Distinguishing Carya guianensis Aubl. from Carya procera D.C. (Meliaceae) by Morphology of Young Seedlings.

Siney Thury Vieira FISCH1, Isobé Dorothy Konermann FERRAZ2, William Antonio Rodrigues3

ABSTRACT. — Seedling morphology was studied in Carya guianensis Aubl. and Carya procera D.C. from germination to 90 days age. In both species germination is hypogal and cryptocotylar. Both have rare albino seedlings. Though both species have compound leaves when adult, C. procera puts on an average total of six simple leaves at germination, while leaves of C. guianensis are compound at all stages. This is the best diagnostic character for separation of the two species at the young seedling stage. Not diagnostic, but sometimes useful is the fact that polyembryonic seeds are more found in C. procera, but not observed in C. guianensis.

Key words: Carya guianensis Aubl., Carya procera D.C., seedling morphology, germination, polyembryony.

Comparação Morfológica da Germinação e do Desenvolvimento das Nântitas Visando a Identificação das Espécies Carya guianensis Aubl. e Carya procera D.C. - Meliaceae.

RESUMO. — Estudou-se aspectos morfológicos de plântulas de Carya guianensis Aubl. e Carya procera D.C., desde a germinação até 90 dias de idade. Ambas as espécies possuem germinação hipogálica e criptocotilar, e, embora não muito frequentes, apresentam plântulas albínicas. Apesar de que na fase adulta as duas espécies apresentam folhas compostas, a plântula de C. procera primariamente tem em média seis folhas simples, enquanto a de C. guianensis, desde o início, tem folhas compostas. C. procera possui comumente sementes poliembriónicas, ao se observa esta fenômeno em C. guianensis. Portanto, um dos principais caracteres morfológicos, para a distinção das plântulas destas espécies, é a fólia emitida. A presença ou ausência de poliembriónia, também pode ser um caráter útil para a identificação.


INTRODUCTION

The genus Carya is comprised of two commercially valuable tree species native to the Brazilian Amazon, C. guianensis Aubl. and C. procera D.C. (Pennington et al., 1981). Both species provide wood of excellent quality, similar to mahogany. Swietenia macrophylla King (LE COINTE, 1934; CARRUJO, 1972; LOUREIRO et al., 1979). The large seeds of both species produce an oil widely used as a folk medicine (AVILET, 1977; PINTO, 1956: LOUREIRO et al., 1979).

Thought treated as a single species by popular and commercial taxonomists under the common Brazilian name of “Andiroba”, adult plants are the botanically distinguishable by inflorescence and leaf morphology. These characters, however, are not easily observed in the field and no morphological distinctions have yet

1 Departamento de Biologia da Universidade de Tietê - São Paulo, Brasil.
2 Instituto Nacional de Pesquisas da Amazônia - INPA/CPqR, Manaus - Amazonas, Brasil.
3 Universidade Federal do Paraná, Centro Político, Departamento de Boticânia, Curitiba - Paraná, Brasil.


Impreso em Julho 1996
been reported at the early seedling stages. Recognition of new diagnostic descriptors is thus of practical value and is the object of this work.

MATERIALS AND METHODS

Seeds used in the study were collected from plantations established in the 1960’s at the INPA Ducke Forest Reserve (30°S, 59°32’W), near the city of Manaus. The plantations are derived from genetic material collected originally at Curaça-Uma, 600 km east of Manaus (ARAÚJO & ALENÇAR, pers. com.). Some seeds were also taken from trees of unknown origin at the Botanical Garden of Rio de Janeiro. Predation precluded collecting a sufficiently large number of seeds from low-density native tree populations. Data, of seedling morphology were lumped from experiments over five annual fruiting seasons (1986–1990), including some experiments conducted as part of a master’s thesis (FISCH, 1990).

Seeds were collected where they fell under the trees, soaked for 14 days in water changed daily, then germinated in sealed clear-plastic bags. This procedure drowns the common bores, Hypsipygia sp., and allows the seeds to become turgid (FERRAZ et al., 1987; FERRAZ, 1989).

Successfully germinated seeds were planted in the nursery in black plastic bags with four different treatments. These were combinations of two light intensities (100% and 50%) and three substrates: - washed sand; - washed sand: clay (2:1); - washed sand with nutrient solution (DOWNS & HELLMERS, 1975). Soil was weeded as necessary and watered by fine spray.

RESULTS AND DISCUSSION

Both species had a wide range in seed fresh-weight. Fresh weight of C. guianensis ranged 1 - 70 g and clustered at 20 - 30 g, while C. procera ranged 1 - 40 g and was generally smaller between 10 - 20 g. In their natural habitat, seeds of both species germinate at the soil surface. Following the terminology of DUKE (1969) germination is hypogeal and cryptocotylar since the hypocotyl does not grow and the cotyledons remain within the seed coat. This hypogeal-cryptocotylar syndrome is common among heavy-seeded, tropical forest trees (NG, 1976; HLADIJK & MIQUEL, 1990).

Germination starts with the rupture of the seed coat in the micropylar region by the thick fused peltololes and afterwards the radicle grows (Fig. 1a). HARSHBERGER (1902) and ALBUQUERQUE (1987) used the terms “thick tenuous tuber” and “minuscule tuber”, respectively. Though the peltololes and the radicle are thick when they first appear, the term “tuber” should not be employed, as it does not grow thicker with time. Numerous secondary roots arise from the radicle. Their form varies with the texture of the substrate, being longer and thinner in clay soils.

After the radicle has started its growth the proximal portion of the two
cotelodons are also projected out of the seed coat. In his landmark study of *C. guianensis*, HARSEMBERGER (1902) described the cotelodons as "conformitate", a term synonymous with "syncotylous" (FONTQUER, 1905) or "fused". In this study both species were found to have completely fused cotelodons. The petioles are not fused. In plants germinated in the dark the petioles grow longer and can be observed easily. The epicotyl arises with a downs-tumed apex in a hook shape between the two cotelodons petioles (Figs. 1a; 1c). The epicotyl grows in this shape for several days, then the apex turns up and the organ becomes an erect shoot (Figs. 1d; 2).

Both species showed their most rapid stem growth at this stage, reaching a height of 15 cm in 15 days. The first leaves are then produced and stem growth slows. Prior to leaf emergence the reddish shoot produces spiral arranged catapthylls numbering about four in *C. guianensis* but rarely exceeding three in *C. procera* (Tab. 1, Fig. 3).

The first leaves were purplish when very young in both species. In *C. procera* they were simple and entire, though some older seedlings had compound leaves with no more than three leaflets (Tab. 1, Fig. 3). Though PENNINGTON and co-authors (1981) considered simple, entire leaves to be a trait common to both species, in our study *C. guianensis* was found to have first leaves usually compound, long-peciolate, with 2-5 leaflets (Tab. 1, Fig. 3). Only rarely did this species produce simple first leaves. First leaves persist for a long time and therefore constitute a diagnostic character for distinguishing the two species at the seedling stage.

The apparent association between simple first leaves and fewer catapthylls in *C. guianensis* vs. compound first leaves and more catapthylls in *C. procera* points out the need for a study of ontogeny in both species. Secondary seedlings sometimes appeared in *C. procera*, usually at intervals of days to weeks during seedling growth but occasionally right after germination. Many of these were complete, viable individuals that could be separated after abscission of the cotelodons. The ontogeny of these secondary seedlings was studied by sectioning and staining seeds of *C. procera* with 0.1% Tetrazolium. As many as four embryo axes were found in a single seed, though corresponding separate parts of the cotyledon mass could not be distinguished, an observation in agreement with that of HARSEMBERGER (1902). The embryo axes were at different distances from the microple and this may determine the order of their appearance, those closest to the microple probably developing first.

Seeds of *C. procera* clearly can be polyembryonic, but multiple shoots can also arise at the stem-root transition by resprouting from an area of intense meristematic activity. This was indicated by the occurrence of some seedlings with up to four shoot axes sharing the same thickele. Both polyembryony and multiple sprouting may be evolutionary strategies for surviving partial.
<table>
<thead>
<tr>
<th>SPECIES</th>
<th>ORIGIN</th>
<th>NR</th>
<th>AGE</th>
<th>AGE</th>
<th>CAV-CA</th>
<th>1 leaf</th>
<th>2 leaves</th>
<th>3 leaves</th>
<th>4 leaves</th>
<th>COMPOUND</th>
<th>COMPOUND</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. procera</td>
<td>MCO</td>
<td>20</td>
<td>26</td>
<td>75</td>
<td>T</td>
<td>1.0</td>
<td>2.4</td>
<td>3.0</td>
<td>3.1</td>
<td>5.0</td>
<td>6.0</td>
</tr>
<tr>
<td>C. procera</td>
<td>MCO</td>
<td>20</td>
<td>26</td>
<td>75</td>
<td>T</td>
<td>1.6</td>
<td>1.4</td>
<td>1.1</td>
<td>0.8</td>
<td>0.5</td>
<td>0.0</td>
</tr>
<tr>
<td>C. procera</td>
<td>MCO</td>
<td>50</td>
<td>12</td>
<td>T</td>
<td>4.7</td>
<td>6.8</td>
<td>4.7</td>
<td>2.9</td>
<td>2.3</td>
<td>0.4</td>
<td>0.0</td>
</tr>
<tr>
<td>C. procera</td>
<td>MCO</td>
<td>22</td>
<td>75</td>
<td>T</td>
<td>5.0</td>
<td>1.3</td>
<td>1.0</td>
<td>0.9</td>
<td>0.8</td>
<td>0.7</td>
<td>0.0</td>
</tr>
<tr>
<td>C. procera</td>
<td>MCO</td>
<td>38</td>
<td>36</td>
<td>T</td>
<td>7.4</td>
<td>2.9</td>
<td>2.9</td>
<td>2.9</td>
<td>2.9</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>C. procera</td>
<td>MCO</td>
<td>130</td>
<td></td>
<td></td>
<td></td>
<td>0.3</td>
<td>1.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>C. quercus</td>
<td>MCO</td>
<td>10</td>
<td>75</td>
<td>T</td>
<td>0.8</td>
<td>0.5</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>C. quercus</td>
<td>MCO</td>
<td>10</td>
<td>75</td>
<td>T</td>
<td>0.8</td>
<td>0.5</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>C. quercus</td>
<td>MCO</td>
<td>10</td>
<td>46</td>
<td>T</td>
<td>0.8</td>
<td>0.5</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>C. quercus</td>
<td>RIO</td>
<td>10</td>
<td>75</td>
<td>T</td>
<td>0.8</td>
<td>0.5</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>C. quercus</td>
<td>RIO</td>
<td>10</td>
<td>75</td>
<td>T</td>
<td>0.8</td>
<td>0.5</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>C. quercus</td>
<td>RIO</td>
<td>50</td>
<td>12</td>
<td>T</td>
<td>0.8</td>
<td>0.5</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Flach et al.
Figure 1. Germination of *Carapa guianensis* Aubl. A) appearance of the petiotes and the radicle B) appearance of the epicotyl between the cotyledonary petiotes. C) growth of the epicotyl in hook shape D) erect epicotyl.

Figure 2. *Carapa guianensis* Aubl. and *C. procera* D.C. seedlings about 3 months after germination. *C. procera* is shown with secondary plant.

Distinguishing *Carapa guianensis* Aubl. ...
Figure 3. Number of cataphylls and leaf types of 3 months old seedlings of *Crypsis galioides* Aus. (Cg, n = 89) and *C. procera* D.C. (Cp, n = 120).
consumption by herbivores at the seed and seedling stages. 

Albinism occurred at a low rate in seedlings of both species from forest and nursery. The phenomenon appears to be more common in C. procera. The two species had morphologically different albinos. In C. procera the albinos had a twisted shoot with slight reddish pigmentation, small white leaves and poor growth. In C. guianensis albinos had erect shoot, white leaves with some greenish pigmentation at the leaf margin and along veins, and were only slightly stunted compared with normal indi-

ACKNOWLEDGMENT

The authors express their grati- tude to the technical staff, the volun-
teer students and all the other persons of the Seed Laboratory INPA-CPST who were involved in the studies of androecia. We are thankful to Tania Pereira of the Botanical Garden of Rio de Janeiro - RJ for the seed support of C. guianensis and Dr. Paulo Cavalcante for literature exchange.

Literature Cited

ALBUQUERQUE, J. M. 1987. Estudo morfologic e da semente e semiegamento ate a fase de plântula, principalmente de espécies de cultivo e de espécies florestais da Amazônia. Tese de Douto-


DOWNES, W. J. 1970. Semeing-


BLAXD, A.; MIQUEL, S. 1960. Seedlings types and plant establishment in an Afri-

can rain forest. Inc: BAWA, K. S.; HADLEY M (eds.). Reproductive ecol-


Aceito para publicação em 1.11.95

200

Flech et al.