L.A. Martinelli · S. Almeida · I.F. Brown M.Z. Moreira · R.L. Victoria · L.S.L. Sternberg C.A.C. Ferreira · W.W. Thomas

Stable carbon isotope ratio of tree leaves, boles and fine litter in a tropical forest in Rondônia, Brazil

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Abstract Leaves of 208 trees were collected for isotopic analysis together with wood from 36 tree boles and 18 samples of fine litter from a *terra-firme* forest located at Samuel Ecological Reserve, Rondônia State, in the southwestern Amazon region. The range of δ^{13} C values in leaves was from -28 to -36%, with an average (±1 SD) of -32.1 ± 1.5%, which was more negative than the δ^{13} C values of bole samples (-28.4 ± 2.0%) and fine litter (-28.7 ± 2.0%). These values are within the range found for tropical and subtropical forests. Pooling the δ^{13} C values for leaf samples from trees of the same height gave averages which were positively correlated with plant height at a highly significant level, with a slope of 0.06 and an intercept of -33.3% and a correlation coefficient $r^2 = 0.70$ (P < 0.001).

Key words Amazon · Vegetation · Forest · Stable carbon isotope · Rondônia

Introduction

The abundance of stable carbon isotopes in plants of the C_3 group is controlled by environmental variables, such

L.A. Martinelli $(\boxtimes) \cdot S$. Almeida¹ \cdot M.Z. Moreira R.L. Victoria

Centro de Energia Nuclear na Agricultura,

Av. Centenário 303, Piracicaba, 13416-000, SP, Brazil

I.F. Brown

Woods Hole Research Center, Woods Hole, MA 02543, USA

L.S.L. Sternberg Department of Biology, University of Miami, Coral Gables, FL 33124, USA

C.A.C. Ferreira Departamento de Botânica, Instituto Nacional de Pesquisas da Amazônia, Manaus, 69000-000, AM, Brazil

W.W. Thomas The New York Botanical Garden, Bronx, NY 10458, USA

Present Address: ¹INPE, Av. dos Astronautas, São José dos Campos, SP, Brasil as the concentration of atmospheric CO_2 (ca) and its isotopic composition and by physiological factors, such as the CO_2 concentration inside the leaf intercellular space (ci), which in turn can be affected by environmental factors, such as light and water availability (Farquhar et al. 1982).

Tropical forest environments provide conditions promoting large variability in the carbon isotope composition of plant tissues, for several reasons: (1) a high number of plant species increasing the chances that genetic variability will affect carbon isotope composition, (2) strong variability in both CO_2 concentration and its isotopic composition due to the dilution of atmospheric CO_2 by isotopically depleted biogenic respired CO_2 (Sternberg et al. 1989; Grace et al. 1995; Buchmann et al. 1996; Lloyd et al. 1996), and (3) a gradient in light penetration inside the forest canopy (Ehleringer et al. 1986). With less light available for photosynthesis, the ratio of stomatal conductance to photosynthesis increases and the ci/ca ratio therefore, also rises (Farquhar et al. 1989). The isotopic fractionation resulting from limitation of light will produce plant organic matter depleted in ¹³C and this effect is indistinguishable from the isotopic effect produced by the contribution of biogenic CO_2 for photosynthesis. As a consequence of the last two factors, the "canopy effect" is observed, where leaves become progressively isotopically depleted towards the forest floor (Medina and Minchin 1980; Schleser and Jayasekera 1985; Medina et al. 1986; van der Merwe and Medina 1989; Sternberg et al. 1989; Kapos et al. 1993; Kruijt et al. 1996).

Most of the studies on variability in stable carbon isotopes in tropical forest plants are limited to a few number of samples collected at several heights in order to establish a gradient between leaf height and stable carbon isotope composition. As tropical forests are very diverse systems in terms of biodiversity (number of tree species) and environmental conditions (e.g., light penetration), we decided to explore in more detail the stable carbon isotope composition variability in a patch of undisturbed tropical forest. The opportunity for such study came when EletroNorte (the electric company for the north region of Brazil) supported a 2-week field campaign in 1-ha transects of *terra-firme* located in the Samuel Ecological Reserve. The objectives of this campaign were to estimate biomass, characterize nutrient cycling in the site (Brown et al. 1995) and, as already mentioned, examine the stable carbon isotope composition of the vegetation. In this study, we determined the variability in stable carbon isotopes in 208 tree leaves, 57 tree boles, and 18 litter samples found in 1 ha of *terra-firme* forest at Samuel Ecological Reserve.

This extensive database offers the opportunity to explore several aspects of the carbon stable isotope composition of tropical plants.

Materials and methods

The study was conducted in an area of 20,000 ha within the Ecological Reserve of Samuel (8°45' S, 63°23' W), bordering the Samuel Hydroelectric Reservoir. The dominant upland forest type in the reserve is tropical moist forest (classification of Holdridge et al. 1971). In the RADAMBRASIL classification, the major forest type for this region at the 1:1,000,000 scale is open forest (floresta aberta) with the presence of palms and lianas (Departamento Nacional de Produção Mineral, Brazil 1978). Sampling was conducted in three subtransects, two (subtransects 1 and 2) with an area of 3,000 m² (10 m by 300 m) and the remainder (subtransect 3) 4,000 m² (10 m by 400 m), making a total of 1 ha study area. A total of 474 trees with a diameter at 1.35 m greater than 10 cm were mapped. These individuals belonged to approximately 220 species classified in 41 botanical families. From this total, leaves of 208 trees from approximately 100 species were collected for isotopic analysis. Several leaves from branches collected for botanical classification were sampled and formed a unique sample. Only leaves with a healthy aspect were collected, avoiding yellow to brownish leaves. Leaves were collected approximately in the middle and only on one side of the crown. During the field campaign, we measured two heights for trees: a total height that corresponds to the top of the crown and one that corresponds to approximately the middle of the crown. These latter heights are listed in Appendix 1 and 2 and were those used to correlate with leaf δ^{13} C values. We are aware that the ideal situation would have been to collect leaves from more than one height within the crown and from more than one side. However, we had just one climber, who, in 10 days, climbed and sampled 474 trees. Considering the logistic difficulties faced in a tropical forest, more accurate sampling would be virtually impossible during 2 weeks. It is appropriate to remember that Bassow and Bazzaz (1997) pointed out that sampling foliage from the top of trees in natural forests poses many logistical problems, and they concluded that such difficulties have been the main cause of small sample sizes in terms of number of trees in canopy research. Working within these restrictions, we selected 57 trees for bole samples among 474 trees. These trees were selected in order to encompass a broad range of height and diameter. Samples of wood from bole were taken using a tree auger. To avoid damaging the tree, the hole made with the auger was closed and the region was covered with a fungicide. The 1-ha transect was subdivided into 40 parcels of 250 m² each. From this total, we randomly choose 18 parcels where we sampled fine litter. In each parcel we collected litter inside a square of 1-m² that was placed in five positions in each parcel: in its four corners and in the center. These five subsamples were combined into one sample representative of that parcel. For more details about the study area and transect sampling refer to Brown et al. (1995).

Samples were combusted for 12 h with CuO in evacuated tubes at 550°C. Isotope measurements were performed with a Finnigan Delta-E mass spectrometer fitted with double-inlet and doublecollector systems. Results are expressed in $\delta^{13}C$ relative to a PDB standard, defined as:

$$\delta^{13}C = (R_{\text{sample}}/R_{\text{std}}) - 1 * 1,000$$

where R_{sample} and R_{std} are the ratio ${}^{13}\text{C}:{}^{12}\text{C}$ of the sample and standard, respectively. Samples were analyzed at least in duplicate with a maximum difference of $0.2\%_{oo}$ between replicates. The average values are followed by ± 1 SD and by the number

The average values are followed by ± 1 SD and by the number of samples used to compose that average. For differences among leaves, bole, and litter, we used the *t*-test for unequal variance with the STATISTICA package. For differences among families, we used ANCOVA blocking for height, also using the STATISTICA package.

Results and discussion

The δ^{13} C values of tree leaf samples at Samuel are shown in Appendix 1. The average $\delta^{13}C$ of leaves was $-32.1 \pm 1.5\%$ (n = 208), which is significantly more negative (P < 0.001) than bole samples, with an average of $-28.4 \pm 1.8\%$ (n = 57) and fine litter, averaging $-28.7 \pm 2.0\%$ (n = 18). The box-whisker plot of δ^{13} C values for leaves, boles, and fine litter can be seen in Fig. 1. The range of values for leaves was from -36 to -28%, which is within the range found for tropical and subtropical forests (Table 1). With the exception of one very negative value (-34.2%), the δ^{13} C values in bole samples varied from -31.6 to -25.4%, and in fine litter samples from -32.0 to -24.1% (Fig. 1). The heavier isotopic values found in boles in comparison to leaves is a common feature in plants, both from tropical systems (Medina et al. 1986, 1991) and from temperate regions (Francey et al. 1985; Leavitt and Long 1986). From the 57 trees sampled for wood, 33 also provided leaf δ^{13} C values. Comparing δ^{13} C values of leaves and wood samples from these trees, for only one tree was the isotope value for wood lighter than in the leaves. In this case, the bole was 0.85% lighter than the leaves. Excluding this exception, the smallest isotope enrichment observed between leaves and wood was 1.2% and the



Fig. 1 Box-whisker plots of δ^{13} C values for leaves, boles, and fine litter. The *full circle* indicates the average values, *boxes* are the SEs of the average values, and *bars* represent 1 SD

 $\delta^{13}C~(\rlap{hoo})$ Site Forest type Reference Terra-firme Rondônia (Brazil) -32.1This study S.C. do Rio Negro (Venezuela) Terra-firme -32.1Media and Minchin (1980) Amazon river (Brazil) Várzea -32.1Martinelli et al. (1994) Paracou (French Guiana) Terra-firme -32.1Buchmann et al. (1997a) -31.6 Ducatti et al. (1991) Manaus (Brazil) Terra-firme Luquillo (Puerto Rico) Tabonuco -31.6Medina et al. (1991) Ding Hu Shan (China) -31.1Ehleringer et al. (1987) Monsoon Pantanal (Brazil) Arboreal savanna -30.9Victoria et al. (1995) -30.8Manaus (Brazil) Terra-firme Kapos et al. (1993) Luquillo (Puerto Rico) Tabonuco -30.7Fischer and Tieszen (1995) Luquillo (Puerto Rico) -30.5Fischer and Tieszen (1995) Colorado Hokaiddo (Japan)^a Broad-leaved trees -29.5Hanba et al. (1997) -29.0Jülich (Germany)^a Fagus sylvatica Schleser (1992) Utah (USA)^a Pinus contorta and P. tremuloides -27.3Buchmann et al. (1997b)

P. mariana, P. banksina, P. tremuloides

^aTemperate sites

Prince and Thompson Albert (Canada)^a

largest almost 9%. The average enrichment was $4.2 \pm 2.4\%$ (n = 33).

There are two major explanations for isotopic differences between bole and leaf organic matter. Leavitt and Long (1986) hypothesized that respiratory effects cause this difference, suggesting that respiration releases isotopically light carbon. Thus, the remaining pool available for biomass production in the bole becomes isotopically heavier. Francey et al. (1985) hypothesized that the relative timing of carbohydrate export causes this difference between leaves and boles. Apart from differences among wood and leaf samples, δ^{13} C values of bole samples showed 6% variation. This variation may be caused in part by the so-called "canopy effect." In other words, the $\delta^{13}C$ value of wood samples would be related to tree height. Pooling the δ^{13} C values for wood samples of the same tree height gave averages which were positively correlated with plant height at a highly significant level, with a slope of 0.09 and an intercept of -30.5%, and a correlation coefficient $r^2 = 91\%$ (P < 0.001). This correlation between tree height and $\delta^{13}C$ of wood implies that this tissues can also be used to test the "canopy effect" (Fig. 2). Since it is easier to sample wood than leaves in tropical forests, this may facilitate future sampling in forests. In contrast, Schleser (1992) did not find a significant correlation between wood and height in a 140-year-old Fagus sylvatica forest near Jülich, Germany. Schleser (1992) hypothesized that the CO_2 fixed by the leaves of the lower branches, which have lighter δ^{13} C values, does not supply a significant amount of carbon to the corresponding twigs and branches. Accordingly, the bole will receive carbon from the upper part of the tree, which has heavier δ^{13} C values. These heavier values would prevail all along the bole. The good correlation between δ^{13} C values of the wood in the boles and tree height in our samples, however, suggests that the same is not occurring in Samuel tropical forest. If future results confirm such a difference between tropical and tem-



-26.9

Flanagan et al. (1996)

Fig. 2 Relationship between tree height classes and average $\delta^{13}C$ of leaves (\bullet) and wood (\bigcirc) from boles. Bars represent 1 SD

perate forests, this may indicate that different mechanisms of carbon transfer are operating in tropical and temperate trees.

In general, the negative δ^{13} C values observed for tree leaves in part characterize an open system regarding the balance of stomatal conductance to photosynthesis (Farquhar et al. 1982). These negative values are determined by the higher ratios of stomatal conductance to photosynthesis, leading to high ci/ca ratios, that in turn lead to a higher fractionation in relation to the atmospheric CO₂ and consequently lower δ^{13} C values in relation to temperate systems (Table 1).

Some variability was observed among leaves of individuals of the same species collected at approximately the same height and near to each other. For instance, leaves of *Protium robustum* (tree numbers 424 and 444) differed by almost $3\%_0$. A similar difference was also found for *Tachigalia paniculata* (tree numbers 305 and 314) and for *Pseudomedia laevis* (tree numbers 331 and 396). Such inter- and intra-species variation has been found elsewhere. Berry et al. (1997) found a variation of $4\%_0$ among understory plants species in a *Pinus resinosa* plantation located south of Ottawa, Canada. They at-

Table 1 Average δ^{13} C (%) values of tree leaves in distinct sites and types of forest

tributed such variability mainly to differences in CO_2 assimilation and conductance rates among the four species. Walcroft et al. (1996) found that the gas exchange of *Pinus radiata* foliage was affected by branch morphology. They found a variation of $3.8\%_0$ between short and long *P. radiata* branches collected in New Zealand.

It is difficult to pinpoint causes for such variability since forest canopies are heterogeneous environments with regard to the light exposure of different leaves and, consequently, photosynthetic characteristics within the canopy (Lloyd et al. 1996; Bassow and Bazzaz 1997; Berry et al. 1997). Intra-specific differences caused by structural and compositional differences between leaves (Schleser and Jayasekera 1985; Hubick et al. 1986; Broadmeadow and Giffiths 1993), leaf age, and position in the crown (Gebauer and Schulze 1991) may play a role. The latter exposes leaves to different microclimates, and key environmental parameters like leaf-to-air vapor pressure (Farquhar et al. 1989) and light intensity (Ehleringer et al. 1986, 1987; Pearcy and Pfitsch 1991). The mutual effects of all these variables will determine the photosynthetic rate of a specific leaf which in turn will affect ci/ca that, together with the isotope ratio of source CO_2 is a dominant factor affecting variation in isotopic discrimination by C₃ plants (Hubick et al. 1988; Hanba et al. 1997).

Comparisons within species or even within genera were not possible with this dataset because tropical rain forests are characterized by high species diversity, with few individuals of the same species within a particular area. This makes statistical comparisons difficult, even for cases where there are enough individuals of the same species, since they tend to differ in height, precluding direct comparisons. However, there are a number of samples encompassing a broad range of heights within families. This is especially the case for four families: Burseraceae, Casealpinaceae, Lecythidaceae, and Moraceae. The average δ^{13} C of these families varies from -31.4 to -32.0‰, without any statistical difference among them, tested by ANCOVA blocking for height.

Pooling the δ^{13} C values for leaf samples of the same height gave averages which were positively correlated with plant height at a highly significant level, with a slope of 0.06 and an intercept of -33.3% and a correlation coefficient $r^2 = 70\%$ (P < 0.001). Previous studies did not have a sufficient sample number to permit the use of regressions, or to evaluate the variability in the data (Medina and Minchin 1980; Schleser and Jayasekera 1985; Medina et al. 1986; van der Merwe and Medina 1989; Sternberg et al. 1989; Kapos et al. 1993). Kruijt et al. (1996), also working in Rondonia State, at Reserva Jaru, also found a good correlation between $\delta^{13}C$ of leaves and height above the forest floor. They found a broader range of variation in δ^{13} C values with height than we found in Samuel. The most depleted average value in Samuel was -34.0%, whereas in the Reserve Jaru, δ^{13} C values varied from -35.0 to -38.0% for the understory foliage. In Samuel, the most enriched average value was -31.0%, while in Reserva Jaru, a δ^{13} C value of -29% was found at 30 m height.

Given that light penetration appears to be not only a function of height but also of forest structure, we found it useful to try to find a better relationship between leaf isotopic values and forest structure. Lieberman et al. (1989) noted that the simple dichotomy of forest structure into forest and gaps could be too simplistic. Indeed, the forest at any given geographic site in Samuel was once a gap sometime in the past few hundred years. Consequently, the forest can be considered a mosaic of tree patches recovering from gap disturbance. From this perspective, the light regime and relative contribution of CO_2 from the atmosphere overhead and from respiration on the ground is not only a function of the leaf height on a given tree but also of the distribution of trees around that tree. To estimate the effect of the surrounding taller trees on the local environment of sample trees, we used Lieberman et al.'s (1989) suggestion of calculating the sine of the vertical angles between surrounding taller trees and the sample tree. These sine values were then summed for taller trees in a 10-m radius of the sample to derive a G value for each tree sampled. Due to the narrow nature of the transect (10 m), these sample circles covered only between 50 and 61% of the transect; as a result, shading by taller trees outside the transect is not incorporated. Emergent trees have a Gvalue of 0, while small trees often have G values above 10 (Table 2). The working hypothesis is that for trees of the same height, those with higher G values will have more negative $\delta^{13}C$ because the surrounding taller trees will impede penetration of overlying atmospheric air and the light intensity will be lower. This working hypothesis is based on the fact that Broadmeadow and Griffiths (1993) have shown that the stratification of CO_2 within the canopy is dependent on canopy formation, while more recently, Buchmann et al. (1996) have shown that stratification of

Table 2 Average δ^{13} C of leaves (%) and average G values composed by tree height classes (m)

Height class	Aveage $\delta^{13}C$	Avearge G
3–5	-34.00	7.32
5–7	-32.48	5.33
7–9	-32.87	6.03
9–11	-32.14	4.41
11-13	-32.31	3.85
13-15	-31.94	4.16
15-17	-32.49	2.18
17–19	-31.99	2.23
19–21	-32.05	1.28
21-23	-31.86	1.28
23-25	-31.64	1.30
25-30	-31.13	0.57
30-40	-31.21	0.49

 CO_2 within the canopy is also dependent on the stand structure and on the vegetation type.

Multiple linear regression with data from Table 2, using δ^{13} C values against height and *G* values yields $r^2 = 76\%$ (P < 0.001), which was not significantly higher than the r^2 found before. Therefore, *G* values do not help to explain the variability observed within the canopy. A variety of other mechanisms previously listed must also be playing a role in the variability of δ^{13} C values in tree leaves. But, more important, the "canopy effect" prevailed over a large number of different tree species, indicating that the δ^{13} C values of atmospheric CO₂ and light penetration within the forest canopy are the driving forces of the δ^{13} C values of tree leaves within forests.

In the introduction we listed three factors that can promote variability in δ^{13} C values in tropical forests. Bassow and Bazzaz (1997) have demonstrated that photosynthesis can vary among species and even within an individual tree in temperate forests. If this is also true for tropical forests, the high number of individuals per hectare and the high number of species would promote a highly variable environment in terms of photosynthesis, which in turn will affect the δ^{13} C values of the vegetation. In addition to variation in photosynthesis itself, it has been shown that the light gradient within the canopy and even among understory plants can be responsible for much of the variation in the δ^{13} C of tree leaves (Berry et al. 1997). This can help explain differences in δ^{13} C values of leaves collected at the same height. Both of these factors (photosynthesis and light) would affect the ci/ca ratio, which with the recycling of isotopically depleted CO_2 of biogenic origin is responsible for the δ^{13} C of the vegetation. The relative importance of these two attributes is still being debated (e.g., Lloyd et al. 1996; Sternberg 1997). Broadmeadow and Griffiths (1993) summarized the proportion of respiratory flux reassimilated by the understory vegetation from the literature – values varied from 8 to 26%.

An important feature found here was the good correlation between wood samples and tree height. Considering that canopy sampling is not trivial (Bassow and Bazzaz 1997), this fact may facilitate future research in this area.

Appendix 1 Tree height (m) and δ^{13} C values (%) of leaves for species collected at Samuel Ecological Reserve, Rondônia

Tree	Species	Family	Height (m)	Leaf $\delta^{13}C(\rlap{hoo})$
1	Parkia cf. nitida Miq.	Leg-mimosaceae	12.0	-32.8
3	Pouteria sp.	Sapotaceae	17.5	-34.2
7	Duroia macrophylla Huber	Rubiaceae	9.0	-31.7
10	Richardella sp.	Sapotaceae	21.0	-31.5
11	Maquira guianensis Aubl.	Moraceae	12.5	-33.1
12	Bauhinia forticata Link	Leg-Caesalpiniaceae		-34.1
13	Parkia cf. nitida Miq.	Leg-Mimosaceae	24.0	-32.1
14	Oxandra xylopoides Diels	Annonaceae	22.7	-32.9
15	Licania latifolia Bth.	Chrysobalanaceae	13.5	-33.6
16	Euterpe precatoria Mart.	Palmae	14.0	-33.7
17	Brosimum guianensis (Aubl.) Huber	Moraceae	16.5	-32.0
18	Pithecellobium racemosa Ducke	Leg-Mimosaceae	16.5	-29.5
19	Naucleopsis imitans (Ducke) C.C. Berg	Moraceae	16.5	-32.4
26	Eschweilera coriacea (A.P.DC.) Mart. ex erg.	Lecythidaceae	10.7	-29.7
30	Copaifera multijuga Hayne	Leg-Caesalpiniaceae	33.3	-28.8
31	Endopleura uchi (Huber) Cuatr.	Humiriaceae	14.4	-31.4
33	Copaifera sp.	Leg-Caesalpiniaceae	28.3	-30.1
35	Dodecastigma intergrifolium (Lanj.) Lanj. & Sandw.	Euphorbiaceae	9.4	-32.0
37	Dialium guianense (Aubl.) Sandwith	Leg-Caesalpiniaceae	7.1	-32.9
39	Rheedia sp.	Guttiferae	10.1	-33.7
40	Mouriri sp.	Melastomataceae	11.1	-29.3
43	Naucleopsis glabra sp. ruce	Moraceae	15.3	-29.9
46	Eschweilera sp.	Lecythidaceae	18.2	-31.9
51	Pseudomedia laevis (R. & P.) Macbr.	Moraceae	23.6	-30.4
53	Heliocostylis tomentosa (P. & E.) Rusby	Moraceae	29.3	-28.8
58	Protium cf. carnosum A.C. Smith	Burseraceae	14.5	-32.3
61	Tymatococcus amazonicus P. & E.	Moraceae	15.8	-32.3
65	Theobroma subincanum Mart.	Sterculiaceae	18.0	-32.9
68	Tymatococcus amazonicus P. & E.	Moraceae	22.4	-31.9
76	Pseuldomedia sp.	Moraceae	19.9	-31.8
77	Undetermined	Myrtaceae	10.5	-32.7
82	Bocageopsis multiflora (Mart.) R.E. Fries	Annonaceae	24.8	-33.3
83	Theobroma subincanum Mart.	Sterculiaceae	3.5	-34.1
86	Apeiba echinata Gaertn.	Tiliaceae	14.8	-32.5
87	Bocageopsis multiflora	Annonaceae	22.3	-31.8
96	Peltogyne cf. heterophylla M.F. da Silva	Leg-Caesalpiniaceae	10.9	-31.6
98	Tourouli guianensis Aubl.	Quiinaceae	15.9	-31.6
104	Peltogyne cf. heterophylla M.F. da Silva	Leg-Caesalpiniaceae	28.1	-32.2
109	Naucleopsis imitans (Ducke) C.C. Berg	Moraceae	21.0	-33.2

Appendix 1 (contd.)

Tree	Species	Family	Height (m)	Leaf $\delta^{13}C(\rlap{hoo})$
110	Undetermined	Moraceae	15.5	-32.0
111	Minquartia guianensis Aubl.	Olacaceae		-33.5
113	Maquira calophylla (P. & E.) C.C. Berg	Moraceae	21.0	-31.2
116	Rauwola paraensis Ducke	Apocynaceae	17.8	-28.6
117 120	Brosimum guianensis (Aubl.) Huber Undetermined	Moraceae Icacinaceae	11.3 14.7	-33.8 -31.6
120	Naucleopsis imitans (Ducke) C.C. Berg	Moraceae	16.4	-32.6
123	Peltogyne prancei M.F. da Silva	Leg-Caesalpiniaceae	15.9	-31.3
131	Andira parviflora Ducke	Leg-Papilionaceae	12.7	-33.1
133	Cecropia sp.	Moraceae	23.3	-34.5
135	Coepia guianensis Aubl.	Chrysobalanaceae	22.5	-33.1
143	Amaioua corymbosa H.B.K.	Rubiaceae	6.0	-31.4
151	Eschweilera sp.	Lecythidaceae	17.5	-32.2
152	Micropholis sp.	Sapotaceae	8.8	-31.7
157	Sapotaceae sp.	Sapotaceae	21.0	-32.5
161	Eschweilera sp.	Lecythidaceae	11.0	-31.4
169	Brosimum mollis	Moraceae	8.9	-31.6
171	Grisma densiflora sp. ruce ex Warm	Vochysiaceae	22.5	-30.2
179	Pithecellobium cauliflorum (illd) Bth	Leg-Mimosaceae	5.0	-34.5
180	Malouetia tamaquirana	Apocynaceae	19.0	-33.6
182 186	Undetermined <i>Lecythidaceae</i> sp.	Apocynaceae	19.6 16.5	-34.1 -31.6
180	Heisteria sp. ruceana Engl.	Lecythidaceae Olacaceae	14.1	-31.9
190	Iryanthera sp.	Myristicaceae	9.0	-32.3
196	Licania micrantha Miq.	Myrtaceae	16.5	-33.7
200	Undetermined	Chrysobalanaceae	10.5	-32.8
202	Undetermined	Palmae	15.9	-35.9
206	Cordia ucayliensis Johnston	Boraginaceae	19.1	-30.0
214	Guarea pubescens	Meliaceae	7.5	-32.1
218	Protium opacum Swart	Burseraceae	24.0	-31.9
221	Amphirrox cf. latifolia Mart.	Violaceae	17.1	-31.7
222	Crepidosp. ermum cf. goudotiana (Tul.) Tr. & Pl.	Burseraceae	15.0	-33.7
233	Couratari sp.	Lecythidaceae	33.5	-30.2
235	Undetermined	Moraceae	28.5	-30.1
237	Cariniana decandra Ducke	Lecythidaceae	34.0	-29.8
240 243	<i>Licania lata</i> Macbrid <i>Leonia</i> cf. <i>crassa</i> Smith.	Chrysobalanaceae Violaceae	4.5 23.5	-33.5 -32.5
243 244	Pseudomedia laevis (R. & P.) Macbr.	Moraceae	25.5 25.5	-32.5
250	Inga cf. capitata Willd	Leg-Mimosaceae	12.7	-32.9
254	Tachigalia paniculata Aubl.	Leg-Caesalpiniaceae	20.4	-31.9
255	Quararibea muricata Cuatr.	Bombacaceae	12.1	-33.3
256	<i>Lindackeria paludosa</i> Bth. ex Eichl.	Flacourtiaceae	12.7	-32.0
260	Undetermined	Lauraceae	18.3	-33.7
265	Payparola cf. guianensis Aubl.	Violaceae	15.5	-33.6
267	Manilkara longiciliata Ducke	Sapotaceae	13.4	-32.6
270	Bombacopsis cf. nervosa (Vitt.) A. Robyns	Bombacaceae	23.3	-28.0
271	Micropholis cf. venuloso (Mart. Eichl.) Pierre	Sapotaceae	11.7	-32.0
275	Calophyllum sp.	Guttiferae	12.0	-33.4
277	Protium cf. krukofii Swart	Burseraceae	22.3	-33.2
279	Clarisa racemosa R. et P.	Moraceae	26.2	-30.6
280	Sterculia excelsa Mart.	Sterculiaceae	12.2	-29.9
285 286	<i>Tavomita</i> sp. Undetermined	Guttiferae	18.0 18.0	-31.0 -32.3
280 294	Metrodorea flavida rause	Burseraceae Rutaceae	16.5	-32.5
299	Diosp. yros subrolata Hiern.	Ebenaceae	14.0	-31.5
300	Hevea cf. brasiliensis Muell. Arg.	Euphorbiaceae	18.8	-28.9
305	Tachigalia paniculata Aubl.	Leg-Caesalpiniaceae	24.0	-32.3
309	Cordia ucayliensis Johnston	Boraginaceae	12.0	-34.3
311	Undetermined	Hippocrateaceae	7.0	-33.3
312	Astronium fraxinifolium Schott	Anacardiaceae	9.0	-33.8
313	Dacryoides cf. sclerophylla Cuatr.	Burseraceae	18.3	-32.8
314	Tachigalia paniculata Aubl.	Leg-Caesalpiniaceae	20.5	-29.9
315	Heliocostylis tomentosa (P. & E.) Rusby	Moraceae	32.6	-30.4
317	Inga cf. alba Willd	Leg-Mimosaceae	14.1	-31.1
318	Castiloa ulei Warb	Moraceae	13.5	-28.3
471	Undetermined	Lauraceae	23.7	-32.1
321		T		22.1
322 324	<i>Eschweilera</i> sp. <i>Socratea</i> cf. <i>exorrhiz</i> a (Mart.) Barb. Rodr.	Lecythidaceae Palmae	17.7 7.0	-33.1 -32.0

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Appendix 1 (contd.)

331 Pseudomedia laevis (R. & P.) Macbr. Moraceae 1 333 Undetermined Leg-undetermined 1 334 Undetermined Leg-undetermined 1 334 Undetermined 1 1 334 Trattinickia sp. Burseraceae 2 339 Protium of. robustum (Swart) Porter Burseraceae 2 344 Helicocoxityis tomentosa (P. & E.) Rusby Moraceae 2 344 Helicocoxityis tomentosa (P. & E.) Rusby Moraceae 1 344 Helicocoxityis tomentosa (P. & E.) Nusby Moraceae 1 345 Pseudomedia laevis (R. & P.) Macbr. Moraceae 1 346 Exterpe precatoria Mart. Palmae 1 350 Naucleopsis glabra sp. ruce Moraceae 1 351 Pseudomedia laevis (R. & P.) Macbr. Moraceae 1 352 Undetermined Lurysobalanaceae 1 353 Maguira calophylla (P. & E.) CC. Berg Moraceae 1 354 Leopila dia carous Smith. Violaceae 1 355 Loria macemosa Sm	Height (m)	Leaf $\delta^{13}C(\%$
333 Undetermined Lecythidaceae 334 Undetermined Lecythidaceae 337 Guatteria sp. Annonaceae 338 Trattinickia sp. Burseraceae 1 338 Trattinickia sp. Burseraceae 1 338 Frottinicki sp. Burseraceae 1 343 Sorocca guillemiana Guaud Moraceae 1 344 Heliocastlyis tomperators (P, & E.) Rusby Moraceae 1 345 Sorocca guillemiana Guaud Moraceae 1 346 Eschweilera contacea (A.P.D.C.) Mart, ex eg. Anacardiaceae 11 347 Anacardiana sp. race Moraceae 1 348 Eurept percentrine Mart, Halmae 1 350 Youdeensis gubata sp. race Moraceae 1 351 Leadian macrophilla Bh. Nonaceae 2 352 Leadian macrophilla Bh. Burseraceae 1 353 Leadian macrophilla Bh. Burseraceae 1 354 Undetermined Moraceae 2 355 Machadeaphilla Aubl.	16.5	-31.2
313 Undetermined Leg-undetermined 1 313 <i>Trattitickia</i> sp. Annonaccae 2 313 <i>Trattitickia</i> sp. Burseraccae 2 314 <i>Amphirrox cl. latifola</i> Mart. Violaccae 1 412 <i>Amphirrox cl. latifola</i> Mart. Violaccae 1 414 <i>Helicoxstrifus tomentosa</i> (P. & E.) Rusby Moraccae 2 414 <i>Helicoxstrifus tomentosa</i> (P. & E.) Rusby Moraccae 1 414 <i>Eucordina giganicum</i> Hane. ex Engl. Anacardiaccae 1 415 <i>Eucordina giganicum</i> Hane. ex Engl. Anacardiaccae 1 416 <i>Eucordina sp. ruce</i> Moraccae 1 417 <i>Anacardiaccae</i> Smith. Palmae Leavindecae 1 418 <i>Eucorsta functoreas</i> Smith. Violaccae 2 1 419 <i>Lacania macrophylla</i> Bth. Violaccae 2 1 510 <i>Lacania macrophylla</i> Bth. Cripidop. ennum Carbipia nitida Dun. Anonaccae 1 513 <i>Medianic calophylla</i> Bth. Violaccae 1 1 1	16.9	-34.2
37 Guatteria sp. Annonaccee 1 38 Tratinicka sp. Buseracceae 1 39 Protium cf. robustum (Swart) Porter Buseracceae 1 42 Amphirox cf. Int/fold Mart. Violacceae 1 43 Sorocce guillemian Guaud Moracceae 1 44 Helicostrylis tormetosa (P. & E. J. Rusby Moracceae 1 44 Helicostrylis tormetosa (P. & E. J. Nusby Moracceae 1 45 Pseudometha lacvis (R. & P.) March. Moracceae 11 46 Eschweilera contaccea (R. DC.) Mart. ex erg. Lecylhidacceae 11 47 Anacardiacceae 12 Undetermined Karacceae 12 50 Kaucepsis glabra sp. race Moracceae 12<	9.2	-31.9
38 Tratitiickä sp. Burseraceae 2 39 Protitim of, robustum (Swart) Porter Burseraceae 1 42 Amphirrox el, latifolia Mart. Violaceae 1 43 Soracea guillemiana Guaud Moraceae 1 44 Heliocostylis tomentosa (P. & E.) Rusby Moraceae 2 45 Eschweilera coriacea (A. P.DC.) Mart, ex erg. Lecythidaceae 1 46 Eschweilera chartacea Berg. Moraceae 1 50 Natcleopsis glabra sp. race Moraceae 1 51 Pseudomedia laevis (R. & P.) Macbr. Moraceae 1 52 Undetermined Burseraceae 1 53 Leonia cl. crosus Smith. Violaceae 2 54 Leonia cl. crosus Smith. Violaceae 2 55 Licania macrophylla Bih. Chrysobalanaceae 1 56 Ladetermined Burseraceae 1 57 Statia paniculata Aubl. Burseraceae 1 58 Maquira colophylla (P. & E.) C.C. Berg Moraceae 2 59 Licania macrophylla Bih. Moraceae 2 50 Latermined Burseraceae 1 51 Statigapis sp. Morace	15.0	-32.5
39 Protium (C. robustum (Swart) Porter Burseraceae 1 42 Amphirros C. Lafidola Mart. Violaceae 1 43 Sarocea guillemiana Guaud Moraceae 1 44 Helicostylis tomentosa (P. & E.) Rusby Moraceae 1 45 Pseudomedia laevis (R. & P.) Macbr. Moraceae 1 46 Eschweilera coriacea (A. P.) D.C.) Mart. ex erg. Lecythidaceae 1 47 Anacardiae gigantaean Hanc. ex Engl. Anacardiaecae 11 48 Eschweilera characeae Brg. Lecythidaceae 11 50 Naucleopsis glabra sp. race Moraceae 12 51 Dicdetermined K. P.) Macbr. Moraceae 12 52 Undetermined K. P.) Macbr. Moraceae 12 53 Lecain accorphylla (P. & E.) C.C. Berg Moraceae 12 54 Undetermined Burseraceae 12 55 Licain amacrophylla (P. & E.) C.C. Berg Moraceae 12 56 Undetermined Burseraceae 12 57 Asprolon cone 12 14 Anonace	12.0	-31.8
42 Amphirrox cf. latifolia Mart. Violaceae 1 43 Sorceae guilleminan Guaud Moraceae 12 44 Heliocostylis tomentosa (P. & E.) Rusby Moraceae 12 45 Pseudomedia laevis (R. & P.) Machr. Moraceae 12 46 Eschweilera coriacea (A.P.DC.) Mart. ex erg. Lecythidaceae 11 47 Anacarding giganteum Hanc. ex Engl. Anacardiaeeae 11 48 Euterps precatoria Mart. Palmae 12 49 Eschweilera coriacea Berg. Lecythidaceae 13 50 Naucleopsis gibbars sp. ruce Moraceae 13 51 Pseudomedia laevis (R. & P.) Macbr. Moraceae 14 52 Licania macrophylla Bth. Chrysobalanaceae 14 63 Undetermined Burseraceae 11 64 Dachermined Burseraceae 11 65 Wadetermined. Apocynaceae 14 64 Tachigalia paniculata Aubl. Leg-Caesalpiniaceae 11 74 Tachigalia paniculata Aubl. Moraceae 22 76 Cl	25.5	-31.7
43 Sorieves guillemian Guaud Moraceae 12 44 Helicostylis tormentosa (P. & E.) Rusby Moraceae 12 45 Pseudomedia laevis (R. & P.) Macbr. Moraceae 11 46 Eschwellera coriacea (A. P.DC.) Mart. ex erg. Lecythidaceae 11 47 Anacardiane gigamean Hanc. ex Engl. Anacardiaceae 11 48 Eschwellera characea Brg. Lecythidaceae 11 50 Naucleopsis glabra sp. ruce Moraceae 23 51 Loind ef. crassa Smith. Violaceae 23 52 Undetermined Burseraceae 11 63 Grisma bicolor Ducke Vochysiaceae 12 64 Maguira calophylla (P. & E.) C.C. Berg Moraceae 22 76 Crepidosp. ermum of. goudotiana (Tul.) Tr. & Pl. Burseraceae 12 65 Undetermined Burseraceae 12 66 Naucleopsis sp. Moraceae 2 67 Grisma bicolor Ducke Vochysiaceae 14 7 Tachigala paniculata Aubl. Leg-Caesalpiniaceae 12 7	11.9	-32.9
44 Heliocoryliki tomentosa (P. & E.) Rusby Moraceae 2 45 Psculomedia laevis (R. & P.) Macbr. Moraceae 1 46 Exchweilera coriacea (A.P.DC.) Mart. ex erg. Lecythidaceae 1 47 Anacardium giganteum Hanc. ex Engl. Anacardiaceae 11 48 Euterpe precatoria Mart. Palmae 1 49 Eschweilera chartacea Berg. Lecythidaceae 11 50 Naucleopsis gibtors sp. ruce Moraceae 13 51 Pscudomedia laevis (R. & P.) Macbr. Moraceae 12 52 Undetermined Lauraceae 13 53 Leonia cl. crassa Smith. Violaceae 12 54 Maquira calophylla Bth. Chrysobalanaceae 12 55 Undetermined Burseraceae 14 66 Undetermined Burseraceae 14 66 Naucleospis sp. Moraceae 14 74 Tachigdia panichata Aubl. Leg-Caesalpiniaceae 14 75 Ag. idosp. erma sp. Apocynaceae 14 76 Clarisa raemosa R. et P. Moraceae 22 79 Brosimum guianesis Aubl. Moraceae 24 71 Leonia cf. crassa Smi	8.0	-32.6
45 Pseudomédia laevis (R. & P.) Macht, * Moraceae II 46 Extenveitra coriacea (A.P.DC.) Mart, ex erg, Lecythidaceae Lecythidaceae II 47 Anacardium giganteum Hane, ex Engl. Anacardiaceae II 48 Euterpe precutoria Mart. Palmae II 49 Eschweiltera characeae Brg. Lecythidaceae II 50 Naucleopsis glabra sp. ruce Moraceae II 51 Dia et al. crassa Smith. Violaceae II 52 Undetermined Burseraceae II 53 Econia macrophylla Bth. Chrysobalanaceae II 64 Grisma bicolor Ducke Vochysiaceae II 65 Undetermined Burseraceae II 66 Naucleospsi sp. Moraceae II 74 Tachigdia paniculata Aubl. Leg-Caesalpiniaceae II 75 Lorias racemosa R. et P. Moraceae II 76 Clarisa racemosa S. Mubl. Moraceae II 77 Leonia cl. crassa Smith. Violaceae II 78 Jobos, russ	15.9	-31.5
46 Eschweilera coriacea (A P. DC.) Mart, ex erg. Lecythidaceae 11 47 Anacardium gigmetum Hanc, ex Engl. Anacardiaceae 11 48 Euterpe precatoria Mart, Palmae 12 49 Eschweilera chartacea Berg. Lecythidaceae 11 50 Naucleopsis glabra sp. ruce Moraceae 32 51 Pseudomedia laevis (R. & P.) Macbr. Moraceae 33 55 Leonia cf. crassa Smith. Violaceae 23 56 Lorania macrophylla Bth. Chrysobalanaceae 12 63 Grisma bicolor Ducke Vochysiaceae 11 64 Nucleospis sp. Moraceae 21 65 Maqueospis sp. Moraceae 12 66 Naudesopsis sp. Apocynaceae 14 76 Claris ar acennos R. et P. Moraceae 14 77 Leonia cf. crassa Smith. Violaceae 22 78 Maquira guimensis (Aubl.) Huber Moraceae 22 79 Brosimum guianensis (Aubl.) Huber Moraceae 14 70 Undetermined Bu	28.4	-28.8
47 Anacardium giganteum Hanc, ex Engl. Anácardiaceae I 48 Enterpe precatoria Mart. Palmae Palmae 49 Eschweilera chartacea Berg. Lecythidaceae II 50 Naucleopsis glabra sp. ruce Moraceae II 51 Dicain al. crassa Smith. Violaceae II 52 Undetermined Chrysobalanaceae II 53 Econia cl. crassa Smith. Violaceae II 54 Carpidosp, ermun cl. goudotiana (Tul.) Tr. & Pl. Burseraceae II 55 Undetermined Burseraceae II Chrysobalanaceae II 65 Undetermined Burseraceae II Chrysobalanaceae II 66 Naucleopsis sp. Moraceae II Chrysobalanaceae II 74 Tachigalia paniculata Aubl. Leg-Caesalpiniaceae II II Charisa racemosa R. et P. Moraceae II 75 Ago indog: erma sp. Apocymaceae II Mogaura guianensis Aubl. Moraceae II 76 Clarisa racemosa Smith. Violaceae II <	12.0	-31.1
48 Enterpe precatoria Mart. Palmae 49 Extensition characea Berg. Lecythidaceae II 50 Naucleopsis glabra sp. ruce Moraceae II 51 Pseudomedia laevis (R. & P.) Macbr. Moraceae II 52 Leonia cf. crassa Smith. Violaceae 23 56 Leonia macrophylla Bth. Chrysobalanaceae 21 57 Licania macrophylla Bth. Chrysobalanaceae 11 63 Undetermined Burseraceae 11 64 Undetermined Burseraceae 12 65 Undetermined Burseraceae 11 66 Naucleospis sp. Moraceae 2 67 Anelesmis Sp. Moraceae 12 68 Ny, idosp. erma sp. Apocynaceae 14 70 Clarisa racemosa R. et P. Moraceae 2 71 Leonia cf. crassa Smith. Violaceae 2 72 Brosimum guianensis Aubl. Moraceae 2 73 Maguira guianensis Aubl. Lauraceae 14 74 Undete	15.5	-30.5
49 Eschweilera chartacea Berg. Lecythidaceae 1 50 Naucleopsis glabra sp. ruce Moraceae 1 51 Dindetermined Lauraceae 11 52 Undetermined Lauraceae 11 53 Pseudomedia laevis (R. & P.) Macbr. Moraceae 22 54 Licani and corphylla Bth. Violaceae 22 55 Licani anaccophylla Bth. Chrysobalanceae 22 56 Undetermined Burseraceae 11 56 Undetermined Burseraceae 12 56 Undetermined Burseraceae 12 56 Undetermined Leg-Caesalpiniaceae 11 56 Violaceae 14 Tachigalia paniculata Aubl. Leg-Caesalpiniaceae 12 57 App. jidsop. erma sp. Apocynaceae 14 Maquira guianensis (Aubl.) Huber Moraceae 22 58 Gaurae pubescens Meliaceae 14 Lauraceae 14 57 Brosimun guianensis (Aubl. Moraceae 22 16 58 Gachigalia paniculata Aubl. </td <td>10.0</td> <td>-32.5</td>	10.0	-32.5
50 Naucleopsis glabra sp. ruce Moraceae I 52 Undetermined Lauraceae II 55 Pseudomedia laevis (R. & P.) Macbr. Moraceae I 56 Leonia cf. crassa Smith. Violaceae 2 57 Licania macrophylla Bth. Chrysobalanaceae 1 59 Licania macrophylla Bth. Chrysobalanaceae 1 63 Grisma bicolor Ducke Vochysiaceae 1 64 Naucleopsis sp. Moraceae 2 65 Undetermined Burseraceae 1 7 Tachigalia paniculata Aubl. Lege-Caesalpiniaceae 1 7 Tachigalia paniculata Aubl. Noraceae 1 7 Leonia cf. crassa Smith. Violaceae 1 7 Leonia cf. crassa Smith. Violaceae 2 70 Brosimur guianensis (Aubl.) Huber Moraceae 2 70 Brosimur guianensis (Aubl.) Huber Moraceae 1 70 Undetermined Baryaceae 1 80 Undetermined Burseraceae 1		-29.5
52 Undetermined Lauraceae 11 53 Pseudomedia laevis (R. & P.) Macbr. Moraceae 32 54 Leonia cl. crassa Smith. Violaceae 22 55 Maquira calophylla (P. & E.) C.C. Berg Moraceae 12 56 Licania macrophylla Bth. Chrysobalanaceae 12 57 Licania macrophylla Bth. Chrysobalanaceae 12 58 Maquira calophylla (P. & E.) C.C. Berg Moraceae 12 56 Licania macrophylla Bth. Chrysobalanaceae 12 57 Argoira aliana Sp. Moraceae 12 58 Walerennined Burseraceae 11 56 Larachigalia paniculata Aubl. Leg-Caesalpiniaceae 14 76 Clarisa racemosa R. et P. Moraceae 22 77 Leonia cf. crassa Smith. Violaceae 14 78 Maquira guianensis Aubl. Moraceae 22 80 Undetermined Lauraceae 14 78 Undetermined Lauraceae 14 79 Brosimum guianensis Aubl. Diaceae	10.0	-29.9
55Pseudomedia laevis (R. & P.) Macbr.Moraceae356Leonia cf. crassa Smith.Violaceae258Maquira calophylla (P. & E.) C.C. BergMoraceae159Licania macrophylla Bth.Chrysobalanaceae262Crepidosp. ermun cf. goudotiana (Tul.) Tr. & Pl.Burseraceae163Grisma bicolor DuckeVochysiaceae164MudeterminedBurseraceae165UndeterminedAnnonaceae174Tachigalia paniculata Aubl.Leg-Caesalpiniaceae175Asp. idosp. erma sp.Apocynaceae176Clarias racemosa R. et P.Moraceae279Brosimum guianensis (Aubl.) HuberMoraceae279Brosimum guianensis (Aubl.) HuberMoraceae270UndeterminedLauraceae171Leonia cf. crassa Smith.Violaceae172Leonia df. crassa Smith.Violaceae273Brosimum guianensis (Aubl.) HuberMoraceae274Tachigalia paniculata Aubl.Leg-Caesalpiniaceae475MeaterminedBurseraceae176Clarigalia paniculata Aubl.Leg-Caesalpiniaceae277Brosimus sh Aubl.Olacaceae178Maquira guianensis Aubl.Olacaceae179Brosima sh Aubl.Olacaceae170Chrigalia sp.Leg-Caesalpiniaceae271Arachigalia sp. <td>11.0</td> <td>-30.7</td>	11.0	-30.7
56Leonia cf. crassa Smith.Violaceae258 $Maquira calophylla (P, & E.) C.C. BergMoraceae1:59Licania macrophylla (Bth.Chrysobalanaceae1:62Crepidosp. ermun cf. goudotiana (Tul.) Tr. & Pl.Burseraceae1:63Grisma bicolor DuckeBurseraceae1:66Naucleospis sp.Moraceae2:67L'antonaceae1:Vochysiaceae1:74Tachigalia paniculata Aubl.Leg-Caesalpiniaceae1:75A.p., idosp. erma sp.Apocynaceae1:76Clarisa racemosa R. et P.Moraceae2:77Leonia cf. crass Smith.Violaceae2:78Maquira guianensis Aubl.Moraceae2:79Brosinum guianensis (Aubl.) HuberMoraceae2:70UndeterminedLauraceae1:84UndeterminedLauraceae1:85Gaurea pubescensMeliaceae1:86UndeterminedBurseraceae1:87UndeterminedBurseraceae1:88Tachigalia paniculata Aubl.Leg-Caesalpiniaceae2:90Statigopis is sp.Sapotaceae1:91Statigopis is sp.Sapotaceae1:92Minguartia guianensis Aubl.Olacaceae1:93Tachigalia sp.Leg-Caesalpiniaceae2:94Tachigalia sp.Leg-Caesalpiniaceae2:95Pseudomedia laevis (R. & P.) Macbr.$	18.0	-32.7
58Maquira calophylla (P. & E.) C.C. BergMoraceaeI59Licania macrophylla Bth.Chrysobalanaceae2162Crepidosp. erman cl. goudotiana (Tul.) Tr. & Pl.Burseraceae1163Grisma bicolor DuckeVochysiaceae1164MaterminedBurseraceae1265UndeterminedBurseraceae1266Naucleospsis sp.Moraceae274Tachigalia paniculata Aubl.Leg-Caesalpiniaceae1175Asp. idosp. erma sp.Apocynaceae1476Clarisa racemosa R. et P.Moraceae2277Leonia cl. crassa Smith.Violaceae1478Maquira guianensis (Aubl.) HuberMoraceae2279Brosinum guianensis (Aubl.) HuberMoraceae2280UndeterminedLauraceae1481UndeterminedBurseraceae1482Tachigalia paniculata Aubl.Leg-Caesalpiniaceae1483Tachigalia guianensis Aubl.Olacaceae1494Strigiopsis sp.Sapotaceae1495Neea sp.Leg-Caesalpiniaceae2296Pseudomedia laevis (R. & P.) Macbr.Moraceae1297Brosinua guianensis Aubl.Olacaceae1498Symphonia globulifera L.Guesapiniaceae2499Conrigoneura utei Warb.Myrtiscaceae1490UndeterminedMyrtiscaceae1491Strigiopsis sp. <td< td=""><td>33.0</td><td>-30.5</td></td<>	33.0	-30.5
59 Licania macrophylla Bth. Chrysobalanaceae 22 62 Crepidosp. ermum cf. goudotiana (Tul.) Tr. & Pl. Burseraceae 1 63 Grisma bicolor Ducke Vochysiaceae 1 64 Undetermined Burseraceae 1 65 Undetermined Burseraceae 1 66 Naucleospis sp. Annonaceae 1 74 Tachigalia paniculata Aubl. Leg-Caesalpiniaceae 1 75 Asp. idosp. erma sp. Apocynaceae 1 76 Clarisa racemosa R. et P. Moraceae 2 77 Lonia cf. crasa Smith. Violaceae 2 78 Maquira guianensis Aubl. Moraceae 2 80 Undetermined Lauraceae 10 81 Tachigalia pniculata Aubl. Leg-Caesalpiniaceae 10 82 Guarea pubescens Meliaceae 2 84 Tachigalia sp. Sapotaceae 10 90 Undetermined Burseraceae 10 91 Sizigiopsis sp. Sapotaceae 11 92	20.8	-32.3
62 Crepidosp. erminin cf. goudotiana (Tul.) Tr. & Pl. Burseraceae 1 63 Grisma bicolor Ducke Burseraceae 1 64 Maucleospsis sp. Moraceae 2 65 Undetermined Burseraceae 1 74 Tachigalia paniculata Aubl. Leg-Caesalpiniaceae 1 74 Tachigalia paniculata Aubl. Leg-Caesalpiniaceae 1 75 Asp. idosp. erma sp. Apocynaceae 1 76 Clarisa racemosa R. et P. Moraceae 2 77 Leonia cf. crassa Smith. Woraceae 2 78 Maquira guianensis (Aubl.) Huber Moraceae 2 79 Brosimum guianensis (Aubl.) Huber Moraceae 2 80 Undetermined Lauraceae 16 81 Undetermined Burseraceae 16 82 Tachigalia paniculata Aubl. Leg-Caesalpiniaceae 16 84 Tachigalia sp. Sapotaceae 16 90 Undetermined Burseraceae 10 91 Sizigiopsis sp. Sapotaceae 10 </td <td>12.7</td> <td>-32.0</td>	12.7	-32.0
63 Grisma bicolor Ducke Vochysiaceae 1 65 Undetermined Burseraceae 1 66 Naucleospsis sp. Moraceae 2 68 Xylopia nitida Dun. Annonaceae 1 74 Tachigalia paniculata Aubl. Leg-Caesalpiniaceae 11 75 Asp. idosp. erma sp. Apocynaceae 1 76 Clarisa racemosa R. et P. Moraceae 2 77 Lonia cl. crassa Smith. Violaceae 14 78 Maquira guianensis Aubl. Moraceae 2 79 Brosimum guianensis (Aubl.) Huber Moraceae 2 80 Undetermined Lauraceae 14 87 Undetermined Burseraceae 16 88 Tachigalia paniculata Aubl. Leg-Caesalpiniaceae 16 90 Undetermined Burseraceae 16 91 Sizigiopsis sp. Sapotaceae 4 92 Minquartia guianensis Aubl. Olacaceae 12 93 Tachigalia sp. Leg-Caesalpiniaceae 12 94 <	28.4	-33.2
65 Undetermined Burseraceae 1 66 Natcleospsis sp. Anonaccae 2 74 Tachigalia paniculata Aubl. Leg-Caesalpiniaccae 11 74 Tachigalia paniculata Aubl. Leg-Caesalpiniaccae 11 75 Asp. idosp. erma sp. Apocynaccae 12 76 Clarisa racemosa R. et P. Moraccae 12 77 Leonia cf. crassa Smith. Woraccae 22 78 Maquira guianensis (Aubl.) Huber Moraccae 22 79 Brosimum guianensis (Aubl.) Huber Moraccae 22 80 Undetermined Lauraccae 14 86 Undetermined Lauraccae 14 87 Undetermined Sapotaccae 16 88 Tachigalia paniculata Aubl. Burseraceae 16 89 Undetermined Burseraceae 16 80 Undetermined Burseraceae 16 81 Tachigalia sp. Sapotaccae 16 92 Minquartia guianensis Aubl. Olaccacae 17 93 Tachigalia sp. Leg-Caesalpiniaccae 16 94 Tachigalia sp. Leg-Caesalpininaccae 16 95 <t< td=""><td>11.0</td><td>-32.1</td></t<>	11.0	-32.1
66 Naucleospsis sp. Moraceae 2 68 Xytopia nitida Dun. Annonaceae 11 74 Tachigalia paniculata Aubl. Leg-Caesalpiniaceae 11 75 Asp. idosp. erma sp. Apocynaceae 11 76 Clarisa racemosa R. et P. Moraceae 22 77 Leonia cf. crassa Smith. Violaceae 22 78 Maquira guianensis (Aubl.) Huber Moraceae 22 80 Undetermined Hippocrateaceae 2 81 Guarea pubescens Meliaceae 14 86 Undetermined Burseraceae 16 87 Undetermined Burseraceae 16 88 Tachigalia paniculata Aubl. Leg-Caesalpiniaceae 16 90 Undetermined Burseraceae 16 91 Sizigiopsis sp. Sapotaceae 16 92 Minguarti guianensis Aubl. Olacaceae 17 93 Tachigalia sp. Leg-Caesalpiniaceae 22 94 Tachigalia sp. Leg-Caesalpiniaceae 16 95	14.0	-29.6
68 Xylopia nitida Dun. Annonaceae 1 74 Tachigalia paniculata Aubl. Leg-Caesalpinaceae 1 75 Asp. idosp. erma sp. Apocynaceae 1 76 Clarisa racemosa R. et P. Moraceae 1 77 Leonia cf. crassa Smith. Violaceae 1 78 Maquira guianensis (Aubl.) Huber Moraceae 2 79 Brosimum guianensis (Aubl.) Huber Moraceae 2 80 Undetermined Lauraceae 1 81 Undetermined Lauraceae 1 82 Tachigalia paniculata Aubl. Leg-Caesalpiniaceae 1 93 Tachigalia sp. Sapotaceae 1 94 Tachigalia sp. Leg-Caesalpiniaceae 2 95 Neca sp. Nyctaginaceae 1 96 Pseudomedia laevis (R. & P.) Macbr. Moraceae 1 97 Rheidia sp. Leg-Caesalpiniaceae 1 98 Stoanea cf. rufa Planch. ex Benth. Moraceae 1 99 Compsoneura ulei Warb. Myristicaceae 3	15.1	-31.0
74 Tachigalia paniculata Aubl. Leg-Caesalpiniaceae 11 75 Asp. idosp. erma sp. Apocynaceae 1 76 Clarisa racemosa R. et P. Moraceae 14 77 Leonia cf. crassa Smith. Woraceae 22 78 Maquira guianensis (Aubl.) Huber Moraceae 22 79 Brosimum guianensis (Aubl.) Huber Moraceae 22 80 Undetermined Lauraceae 11 81 Undetermined Lauraceae 12 86 Undetermined Burseraceae 14 87 Undetermined Burseraceae 14 88 Tachigalia sp. Sapotaceae 4 90 Undetermined Burseraceae 11 91 Sizigiopsis sp. Sapotaceae 12 92 Minquarti guianensis Aubl. Olacaceae 12 93 Tachigalia sp. Leg-Caesalpiniaceae 12 94 Tachigalia sp. Myrtaginaceae 11 96 Pseudomedia laevis (R. & P.) Macbr. Moraceae 12 97 <td< td=""><td>21.1</td><td>-30.4</td></td<>	21.1	-30.4
74 Tachigalia paniculata Aubl. Leg-Caesalpiniaceae 11 75 Asp. idosp. erma sp. Apocynaceae 1 76 Clarisa racemosa R. et P. Moraceae 14 77 Leonia cf. crassa Smith. Woraceae 22 78 Maquira guianensis (Aubl.) Huber Moraceae 22 79 Brosimum guianensis (Aubl.) Huber Moraceae 22 80 Undetermined Lauraceae 11 81 Undetermined Lauraceae 12 86 Undetermined Burseraceae 14 87 Undetermined Burseraceae 14 88 Tachigalia sp. Sapotaceae 4 90 Undetermined Burseraceae 11 91 Sizigiopsis sp. Sapotaceae 12 92 Minquarit guianensis Aubl. Olacaceae 12 93 Tachigalia sp. Leg-Caesalpiniaceae 12 94 Tachigalia sp. Myrtaginaceae 11 96 Pseudomedia laevis (R. & P.) Macbr. Moraceae 12 97 <td< td=""><td>17.9</td><td>-32.5</td></td<>	17.9	-32.5
75Asp. idosp. erma sp.Apocynaceae176Clarisa racemosa R. et P.Moraceae177Leonia cf. crassa Smith.Violaceae178Maquira guianensis Aubl.Moraceae279Brosimum guianensis (Aubl.) HuberMoraceae280UndeterminedHippocrateaceae281Guarea pubescensMeliaceae182Guarea pubescensMeliaceae183Tachigalia paniculata Aubl.Leg-Caesalpiniaceae184Tachigalia paniculata Aubl.Leg-Caesalpiniaceae190UndeterminedBurseraceae191Sizigiopsis sp.Sapotaceae192Minquartia guianensis Aubl.Olacaceae193Tachigalia sp.Leg-Caesalpiniaceae294Tachigalia sp.Leg-Caesalpiniaceae195Neea sp.Nyctaginaceae196Pseudomedia laevis (R. & P.) Macbr.Moraceae197Compsoneura ulei Warb.Myristicaceae198Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae299Sloanea cf. altissima R. & E.Nyctaginaceae291Siloanea at C. altissima (Aubl.) SwartBurseraceae392Protium rg.Guttiferae193Sloanea cf. altissima (Aubl.) SwartBurseraceae394Tachigalia sp.Leg-Caesalpiniaceae295Neea cf. altissima (Aubl.) Swart	18.8	-29.6
76 Clarisa racemosa R. et P. Moraceae 1 77 Leonia cf. crassa Smith. Violaceae 1 78 Maquira guianensis Aubl. Moraceae 2 79 Brosimum guianensis (Aubl.) Huber Moraceae 2 80 Undetermined Hippocrateaceae 2 81 Guarea pubescens Meliaceae 3 82 Guarea pubescens Meliaceae 4 83 Tachigalia paniculata Aubl. Leg-Caesalpiniaceae 10 90 Undetermined Burseraceae 11 91 Sizigiopsis sp. Sapotaceae 12 92 Minquartia guianensis Aubl. Olacaceae 12 93 Tachigalia sp. Leg-Caesalpiniaceae 24 94 Tachigalia sp. Leg-Caesalpiniaceae 14 95 Neea sp. Nyctaginaceae 11 96 Pseudomedia laevis (R. & P.) Macbr. Moraceae 12 97 Compsoneura ulei Warb. Myristcaeea 14 98 Neea f. altissima R. & E. Nyctaginaceae 20	11.0	-31.3
78 Maquira guianensis Aubl. Moraceae 22 79 Brosimum guianensis (Aubl.) Huber Moraceae 22 80 Undetermined Hippocrateaceae 22 81 Guarea pubescens Meliaceae 23 82 Guarea pubescens Meliaceae 13 84 Undetermined Lauraceae 14 85 Guarea pubescens Meliaceae 14 86 Undetermined Leg-Caesalpiniaceae 14 87 Undetermined Burseraceae 14 88 Tachigalia paniculata Aubl. Leg-Caesalpiniaceae 14 90 Undetermined Sapotaceae 14 91 Sizigiopsis sp. Sapotaceae 14 92 Minquartia guianensis Aubl. Olacaceae 12 93 Tachigalia sp. Leg-Caesalpiniaceae 12 94 Tachigalia sp. Leg-Caesalpiniaceae 12 95 Neea sp. Nyctaginaceae 12 96 Pseudomedia laevis (R. & P.) Macbr. Myristicaceae 12 97 Rhee	14.0	-32.7
79Brosimum guianensis (Aubl.) HuberMoraceae2280UndeterminedHippocrateaceae281Guarea pubescensMeliaceae282Guarea pubescensLauraceae1083Tachigalia paniculata Aubl.Leg-Caesalpiniaceae1084Tachigalia paniculata Aubl.Leg-Caesalpiniaceae1090UndeterminedBurseraceae1091Sizigiopsis sp.Sapotaceae1192Minquartia guianensis Aubl.Olacaceae1293Tachigalia sp.Leg-Caesalpiniaceae2294Tachigalia sp.Leg-Caesalpiniaceae1495Neea sp.Nytaginaceae1196Pseudomedia laevis (R. & P.) Macbr.Moraceae1197Compsoneura ulei Warb.Myristicaceae1298Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae2299Neea cf. altissima R. & E.Nytaginaceae2490Protium sp.Burseraceae3691Protium cf. paniculatum Engl. var paniculatumBurseraceae3791Tachiggalia sp.Leg-Caesalpiniaceae1292Ithecellobium racemosa DuckeLeg-Caesalpiniaceae1293Tachiggala sp.Leg-Caesalpiniaceae1294Tachiggala sp.Leg-Caesalpiniaceae1295Protium cf. neglectum Swart var. robustum SwartBurseraceae1296Protium cf. neglectum Swart var. robustum SwartBurseraceae<	14.1	-33.6
79Brosimum guianensis (Aubl.) HuberMoraceae2280UndeterminedHippocrateaceae281Guarea pubescensMeliaceae282Guarea pubescensMeliaceae1083Tachigalia paniculata Aubl.Lauraceae1084Tachigalia paniculata Aubl.Leg-Caesalpiniaceae1090UndeterminedBurseraceae1091Sizigiopsis sp.Sapotaceae492Minquartia guianensis Aubl.Olacaceae1193Tachigalia sp.Leg-Caesalpiniaceae2294Tachigalia sp.Leg-Caesalpiniaceae2495Neea sp.Nytaginaceae1196Pseudomedia laevis (R. & P.) Macbr.Moraceae1197Compsoneura ulei Warb.Myristicaceae3198Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae3299Neea cf. altissima R. & E.Nytaginaceae3290Protium sp.Burseraceae3391Protium cf. paniculatum Engl. var paniculatumBurseraceae3492Tachigalia sp.Leg-Caesalpiniaceae1293Symphonia globulifera L.Guttiferae1194Tachigalia sp.Leg-Caesalpiniaceae3495Protium cf. neglectum Swart var. robustum SwartBurseraceae3496Protium cf. neglectum Swart var. robustum SwartBurseraceae3497Rheedia sp.Leg-Caesalpiniaceae34	25.5	-30.9
80UndeterminedHippocrateaceae285Guarea pubescensMeliaceae186UndeterminedLauraceae187UndeterminedSapotaceae1688Tachigalia paniculata Aubl.Leg-Caesalpiniaceae1690UndeterminedBurseraceae1691Sizigiopsis sp.Sapotaceae1692Minquartia guianensis Aubl.Olacceae1793Tachigalia sp.Leg-Caesalpiniaceae2294Tachigalia sp.Leg-Caesalpiniaceae1295Neea sp.Nyctaginaceae1196Pseudomedia laevis (R. & P.) Macbr.Moraceae1197Compsoneura ulei Warb.Myristicaceae1198Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae2294Neea cf. altissima R. & E.Nyctaginaceae2495Neea sp.Burseraceae3696Protium sp.Burseraceae3797Rheedia sp.Guttiferae1198Symphonia globulifera L.Guttiferae1299Compsonculatum Engl. var paniculatumBurseraceae3791Protium of. neglectum Swart var. robustum SwartBurseraceae3492Tachigalia sp.Leg-Caesalpiniaceae1293Somphonia (AD.C.) A.C. SmithMyristicaceae1294Tachigalia sp.Leg-Caesalpiniaceae1295SeraesMoraceae1296	24.6	-30.3
85Guarea pubescensMeliaceae1486UndeterminedLauraceae1487UndeterminedSapotaceae1688Tachigalia paniculata Aubl.Leg-Caesalpiniaceae1690UndeterminedBurseraceae1691Sizigiopsis sp.Sapotaceae492Minquartia guianensis Aubl.Olacaceae1293Tachigalia sp.Leg-Caesalpiniaceae2294Tachigalia sp.Leg-Caesalpiniaceae1295Neea sp.Nyctaginaceae1296Pseudomedia laevis (R. & P.) Macbr.Moraceae1290Eschweilera coriacea (A.P. DC.) Mart. ex erg.Lecythidaceae3391UndeterminedMyristicaceae1292Noeca sp.Suphanea cf. rufa Planch. ex Benth.Euphorbiaceae2493Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae2694Neea of. altissima R. & E.Nyctaginaceae2495Neea sp.Guttiferae1196Protium sp.Burseraceae3397Rheedia sp.Guttiferae1298Symphonia globulifera L.Guttiferae1299Composition account of the sp.Guttiferae1291Protium of . paniculatum Engl. var paniculatumBurseraceae3492Tachigalia sp.Leg-Caesalpiniaceae1293Superaceae1212Guttiferae1294Protium of . n	21.0	-34.1
86UndeterminedLauraceae1487UndeterminedSapotaceae1688Tachigalia paniculata Aubl.Leg-Caesalpiniaceae1090UndeterminedBurseraceae1691Sizigiopsis sp.Sapotaceae1692Minquartia guianensis Aubl.Olacaceae1793Tachigalia sp.Leg-Caesalpiniaceae2294Tachigalia sp.Leg-Caesalpiniaceae4295Neea sp.Nyctaginaceae1296Pseudomedia laevis (R. & P.) Macbr.Moraceae1297Compsoneura ulei Warb.Myristicaceae1698Compsoneura ulei Warb.Myristicaceae1699Compsoneura ulei Warb.Myritaceae1600Eschweilera coriacea (A.P. DC.) Mart. ex erg.Lecythidaceae3001UndeterminedMyrtaceae1603Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae2004Neea cf. altissima R. & E.Nyctaginaceae3005Rheedia sp.Guttiferae1110Protium cf. paniculatum Engl. var paniculatumBurseraceae3411Pithecellobium racemosa DuckeLeg-Caesalpiniaceae1212Tachigalia sp.Leg-Caesalpiniaceae1213Tachigalia sp.Leg-Caesalpiniaceae1214Tetragastris cf. altissima (Aubl.) SwartBurseraceae1215Tachigalia sp.Leg-Caesalpiniaceae1216 <t< td=""><td>8.0</td><td>-34.9</td></t<>	8.0	-34.9
87UndeterminedSapotaceae1688Tachigalia paniculata Aubl.Leg-Caesalpiniaceae1690UndeterminedBurseraceae1691Sizigiopsis sp.Sapotaceae1692Minquartia guianensis Aubl.Olacaceae1293Tachigalia sp.Leg-Caesalpiniaceae2294Tachigalia sp.Leg-Caesalpiniaceae2495Neea sp.Nyctaginaceae1196Pseudomedia laevis (R. & P.) Macbr.Myristicaceae1197Compsoneura ulei Warb.Myristicaceae1298Compsoneura ulei Warb.Myristicaceae1299Compsoneura ulei Warb.Myristicaceae1290Eschweilera coriacea (A.P. DC.) Mart. ex erg.Lecythidaceae3391UndeterminedMyrtaceae1292Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae2493Shoanea cf. rufa Planch. ex Benth.Burseraceae3494Tachigalia sp.Burseraceae3495Neea of. altissima R. & E.Nyctaginaceae2496Protium sp.Burseraceae3497Rheedia sp.Guttiferae1298Symphonia globulifera L.Guttiferae1210Protium cf. paniculatum Engl. var paniculatumBurseraceae2215Tachigalia sp.Leg-Caesalpiniaceae2416Eschweilera sp.Leg-Caesalpiniaceae1217Tachigalia sp. </td <td>18.8</td> <td>-33.0</td>	18.8	-33.0
88Tachigalia paniculata Aubl.Leg-Caesalpiniaceae90UndeterminedBurseraceae1491Sizigiopsis sp.Sapotaceae492Minquartia guiamensis Aubl.Olacaceae1293Tachigalia sp.Leg-Caesalpiniaceae2294Tachigalia sp.Leg-Caesalpiniaceae2195Neea sp.Nyctaginaceae1296Pseudomedia laevis (R. & P.) Macbr.Moraceae1299Compsoneura ulei Warb.Myristicaceae1200Eschweilera coriacea (A.P. DC.) Mart. ex erg.Leg/thidaceae3201UndeterminedMyrtaceae1203Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae3204Neea cf. altissima R. & E.Nyctaginaceae3307Rheedia sp.Guttiferae1208Symphonia globulifera L.Guttiferae1210Protium cf. paniculatum Engl. var paniculatumBurseraceae3311Pithecellobium racemosa DuckeLeg-Caesalpiniaceae1215Tachigalia sp.Leg-Caesalpiniaceae1216Eschweilera sp.Leg-Caesalpiniaceae1217Tachigalia sp.Leg-Caesalpiniaceae1218Protium cf. neglectum Swart var. robustum SwartBurseraceae1219Tachigalia sp.Leg-Caesalpiniaceae1220Virola pavonis (A.D.C.) A.C. SmithMyristicaceae1421Guatteria cf. pooppigiana Mart.Annonac	16.9	-34.9
90UndeterminedBurseraceae1691Sizigiopsis sp.Sapotaceae492Minquartia guianensis Aubl.Olacaceae1193Tachigalia sp.Leg-Caesalpiniaceae2294Tachigalia sp.Leg-Caesalpiniaceae2495Neea sp.Nyctaginaceae1196Pseudomedia laevis (R. & P.) Macbr.Myristicaceae1197Compsoneura ulei Warb.Myristicaceae1298Compsoneura ulei Warb.Myristicaceae1299Compsoneura ulei Warb.Myristicaceae1290Eschweilera coriacea (A.P. DC.) Mart. ex erg.Lecythidaceae3291UndeterminedMyrtaceae1292Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae2493Sloanea cf. rufa Planch. ex Benth.Burseraceae3494Tachigalia sp.Burseraceae3495Neea cf. altissima R. & E.Nyctaginaceae2496Protium sp.Burseraceae3497Rheedia sp.Guttiferae1198Symphonia globulifera L.Guttiferae1299Continencia advisima (Aubl.) SwartBurseraceae2490Protium cf. naglectum Swart var. robustum SwartBurseraceae2498Symphonia (A.D.C.) A.C. SmithMyristicaceae1299Guatteria cf. robustum (Swart) PorterBurseraceae1499Pooligaia sp.Moraceae2499 <td></td> <td>-32.0</td>		-32.0
91Sizigiopsis sp.Sapotaceae492Minquartia guianensis Aubl.Olacaceae1193Tachigalia sp.Leg-Caesalpiniaceae1294Tachigalia sp.Leg-Caesalpiniaceae4195Neea sp.Nyctaginaceae1196Pseudomedia laevis (R. & P.) Macbr.Moraceae1197Compsoneura ulei Warb.Myristicaceae1198Compsoneura ulei Warb.Myristicaceae1299Compsoneura ulei Warb.Myristicaceae1290Leg-thidaceae333391UndeterminedMyrtaceae1292Neea cf. altissima R. & E.Nyctaginaceae2493Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae2694Neea cf. altissima R. & E.Nyctaginaceae2695Neea cf. altissima R. & E.Symphonia globulifera L.Guttiferae1196Protium sp.Burseraceae343497Rheedia sp.Guttiferae1298Symphonia globulifera L.Guttiferae1299Protium cf. paniculatum Engl. var paniculatumBurseraceae3499Protium cf. paniculatum Engl. var paniculatumBurseraceae2299Stockweilera sp.Leg-Caesalpiniaceae1290Ithecellobium racemosa DuckeLeg-Caesalpiniaceae1291Tachigalia sp.Leg-Caesalpiniaceae1292Virola pavonis (A.D.C.) A.C. SmithMyristica	16.5	-32.4
92Minuartia guianensis Aubl.Olacaceae1193Tachigalia sp.Leg-Caesalpiniaceae2294Tachigalia sp.Leg-Caesalpiniaceae2495Neea sp.Nyctaginaceae1496Pseudomedia laevis (R. & P.) Macbr.Moraceae1699Compsoneura ulei Warb.Myristicaceae1700Eschweilera coriacea (A.P. DC.) Mart. ex erg.Leeythidaceae3601UndeterminedMyristicaceae1603Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae2604Neea cf. altissima R. & E.Nyctaginaceae2606Protium sp.Burseraceae3307Rheedia sp.Guttiferae1108Symphonia globulifera L.Guttiferae1210Protium cf. paniculatum Engl. var paniculatumBurseraceae3611Pithecellobium racemosa DuckeLeg-Caesalpiniaceae1214Tetragastris of. altissima (Aubl.) SwartBurseraceae2215Tachigalia sp.Leeythidaceae2216Eschweilera sp.Leeg-Caesalpiniaceae1219Tachigalia sp.Leg-Caesalpiniaceae1421Guatteria cf. noeppigiana Mart.Annonaceae2223Naucleopsis sp.Moraceae1224Protium cf. robustum (Swart) PorterBurseraceae1425UndeterminedLeg-undetermined2226UndeterminedLeg-undetermined22	41.3	-31.1
93Tachigalia sp.Leg-Caesalpiniaceae2294Tachigalia sp.Leg-Caesalpiniaceae4495Neea sp.Nytaginaceae1196Pseudomedia laevis (R. & P.) Macbr.Moraceae1299Compsoneura ulei Warb.Myristicaceae1100Eschweilera coriacea (A.P. DC.) Mart. ex erg.Lecythidaceae3601UndeterminedMyritaceae1203Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae2604Neea cf. altissima R. & E.Nyctaginaceae2605Symphonia globulifera L.Guttiferae1210Protium sp.Burseraceae3608Symphonia globulifera L.Guttiferae1210Protium cf. paniculatum Engl. var paniculatumBurseraceae2714Tetragastris cf. altissima (Aubl.) SwartBurseraceae2715Tachigalia sp.Lecythidaceae2716Eschweilera sp.Lecythidaceae2719Tachigalia sp.Leg-Caesalpiniaceae1621Guatteria cf. noepigiana Mart.Annonaceae2722UndeterminedLeg-undetermined2923Naucleopsis sp.Moraceae1624Protium cf. robustum (Swart) PorterBurseraceae1725UndeterminedLeg-undetermined2926UndeterminedLeg-undetermined2927Protium cf. paniculatum Engl. var paniculatumBurseraceae17 <td>13.5</td> <td>-31.0</td>	13.5	-31.0
94Tachigalia sp.Leg-Caesalpiniaceae4495Neea sp.Nyctaginaceae196Pseudomedia laevis (R. & P.) Macbr.Moraceae197Compsoneura ulei Warb.Myristicaceae198Compsoneura ulei Warb.Myristicaceae199Compsoneura ulei Warb.Myristicaceae390Eschweilera coriacea (A.P. DC.) Mart. ex erg.Lecythidaceae391UndeterminedMyrtaceae192Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae2094Neea cf. altissima R. & E.Nyctaginaceae2095Protium sp.Burseraceae3096Protium sp.Guttiferae1197Rheedia sp.Guttiferae1298Symphonia globulifera L.Guttiferae1299Protium cf. paniculatum Engl. var paniculatumBurseraceae2291Tachigalia sp.Leg-Caesalpiniaceae1292Virola pavonis (A.D.C.) A.C. SmithMyristicaceae2293Naucleopsis sp.Moraceae2294Protium cf. robustum (Swart) PorterBurseraceae2295Naucleopsis sp.Moraceae2496Protium cf. robustum (Swart) PorterBurseraceae2497Protium cf. robustum (Swart) PorterBurseraceae2498Astrocaryum murumuru Mart.Palmae24	25.0	-31.7
95Need sp.Nyctaginaceae196Pseudomedia laevis (R. & P.) Macbr.Moraceae1297Compsoneura ulei Warb.Myristicaceae1298Compsoneura ulei Warb.Myristicaceae1299Compsoneura coriacea (A.P. DC.) Mart. ex erg.Lecythidaceae3690Eschweilera coriacea (A.P. DC.) Mart. ex erg.Lecythidaceae3691UndeterminedMyrtaceae1292Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae2693Sloanea cf. altissima R. & E.Nyctaginaceae2694Neea cf. altissima R. & E.Nyctaginaceae2695Meedia sp.Burseraceae3696Protium sp.Burseraceae3697Rheedia sp.Guttiferae1198Symphonia globulifera L.Guttiferae1299Protium cf. paniculatum Engl. var paniculatumBurseraceae2291Protium cf. altissima (Aubl.) SwartBurseraceae2292Virola pavonis (A.D.C.) A.C. SmithMyristicaceae1194Protium cf. neglectum Swart var. robustum SwartBurseraceae1295Naucleopsis sp.Moraceae2296Virola pavonis (A.D.C.) A.C. SmithMyristicaceae1497Protium cf. robustum (Swart) PorterBurseraceae1498Naucleopsis sp.Moraceae2499CalueterminedLeg-undetermined2690Undetermined	42.4	-30.7
96Pseudomedia laevis (R. & P.) Macbr.Moraceae1199Compsoneura ulei Warb.Myristicaceae1200Eschweilera coriacea (A.P. DC.) Mart. ex erg.Lecythidaceae3301UndeterminedMyraceae1203Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae2404Neea cf. altissima R. & E.Nyctaginaceae2405Protium sp.Burseraceae3606Protium sp.Burseraceae3607Rheedia sp.Guttiferae1210Protium cf. paniculatum Engl. var paniculatumBurseraceae3411Pithecellobium racemosa DuckeLeg-Mimosaceae1214Tetragastris cf. altissima (Aubl.) SwartBurseraceae2215Tachigalia sp.Leg-Caesalpiniaceae1216Eschweilera sp.Leg-Caesalpiniaceae1219Tachigalia sp.Leg-Caesalpiniaceae1220Virola pavonis (A.D.C.) A.C. SmithMyristicaceae2223Naucleopsis sp.Moraceae2224Protium cf. robustum (Swart) PorterBurseraceae1425UndeterminedLeg-undetermined2026UndeterminedLeg-undetermined2027Protium cf. consutum (Swart) PorterBurseraceae1228Astrocaryum murumuru Mart.Palmae24	11.0	-34.8
99Compsoneura ulei Warb.Myristicaceae100Eschweilera coriacea (A.P. DC.) Mart. ex erg.Lecythidaceae3001UndeterminedMyrtaceae3003Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae2004Neea cf. altissima R. & E.Nyctaginaceae2005Protium sp.Burseraceae3006Protium sp.Guttiferae1108Symphonia globulifera L.Guttiferae1210Protium cf. paniculatum Engl. var paniculatumBurseraceae3411Pithecellobium racemosa DuckeLeg-Mimosaceae1214Tetragastris cf. altissima (Aubl.) SwartBurseraceae2215Tachigalia sp.Leg-Caesalpiniaceae1216Eschweilera sp.Leg-Caesalpiniaceae1220Virola pavonis (A.D.C.) A.C. SmithMyristicaceae2221Guatteria cf. poeppigiana Mart.Annonaceae2223Naucleopsis sp.Moraceae1424Protium (Swart) PorterBurseraceae1425UndeterminedLeg-undetermined2226UndeterminedLeg-undetermined2227Protium cf. paniculatum Engl. var paniculatumBurseraceae1428Astrocaryum murumuru Mart.Palmae44	15.0	-31.0
00Eschweilera coriacea (A.P. DC.) Mart. ex erg.Lecythidaceae3001UndeterminedMyrtaceae1203Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae2004Neea cf. altissima R. & E.Nyctaginaceae2006Protium sp.Burseraceae3007Rheedia sp.Guttiferae1208Symphonia globulifera L.Guttiferae1210Protium cf. paniculatum Engl. var paniculatumBurseraceae3411Pithecellobium racemosa DuckeLeg-Mimosaceae1214Tetragastris cf. altissima (Aubl.) SwartBurseraceae2115Tachigalia sp.Leg-Caesalpiniaceae1216Eschweilera sp.Leg-Caesalpiniaceae2119Tachigalia sp.Leg-Caesalpiniaceae2220Virola pavonis (A.D.C.) A.C. SmithMyristicaceae1221Guatteria cf. poeppigiana Mart.Annonaceae2223Naucleopsis sp.Moraceae1424Protium cf. robustum (Swart) PorterBurseraceae1425UndeterminedLeg-undetermined2426UndeterminedLeg-undetermined2427Protium cf. paniculatum Engl. var paniculatumBurseraceae1428Astrocaryum murumuru Mart.Palmae44	11.9	-32.7
01UndeterminedMyrtaceae1103Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae0404Neea cf. altissima R. & E.Nyctaginaceae2006Protium sp.Burseraceae3007Rheedia sp.Guttiferae1108Symphonia globulifera L.Guttiferae1210Protium cf. paniculatum Engl. var paniculatumBurseraceae3411Pithecellobium racemosa DuckeLeg-Mimosaceae1214Tetragastris cf. altissima (Aubl.) SwartBurseraceae2215Tachigalia sp.Leg-Caesalpiniaceae1216Eschweilera sp.Leg-Caesalpiniaceae1219Tachigalia sp.Leg-Caesalpiniaceae1220Virola pavonis (A.D.C.) A.C. SmithMyristicaceae1221Guatteria cf. poeppigiana Mart.Annonaceae2223Naucleopsis sp.Moraceae1424Protium cf. robustum (Swart) PorterBurseraceae1425UndeterminedLeg-undetermined2426UndeterminedLeg-undetermined2427Protium cf. paniculatum Engl. var paniculatumBurseraceae1428Astrocaryum murumuru Mart.Palmae44	30.5	-34.3
03Sloanea cf. rufa Planch. ex Benth.Euphorbiaceae0404Neea cf. altissima R. & E.Nyctaginaceae2006Protium sp.Burseraceae3007Rheedia sp.Guttiferae1108Symphonia globulifera L.Guttiferae1110Protium cf. paniculatum Engl. var paniculatumBurseraceae3411Pithecellobium racemosa DuckeLeg-Mimosaceae1114Tetragastris cf. altissima (Aubl.) SwartBurseraceae2215Tachigalia sp.Leg-Caesalpiniaceae1216Eschweilera sp.Leg-Caesalpiniaceae1219Tachigalia sp.Leg-Caesalpiniaceae1220Virola pavonis (A.D.C.) A.C. SmithMyristicaceae1221Guatteria cf. poeppigiana Mart.Annonaceae2223Naucleopsis sp.Moraceae1424Protium cf. robustum (Swart) PorterBurseraceae1425UndeterminedLeg-undetermined2026UndeterminedLeg-undetermined2027Protium cf. paniculatum Engl. var paniculatumBurseraceae1428Astrocaryum murumuru Mart.Palmae44	15.3	-33.9
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08Symphonia globulifera L.Guttiferae1210Protium cf. paniculatum Engl. var paniculatumBurseraceae3411Pithecellobium racemosa DuckeLeg-Mimosaceae1214Tetragastris cf. altissima (Aubl.) SwartBurseraceae2215Tachigalia sp.Leg-Caesalpiniaceae1216Eschweilera sp.Lecythidaceae2218Protium cf. neglectum Swart var. robustum SwartBurseraceae1219Tachigalia sp.Leg-Caesalpiniaceae1220Virola pavonis (A.D.C.) A.C. SmithMyristicaceae1221Guatteria cf. poeppigiana Mart.Annonaceae2223Naucleopsis sp.Moraceae1424Protium cf. robustum (Swart) PorterBurseraceae1425UndeterminedLeg-undetermined2026UndeterminedLeg-undetermined2027Protium cf. paniculatum Engl. var paniculatumBurseraceae1428Astrocaryum murumuru Mart.Palmae44	15.0	-33.5
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18Protium cf. neglectum Swart var. robustum SwartBurseraceae1119Tachigalia sp.Leg-Caesalpiniaceae1220Virola pavonis (A.D.C.) A.C. SmithMyristicaceae1421Guatteria cf. poeppigiana Mart.Annonaceae2223Naucleopsis sp.Moraceae1624Protium cf. robustum (Swart) PorterBurseraceae1725UndeterminedLeg-undetermined2026UndeterminedLeg-undetermined2027Protium cf. paniculatum Engl. var paniculatumBurseraceae1428Astrocaryum murumuru Mart.Palmae44	25.1	-32.3
19Tachigalia sp.Leg-Caesalpiniaceae1920Virola pavonis (A.D.C.) A.C. SmithMyristicaceae1621Guatteria cf. poeppigiana Mart.Annonaceae2223Naucleopsis sp.Moraceae1624Protium cf. robustum (Swart) PorterBurseraceae1625UndeterminedLeg-undetermined2026UndeterminedLeg-undetermined2027Protium cf. paniculatum Engl. var paniculatumBurseraceae1128Astrocaryum murumuru Mart.Palmae40	13.2	-31.0
20Virola pavonis (A.D.C.) A.C. SmithMyristicaceae1021Guatteria cf. poeppigiana Mart.Annonaceae2223Naucleopsis sp.Moraceae1824Protium cf. robustum (Swart) PorterBurseraceae1725UndeterminedLeg-undetermined2026UndeterminedLeg-undetermined2027Protium cf. paniculatum Engl. var paniculatumBurseraceae1728Astrocaryum murumuru Mart.Palmae44	5.0	-32.8
21Guatteria cf. poeppigiana Mart.Annonaceae2223Naucleopsis sp.Moraceae1824Protium cf. robustum (Swart) PorterBurseraceae1725UndeterminedLeg-undetermined2026UndeterminedLeg-undetermined2027Protium cf. paniculatum Engl. var paniculatumBurseraceae1728Astrocaryum murumuru Mart.Palmae44	16.5	-33.5
23Naucleopsis sp.Moraceae1824Protium cf. robustum (Swart) PorterBurseraceae1225UndeterminedLeg-undetermined2026UndeterminedLeg-undetermined2027Protium cf. paniculatum Engl. var paniculatumBurseraceae1228Astrocaryum murumuru Mart.Palmae24	22.3	-31.6
24Protium cf. robustum (Swart) PorterBurseraceae1225UndeterminedLeg-undetermined2026UndeterminedLeg-undetermined2027Protium cf. paniculatum Engl. var paniculatumBurseraceae1228Astrocaryum murumuru Mart.Palmae24	18.9	-30.1
25UndeterminedLeg-undetermined2026UndeterminedLeg-undetermined2027Protium cf. paniculatum Engl. var paniculatumBurseraceae1228Astrocaryum murumuru Mart.Palmae20	17.1	-30.1 -30.6
26UndeterminedLeg-undetermined2027Protium cf. paniculatum Engl. var paniculatumBurseraceae1228Astrocaryum murumuru Mart.Palmae4	26.5	-31.8
27Protium cf. paniculatum Engl. var paniculatumBurseraceae1228Astrocaryum murumuru Mart.Palmae4	26.5 26.5	-31.9
28 Astrocaryum murumuru Mart. Palmae	20.5 12.0	-31.9
		-31.2 -35.1
20 Protium of anapolahini (Aubl.) March Dynamic and 14	4.0	-33.3
	16.5 23.1	-33.3 -32.9

Appendix 1 (contd.)

Tree	Species	Family	Height (m)	Leaf $\delta^{13}C(\rlap{hoo})$
433	Sclerolobium cf. crysophyllum P. & E.	Burseraceae	15.0	-32.2
434	Maquira sclerophylla (Ducke) Berg	Moraceae	14.0	-30.7
436	Protium cf. paniculatum Engl. var paniculatum	Burseraceae	17.6	-30.5
437	Protium sp.	Burseraceae	17.6	-31.5
438	Virola pavonis (A.D.C.) A.C. Smith	Myristicaceae	34.5	-32.8
439	Undetermined	Lauraceae	10.0	-33.8
441	Tachigalia sp.	Leg-Caesalpiniaceae	34.5	-31.0
442	Eschweilera sp.	Lecythidaceae	21.3	-31.3
443	Protium opacum Swart	Burseraceae	17.1	-32.9
444	Protium cf. robustum (Swart) Porter	Burseraceae	17.1	-33.4
446	Metrodorea flavida rause	Rutaceae	8.0	-32.6
447	Metrodorea flavida rause	Rutaceae	16.5	-32.0
450	Neea sp.	Nyctaginaceae	7.0	-31.4
451	Protium cf. robustum (Swart) Porter	Burseraceae	10.0	-31.7
454	Cordia sp. rucei Meaz.	Boraginaceae	8.0	-33.4
458	Metrodorea flavida rause	Rutaceae	8.0	-32.5
459	Pseudomedia laevis (R. & P.) Macbr.	Moraceae	8.0	-32.7
461	Guatteria cf. poeppigiana Mart.	Annonaceae	34.5	-32.6
462	Ocotea sp.	Lauraceae	40.7	-31.9
463	Protium cf. robustum (Swart) Porter	Burseraceae	13.7	-29.6
464	Pithecellobium jupunba (Willd) Urb.	Leg-Mimosaceae	24.6	-30.2
465	Maquira sclerophylla (Ducke) Berg	Moraceae	25.0	-30.8
466	Neea sp.	Nyctaginaceae	13.5	-34.7
467	Undetermined	Nonimiaceae	9.0	-34.1
471	Licaria sp.	Lauraceae	17.2	-34.1
473	Minguartia guianensis Aubl.	Olacaceae	25.1	-31.7
474	Theobroma subincanum Mart.	Sterculiaceae	18.0	-32.2
475	Undetermined	Moraceae	18.0	-31.8
476	Undetermined	Burseraceae	11.0	-33.8
477	Bocageopsis sp.	Annonaceae	9.0	-34.1
481	Tachigalia sp.	Leg-Caesalpiniaceae	18.0	-32.0

Appendix 2 Tree height (m) and $\delta^{13}C$ values (%) of wood samples from boles for species collected at Samuel Ecological Reserve, Rondônia

Гree	Species	Height (m)	Wood $\delta^{13}C(\%_{00})$
1	Parkia cf. nitida Miq.	12.00	-29.1
2 3	Undetermined	17.50	-29.1
3	<i>Pouteria</i> sp.	17.50	-29.9
7	Duroia macrophylla Huber	9.00	-29.7
10	Richardella sp.	21.00	-29.9
11	Maquira guianensis Aubl.	12.50	-29.3
13	Parkia cf. nitida Miq.	24.00	-29.4
14	Oxandra xylopoides Diels	22.70	-30.3
15	Licania latifolia Bth.	13.50	-28.0
16	Euterpe precatoria Mart.	14.00	-31.2
17	Brosimum guianensis (Aubl.) Huber	16.50	-29.9
18	Pithecellobium racemosa Ducke	16.50	-28.3
19	Naucleopsis imitans (Ducke) C.C. Berg	16.50	-28.2
51	Pseudomedia laevis (R. & P.) Machbr.	23.60	-27.3
68	Tymatococcus amazonicus P. & E.	22.40	-26.5
82	Bocageopsis multiflora (Mart.) R.E. Fries	24.80	-25.5
09	Naucleopsis imitans (Ducke) C.C. Berg	21.00	-27.8
16	Rauwolia paraensis Ducke	17.80	-25.6
51	Eschweilera sp.	17.50	-29.0
93	Eschweilera chartacea Berg.	22.90	-28.9
202	Undetermined	15.90	-27.8
203	Undetermined	10.50	-31.0
204	Undetermined	18.75	-34.2
11	Minquartia guianensis Aubl.	14.30	-28.9
12	Protium sp.	29.00	-26.7
216	Swartzia cf. ingiaefolia Ducke	32.00	-26.0
218	Protium opacum Swart	24.00	-29.6
226	Undetermined	27.90	-29.0

Appendix 2 (contd.)

Tree	Species	Height (m)	Wood $\delta^{13}C(\%_{00})$
228	Apeiba echinata Gaertn.	26.00	-31.5
233	<i>Couratari</i> sp.	33.50	-26.1
238	Martiodendrum sp.	39.60	-26.1
241	Bagassa guianensis Aubl.	31.50	-27.5
258	Protium cf. robustum (Swart) Porter	28.80	-25.8
268	Protium cf. tenvifolium (Engler) Engler	14.10	-27.0
270	Bombacopsis cf. nervosa (Vitt.) A. Robyns	23.30	-28.9
282	Undetermined	52.80	-26.4
286	Undetermined	18.00	-25.5
301	Undetermined	23.99	-30.6
303	Pseudomedia laevis (R. & P.) Macbr.	22.00	-27.4
310	Anacardium giganteum Hanc. ex Engl.	22.26	-26.8
315	Heliocostylis tomentosa (P. & E.) Rusby	32.60	-28.0
319	Undetermined	21.27	-30.0
354	Brosimum guianensis (Aubl.) Huber	43.50	-29.8
365	Undetermined	15.10	-27.8
372	Swartzia cf. ingiaefolia Ducke	18.80	-31.6
382	Bertholletia excelsa Humb. Bonpl.	46.58	-26.6
391	Sizigiopsis sp.	41.30	-26.3
400	Eschweilera coriacea (A.P.DC.) Mart. ex erg.	30.50	-29.6
409	Undetermined	49.50	-25.4
416	Eschweilera sp.	25.10	-28.9
121	Guatteria cf. Poeppigiana Mart.	22.30	-29.5
130	Undetermined	19.50	-25.7
438	Virola pavonis (A.D.C.) A.C. Smith	34.50	-29.5
145	Apuleia molaris Bth.	46.26	-27.7
461	Guatteria cf. poeppigiana Mart.	34.50	-28.4
475	Undetermined	18.00	-28.3
478	Pseudomedia laevis (R. & P.) Macbr.	28.67	-28.0

References

- Bassow SL, Bazzaz FA (1997) Intra- and inter-specific variation in canopy photosynthesis in a mixed deciduous forest. Oecologia 109:507–515
- Berry SC, Varney GT, Flanagan LB (1997) Leaf δ^{13} C in *Pinus* resinosa trees and understory plants: variation associated with light and CO₂ gradients. Oecologia 109:499–506
- Broadmeadow MSJ, Griffiths H (1993) Carbon isotope discrimination and the coupling of CO₂ fluxes within forest canopies. In: Ehleringer JR, Hall AE, Farquhar GD (eds) Stable isotopes and plant carbon-water Relations. Academic Press, San Diego, Calif., pp 109–130
- Brown IF, Martinelli LA, Thomas WW, Moreira MZ, Cid Ferreira CA, Victoria RL (1995) Uncertainty in the biomass of Amazonian forests: an example from Rondônia, Brazil. For Ecol Manage 75:175–189
- Buchmann N, Kao WY, Ehleringer JR (1996) Carbon dioxide concentrations within forest canopies – variation with time, stand, and vegetation type. Global Change Biol 2:421–432
- Buchmann N, Guehl JM, Barigah TS, Ehleringer JR (1997a) Interseasonal comparison of CO₂ concentrations, isotopic composition, and carbon dynamics in an Amazonian rainforest (French Guiana). Oecologia 110:120–131
- Buchmann N, Kao WY, Ehleringer JT (1997b) Influence of stand structure on carbon-13 of vegetation, solids, and canopy air within deciduous and evergreen forests in Utah, United States. Oecologia 110:109–119
- Departamento Nacional de Produção Mineral, Brazil (1978) Projeto RADAMBRASIL. Folha SC.20 Porto Velho. DNPM, Rio de Janeiro, Brazil
- Ducatti C, Salati E, Martins D (1991) Measurement of the natural variation of ¹³C:¹²C ratio in leaves at Rserve Ducke Forest, central Amazonia. For Ecol Manage 38:201–210

- Ehleringer JR, Field CB, Lin Z, Kuo C (1986) Leaf carbon isotope and mineral composition in sub-tropical plants along an irradiance cline. Oecologia 70:520–526
- Ehleringer JR, Lin ZF, Field CB, Sun GC, Kuo CY (1987) Leaf carbon ratios of plants from a subtropical monsoon forest. Oecologia 72:109–114
- Farquhar GD, O'Leary OL, Berry JA (1982) On the relationship between carbon isotope discrimination and the intercellular carbon dioxide concentration in leaves. Aust J Plant Physiol 9:121–137
- Farquhar GD, Ehleringer JR, Hubick KT (1989) Carbon isotope discrimination and photosynthesis. Annu Rev Plant Physiol Plant Mol Biol 40:503–537
- Fisher JC von, Tieszen LL (1995) Carbon isotope characterization of vegetation and soil organic matter in subtropical forests in Luquillo, Puerto Rico. Biotropica 27:138–148
- Flanagan LB, Brooks JR, Varney GT, Berry SC, Ehleringer JR (1996) Carbon isotope discrimination during photosynthesis and the isotope ratio of respired CO₂ in boreal forest ecosystem. Global Biogeochem Cycles 10:629–640
- Francey RJ, Gifford RM, Sharkey TD, Weir B (1985) Physiological influences on carbon isotope discrimination in huon pine (*Lagarostrobus franklinii*). Oecologia 66:469–481
- Gebauer G, Schulze E-D (1991) Carbon and nitrogen isotope ratios in different compartments of a healthy and a declining *Picea abies* forest in the Fichtelgebirge, NE Bavaria. Oecologia 97:198–207
- Grace J, Lloyd J, McIntyere J, Miranda A, Meir P, Miranda H, Moncriedd J, Massheder J, Wright I, Gash J (1995) Fluxes of carbon dioxide and water vapour over an undisturbed tropical forest in south-west Amazonia, Global change Biol 1:1–12
- Hanba YT, Shigeta M, Lei TT, Koike T, Wada E (1997) Variations in leaf δ^{13} C along a vertical profile of irradiance in a temperate Japanese forest. Oecologia 110:253–361
- Holdridge LR, Grenke WC, Hatheway WH, Liang T, Tosi JA Jr (1971) Forest environments in tropical life zones: a piloty study. Pergamon, New York

- Hubick KT, Farquhar GD, Shorter R (1986) Correlation between water-use efficiency and carbon isotope discrimination in diverse peanut (*Arachis*) germplasm. Aust J Plant Physiol 13:803–816
- Hubick KT, Shorter R, Farquhar GD (1988) Heritability and genotype × environment interactions of carbon isotope discrimination and transpiration efficiency in peanut (*Arachis hypogae* L.). Aust J Plant Physiol 15:799–813
- Kapos V, Ganade G, Matsui E, Victoria RL (1993) δ^{13} C as an indicator of edge effects in tropical rainforest reserves. J Ecol 81:425–432
- Kruijt B, Lloyd J, Grace J, McIntyer JA, Farquhar GD, Miranda AC, McCracken P (1996) Sources and sinks of CO₂ in Rondona tropical rainforest. In: Gash JHC, Nobre CA, Roberts JM, Victoria RL (eds) Amazonian deforestation and climate. Wiley, Chichester, pp 331–351
- Leavitt SW, Long A (1986) Stable-carbon isotope variability in tree foliage and wood. Ecology 67:1002–1010
- Lieberman M, Lieberman D, Peralta R (1989) Forests are not just Swiss cheese: canopy stereogeometry of non gaps in tropical forests. Ecology 70:550–552
- Lloyd J, Kruijt B, Hollinger DY, Grace J, Francey RJ, Wond SC, Kelliher FM, Miranda AC, Farquhar GD, Gash JHC, Vygodskaya NN, Wright IR, Miranda HS, Schulze E-D (1996) Vegetation effects on the isotopic composition of atmospheric CO₂ at local and regional scales: theoretical aspects and a comparison between rain forest in Amazonia and a boreal forest in Siberia. Aust J Plant Physiol 23:371–399
- Martinelli LA, Victoria RL, Forsberg BR, Richey JE (1994) Isotopic composition of major carbon reservoirs in the Amazon floodplain. Int J Ecol Environ Sci 20:31–46

- Medina E, Minchin P (1980) Stratification of δ^{13} C values of leaves in Amazonian rain forests. Oecologia 45:377–378
- Medina E, Montes G, Ceuvas E, Rokzandic Z (1986) Profiles of CO_2 concentration and $\delta^{13}C$ values in tropical rain forests of the upper Rio Negro Basin, Venezuela. J Trop Ecol 2:207–217
- Medina E, Sternberg L, Cuevas E (1991) Vertical stratification of δ^{13} C values in closed natural and plantation forests in the Luquillo mountains, Puerto Rico. Oecologia 87:369–372
- Merwe NJ van der, Medina E (1989) Photosynthesis and ¹³C/¹²C ratios in Amazonian rain forests. Geochim Cosmochim Acta 53:1091–1194
- Pearcy RW, Pfitsch WA (1991) Influence of sunflecks on the δ^{13} C of *Adenocaulon bicolor* plants occurring in contrasting forest understory microsites. Oecologia 86:457–462
- Schleser GH (1992) δ^{13} C pattern in a forest tree as an indicator of carbon transfer in trees. Ecology 73:1922–1925 Schleser GH, Jayasekera R (1985) δ^{13} C variation of leaves in for-
- Schleser GH, Jayasekera R (1985) δ^{13} C variation of leaves in forests as an indicator of reassimilated CO₂ from soil. Oecologia 458:26–32
- Sternberg LSL (1997) Interpretation of recycling indexes. Aust J Plant Physiol 24:395–398
- Sternberg LSL, Mulkey SS, Wright SJ (1989) Ecological interpretation of leaf carbon isotope ratios: influence of respired carbon dioxide. Ecology 70:1317–1324
- Victoria RL, Fernandes F, Martinelli LA, Piccolo MC, Camargo PB, Trumbore S (1995) Past vegetation changes in the Brazilian Pantanal arboreal-grassy savanna ecotone by using carbon isotopes in the soil organic matter. Global Change Biol 1:165–171
- Walcroft AS, Silvester WB, Grace JC, Carson SD, Waring RH (1996) Effects of branch length on carbon isotope discrimination in *P. radiata*. Tree physiol 16:281–286