fruits). The parts of the plants eaten were also recorded (leaf, entire fruit, whole seed, mesocarp etc.). For fresh seeds, the presence of insects within was also recorded.

***quantitative botany:***

Transects were set up to quantify the abundance of tree species in terra firme and the two igapó sub-habitats (igapó alto and baixo). Within each habitat type, two 250x2m transects (total per habitat, 1000 square meters) were set at right angles to each other at a place in that vegetation type where uacaris had been sighted. All trees meeting the criteria for inclusion were identified by local name, samples taken as above and identified as above. Criteria for inclusion were designed to take a 'monkey's eye view' of food-item availability. The criteria were: trees greater than 10cm DBH, trees that are adult at less than 10cm DBH, all adult palms, vines and lianas if they reached the canopy. Though Boubli (1997) found them to be a minor but important food resource for *C. m. melanocephalus*, no attempt was made to quantify the volume of epiphytes.

To further quantify food availability, notes were made of all species in fruit or flower within the transects. Fruits and flowers were also collected from the forest floor within the 1000 square meters sampled in each habitat.

## *Results*

***monkeys:***
A total of 17 days were spent searching for uacaris. During this period eight visual contacts were made with uacari groups (five in igapó baixo, three in igapó alto and one in terra firme). There were an additional seven auditory contacts (two in igapó baixo, two in igapó alto, two in campinerana, and one too distant to be certain). Total visual contact time was 1 hour 57 minutes. Contact times varied from fleeting (five seconds) to prolonged (55 mins.). Observer-group distance varied between 15 and 60m. However, the animals usually ran at their first sight of humans. All longer contacts were intermittent, and little in the way of behavioural observation could be made.

Group size varied from 1 to 100+. Contact calls were heard only in larger groups (50+). All groups appeared to be mixed-sex, each with several larger (assumed to be males) and smaller adults (assumed to be females). Independently locomoting juveniles were observed on three occasions. No babies were seen. All groups were in the upper tree canopy (7m from ground in igapó baixo; 10-12m from the ground in igapó alto and 17m in terra firme). In one sighting, seven animals were observed to leap a gap of approximately 10 body lengths (approx. 10m). One large (80+) group of uacaris was seen to be moving with a band (20+) of *Saimiri.* Such associations is noteworthy, for uacaris are generally considered to travel alone, unlike *Cebus* and even other pitheciines (see Leonard & Bennett, 1996).

***food items:***
Five direct and four indirect feeding records were obtained. A further 55 species were recorded from interviews. These dietary items are presented in Table One and include 64 species from which the fruits were eaten and three species (*Buchenavia oxicarpa* Combretaceae, *Eschweilera tenuifolia* Lecythidaceae and *Mabea taquari* Euphorbiaceae) from which leaves were eaten. Leaves of the three species appeared to be consumed in different ways: for *Buchenavia* the young leaves were nibbled out from the centre of a crown of plucked leaves, which was then dropped; for *Eschweilera* single young leaves appear to be plucked and eaten entire; in *Mabea* only the proximal part of the laminae of near-adult leaves appears to be eaten.

Three feeding observations were obtained in terra firme. Part of a large group was disturbed while eating in a large individual of Ingarana (*Inga laurina* Leg: Mim.). Fresh pods were collected immediately afterwards bearing uacari tooth marks. Analysis of 12 pods showed that the uacaris were nipping out individual seeds, and were not eating the fibrous material of the pod itself. Furthermore, only the largest of the seeds were being eaten. Most eaten pods had seeds remaining in them. Judging by the size of the remaining cavities in the pod wall, the uneaten seeds were always smaller than the seeds that had been eaten. The pod wall is neither thick nor tough, and this behaviour shows that uacaris are capable of the fine degree of food selectivity that has been found to characterize other primate species (e.g. *Ateles p. paniscus;* Roosmalen, 1985b). This tree species is, reportedly, widely used by other primate species in the region, including *Cebus apella* and *Saimiri.*

Fruits of two palms (inaja, *Attalea maripa* and pataua, *Oenocarpus bataua*) were discovered close by, bearing uacari tooth marks. The seeds are protected by a thick (4mm) and immensely hard testa, which required a hammer and nail to open it. Not surprisingly, uacari feeding action was restricted to gnawing the mesoderm from the fruits. Measurements of eaten and uneaten fruits revealed that each fruit had a layer of mesocarp some 2mm thick (weighing 7-8g) surrounding its seed. Observations on two partly eaten fruits and 10 fruits with the mesocarp completely removed revealed no attempts to bite into the seed casing to access the seed. The fruits were being eaten solely for the mesocarp alone.

We received four separate reports that, in the dry season, uacaris descend to the ground in igapó alto to feed on seedlings of *Pouteria* sp. (Sapotaceae) and other (unidentified) tree species. It was also reported that, in late November-early December uacaris feed on a type of beetle larvae that lives beneath the leaf litter in igapó alto. Such actions have not been previously reported for this species of uacari, though Ayres (1986) reports that *C. c. calvus* comes to the ground in várzea to eat seedlings.

Measurements of the hardness and thickness were made of the seeds of 31 uacari food species. These are presented in Table Two. It will be seen that, although 19 species have thick (>2mm) or hard shells, a significant proportion (12, 38.7%) of the documented species are thinner or softer than this. Many of these thinner-skinned fruits were said to be also eaten by *Cebus* spp. and *Saimiri*. These include the thin-

walled pyxidia of *Couratari multiflora* (Lecythidaceae), which are siezed in two hands and snapped like bread-sticks to reveal the small winged seeds inside. Two large pyxidia of *Escweilera tenuifolia* (Lecythidaceae) were found that had been eaten by macaws (*Ara* sp.,), and two smaller ones that had been eaten by *Amazona* parrots. A flock of 12 scarlet macaws (*Ara macao*) were seen feeding on pods of *Parkia* (*discolor*?) (Leg.:Mim.). Both of these plants are also eaten by *C. m. ouakary* (Barnett et al., 2000). None of the fresh seeds analysed had insects within.

After some initial attempts, the use of a penetrometer to quantify fruit puncturability was abandoned as inappropriate and anthropocentric (since it gives an absolute measure, without reference to the morphology of the teeth of the primate whose diet is being studied). A new method, using casts of *Cacajao* canines (and those of other primate species) attached to a strain gauge, will be tried next year. This should give a more appropriately primate-centric approach and readings that are more closely representative of the relative puncturability of a fruit *vis á vis* the three-dimensional shape of the tooth involved. It is hoped this will more properly reflect fruit hardness from the primate's point of view.

***quantitative botany:***
The results of transect studies are given in Table Three. It will be seen that igapó baixo is by far the poorest in terms of tree species diversity. Fruits and flowers found within the transects are given in Table Four.

## *Discussion*

***seasonal habitat choice:***
The records of *C. m. ouakary* feeding in terra firme are, as far as we know, the first feeding records from this habitat for this taxon. They are significant because i) they give tentative support to the suggestion of Barnett & Brandon-Jones (1997) that uacaris might seasonally migrate between habitats and ii) because it shows that the resources used there are not always ones that the uacaris' putative niche of sclerocarpic forager (Kinzey, 1990) would lead one to predict. From interviews with local people and information from our guides, Antenor and Eduardo, it would appear that the uacaris only fully leave the igapó in December. At this time they move to the terra firme forest, where fruits are beginning to appear. Brief observations in terra firme revealed flowers of such food item trees as *Eschweilera* sp. and other Lecythidaceae, tentatively supporting this phenological supposition (see Table Four). As yet there have been no phenological studies of terra firme forest at Jaú. However, a study by Alencar et al. (1979) presented phenological data from 12 consecutive years on 27 tree species in terra firme at Reserva Ducke, some 230 km east of Jaú. Of these, 17 species had peak fruit loads between November and January. These included such known *Cacajao* food genera as *Couma* (Apocynaceae), *Erisma* (Vochysiaceae), *Hevea* (Euphorbiaceae), *Manilkara* (Sapotaceae), *Nectandra* (Lauraceae) and *Tabebuia* (Bignoniaceae) (see Barnett & da Cunha, 1991; Barnett & Brandon-Jones, 1997; Boubli, 1999).

Another exception to this seasonal rhythm appears to be the *C. m. ouakary*'s incursions into buritizal vegetation to feed on the fruits of the palm *Mauritia flexuosa*. This palm fruits in June-July. At this time the uacaris are reported to travel inland along creeks (*igarapés*) to feed there, thus leaving the igapó and nominally entering into terra firme. The buritzals so used may not be extensive (the one near Seringalzingo is no more than 200mx15m) and are often quite isolated from igapó. Their use by *C. m. ouakary* is indicative of a precise temporal and spatial patterning of resource utilization by this primate, and of a long-term memory of location of resources. It awaits further research to see if this is also the case with other types of trees.

Eleven records of food items from the Campinerana vegetation type were made (see Table One). Though five of these species also occur in igapó, six are unique to this white-sand forest type. Campinerana is floristically very distinct (Anderson, 1981) and occurs in patches of varying size at Jaú. This is the first time use of this habitat type has been reported for *C. m. ouakary*, though its extensive use has been reported for *C. m. melanocephalus* by Boubli (1997, 1999). The timing of visits, the importance of the food resources used there and the extent to which this habitat is used by uacaris await further evaluation.

***leaves and insects:***
The records of leaves of *Buchenavia oxicarpa*, *Eschweilera tenuifolia* and *Mabea taquari* as a major dietary item is extremely interesting. Although leaves have been reported as a minor component in the

diet of *Cacajao, Chiropotes* and *Pithecia*, no previous studies of Pitheciine diets have recorded leaves as a major dietary component, either seasonally or in total. It would appear that this use is highly seasonal in *C. m. ouakary* and related to the dearth of other suitable foods at this part of the inundation cycle, there being few fruits available in any forest type at this time (see Table Four).

Though it requires further analysis to be sure, consumption patterns of the three leaf types may well be related to phytochemistry. It is common for folivores to consume young leaves, avoiding the high levels of tannins present in older leaves (Chivers, 1998). The avoidance of the very young leaves of *Mabea* may be because it is a member of the Euphorbiaceae, where young leaves in particular are often rich in toxic and ascerbic latex (Gentry, 1993).

Although leaves may be a refuge food in a time of seasonal scarcity, they may also be a source of protein (Chivers, 1998). It may be significant that only young leaves were recorded as being eaten. These generally have lower absolute levels of tannins and phenols and higher proportionate levels of proteins than older leaves (Chivers, 1998). Ayres (1986) recorded lepidopteran larvae as an important seasonal food item in *C. c. calvus*, and thus a protein source. For *C. m. ouakary*, however, no evidence of insect eating has been recorded. Plant leaf chemistry in forests adjacent to black water river systems may act to reduce the density of such invertebrate folivores (da Cunha & Barnett, 1989) – possibly to levels where foraging on them would not be optimal.

The absence of insects in collected fresh fruits is in marked contrast to the situation reported by Barnett et al. (2000), where a high proportion of analysed fruits were so infected. If this is a general occurrence, then it may betoken a general dearth of available protein and eating leaves may be a response to this. In this context it is also interesting to note that no evidence was observed in this season of consumption of the larvae of *Polistes* wasps, an event reported from wet season studies by Barnett et al. (2000). Insectivory is a quite widely reported, if generally low-level affair, in Pitheciines (e.g. Heymann & Bartecki, 1990; Frazao, 1991 ) and seems to be a response to the low levels of overall protein in their seed-centered diet (and perhaps the very specific lack of particular amino; Chivers, 1998). The records of uacaris feeding on seedlings and on insect-larvae in igapó alto should also be investigated further in this context. This has not been done, even in *C. c. calvus* where the phenomenon was first reported.

***competition:***

*Cacajao* is often considered to be an obligate predator of hard-shelled fruits, to be a genus that feeds on little else and, as a result, to have adopted a highly specialized and near competition-free niche (Kinzey, 1992). To this is added a certain degree of habitat specialization; Ayres (1986) reported that few other primates regularly used várzea and Boubli (1997, 1999) found little evidence of microsympatry for three primates at his study site and very low densities of four others. The situation at Jaú appears to be somewhat different from the splendid isolation reported by these authors, with frequent sightings of *Cebus apella, C. albifrons, Saimiri* and (in the wet season, at least) *Alouatta* in habitats used by *C. m. ouakary*. This opens-up the possibility of an active competition for resources between the species.

There certainly appears to be considerable overlap between *Cacajao*, *Cebus* and *Saimiri* for smaller, softer fruits. It is possible that these are abundant and taken opportunistically. However, the diet of *Cebus apella* in Jaú also includes some very hard-shelled fruits. Lacking the powerful jaw musculature of *Cacajao, C. apella* is reported to access the seeds of mature *Couroupita* spp. (Lecythidaceae) by banging the pyxidium against a branch until the lid pops off, revealing the single large seed within (see Table Two), behaviour also reported by Peres (1991) for *Cariniana micrantha* (Lecythidaceae). In contrast, when eating *Couroupita, Cacajao* simply rips the pyxidium open with its teeth. Both species are reported to eat the softer, young, pyxidia, consuming them whole like small cakes. The extent to which *Cebus*' use of *Couroupita* (and other hard fruits?) might actually deprive *C. m. ouakary* of resources remains to be determined and will depend both on the frequency of the phenomenon and the abundance of *Couroupita* and its proportional importance in the diet *Cacajao.* However, in a list of the twenty most common trees at Jaú, reported by Ferreira (1997) and including 13 known food items of *C. m. ouakary*, the tree genus *Couroupita* was not included. In consequence, this example of diet overlap may be of minor impact in terms of resource competition between the species. This possibility should be confirmed with studies of the crop size, the duration of the crop and the timing of crop availability in relation to other uacari food items.

Other important possibilities for competition exist around *Eschweilera.* Members of this genus of Lecythidaceae are extremely common in both igapó sub-types at Jaú (see Ferreira, 1997) and *E. tenuifolia* is a major wet-season dietary item for uacaris in Jaú (Barnett et al., 2000). Kinzey (1992) posited that macaws, as seed predators of hard-shelled fruits, might be ecological competitors of *Cacajao*, but did not provide any evidence. The *Eschweilera tenifolia* pyxidia collected with macaw bite-marks, plus the observation by Boubli (1999) of macaws eating *Chrysophyllum sanguinolentum* (Sapotaceae: a known food for *C. m. melanocephalus*) provide the first evidence of such competition.

Although *Pithecia* is reported in the Park, it is said to be everywhere rare, occurring only deep in inter-fluvial terra firme (see Neri & Borges, 1998). It and *C. m. ouakary* are unlikely to be competitors. No records of *Alouatta* were made in igapó during the study period, though it was recorded several times from terra firme and has been recorded in inundated igapó (Barnett, 1999). If *Alouatta* is genuinely absent from igapó at this time of year, it would mean *Cacajao* had no competition for the leaves of *Buchenavia, Eschweilera* and *Mabea* it was observed to be eating. Finally, there are some fruits which appear too hard even for *Cacajao* to crack. These include the pyxidia of *Bertholecia* and the seeds of *Astrocarium jauari* and *Oenocarpus bataua* palms. [1]These are, however, eaten by agoutis and pacas.

***ecological role:***
*Cacajao* is generally considered to be a seed predator (Barnett & Brandon-Jones, 1997). However, many of the smaller, softer fruits included in Tables One and Two are probably eaten whole or with little mastication. For these, *Cacajao* may act as a seed disperser in the same way that *Cebus* and *Saimiri* probably do. For some species, however, the golden-backed uacari may act as an indirect seed predator. Only the mesocarp of *Attalea maripa* and *Oenocarpus batua* palm fruits was seen to be eaten. The fruits were then dropped to the ground from the tree in which the uacaris were feeding, littering the ground with fruits. Such clumping can increase both seed and seedling mortality through increased predation by agoutis and pacas, infection by seed-boring weevils and by increased competition for nutrients and light between seedlings and with parent tree (Connell, 1984; Howe & Smallwood, 1982; Janzen, 1971). In such circumstances, *Cacajao* may be regarded as being an indirect agent of mortality for the plant species concerned (Janzen, 1971).

## *Conclusions*

Information on the use of buritizal and campinerana provide tantilizing glimpses of habitat use by uacaris at Jaú. The situation is clearly more complex than the simple back-and-forth resource-tracking migration envisaged by Barnett & Brandon-Jones (1997). These, and the observations of feeding on leaves, mesocarp and of a high frequency of small, soft fruits in the diet show the diet to be more varied than previously thought. While *C. m. ouakary* may be a specialist in hard-shelled fruit, it is far from the obligate sclerocarpic forager that it was once thought to be (see Kinzey, 1990).

With this in mind, the following should be priorities for future, long-term, studies:

- quantify abundance and temporal and spatial distribution of uacari diet items
- analysis of hardness and chemical constituents as determinants of what is and is not eaten
- size of trees, size of crop, duration of crop of food-item trees
- quantification of the level of competition for dietary resources between uacaris, macaws and parrots, and between uacaris and other primates
- phenological and chemical studies of the leaves eaten by uacaris. Why just those in igapó baixo?
- detailed studies of use of small patchy habitats like buritzal and campinerana
- studies of on-ground feeding on germinating seedlings and beetle larvae
- the role of insectivory in uacari diet. Is it age-related?
- how do young uacaris feed? Do they eat only softer fruits, steal opened hard fruits from adults, or eat those structurally compromised ones infected with boring insects?
- estimations of uacari group sizes and the patterns and reasons for their variation in size
- estimations of group range – both daily and annual (leading to population density estimations)
- assessment of uacari sensitivity to habitat disturbance (and an estimation of its conservation requirements)

It appears to be very difficult to get close to uacaris in the Seringalzinho-Flutuante region of the park. This may be due to past (and current?) hunting levels. Though it seems to be slightly easier to approach them from a canoe, it is uncertain if this will be enough to be able to habituate them to a level that permits good observations of the kind the study really demands. Accordingly, it may prove necessary to move the study site to a more remote location within the park.

Overall it would seem that hard seeds and igapó act as dietary refuge for uacaris. This appears to support Jean-Philippe Boubli's idea (Boubli, 1997, 1999) that the genus originated as a specialist sclerocarpic forager in the Campinerana of the Pico de Neblina region, a habitat where hard fruits are plentiful and competitors are few. Only later did the genus spread out into habitats such as várzea and igapó, vegetation types rich in sclerocarpic fruits and relatively poor in species to compete for them.

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## *Appendix One: papers expected from this study:*

Barnett A., Borges S., Castilho C., Neri F., Rylands A., Nascimento H. & Shapley R. Primates of the Parque Nacional do Jaú, Amazonas, Brazil. In prep for Neotropical Primates.

Barnett A., Castilho C., Borges S. & Antenor. The golden-backed uacari, *Cacajao melanocephalus uacari*, in Jaú National Park: preliminary observations on wet and dry season diet and habitat selection. To be prepared for International Journal of Primatology.

Barnett A., Boubli J-P. & Castilho C. Evidence for competition between two specialist Neotropical seed-predators, *Cacajao melanocephalus* (Cebidae) and macaws (*Ara* spp.: Psittidae). To be prepared for Biotropica.

Barnett A, Castilho C. & Antenor . A case of cooperative hunting by jaguars (*Felis onca*) in Jaú National Park, Brazil. To be prepared for Mammalia.

**TABLE ONE:**
**PLANTS IDENTIFIED AS CONSTITUENTS IN THE DIET OF *Cacajao melanocephalus ouakary*, JAÚ NATIONAL PARK OCT-NOV. 2000.**

**Key: I = igapó, TF = terra firme, C = caatinga, FWA = whole adult fruit, FWI = whole immature fruit,**
**S = seed, M = mesocarp, L = leaf.**

| FAMILY | SPECIES | COMMON NAME | HABITAT | PART EATEN |
|---|---|---|---|---|
| Arecaceae | ***Astrocaryum gynacanthum*** | mumbaca | TF | M |
| | ***Astrocaryum jauari*** | jauari | I | M |
| | ***Attalea maripa*** | inajá | TF | M |
| | ***Euterpe precatoria*** | açaí | TF | FWA |
| | ***Leopoldinia pulchra*** | jará | I | M |
| | ***Mauritia flexuosa*** | buriti | TF | M |
| | ***Mauritiella armata*** | buritirana | C | M |
| | ***Oenocarpus bataua*** | patauá | TF | M |
| | ***Oenocarpus minor*** | bacabinha | TF | M |
| Apocynaceae | ***Couma guianensis*** | sorva | TF | FWA |
| Euphorbiaceae | ***Hevea spruceana*** | seringueira do igapó | I | S |
| | ***Mabea taquari*** | taquari | I | FWA, L |
| | ***Amanoa sp.*** | bico de japó | I | FWA |
| Malpighiaceae | ***Byrsonima amazonica*** | buxuxu | C | FWA |
| | ***Burdachia prismatocarpa*** | pau vidro | I | FWA |
| Myrtaceae | ***Myrcia fallax ou pyrifolia ?*** | araçá do igapó | I | FWA |
| | ***Marliera sp.*** | murta | C/I | FWA |
| | ***Eugenia sp.*** | daicu | C/I | FWA |
| | ***Myrtaceae sp1*** | araçá (casca preta) | I | FWA |
| Melastomataceae | ***Clidemia sp.*** | buxuxu da campinarana | C | FWA |
| Memecylaceae | ***Mouriri sp.*** | jacareúba | C/I | FWA |
| Rubiaceae | ***Alibertia edulis*** | apuruí peludo | I | FWA |
| Nyctaginaceae | ***Nyctaginaceae sp.1*** | jenipapo | I | FWA |
| Celastraceae | ***Goupia glabra*** | cupiúba | TF | FWA |
| Icacinaceae | ***Calatola sp.*** | tucano patauá | I | FWA |
| Annonaceae | ***Duguetia sp.*** | envira | I | - |
| | ***Bocageopsis sp.*** | envira preta | TF | FWA |
| Moraceae | ***Brosimum parinarioides*** | amapá | TF | FWA |
| Burseraceae | ***Protium sp.*** | breu branco | TF | FWA |
| Sterculiaceae | ***Theobroma subincanum*** | cupuí | TF | FWA |
| | ***Theobroma sylvestre*** | cabeça de urubutinga | TF | FWA |
| Hippocrateaceae | ***Salacia sp.*** | bochecha de velho | I | S |
| Bignoniaceae | ***Tabebuia sp.*** | capitari | I | S |
| Vochysiaceae | ***Vochysia sp.*** | araçá | I | S |
| | ***Qualea sp.*** | comati | TF | S |
| Lauraceae | ***Lauraceae sp.1*** | louro abaticarana | I/TF | - |
| | ***Lauraceae sp.2*** | louro amarelo | I | - |
| Violaceae | ***Rinorea sp.*** | olho de peixe | I | FWA |
| Amaranthaceae | ***Pleuropetalum sp.*** | seringaí da terra-firme | TF | - |
| Combretaceae | ***Buchenavia oxycarpa*** | tanimbuca | I | -, L |
| Humiriaceae | ***Sacoglotis sp.*** | uchirana | I | - |
| Chrysobalanaceae | ***Couepia sp.*** | marirana | C | S |
| Elaeocarpaceae | ***Sloanea laurifolia*** | urucurana | I | S |

| | | | | |
|---|---|---|---|---|
| | ***Sloanea sp.*** | seringaí | C | S |
| Sapotaceae | ***Pouteria sp.*** | abiu do igapó | I | S |
| | ***Pouteria elegans*** | abiurana | I | S |
| | ***Micropholis sp.*** | abiurana | I | S |
| | ***Pouteria oxythece*** | | I | S |
| | ***Elaeoluma sp.*** | caramuri | I | S |
| Lecythidaceae | ***Eschweilera tenuifolia*** | macacarecuia | I | S |
| | ***Eschweilera sp. 1*** | matamatá | TF | S |
| | ***Eschweilera sp.2*** | matamatá preto | TF | S |
| | ***Couratari sp.1*** | xuru | I | S |
| | ***Couratari sp.2*** | macacarecuia da campinarana | C | S |
| | ***Corythophora sp.*** | xuru | I | S |
| Leguminosae | | | | |
| Papilionoideae | ***Swartzia polyphylla*** | arabá | I/TF | S |
| | ***Swartzia sp.*** | saboarana | I | S |
| | ***Aldina heterophylla*** | macucu | I/C | S |
| | ***Dalbergia sp.*** | arapari | I/C | S |
| | ***Macrolobium suaveloens*** | itaubarana | I | S |
| Caesalpinoideae | ***Sclerolobium sp.*** | tachi | I | S |
| Mimosoideae | ***Inga laurina*** | ingarana | TF | S |
| | ***Inga sp.*** | macucu da terra-firme | TF | S |
| | ***Parkia discolor*** | arara tucupi | I | S |

**TABLE TWO: QUANTITATIVE DATA ON FRUIT AND SEED WEIGHT AND HARDNESS FOR SOME SPECIES IN THE DIET OF *Cacajao melanocephalus ouakary.***

**Key: S = soft, T = tough, H = hard, * = empty shell only, ^ = uneaten fruit only**

| Species | Resistivity Class | Fruit wall thickness (mm) | Fruit length (mm) | Fruit width (mm) | Fruit weight (g) | Seed length (mm) | Seed width (mm) | Seed weight (g) | Mean number of seeds per fruit | Sample size |
|---|---|---|---|---|---|---|---|---|---|---|
| "Jabuchicaba" | S | <1 | 19 | 19 | 1.5-2.5 | | | | 1 | 4 |
| ***Alchornea sp.**** | H | 2 | 26-31 | 21-24 | | | | | >20 | 3 |
| ***Aldinia heterophylla*** | T | 5-13 | 82-103 | 61-90 | 108-320 | | | | | 7 |
| ***Attalea maripa^*** | H | 2 | 51-52 | 25-28 | 16-21 | | | 9-13 | 1 | 2 |
| ***Brosimum cf. parinaroides*** | S | <2 | 9.5-11 | 10-12 | | | | | | 4 |
| ***Brysonima amazonica*** | S | <2 | 6 | 5 | | | | | 1 | 10 |
| ***Burdachia prismatocarpa*** | T | 2.5-4 | 19-26 | 14-17 | 2 | 11.5 | | 10 | 1 | 10 |
| ***Corythophora sp.1**** | H | 8 | | | 90* | | | | | 1 |
| ***Corythophora sp.2*** | H | 7-8 | 50-61 | 32-53 | 28-47 | 30-32 | 15-21 | 4-6 | 1.25 (1-20 | 6 |
| ***Couepia sp.**** | H | 5-6 | | | | | | | | 2 |
| ***Couma sp. 2*** | T | 6 | 36 | 22 | | | | | >20 | 1 |
| ***Couma sp.1*** | T | 10 | 43 | 36 | | | | | >20 | 1 |
| ***Couratari sp.1**** | H | 4 | 42-49 | 33 | | | | | | 2 |
| ***Couratari sp.2**** | H | 4 | 62 | 42 | | | | | | 1 |
| ***Eschweilera sp. 1**** | H | 3 | | | | | | | | 7 |
| ***Eschweilera sp. 2**** | H | 8 | | | | | | | | 7 |
| ***Eschweilera tenuifolia*** | H | 2-4 | | | 40-150 | 21-45 | 7.5-26 | 2-8.5 | 25-40 | 12 |
| ***Eugenia sp.*** | T | 2# | 12-16 | 9-11 | | 11 | 8 | | 1 | 10 |
| ***Inga laurina*** | T | 0.5-1.25 | | | | 5.5-13 | 4.5-9 | 1 | 4-13 | 9 |
| ***Mabea taquari*** | S | 2.75 | 14 | 16 | | | | | | 10 |
| ***Marliera sp.*** | S | <1 | 7.5-10 | 11-11.5 | | | | | 4 | 2 |
| ***Myrcia fallax/pyrifolia*** | S | <1 | 13-15 | 14-16 | | | | | 2.5 (1-3) | 10 |
| ***Oenocarpus batua^*** | H | 1 | 28-30.5 | 19-20 | 7 | | | | 1 | 2 |
| ***Parkia sp.*** | T | 3 | | | | | | | | 1 |
| ***Pouteria sp. 1*** | T | 1.5-2 | 21-28 | 21-28 | | | | | | 3 |
| ***Pouteria sp. 2*** | T | 1 | 21 | 21 | | | | | 3.5(3-5) | 5 |
| ***Salacia sp.*** | S | 1.5 | 25 | 25 | | | | | | 3 |
| ***Sloania laurifolia*** | H | 2-4 | 14-22 | 12-20 | | 7 | | | 1 | 10 |
| ***Swartzia polyphylla*** | T | 5.5-8.25 | 92-149 | 47-70 | 125-340 | | | 65-120 | 1 | 6 |
| ***Swartzia sp.*** | T | 2 | 57 | 37 | | 42 | 12 | | 1 | 1 |

**TABLE THREE(i): RESULTS OF BOTANICAL TRANSECTS FOR TERRA FIRME.**

Local: TERRA-FIRME (Pique - Cachoeira)

| | | Nº of individuals | |
|---|---|---|---|
| **Species** | **Common name** | **Transect 1** | **Transect 2** |
| ***Bertholletia excelsa*** | Castanheira | 1 | 1 |
| ***Phenakospermum guyanense*** | Sororoca | 1 | |
| ***Couma guianensis*** | Sorva | 1 | |
| ***Theobroma subincanum*** | Cupuí | 1 | |
| ***Protium*** sp. | Breu branco | 2 | 2 |
| ***Astrocaryum gynacanthum*** | Mumbaca | 8 | 12 |
| ***?*** | Isqueira | 1 | |
| ***Lecythidaceae*** | Tauari | 1 | |
| ***?*** | Envira de cutia | 1 | |
| ***Theobroma sylvestre*** | Cabeça de urubutinga | 2 | |
| ***?*** | Bolacheira | 2 | 3 |
| ***?*** | Indeterminada 1T | 1 | |
| ***?*** | Cabário | 3 | 3 |
| ***Oenocarpus bataua*** | Patauá | 1 | |
| ***Bocageopsis*** sp. | Envira preta | 6 | 4 |
| ***?*** | Inga chichica | 1 | 1 |
| ***Pleuropetalum*** sp***.*** | Seringaí da terra-firme | 1 | |
| ***Lauraceae*** sp.2 | Louro amarelo | 1 | |
| ***?*** | Cipó de fogo | 3 | |
| ***?*** | Cipó 1T | 1 | |
| ***?*** | Cipó 2T | 1 | |
| ***Qualea*** sp. | Comati | 2 | |
| ***Micropholis*** sp***.*** | Balatinha | 1 | |
| ***?*** | Matintarana | 4 | 2 |
| ***?*** | Cipó cururu | 1 | |
| ***Inga*** sp***.*** | Macucu da terra-firme | 1 | |
| ***Euterpe precatoria*** | Açaí | 1 | 2 |
| ***Pouroma bicolor*** | Embaúba | 1 | |
| ***Caesalpinioideae*** sp.1 | Tachi de formiga | | 1 |
| ***Eschweilera*** sp.2 | Matamatá preto | | 2 |
| ***?*** | Cipó 3T | | 1 |
| ***Swartzia*** cf. ***arborescens*** | Indeterminada 2T | | 1 |
| ***Swartzia*** cf. ***polyphylla*** | Arabá da terra-firme | | 1 |
| ***Inga laurina*** | Ingarana | | 1 |
| ***Eschweilera tessmannii*** | Ripeiro | | 1 |
| ***Aldina heterophilla*** | Macucu | | 1 |
| ***?*** | Cipó 4T | | 1 |
| ***Eugenia*** sp***.*** | Daicu | | 1 |
| ***?*** | Uiqui | | 1 |
| ***Oenocarpus minor*** | Bacabinha | | 1 |
| ***Goupia glabra*** | Cupiúba | | 3 |
| ? | Marupá | | 1 |
| ? | Cipó 5T | | 1 |
| | **Nº of individuals** | **51** | **48** |
| | **Nº of species** | **28** | **24** |

**TABLE THREE(ii): RESULTS OF BOTANICAL TRANSECTS FOR IGAPÓ ALTO.**

Local: IGAPÓ ALTO (Lago do Patauá – Cachoeira)

| | | Nº of individuals | |
|---|---|---|---|
| **Species** | **Common name** | **Transect 1** | **Transect 2** |
| ***Mabea taquari*** | Taquari | 15 | 10 |
| ***?*** | Indeterminada 1 | 7 | 4 |
| ***Pouteria sp.*** | Macucuzinho | 6 | 6 |
| ***Asrocaryum jauari*** | Jauari | 5 | |
| ***Myrtaceae sp.2*** | Araçá (da folha graúda) | 7 | 7 |
| ***?*** | Indeterminada 2 | 1 | |
| ***Pouteria sp.*** | Abiu do igapó | 4 | 2 |
| ***Pouteria elegans*** | Abiurana | 2 | 1 |
| ***?*** | Cipó 1 | 1 | |
| ***Lauraceae sp.1*** | Louro abaticarana | 2 | |
| ***Alibertia edulis*** | Apuruí peludo | 4 | 2 |
| ***Himatanthus sp.1*** | Jarmim | 3 | |
| ***Dalbergia sp.*** | Arapari | 2 | |
| ***Myrcia sp.*** | Araçá | 1 | |
| ***Eugenia sp.*** | Olho de preguiça | 4 | 1 |
| ***Marliera sp.*** | Murta | 6 | 1 |
| ***Burdachia prismatocarpa*** | Pau Vidro | 1 | 1 |
| ***Sacoglotis sp.*** | Uchirana | 3 | 1 |
| ***Eschweilera tessmannii*** | Ripeiro | 1 | |
| ***Hevea spruceana*** | Seringueira do igapó | 5 | |
| ***Lauraceae sp.2*** | Louro amarelo | 1 | 1 |
| ***?*** | Puleiro de pato | 1 | |
| ***Quiina sp.*** | Indeterminada 3 | 2 | 2 |
| ***?*** | Cipó 2 | 1 | |
| ***Myrtaceae sp 1.*** | Araçá da casca preta | 1 | 1 |
| ***Buchenavia oxycarpa*** | Tanimbuca | 1 | |
| ***Licaria sp.*** | Indeterminada 4 | | 1 |
| ***Tabebuia sp.*** | Capitari | | 1 |
| ***Sclerolobium sp.*** | Tachi | | 1 |
| ***?*** | Orelha de cachorro | | 1 |
| ***Elaeoluma sp.*** | Caramuri | | 1 |
| ***Himatanthus sp.2*** | Jarmim preto | | 1 |
| ***Vochysia sp.*** | Araçá | | 1 |
| | **Nº of individuals** | **87** | **46** |
| | **Nº of species** | **26** | **21** |

**TABLE THREE(iii): RESULTS OF BOTANICAL TRANSECTS FOR IGAPÓ BAIXO**

Local: Igapó Baixo (Igarapé do Cutiuaú - Seringalzinho)

| | | Nº of individuals | |
|---|---|---|---|
| **Species** | **Common name** | **Transect 1** | **Transect 2** |
| ***Eschweilera tenuifolia*** | Macacarecuia | 17 | 7 |
| ***Buchenavia oxicarpa*** | Tanimbuca | 8 | 7 |
| ***Burdachia prismatocarpa*** | Pau Vidro | 13 | 18 |
| ***Marliera sp.*** | Murta | 11 | 1 |
| ***Mabea taquari*** | Taquari | 5 | 5 |
| ***Elaeoluma sp.*** | Caramuri | 1 | 1 |
| ***Mandevilla sp.*** | Pincel (cipó) | 11 | |
| ***Rinorea sp.*** | Olho de peixe | 1 | |
| ***Eugenia sp.*** | Olho de preguiça | 1 | |
| | **Nº of individuals** | **68** | **39** |
| | **Nº of species** | **9** | **6** |

**TABLE FOUR: FRUITS AND FLOWERS SEEN WITHIN BOTANICAL TRANSECTS.**

| **Species** | **Type** | **Terra Firme** | **IgapóAlto** | **Igapó Baixo** | **Eaten by uacari?** |
|---|---|---|---|---|---|
| "bulacheira" | Mature Fruit | X | | | ? |
| Apocynaceae sp. | Flowers | | X | | ? |
| ***Bertholecia excelsa*** (Lecythidaceae) | Flower | X | | | ? |
| ***Bocageopsis multiflora*** (Annonaceae) | Mature Fruit | X | | | ? |
| ***Burdachia prismatocarpa*** (Malpighiaceae) | Immature fruits | | X | | yes (but not at this time) |
| ***Burdacia prismatocarpa*** (Malpighiaceae) | Immature fruits | | | X | yes (but not at this time) |
| Burseraceae ***sp.*** | Immature fruits | X | | | ? |
| ***Eschweilera sp.2*** (Lecythidaceae) | Flowers | X | | | ? (yes, as fruit) |
| ***Eschweilera sp.3*** (Lecythidaceae***)*** | Flowers | | X | | ? (possibly, as fruit) |
| ***Foramea sp.*** (Rubiaceae) | Mature Fruit | X | | | yes |
| Guttiferaceae sp. | Flowers, Immature Fruit | X | | | ? |
| ***Leopoldinia pulchra*** (Arecaceae) | Immature fruits | | X | | yes |
| ***Licania*** (Chrysobanenaceae) | Mature Fruit | X | | | ? (yes in Boubli, 1999) |
| ***Lophopterys sp.*** (Malpighiaceae) | Mature Fruit | X | | | ? |
| ***Ocotea cf. nitida*** (Lauraceae) | Mature Fruits | X | | | ? |
| ***Oenocarpus bataua*** (Arecaceae) | Mature Fruit | X | | | yes |
| ***Ouratea sp.*** (Ochnaceae) | Mature Fruit | X | | | ? |
| ***Parkia discolor*** (Leg.:Mim.) | Immature fruits | | X | | yes |
| ***Salacia sp.*** (Hippocrataceae) | Mature Fruits | | X | | yes |
| ***Theobroma subincanum*** (Sterculiaceae) | Flowers | X | | | ? (as fruit) |
| ***Theobroma sylvestre*** (Sterculiaceae) | Mature Fruits | X | | | yes |
| ***Vitex sp.*** (Verbenaceae) | Mature fruits | | | | ? |