

## PYRENE MORPHOLOGY OF THREE SPECIES OF *Byrsonima* Rich. ex Kunth (Malpighiaceae)<sup>1</sup>

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**ABSTRACT** - The species of the genus *Byrsonima* Rich. ex Kunth are of great medicinal and economic importance, but they are still poorly studied with respect to their propagules. This study describes, illustrates and compares morphological aspects of the pyrenes of *Byrsonima crassifolia* (L.) Kunth, *Byrsonima verbascifolia* (L.) DC. and *Byrsonima coccolobifolia* Kunth occurring in areas of savannah of Boa Vista, Roraima. The pyrenes are globose, obovoid to ovoid, with endocarp dark brown in color, with a corrugated and reticulate surface and corneous consistency. They possess distinctly septate locules with or without seeds, the outer wall of which are dark brown in color with corneous consistency and thin black inner walls also with corneous consistency. The number of locules and seeds per pyrene among the species varies. The seeds are exalbuminous, globose, obovoid to ovoid, with a thin, smooth integument and are light-brown in color. They have radicular lobes and hypostasis. The embryo is continuous and axial with cylindrical spirally rolled cotyledons. The diameter of pyrenes of *Byrsonima crassifolia* is greater than in the other two species. The pyrenes of *B. coccolobifolia* are longer and heavier, while those of *B. verbascifolia* are lighter and the seeds have greater lengths, widths and thickness compared to the other two species studied. The three species have similar morphologies, differing in the size and weight of pyrenes and seeds.

**Keywords:** Diaspore; Plant morphology; Murici.

## MORFOLOGIA DE PIRÊNIO DE TRÊS ESPÉCIES DE *Byrsonima* Rich. ex Kunth (Malpighiaceae)

**RESUMO** - As espécies de *Byrsonima* Rich. ex Kunth são de grande importância medicinal e econômica, mas ainda são pouco estudadas quanto à unidade de propagação. Este estudo teve como objetivo descrever, ilustrar e comparar aspectos morfológicos dos pirênios de *Byrsonima crassifolia* (L.) Kunth, *Byrsonima verbascifolia* (L.) DC. e *Byrsonima coccolobifolia* Kunth ocorrentes em áreas de savana de Boa Vista, Roraima. Os pirênios são globóides, obovoide a ovoide, com endocarpo de coloração marrom-escuro, superfície rugosa e reticulada, e consistência córnea. Possuem lóculos distintos septados com ou sem sementes, cujas paredes externas são de coloração marrom-escuro, grossa e de consistência córnea e as paredes internas são de cor preta, fina e de consistência córnea. Foi observada a variação do número de lóculos e sementes por pirênio entre as espécies. As sementes são exalbuminosas, globóides, obovoide a ovoide, com tegumento de coloração marrom-claro, delgado e liso. Apresentam lobo radicular e hipóstase. O embrião é contínuo e axial, com cotilédones cilíndricos e enrolados em espiral. Os pirênios de *B. crassifolia* apresentam diâmetro superior aos das duas outras espécies. Por sua vez, os de *B. coccolobifolia* possuem maior comprimento e peso, enquanto que os de *B. verbascifolia* apresentam menor peso e as sementes com maior comprimento, largura e espessura em relação às outras duas espécies estudadas. As três espécies apresentam padrão morfológico semelhante entre si, diferenciando-se na dimensão e peso dos pirênios e sementes.

**Palavras-chave:** Diásporo; Morfologia vegetal; Murici.

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## 1. INTRODUCTION

Malpighiaceae comprises 44 genera and 528 species distributed in all phytogeographic areas of Brazil (GIULIETTI et al., 2005; MAMEDE, 2013). *Byrsonima* Rich. ex Kunth is the largest genus in the family with 130 exclusively neotropical species (DAVIS; ANDERSON, 2010). Ninety three species occur in Brazil, of which 49 species are concentrated in Northern Region, which has the largest in number of species (MAMEDE, 2013).

In Roraima, some *Byrsonima* species are fundamental elements of the structure of many savanna communities, especially *B. crassifolia* (L.) Kunth, *B. verbascifolia* (L.) DC. and *B. coccolobifolia* Kunth (MIRANDA et al., 2003; BARBOSA; FEARNside, 2004). Seventeen percent of Roraima is occupied by savannas, locally known as "Lavrado" (BARBOSA, 1997). These represent the largest continuous area of savannas of the Amazon Biome, with about 42,706 km<sup>2</sup>, forming the "Rio Branco-Rupununi" landscape complex (BARBOSA et al., 2007; BARBOSA; CAMPOS, 2011). These species, popularly known as "murici", are extensively used in popular medicine, especially in the treatment of diarrhea and skin infections (AMARQUAYE et al., 1994; MENDANHA et al., 2010). Furthermore, the sweet and juicy fruits are used in the preparation of juices, soft drinks and ice creams (GUSMÃO et al., 2006; ARAÚJO et al., 2009). Finally, some species have great potential as ornamental and forage plants, serving for restoration of degraded areas (VALLILO, 2007).

Despite their recognized potential in economy and medicine, few *Byrsonima* species have been studied with respect to the structure of their propagules (SOUTO; OLIVEIRA, 2005). The propagule of these species is a pyrene (BARROSO et al., 1999), popularly called core, which consists of the endocarp and the seeds (CARVALHO et al., 2006).

The morphologies of propagules is extremely important in the identification of species for ecological and systematic studies, as they show little phenotypic plasticity (MARTINS; OLIVEIRA 2001; BRAZ et al., 2009; LOPES et al., 2010). Knowledge of morphological aspects of seed coats is fundamental to management, paleobotany, archeology and plant pathology, and also to help understand the germination process, vigor, storage, quality tests, viability and propagation of the species (MATHEUS; LOPES, 2007).

No detailed morphological studies of the pyrenes and seeds of the species of *Byrsonima* of Roraima were found in a survey of the literature. In this study we describe, illustrate and compare morphological aspects of the pyrenes of *B. crassifolia*, *B. verbascifolia* and *B. coccolobifolia* from savanna areas of Boa Vista, Roraima.

## 2. MATERIAL AND METHODS

The observations and descriptions were made on pyrenes and seeds of *Byrsonima crassifolia*, *B. verbascifolia* and *B. coccolobifolia* from ripe fruits collected manually from 12 individuals, between April and July 2012, in the Água Boa Experimental Field, belonging to Embrapa/Roraima, located 36 km south of the city of Boa Vista, the capital of the state of Roraima (02°39'00" - 02°41'10"N and 60°49'40" - 60°52'20"W) (RODRIGUES et al., 2000).

For each species, voucher specimens was deposited in the Herbarium of the Integrated Museum of Roraima (MIRR): *B. crassifolia* - BRASIL, Roraima, Boa Vista, Campo Experimental Água Boa of Embrapa Roraima, 03/IV/2012, fl., C.Z.R. Barbosa s.n. (MIRR 9551), *B. verbascifolia* - BRASIL, Roraima, Boa Vista, Campo Experimental Água Boa of Embrapa Roraima, 03/IV/2012, fl., C.Z.R. Barbosa s.n. (MIRR 9553) and *B. coccolobifolia* - BRASIL, Roraima, Boa Vista, Campo Experimental Água Boa of Embrapa Roraima, 03/IV/2012, fl., C.Z.R. Barbosa s.n. (MIRR 9550).

After collection, the fruits were kept in polyethylene bags for three to five days at room temperature of 24 ± 2° C and relative humidity of 60 ± 5% to complete maturation and make the removal of the mesocarp easier (MURAKAMI et al., 2011). The mesocarp removal was carried out by rubbing it on the screen of a plastic sieve under a continuous flow of running water until the pyrenes were completely devoid of mesocarp residues (CARVALHO; NASCIMENTO, 2008; BIZÃO et al., 2011; MURAKAMI et al., 2011; NASCIMENTO et al., 2011). After removing the mesocarp and excess water, the pyrenes were placed to dry on paper towel (CARVALHO; NASCIMENTO, 2008) for three days at room temperature of 24 ± 2° C and relative humidity 60 ± 5% of the Seed Analysis Laboratory of Embrapa/Roraima and then placed in sealed polyethylene bags and stored for further morphological assessments.

The morphology of the pyrenes was described and illustrated from 100 examples of each species.

Externally, the shape, color, surface, texture, consistency, length, diameter and weight of the pyrenes were recorded. Internally, the number of loci and seeds, their color, surface, texture and consistency were recorded. The moisture content and the weight of a thousand pyrenes were made according to Brasil (2009). The internal and external morphology of the seeds was described and illustrated from 50 examples of each species. Internally, the type and shape, color, surface, texture, and seed coat consistency, presence of radicular lobe and hypostasis, hilum position, micropyle position, length, breadth, thickness and weight were recorded. Internally, the shape and position of the embryo, type and color of the cotyledon, color and position of the hypocotyl-radicle axis were recorded. The descriptions and illustrations of the interiors of the pyrenes and seeds were from samples soaked in water for 24 hours and cut in lengthwise and crosswise sections using a simple blade. The length and diameter of the pyrenes and the length, breadth and thickness of seeds were measured with the aid of a digital caliper with precision of 0.01 mm and the weight with the aid of a precision balance of 0.001 g. The length was measured between the basal and apical tips and the diameter, breadth and thickness at the middle. The seeds were extracted from the pyrenes by compressing them at the base towards the apex with the aid of clamp pliers fitted with conical steel bases, which is an efficient, practical and novel method for these species. Those which were malformed or had mechanical injuries were discarded. The maximum, mean, and minimum values, and the variance, standard deviation and coefficient of variation were calculated for the length, width, thickness and weight of the seeds and also for the length, diameter, weight, moisture content of the pyrenes and weight of a thousand pyrenes. The number of locules and seeds per pyrene was estimated from the frequency distribution.

The morphological terminology is based on Corner (1976), Barroso et al. (1999), Souto and Oliveira (2005) and Camargo et al. (2008). Morphological illustrations of pyrenes and seeds were made visually and from photographs taken with an Opton stereomicroscope with a camera clara, coupled to a Power Samsung MV-800 digital camera.

### 3. RESULTS

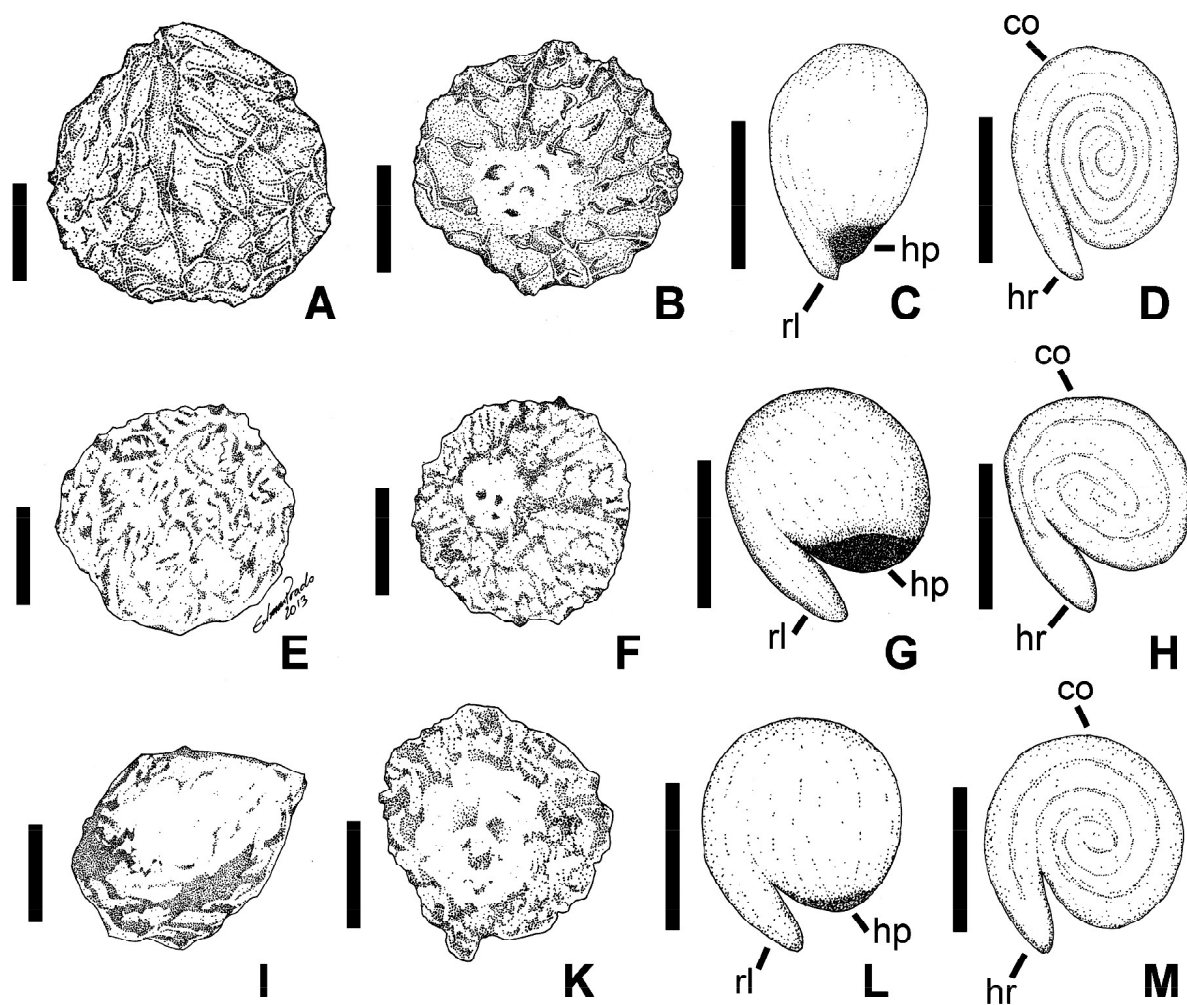
The pyrenes of *B. coccolobifolia*, *B. crassifolia* and *B. verbascifolia* vary from globoid, obovoid to

ovoid and have dark, brown-colored, opaque endocarp, with a rough and reticulate surface, harsh texture and corneous consistency, with a truncated and invaginated base and an acute apex (Figure 1A-B; Figure 1E-F; Figure 1I-J).

The three species of *Byrsonima* have varying size, moisture content and weight of a thousand pyrenes (Table 1). *B. coccolobifolia* had the longest pyrenes (4.67-6.86 mm) and greatest weight (0.04-0.90 g); *B. crassifolia* had the greatest diameter (4.40-6.94 mm) and *B. verbascifolia* had the lowest weight (0.03-0.09 g). The pyrenes of *B. crassifolia* (11.22-11.32%) and *B. verbascifolia* (11.09-11.19%) had the highest moisture content, while those of *B. coccolobifolia* and *B. crassifolia*, the greatest values of weight of one thousand pyrenes (8.101-8.363 g and 7.124-7.710 g, respectively).

The pyrenes of the three species possess distinct septate locules, with or without seeds, the outer walls are dark-brown in color, opaque and thick, with a smooth surface, rough texture and corneous consistency and their inner walls are black, bright and thin, with a smooth, waxy surface and corneous consistency. The number of locules and seeds per pyrene ranged amongst the species studied (Figure 2 and Figure 3). *B. verbascifolia* had the highest number of pyrenes with three locules (78.7%) and *B. coccolobifolia* highest number of pyrenes with two locules (43.3%). *B. coccolobifolia* had the lowest number of pyrenes without zero or three seeds (17.5% and 0.8%, respectively) and the highest number of pyrenes with one and two seeds (46.7% and 35.0%, respectively). It was still observed that the dimensions of the seeds on the inside of the pyrenes are variable in the three species.

The seeds of *B. coccolobifolia*, *B. crassifolia* and *B. verbascifolia* are exalbuminous, ranging from globoid, obovoid to ovoid with light-brown, thin, smooth, oily and membranous tegument. The three species of *Byrsonima* have a radicular lobe ranging from inconspicuous to exposed, in which lies the micropyle and the inconspicuous hilum and next to it, a more or less discrete, more pigmented area which corresponds to the hypostasis (Figure 1C; Figure 1G; Figure 1K). The size and weight of the seeds ranged amongst the



**Figure 1** – Pyrenes and seeds of *Byrsonima coccolobifolia*, *Byrsonima crassifolia* and *Byrsonima verbascifolia* from savanna areas in Boa Vista, Roraima. A. Side view of pyrene of *B. coccolobifolia*. B. Truncated base of pyrene of *B. coccolobifolia*. C. Side view highlighting the radicular lobe and seed hypostasis of *B. coccolobifolia*. D. Embryo in longitudinal section of *B. coccolobifolia*. E. Side view of pyrene of *B. crassifolia*. F. Truncated base of pyrene of *B. crassifolia*. G. Side view highlighting the radicular lobe and seed hypostasis of *B. crassifolia*. H. Embryo in longitudinal section of *B. crassifolia*. I. Side view of pyrene of *B. verbascifolia*. J. Truncated base of pyrene of *B. verbascifolia*. K. Side view highlighting the radicular lobe and seed hypostasis of *B. verbascifolia*. L. Embryo in longitudinal section of *B. verbascifolia*. (rl = radicular lobe; hp = hypostasis; co = cotyledon; hr = hypocotyl-root axis). Bars = 2 mm.

**Figura 1** – Pirênios e sementes de *Byrsonima coccolobifolia*, *Byrsonima crassifolia* e *Byrsonima verbascifolia* de áreas de savana de Boa Vista, Roraima. A. Vista lateral do pirênio de *B. coccolobifolia*. B. Vista da base truncada do pirênio de *B. coccolobifolia*. C. Vista lateral destacando o lobo radicular e a hipóstase da semente de *B. coccolobifolia*. D. Embrião em secção longitudinal da semente de *B. coccolobifolia*. E. Vista lateral do pirênio de *B. crassifolia*. F. Vista da base truncada do pirênio de *B. crassifolia*. G. Vista lateral destacando o lobo radicular e a hipóstase da semente de *B. crassifolia*. H. Embrião em secção longitudinal da semente de *B. crassifolia*. I. Vista lateral do pirênio de *B. verbascifolia*. J. Vista da base truncada do pirênio de *B. verbascifolia*. K. Vista lateral destacando o lobo radicular e a hipóstase da semente de *B. verbascifolia*. L. Embrião em secção longitudinal da semente de *B. verbascifolia*. (rl = lobo radicular; hp = hipóstase; co = cotilédono; hr = eixo hipocótilo-radicular). Barras = 2 mm.

**Table 1** – Length, diameter, weight, moisture content and weight of a thousand pyrenes of *Byrsonima crassifolia*, *B. verbascifolia* and *B. coccolobifolia* from savanna areas in Boa Vista, Roraima.**Tabela 1** – Comprimento, diâmetro, peso, grau de umidade e peso de mil pirênios de *Byrsonima crassifolia*, *B. verbascifolia* e *B. coccolobifolia* de áreas de savana de Boa Vista, Roraima.

Species	Maximum	Average	Minimum	S <sup>1</sup>	DP <sup>2</sup>	CV (%) <sup>3</sup>	
		Pyrene length (mm)					
<i>B. crassifolia</i>	6.38	5.263	4.09	0.2028	0.4504	8.56	
<i>B. verbascifolia</i>	6.66	5.233	2.02	0.4034	0.6352	12.14	
<i>B. coccolobifolia</i>	6.86	5.555	4.67	0.2395	0.4893	8.81	
		Pyrene diameter (mm)					
<i>B. crassifolia</i>	6.94	5.564	4.40	0.2487	0.4987	8.96	
<i>B. verbascifolia</i>	6.00	5.172	4.39	0.1318	0.3631	7.02	
<i>B. coccolobifolia</i>	6.78	5.642	4.32	0.3258	0.5708	10.12	
		Pyrene weight (g)					
<i>B. crassifolia</i>	0.76	0.089	0.03	0.0063	0.0797	89.14	
<i>B. verbascifolia</i>	0.09	0.054	0.03	0.0001	0.0113	20.99	
<i>B. coccolobifolia</i>	0.90	0.096	0.04	0.0112	0.1057	109.95	
		Moisture content of pyrene (%)					
<i>B. crassifolia</i>	11.32	11.27	11.22	0.0050	0.0707	0.62	
<i>B. verbascifolia</i>	11.19	11.14	11.09	0.0050	0.0707	0.63	
<i>B. coccolobifolia</i>	10.86	10.83	10.79	0.0025	0.0494	0.45	
		Weight of a thousand pyrenes (g)					
<i>B. crassifolia</i>	7.710	7.353	7.124	0.0488	0.2208	3.00	
<i>B. verbascifolia</i>	4.981	4.806	4.531	0.0415	0.2036	4.24	
<i>B. coccolobifolia</i>	8.363	8.205	8.101	0.0085	0.0925	1.13	

<sup>1</sup>S = Variance; <sup>2</sup>DP = Standard deviation; <sup>3</sup>CV = Coefficient of variation (%).

species (Table 2). *B. verbascifolia* had seeds with greater length, breadth and thickness (2.53-4.08 x 2.28-3.51 x 1.45-2.38 mm) and *B. coccolobifolia* with greatest weight ranging from 0.005 to 0.013 g (Table 2).

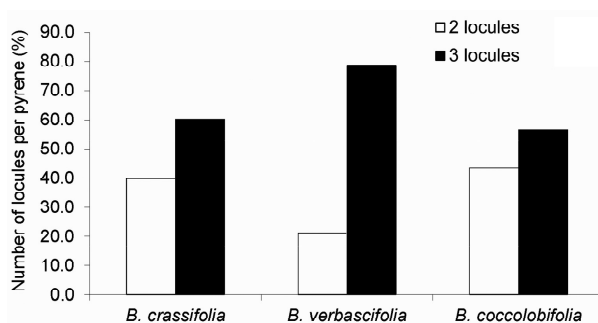
The embryos of *B. coccolobifolia*, *B. crassifolia* and *B. verbascifolia* are continuous and axial with white, circinate cotyledons; the hypocotyl-radicle axis is white and continuous to the two adjacent cotyledons and rolled spirally on itself (Fig 1D; Fig. 1H; Fig. 1L).

#### 4. DISCUSSION

The pyrenes of the three species have homogeneity of color and form, however, variations in color and shape have been documented for some species of *Byrsonima*. According to the classification of Barroso et al. (1999), the pyrenes of *Byrsonima* species are angular. Camargo et al. (2008) reported that the pyrene of *B. chrysophylla* Kunth is globe-shaped, whitish brown and opaque, rough and reticulate, with firm consistency and a truncated to invaginated base with a slightly pointed apex. Among in Açú clone of *B. crassifolia*, Carvalho and Nascimento (2008) observed

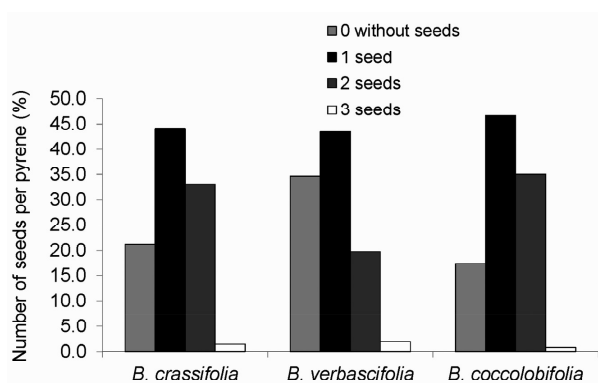
that the pyrenes were oval, brown, hard, reticulated and pointed at the apical end and depressed in the basal portion. Although observations vary as to the color and shape of pyrenes, it is noteworthy that the remaining characters of the general morphology described for the species mentioned above reflect the pattern found in *B. crassifolia*, *B. verbascifolia* and *B. coccolobifolia*.

The length and diameter of the pyrenes in the present study are, in general, larger when compared to the pyrenes of the Açú clone of *B. crassifolia* (CARVALHO; NASCIMENTO, 2008) and to those of *B. crassa* Nied. (SILVÉRIO; FERNANDES-BULHÃO, 2009) and smaller than those of *B. verbascifolia* (L.) DC. and *B. orbignyana* A. Juss. (SILVÉRIO; FERNANDES-BULHÃO, 2009). The pyrenes of *B. coccolobifolia* are lighter than those of the Açú clone of *B. crassifolia* (CARVALHO et al., 2006; CARVALHO; NASCIMENTO, 2008). It was also found that the pyrenes of *B. coccolobifolia* are heavier than those of *B. crassifolia* and *B. verbascifolia*. But, the pyrenes of *B. verbascifolia* here studied are heavier than those examined by Silvério and Fernandes-Bulhão (2009). It is noteworthy that these morphological data are relevant in the identification of species of the same



**Figure 2** – Number of locules per pyrene of *Byrsonima crassifolia*, *B. verbascifolia* and *B. coccolobifolia* from savanna areas in Boa Vista, Roraima.

**Figura 2** – Número de lóculos por pirênio de *Byrsonima crassifolia*, *B. verbascifolia* e *B. coccolobifolia* de áreas de savana de Boa Vista, Roraima.



**Figure 3** – Number of seeds per pyrene of *Byrsonima crassifolia*, *B. verbascifolia* and *B. coccolobifolia* from savanna areas in Boa Vista, Roraima.

**Figura 3** – Número de sementes por pirênio de *Byrsonima crassifolia*, *B. verbascifolia* e *B. coccolobifolia* de áreas de savana de Boa Vista, Roraima.

genus of different biomes. Lopes et al. (2010) found that the seeds of *Plathymania foliolosa* of Atlantic Forest patches are longer and thicker than those of *P. reticulata* in cerrado.

The pyrenes of *B. crassifolia* and *B. verbascifolia* showed higher values of moisture content than those of *B. coccolobifolia* (10.79 to 10.86%). The determination of the moisture content of the seeds of the species is important for their storage. According to Marcos Filho (2005) seeds stored with a moisture content of between 10-13% have no biochemical reactions that compromise their germination, furthermore, a low moisture range reduces the rate of deterioration.

*Byrsonima coccolobifolia* and *B. crassifolia* were heavier thousand pyrenes (8.101 to 8.363 and 7.710 to 7.124 g), such information is important for calculation sowing density. Araújo et al. (2009), studying *B. verbascifolia*, recorded a weight of 1000 pyrenes, 136.30 g, higher than in the present study, which can be attributed, among other factors, to the environmental and genetic diversity of the species studied that have not yet been domesticated.

Some of the features of the locules of *B. crassifolia*, *B. verbascifolia* and *B. coccolobifolia* are similar to those described by Carvalho and Nascimento (2008) for the Açú clone of *B. crassifolia*. They describe seminiferous locules with the internal wall much thinner than the external. According to Barroso et al. (1999), pyrenes of *Byrsonima* are crested and trilocular. This is seen in *B. verbascifolia* and *B. crassifolia*, which had a higher percentage of pyrenes with three locules (60.3 and 78.7%, respectively), while *B. coccolobifolia* had the highest number of pyrenes with two locules (43.3%). *B. coccolobifolia* had more seeds per locule than the other species, with the highest number of pyrenes with one seed (more than 45%) and with two seeds (35%). *B. verbascifolia* had the highest number of pyrenes with three seeds, 2.0% relative to the other two species. Furthermore, *B. verbascifolia* had the lowest number of pyrene with two seeds (less than 20%), which is less than than those observed by Silverio and Fernandes-Bulhão (2009), who recorded 32% of pyrenes with two seeds. *B. crassifolia* had the highest frequency of pyrenes with one (44.22%) and two (33.1%) seeds relative to *B. verbascifolia*. These results differed from those reported by Carvalho and Nascimento (2008), who observed for the Açú clone of *B. crassifolia*, the highest frequency of pyrenes contained two seeds, however, the ratio of pyrenes with no seeds was also small, as was also observed in this study.

*B. intermedia* A. Juss. has exalbuminous, obovate seeds, with radicular lobes and hypostasis (SOUTO; OLIVEIRA, 2005), these were also observed in the seeds of three species of *Byrsonima* studied, except that seed shape ranged from globoid, obovoid to ovoid. The presence of a thin seed coat with corneous consistency on removal from the pyrene is also common in Malpighiaceae (CORNER, 1976; CARVALHO; NASCIMENTO, 2008). Despite the constancy of traits

**Table 2** – Length, width, thickness and weight of the seeds of *Byrsonima crassifolia*, *Byrsonima verbascifolia* and *Byrsonima coccolobifolia* from savanna areas in Boa Vista, Roraima.**Tabela 2** – Comprimento, largura, espessura e peso das sementes de *Byrsonima crassifolia*, *B. verbascifolia* e *B. coccolobifolia* de áreas de savana de Boa Vista, Roraima.

Species	Maximum	Average	Minimum	S <sup>1</sup>	DP <sup>2</sup>	CV (%) <sup>3</sup>
Seed length (mm)						
<i>B. crassifolia</i>	3.83	2.791	2.22	0.0870	0.2950	10.57
<i>B. verbascifolia</i>	4.08	3.485	2.53	0.1098	0.3314	9.51
<i>B. coccolobifolia</i>	3.85	2.828	2.23	0.1184	0.3441	12.17
Seed width (mm)						
<i>B. crassifolia</i>	3.14	2.593	2.10	0.0679	0.2606	10.05
<i>B. verbascifolia</i>	3.51	2.862	2.28	0.0568	0.2383	8.33
<i>B. coccolobifolia</i>	3.23	2.589	1.96	0.0929	0.3048	11.77
Seed thickness (mm)						
<i>B. crassifolia</i>	2.05	1.485	1.05	0.0502	0.2240	15.09
<i>B. verbascifolia</i>	2.38	1.815	1.45	0.0516	0.2272	12.52
<i>B. coccolobifolia</i>	2.24	1.693	1.24	0.0368	0.1920	11.34
Seed weight (g)						
<i>B. crassifolia</i>	0.010	0.006	0.004	4.4636	0.0021	30.89
<i>B. verbascifolia</i>	0.010	0.007	0.004	2.1832	0.0015	21.05
<i>B. coccolobifolia</i>	0.013	0.009	0.005	3.4893	0.0019	20.71

<sup>1</sup>S = Variance; <sup>2</sup>DP = Standard deviation; <sup>3</sup>CV = Coefficient of variation (%).

among the seeds of these species, variation in seed coat color stands out, being light brown in *B. crassifolia*, *B. verbascifolia* and *B. coccolobifolia*. Souto and Oliveira (2005) studying the species *B. intermedia*, reported that the seed coats are blackened, while Carvalho and Nascimento (2008) report the seed coat color of the Açú clone of *B. crassifolia* as cream. Camargo et al. (2008) record the seeds of *B. chysophylla* as light yellow to brown.

Seeds of *B. verbascifolia* are bigger (2.53 to 4.08 x 2.28 to 3.51 x 1.45 to 2.38 mm) compared to the other two species. These dimensions are similar to those observed by Souto and Oliveira (2005), which were 0.22 to 0.43 x 0.21 to 0.35 x 0.13 to 0.24 cm for seeds of *B. intermedia*. However, seeds of *B. coccolobifolia* are heavier (0.005 to 0.013 g) than those of *B. crassifolia* and *B. verbascifolia* which weighed 0.004 to 0.010 g, similar to those observed by Carvalho and Nascimento (2008), with a weight of 0.003 to 0.037 g in the Açú clone of *B. crassifolia*.

A typical characteristic of the species of *Byrsonima* is the continuous and axial embryo with circinate cotyledons (BARROSO et al., 1999; SOUTO; OLIVEIRA, 2005; CAMARGO et al., 2008), as observed in *B. crassifolia*, *B. verbascifolia* and *B. coccolobifolia*.

## 5. CONCLUSION

The pyrenes and seeds of the three species studied have a similar morphology. However, the pyrenes of *B. crassifolia* have a greater diameter than those of the two other species. The pyrenes of *B. coccolobifolia* are longer and heavier, while those of *B. verbascifolia* are lighter, and the seeds are longer, wider and thicker relative to the other two species. These traits of pyrenes and seeds allow identification of the three species of *Byrsonima* of Roraima's savannah areas. In addition, the results obtained in this work represent the first report of the morphology of pyrenes and seeds for *B. crassifolia*, *B. verbascifolia* and *B. coccolobifolia* and can serve to guide future studies on ecology, taxonomy, seed technology and breeding of these species which have yet to be domesticated.

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