

MANAGEMENT OF PLANTS TO MAINTAIN AND STUDY POLLINATING BEE SPECIES, AND ALSO TO PROTECT VERTEBRATE FRUGIVOROUS FAUNA

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ABSTRACT

In Brazil, two areas of about 2 hectares each (São Simão SP, Luziânia GO) and 3 smaller ones, (Campinas SP, Limeira SP, Xapuri AC) are being established as arboreta with collections of trees and bushes attractive to bees and in some instances attractive also to frugivorous and insectivorous birds. Lists of these plants, and some observations on the bees and the resources they obtain from these flowers are presented. Close to these arboreta the author keeps colonies of several species of tropical and subtropical stingless bees (Meliponinae). *Apis mellifera* colonies also exist nearby.

INTRODUCTION

In 1953, in a book on stingless bees, I published chapters on pollination and also on plants attractive to bees and which I cultivated (Nogueira-Neto 1953). In 1973, and again in 1985, I presented a list of plants that are attractive to birds, according to my personal experience (Nogueira-Neto 1973, 1985). Since 1980, in Luziânia, Goiás, I have been cultivating plants attractive to native bees, and also plants that are attractive to native frugivorous and insectivorous birds or to both, bees and birds. This is an experiment that could be important to the conservation of many bee species which help the pollination of plants used in agriculture or in other ways are also important in our forests.

Through pollination, bees may help some plants to produce more fruit that are valuable to keep birds that also predate on insect pests of agricultural or silvicultural importance. It should be realised that in the tropics such bees and many birds must live and remain in their habitats during the whole year, not only when crop plants are flowering. Eurico Santos and Eusebio de Queiroz (apud Kuhlmann & Kuhn 1947 p.188-189) wrote on the importance of insects in the diet of nestlings of seed-eating birds.

Also, when maintaining and restoring native forests, one must protect or reintroduce native bees and birds.

I started the first of these experiments in a mesocerrado (savannahs with medium size trees) in Farm Jatiara, Luziânia, Central Brazil, 100 km South of Brasília, in deep and red latosol soils. Many observations were made, but in 1994 I realised that the arboretum was too far from the meliponary where I breed and keep stingless bees and too distant from a watercourse and its riverine forest and birds. It was also difficult to irrigate young plants there. Therefore, a better approach was made. An arboretum of around 2 hectares was planted, in yellow-red latosol soil, also in Farm Jatiara, Luziânia, GO, but near a watercourse and near the meliponary.

The soil was treated with lime and fertilised. Another arboretum of the same size, was planted in red soils of basalt origin, a fertile "terra roxa", in Farm Aretuzina, São Simão (SP) near Ribeirão Preto. Three smaller arboreta were also started, one in Farm São Quirino, Campinas (SP), one in Farm Tabajara in Limeira (SP) and another one in the Amazon, Xapuri (Acre), near Bolivia.

The old arboretum of Farm Jatiara was left, but many trees remained and survived. I still learn from them. Also, the native cerrado savannahs of Farm Jatiara are a source of interesting observations. The major different types of Brazilian savannahs are found there: associated

grasslands, minicerrados, mesocerrados, and maxicerrados. Each type may be subdivided in open, mid and dense. This cerrado classification was presented by Nogueira-Neto (1991).

In the arboreta many linear groups of different species are cultivated, each group having generally 10 or more individual plants (trees and shrubs). They are planted in contour lines 3 or 6 m apart from the next line. Some species occupy 50 or even 100 m of a line. Most plants are pruned in order to make observations easier. When planting, generally 18% superphosphate is used. Brazilian soils are nearly always poor in phosphates. Afterwards, the plants receive an N P K fertiliser, at least once a year and are weeded when necessary. In the new arboreta many of the plants have not yet begun to flower, but are growing well. However, some have already bloomed intensively.

Some Promising Plants for Research

AGASTACHE (*Agastache anethiodora* (Nutt.) Britt.) - Nectar and pollen. This is a plant of the mint family, native in the prairies of North America. The flowers are very attractive to *Apis mellifera* because of their nectar. They are also very attractive to jataí (*Tetragonisca angustula*) for pollen. It blooms in November and in other times of the year in São Simão and Campinas, State of S. Paulo, and in Luziânia, Goiás. I started to cultivate this plant 45 years ago.

AGLAIA (*Aglaia odorata* Lour.). Nectar. Tree from China. It does not bloom in Central Brazil, but in the State of São Paulo (São Paulo City, Campinas and probably Southwards) it flowers well in June-August. It is very attractive to mandaguari or canudo (*Scaptotrigona postica*) and other meliponines. Its small red fruits are attractive to several birds.

AMOR AGARRADO or **CORALITA** (*Antigonum leptopus* Hook. et Arn). Nectar. It is an ornamental climber. Flowers are generally red, but there are also plants with white or pink flowers. Very attractive to *Apis mellifera* and to *Scaptotrigona postica*. In Merida, Mexico, I saw many bees of a native *Scaptotrigona* visiting the flowers.

AMOREIRA (*Morus nigra* L.). Fruits much eaten by birds. It grows quickly and produces many fruits (berries). It is native of Europe. No bees visit it, as far as I know.

ASSA-PEIXE (*Vernonia* spp). Chiefly nectar. There are several species. In Southeastern Brazil one of the species most visited by bees is the assa-peixe-roxo (*V. westiniana* Less), that flowers in humid places, near the coast and over Serra do Mar. It has purplish flowers which bloom in April. Another species, *V. polyanthes* Less., has whitish flowers which blooms in June-July. It is the source of one of the best tasting honeys of the world. However, the plant is considered a weed in pastures. *V. polyanthes* and *V. westiniana* are very attractive to *Apis mellifera*, mandaçaia (*Melipona quadrifasciata*) and several other meliponines. Some species, with thicker leaves and white flowers slightly purple, are not so attractive to bees.

CALABURA (*Mutingia calabura* L.). Chiefly nectar for bees and fruits for birds. It is a medium size tree, from Central America. It grows very quickly. It flowers and produces small edible reddish fruits, during the whole year. The fruits are very attractive to several birds. The flowers attract moderate number of *A. mellifera*, *S. postica* and small meliponines.

CALIANDRA ROSEA - (*Calliandra brevipes* Benth). Nectar. Pink and part whitish, or entirely white flowers. Blooms several times during the year. Very attractive to *A. mellifera*, mandaçaia (*Melipona quadrifasciata*), uruçú amarela (*M. rufiventris rufiventris*) and other bees.

CAPIXINGUI (*Croton floribundus* Spreng). Nectar. Very attractive to *Apis mellifera* and mandaçaia (*M. quadrifasciata*). The seeds are eaten by doves (*Leptoptila* spp) and parrots (Psittacidae). It flowers in November, December and January.

CITRUS (*Citrus* spp). Nectar and pollen. In all publications dealing with tropical plants attractive to bees, *Citrus* cultivars are highly praised and considered important as a source of honey.

CLARAIBA or **LOURO PARDO** (*Cordia trichotoma* (Vell.) Arrab ex Stend). Nectar. Good timber. In May, June and July, this nice timber and ornamental tree is covered with small white flowers, very attractive to *A. mellifera* and also to mandaçaia (*M. quadrifasciata*).

COQUEIRO JERIVÁ (*Syagrus romanzoffiana* (Cham.) Glassm.). Pollen. Its flowers, in big clusters, are highly attractive to *A. mellifera* and medium size meliponines. Its pollen is so abundant and attractive that often the bee jataí (*Tetragonisca angustula*) gather it from flowers that fall to the ground. It may flower in São Paulo State in any month of the year, but blooms chiefly in the warmer months. It is a palm native to South and Southeastern Brazil, Uruguay and Northeastern Argentina. Its small coconuts have a yellow outside pulp, eaten by birds and wild mammals.

COROA DE CRISTO (*Euphorbia milii* des Moulins). Nectar. Native to Madagascar. Generally very attractive to mirim da terra (*Paratrigona* spp), jataí (*Tetragonisca angustula*), irapuá (*Trigona spinipes*). Sometimes it is also attractive to *A. mellifera* and other bees. In Central and Southeastern Brazil, it flowers much more during the cooler months of the year.

COSMOS (*Cosmos bipinnatus* Cav. and *C. sulphureus* Cav.). Nectar and pollen. These are common ornamental plants, moderately visited by *A. mellifera* and sometimes also by mandaçaia (*Melipona quadrifasciata*) and uruçú amarela (*M. rufiventris*). They flower in several seasons of the year, in the State of São Paulo. Sometimes the plants of *C. sulphureus* grow to approximately 2 m high, not a desirable size.

EUCALIPTUS (*Eucalyptus* spp). Nectar and pollen. It seems that all species of *Eucalyptus* have flowers very attractive to bees. However, *E. robusta* was more praised than other members of the genus, in the bee literature dealing with *A. mellifera*. The species *E. urophila* is also being tested.

EXTREMOSA or **RESEDÁ ARBÓREO** (*Lagerstroemia indica* L.). Pollen. Plant much planted in city walks. As an ornamental, I saw it in Belém do Pará, Amazon, in Xapuri, Acre, Amazon, also in Washington DC USA, in Porto Alegre (Rio Grande do Sul), in São Paulo State and in many other places. Therefore it survives in very different climates. It is attractive to *A. mellifera* and to jataí (*T. angustula*), to mirim da terra (*Paratrigona* sp.), to irapuá (*T. spinipes*), etc. In Southeastern Brazil it flowers more from November to March.

GUARUCAIA or **MONJOLEIRO** (*Acacia polyphylla* DC.). Chiefly nectar. It is highly attractive to *A. mellifera* and (*S. postica*), because of its nectar. It flowers in January-February.

JERIVÁ = See **COQUEIRO JERIVÁ**

JUÇARA, **PALMITO** (*Euterpes edulis* Mart.). Pollen. Very attractive palm, much visited by *A. mellifera* and medium size meliponines. Blooms during the whole year. Grows well in Mata Atlântica, where it is native. The small coconuts are very attractive to frugivorous/insectivorous birds, such as thrush (*Turdus* spp).

LACRE (*Vismia guianensis* Choisy). Pollen. Jandaira amarela de Manaus (*Melipona seminigra merrillae*) brought to its nest a red gum together with seeds from this plant (Absy & Kerr 1977, Kerr et al. 1986). I have often seen what seems to be the smashed red fruit, together with the small seeds, brought by uruçú roxa (*M. fuscopilosa*) and uruçú avermelhada (*M. crinita*) to their nests to reinforce their batumem (inside walls of stingless bee's nests). I saw this in Xapuri (AC) in February 1998. David Roubik (personal communication) saw it in Panama.

LIXEIRA BRANCA (*Lippia virgata* Stend.). Nectar. This wild plant is highly attractive to *A. mellifera*. Flowers in August-September. Another *Lippia* attracted *A. mellifera* and mandaçaia (*M. quadrifasciata anthidioides*) in December, in São Simão (SP).

LITCHI or ALICHIA - (*Litchi chinensis* Sonn.). Pollen. In August-September, in Campinas (SP), it is very attractive to borá (*Tetragona clavipes*). Moderately attractive to *A. mellifera*, jataí (*Tetragonisca angustula*) and mirim droriana (*Plebeia droryana*).

MIOSÓTIS CHINÊS (*Cynoglossum amabile* Stapf & Drum). Nectar, in the State of São Paulo. It is a herbaceous plant, some 30-70 cm high, with blue flowers, miosotis like, in spikes. It sometimes attracts mandaguari (*S. postica*), mandaguari amarela (*S. xanthotrica*), mirim da terra (*Paratrigona* spp), mandaçaia (*M. quadrifasciata*) and *A. mellifera*.

MONJOLEIRO = GUARUCAIA

PALMEIRA ARCONTOFENIX or SEAFORTIA (*Archontophoenix cunninghamii* H. Weddl. & Drude). This palm is a native of Australia that grows very well in São Paulo City. Also found in the Gramado region of Rio Grande do Sul, in Santa Catarina and in many other places in Southeastern and Southern Brazil. Several birds, including the small parrot plain parakeet (*Brotogeris tirica*) and the tyrant flycatcher (*Pitangus sulphuratus*) eagerly eat the small red coconuts. The flowers are much visited by *A. mellifera* and small and medium sized meliponines, for pollen.

PALMEIRAS (Palms, Palmae). Nectar and pollen. The flowers are much visited by bees and also several birds eat parts of the small coconuts. Presently, in my arboreta in São Simão (SP) and in Luziânia (GO), a number of different palm species were planted. See also COQUEIRO JERIVÁ, JUÇARA.

RESEDÁ ARBÓREO = See EXTREMOSA

RUBIM (*Leonurus sibiricus* L.). Nectar and pollen. Much visited by *A. mellifera*. Small meliponines, chiefly jataí (*T. angustula*) also take their pollen but not the nectar, which is deep inside the corolla. In São Simão (SP) it flowers best in September, October, November.

VITEX (*Vitex negundo* L. var. *incisa* Clarke). Nectar and pollen. Very attractive to honeybee *A. mellifera*, mandaguari (*S. postica*) and jataí (*T. angustula*). Sometimes attracts also mandaçaia (*M. quadrifasciata*) and uruçú nordestina (*M. scutellaris*). Seeds much eaten by a very small parrot (blue-winged parrotlet = *Forpus* sp), in Campinas (SP). It is a Mongolian and Chinese native plant, introduced by me in Brazil, from the USA (Nogueira-Neto 1961).

Other Plants of Interest

The following list of plants, also cultivated in the arboreta mentioned in this paper, are under observation, generally in an initial stage:

- ABACATEIROS (*Persea americana* Mill.)
- AÇAI (*Euterpe oleracea* Mart.)
- ABÉLIA (*Abelia chinensis* R.Br.)
- ABUTILONS (*Abutilon* spp)
- AMENDOEIRA da PRAIA (*Terminalia catappa* L.)
- ANGICOS (*Adenantha* spp and *Piptadenia* spp)
- ARECA = PALMEIRA ARECA
- AROEIRA (*Astronium urundeuva* (Fr.All.) Engl.)
- AROEIRA MANSA (*Schinus terebinthifolius* Raddi)
- BIRIBA (*Rollinia mucosa* (Jacq.) Bail).
- BEIJO DA SERRA (*Impatiens walleriana* Hook. f.)
- BICO DE PAPAGAIO (*Euphorbia pulcherina* Willd. ex Klot)

CABELUDA (*Plinia glomerata* (Berg) Ansh.)
CABREUVA (*Myroxylum perviferum* L.f)
CALIANDRA (*Calliandra* spp)
CALICARPA (*Callicarpa* sp.)
CANELA BATALHA (*Cryptocaria aschersoniana* Mez.)
CAMBARÁ (*Gochnatia polymorpha* (Less.) Cabr.)
CAMBUÍ AMARELO (*Myrciaria* sp)
CANUDO de PITO (*Senna bicapsularis* (L.) Roxb.)
CATINGUDA (*Tetradenia riparia* (Hochst.) Codd.)
CIPÓ CABOCLO (*Davilla rugosa* Poir)
COQUEIRO DO LITORAL (*Cocos nucifera* L.)
EMBAÚBAS (*Cecropia* spp)
FIGUEIRAS BRANCAS (*Ficus nymphaeifolia* Mill., *guaranitica* Schodat, etc)
GUEROBA (*Syagrus oleracea* (Mart.) Becc.)
GIRASSOL (*Helianthus annuus* L.)
GOIABEIRA (*Psidium guajava* L.)
IBAJÁ = UVAIA GRANDE
INGÁS (*Inga* spp).
JACARÉ (*Piptadenia gonoacantha* (Mart.) Maclr.).
JAMBOLÃO (*Syzygium jambolano* (Lam) D.C.).
MADRE DE CACAU (*Gliricidia sepium*).
MAGNOLIA AMARELA (*Michelia champaca* L.).
MALVAVISCO (*Malvaviscus arboreus* Cav).
MULUNGÚ, SUINÁ, CORTICEIRA (*Erythrina verna* Vell., *Erythrina poeppigiana* (Walp.);
Erythrina molungu Mart.; *Erythrina falcata* Benth; *Erythrina crista-galli* L. and others).
MURICÍS (*Byrsonima* spp), in the mesocerrado.
MURTA (*Murraya paniculata* (L.) Jack.)
NÊSPERA (*Eriobotrya japonica* Lindl)
PAINEIRA (*Chorisia speciosa* St. Hill.)
PALMEIRA ARECA (*Crysalidocarpus lutescens* Wendl)
PALMEIRA BACABA (*Oenocarpus bacaba* Mart.)
PATAS DE VACA (*Bauhinia* spp)
PESSEGUEIRO (*Prunus persica* (L.) Sieb. & Zucc.)
PITANGUEIRA (*Eugenia uniflora* L.)
PÔNCIRO or LIMÃOZINHO DO JARDIM (*Poncyrus trifoliata* L.)
SABIÁ or SANSÃO (*Mimosa caesalpiniiifolia* Benth.)
SARAGUAGI VERMELHO (*Colubrina glandulosa* Perk.)
SANGRA D'AGUA (*Croton urucurana* Baill)
SIBIPIRUNA (*Caesalpinia peltophoroides* Benth.)
TAPETE INGLÊS (*Polygonum capitatum* Korth ex Meissn.)
UVAIA (*Eugenia pyriformis* Camb.)
UVAIA GRANDE or IBAJÁ (*Hexachlamys edulis* (Berg) Kans. et Legr.)

An important fact related to observations in the cerrado (savannah) and a neighbouring stingless bee (meliponines) breeding station, was observed in Farm Jatiara, Luziânia (Goiás). In 1998, a few days before the end of the long 4 to 5 month dry season, a colony of jataí (*T. angustula*) increased its food reserves very quickly. In August 16 this colony had 5 pots of honey and 10 pots of pollen. In September 22, it had 158 pots of honey and 32 pots of pollen. Also, about that time, a swarm of the same bee species occupied an empty hive. All this, as I said, occurred before the end of the dry season.

DISCUSSION AND CONCLUSIONS

The study of pollination is a large field that requires research on several situations:

A- interactions between plants and pollinators;

- B- competition among different pollinators;
- C- competition among different plants;
- D- influence of other factors related to bees or to plants;

Sometimes it is difficult or impossible to explain with present knowledge, why in some years a bee species does not visit the flowers of a plant that are much visited in other years. This happened several times, during my observations, with flowers of jabuticabeira (*Myrciaria cauliflora*) visited by the stingless bee mandaçaia (*M. quadrifasciata anthidioides*) in Campinas (SP). This is a good example of the fact that we must know more about bees, plants and their interactions.

The relationships between fruit producing plants and the birds that eat them, are also being examined in my arboreta. The activities of such frugivorous birds are important in the dynamics of ecosystems and may be useful to agriculture, in relation to pest control. During their whole lives but chiefly during their breeding season, such birds also eat large amounts of insects. These are the source of vitally needed proteins and their aminoacids, for the adult birds themselves but mostly for their nestlings, which need to grow quickly, to better escape predators. As was told here, Eurico Santos and Eusebio de Queiroz (Kuhlmann & Khun 1947) explained the importance of an insect diet to the nestlings of seed-eater birds.

As already mentioned, an unexpected conclusion from my observations was the fact that in Central Brazil, in the cerrado (savannah), the pollination of many native plants occurs chiefly during the time of the year (September) when the climate attains its maximum dryness. This happens before the end of the 4 to 5 month yearly dry season. Instead of the deep ecological stress that should be expected at that time of the year, many plants are then covered with new leaves, and they also bloom. As a consequence, meliponine bees increase very much their activities, even swarm. At least one of them (jataí, *Tetragonisca angustula*) dramatically increases its food stocks, as was previously mentioned. This means that pollination activities in the cerrado savannahs by the jataí bees, certainly also have a similar increase, at the same time.

One could also speculate about the xeromorphic morphological adaptations of the cerrado plants. These adaptations would save water in the soil, in such a way that most of it would remain there until the last month of the dry season. Then the water kept deep in the soil can be used on a large scale for new plant growth, for flower bloom and consequently for pollination activities. Photoperiodism probably would set the right time of the year for this burst of activities before the end of the dry season.

As a general conclusion, we may say that in the tropical world we still know very little about pollination and pollinators of our native plants and also of many introduced species. Therefore, research projects destined to improve basic knowledge on these matters should be a priority. To do such research, we need to establish more arboreta and to breed more intensively our native bee species, chiefly meliponines. For them, there is already a detailed breeding technology (Nogueira-Neto 1997). They are also, by far, the most common native bee pollinators in tropical America. To encourage their breeding, it is necessary to establish incentives, chiefly a bigger market for their honey. Such honey should be well filtered, properly pasteurised, well kept and well presented to attract buyers. In Pernambuco, Brazil, the honey urucu nordestina (*Melipona scutellaris*) costs as much as good French champagne.

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