Oxygen uptake from aquatic macrophyte decomposition from Piraju Reservoir (Piraju, SP, Brazil)

Bianchini Jr., I.[a,b]*, *Cunha-Santino, MB.*[a,b]* *and Panhota, RS.*[a]

[a]Programa de Pós-graduação em Ecologia e Recursos Naturais, Universidade Federal de São Carlos – UFSCar, Rod. Washington Luiz, Km 235, CP 676, CEP 13565-905, São Carlos, SP, Brazil

[b]Departamento de Hidrobiologia, Universidade Federal de São Carlos – UFSCar, Rod. Washington Luiz, Km 235, CP 676, CEP 13565-905, São Carlos, SP, Brazil

*e-mail: irineu@ufscar.br, cunha_santino@ufscar.br

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(With 2 figures)

Abstract

The kinetics of oxygen consumption related to mineralisation of 18 taxa of aquatic macrophytes (*Cyperus* sp, *Azolla caroliniana, Echinodorus macrophyllus, Eichhornia azurea*, *Eichhornia crassipes, Eleocharis* sp1, *Eleocharis* sp2, *Hetereanthera multiflora, Hydrocotyle raniculoides, Ludwigia* sp, *Myriophyllum aquaticum, Nymphaea elegans, Oxycaryum cubense, Ricciocarpus natans*, *Rynchospora corymbosa, Salvinia auriculata*, *Typha domingensis* and *Utricularia foliosa*) from the reservoir of Piraju Hydroelectric Power Plant (São Paulo state, Brazil) were described. For each species, two incubations were prepared with *ca.* 300.0 mg of plant (DW) and 1.0 L of reservoir water sample. The incubations were maintained in the dark and at 20 °C. Periodically the dissolved oxygen (DO) concentrations were measured; the accumulated DO values were fitted to 1st order kinetic model and the results showed that: i) high oxygen consumption was observed for *Ludwigia* sp (533 mg g^{-1} DW), while the lowest was registered for *Eleocharis* sp1 (205 mg g^{-1} DW) mineralisation; ii) the higher deoxygenation rate constants were verified in the mineralisation of *A. caroliniana* (0.052 day^{-1}), *H. raniculoides* (0.050 day^{-1}) and *U. foliosa* (0.049 day^{-1}). The oxygen consumption rate constants of *Ludwigia* sp and *Eleocharis* sp2 mineralisation (0.027 day^{-1}) were the lowest. The half-time of oxygen consumption varied from 9 to 26 days. In the short term, the detritus of *E. macrophyllus*, *H. raniculoides*, *Ludwigia* sp, *N. elegans* and *U. foliosa* were the critical resources to the reservoir oxygen demand; while in the long term, *A. caroliniana*, *H. multiflora* and *T. domingensis* were the resources that can potentially contribute to the benthic oxygen demand of this reservoir.

Keywords: aquatic macrophytes, oxygen consumption, decomposition, detritus, Piraju Hydroelectric Power Plant, kinetic.

Consumo de oxigênio da decomposição de macrófitas aquáticas do reservatório da usina hidrelétrica Piraju (Piraju, SP, Brasil)

Resumo

Neste estudo foram descritas as cinéticas dos consumos de oxigênio dissolvido (OD) das mineralizações de 18 espécies de macrófitas aquáticas (*Cyperus* sp, *Azolla caroliniana, Echinodorus macrophyllus, Eichhornia azurea*, *Eichhornia crassipes, Eleocharis* sp1, *Eleocharis* sp2, *Hetereanthera multiflora, Hydrocotyle raniculoides, Ludwigia* sp., *Myriophyllum aquaticum, Nymphaea elegans, Oxycaryum cubense, Ricciocarpus natans*, *Rynchospora corymbosa, Salvinia auriculata*, *Typha domingensis* e *Utricularia foliosa*) do reservatório da Usina Hidrelétrica Piraju (São Paulo, Brasil). Para cada planta, duas incubações foram preparadas, com *ca.* 300,0 mg de planta (PS) em 1,0 L de água do reservatório. As incubações foram mantidas no escuro a 20 °C. Periodicamente, as concentrações de oxigênio dissolvido (OD) foram determinadas; os consumos acumulados de OD foram ajustados a um modelo cinético de 1ª ordem e os resultados indicaram que: i) o consumo mais elevado foi observado na mineralização de *Ludwigia* sp (533 mg g^{-1} PS), enquanto que o menor foi registrado para os detritos de *Eleocharis* sp1 (205 mg g^{-1} PS); ii) os maiores coeficientes de desoxigenação foram verificados nas mineralizações de *A. caroliniana* (0,052 dia^{-1}), *H. raniculoides* (0,050 dia^{-1}) e *U. foliosa* (0,049 dia^{-1}). Os coeficientes de desoxigenação das mineralizações de *Ludwigia* sp e *Eleocharis* sp2 foram os mais baixos (0,027 dia^{-1}). Os tempos de meia-vida dos consumos de oxigênio variaram entre 9 e 26 dias. A curto prazo, os detritos de *E. macrophyllus*, *H. raniculoides*, *Ludwigia* sp, *N. elegans* e *U. foliosa* representam os recursos mais críticos para a demanda de oxigênio, enquanto que a longo prazo, *A. caroliniana*, *H. multiflora* e *T. domingensis* são os recursos que potencialmente mais podem contribuir para as demandas bentônicas do reservatório.

Palavras-chave: macrófitas aquáticas, consumo de oxigênio, decomposição, detritos, Usina Hidrelétrica Piraju, cinética.

1. Introduction

Macrophytes in tropical regions continuously supply the food webs of different types of aquatic environments, mainly in the littoral zones (Wetzel, 1990; Camargo and Esteves, 1995). Depending on the amount of plant detritus, decomposition may contribute to water fertilisation and raise the oxygen demands (Bianchini Jr. et al., 2008). This may endanger the long-term health of the aquatic ecosystem, and also the water multipurpose uses and the power generation equipment (Tundisi and Matsumura-Tundisi, 2003). However, such intensive development of aquatic macrophytes depends on conditions such as absence of strong winds, low water turbulence, and availability of propagules or other sources of dispersion, that occur simultaneously with typical nutrient increases within the filling phase of the reservoir (Agostinho et al., 1999). Several species grow in natural and man-made freshwater ecosystems in tropical regions, and an excess presence is usually noted for *Eichhornia crassipes*, *Egeria* spp, *Eleocharis* sp, *Ludwigia* spp, *Oxycaryum cubense*, *Pistia stratiotes*, *Salvinia* spp and *Typha domingenseis* (Bini et al., 1999; Tanaka et al., 2002; Marcondes et al., 2003; Thomaz. et al., 2005, 2006; Bianchini Jr. et al., 2006a; Camargo et al., 2006; Martins et al., 2008).

The tissues of the macrophytes are composed of particulate organic matter (POM), soluble organic (in the form of dissolved organic matter, DOM) and inorganic compounds (Little, 1979; Henry-Silva et al., 2001). During decomposition, the POM and DOM are processed at different rates and in general, the detritus in the sediments show the predominance of structural compounds as cellulose and lignin. Processes related to decomposition (e.g. leaching, comminution and catabolism; Swift et al., 1979) are regulated by biotic (e.g. types of organisms), abiotic (e.g. quality and size of detritus, temperature, pH, redox potential; Wetzel, 1990; Enríquez et al., 1993; Hohmann and Neely, 1993; Gessner, 2000) and catabolism occurs by specific metabolic pathways and produce different intermediates that interact with other compounds and biota (Steinberg, 2003). The prevalence and characteristics of microbial catabolic often results from oxygen availability. Aerobic mineralisation generates more stable products and tends to transfer carbon for the growth of microorganisms (Davis and Cornwell, 2008). However, other factors change the respiratory coefficients of metabolic processes (e.g. presence of alternative electron receptors, and aliphatic amino acids) and generate interference in the degradation of organic substances and dissolved oxygen availability (Dilly, 2001). The knowledge of events related to decomposition of macrophytes is important for understanding the role of these organisms in the functioning of biogeochemical cycles within aquatic ecosystems.

The aim of this study was to describe the oxygen uptake and mineralised carbon formations resulting from the decomposition of eighteen taxa of aquatic macrophytes from the reservoir of the Hydroelectric Power Plant (HPP) Piraju (Piraju, São Paulo state, Brazil). The effects of decomposition of these organisms in this environment are also discussed, using two kinetic models for the comparisons of mineralisation parameters.

2. Material and Methods

2.1. Study area

Water samples and aquatic macrophytes were collected in the reservoir of the HPP Piraju. This reservoir was formed in September, 2002 and is located at Alto Paranapanema in the southeast of São Paulo state, Brazil (parallels between 23K 257.468 UTM 7.450.796 and 22J 666.086 UTM 7.339.238). It is the second of a cascade of reservoirs from upstream-downstream in the Paranapanema River; it is located between Jurumirim and Paranapanema reservoirs. At 531.5 m above sea level, the reservoir presents the following characteristics: i) area: 17.1 km^2; ii) length: 16.2 km; iii) total cumulative volume: 105.6×10^6 m^3; iv) mean residence time: 5.7 days; v) mean depth: 6.96 m; and vi) maximum depth: 25.2 m (ANEEL, 2005). The main tributary of the reservoir is the Paranapanema River and some small tributaries (i.e. Mina d'água, Virado, Bananeira, São Bartolomeu, Monte Alegre, Brejão, Douradinho and Santa Lúcia streams). According to the classification proposed by Straškraba (1999), this reservoir is small (area between 1 and 100 km^2) and Class A (mean residence time less than 15 days). It is an oligo-mesotrophic system (sensu. Vollenweider, 1968) under low anthropogenic pressures (UFSCar/CBA, 2008). In Piraju Reservoir, the appearance of macrophytes is restricted to littoral regions, with the predominance of *Eichhornia azurea* and *Typha domingensis* (UFSCar/CBA, 2008). The sampling of macrophytes occurred from August, 2003 to May, 2004. In 2004, the water from the reservoir had a high concentration of dissolved oxygen (average: 7.8 ± 2.1 mg L^{-1}). pH, total solids and electrical conductivity were 6.92 ± 0.20, 0.172 ± 0.267 mg L^{-1} and 41.0 ± 6.7 µS cm^{-1}, respectively. Secchi depth disappearance was 2.1 ± 0.8 m. Dissolved inorganic carbon varied from 3.7 (August) to 8.9 mg L^{-1} (May), with a mean value of 5.7 ± 1.2 mg L^{-1}. Total-P and total-N were, respectively, 14.5 and 533 µg L^{-1}, and considering N forms, the organic fraction predominated (ca. 76%). On average, 8.7% of the sediments were organic (UFSCar/CBA, 2008).

2.2. Mineralisation experiment design

Samples of aquatic macrophytes (n = 18 taxa) were collected in the Piraju reservoir: *Azolla caroliniana* Willd., *Cyperus* sp, *Echinodorus macrophyllus* (Kunth) Micheli, *Eichhornia azurea* (Sw.) Kunth, *Eichhornia crassipes* (Mart.) Solms, *Eleocharis* sp1, *Eleocharis* sp2, *Heteranthera multiflora* (Griseb.) Horn, *Hydrocotyle ranunculoides* L. f., *Ludwigia* sp, *Myriophyllum aquaticum* (Vell.) Verdec, *Nymphaea elegans* Hook, *Oxycaryum cubense* (Poepp. & Kunth) Lye, *Ricciocarpus natans* (L.) Corda, *Rhynchospora corymbosa* (L.) Britt., *Salvinia auriculata* Aubl., *Utricularia foliosa* L.and *Typha domingensis* Pers. The plants were washed, dried at 40 °C and grounded. After plant fragments preparation, reservoir water samples (ca. 10 L) were collected (22K 065.839 UTM 7.438.694 in May, 2004) with a Van Dorn bottle and equivalent aliquots of water (from the surface, middle and bottom) were mixed. In the laboratory, water samples were filtered (cellulose ester membrane, Millipore 0.45 µm) and submitted to aeration (24 hours). For each taxon, incubations (n = 2) were prepared with ca. 300.0 mg of plant (DW) in 1.0 L reservoir water (Bianchini Jr. et al., 2003). Two control incubations (with only water reservoir) were also prepared. The incubations were maintained in the dark under controlled temperature (20 ± 0.6 °C). Periodically, during 85 days DO concentrations were recorded by the polarographic method (oximeter YSI model 58). In order to maintain the solutions under aerobic conditions, they were oxygenated during 1 hour, with clean filtered air to keep the dissolved oxygen near saturation. When the dissolved oxygen concentrations were near 2.0 mg L^{-1}, the solutions where oxygenated again, until the oxygen reached the saturation value; this procedure avoided anaerobiosis of the solutions. After measurements, the bottles were closed to prevent oxygen diffusion (Cunha-Santino and Bianchini Jr., 2003a).

After 85 days, the incubation contents (particulate and dissolved fractions) were fractionated with cellulose ester membrane (Millipore, 0.22 µm) in order to calculate the mass balance. After being dried (at 40 °C), the fractions of particulate organic carbon (POC) were estimated from remaining detritus masses (ash free basis), by multiplication of the factor 0.47 (Westlake, 1965; Wetzel and Likens, 1979). The concentrations of dissolved organic carbon (DOC) were determined by combustion and non-dispersive infrared detection (TOC Analyzer, Shimadzu model 5000A). Based on the differences between initial and final carbon contents (Equation 1), the yields of mineralised carbon (MC) were evaluated.

$$MC = TOC - POC - DOC \quad (1)$$

where: MC = mineralised carbon; TOC = total organic carbon (initial content of organic carbon); POC = particulate organic carbon; DOC = dissolved organic carbon.

2.3. Kinetic parameters

For representations of mineralisation kinetics, the temporal variations of accumulated oxygen consumption (OC) were fitted to the first order model (Equation 2), as usually used in BOD tests (Borsuk and Stow, 2000; Davis and Cornwell, 2008). For the fittings and the coefficient estimations, a nonlinear regression method was used, using the iterative algorithm of Levenberg-Marquardt (Press et al., 1993). The mineralisation coefficient (k_M) was determined according to Equation 3 (Xie et al., 2004).

$$OC = OC_{MAX} \times (1 - e^{-k_d t}) \quad (2)$$

where: OC = cumulative oxygen consumption; OC_{MAX} = maximum amount of consumed oxygen (mg g^{-1} DW); k_d = deoxygenation rate constant (day^{-1}); t = time (day).

$$k_M = \frac{\ln\left(ROC/TOC\right)}{\Delta t} \quad (3)$$

where: k_M = mineralisation rate constant (day^{-1}); ROC = remaining organic carbon (final amount of detritus organic carbon: POC + DOC).

The times of half-life ($t_{½}$) from oxygen consumption ($t_{½}$-k_d) and decrease of mass owing to macrophyte decomposition ($t_{½}$-k_M) were calculated according to Equation 4,

$$t_{1/2} = \frac{\ln 0.5}{-k} \quad (4).$$

The stoichiometric relationship associated with oxygen consumption and mineralised carbon (O/C) were estimated from the ratio OC_{MAX}:MC (Bianchini Jr. et al., 2006b). The frequency distributions of the following parameters were considered: OC_{MAX}, k_d, $t_{½}$-k_d, O/C, ROC, MC, k_M and $t_{½}$-k_M. These parameters were also submitted to the normality test (Shapiro and Wilk, 1965) with a significant level of 0.05.

3. Results

The oxygen uptakes involved in the mineralisation of aquatic macrophytes are presented in Table 1; by difference, the effects of DOC oxidation from reservoir water samples (control flasks) were neutralised. The oxygen consumptions were more pronounced in the mineralisation of *Ludwigia* sp and *E. macrophyllus* (533 and 489 mg g^{-1} DW, respectively), the lowest oxygen consumption occurred in the mineralisation of *Eleocharis* sp1 (205 mg g^{-1} DW) and *E. azurea* (206 mg g^{-1} DW). The kinetics of the higher and lowest oxygen consumptions are shown in Figure 1a; thus, all the other kinetics were included among these two curves. The normal distributions (at 0.05 level) were only verified for the following parameters: OC_{MAX}, $t_{½}$-k_d, O/C and $t_{½}$-k_M (Figures 1 and 2). The slope derived from MC and OC_{MAX} refers to the total O/C stoichiometric relationship. Comparing the results, it is possible to note that this value is equivalent to the O/C average value registered in Table 1.

The distributions also show that the macrophytes detritus are mainly refractory resources (Figures 1e and 2a) and that oxygen consumption and decrease in mass were not linked processes; thus, on average, the oxygen consumption was 5.3-fold fast (Figures 1c and 2b). The changes in OC_{MAX}, k_d, k_M and MC consequently promoted changes in the O/C values (Figures 1b,c, 2a,b); but without strong variation (range: 1.06-2.07; Table 1 and Figure 2d).

The highest amount of MC was observed in the mineralisation of *N. elegans* (73%) and lowest in *S. auriculata* (33%). In the experimental period (85 days), on average, 54% of carbon was not oxidized. The mineralisation coefficients ranged from 0.005 (*E. azurea*, *O. cubense*, *R. corymbosa* and *S. auriculata*) to 0.015 day^{-1} (*N. elegans*). The average value (0.008 day^{-1}) is equivalent to a half-time of 90 days (Table 1).

Table 1. Kinetics parameters from mineralisation of aquatic macrophytes.

Taxon	OC_{MAX} (mg g^{-1} DW)	Error (%)	k_d (day^{-1})	Error (%)	r^2	MC (mg g^{-1} DW)	O/C	k_M (day^{-1})
Azolla caroliniana	304	1.0	0.052	2.6	1.00	181	1.68	0.006
Cyperus sp	302	3.8	0.030	7.3	0.96	199	1.52	0.006
Echinodorus macrophyllus	489	1.5	0.042	3.3	1.00	304	1.61	0.012
Eichhornia azurea	206	3.5	0.045	8.1	0.97	165	1.25	0.005
Eichhornia crassipes	231	5.4	0.032	10.7	0.97	201	1.15	0.007
Eleocharis sp1	205	5.0	0.035	10.4	0.96	194	1.06	0.006
Eleocharis sp2	292	5.6	0.027	10.4	0.98	217	1.35	0.007
Hetereanthera multiflora	409	2.3	0.032	4.6	0.99	198	2.06	0.006
Hydrocotyle raniculoides	419	1.5	0.050	3.8	0.99	322	1.30	0.014
Ludwigia sp	533	1.6	0.027	2.8	1.00	258	2.07	0.009
Myriophyllum aquaticum	290	1.7	0.044	3.8	0.99	184	1.58	0.006
Nymphaea elegans	477	1.7	0.041	3.8	0.99	344	1.39	0.015
Oxycaryum cubense	244	3.2	0.041	7.1	0.98	163	1.50	0.005
Ricciocarpus natans	261	0.6	0.076	1.9	1.00	202	1.29	0.007
Rynchospora corymbosa	268	4.3	0.034	8.7	0.98	174	1.54	0.005
Salvinia auriculata	244	1.5	0.040	3.2	1.00	155	1.57	0.005
Typha domingensis	341	2.1	0.038	4.5	0.99	195	1.75	0.006
Utricularia foliosa	381	1.0	0.049	2.4	1.00	271	1.41	0.010
Average	328		0.041			218	1.50	0.008
Standard deviation	101		0.012			57	0.27	0.003
Average $t_{½}$ (day)			17					90

4. Discussion

The oxygen consumption patterns recorded in this experiment were similar to those obtained in related experiments (e.g. Brum et al., 1999; Farjalla et al., 1999; Bitar and Bianchini Jr., 2002). The decomposition experiment with aquatic macrophytes from Óleo Lagoon (São Paulo, Brazil) recorded the lowest value of OC_{MAX} (165 mg g^{-1} DW) in the mineralisation *Salvinia auriculata* and the highest (700 mg g^{-1} DW) of *Egeria najas* (Bianchini Jr. et al., 2008). The results were analogous, still, to those obtained in an experiment that tested the size of the detritus (from *Scirpus cubensis*) as a determinant of mineralisation, in this case the values of OC_{MAX} ranged between 143 and 203 mg g^{-1} DW (Bianchini Jr. and Cunha-Santino, 2006). According to the low values of errors and high correlation coefficients (r^2) (Table 1), the selected model (Equation 2) was appropriate for the descriptions of the aerobic mineralisation kinetics.

The temporal variations of oxygen consumption were similar to those obtained from mineralisation experiments that tested resources other than aquatic macrophytes (e.g. leaves, branches, barks, litter, sediments, phytoplankton, DOM, humic substances, sugars, polyphenolic compounds and amino acids; Almazan and Boyd, 1978; Antonio et al., 1999; Borsuk and Stow, 2000; Bitar and Bianchini Jr., 2002; Cunha-Santino et al., 2002, 2008; Cunha-Santino and Bianchini Jr., 2003b, 2004). Initially, consumption tended to be high, and after, there was a gradual decrease in the rates of oxygen uptake. Considering that these resources are heterogeneous from the structural point of view (Silva et al., 1994; Henry-Silva et al., 2001), in the beginning of the experiment, the oxidation of labile fraction with high oxygen demands prevailed due to substances derived from the cytoplasmatic content of the macrophyte tissues (Nelson et al., 1990). Thus, oxygen consumption has been frequently associated with the increments of microbial respiration rates when decomposing the detritus that are rich in nutrients and with the low content of recalcitrant structures (Gessner, 2000; Komínková et al., 2000).

The oxidation of nitrogen compounds (e.g. nitrification) may also have contributed to the oxygen uptake, especially from the second week (USEPA, 1985; Davis and Cornwell, 2008). Moreover, it is assumed that decreases in oxygen consumption rates were mainly related to the mineralisation of refractory fractions. However, other factors may have occurred: i) the photo-oxidation of humic compounds (Cooper et al., 1989); ii) the hydroxylation of aromatic organic compounds (Dagley, 1971); iii) mechanical agitation during sample homogenisation (Cunha-Santino and Bianchini Jr., 2003a); and iv) the chemical and biochemical reactions for the formation of hydrogen peroxide (Mopper and Zika, 1987), e.g. amino acid degradation (Rose, 1976). Affecting these values, other oxidations not directly related to carbon mineralisation must be included (e.g. sulfur oxidizing processes; Wetzel, 2001).

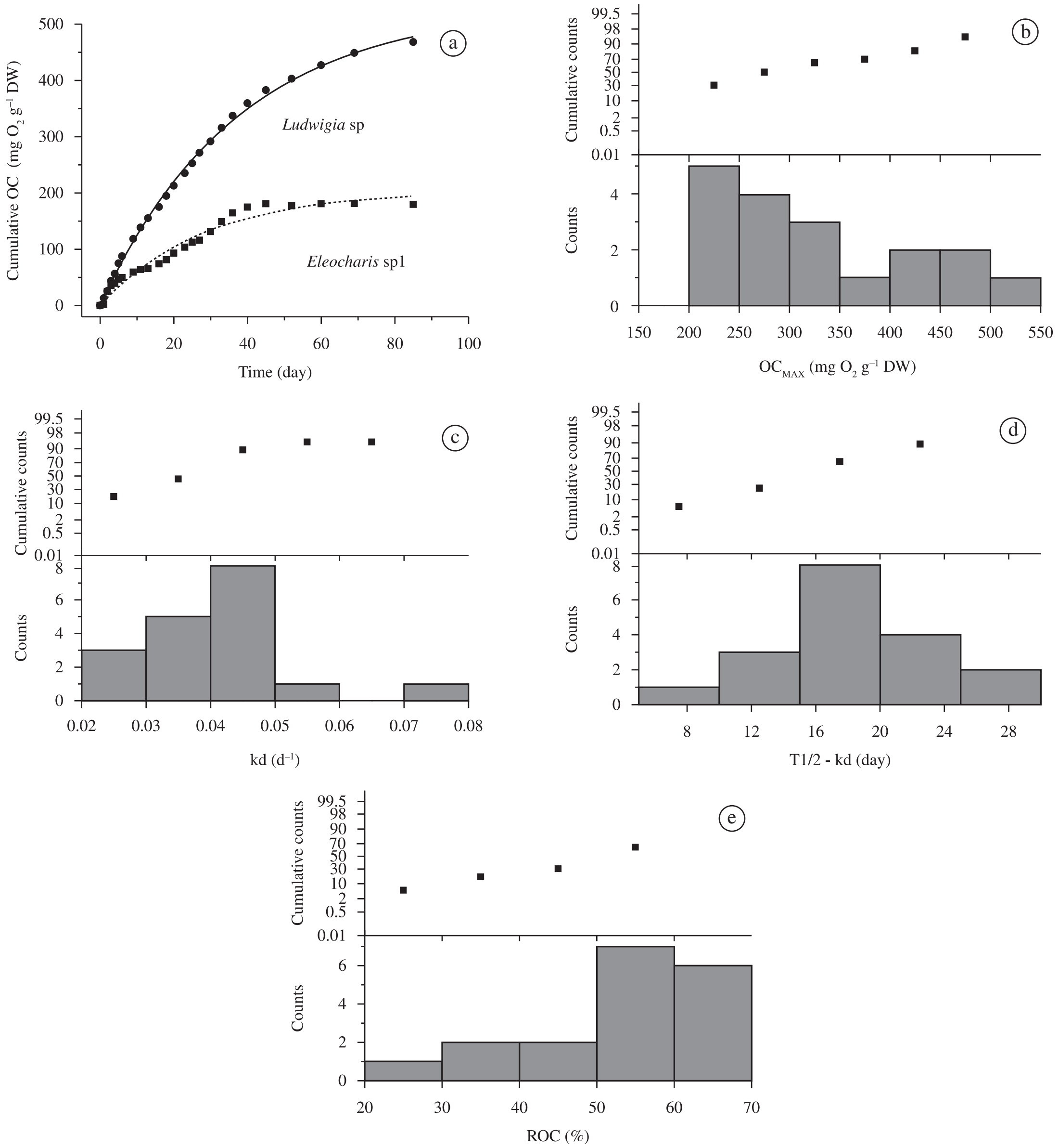

Figure 1. a) Kinetics curves for oxygen consumption during decomposition of *Eleocharis* sp1 (smaller value of cumulative OC) and *Ludwigia* sp. (higher value of cumulative OC). The distributions and probabilities for models parameters: b) OC_{MAX}; c) kd; d) $t_{1/2} - k_d$; and e) ROC.

According to the deoxygenation rate (k_d) it was estimated that the half-time of oxygen consumption ranged between 9 and 26 days (mineralisations of *R. natans* and *Eleocharis* sp1 e *Ludwigia* sp, respectively). The mean values of k_d and OC_{MAX} obtained from other mineralisation experiments of aquatic plants (Cunha and Bianchini Jr., 1998; Lemos and Bianchini Jr., 1998; Brum et al., 1999; Farjalla et al., 1999; Bitar and Bianchini Jr., 2002) were respectively 0.18 day^{-1} and 229 mg g^{-1} (DW). The k_d mean value corresponds to a half-time of 4 days. These results indicate that, on average, the processes of mineralisation of the detritus of aquatic macrophytes from the HPP Piraju reservoir were 4.7 times slower than that showed in other studies. By contrast, the mean value of OC_{MAX} achieved in the present experiment was 43% higher than the average consumption of related studies. Besides the effect of the chemical structure of detritus composition, the diversity and number of microorganisms are considered factors responsible for low values of k_d, referring to the Piraju Reservoir. The predominance of the meso-oligotrophic conditions implies that it is possible that the microflora used as inoculum were not adapted to the high amount of detritus as used in this experiment.

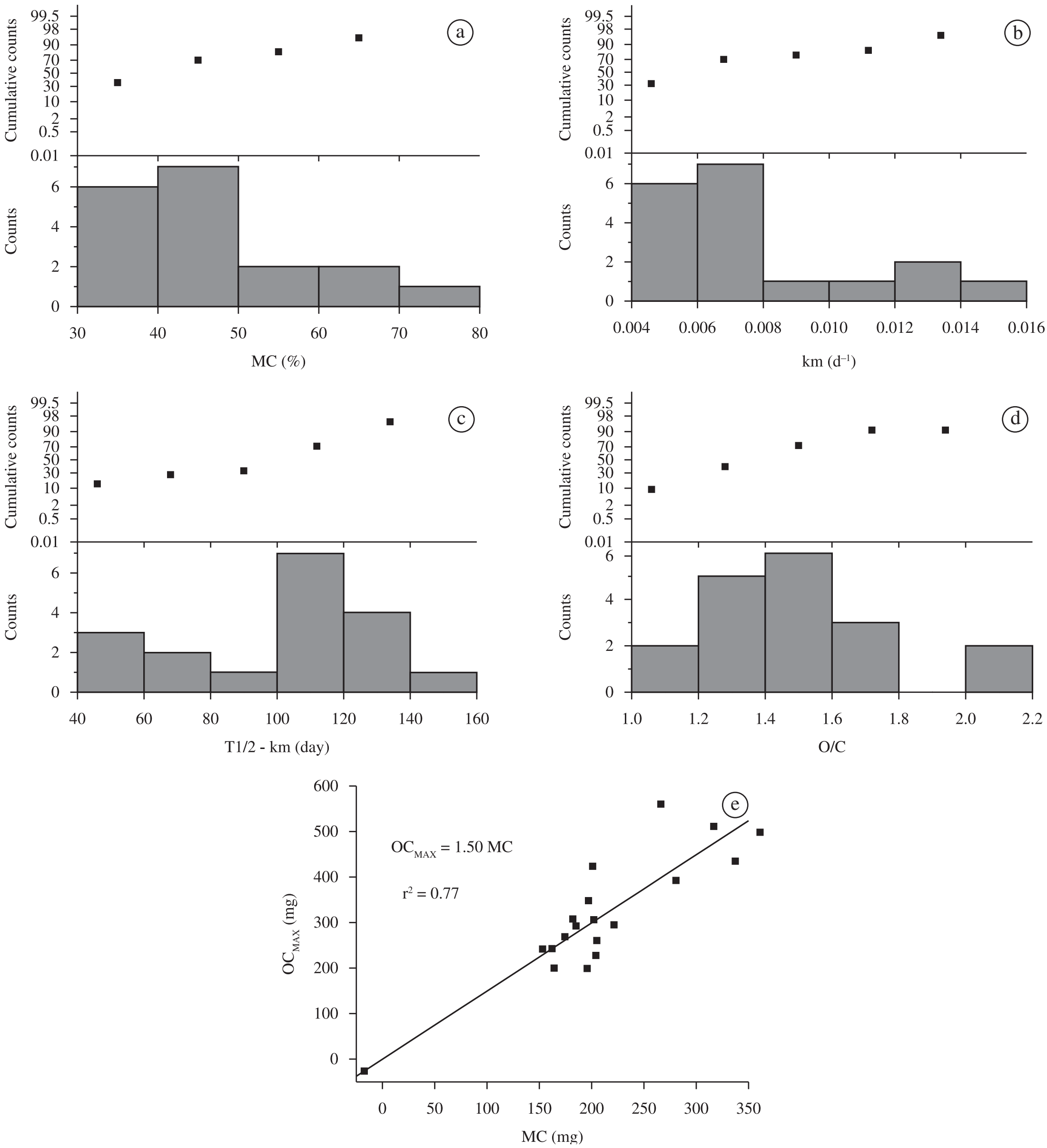

Figure 2. The distributions and probabilities for models parameters a) MC; b) k_M; c) $t_{1/2} – k_M$); and d) to O/C values. The relation between mineralized carbon and total consumed oxygen.

Comparing the OC_{MAX} with CM, there was a direct relationship between these processes (r^2: 0.73) a slope value of 1.5, corresponding to the total stoichiometric coefficient of O/C (Table 1). Thus, this experiment showed that for the oxidation of each atom of carbon, on average 1.5 atoms of oxygen were required; this number corresponds to 56% of the theoretical value (2.67), considering as a reference the oxidation of glucose (Davis and Cornwell, 2008). The stoichiometric relationships are valid for carbon compounds mineralised in the short term, i.e. the labile organic forms, in view of the experiment's duration (85 days) and the differences between mean half-time processes of oxygen consumption and carbon mineralisation. The values of O/C were higher in mineralisation and *Ludwigia* sp and *H. multiflora* (2.07 and 2.06, respectively) and the lowest value was observed for *Eleocharis* sp1 (1.06). Once k_M values were derived from MC, the mineralisation coefficients (Equation 3) were also directly related to OC_{MAX} (r^2: 0.70); on the other hand, no relationship was found between the values of OC_{MAX} and k_d. The magnitude of k_d was primarily related to the quality and quantity of labile compounds, considering that the values of k_d vary basically as a function of temperature, types of microorganisms and the resource quality (Davis and Cornwell, 2008) and that the incubations were maintained under the same experimental conditions (temperature and inoculums).

Comparing the values of k_M with the k_d, the processes of decarboxylation were slower (ca. 5.3 times), the mineralisation of *N. elegans* showed the lowest value of the ratio k_d:k_M (2.6) and *R. natans* the highest (11.5). Among other factors (e.g. detritus structural heterogeneity), it is possible that the lack of synchronisation between oxidative processes and decarboxylation results in the underestimation of mineralisation net rates. Considering that the growth of microorganisms tends to conserve carbon in organic form, it interferes, in this manner, in the precise recording of organic compounds circulation. In this case, even considering that the oxygen uptake and the carbon mineralisation processes are coupled, experiments have shown that decarboxylation is processed by different routes, with specific rates and individual stoichiometric relationships that normally do not contribute to the experimental acquisition of theoretical stoichiometry values used to make the connection between these processes (Cunha-Santino and Bianchini Jr., 2002). The variations in the stoichiometric coefficients were related to the chemical compositions of detritus, with the predominance of catabolic routes and with the densities of the main microorganisms involved (Cunha-Santino and Bianchini Jr., 2002). Several organic compounds are used by microorganisms as an energy source, the catabolism of these substances leads to the production of intermediate compounds that are also used in the reactions of biosynthesis and energy acquisition. Thus, the stoichiometric coefficients were related to the metabolic pathways of degradation via the organic compounds that are processed. Hence, the set of predominate metabolic pathways resulting from the specific action of the organisms community altered the values of the stoichiometric relationships.

With regard to the decomposition of aquatic macrophytes in the reservoir of the HPP Piraju, it is possible to infer from the results that: i) in the short term, the resources that showed the lowest mineralisation coefficient (i.e. *Cyperus* sp, *E. azurea*, *E. crassipes*, *Eleocharis* spp, *M. aquaticum*, *O. cubense*, *R. corymbosa*, *S. auriculata*) probably served primarily for the humification or other forms of refractory organic matter, to the detriment of microbial catabolic processes (respiration). Regarding the decomposition of these plants, these results suggest that those with the lowest values of k_M contributed potentially to the organic matter formation in the reservoir sediments; ii) by presenting high mineralisation rates and values of O/C, *E. macrophyllus*, *H. raniculoides*, *Ludwigia* sp, *N. elegans* and *U. foliosa* were characterised as resources that generate high oxygen deficits in the short and medium term, depending on the form in which these plants were incorporated into the detritus chain; and iii) by presenting low values of k_M and high O/C, the mineralisation of *A. caroliniana*, *H. multiflora* and *T. domingensis* possibly promotes low demands for oxygen in the long-term, and so it is possible that these species are the main sources of detritus responsible for the occurrence of benthonic oxygen demand in the Piraju reservoir.

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