Plant and Soil

Forest edges favor conservative resource-use and symbiotic belowground strategies in Eastern Amazonian forest fragments

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Table S1. Characterization of the forest fragments sampled in the study, including fragment identification, municipality of occurrence, geographic coordinates (latitude/longitude), and total area of each fragment in hectares (ha).

Fragment	Municipality	Coordinates (Lat/Long)	Area (ha)	Topographic variation between edge and interior (m)
MA3	Barcarena	01°30′21″S / 48°29′45″W	576,83	8.928
MA14	Barcarena	01°36′41″S / 48°31′14″W	11,80	2.303
PC02	Abaetetuba	01°32′32″S / 48°41′45″W	1301,33	1.079
PC09	Abaetetuba	01°37′46″S / 48°41′40″W	323,06	11.714
L3	Moju	01°38′56″S / 48°46′18″W	338,15	1.004
M3	Moju	01°40′28″S / 48°45′41″W	21,34	16.974
U3	Moju	01°41′09″S / 48°36′35″W	10148,50	26.066
V1	Moju	01°33′59″S / 48°44′52″W	177,76	2.276

Table S2. Characterization of the trees sampled in the different forest fragments, including sampling fragment, environment (edge or interior), taxonomic identification of species, voucher number, species number, sampled individual, diameter at breast height (DBH), and total height (in meters). Missing values

(NA*) indicate individuals that were felled by human activity, making it impossible to measure these characteristics.

Fragment	Environment	Species	Voucher	Nº of the Species	Individual	DBH (m)	Height (m)
MA3	Edge	*Vismia guianensis (Aubl.) Choisy.*	8067	1	1	0.32	5
MA3	Edge	*Vismia guianensis (Aubl.) Choisy.*	8067	1	2	0.64	9.5
MA3	Edge	*Vismia guianensis (Aubl.) Choisy.*	8067	1	3	NA*	NA*
MA3	Edge	*Theobroma grandiflorum (Willd. ex Spreng.) K.Schum.*	8068	2	3	0.96	7.3
MA3	Edge	*Theobroma grandiflorum (Willd. ex Spreng.) K.Schum.*	8068	2	2	0.64	7.2
MA3	Edge	*Theobroma grandiflorum (Willd. ex Spreng.) K.Schum.*	8068	2	1	0.32	6.4
MA3	Edge	*Inga heterophylla Willd.*	8069	3	3	0.96	8
MA3	Edge	*Inga heterophylla Willd.*	8069	3	2	0.64	8
MA3	Edge	*Inga heterophylla Willd.*	8069	3	1	0.32	11
MA3	Interior	*Myrcia sylvatica (G.Mey.) DC.*	8071	1	2	0.64	4.5
MA3	Interior	*Myrcia sylvatica (G.Mey.) DC.*	8071	1	3	0.96	12
MA3	Interior	*Myrcia sylvatica (G.Mey.) DC.*	8071	1	1	0.32	6.2
MA3	Interior	*Protium aracouchini (Aubl.) Marchand.*	8072	2	2	0.64	56.9
MA3	Interior	*Protium aracouchini (Aubl.) Marchand.*	8072	2	3	0.96	12.1
MA3	Interior	*Protium aracouchini (Aubl.) Marchand.*	8072	2	1	0.32	14.6
MA3	Interior	*Guatteria schomburgkiana Mart.*	8073	3	1	0.32	6.5
MA3	Interior	*Guatteria schomburgkiana Mart.*	8073	3	2	0.64	4.2
MA3	Interior	*Guatteria schomburgkiana Mart.*	8073	3	3	0.96	6.5
MA14	Edge	*Miconia cuspidata Naudin.*	8098	1	2	0.64	6.2
MA14	Edge	*Miconia cuspidata Naudin.*	8098	1	3	0.96	5.4
MA14	Edge	*Miconia cuspidata Naudin.*	8098	1	1	0.32	6.8
MA14	Edge	*Vismia guianensis (Aubl.) Choisy.*	8099	2	1	0.32	7.1
MA14	Edge	*Vismia guianensis (Aubl.) Choisy.*	8099	2	2	0.64	7.5
MA14	Edge	*Vismia guianensis (Aubl.) Choisy.*	8099	2	3	0.96	3.2
MA14	Edge	*Inga thibaudiana DC.*	8100	3	1	0.32	8.1
MA14	Edge	*Inga thibaudiana DC.*	8100	3	2	0.64	11
MA14	Edge	*Inga thibaudiana DC.*	8100	3	3	0.96	11

MA14	Interior	*Calliandra surinamensis Benth.*	8102	1	1	0.32	7.5
MA14	Interior	*Calliandra surinamensis Benth.*	8102	1	2	0.64	7.2
MA14	Interior	*Calliandra surinamensis Benth.*	8102	1	3	0.96	7.2
MA14	Interior	*Siparuna guianensis Aubl.*	8103	2	1	0.32	15
MA14	Interior	*Siparuna guianensis Aubl.*	8103	2	2	0.64	17
MA14	Interior	*Siparuna guianensis Aubl.*	8103	2	3	0.96	17
MA14	Interior	*Endlicheria anomala (Nees) Mez.*	8104	3	1	0.32	6.8
MA14	Interior	*Endlicheria anomala (Nees) Mez.*	8104	3	2	0.64	6.8
MA14	Interior	*Endlicheria anomala (Nees) Mez.*	8104	3	3	0.96	6.8
PC02	Edge	*Vismia guianensis (Aubl.) Choisy.*	8075	1	3	0.96	4.5
PC02	Edge	*Vismia guianensis (Aubl.) Choisy.*	8075	1	2	0.64	8.15
PC02	Edge	*Vismia guianensis (Aubl.) Choisy.*	8075	1	1	0.32	7.4
PC02	Edge	*Humiria balsamifera (Aubl.) A.St.-Hil.*	8076	2	2	0.64	10.5
PC02	Edge	*Humiria balsamifera (Aubl.) A.St.-Hil.*	8076	2	3	0.96	10.5
PC02	Edge	*Humiria balsamifera (Aubl.) A.St.-Hil.*	8076	2	1	NA*	NA*
PC02	Edge	*Calliandra surinamensis Benth.*	8077	3	2	0.64	21
PC02	Edge	*Calliandra surinamensis Benth.*	8077	3	3	0.96	4.2
PC02	Edge	*Calliandra surinamensis Benth.*	8077	3	1	0.32	4
PC02	Interior	*Miconia affinis DC.*	8078	1	1	0.32	6.8
PC02	Interior	*Miconia affinis DC.*	8078	1	2	0.64	6.8
PC02	Interior	*Miconia affinis DC.*	8078	1	3	0.96	6.5
PC02	Interior	*Calliandra surinamensis Benth.*	8079	2	1	0.32	3.5
PC02	Interior	*Calliandra surinamensis Benth.*	8079	2	2	0.64	5.5
PC02	Interior	*Calliandra surinamensis Benth.*	8079	2	3	0.96	5.5
PC02	Interior	*Myrciaria tenella (DC.) O.Berg.*	8080	3	1	0.32	4.6
PC02	Interior	*Myrciaria tenella (DC.) O.Berg.*	8080	3	2	0.64	2.5
PC02	Interior	*Myrciaria tenella (DC.) O.Berg.*	8080	3	3	0.96	5.2
PC09	Edge	*Carapa guianensis Aubl.*	8093	1	2	0.64	16.3
PC09	Edge	*Carapa guianensis Aubl.*	8093	1	3	0.96	15.4
PC09	Edge	*Carapa guianensis Aubl.*	8093	1	1	0.32	16.1
PC09	Edge	*Vismia guianensis (Aubl.) Choisy.*	8094	2	2	0.64	10.5

PC09	Edge	*Vismia guianensis (Aubl.) Choisy.*	8094	2	3	0.96	6.2
PC09	Edge	*Vismia guianensis (Aubl.) Choisy.*	8094	2	1	0.32	8.6
PC09	Edge	*Xylopia ferruginea (Hook.f. & Thomson) Baill.*	8095	3	1	NA*	NA*
PC09	Edge	*Xylopia ferruginea (Hook.f. & Thomson) Baill.*	8095	3	2	NA*	NA*
PC09	Edge	*Xylopia ferruginea (Hook.f. & Thomson) Baill.*	8095	3	3	NA*	NA*
PC09	Interior	*Theobroma grandiflorum (Willd. ex Spreng.) K.Schum.*	8096	1	3	0.96	7.8
PC09	Interior	*Theobroma grandiflorum (Willd. ex Spreng.) K.Schum.*	8096	1	2	0.64	5.9
PC09	Interior	*Theobroma grandiflorum (Willd. ex Spreng.) K.Schum.*	8096	1	1	0.32	3.7
PC09	Interior	*Caraipa grandifolia Mart.*	8097	2	3	0.96	4.6
PC09	Interior	*Caraipa grandifolia Mart.*	8097	2	2	0.64	4.5
PC09	Interior	*Caraipa grandifolia Mart.*	8097	2	1	0.32	11.7
PC09	Interior	*Caraipa grandifolia Mart.*	8097	3	1	NA*	NA*
PC09	Interior	*Caraipa grandifolia Mart.*	8097	3	2	NA*	NA*
PC09	Interior	*Caraipa grandifolia Mart.*	8097	3	3	NA*	NA*
L3	Edge	*Vismia guianensis (Aubl.) Choisy.*	8087	1	1	0.32	8.7
L3	Edge	*Vismia guianensis (Aubl.) Choisy.*	8087	1	2	0.64	6.9
L3	Edge	*Vismia guianensis (Aubl.) Choisy.*	8087	1	3	0.96	10.1
L3	Edge	*Inga edulis Mart.*	8088	2	1	0.32	12.5
L3	Edge	*Inga edulis Mart.*	8088	2	2	0.64	5.6
L3	Edge	*Inga edulis Mart.*	8088	2	3	0.96	7.5
L3	Edge	*Xylopia frutescens Aubl.*	8089	3	1	0.32	10.6
L3	Edge	*Xylopia frutescens Aubl.*	8089	3	2	0.64	4.8
L3	Edge	*Xylopia frutescens Aubl.*	8089	3	3	0.96	7.3
L3	Interior	*Theobroma grandiflorum (Willd. ex Spreng.) K.Schum.*	8090	1	3	0.96	6.4
L3	Interior	*Theobroma grandiflorum (Willd. ex Spreng.) K.Schum.*	8090	1	2	0.64	10.4
L3	Interior	*Theobroma grandiflorum (Willd. ex Spreng.) K.Schum.*	8090	1	1	0.32	5.1
L3	Interior	*Simarouba amara Aubl.*	8091	2	1	0.32	3.2
L3	Interior	*Simarouba amara Aubl.*	8091	2	2	0.64	6.8
L3	Interior	*Simarouba amara Aubl.*	8091	2	3	0.96	8.2

L3	Interior	*Macrosamanea pubiramea (Steud.) Barneby & J.W.Grimes var. pubiramea.*	8092	3	1	0.32	2.3
L3	Interior	*Macrosamanea pubiramea (Steud.) Barneby & J.W.Grimes var. pubiramea.*	8092	3	2	0.64	5.5
L3	Interior	*Macrosamanea pubiramea (Steud.) Barneby & J.W.Grimes var. pubiramea.*	8092	3	3	NA*	NA*
M3	Interior	*Theobroma grandiflorum (Willd. ex Spreng.) K.Schum.*	8090	1	1	0.32	6.4
M3	Interior	*Theobroma grandiflorum (Willd. ex Spreng.) K.Schum.*	8090	1	2	0.64	7.15
M3	Interior	*Theobroma grandiflorum (Willd. ex Spreng.) K.Schum.*	8090	1	3	0.96	9.25
M3	Interior	*Miconia cuspidata Naudin*	8105	2	1	0.32	6.8
M3	Interior	*Miconia cuspidata Naudin*	8105	2	2	0.64	14.4
M3	Interior	*Miconia cuspidata Naudin*	8105	2	3	NA*	NA*
M3	Interior	*Pouteria venosa (Mart.) Baehni*	8106	3	1	0.32	5.1
M3	Interior	*Pouteria venosa (Mart.) Baehni*	8106	3	2	0.64	7.8
M3	Interior	*Pouteria venosa (Mart.) Baehni*	8106	3	3	NA*	NA*
M3	Edge	*Myrcia sylvatica (G.Mey.) DC.*	8107	1	1	0.32	7.7
M3	Edge	*Myrcia sylvatica (G.Mey.) DC.*	8107	1	2	NA*	NA*
M3	Edge	*Myrcia sylvatica (G.Mey.) DC.*	8107	1	3	NA*	NA*
M3	Edge	*Myrcia sylvatica (G.Mey.) DC.*	8107	2	1	0.32	4.7
M3	Edge	*Myrcia sylvatica (G.Mey.) DC.*	8107	2	2	NA*	NA*
M3	Edge	*Myrcia sylvatica (G.Mey.) DC.*	8107	2	3	NA*	NA*
M3	Edge	*Eschweilera coriacea (DC.) S.A.Mori*	8108	3	1	0.32	10.4
M3	Edge	*Eschweilera coriacea (DC.) S.A.Mori*	8108	3	2	0.64	10.4
M3	Edge	*Eschweilera coriacea (DC.) S.A.Mori*	8108	3	3	0.96	7
U3	Interior	*Miconia affinis DC.*	8060	1	1	0.32	4.2
U3	Interior	*Miconia affinis DC.*	8060	1	2	0.64	9.5
U3	Interior	*Miconia affinis DC.*	8060	1	3	0.96	6.5
U3	Interior	*Theobroma grandiflorum (Willd. ex Spreng.) K.Schum.*	8061	2	1	0.32	6.9

U3	Interior	*Theobroma grandiflorum (Willd. ex Spreng.) K.Schum.*	8061	2	2	0.64	7.8
U3	Interior	*Theobroma grandiflorum (Willd. ex Spreng.) K.Schum.*	8061	2	3	0.96	8.7
U3	Interior	*Endopleura uchi (Huber) Cuatrec.*	8062	3	1	0.32	7.8
U3	Interior	*Endopleura uchi (Huber) Cuatrec.*	8062	3	2	0.64	8.3
U3	Interior	*Endopleura uchi (Huber) Cuatrec.*	8062	3	3	0.96	10.2
U3	Edge	*Calliandra surinamensis Benth.*	8064	1	1	0.32	7.4
U3	Edge	*Calliandra surinamensis Benth.*	8064	1	2	0.64	8.15
U3	Edge	*Calliandra surinamensis Benth.*	8064	1	3	0.96	4.5
U3	Edge	*Vismia guianensis (Aubl.) Choisy.*	8065	2	1	0.32	NA
U3	Edge	*Vismia guianensis (Aubl.) Choisy.*	8065	2	2	0.64	10.5
U3	Edge	*Vismia guianensis (Aubl.) Choisy.*	8065	2	3	0.96	10.5
U3	Edge	*Inga alba (Sw.) Willd.*	8066	3	1	0.32	4
U3	Edge	*Inga alba (Sw.) Willd.*	8066	3	2	0.64	21
U3	Edge	*Inga alba (Sw.) Willd.*	8066	3	3	0.96	4.2
V1	Interior	*Guarea macrophylla Vahl.*	8084	1	1	0.32	9
V1	Interior	*Guarea macrophylla Vahl.*	8084	1	2	0.64	9
V1	Interior	*Guarea macrophylla Vahl.*	8084	1	3	0.96	5.5
V1	Interior	*Miconia cuspidata Naudin.*	8085	2	1	0.32	8.9
V1	Interior	*Miconia cuspidata Naudin.*	8085	2	2	0.64	8.6
V1	Interior	*Miconia cuspidata Naudin.*	8085	2	3	0.96	6
V1	Interior	*Aparisthmium cordatum (A.Juss.) Baill.*	8086	3	1	0.32	7
V1	Interior	*Aparisthmium cordatum (A.Juss.) Baill.*	8086	3	2	0.64	5.2
V1	Interior	*Aparisthmium cordatum (A.Juss.) Baill.*	8086	3	3	0.96	5.2
V1	Edge	*Miconia cuspidata Naudin.*	8081	1	1	0.32	8.2
V1	Edge	*Miconia cuspidata Naudin.*	8081	1	2	0.64	6
V1	Edge	*Miconia cuspidata Naudin.*	8081	1	3	0.96	6
V1	Edge	*Deguelia spruceana (Benth.) A.M.G.Azevedo & R.A.Camargo.*	8082	2	1	0.32	6.4
V1	Edge	*Deguelia spruceana (Benth.) A.M.G.Azevedo & R.A.Camargo.*	8082	2	2	0.64	6.1

V1	Edge	*Deguelia spruceana (Benth.) A.M.G.Azevedo & R.A.Camargo.*	8082	2	3	0.96	3.1
V1	Edge	*Guarea macrophylla Vahl.*	8083	3	1	0.32	8.2
V1	Edge	*Guarea macrophylla Vahl.*	8083	3	2	0.64	7.1
V1	Edge	*Guarea macrophylla Vahl.*	8083	3	3	0.96	6.15

Fig S1. Spearman correlation matrix between root functional traits sampled trees in Eastern Amazonian forest fragments. Values represent the Spearman's rho (ρ) correlation coefficient, and the color scale indicates the direction and strength of the associations, ranging from deep blue (strong positive correlations) to deep red (strong negative correlations), where color intensity and circle size are proportional to the magnitude of the coefficient, while blank areas indicate non-significant correlations ($p \geq 0.05$). Abbreviations correspond to: SRL (Specific root length, cm g^{-1}), RTD (Root tissue density, g cm^{-3}), SRA (Specific root area, cm^2 g^{-1}), DM (Mean diameter of fine roots, mm), M% (Mycorrhizal colonization intensity) and A% (Arbuscule abundance). Statistical significance was assessed using the pairwise method, with significance levels indicated by * ($p < 0.05$), ** ($p < 0.01$), and *** ($p < 0.001$).

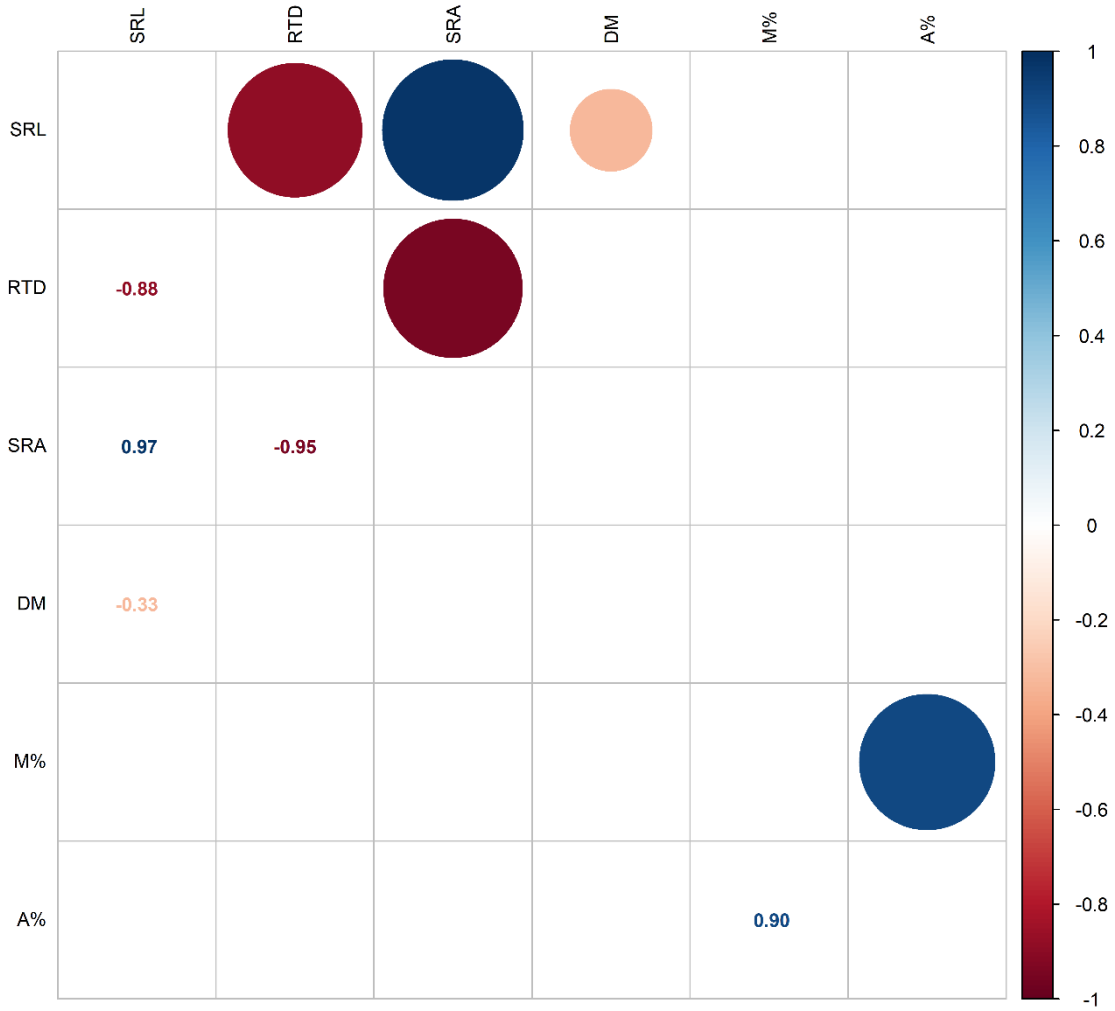

Table S3. Description of root functional traits and leaf physiological variables measured in sampled trees in Eastern Amazonian forest fragments. The table presents the abbreviations used, the calculation formulas or methods of determination, and the units of measurement. Abbreviations correspond to: SRL (Specific root length, cm g^{-1}), SRA (Specific root area, cm^2 g^{-1}), RTD (Root tissue density, g cm^{-3}), DM (Mean diameter of fine roots, mm), F% (Mycorrhizal frequency), M% (Mycorrhizal colonization intensity), A% (Arbuscule abundance in the root system), Ψpd (Predawn leaf water potential, MPa), and Ψmd (Midday leaf water potential, MPa). Methods for mycorrhizal quantification followed Trouvelot et al. (1986), morphological analyses were processed using the Rhizovision Explorer software, and water potential measurements were obtained using a Scholander pressure chamber (Scholander et al., 1965).

Attribute	Abbreviation	Formula / Method	Unit
Specific root length	SRL	Total_length / Dry_mass	cm g^{-1}
Specific root area	SRA	Surface_area / Dry_mass	$cm^2 \cdot g^{-1}$

Root tissue density	RTD	Dry_mass / Total_volume	$g \cdot cm^{-3}$
Mean diameter	DM	Analysis via Rhizovision Explorer	mm
Mycorrhizal frequency	F%	(N_mycorrhizal_fragments / N_total) × 100	%
Mycorrhizal intensity	M%	M% = (95n5 + 70n4 + 30n3 + 5n2 + n1) / total nb	%
Arbuscule abundance	A%	a × (M / 100)	%
Water potential (Predawn)	Ψpd	Scholander pressure chamber	MPa
Water potential (Midday)	Ψmd	Scholander pressure chamber	MPa

Table S4. Table S3. Detailed Spearman correlation coefficients (ρ) between root morphological traits and mycorrhizal associations. This table complements Figure S1 by presenting the exact numerical values of the pairwise comparisons among variables. Values outside the diagonal represent the correlation coefficient, where the sign indicates the direction of the relationship (positive or negative). Statistical significance is indicated by asterisks according to p-values: * ($p < 0.05$), ** ($p < 0.01$), and *** ($p < 0.001$).

Attribute	SRL	RTD	SRA	DM	M%	A%
SRL	1					
RTD	-0.88***	1				
SRA	0.97***	-0.95***	1			
DM	-0.33**	0.05	-0.19	1		
M%	-0.12	0.16	-0.11	0.09	1	
A%	-0.05	0.1	-0.04	0.08	0.90***	1

Table S5. Mean values (± standard deviation) of the functional attributes measured at the edge and in the interior of the study areas. The significance of differences between environments was assessed using a likelihood ratio test (χ^2, LRT), with the corresponding *p*-values. The main explanatory factor for each attribute is indicated based on the explained variance (σ^2), considering species and site effects. Ψmd = midday water potential; Ψpd = predawn water potential; A = arbuscule abundance in the root system; M = mycorrhizal colonization intensity; RTD = root tissue density; DM = mean root diameter; SRA = specific root area.

Attribute	Mean ± SD (Edge)	Mean ± SD (Interior)	χ^2 (LRT)	p-value	primary driver (σ^2)
Ψmd	−2,08 ± 0,77	−1,79 ± 0,80	53,55	< 0,001	Species (0,163) / Fragment (0,052)

Ψpd	−0,52 ± 0,29	−0,55 ± 0,28	0,50	0,480	Species (0,105) / Fragment (0,011)
A (%)	30,6 ± 39,7%	2,6 ± 2,5%	37,78	< 0,001	Species (0,157) / Fragment (≈ 0)
M (%)	3,45 ± 2,96	1,38 ± 0,67	31,62	< 0,001	Fragment (0,048) / Species (0,022)
RTD	0,021 ± 0,023	0,008 ± 0,005	34,92	< 0,001	Fragment (0,114) / Species (0,068)
DM	0,66 ± 0,15	0,63 ± 0,16	3,11	0,374	Species (0,005) / Fragment (0,002)
SRA	176,5 ± 152,1	284,4 ± 177,9	7,15	0,067	Fragment (0,050) / Species (≈ 0)
SRL	59,15 ± 54,58	117,44 ± 88,49	13,60	0,003	Fragment (0,097) / Species (≈ 0)