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Foliar growth, longevity and herbivory in two "cerrado" species near Cuiabá, MT, Brazil.

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ABSTRACT - (Foliar growth, longevity and herbivory in two "cerrado" species near Cuiabá, MT, Brazil). Growth and longevity of leaves of two tree species from the "cerrado", *Vochysia rufa* Mart. (Vochysiaceae) and *Curatella americana* L. (Dilleniaceae), were evaluated and related to intensity of herbivory. A branch from three individuals of each species was marked and all leaves followed from April 1985 to August 1986. Leaf growth, longevity and herbivory intensity measured every two weeks. Also, every three months, samples of leaves of these species were collected in order to quantify leaf damage due to herbivory with respect to the rainy and dry seasons. In both species, growth was completed by the 45th day. Leaf fall pattern differed between species. Herbivory intensity and the number of attacked leaves in *V. rufa* (2.9%) was lower than for *C. americana* (4.6%). The herbivory intensity was lower than values reported for other tropical species. Leaf longevity of both species was apparently not related to herbivory. The synchrony of the initial, fast growth of leaves with the end of the dry season and after fires seems to be an effective anti-herbivore strategy in these species, although some chemical defenses, such as high content of Al and Si may play a secondary role.

RESUMO - (Crescimento, longevidade e herbivoria foliares em duas espécies de cerrado em Cuiabá, MT, Brasil). O crescimento e a longevidade foliares de duas espécies do cerrado, *Vochysia rufa* Mart. (Vochysiaceae) e *Curatella americana* L. (Dilleniaceae), foram avaliados e relacionados com a intensidade de herbivoria. Foi marcado um ramo de três indivíduos de cada espécie e todas as folhas foram mapeadas de abril/85 a agosto/86. O crescimento foliar, a longevidade e a intensidade de herbivoria, foram medidas a cada quinze dias. Além disso, a cada três meses foram coletadas amostras de folhas destas espécies, para quantificar os danos foliares causados pelos herbívoros, de acordo com as estações chuvosa e seca. Em ambas as espécies, o crescimento se completou até o 45º dia. O padrão de queda foliar diferiu entre as espécies. A intensidade de herbivoria e o número de folhas atacadas, foram menores em *V. rufa* que em *C. americana*. A intensidade de herbivoria foi menor que os valores citados para outras espécies tropicais. A sincronia de um rápido crescimento inicial das folhas ao término da estação seca e após o fogo, parece ser uma estratégia anti-herbívora efetiva nestas espécies, embora algumas defesas químicas, tais como altas concentrações de Al e Si, possam funcionar como um papel secundário.

Key words - *Curatella americana*, *Vochysia rufa*, cerrado, fire, herbivory, leaf growth, leaf longevity

Introduction

Quantitative analysis of growth and knowledge of longevity of leaves are fundamental for the understanding of the evolution of deciduous behaviour, litter fall dynamics, fruiting patterns, among others ecophysiological aspects of plants (Janzen 1980). Throughout their life span, leaves are subjected to herbivory, and this loss of photosynthetic biomass may lead to reduced growth and reproduction (Harper 1977, Marquis 1987), reduced longevity (Jacobs 1962, Owen 1978, Janzen 1980, Risley & Crossley 1988), and translocation of energy from the main metabolic pathways to the production of defense mechanisms (Feeny 1975, Coley 1983, Lacerda et

al. 1986). Although these effects are well documented for agricultural systems, they are poorly understood in natural plant communities (Reed & Stephenson 1972, Marquis 1987).

In the present paper we studied the growth and longevity of leaves of two tree species from the Brazilian "cerrado", *Vochysia rufa* and *Curatella americana*, in relation to intensity of herbivory, characterizing its effects and the possible anti-herbivore mechanisms presented by these species.

Material and methods

The study was carried out with *Vochysia rufa* Mart. (Vochysiaceae) and *Curatella americana* L. (Dilleniaceae) on a typical "cerrado" area near Cuiabá, Mato Grosso, Brazil (15° 30' S, 50° 00' W). These species are frequent in the area, occurring on dystrophic sandy-clay soils, acidic and rich in aluminum, and fires occur annually.

A branch from three individuals of each species was marked and all leaves on it were mapped. The study was conducted during 16 months (from April 1985 to August 1986). In ~~late~~ 1985 a fire caused total defoliation of the trees and new branches were marked and mapped. Leaf growth was measured in millimeters, using a nylon line and ruler. For each

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leaf the maximum length and width was recorded. Herbivory intensity was estimated visually and leaves were classified into five intensity classes (not damaged leaves (ND), <25%; 25-50%; 50-75% and >75% of loss of the leaf surface). These measurements were done every two weeks.

In October 1985, January, April and August 1986 samples of leaves of these species were collected in order to quantify leaf damage due to herbivory in relation to the rainy (November-April) and dry (May-October) seasons. At each sampling date, one branch from three individuals of each species was collected. These individuals were not the same ones used to previously. The outline of all leaves was traced on graph paper and the total damaged area was measured by counting the number of squares in damaged areas. Total leaf area was measured using a electronic planimeter. Leaves were classified into seven intensity classes (not damaged leaves (ND), <5%, 5-10%, 10-15%, 15-25%, 25-35%, 35-45% of loss of the leaf surface). Types of damage follow Johnstone (1981).

Results

Growth and foliar longevity—In both species, growth was completed by the 45th day. *Curatella americana* leaves at the base of branches presented an abnormal growth pattern reaching only 4cm at the end of the growing period (figure 1). After the fire, *V. rufa* produced new leaves before *C. americana*.

The first interval used for measuring leaf growth after fire, was too large to evaluate leaf growth of *V. rufa*, since after one month, most leaves (45%) were in the 4-8cm length class and only 4% in the 0-4cm length class. However the same interval was applicable for *C. americana* growth rate, since after one month of the fire, 33% of the leaves were still in the 0-4cm length class (figure 2).

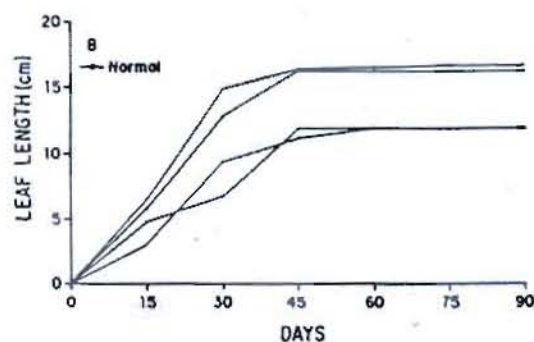
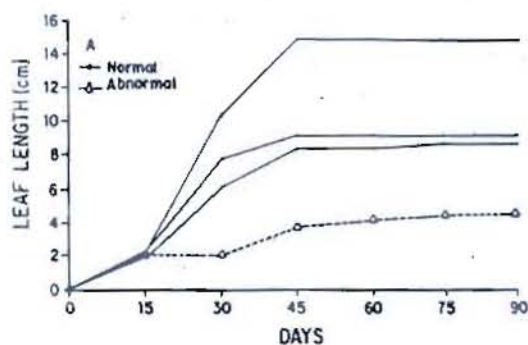


Figure 1. Leaf growth of *Curatella americana* (A, n=4) and *Vochysia rufa* (B, n=4). Note the abnormal growth of one *C. americana* leaf. For both species day 0 corresponds to July 25th 1985.

Table 1. Cumulative production and loss of leaves in marked branches of *Curatella americana* and *Vochysia rufa* over the study period.

	1985						1986						
	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
% of new leaves produced (cumulative)													
<i>C. americana</i>	67	81	85	87	89	93	100	100	100	100	100	100	100
<i>V. rufa</i>	98	100	100	100	100	100	100	100	100	100	100	100	100
% of leaf fall (cumulative)													
<i>C. americana</i>	0	2	4	4	6	10	12	16	24	33	41	50	90
<i>V. rufa</i>	0	2	2	2	2	2	2	2	2	2	4	4	70

A. *Vochysia rufa*

B. *Curatella americana*

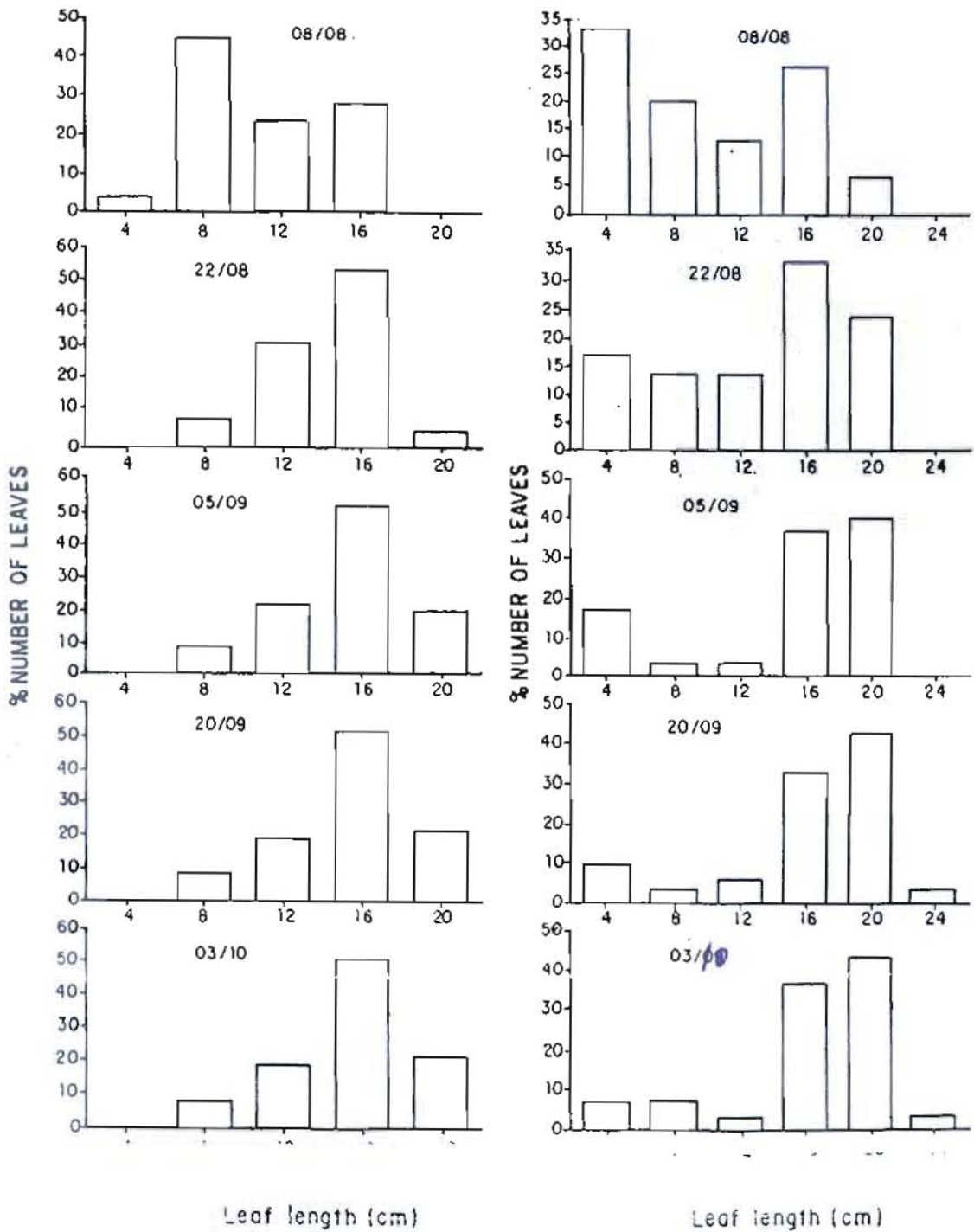


Figure 2. Frequency of leaf lengths in marked branches of *Vochysia rufa* (A, n = 47) and *Curatella americana* (B, n = 30) during the study period.

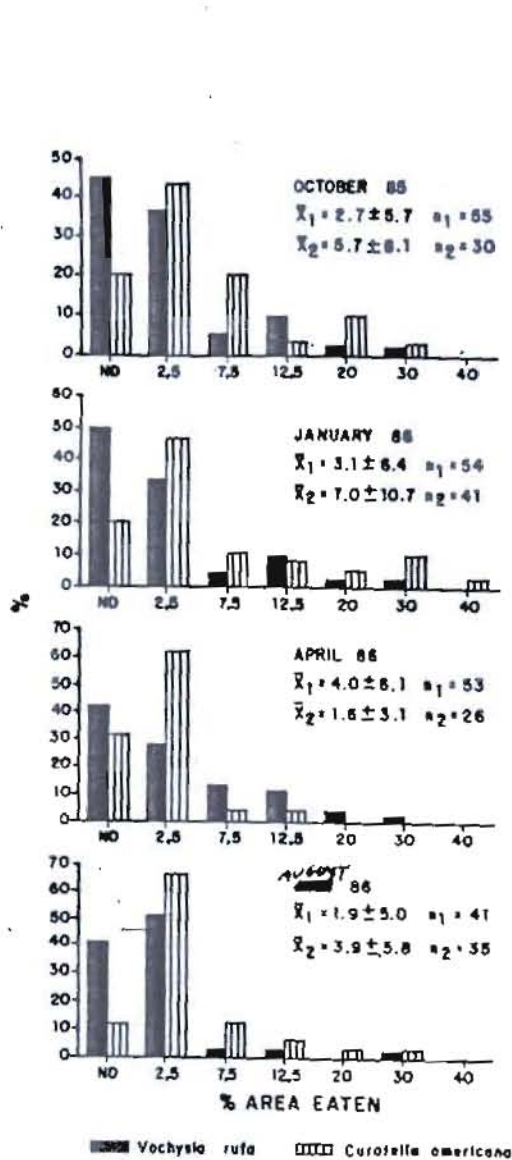


Figure 3. Frequency of area eaten in samples of leaves. ND = not damaged.

When leaves stabilized their growth, 50% of *V. rufa* were in the 12-16cm length class, while 43% of *C. americana* leaves were in the 16-20cm length class. Maximum lengths for *V. rufa* and *C. americana* were 16-20cm and 20-24cm respectively.

Table 1 shows the number of new leaves and leaf fall for the marked branches during the study period. Most new leaves of both species were

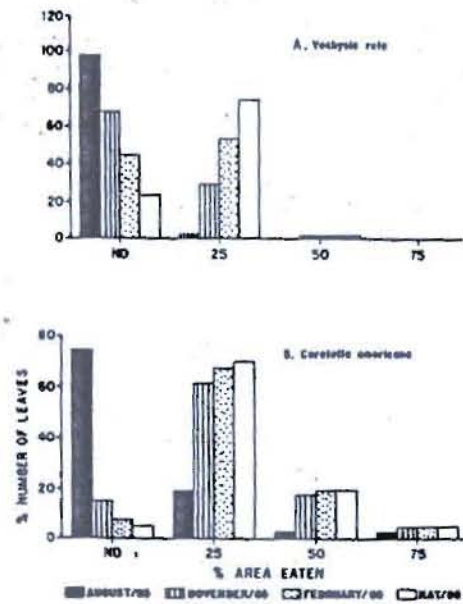


Figure 4. Frequency of leaf area eaten of *Vochysia rufa* (A, $n = 47$) and *Curatella americana* (B, $n = 30$) in marked branches. ND = not damaged.

produced within the first month after fire, although new leaves of *C. americana* were produced until six months after the fire.

The leaf fall pattern was different between species; *C. americana* presented a progressively increasing leaf fall after the second month with most leaves falling in the dry season. *Vochysia rufa* presented only one period of leaf fall, also concomitant with the dry season. Leaf longevity was ca. 12 months for both species, however leaves presenting abnormal growth in *C. americana* had a shorter life span.

Leaf herbivory - Figure 3 shows herbivory intensity in leaves of the two species studied. *Vochysia rufa* presented a smaller number of damaged leaves than *C. americana*. Leaf area consumed was also smaller in *V. rufa* than in *C. americana* (2.9 vs. 4.6% of total leaf area). Most damaged leaves of the two species were in the 5% damage class, however *C. americana* presented a higher number of leaves in higher herbivory intensity class than *V. rufa* (figure 3).

After fire, new leaves presented lower herbivory. However the number of the damaged leaves increased steadily reaching 75% and 100% of total number of leaves in *V. rufa* and *C.*

americana, after seven months (figure 4). After this period no increase in herbivory was observed. In August 1986, when most of leaves were young, herbivory intensity was high, contrary to the results observed in August 1985 (figure 3⁴).

Discussion

Various authors have suggested that herbivory may affect leaf longevity (Jacobs 1962, Owen 1978, Janzen 1980, Risley & Crossley 1988). In the present study, however, leaf longevity of the two species was not related to herbivory, since leaf fall was apparently a function of the dry season.

Herbivory, for *V. nifa* and *C. americana*, was lower than reported for tropical mangroves (Lacerda et al 1986; Johnstone 1981); and tropical forest species (Dirzo 1987, Marquis 1987). Although it was similar to another *Vochysia* species studied by Nascimento (1987) in the Pantanal (Mato Grosso).

The fast leaf growth rate of the two species may explain, in part, these low values. Aide & Londono (1988) suggested that fast growth rates can be an important strategy for protection of young leaves against herbivores. The sprouting and fast growth of new leaves coincided with the end of the dry season, which may enhance the effectiveness of this strategy since herbivores are rarer in this period (Janzen & Schoener 1968, Janzen 1973, Wolda 1978).

The difference observed in the number of attacked leaves between August 1985 and August 1986, may be the result of high mortality of insect populations due to the fire in 1985. The chemical composition of these species may also be involved in their anti-herbivory strategy. *Curatella americana* has a high concentration of Si in its leaves (Silva 1976), making them very hard and rough. This plant is locally called "lixreira", Portuguese for file because of its rough texture. High Si concentrations makes leaves less palatable to herbivores (McNaughton et al. 1985).

Vochysia nifa, presents a high concentration of Al, especially in leaf veins and epidermal cells (Haridasan et al. 1986). Although Al is not toxic to animals (Hutchinson 1945), it may decrease the nutritional value of leaves to herbivores (Goodland 1971). Low intensity of herbivory was also found for an other Al-rich *Vochysia* species

by Nascimento (1987).

The synchrony of the initial, fast growth of leaves with the end of the dry season and after fires seems to be an effective anti-herbivory strategy in these species, although some chemical defenses such as high content of Al and Si may play a secondary role.

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