SEASONAL VARIATIONS RESULT IN SLIGHT CHANGES IN THE MACROPHYTE COMMUNITY OF AN ATLANTIC FOREST WETLAND

Yasmin de Mello Canalli[1]*, Bruno Eleres Soares[2] & Cássia Mônica Sakuragui[1]

[1] Universidade Federal do Rio de Janeiro, Instituto de Biologia, Programa de Pós-Graduação em Biodiversidade e Biologia Evolutiva, Laboratório Integrado de Sistemática Vegetal, Avenida Carlos Chagas Filho 373, Cidade Universitária, 21941-599, Rio de Janeiro, RJ, Brasil

[2] University of Regina, Faculty of Science, Institute of Environmental Change & Society, Wascana Pkwy, 3737, S4S 0A2, Regina, SK, Canada.

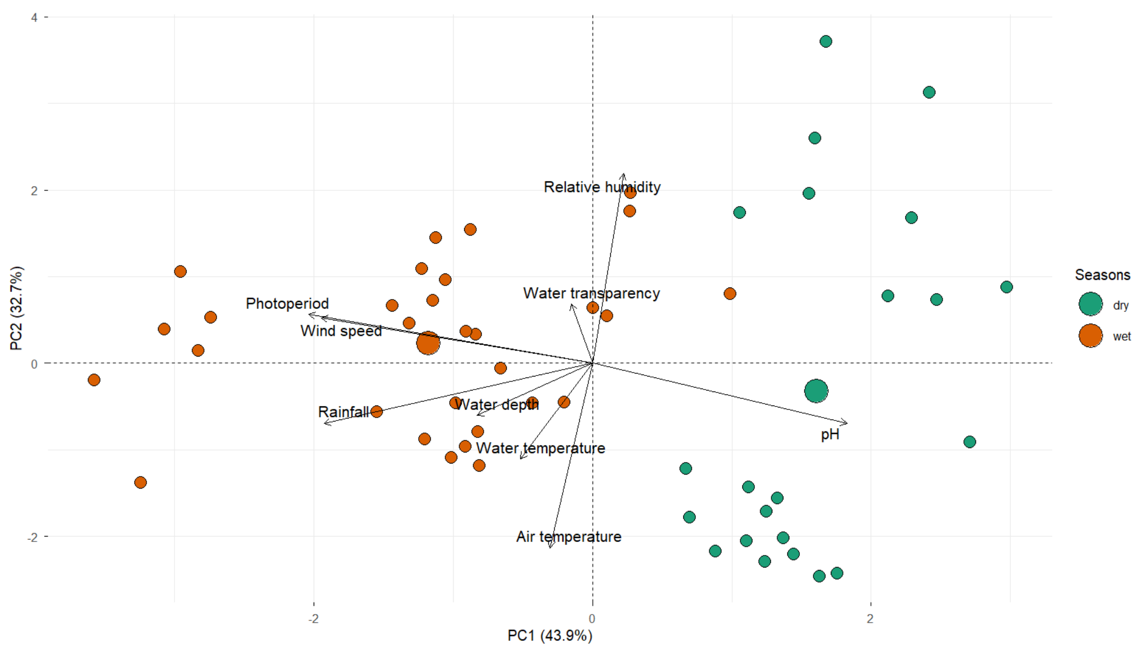
E-mails: yasmincanalli@hotmail.com (*corresponding author); bruno.soares@uregina.ca; cmsakura12@hotmail.com

SUPPLEMENTARY MATERIAL

Methodology details

In each plot, we measured pH, water temperature (Akso AK90), room temperature, relative humidity (Akso AK632), transparency, depth (Secchi disc), local photoperiod (ESALQ-USP), wind speed, and rainfall from the nearest weather station (INMET, 2021). Photoperiod is the duration of the light period during a 24-hour cycle and influences growth and flowering, and the unit is hours. For further analysis, we calculated the transect value for each environmental variable measured as the mean of the measurements from each plot. A Principal Component Analysis (PCA) was used to identify environmental patterns differently between hydrological seasons, considering only two main explanatory axes. This approach made it possible to identify the components that most contributed to the variation in the data, in addition to allowing the reduction of the number of variables. To decide which components should be kept for interpretation, Kaiser-Guttman cutoff values were used. The function decostand in the R environment was used as a standardization method for the environmental data prior to the PCA.

The environmental conditions measured on site during expeditions varied over the hydrological season. The increased rainfall during the wet season was accompanied by decreased pH and increased photoperiod, which made us expect community changes between periods because they impact certain species differently. PCA was based on nine environmental variables and resulted in three statistically significant axes based on the Broken Stick Modell. The first three axes explained 74.5% of the total variation in ecological space related to seasonality. Environmental factors showed differences between the dry and wet seasons (Supplementary Material S3). The dry season was more correlated with pH, while the wet season was more associated with photoperiod and rainfall.



Supplementary Material S1. Principal Components Analysis (PCA) of standardized abiotic variables measured across transects during the wet and dry seasons at Ribeirão das Crioulas, state of Rio de Janeiro, Brazil. Points represent transects sampled in each season (wet and dry), and larger symbols indicate the centroids of each group. Arrows represent the direction and strength of correlations between environmental variables (pH, water temperature, air temperature, relative air humidity, water transparency, water depth, wind speed, rainfall, and photoperiod) and the PCA axes.

Supplementary Material S2. Pearson correlation coefficients between abiotic variables (pH, relative air humidity, water temperature, room temperature, water transparency, water depth, rainfall, wind speed, and photoperiod) and the first three principal components (PC1-PC3) obtained from a Principal Components Analysis (PCA) of standardized environmental data collected across transects during the wet and dry seasons at Ribeirão das Crioulas, state of Rio de Janeiro, Brazil.

Variables	PC 1	PC 2	PC 3
pH	0.4552	-0.1931	0.2247
Relative air humidity	0.0554	0.6082	0.2590
Water temperature	-0.1285	-0.3071	0.2735
Room temperature	-0.0763	-0.5924	-0.3057
Water transparency	-0.0382	0.1904	-0.6487
Water depth	-0.2061	-0.1676	0.5397

Rainfall	-0.4802	-0.1925	0.0080
Wind speed	-0.4847	0.1462	0.0411
Photoperiod	-0.5077	0.1564	-0.0105
Eigenvalues	2.8147	2.2634	1.6300
% Variability	31.2749	25.1499	18.1119

Supplementary Material S3. Summary of abiotic variables measured across transects during the wet and dry seasons at Ribeirão das Crioulas, state of Rio de Janeiro, Brazil. Values represent mean, minimum, maximum, and standard deviation for each variable (pH, relative air humidity, water temperature, room temperature, water transparency, water depth, rainfall, wind speed, and photoperiod).

Variable	Season	Mean	Minimum value	Maximum value	Standard deviation
pH	Dry	7.13	5.10	9.60	1.04
	Wet	6.15	5.00	8.90	0.56

Relative air humidity	Dry	36.12	16.20	93.10	23.18
	Wet	39.22	14.80	82.60	13.09
Water Temperature (ºC)	Dry	25.73	18.20	33.30	3.89
	Wet	27.62	18.70	39.10	3.21
Room temperature (ºC)	Dry	41.69	21.60	54.90	11.47
	Wet	40.79	26.20	55.80	6.68
Transparency (m)	Dry	0.69	0.08	1.94	0.45
	Wet	0.87	0.03	1.94	0.58
Depth (m)	Dry	1.54	0.45	2.35	0.28
	Wet	1.65	0.83	3.70	0.43
Rainfall (mm)	Dry	114.13	50.00	250.80	81.19
	Wet	204.16	138.00	330.00	64.36
Wind speed	Dry	10.93	9.76	13.46	1.48
	Wet	25.30	13.46	47.10	13.36

Photoperiod	Dry	11.20	10.80	12.00	0.47
	Wet	13.10	12.60	13.50	0.35

Supplementary Material S4. Dichotomous identification key for macrophyte species recorded at Ribeirão das Crioulas wetland, state of Rio de Janeiro, Brazil, based on morphological characteristics observed in the field.

1a. Cryptogam; free-floating; orbicular floating leaves with fouet-like trichomes .... *Salvinia auriculata*

1b. Angiosperm 2

2a. Plants epiphytic, amphibious or emergent 3

2b. Plants free-floating, rooted-floating or submerged 6

3a. Epiphytic; linear leaves; inconspicuous flowers .... *Cyperus gardneri*

3b. Amphibious or emergent plants 4

4a. Linear leaves; inconspicuous flowers .... Poaceae

4b. Lanceolate or orbicular leaves; showy flowers 5

5a. Lanceolate leaves; yellow flowers .... *Ludwigia* sp.

5b. Orbicular leaves; white or pale pink flowers .... *Bacopa monnieri*

6a. Rooted-floating plants; roots attached to substrate 7

6b. Free-floating or submerged plants 9

7a. Emergent leaves; lilac flowers .... *Pontederia azurea*

7b. Floating leaves 8

8a. Yellow flowers .... *Hydrocleys nymphoides*

8b. Lilac flowers .... *Nymphaea caerulea*

9a. Insectivorous plants with utricles 10

9b. Non-insectivorous plants without utricles 11

10a. Float present in floral scape .... *Utricularia breviscapa*

10b. Float absent in floral scape .... *Utricularia foliosa*

11a. Free-floating plants 12

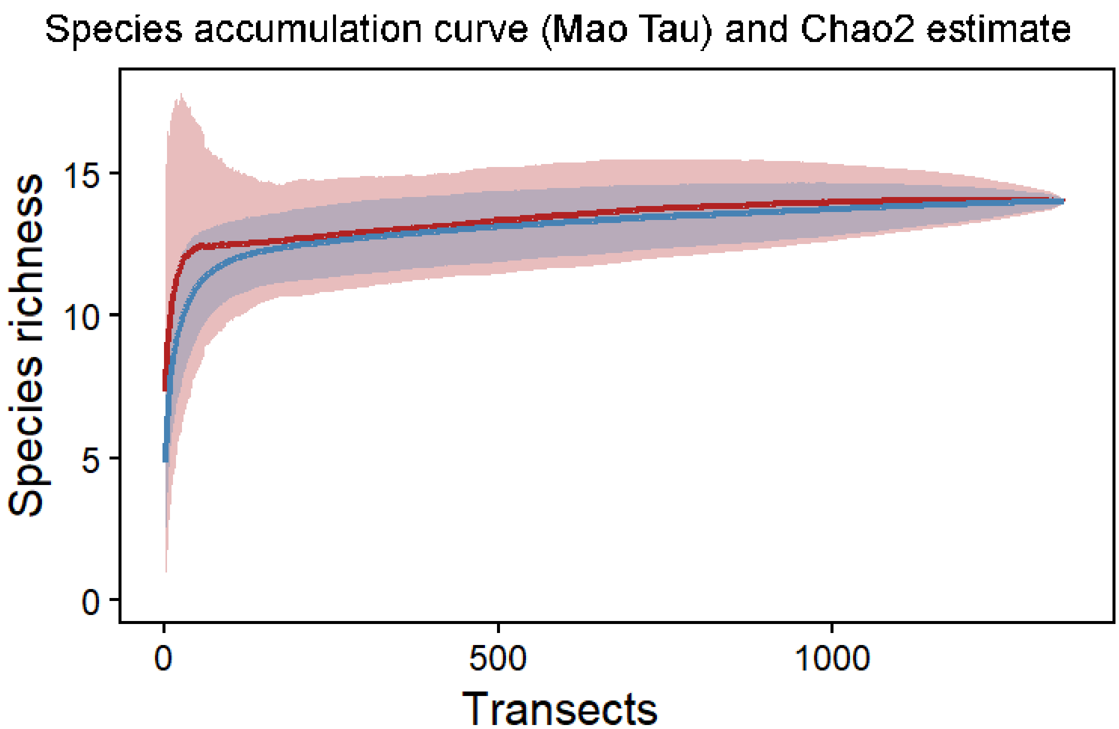
11b. Submerged plants 13

12a. Inconspicuous flowers .... *Cyperus blepharoleptos*

12b. Lilac flowers .... *Pontederia crassipes*

13a. White flowers .... *Egeria densa*

13b. Pink flowers .... *Cabomba furcata*



Supplementary Material S5. Species accumulation curve showing observed species richness (Mao Tau) in blue and estimated richness (Chao2) in red, across sampling effort at Ribeirão das Crioulas wetland, state of Rio de Janeiro, Brazil. Lines represent mean richness values based on sample permutations, and shaded areas indicate 95% confidence intervals. The comparison between observed and estimated richness allows the assessment of sampling completeness.

Supplementary Material S6. SIMPER analysis showing the contribution of macrophyte species to the Bray–Curtis dissimilarity between wet and dry seasons at Ribeirão das Crioulas wetland, state of Rio de Janeiro, Brazil. Mean values represent species coverage in each season (dry and wet), and Contribution (%) indicates the relative contribution of each species to the overall dissimilarity between seasons. Species are ordered by decreasing contribution.

Species	Mean coverage (Dry)	Mean coverage (Wet)	Contribution (%)
Cabomba furcata	11.33	37.64	18.20
Salvinia auriculata	41.70	37.15	17.90
Pontederia azurea	18.83	17.07	10.86
Egeria densa	7.91	13.37	7.25
Utricularia foliosa	9.83	5.32	4.15
Nymphaea caerulea	0.13	3.81	1.93
Cyperus gardneri	4.70	0.82	1.51
Hydrocleys nymphoides	0.56	1.04	0.73
Pontederia crassipes	2.21	0.22	0.62
Utricularia breviscapa	1.13	0.10	0.38
Cyperus blepharoleptos	0.14	0.39	0.29
Poaceae	0.61	0.13	0.18
Ludwigia	0.00	0.00	0.00

Supplementary Material S7. Summary of Redundancy Analysis (RDA) partitioning of variation in macrophyte community composition explained by environmental variables at Ribeirão das Crioulas wetland, state of Rio de Janeiro, Brazil. “Total” represents the total inertia (total variation) in the species data; “Constrained” corresponds to the fraction of variation explained by the environmental variables included in the model; and “Unconstrained” represents the residual (unexplained) variation. “Proportion” indicates the relative contribution of each component to total variation, and “Rank” represents the number of axes associated with each fraction.

	Inertia	Proportion	Rank
Total	0.3358	1.0000	
Constrained	0.1215	0.3619	9
Unconstrained	0.2142	0.6381	14