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FRUIT AND SEED BIOMETRY AND SEEDLING MORPHOLOGY OF *Parkia discolor* (Spruce ex Benth.)¹

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ABSTRACT – *Parkia discolor* (Spruce ex Benth.) is a species of floodplain forest permanently flooded, mainly used in folk medicine and with economic potential. The purpose of this study was to estimate the biometric characteristics of fruits and seeds of *Parkia discolor* and describe the morphology and development of its seedlings and young plants. On average, fruits have shown the following dimensions: 18.45 cm long with pedicel, 13.25 cm long without pedicel, 4.4 cm wide and 0.66 cm thick mass of 11.91 g. The seeds have shown 1.73 cm long, 0.68 cm wide and 0.39 cm thick mass of 0.38 g. A thousand seeds mass was estimated to be 361.15 g and the number of seeds per kilogram was 2769. The fruits and seeds of these species are preyed by insects of the families Scolytidae, Nitidulidae, Cerambycidae and Bruchidae. Germination is epigeal - phanerocotylar; the seedling presents hypocotyl herbaceous, sessile cotyledons, based split, eophyll compound, paripinnatus with 1-3 pairs of leaflets, most 2 pairs, with the insertion of a spherical gland leaflets, bright green. The young plant has a woody base with 5 eophylls, alternate and presents between 21-26 pairs of foliolums. The use of plastic bags of 900 cm³ was more proper than using a styrofoam tray with “cell” of 125 cm³ for the development of the plants during the period of three months.

Keywords: Biometric characteristics; Morphological studies; Fabaceae.

BIOMETRIA DO FRUTO E DA SEMENTE E MORFOLOGIA DA PLÂNTULA DE *Parkia discolor* (Spruce ex Benth.)

RESUMO – *Parkia discolor* (Spruce ex Benth.) é uma espécie de floresta inundável de igapó, utilizada principalmente na medicina popular e com potencial econômico. Este trabalho teve como objetivo estimar as características biométricas de frutos e das sementes e descrever a morfologia e o desenvolvimento da plântula e da planta jovem de *Parkia discolor*. Em média, os frutos apresentaram as seguintes dimensões: 18,45 cm de comprimento com pedicelo, 13,25 cm de comprimento sem pedicelo, 4,4 cm de largura, 0,66 cm de espessura e massa de 11,91 g. As sementes apresentaram 1,73 cm de comprimento, 0,68 cm de largura, 0,39 cm de espessura e massa de 0,38 g. A massa de mil sementes foi estimada em 361,15 g e número de sementes por quilo de 2769. Frutos e sementes da espécie são predados por insetos das famílias Scolytidae, Nitidulidae, Cerambycidae e Bruchidae. A germinação é epígea-fanerocotiledonar; a plântula apresenta hipocótilo herbáceo, cotilédones sésseis, com base fendida, eófilo composto, paripinado, apresentando de 1 a 3 pares de folíolos, maioria 2 pares, apresentando na inserção dos folíolos uma glândula esférica, verde-clara. A planta jovem apresenta base lenhosa, com 5 eófilos, alternos, os quais apresentam entre 21-26 pares de folíolos. O uso de sacos de plástico de 900 cm³ foi mais adequado que a bandeja de isopor, com “célula” de 125 cm³, para o desenvolvimento da muda durante o período de três meses.

Palavras-chave: Características biométricas; Estudos morfológicos; Fabaceae.

1. INTRODUCTION

The *Parkia* genus belongs to Fabaceae family and it presents 17 species in Brazil with higher occurrence in Amazonia, Atlantic Forest and the Cerrado (Iganci, 2015). Among the species which represent that genus *Parkia discolor* (Spruce ex Benth.) stands out, commonly known as visgueiro-of-igapó, arapari, piradabi, arara-tucupi and faveira. It is a kind of small tree or a medium height one with a few ramification, often irregular crown, open, with twisted and long twigs (Hopkins, 1986). Developed in igapó flooded forest, mainly on the banks of Negro river with also occurrence in isolated populations in other parts of Amazonia, with uses at folk medicine (Hopkins, 1986), with ecologic (Cavada et al., 2000) and economic (Souza and Silva, 2003) potentials.

Despite its uses and economic potential little is found in literature about morphological characteristics of its reproductive organs, propagules, germination and seedlings development being this knowledge necessary for management, propagation and ecological studies with regard to domestication of species.

A great quantity of taxonomic and phylogenetic characteristics is given for seeds (varying in size, shape, color and superficial aspect of testa), fruits and seedlings which allow to identify and detect the genetic variability in populations of the same specie; as well as support the morpho-anatomic studies or in ampliation of knowledge about determined specie or vegetable group (Santos et al., 2014; Silva et al., 2014a).

In this context works about seed and seedlings morphology are used to studies of seed identification and plants in young stage which are presented during a succession of a specie, in related studies with the development of the vegetation (Baos et al., 2014; Rodrigues et al., 2014).

For the purpose of a specie's domestication, the planting of forests depend, among other factors, of the seedlings quality produced. Those, despite having greater capacity of resisting to diverse conditions found in the field, they should grow as fast as possible to compete with spontaneous vegetation and diminish possible damages caused by forest pests. The amount of seedlings depend, among other factors again, on the type of vessel used since they allow the suitable formation of root system and contribute to the maximum survival and initial growth in the field (Carneiro, 1995; Gomes et al., 2016; Gonzaga et al., 2016).

With the aim of enlarging the knowledge of the native flora from igapó areas and contribute in the recognition of the specie in floristic inventories, identification in the seed bank and in its management. This work has the aim to estimate biometric characteristics of fruits and seeds and describe the morphology and also the development of seedlings and the young plant of *Parkia discolor* (Spruce ex Benth.).

2. MATERIAL AND METHODS

The fruits and seeds were collected in October 2005, at the end of fruiting period, coinciding with the start of ebb, in the Sustainable Development Reserve of Tupé, located at 03°02'51" S, 60°15'21" W, to an altitude of 20 m a.n.m.; on the left bank of Negro River, to the West of Manaus, approximately 25 km straight line of the center of the city. The evaluations and the laboratory tests were conducted at Laboratory of Seeds and at Seedling Nursery of Coordination Agronomic Sciences Research, of the National Institute for Amazonian Research (INPA), in Manaus (AM).

To estimate the dimensions of fruits were used 100 units, obtained at random, from a batch which is characterized as a mixture of 13 individuals. The variables of fruits were measured: length of fruit, including pedicel (cm); length of fruit, without considering pedicel (cm); width and thickness (cm); mass (g); and number of seeds for pod.

Those same fruits, after the elimination of gum, were reserved randomly, 100 seeds which were measured length, distance from top to base (cm); width and thickness, assessed in the middle line of seeds (cm); and mass (g). To those measures, a metric ruler was used, a digital caliper and also an accuracy electronic scale were. With the values taken, the arithmetic mean, standard deviation and maximum and minimum values were calculated to each variable. By using eight subsamples of 100 seeds, it was estimated the number of seeds per kilogram and the mass of 1000 seeds, as shown in Brasil (2009).

As a contribution to the knowledge of types of plagues which can affect species of this genus, it was used a batch from biometry for measurement of predation of fruit and seeds by means of count the number of holes (signs of predation) for pod and number of seeds predated. The insects collected were identified for specialists, at Coordination of Entomology Research of INPA.

For the production of seedlings it was installed an experiment in October 2006 to test two types of recipients. For this purpose, parallel to monitoring the development of seedling and the young plant, were used as recipients: 100 black plastic bags of 15 X 16 cm (900 cm³ estimated volume) and 100 “cells” (compartments) of styrofoam plantagil tray (shaped as an inverted pyramid with 4,7 cm X 4,7 cm X 11,3 cm; with estimated volume of 125 cm³), which were filled with commercial substrate called “composted earth” (50% earth, 30% of organic compound, more 20% earthworm compost, v:v:v). From the non-predated seeds batch were taken two seeds for each plastic bag, while in each compartment of the tray it was taken only one. The recipients were kept in covered nursery with shade net of 50%. To accelerate the germination, or emergence, it was carried out the clipping at the distal portion of the seed, the opposite side of radicle protrusion, following the procedure adopted by Pereira e Ferreira (2010).

The period of observation was three months with monitoring of seedling and young plant every three days, irrigation was manual and always necessary. In plastic bags, after the emergence of seedling, thinning was undertaken, leaving a seedling per recipient; related to the styrofoam tray, a great number of “cell” has been cultivated so that, after the emergence, laid 100 seedlings in development.

The stages of seedling considered were since the protrusion of primary root, noticed by “fracturation of substrate”, up to the 1st eophyll completely expanded; at the young plant, was from the emergence of the 2nd eophyll up to the 5th expanded eophyll. The described and illustrated vegetative elements were root, hypocotyl, cotyledon, epycotyl, eophyll (1st, 2nd, 3rd, 4th and 5th order) and apical bud. The descriptions of seedlings and young plants were made considering mainly the most representative stages of them, based on the works of Damião-Filho (1993) and Ribeiro et al. (1999). The illustrations of the morphologic traits were hand made, with naked eye and with the help of stereomicroscope Olympus 4x.

At the end, after three months of observations, there was the characterization concerning to the seedling production, the variables were: total height (distance in centimeters between the colon and the base of apical bud), dry matter of leaves, stem and roots (mass in grams of the plant parts after oven-drying, with forced

air circulation at 65°C, until the reach of constant weight), rate part aerial/radicular system (relation between the sum of the stem and leaves dry matter with the dry matter of the root) and rate of leaf mass (relation between leaves dry matter with total dry matter) of young plants. In this case, the experimental design was entirely at random, with two treatments (plastic bags and styrofoam tray) and three repetitions, each one constituted by the mean of 10 individuals. After the analysis of variance, the means were compared by Tukey test at the level of 5% of probability.

3. RESULTS

The fruits of *P. discolor* presented on average length with pedicel of 18,45 cm and without pedicel of 13,25 cm; width of 4,40 cm; thickness of 0,66 cm; mass of 11,91 g and 12,93 seeds for pod (Table 1). The seeds of *P. discolor* presented on average the following dimensions: length of 1,73 cm; width of 0,68 cm; thickness of 0,39 cm and mass of 0,38g (Table 1). With water content of 13%, the mass of 1000 seeds was estimated in 361,15 g and the number of seeds per kilogram was 2769 units.

In fruit and seeds studied batches were observed circular holes caused by insects. On an average, each fruit was found with a hole and three predated seeds (Table 1). Among the insects, based on Borror and De Long (1969), were identified individuals from Coleoptera order, from four families: Scolytidae, Nitidulidae, Cerambycidae and Bruchidae.

The germination is epigeous phanerocotyledonary and it started, on average, on the 6th day after sowing (Table 2), when protrusion of the primary root took place, observed by splitting on soil and concomitant development of hypocotyl, breaking the soil and rising it up to the surface (Figure 1a). The hypocotyl presents initially herbaceous, curved, up to become straight, cylinder, with velvety and abundant trichomes, light green color in colon, and reddish along the hypocotyl (Figure 1b).

The cotyledons were sessile, pearly with purple stains on both, oblonge, rounded apex, intact edge, opposing, isophylous, glabrous, with slotted base (Figure 1c). From the 8th day, the cotyledons open and start the formation of epycotil; this is cylindrical, herbaceous, with initial light green color and afterwards reddish, with trichomes in abundance, simple and short, velvet (Figure 1d). On

Table 1 – Biometry of fruits and seeds of *Parkia discolor* harvested in the Sustainable Development Reserve Tupé, in Manaus (AM).**Tabela 1** – Biometria de frutos e sementes de *Parkia discolor* colhidos na Reserva de Desenvolvimento Sustentável do Tupé, em Manaus (AM).

Variables	Means (+/- DP)	Maximum	Minimum
Fruits			
Width (cm)	4,40 (0,53)	5,76	3,08
Thickness (cm)	0,66 (0,10)	0,98	0,46
Length w/pedicle (cm)	18,45 (3,41)	27,00	12,00
Length w/o pedicle (cm)	13,25 (2,56)	19,50	9,00
Mass (g)	11,91 (3,46)	20,40	4,51
Number of seeds per fruit	12,93 (2,75)	19,00	6,00
Number of holes per fruit	1,12 (1,49)	8,00	0
N of predated seeds /fruit	3,24 (3,92)	15,00	0
Seeds			
Width (cm)	0,68 (0,08)	0,92	0,52
Thickness (cm)	0,39 (0,06)	0,55	0,28
Length (cm)	1,73 (0,16)	2,09	1,34
Mass (g)	0,38 (0,08)	0,88	0,19

Table 2 – Mean Time (TM) for the seedling and young plant *Parkia discolor* achieves the different stages of development and the same height when the main stages were achieved, under cultivation in recipients, plastic bags and styrofoam plantagil tray. (SD = + / - standard deviation).**Tabela 2** – Tempo médio (TM) para a plântula e planta jovem de *Parkia discolor* alcançar os diferentes estádios de desenvolvimento e altura das mesmas quando os principais estádios foram atingidos, sob cultivo nos recipientes saco de plástico e bandeja tipo plantágil. (DP = +/- desvio padrão).

Development	Plastic bags (900 cm ³)		Plantagil tray("cell", 125 cm ³)	
	TM (DP) (days)	Height (DP) (cm)	TM (DP) (days)	Height (DP) (cm)
Protrusion of primary root	6,2 (2,3)	-	5,6 (1,2)	-
Developed Hipocotyl	6,8 (2,0)	-	7,4 (1,1)	-
Emergence of 1st eophyll	8,7 (2,8)	-	8,1 (2,8)	-
1st eophyll expanded	11,7 (2,4)	12,7 (2,0)	13,6 (1,2)	11,8 (2,2)
Fall of cotyledons	14,8 (0,9)	-	14,6 (0,6)	-
Emergence of 2nd eophyll	17,9 (3,3)	-	17,3 (5,0)	-
2nd eophyll expanded	30,7 (3,8)	17,3 (2,3)	31,0 (6,4)	16,5 (2,5)
Emergence of 3rd eophyll	34,2 (4,6)	-	33,9 (3,9)	-
3rd eophyll expanded	53,6 (3,5)	22,2 (2,6)	53,9 (4,0)	21,1 (3,6)
Emergence of 4th eophyll	61,3 (3,1)	-	60,1 (2,6)	-
4th eophyll expanded	75,0 (4,3)	26,7 (3,4)	78,3 (6,4)	25,3 (3,7)
Emergence of 5th eophyll	81,1 (6,7)	-	-	-
5th eophyll expanded	88,4 (4,5)	32,1 (3,3)	-	-

the 12th day, the 1th eophyll was expanded, compound, paripinnate, subsessile, presenting from 1 to 3 pairs of foliolums, although the majority presents 2 pairs of foliolums in each side.

It present pulvinus with short trichomes in abundance, reddish in color. Short rachis, corrugated, herbaceous, from green and red, with velvety trichomes. In the insertion of foliolums it was observed a spherical gland, light green, glabrous. Short pulvinus, intumescend, reddish, covered by simple and short trichomes. Petiolule,

short, cylindric, with velvety trichomes. Sessile leaflets, oblonge, rounded apex, irregular and oblique base, intact border, leaf blade coriacea, green on the adaxial face and green with red stains on the abaxial face, glabrous on both faces, with main nervate as trinervate prominent or evident on adaxial face and prominula on abaxial face; secondary venations with brochidodromous venation.

The young plant presents straight stem, of woody base, cylindric, brown on the base and light green as long as it goes to the apex. The cotyledons fall, on



Figure 1 – A-D. Aspect of seedling; E-F. Aspects of the young plant *Parkia discolor*. (rp - primary root; rs - lateral root; co - colon; hp - hypocotyl; nc - node cotyledonary; c - cotyledon; efi - eophyll immature; e - epicotyl; 1º ef - 1st eophyll; fo - leaflet; fl - foliolum, 2º f - 2nd eophyll; 3º f - 3rd eophyll. Scale: 1 cm).

Figura 1 – A-D. Aspecto da plântula; E-F. Aspectos da planta jovem de *Parkia discolor*. (rp – raiz primária; rs – raiz lateral; co – coleto; hp – hipocótilo; nc – nó cotiledonar; c – cotilédone; efi – eófilo imaturo; e – epicótilo; 1º ef - 1º eófilo; fo – foliolo; fl – foliólulo; 2º ef – 2º eófilo; 3º ef – 3º eófilo. BARRA: 1 cm).

average, with 14 days after sowing, leaving an evident scar (Figure 1e). To the direction of apex, the epycotile turns to herbaceous, hairy, the trichomes are simple, short, withish, recovering the whole surface. The 1st eophyll is simple, paripinnate, the oldest foliolums are dark green, while the young ones are light green on both sides, presenting 14-19 pairs of foliolums; and the eophylls of 2nd, 3rd, 4th and 5th order present between

21-26 pairs of foliolums (Figure 1f). In the insertion of foliolums it was observed a spherical gland, light green. In the inferior insertion of each eophyll there is a vegetative gem greenish yellow and densely hairy, where there will be the formation of a new leaf. Its development starts with the final expansion of the previous leaf.

It was observed a significant difference to the height, dry matter of the root and rate aerial/radicular system, depending on the recipient where the plant has developed. The greatest rates were found when development took place in plastic bags due to major volume of substrate and nutrients to its development (Table 3).

4. DISCUSSION

Coutinho and Struffaldi (1971) observed, concerning to *P. discolor* seeds, length between 1-1,5 cm, different from the results achieved on the present work which were 1,34-2,09 cm. Similar outcomes were achieved by Hopkins (1986) and Moreira and Moreira (1996). The samples used for the experiments of the authors, including this research, were collected in periodically flooded areas which allowed to infer that the variables of mass and dimension of fruits and seeds of *P. discolor* observed in these researches can be attributed to interactions with the factors in each locality, where the matrices were and, or, due to genetic variation among them.

Some researches with other species of *Parkia* allow to observe some differences of size among fruits, quantity and size of seeds which are characteristics that can easily be used to differ species of this genus with the help of morphology. Camara et al. (2008) observed for *Parkia pendula* fruits means of length of 20 mm, 20 seeds per fruit, and means of seeds length of 10,1 mm. Rocha et al (2014) observed for *Parkia multijuga* seeds with means of 46,37 mm of length.

Table 3 – Height, dry matter (leaves, stem and root), the ratio shoot / root ratio and leaf mass related to the young plant (seedling) *Parkia discolor* after three months of development in plastic bag and type plantagil tray under shading nursery with 50% in Manaus (AM).

Tabela 3 – Altura, matéria seca (folha, caule e raiz), razão parte aérea/sistema radicular e razão massa foliar referentes à planta jovem (muda) de *Parkia discolor* após três meses de desenvolvimento em saco de plástico e em bandeja do tipo plantágil, sob viveiro com sombreamento de 50%, em Manaus (AM).

Recipient	Height(cm)	Dry matter (g)			Ratio part aerial/radicular system	Ratio foliar mass
		leaves	stem	root		
Styrofoam tray ("cell", 125 cm ³)	25,19 b	0,22	0,56 b	0,28	2,8 b	0,21
Plastic Bag(900 cm ³)	28,16 a	0,26	0,78 a	0,23	4,4 a	0,21
C.V. (%)	4,63	12,82	13,90	14,23	5,98	4,76

Note: Means followed by different letters, in column, differ significantly with each other by Tukey test to the level of 5% of probability.

Insects from Bruchidae Family were the most important in terms of fruit and seed attack in species of *Parkia* genus (Hopkins, 1983; Hopkins and Hopkins, 1983). Teixeira (2005) observed in *Parkia multijuga* Benth. that in the period which pods/seeds reach the maturation, the insect also reach the adult phase, passing to emerge from pods/seeds and drilling the tegument of hosts. The same author also assures that part of perforated seeds have its embryo intact and it presents germination potential, that is to say, when they came to get perforated on the forest floor, they are the most promptly suitable to germinate. Suggesting studies related to biological interaction and effect on the species germination of genus.

The characteristics of seeds, like size as well as like morphofunctional nature of cotyledons, which can be of reserve or photosynthetic, are the two main characteristics present at the start of cycle of life of plants; so as the characteristics of the germination phase up to the complete development of young plant, as the shape of blade, from the edge of the apex, position of eophylls, presence or absence of latex or resin, relation length/width of cotyledons, size and number of pines, winged petiole or not which allow to characterize families, genera and even species which are subsidies that can facilitate a more precise identification of species, especially those present in the forest ecosystems (Gurgel et al., 2012).

Moreira e Moreira (1996) describe initial morphology of *P. discolor* like epigous, what is confirms the observation made on this study. Publications regarding to a seedling morphology of species from *Parkia* genus are scarce (Hopkins, 1986; Santana et al., 2015), in general they focus on overcoming dormancy of seeds (Pereira and Ferreira, 2010; Melo et al., 2011; Silva et al., 2014b). Ibarra-Manríquez et al. (2001) describe a epigous type of germination frequent in Fabaceae, nevertheless it was observed by Melo (2011) that germination in *P. multijuga* Benth. is hypogeal criptocotiledonar, semi-hipogeal fanerocotiledonar in *P. velutina* Benoist and epigous fanerocotiledonar in *P. panurensis* Benth. ex H.C. Hopkins. The coloration of cotyledons can help in the distinction of species, *P. panurensis* present covered with stains red ferruginea, more evident at the edges, while *P. discolor* and *P. velutina* present purple stains on both sides.

On the base of foliolums it was observed a spherical gland, in which Melo (2011) characterizes like nectariferous gland and it was also observed in the

three species *P. multijuga*, *P. velutina* e *P. panurensis*. Hopkins (1986) reports that *P. multijuga* presented 22 to 23 pairs of leaflets per pine, Melo (2011) observed 24 to 26 pairs of opposing leaflets to that specie, while *P. discolor* presented between 21-26 pairs corroborating that there is plasticity in relation to this characteristic.

The best outcomes in this work about types of recipients for the production of seedlings of *P. discolor* were achieved with plastic bags, however, Pereira and Pereira (1986) report that recipients with big dimensions contribute to the rise of costs of production and of transplanting, even though they give good development to plants. Sturion (1980) informs that the dimensions of recipients bring technical implications and economic ones, being considered the best the one which binds the cost of production and the maximum development of seedlings.

5. CONCLUSION

The biometric characteristics of seeds and fruits have diagnostic value to differ the specie inside the genus contributing to the recognition of itself.

Parkia discolor presents epigeous fanerocotiledonar germination. The formation of seedling presents common characteristics of this genus, with coloration and number of foliolums and leaflets to its differentiation. Studies about the anatomy and histochemistry of the specie can help in its comprehension aiming to conservation and economic use.

It is very frequent the incidence of perforated fruit and seeds of *P. discolor* by insects of Coleoptera order in special from Bruchidae family.

For the production of seedlings, the use of plastic bags (900 cm³) despite the use of styrofoam trays with cells (125cm³) was more appropriate to the development of the plant.

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