

**IRON AND MANGANESE DISTRIBUTION IN PLANT COMMUNITIES OF A DUNE MARSH****LACERDA, L.D.\* e CUNHA, C.T.\*****RESUMO - DISTRIBUIÇÃO DE FERRO E MANGANÊS EM COMUNIDADES VEGETAIS DE UM BREJO DE DUNAS**

A distribuição de Fe e Mn em uma comunidade de gramíneas e em uma de ciperáceas num brejo de dunas foi estudada em Maricá (Rio de Janeiro, Brasil). Os dois elementos apresentaram padrões semelhantes de distribuição nas duas comunidades, sendo maior a concentração na interface água-sedimento e nas frações mais ricas em matéria orgânica. No entanto, a maior biomassa e a maior quantidade de matéria orgânica no sedimento do banco de gramíneas resulta em maior mobilidade e biodisponibilidade do Fe e do Mn nesta comunidade. Os resultados mostram o papel das macrófitas aquáticas emergentes na dinâmica de ciclagem dos nutrientes nas áreas inundáveis.

**ABSTRACT - IRON AND MANGANESE DISTRIBUTION IN PLANT COMMUNITIES OF A DUNE MARSH.**

The distribution of Fe and Mn in a graminoid and

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a Cyperaceae community in a coastal dune marsh were studied in the dunes of Maricã, State of Rio de Janeiro, Brazil. The two elements presented similar distribution patterns in the two communities, being concentrated at the sediment-water interface and in sediment horizons rich in organic matter. However, the higher biomass and sediment organic matter in the graminoid stand, resulted in higher mobility and bioavailability of Fe and Mn in this community. The results stressed the role played by emergent macrophytes in controlling the fate of nutrients in flooded areas.

## INTRODUCTION

Aquatic macrophytes may control nutrient cycling in various wetland ecosystems, mostly by mining up nutrients from the sediment deposit and accumulating them in plant biomass (ESTEVEZ & CAMARGO, 1986). The degree of control is a function of plant species and ecological characteristics of the macrophyte community, such as plant density and biomass (KLOPATEK, 1978), and on the bioavailability of the particular element in the system (CARMO & LACERDA, 1984).

Dune marshes along the Southeastern coast of Rio de Janeiro State are frequently dominated by emergent macrophytes, being the Cyperaceae and Poaceae the most important families in terms of plant density and biomass (LACERDA et al., in press). Such communities are characterized by high productivity rates ( $\approx 600$  gDW/m<sup>2</sup>/y; LACERDA et al., 1986), which can account for high remobilization rates of various nutrients. Therefore, to understand nutrient cycling in such ecosystems, the study of the role played by macrophytes is of prime importance.

The present study compares micronutrient (Fe and Mn) distribution in two communities of emergent macrophytes in a dune marsh at Barra de Maricã, Rio de Janeiro State. One is dominated by the Poaceae *Leersia hexandra* Swartz, and

the other by the Cyperaceae *Eleocharis subarticulata* (Nees) Boeckler, being both species the most representative plants of each family in the area.

## MATERIAL AND METHODS

Samples were collected during the winter of 1985. Two sediment cores (55 cm deep) were taken in each plant stand and divided in 5 cm sub-samples. Simultaneously, 4 samples of water at two different depths (500 ml) were also collected and analysed for pH and conductivity in the field by portable electrodes. Two quadracts (0.0625 cm<sup>2</sup>) of aerial plant parts were cut, and all roots to a depth of 10 cm were scavated, in each community.

Sediment and plant samples were oven drier at 80°C for 24 h. Sub-samples of dry material (2.0 g) were ashed (450°C, 16 h) for the gravimetric determination of organic matter content. Ashes were then digested with 20 ml of Aqua Regia, for the total solubilization of Fe and Mn.

Water samples were filtered through Millipore filters (0.45 µ) for the determination of total suspended matter. Filters and suspended matter were ashed and digested as for sediment samples. The filtered water was acidified with 5 ml of HCl. The determination of Fe and Mn in all samples were performed by conventional atomic absorption spectrophotometry.

## RESULTS

Table 1 shows the main ecological parameters measured in the two plant communities studied. The *L. hexandra* community presented higher aerial belowground biomasses, concentration of Mn and content of organic matter in sediments than the *E. subarticulata*. Iron concentration was also higher in the

belowground biomass of the graminoid but not in the aerial parts.

Table 1. Ecological parameters measured in the two communities studied.

|  | <i>L. hexandra</i><br>(Poaceae) | <i>E. subarticulata</i><br>(Cyperaceae) |
|--|---------------------------------|---|
| Water depth (cm)                                 | 15.0 ± 1.3                      | 12.2 ± 1.5                              |
| Plant height (cm)                                | 42.6 ± 2.1                      | 39.6 ± 2.6                              |
| Aerial biomass (gDW/m <sup>2</sup> )             | 336                             | 288                                     |
| Belowground biomass (gDW/m <sup>2</sup> )        | 928                             | 640                                     |
| Fe concentration in aerial biomass (µg/gDW)      | 493                             | 708                                     |
| Fe concentration in belowground biomass (µg/gDW) | 1120                            | 483                                     |
| Mn concentration in aerial biomass (µg/gDW)      | 60.2                            | 48.2                                    |
| Mn concentration in belowground biomass (µg/gDW) | 57.5                            | 42.5                                    |
| Organic matter content of surface sediments (%)  | 19.5-23.0                       | 16.6-18.8                               |

Table 2. Percentual distribution of Fe and Mn in the two communities studied.

|                     | <i>L. hexandra</i> |      | <i>E. subarticulata</i> |      |
|---------------------|--------------------|------|-------------------------|------|
|                     | Fe                 | Mn   | Fe                      | Mn   |
| Aerial biomass      | 1.9                | 9.3  | 2.5                     | 0.7  |
| Belowground biomass | 11.6               | 25.0 | 3.8                     | 1.5  |
| Suspended matter    | 0.03               | 0.2  | 0.02                    | 0.3  |
| Water               | 1.8                | 0.6  | 0.1                     | 2.5  |
| Sediments (0-10 cm) | 84.7               | 64.9 | 93.6                    | 95.0 |

Figure 1 shows the vertical distribution of pH, conductivity and Fe and Mn concentrations in surface and interstitial waters of the two stands. Water pH was more acidic under *L. hexandra* ( $\approx 5.1$ ) than under *E. subarticulata* ( $\approx 5.8$ ), and presented a significant correlation with water conductivity ( $r = 0.755$ ,  $df = 12$ ,  $P 0.01$ ). In the Cyperaceae community however, no correlation was found between these two parameters. In general pH become less acidic with depth.

The concentration of Mn and Fe in waters presented a peak at the sediment-water interface in the two stands and also at 40 cm deep in the *L. hexandra* community. In the Cyperaceae stand Fe presented the highest concentration between 25 cm and 35 cm.

Figure 2 shows Fe, Mn, and organic matter content in sediments of the two plant communities. All variables presented a peak at the sediment-water interface, and another one between 40 cm and 45 cm, except Mn and organic matter content in the *E. subarticulata* stand.

## DISCUSSION

The production of organic matter by aquatic macrophytes and its accumulation in marsh sediments, is of major importance in controlling nutrient chemistry in flooded areas (LACERDA et al., 1986). The results presented confirm this view, since Fe and Mn distribution in the two plant communities is strongly influenced by sediment organic matter content (Table 2).

The two elements are affected by the oxidation potential of sediments. When flooded, sediments with high organic content, become reducing, causing the solubilization of Fe and Mn oxides to  $Fe^{2+}$  and  $Mn^{2+}$  ionic forms, which then diffuse to the interstitial water (PONNAMPERUMA, 1972). Reaching the oxidized surface of sediments, these ionic forms reprecipitate, resulting in high concentrations at the

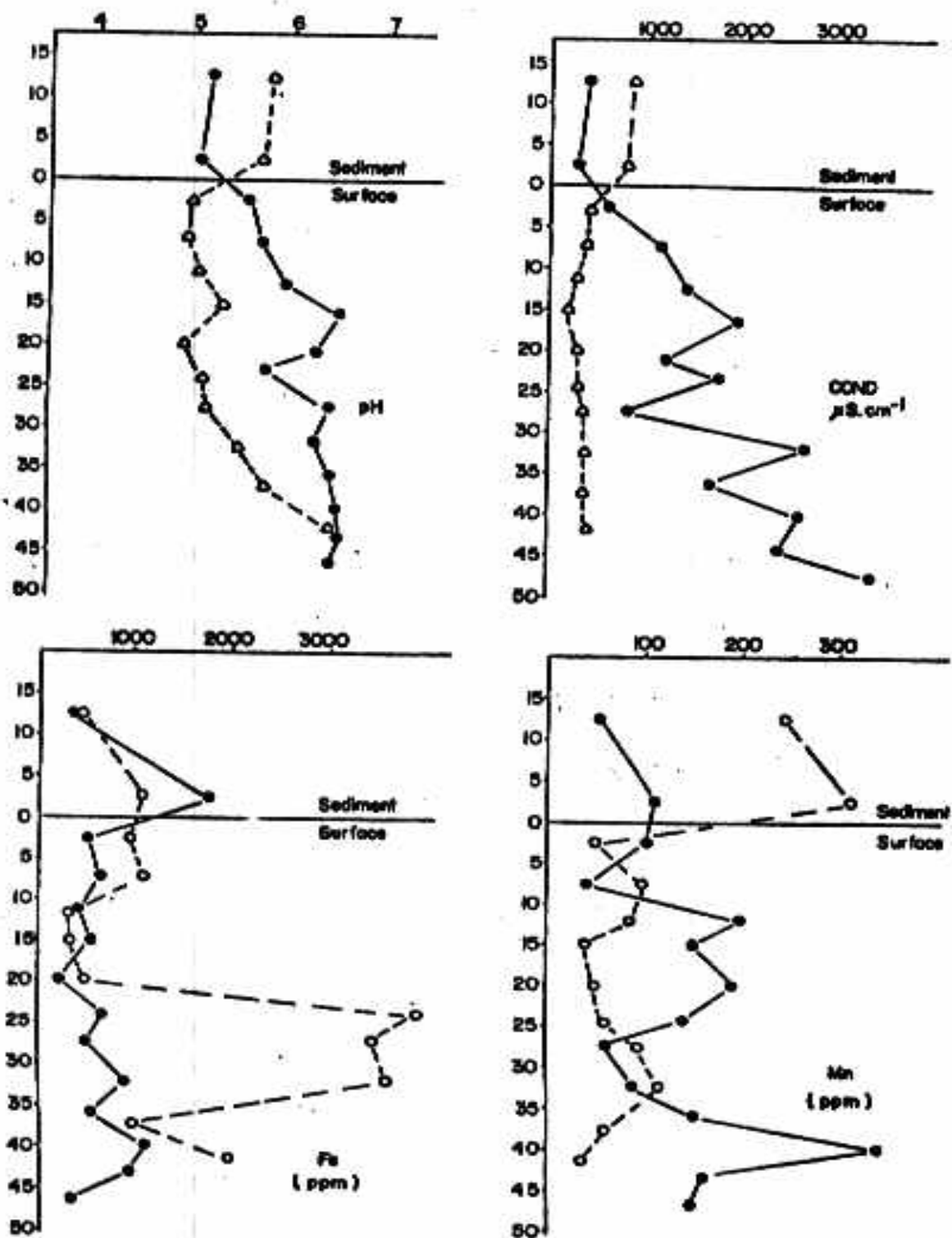


Figure 1 - Distribution of pH, conductivity, Fe and Mn in water and interstitial water in the *L. hexandra* (•) and *E. subarticulata* (o) communities. Core depths are in cm.

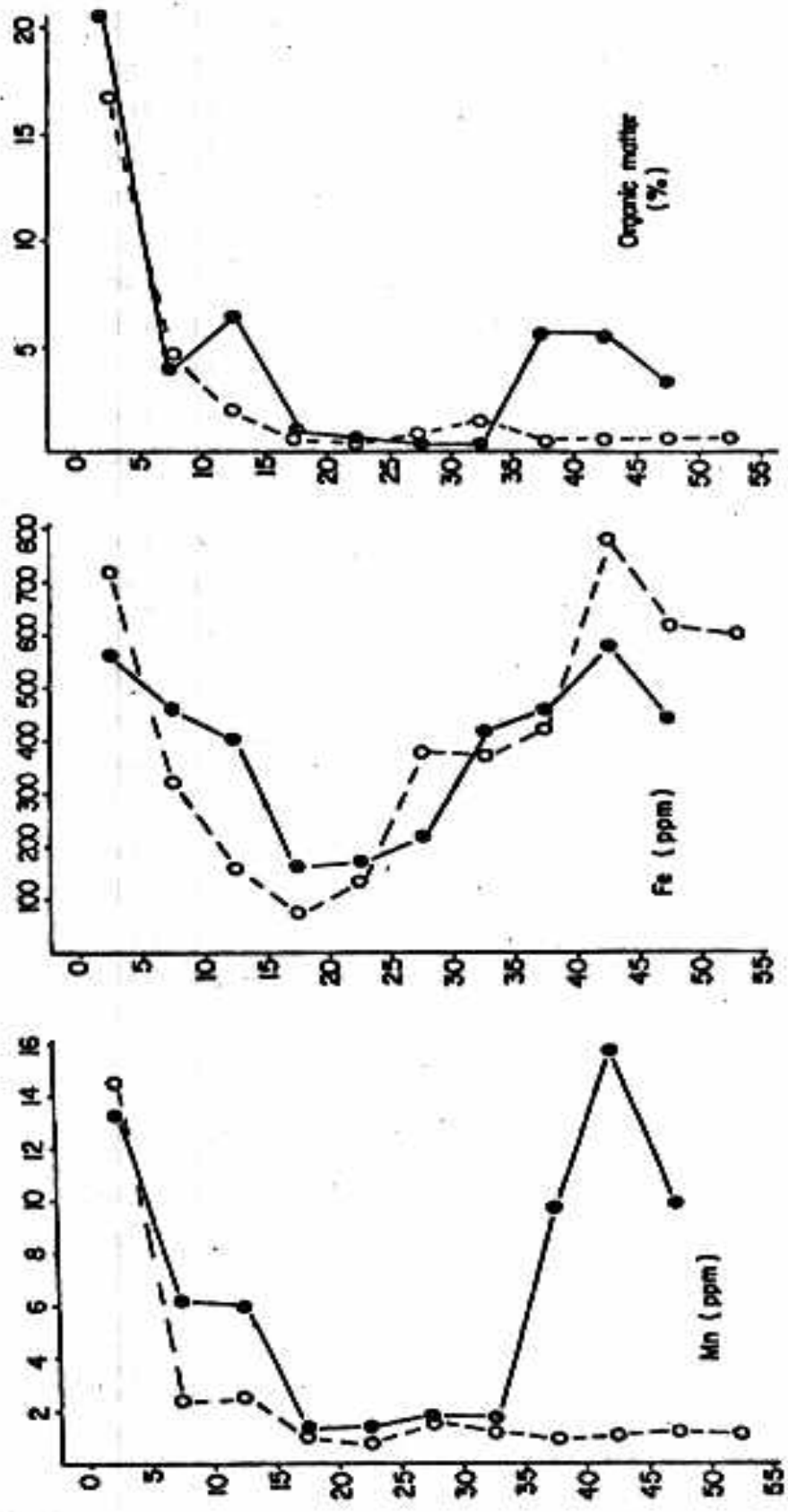


Figure 2 - Distribution of organic matter, Fe and Mn in sediments of the *L. hexandra* (•) and *E. subarticulata* (o) communities. Core depths are in cm.

sediment-water interface as shown in figures 1 and 2.

The deep (45 cm) organic matter horizon in the *L. hexandra* community also caused a peak in Fe and Mn concentration at the same depth. The observed peak in Fe concentration at 45 cm under *E. subarticulata* however, is not followed by either organic matter or Mn contents. This Fe rich horizon caused an increase in dissolved Fe concentration in the interstitial water between 20 cm and 35 cm. The only possible explanation for this odd Fe-rich horizon would be the presence of a paleo "hard-pan" layer. The hard-pan phenomenon is quite typical of these dune systems and normally contains high concentration of precipitated iron oxides of marine origin.

The *L. hexandra* community presented higher organic matter content than the *E. subarticulata* one, as a result of higher biomass of the graminoid (table 1). This must affect differentially the availability of Fe and Mn in the two areas. A mass balance of Fe and Mn in the two communities is presented in table 2. In the *L. hexandra* stand, Fe and in particular Mn, were more mobile than in the *E. subarticulata* one, where the two elements are almost totally bound to sediments. The higher availability of Fe and Mn in the graminoid stand is reflected in the higher concentrations in plant biomass, which accounts for 13.5% of Fe and 34.5% of Mn total content in the area, while in the cyperaceae stand, plant biomass accounts for only 6.3% of Fe and 2.2% of Mn total contents.

Concluding, the results presented here stressed the importance of aquatic macrophyte productivity as a control factor of Fe and Mn distribution and availability in the studied area, by means of high organic matter accumulation and consequent mobilization of the two elements into readily available reduced chemical forms.



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