PRODUCTION OF NECTAR AND GUMS BY FLOWERS OF MONSTERA DELICIOSA (ARACEAE) AND OF SOME SPECIES OF CLUSIA (GUTTIFERAE) COLLECTED BY NEW WORLD TRIGONA BEES

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ABSTRACT

Monstera deliciosa like other aroids produces a stigmatic drop of nectar collected by Trigona bees (Apidae: Meliponidae) both for food and as a nest building material. Several species of Clusia secrete resinous gums on the androecium also collected by the stingless bees. These secretions have a threefold function: to attract pollinators, to be a deceiving food source which prevents flower tissue destruction, and to act as an adhesive for the pollen grains.

The tropical stingless bees (Apidae: Meliponidae) build their nests using many natural products among which are resins and gums normally produced by plants or excreted by injured plant tissues. These are then transformed into propolis. Mud is used by few species, while yet other species prefer to use faeces of animals and man, mostly for the outer batumen layers of the exposed nests. Plant fibers and chewed leaf materials are also used by some Meliponini (Wille & Michener 1973). This opportunistic usage of nest-building materials correlates with the widely varied dietary preferences of the stingless bees (Schwartz 1948). In Costa Rica, Trigona corvina Cockerell is a very common representative of these Hymenoptera.

Monstera deliciosa Liebm. is a common tree-climbing plant found in the tropical New World and is often used as an ornamental (Madison 1977), and the species of Clusia are important elements in the structure of the Neotropical epiphytic flora.

In 1972, the senior author noticed several species of Trigona collecting a gummy substance from the flowers of Clusia odorata Seem. The secretion was produced among the male flowers, which had their stamens protruding through a layer of this gum. In 1977, the same phenomenon was observed in the flowers of Clusia alata Pl.

& Tr., visited by *Trigona corvina*. According to Dr. T. Croat (1977, pers. comm.) he has seen the same thing happen in Barro Colorado Island, Panama, where *Clusia odorata* Seem. forms a thin layer of a resinous substance on the androecium of the male flower, the surface of the anthers is thin and the dry, ripe pollen oozes through them, under considerable pressure, at the slightest puncture. Croat believes this to be an adaptation for pollination since the dry pollen would easily stick to the gums accumulated on the feet of the pollinators, as is the case for *Trigona cupira* Smith, one of the pollinators of *Sechium* (Cucurbitaceae) according to Tristan *et al.* (1931).

In July 1977, large numbers of *Trigona corvina* were seen on an inflorescence of *Monstera deliciosa*. Dodson (*fide* Madison 1977) has observed the pollination of *M. lechleriana* Schott and *M. dilacerata* (Koch & Sello) Koch in Ecuador to be effected by species of *Trigona*. In the Costa Rican plant it was found that most of the bees were collecting the pollen from the upper three-fourths of the inflorescence, while some of the insects were gathering drops of liquid from the basal portion. After gathering the thick, syrupy substance with their mandibles, the bees put it in their corbiculae and left.

The inflorescence of *Monstera deliciosa* (Figs. 1–3) has two types of flowers, those which are fertile and set seed and those which are degenerated and produce only nectar. Like in other Araceae, the secretion is deposited on the stigma (Knoll 1923; Daumann 1930). In the species of *Anthurium* investigated, this stigmatic droplet is sugary (T. Croat 1977 pers. comm.). The liquid deposited on the stigmatic region of the flowers of *Monstera* is also sweet. Thus, the sterile flowers function as nectaries as proposed by Madison (1977), the anemochory syndrome suggested by Bunting (1965) does not hold true at least in *M. deliciosa, M. dilacerata* and *M. lechleriana* and possibly in the other species of the genus.

The cosmopolitan Araceae presents the syndromes of cantharophily, sapromyophily (van der Pijl 1937) and melittophily, accordingly with three basic types of inflorescence structure: the "closed trap" model exemplified by the genus *Arum*, the "open trap" model like in *Zantedeschia, Monstera, Syngonium*, etc., and the "exposed" inflorescence, as is the case of *Anthurium* in which the spatha is either large or much reduced but always perpendicular to the inflorescence's axis and not forming a sheath at anthesis. These models are aimed at the different modes of pollination and fruit dispersal. We consider as the most primitive the *Arum*-model in which the insects cause some destruction of flower tissue in the process of fertilization through feeding. In *Monstera* and allied genera, in which pollinators find an expedite access to the pollen because the spatha is not confining, destruction of reproductive tissues is minimized because the nectar, an extra source of nourishment or building material, is readily available. Upon maturation, the spathe collapses and the infructescence produces an intense scent of fermenting, fruity juices which attract fruit vectors such as frugivorous bats, squirrels (Sciuridae) and some birds (Thraupidae).

In the *Anthurium*-model the spatha serves as a color guide, possibly combined with smells, for hovering pollinators such as hummingbirds and euglossine bees and later as a landing platform for fruit dispersors (except in the group of *Anthurium scandens* where fruit are taken by birds on the wing or is dispersed by gravity alone).

The evolutionary value of the production of gum-like nectar by *Monstera* and other aroids and of resinous, sticky substances by male flowers of *Clusia* is threefold: 1) the secretion attracts pollinators; 2) it prevents untimely destruction of reproductive plant tissue by pollinators or casual foragers by making available an alternative source of energetics; 3) it serves as an adhesive to further guarantee transport of the pollen grains, at least in *Clusia*.

In regard to the second consideration, the stingless bees can not be differentiated into "pollinators" and "foragers", very much like the bats reported by Jaeger (1954), the importance lying on the final effect of the syndrome alone (Baker 1973). As pointed out above, stingless bees do destroy plant tissues to obtain food or building materials, and pollination via partial destruction of floral structures may be regarded as a primitive trait. Still, one can not readily adscribe this particular interception *Monstera: Trigona* to the concept of co-evolution, although Araceae is an old group of monocots and Meliponidae are known from the Miocene, mainly because of the opportunistic alimentary behaviour of these bees. We prefer to place this relationship as a case of facultative mutualism. *Monstera deliciosa* blooms the year round.

Resumen

Se comunica la presencia de secreciones azucaradas, de consistencia gomosa, en los estigmas de flores abortadas de la inflorescencia de *Monstera deliciosa* Liebm., que actúan como nectarios, y la secreción de sustancias resinosas en los androceos de las flores masculinas de varias especies de *Clusia*. Se sugieren tres funciones para esos exudados: 1) atracción de polinizadores; 2) producción de una fuente alterna de nutrientes que pueden a la vez convertirse en propolis lo cual reduce considerablemente la destrucción de tejidos florales por parte de los polinizadores, cuando éstos son casi omnívoros, o por otros visitantes ocasionales u oportunistas y; 3) servir como adhesivo que garantice un mayor y mejor transporte de granos de pólen, al menos en las especies estudiadas de *Clusia*.

Se discuten brevemente los modelos florales relacionados con los tipos de polinización que presentan las aráceas sugiriendo la "trampa cerrada" de *Arum* como un sistema primitivo, las inflorescencias con espata funiforme o acampanado pero abierto, como en *Monstera*, como tipo intermedio y el modelo de *Anthurium* como avanzado. Se excluye de la discusión el caso de *Amorphophallus*.

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Tristan, J. F., Tristan, E. & O. Porsch 1931. Bau und Bestäubung der Blüte von *Sechium edule* Sw. Haim's Biologia Generalis 7(3):335—344.

van der Pijl, L. 1937. Biological and physiological observations on the inflorescence of *Amorphophallus*. Rec. trav. bot. Neerlandais 34:157:167.

Wille, A. & C. D. Michener 1973. The nest architecture of stingless bees with special reference to those of Costa Rica. Rev. Biol. Trop. 21: supl. 1:278 pp.

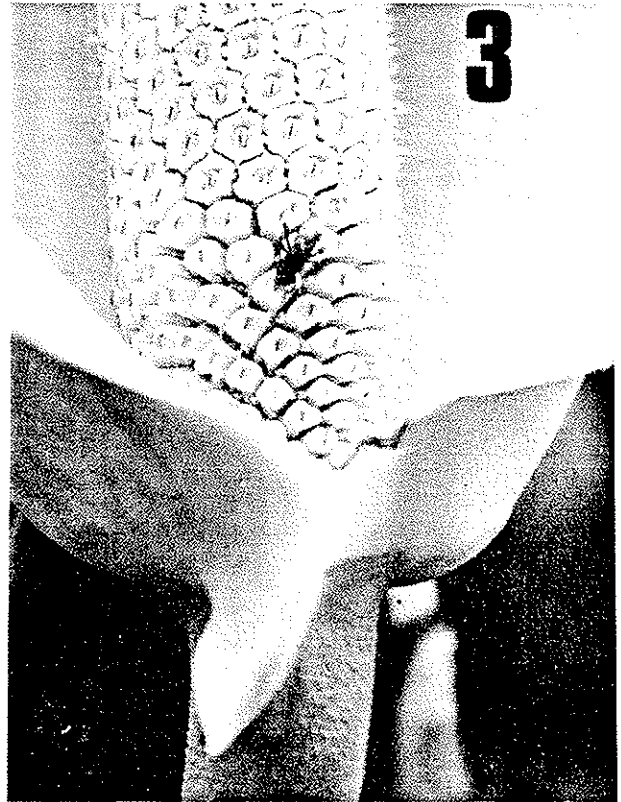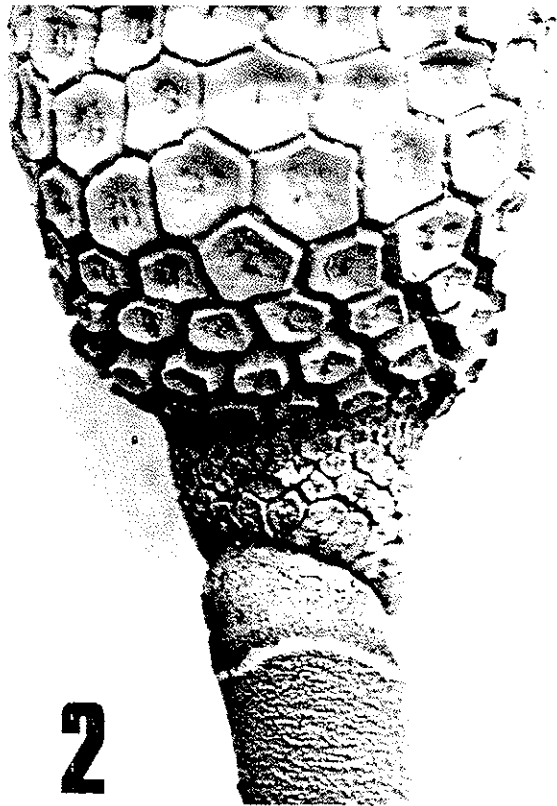Fig. 1. Inflorescence of *Monstera deliciosa,* an open trap, visited by *Trigona corvina* in Costa Rica.

Fig. 2. Basal portion of the inflorescence of *Monstera* showing fertile flowers, nectar producing flowers and a number of completely aborted, sterile and dry flowers.

Fig. 3. *Trigona corvina* gathering the stigmatic drops of nectar.