Melipona fasciculata in Euterpe oleracea flower. Photo: Giorgio C. Venturieri

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FLORAL BIOLOGY AND MANAGEMENT OF STINGLESS BEES TO POLLINATE Assai Palm (*Euterpe oleracea* Mart., ARECACEAE) IN EASTERN AMAZON

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The assai tree is a typical palm from the Amazon region, very important on the diet and economy of human populations of the Amazon estuary. According to the Brazilian Institute of Geography and Statistics (IBGE), in 2006 the assai was the non-timbes forest product that generated the largest income in Brazil, totaling R$ 103.2 million. The Amazon estuary region was described as the center of the origin and genetic diversity of this species. In the Amazon region, the assai tree blossoms and fructify almost the entire year. However, the blossom and fruiting peaks with larger frequencies during the periods of January-May and September-December, respectively. The most intense blossom period coincide with the time of larger pluviometric precipitation, and the fruiting period prevails in the dryer period. This research had as a goal to study the assai tree reproductive biology and its main pollinators. Due to the progressive increase of local assai consumption, and its exportation to other Brazilian States, there was a great increase on the cropped areas, in its majority, in the northeast of Pará State. The increase of cropped areas, by its turn, has provoked a search for a greater understanding on its cropping system, its ecology and the management of its pollinators.

Field studies were conducted in the experimental area of Embrapa Amazônia Oriental, in the Combú Island, municipality of Belém, and in two farms in the cities of Benfica and Santo Antônio do Tauá, Pará State, Brazil. For observations, we used metallic scaffoldings and aluminum ladders. Flower morphology was analyzed with the help of portable and stereoscopic lens. Flower measurement was done with the help of a digital caliper. The period of masculine and feminine flower emission, anthesis, floral changes (color, odor, pollen and nectar secretion, and floral senescence) were observed. Stigma receptivity was tested through hydrogen peroxide 1% and pollination tests *in vivo*. For the analysis of sugar concentration and nectar volume, rachillae were previously bagged and investigated helped by microcapillary tubes and refractometer. Sugar concentration in masculine flowers was assessed

in intervals of half hour, from 9:30AM until 12:30PM. In each measurement, several flowers were used, randomly chosen, to complete the 2 µl capacity of the microcapillary tubes. Regarding feminine flowers, the measurement of sugar concentration and volume was followed using the same flowers, since the start of the first collect until the end of production (9:00AM until 4:00PM). In each interval of two hours between measurements, flowers were wiped with a paper handkerchief to verify the melliferous potential of these flowers. Microcapillary tubes of 1 and 2 µl were used, respectively, to measure sugar concentration and nectar volume. The osmophores presence was determined through red neutral solution 0.1% and nose bioassay tests. Direct observations over the floral visitors were performed, flower morphology, compatibility with reproductive events, abundance and the insect food collection behavior. The collected insects were deposited in the Entomological Collection of Embrapa Amazônia Oriental. The pollen/ovule relation was evaluated, and the results were compared following the Cruden system. The treatments used for the pollination tests were the spontaneous self-pollination, induced self-pollination, xenogamy, and control. After the analysis of the results, the Self-Incompatibility Index – SII and the Reproductive Efficacy Index – REI, were calculated. These indexes allow estimate the indicative limit of self-incompatibility and the relative efficiency of natural

Melipona flavolineata in *Euterpe oleracea* flower. Photo: Giorgio C. Venturieri

pollination (open), respectively. Based upon the observations about the ecology of pollinators, a management plan for *Melipona flavolineata* and *M. fasciculata*, genuine pollinators of *Euterpe oleracea*, and endemic of this region, was established. Fourteen colonies of *M. flavolineata* and 26 colonies of *M. fasciculata* were introduced in a 170 hectares crop of *E. oleraceae*. The performance of the colonies and the efficacy of the bees in the assai pollination were evaluated.

Flowers are placed in inflorescences of the intrafoliar spicate type that measure 57-81 cm long and 70-102 cm diameter, with 85-141 rachillae/ inflorescences and 2088-8063 flowers/ inflorescence. Flowers are masculine and feminine unisexual, normally disposed over the rachillae, with a proportion of two masculine flowers for each feminine. One of the individuals showed a proportion 1:1, and this may be an indicative of the existence of more productive varieties. The flower color varies from red to purple. The length and average diameter of the masculine flower was 5.24 and 4.93 mm and in the feminine 3.93 and 2.36 mm, respectively. The total anthesis period of inflorescences lasted in average 17 days, the first phase corresponding to the emission of masculine flowers, lasting about 13 days, and the second phase of feminine flowers, lasting in average 3 days. The masculine flowers start to open at 9:00AM, and the senescence occurs in the same day, between 12:30 and 1:30PM. Feminine flowers start to open at 10:00PM, and when they are not fecundated, they remain in the flower until the fifth day after the anthesis. The receptivity tests of the stigma, using peroxide hydrogen, showed that flowers remain viable until the fifth day after anthesis. However, pollination tests *in vivo* showed that only feminine flowers pollinated in the first day fructify. The average sugar concentration in masculine flowers was 29.23%, and the volume per flower varied from zero up to 0.37µl. The average sugar concentration in feminine flowers was 53.64%, and the volume per flower varied from zero up to 0.25µl. The period of higher visitation coincided with the period of higher sugar availability, which occurs during the morning, from 10:30AM (43.5%) until 00:30PM (63%) for masculine flowers, and from 9:00AM (40.16%) until 04:00PM (73.87%) for feminine flowers. The flowers tested with red neutral for the osmophore detection did not show colored glands, corroborating the direct odor test. The most frequent and diverse group of visitors was stingless bees (11spp.), being present, also, Halictidae bees, small Anthophorid bees and *Apis mellifera*. Beetles, wasps, flies and

ants were also found. The pollination tests, altogether with the estimate of the number of pollen grains and the inference of the reproductive system, shows that *E. oleracea* is a species with obligatory xenogamy. Each flower presents only one ovule and the pollen/ovule relation suggest an obligatory xenogamy reproductive system, with a P/O relation equals to 63,324.00. The rate of formation of fruits from natural pollination was 33.53%, smaller than the cross-pollination, which was 47.13%. The estimate of the SII indicative was 0.11 (0.25 is considered as the maximum limit) and the estimate of relative efficacy of natural pollination through the REI index was 0.81. A management system, including boxes for rearing, supports and a number of colonies of *M. flavolineata* and *M. fasciculata* necessaries for the pollination services, in commercial crops, is proposed.

Assai Palm plantation. Photo: Giorgio C. Venturiere