PATTERNS OF THE AQUATIC MACROPHYTE COVER IN CACHOEIRA DOURADA RESERVOIR (GO-MG)

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(With 2 figures)

ABSTRACT

The relationship between the aquatic macrophyte cover in upper segments of tributaries and this cover in these tributaries but near the reservoir's main body was tested. Sixteen taxa belonging to 12 families of aquatic macrophytes were recorded in Cachoeira Dourada reservoir. The most frequent species were *Eichhornia azurea* (frequency of occurrence = 92%; n = 37 sites) and *E. crassipes* (44%). Upper segments of the tributaries were the main areas colonized by these aquatic macrophytes. The positive relationship between the aquatic macrophyte cover between the upper and lower segments of tributaries indicates the importance of dispersion in the colonization of the arms and the reservoir's main body.

Key words: aquatic macrophytes, cover, reservoirs.

RESUMO

Padrões de cobertura de macrófitas aquáticas no reservatório de Cachoeira Dourada (GO-MG)

Neste trabalho, foi realizado um levantamento da riqueza e da composição de espécies de macrófitas aquáticas no reservatório de Cachoeira Dourada (GO-MG). Os dados obtidos foram utilizados para testar se há relação positiva e significativa entre a cobertura de macrófitas aquáticas nos segmentos superiores dos tributários (próximo às nascentes) e a cobertura de macrófitas aquáticas nos mesmos tributários, próxima ao corpo central. Foram identificados 16 taxa, pertencentes a 12 famílias. *Eichhornia azurea*, a espécie mais freqüente no reservatório, ocorreu em 92% dos locais visitados, enquanto *E. crassipes* ocorreu em 44% dos locais. Os trechos superiores dos tributários foram as principais regiões colonizadas por macrófitas aquáticas. A relação positiva entre a cobertura de macrófitas aquáticas nos segmentos superiores e inferiores dos tributários indica a importância da dispersão para a colonização dos braços e corpo central do reservatório.

Palavras-chave: macrófitas aquáticas, cobertura, reservatórios.

INTRODUCTION

Aquatic macrophytes play a very important role in aquatic ecosystems (Carpenter & Lodge, 1986; Esteves & Camargo, 1986). However, in disturbed bodies of water some species, due to their excessive growth, may interfere with human use of freshwater, as well as recreation, fishing, water supply, and electrical generation, besides creating conditions conducive to the development of disease vectors (Pieterse & Murphy, 1993).

Abundant aquatic macrophyte growth is a common feature of reservoir systems in sub-tropical and tropical regions, especially because reservoir

construction causes many changes in lotic ecosystems, mainly reductions in water velocity, water transparency, sediment stability, and water-level control, as well as increased shoreline development and construction in previously sheltered areas. In addition, these environments are frequently subject to eutrophication, which may enhance the growth of free-floating nuisance species (Thomaz & Bini, 1998). Thus, the problems caused by the growth of these plants are really symptoms and not the first causes of existing impacts (Cook, 1993).

Besides the most frequent impacts caused by floating species such as *Eichhornia crassipes* (Mart.) Solms, *Pistia stratiotes* L., and *Salvinia molesta* D. L. Mitchell, and the submerged macrophytes have required attention due their high nuisance potential. Rapid inventories of aquatic macrophytes in Brazilian reservoirs are important in that they register potential nuisance species at local scales, increase information about distribution at a broader scale, and can be used in testing specific ecological hypotheses. As an example of the latter use, Thomaz & Bini (1998) pointed out that the aquatic macrophyte cover in reservoir arms, near a reservoir's main body, may be positively correlated with the same type of cover in the tributaries (in the upper segments).

The main aim of this study was to test the expected positive relationship between the aquatic macrophyte cover in the reservoir arms near the main body, and this cover in the upper segments of the tributaries or in the arms. To check this hypothesis, spatial data on aquatic macrophytes cover were obtained at Cachoeira Dourada reservoir.

METHODS

The Cachoeira Dourada reservoir (mean area = 74 km^2) is an old impoundment existing since 1958 behind the Cachoeira Dourada dam on the Paranaíba river (15º27'S and 44º41'W; Fig. 1).

A survey of the macrophyte cover was undertaken in a total of 37 sites, distributed in the main reservoir body (17 sites), in the upper segments of the tributaries (10 sites), as well as in the lower ones near the reservoir main body (10 sites).

The aquatic macrophytes, whether free-floating, emergent, and rooted with floating leaves, were collected manually, while the submerged species were sampled with a grapnel. Species were identified to the lowest taxonomic level possible, according to Hoehne (1979), Tryon & Tryon (1982), Cook & Urmi-König (1984), Lowden (1986), Cook (1990), Lorenzi (1991), and Velásquez (1994).

Each plant species was ranked from 0 to 2, according to the following criteria: species absence = 0; presence of the species = 1; species forming large homogeneous stands = 2. Although simple, these standards were used to minimize uncertainties inherent in the use of more cover classes and a detailed cover scale, as a consequence of which two observers would be unlikely to agree (Barbour *et al*., 1987)

To test the main hypothesis of this study, covers were summed irrespective of species so as to provide a general measure of the macrophyte cover (MC) in each site in the tributaries. Afterwards, the Spearman rank correlation was used to test the relationship between MC values obtained for sites located in the upper segments of the tributaries (MC_U) and those obtained for sites located in their lower reaches (MC_L).

RESULTS AND DISCUSSION

Sixteen taxa were recorded in Cachoeira Dourada reservoir, making species richness in Cachoeira Dourada reservoir lower than those of other Brazilian reservoirs (Pedralli *et al*., 1993; Pedralli & Meyer, 1996; Thomaz *et al*., 1999). At Itaipu binational reservoir, for example, 62 taxa were registered (Thomaz *et al*., 1999). Probably, the relatively limited area of Cachoeira Dourada reservoir and, consequently, its meager habitat heterogeneity, could explain this lower richness. However, it is important to emphasize differences in the sampling effort and more data is necessary to better estimate species richness in the Cachoeira reservoir.

According to Table 1, aquatic macrophyte species composition in Cachoeira Dourada reservoir could be considered a subset of the regional "pool" of species found in other Brazilian environments (Pott *et al*., 1989, 1992; Pedralli & Gonçalves, 1997; Thomaz *et al*., 1999).

The pattern of the relative species cover observed in Cachoeira Dourada reservoir is also characteristic of other biological assemblages. In other words, few species are widely distributed in the reservoir, whereas most are rare. The species with the larger cover area and larger frequency of occurrence was Pontederiaceae. For example,

Eichhornia azurea is the most frequent species (frequency of occurrence = 92%) and *E. crassipes* occurred in 44% of the surveyed sites (Fig. 2a). Both species could be considered potential nuisances in the Cachoeira Dourada reservoir. According to Fernández *et al*. (1993), *Eichhornia azurea* is often considered a nuisance species in many Brazilian reservoirs, while *E. crassipes* is considered the main aquatic weed in South and Central America and in other regions of the world (Gopal, 1993).

Some other species, such as *Salvinia auriculata* e *Egeria densa*, with low cover and occurrence, deserve attention due to the problems they cause in many other reservoirs (see Pieterse & Murphy, 1993). In other clear water reservoirs, *E. densa* is considered the main nuisance species (e.g., Jupiá and Paulo Afonso). Thus, considering the high water transparency at Cachoeira Dourada reservoir (mean Secchi disk = 1.7 m; SD = 0.46 m; $n = 37$), this species requires particular attention.

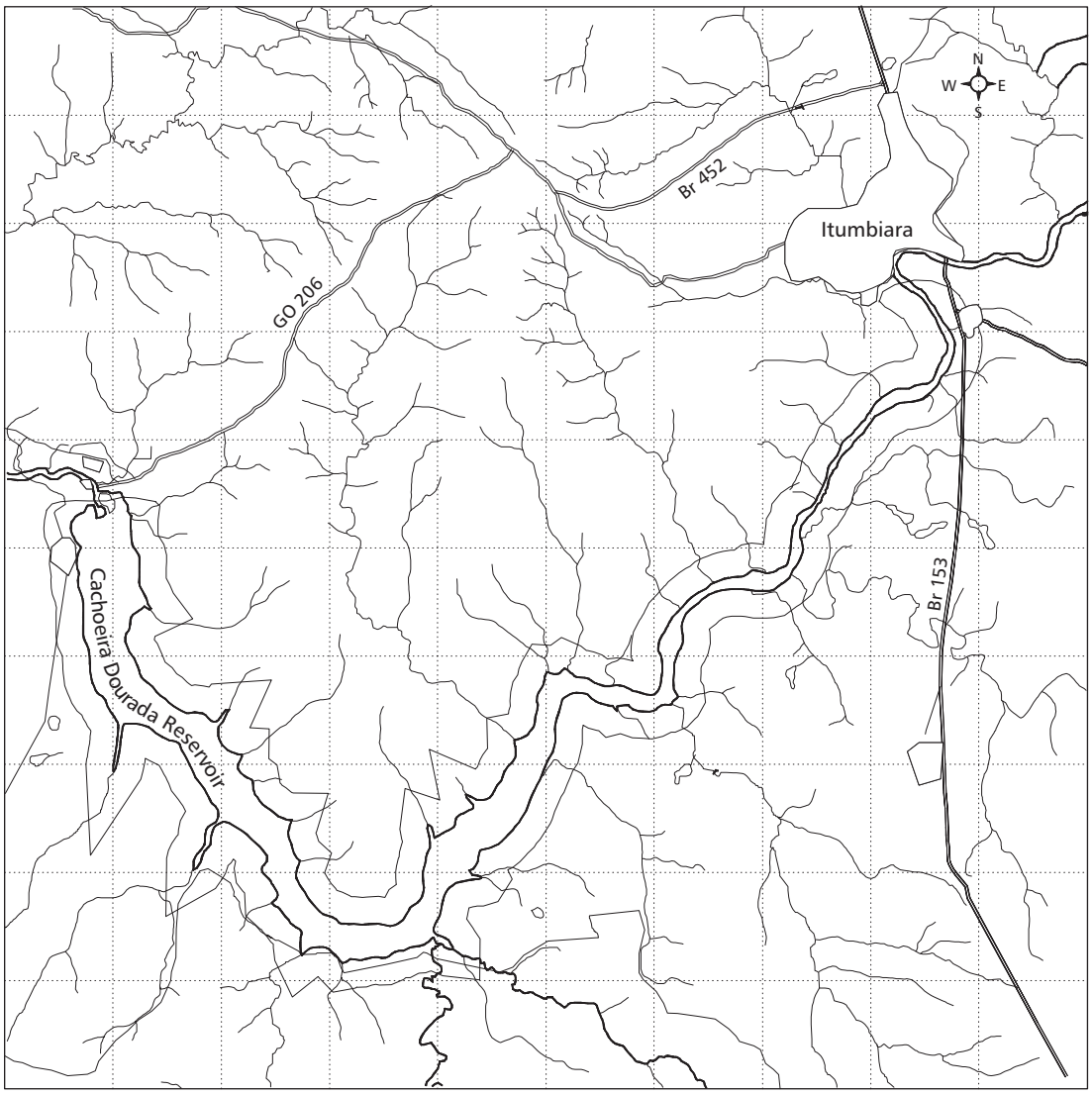

Fig. 1 — Map of Cachoeira Dourada reservoir (GO-MG).

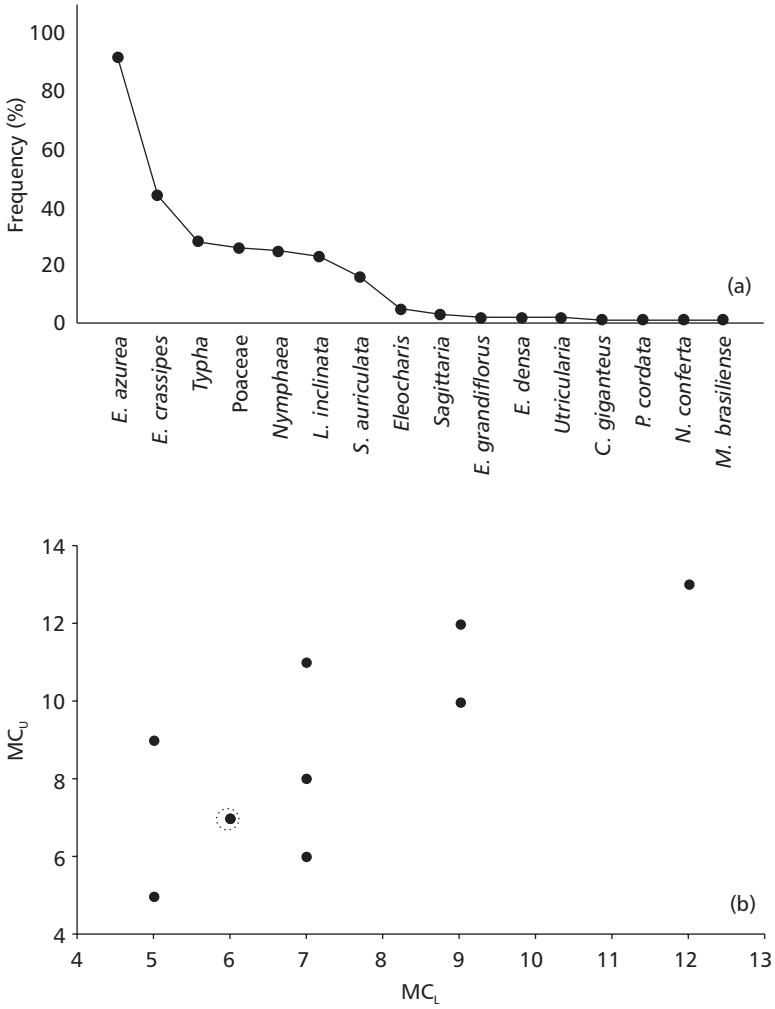

Fig. 2 — (a) Frequency of occurrence of the taxa registered in the Cachoeira Dourada reservoir (number of sampling sites = 37). (b) Relationship between aquatic macrophytes cover in the upper segments (MC_U) near the headwaters and in the lower segments (MC_U) near the reservoir main body of Cachoeira Dourada reservoir (n = 10). The dot inside the circle indicates two observations with the same values.

Patterns of colonization by aquatic macrophytes could be considered predictable. Regions exposed to wind and wave action are rarely colonized by free-floating or emergent aquatic macrophytes (Thomaz & Bini, 1998). Underwater light incidence and sediment declivity are also important predictors of submerged species occurrence (Duarte & Kalf, 1986, 1990; Duarte *et al*., 1986; Thomaz *et al*., 1998). In Cachoeira Dourada reservoir, aquatic macrophyte growth (mainly by free-floating and emergent plants) was higher in the upper segments of the tributaries, when compared to that in the lower segments. This is corroborated by the paired signal test (Z = 2; p = 0.045; n = 10). Upper segments were sheltered and had lower Secchi disk values (mean difference between upper and lower segments = –31 cm; t test = 3.5; n = 10; p = 0.006) when compared with those of the segments located near the main body of the reservoir.

TABLE 1
Families, scientific names, and ecological groups for taxa collected at Cachoeira Dourada reservoir in May 1999.

Family	Taxon	Ecological group
Typhaceae	*Typha* sp.	Emergent
Salviniaceae	*Salvinia auriculata* Aublet	Free-floating
Lentibulariaceae	*Utricularia* sp.	Free submerged
Nymphaeaceae	*Nymphaea* sp.	Rooted with floating leaves
Najadaceae	*Najas conferta* (A. BR.) Brasun	Submerged
Hydrocharitaceae	*Egeria densa* Planchon	Submerged
Haloragaceae	*Myriophyllum brasiliense* Cambess.	Emergent
Alismataceae	*Echinodorus* cf. *grandiflorus* (Cham. and Schlecht.) M. Micheli	Emergent
	Sagittaria sp.	Emergent
Onagraceae	*Ludwigia inclinata* (L. f.) Gomez	Submerged
Pontederiaceae	*Pontederia cordata* L.	Emergent
	Eichhornia crassipes (Mart.) Solms.	Free-floating
	Eichhornia azurea (Swartz) Kunth	Emergent
Cyperaceae	*Cyperus giganteus* Vahl	Emergent
	Eleocharis sp.	Emergent
Poaceae	Not identified due to absence of reproductive structures	Emergent

A significant relationship between MC_U and MC_L was detected (Spearman $r = 0.73$; $p = 0.017$; Fig. 2b). Thus, aquatic macrophyte covers in the upper tributary segments can be used to predict the cover of aquatic macrophytes in the tributaries near the reservoir's main body. This result supports the hypothesis of Thomaz & Bini (1998), which holds that the tributaries act as a major source of viable propagules, the dispersion of which in the direction of the main body is important in maximizing the colonization of different regions in the reservoirs.

The results obtained in this study indicate that control programs and/or the management of aquatic macrophytes at local scales (generally in the reservoir main body) will rarely be successful due to continuous colonization by propagules originating in upper tributary segments, where aquatic vegetation is uncontrolled. Thus, despite evident difficulties, aquatic vegetation management should be undertaken at the regional scale.

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