

GROWTH RATE OF *SALVINIA MOLESTA* MITCHELL IN AN URBAN LAKE OF THE KARSTIC PLATEAU OF LAGOA SANTA – MINAS GERAIS STATE, SOUTHEAST BRAZIL.

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ABSTRACT

Growth rate of *Salvinia molesta* Mitchell in an urban lake of the karstic plateau of Lagoa Santa – Minas Gerais State, southeast Brazil. A new area of occurrence for *Salvinia molesta* is reported together with data on its growth rate measured *in situ* in an impacted urban lake of the karstic plateau of Lagoa Santa, south-east Brazil. A physical and chemical characterization of the water in which this occurrence was recorded is also reported and a model to describe the growth of these macrophytes proposed. The work is aimed at contributing to the conservation of the aquatic environment.

Key words: *Salvinia molesta*, growth rates of macrophytes

INTRODUCTION

In South America seven species of the *Salvinia* genus are naturally occurring, including *Salvinia molesta* which, because of its high growth rate, has become a well known exotic invasive outside South America (5). In a study of this spread from South America Room (1990) describes that after its introduction to Sri Lanka in 1939, it spread rapidly throughout Africa, India and Australia causing environmental perturbations, mostly associated with a reduction in water quality (9).

In an expedition to South America, Forno & Harley (1979) reported the occurrence of *Salvinia molesta* only at altitudes of lower than 500m and only south of the Tropic of Capricorn.

This study describes for the first time an occurrence of *Salvinia molesta* outside of that described range, i.e. in the state of Minas Gerais. It also describes the physical and chemical characteristics of the waterbody in which this population of *Salvinia molesta* occurs and sets out to measure its growth rate and develop a model to explain this.

MATERIAL AND METHODS

Study Site

Olhos d'Água Lake is located on the Lagoa Santa karstic plateau in Minas Gerais district at coordinates 19°44'-33' S; 44°50' - 43°50' W as shown in Figure 1. This system of lakes is one of the main systems of karstic lakes of Brazil. It presents maximum width of 110m and 520m of length, with a maximum depth of 3,5 meters (Fig. 01).

As all next water body situated near agglomerations human, has been suffering considerable impacts mainly as a result of accelerated urbanization, eutrophication and siltation that constitutes the consequences most direct.

The occupational rate of *Salvinia molesta* in the lake can be considered low with 20% of the surface, when compared to other environments (2).

Field Work

Samples were collected at a fixed sampling station between February 1991 and March 1992

and at a interval of circa every 10 days. Estimates of both net and gross growth of *Salvinia molesta* were performed, together with measurements of water temperature, transparency and dissolved oxygen. Conductivity, pH, total alkalinity, nitrite-nitrogen, nitrate-nitrogen, ammonium-nitrogen, total nitrogen, soluble reactive phosphate, and total phosphorous were all measured at monthly intervals. All measurements and samplings were completed during the morning period and water samples were collected at the water surface.

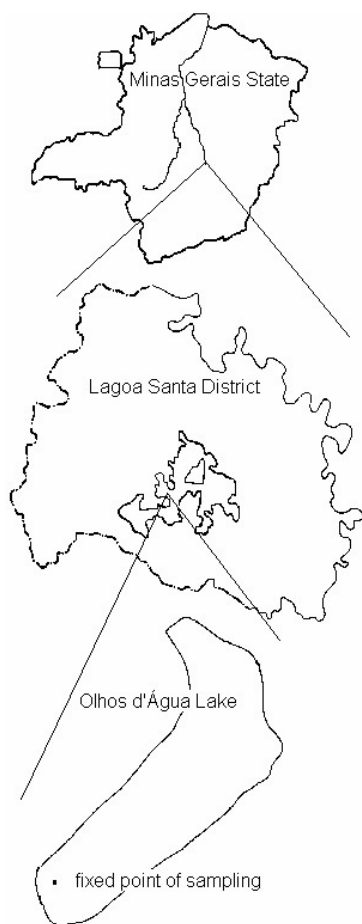


Figure 1. Location of Olhos d'Água lake, showing fixed site of water and macrophyte sampling.

Physical, chemical, and climatic parameters:

Climatic data for the period 1961-1970 was obtained from the meteorological station situated at Lagoa Santa municipality were provided by the 5th District of Meteorology. Temperature was measured in the shade with a manual thermometer of 0.2°C precision. Water transparency was measured with Secchi disk assuming with Cole (1975). Dissolved oxygen was measured through the Winkler

technique, modified by Pomery & Kirchman (1945) and percentage saturation calculated according to Mackereth *et al.*, (1978). The pH measurements were done *in situ* using a portable pHmeter and total alkalinity was measured by potentiometric titration (pH 4.35), using sulphuric acid 0,01N. The conductivity was measured with a portable conductivity meter and nutrient concentrations according to the techniques described in Golterman *et al.*, (1978) and Mackereth *et al.*, (1978).

Growth rate of *Salvinia molesta*

Individuals of *Salvinia molesta* possessing at least six leaves (three ramets) were tied to a nylon thread and stocked to a fixed point (plants or wooden debris) within the littoral region. The number of open leaves was counted and then marked with a needle and a thread. All the procedure was done trying not to cause a significant damage to the plant in order of not affect its growth rate. Three measurements of the net growth rate were done (number of produced leaves by each leaf per day minus the number of lost leaves per day) as well as the gross growth rate (number of produced leaves by each leaf per day).

Multiple stepwise regressions analysis were made, taking as explanatory variables the recorded physical and chemical parameters and the climatologically data.

The stepwise analyses were done according to Draper & Smith (1981), through the MINITAB program.

RESULTS

The insolation obtained by radiometer and the average air temperature showed typical seasonal pattern with lowest values recorded in June and July (Fig. 2).

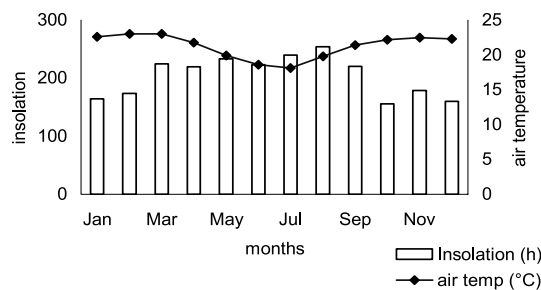


Figure 2. Seasonal variation of the air temperature and insolation, in the Lagoa Santa/MG from 1961 to 1970.

The water transparency oscillated between 0.60 and 1.40m, with the highest values in May and June.

The water temperature values oscillated from 19°C to 30°C, with the lowest temperatures registered in August. The lake is a classical warm-monomictic with stratification period extending from September to March/April and exhibiting isothermal conditions from May to August. This thermal behaviour will affect most of the chemical features within the lake resulting in seasonal differences for the majority of the chemical variables.

The oxygen's saturation values oscillated between 54% and 115%, although seasonal differences were not evident (Fig 3).

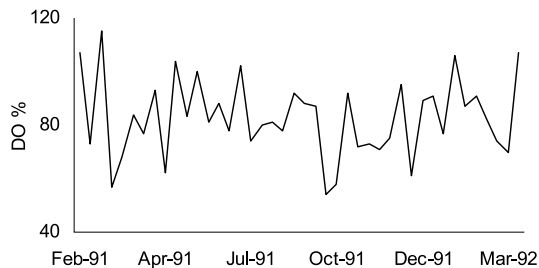


Figure 3. Seasonal variation of the oxygen's saturation in the Lagoa Santa/MG from February of 1991 to march of 1992.

On the other hand, conductivity, pH and total alkalinity values suggested seasonal variations, as follow: conductivity oscillated between 27.5 $\mu\text{S}/\text{cm}$ and 52,1 $\mu\text{S}/\text{cm}$, with the lowest value recorded in August; pH was slightly acid, oscillating between 6.3 and 7.18, with the highest values in November and February, and total alkalinity with values oscillating between 0.031 and 0.074 meq CO_2/l (Figs. 4 and 5).

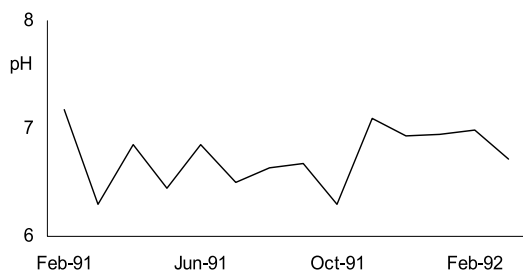


Figure 4. Seasonal variation of the pH in the Lagoa Santa/MG from February of 1991 to march of 1992.

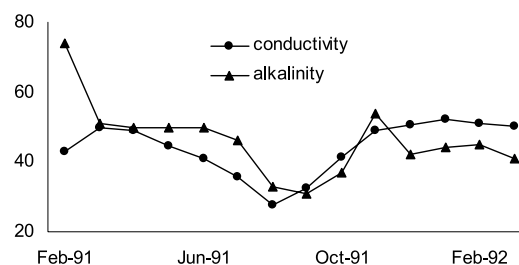


Figure 5. Seasonal variation of the total alkalinity and conductivity in the Lagoa Santa/MG from February of 1991 to march of 1992.

Among the analysed chemical species of dissolved nitrogen, only N-NH_4 showed values above those of the detection limits (11 $\mu\text{g}/\text{L}$) with concentrations between 12 and 86 $\mu\text{g}/\text{l}$ and the highest values recorded in October, probably reflecting allochthonous contributions, when the highest concentrations of total nitrogen were also recorded (311- 414 $\mu\text{g}/\text{l}$). Similar patterns were recorded for soluble reactive phosphorus (Fig. 6) and total phosphorus concentrations, which values ranged between 3 and 11 $\mu\text{g}/\text{l}$ and between 22 and 55 $\mu\text{g}/\text{l}$, respectively.

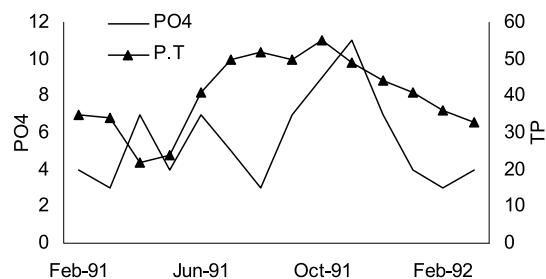


Figure 6. Seasonal variation of the soluble reactive phosphorus and total phosphorus total in the Lagoa Santa/MG from February of 1991 to march of 1992.

Salvinia molesta net and gross growth rates are presented in Figure 7.

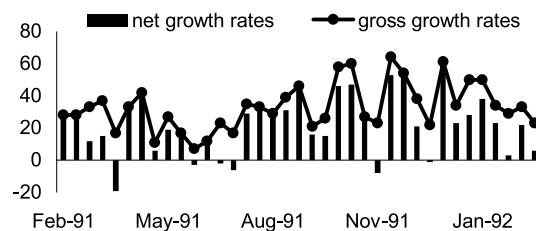


Figure 7. Seasonal variation of the net and gross growth rates of *Salvinia molesta* in the Lagoa Santa/MG from February of 1991 to march of 1992.

The minimum and maximum growth rates were, respectively, -0.019 and 0.061 for the net growth and 0.007 and 0.064 produced leaves per leaf per day for the gross growth rate. The monthly average for net and gross growth rates are presented in Figure 8.

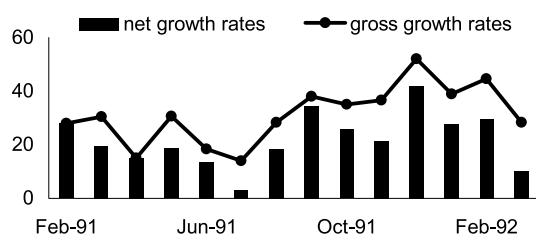


Figure 8. Seasonal variation of the monthly average for net and gross growth rates of *Salvinia molesta* in the Lagoa Santa/MG from February of 1991 to March of 1992.

Similarly as observed by Room & Thomas (1986), the lowest growth rates occurred during the coldest period of the year, also demonstrating a seasonal effect.

In order to explain the observed temporal variations the recorded results were analysed through the stepwise technique and the following models were obtained, considering 5% level:

i) Net growth of *S. molesta* $\times 10^{-3} = -95,38 + 3,6 \times H_2O \text{ temp.} + 4,3 \times \text{soluble reactive phosphorus concentration } (\mu\text{g/l})$.

$N = 12 \quad R^2 = 56,34\%$

ii) Net growth of *S. molesta* $\times 10^{-3} = 63,4 - 0,204 \times \text{insolation}$

$N = 14 \quad R^2 = 45,88\%$

On the first equation water temperature and soluble reactive phosphorus concentrations explained 56% of the variation on the net growth rate of *S. molesta*, as already appointed by Mitchell *et al.* (1980); while on the second equation, insolation determines 45% of the recorded variation.

iii) Gross growth rate of *S. molesta* $\times 10^{-3} = 25 + 1,24 \times \text{average air temperature } (^{\circ}\text{C})$

$N = 14 \quad R^2 = 47,78$

For the gross growth rates of *Salvinia molesta*, this model explains 50% of the recorded variations.

DISCUSSION AND CONCLUSIONS

As stated before, the water temperature

showed a marked seasonal pattern according to which the lake stratifies from September to March and destratifies from end of April/beginning of May, thus exhibiting a classical warm-monomictic pattern.

The concentrations of the different forms of nutrients follow this pattern and frequently present a clear relation to the dry and wet periods, with the highest concentrations during the former. This pattern was clearly exhibited by the distribution of ammonium-nitrogen, total nitrogen, and total phosphorous concentrations, not being so clear with the distribution of soluble reactive phosphorus concentrations. Moreover, the other physical and chemical parameters did not show any relation to the growth rates of *S. molesta*.

The net and gross growth rates of *S. molesta* presented a clear seasonal variation, with the lowest values occurring in July 1991, similarly as recorded by Room & Thomas (1986) and Miller & Wilson (1989).

Considering the models proposed in this study, there is a large number of variables influencing both net and gross growth rates, such as water temperature, concentration of soluble reactive phosphate, insolation, and the average air temperature, already been referred to in the literature as important factors in determining *S. molesta*'s growth rates. Particularly for the case of lake Olhos d'Água and comparing the presented models the growth rates of *S. molesta* are mainly determined by the concentration of soluble reactive phosphorus combined with the seasonal differences in water temperature and insolation.

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RESUMO

Taxas de crescimento de *Salvinia molesta* Mitchell em um lago urbano do Planalto cárstico de Lagoa Santa – Estado de Minas Gerais, no sudeste do Brasil. Uma nova área de ocorrência

para *Salvinia molesta* é relatada juntamente com as taxas de crescimento mensuradas *in situ*, em um lago urbano impactado no planalto cárstico de Lagoa Santa, sudeste do Brasil. Uma caracterização física e química da água foi registrada e relatada. Um modelo para descrever as taxas de crescimento desta macrófita foi proposto. O trabalho visa contribuir para a conservação de ambientes aquáticos.

Palavras chave: *Salvinia molesta*, taxas de crescimento de macrófitas

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