DRY MATTER ALLOCATION IN Jessenia bataua (PALMAE). (*)

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SUMMARY

There are few assessments of lifetime dry matter production for tropical trees. However, several studies have been carried out for palms. This study measures dry matter production for ***Jessenia bataua****, a useful palm common in many areas of the Amazon Valley. Palms in the Ducke Forest Reserve of INPA were studied. Approximately 34% of total aboveground dry matter production in this palm was allocated to reproductive effort, eg., the production of inflorescences and fruits. The meaning of this percentage is discussed, relative to percentages identified in other Neotropical palms.*

INTRODUCTION

Measuring how lifetime dry matter production is allocated in plants provides interesting insights concerning their life histories. Yet most studies have involved temperate herbs (Harper, 1977), and little work has been done on tropical trees. An exception are palms, which have received relatively great attention compared with other families of tropical trees (e.g., Tomlinson & Soderholm, 1975, Sarukhán, 1980, Anderson, 1983). This is probably due to the large and discreet morphological components in palms, which greatly facilitate calculations of dry matter production.

The palm utilized in this study is **Jessenia bataua** (Martius) Burret, which grows over extensive areas of northern South America and forms high density stands in swampy bottomlands throughout the region. **Jessenia bataua** is a solitary stemmed, majestic species that attains heights of nearly 30 meters (Figure 1). Known locally as "patauá" in Brazil and "seje" or "milpesos" in Colombia, this species is extremely useful throughout its range. We selected this palm for study because of its importance as a source of subsistence products. Its leaves serve as thatch, fiber and medicine; its stems are used for construction; its spine-like fibers provide hunting implements and fuel; and its fruits are harvested to produce food, a beverage, protein and oil. This latter product is

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physically and chemically identical to olive oil. Interest has recently developed in domesticating **J. bataua** as an oilseed crop, and efforts have been made in Brasil and Colombia toward this end (FAO, 1984). There are attempts being made to domesticate this species, and estimation of its dry matter allocation to reproduction provides a baseline for future efforts to increase yields in selected strains.

METHODS

The study was conducted in the Ducke Forest Reserve of the National Institute of Amazonian Research (INPA), ca. 30 km N of Manaus, Brazil, on the Manaus - Itacoatiara Highway. The tallest palm present in a swamp forest was selected for harvesting. This palm was clearly in an advanced state of senescence, as indicated by the reduced size of leaves in the crown. Lifetime dry matter production in **Jessenia bataua** was estimated in the following manner:

1. **Root production.** Tomlinson & Soderholm (1975) assumed that lifetime production of roots was equal to 10% of lifetime stem and leaf production; the basis for this assumption was not given. Lifetime root production is virtually impossible to measure in a perennial tree growing in the wild. Consequently, we measured production only in aboveground components of **Jessenia bataua**.

2. **Stem production.** Due to its lack of secondary growth, the stem was treated as an elongated cylinder with a mean diameter of 15.5 cm and a length of 25.1 m. Stem volume was thus calculated as 473,000 cm^3. Density was calculated by oven-drying at $70^{o}C$ a sample of stem (collected from inner and outer portions, from top and bottom of stem). An average weight of 0.7 gm/cm^3 for this component was obtained.

3. **Leaf production.** Lifetime production of leaves was determined by counting the number of leaf scars on the aerial stem plus the number of living leaves in the crown (total = 158)*. To determine the mean mass of a leaf, three leaves from middle-sized mature palms (10-15 m tall) were harvested, oven-dried, and weighed; the mean mass was 8.0 kg (range: 7.7 - 8.4 kg). This figure was considered representative and was used as the mean mass of all leaves produced following stem emergence. The decrease in leaf mass produced during senescence was assumed to be equal to total leaf production in juvenile

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(*) Note that internode length varies with age of the plant, with new internodes becoming shorter when the production of inflorescences commences.

palms prior to stem emergence.

4. **Production of reproductive components.** Reproductive components vary considerably in size and mass. Based on visual inspection of the stand, a representative inflorescence and infructescence were obtained. Mean oven-dried mass of inflorescence components—including bract, prophyll, peduncle, rachillae, and staminate flowers (pistillate flowers were measured as fruits)—was 7.2 kg. Mean ovendried mass of fruits—which numbered 987 on the sampled infructescence—was 5.4 kg (mean mass per fruit = 5.5g). To estimate how many inflorescences were produced during the maximum lifespan, we assumed that fruiting panicles only develop fully in alternate leaf axes, an assumption substantiated by dissection of numerous crowns of this species during the course of taxonomic studies. We further assumed that on forested sites palms begin to reproduce at heights of ca. 6 m, or after producing ca. 30 leaf scars. Thus, 64 inflorescences were assumed to be produced during a maximum lifespan in this environment.

RESULTS AND DISCUSSION

During the maximum lifespan of **Jessenia bataua**, ca. 34% of total aboveground dry matter production was allocated to reproductive effort (Table 1). This is lower than similar measures of allocation to reproductive structures in pleonanthic palms such as **Orbignya phalerata** Mart. (= O. **martiana** Drude), which was 45% (Anderson, 1983), and **Astrocaryum mexicanum** Liebmann ex Martius, which was 37% (Sarukhán, 1980). In contrast, the sole figure for a hapaxanthic (i.e., monocarpic) palm, **Corypha elata**, was only 17% (Tomlinson & Soderholm, 1975).

Table 1. Lifetime production of morphological components in **Jessenia bataua.**

Component	**kg**	**%**
Stem	331	14.1
Leaves	1,216	51.7
Inflorescences	461	19.6
Fruits	346	14.7
Total	2,354	100.1

With the exception of **Corypha elata**, the figures cited above generally exceed those reported for perennial herbs growing in temperate areas (e.g., Struik, 1965, Abrahamson, 1979). The latter are subject to winter dieback, which usually requires considerable allocation of resources to vegetative storage organs. Such allocation is not necessary among annuals growing in temperate areas, and this has apparently led to the general observation that annuals allocate proportionately more dry matter production to reproductive structures than do perennials (Harper & White, 1974). This generalization obviously does not extend to the humid tropics, where evergreen perennials are not subject to dieback each year.

It is no surprise that the monocarpic **Corypha elata** allocates a much lower proportion of lifetime dry matter production to reproductive structures than iteroparous palms such as **Jessenia bataua**, which flower and fruit continuously over extensive periods of time. The sheer size of the reproductive event in **C. elata** is nonetheless impressive. In a single reproductive event, this species produces approximatelly 10 million flowers and a minimum of 240,000 seeds (Tomlinson & Soderholm, 1975). Although its total reproductive effort is relatively greater, we estimate that **J. bataua** produces ca. 2.5 million flowers (20% of which are pistillate) and 60,000 seeds during its lifetime.

The pleonanthic **Jessenia bataua** and **Orbignya phalerata** undergo increased senescence with age, which conforms to the pattern predicted for trees by Harper and White (1974). However, Sarukhán (1980) found no evidence for senescence in a number of tropical trees, including **Astrocaryum mexicanum** (Piñero et al., 1982). Although it has been argued that senescence in plants is inevitable (Hamilton, 1966), many species probably fail to manifest senescence under natural conditions. We suspect that the presence or absence of senescence in palms may be primarily a function of their maximum stem length. As secondary conductive tissue is absent, the phloem is especially susceptible to mechanical stress. In tall (> 25 m) palms such as **O. phalerata** and **J. bataua**, eventual deterioration of long-distance phloem transport is probably the principal cause of senescence (Zimmermann, 1973). The apparent lack of senescence in **A. mexicanum**, which attains a maximum stem length of 7 m (Sarukhán, 1980), may be due to reduced mechanical stress on the phloem.

The reproductive effort of **J. bataua** (34%) is comparable to that of **Astrocaryum mexicanum** (36%). As discussed by Anderson (1983), the relatively high reproductive effort of **Orbignya phalerata** (45%) reflects this species' high allocation to seed protection in the form of an exceptionally thick fruit wall. For reasons not presently understood, such high allocation to seed protection does not appear to be necessary in **J. bataua**. Field observations of this species on bottomland sites have revealed low predation of seeds, coupled with high dispersal and germination. In **J. bataua**, these factors appear to permit high reproductive success with only moderate reproductive effort.

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RESUMO

Poucos são os estudos sobre estratégias de alocação da produção de matéria seca em árvores tropicais. Para as palmeiras, entretanto, vários trabalhos foram concluídos. Neste estudo, os autores mediram a produção de matéria seca e sua distribuição morfológica numa palmeira de grande valor econômico na Amazônia, o Patauá (**Jessenia bataua**). *Do total da produção de matéria seca acima da superfície do solo, aproximadamente 34% é dedicado às partes reprodutivas, ou seja os frutos e as inflorescências. Esta estratégia é analisada e comparada com a de outras palmeiras neotropicais.*

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