

Pollination, floral developmental phases and morphology of a Brazilian *Ficus hemsleyana* tree grown in Costa Rica.

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RESUMEN

Una postura joven (alrededor de 20 mm de altura) de *Ficus hemsleyana* Standley fue colectada en el Campus de la Universidad de Sao Paulo (Ribeirao Preto, Brasil) en 1984 y plantada en el Campus de la Universidad de Costa Rica. La postura creció normalmente hasta ser un árbol, el cual floreció por primera vez en 1994. Sus síconos fueron polinizados por avispas: *Pegoscapus tonduzi* (Grandi) (Agaonidae), el polinizador de *F. hemsleyana* Standley en América Central. También se desarrollan normalmente en las flores del árbol las avispas inquilinas *Idarnes barbiger* Gordh y *Anidarnes* sp., los parásitos *Heterandrium* sp. (Otitesellinae) y un *Pteromalidae* sp. Esto marca la especificidad de las avispas polinizadoras y otras sicofilas y la probable ausencia de ecotipos para las avispas y su ficus hospedero; cada síconio produce un promedio de 150 avispas polinizadoras y 85 semillas. Las semillas se desarrollan y crecen normalmente. Aparentemente no hay mecanismos de aislamiento genético entre el árbol brasileño introducido y la población natural de Costa Rica de *F. hemsleyana*. Las poblaciones mesoamericanas y de Sur América de *F. hemsleyana* no corresponden con *F. laevigata* Vahl, el cual es una especie indígena de la Florida. El árbol brasileño y la población mesoamericana de *F. hemsleyana* se incluyen en la descripción de *F. citrifolia* P. Mill. (sinónimo de *F. hemsleyana*) para los especímenes de Costa Rica.

ABSTRACT

A young seedling (about 20 mm high) of *Ficus hemsleyana* Standley was collected at the Campus of the University of Sao Paulo (Ribeirao Preto, Brazil) in 1984 and planted at the Campus of the University of Costa Rica. The seedling grew normally into a tree that first bloomed in 1994. Its syconia were pollinated by *Pegoscapus tonduzi* (Grandi) wasps (Agaonidae), the pollinator of *F. hemsleyana* Stand. in Central America. The inquiline wasps *Idarnes barbiger* Gordh and *Anidarnes* sp. (Sycophaginae), the parasitic *Heterandrium* sp. (Otitesellinae) and a *Pteromalidae* sp. also developed normally in the flowers of the tree. This points to the specificity of the pollinating and other sycophilous wasps and the probable absence of ecotypes for the wasps and their fig host. Each syconia produced an average of 150 pollinating wasps and 85 seeds. The seeds developed and germinated normally. Apparently there was no genetic isolating mechanisms between the introduced Brazilian tree and the Costa Rican natural population of *F. hemsleyana*. The Mesoamerican and South American populations of *F. hemsleyana* do not correspond to *F. laevigata* Vahl, which is an indigenous species of Florida. The Brazilian tree and the Mesoamerican population of *F. hemsleyana* fit the description of *F. citrifolia* P. Mill. (synonym of *F. hemsleyana*) for Costa Rican specimens.

There have been arguments about the taxonomic identity of *Ficus hemsleyana* Standley (DeWolf 1960, Burger 1977, Berg in prep.). This species was originally described from Nicaragua by Standley (1917), who also examined specimens from El Salvador, Costa Rica and Panama. Standley and Steyermark (1946) mentioned that *F. hemsleyana* was present in Guatemala and Belize. One of the authors (Ramírez) has observed natural populations or herbarium specimens, of this fig species, without difficulty to identify them, in Belize, Costa Rica, Panama, Venezuela, Brazil and Ecuador.

DeWolf (1960) synonymized *F. hemsleyana* Standley, *F. populnea* Willd., *F. turbinata* Pittier, *F. laevigata* Vahl (vernacularly known as the short-leaf fig) and other species with *F. citrifolia* P. Mill. He noted that the latter ranges from Florida to Paraguay. Burger (1977) redescribed *F. citrifolia* and observed that it ranges from Southern Florida and Mexico to Paraguay.

According to Berg (in prep.), "the names *F. laevigata* Vahl and *F. lentiginosa* Vahl, applied to Mesoamerican species, are synonyms of the West Indian form (or subspecies?) of *F. citrifolia*". He also noted that "the

Mesoamerican representatives belong to a very variable, wide-spread species complex of which the intraspecific taxonomy is not yet sorted out". He also noted that the Mesoamerican representatives differ more or less from the very diverse West Indian ones and gradually pass into the South American morph identified as *F. eximia* Schott, extending to East Brazil and Argentina.

The agaonid pollinator of *F. hemsleyana* was described by Grandi (1919) as *Blastophaga tonduzi* from specimens developing in syconia from a tree near La Sabana, San José, Costa Rica at 1200 m over sea level. Gordh (1975) described the inquiline wasp of *B. tonduzi* as *Idarnes barbiger* (Sycophaginae) from *F. hemsleyana* figs collected in Mexico and Costa Rica¹.

Other known pollinator of the *F. citrifolia* complex is *Blastophaga mexicana*, described by Butcher (1964) in

1. The larvae of *Leiopleura melichari ornaticolis* Obenberger fed on the leaves of both the *F. hemsleyana* specimen of Brazil and the *F. hemsleyana* native trees present at the University of Costa Rica Campus.

Puerto Rico from *F. laevigata*. However, Wiebes (1983) concluded that *Pegoscapus assuetus* (Grandi) pollinates *F. citrifolia* in Florida, as a synonym of *F. laevigata*. Furthermore, Wiebes (1986) noted that *P. assuetus* may be a synonym for *B. mexicana* (= *P. mexicanus*). *P. assuetus* was described by Grandi (1938) from an unknown fig species from Minas Gerais, Brazil. Finally *B. baschieri* was described by Grandi in Mexico from *F. turbinata* Pittier (*F. dugandii* Stand.).

One way to prove the specificity and taxonomic identity of a fig species and their associate sycophilous wasp, as well as the existence of ecotypes, is transplanting seedlings from one region to another, allowing them to grow until they produce syconia and observing their floral biology and colonization by pollinators and other local sycophilous wasps.

Here we report the introduction and development at the campus of the University of Costa Rica of a *F. hemsleyana* seedling of about 20 mm high collected by one of the authors (Ramírez) in 1984 at the campus of the University of Sao Paulo, Riberão Preto, Brazil.

The introduced tree developed and grew normally. It first bloomed in 1994 and up to April, 1996, it has produced seven synchronous bloomings, each with several thousand syconia, most of which became pollinated by the local symbiotic wasp of *F. hemsleyana* and developed normally. The prefloral and interfloral phases ranged from 16 to 22 days and 36 to 44 days respectively. The interfloral phase of a young native *F. hemsleyana* tree growing very close to the Brazilian one ranged from 45 to 47 days. That of another young tree of similar age growing in Heredia, Costa Rica, was 44 days.

The average interfloral phase obtained for the three specimens studied was 42.4 days. This value supports the idea that *F. hemsleyana* and *F. citrifolia* are not the same species because the interfloral phase of the latter ranges from 27 to 32 days (Frank 1984), a considerable difference. Furthermore, *F. hemsleyana* has synchronous bloomings, while *F. laevigata* (= *F. citrifolia*) in Florida usually has asynchronous blooming (Frank, 1984; Bronstein, 1989; Ramírez, pers. obs.).

In all bloomings, the syconia were pollinated by *P. tonduzi* wasps, which probably came from other *F. hemsleyana* trees growing naturally in the University of Costa Rica campus and neighboring areas. The pollinating wasps were leptoparasited by the inquiline *Idarnes barbiger*. Some syconia were parasited by a primary sycophilous wasp of the genus *Heterandrium* (Otitellinae). We also found *Anidarnes* sp. (Sycophaginae) and an

unidentified species of Pteromalidae. The sycophilous wasps mentioned were also found developing in other *F. hemsleyana* trees growing at the campus of the University of Costa Rica.

The Costa Rican pollinators (*P. tonduzi*) of *F. hemsleyana* developed normally in the syconia of the introduced specimen and most syconia produced more than 150 wasps (range 130-180). Ten fruits were found to have an average of 85 seeds, and 66% of the seeds germinated normally. On average, a single wasp had the potential to pollinate 235 flowers (summing the average produced wasps and seeds). Thus, there was normal pollination and fertilization between the Costa Rican and Brazilian trees. These observations suggest that there are no ecotypes in Costa Rica and Brazil in the pollinator (*P. tonduzi*) and its host (*F. hemsleyana*). The internal nutritional and physical environment of the syconia, as well as the genetic information carried in the pollen by the Costa Rican wasps, might be equal or very similar in both localities.

The former ideas are reinforced by the following shared morphological characters between the *F. hemsleyana* specimen from Brazil planted in Costa Rica and a Costa Rican specimen of the same age (circa 9 years old). Both trees exemplify differences between *F. hemsleyana* and *F. citrifolia* morphs (e.g., *F. laevigata*).

F. hemsleyana has epiphytic and strangler trees of medium size, without prop roots. The sap is translucent, clear and thick, as observed by Burger (1977). The leaves are elliptic, acuminate or subcordate, glabrous, with two pairs of light green color basal veins and 12 or more pairs of lateral veins (Fig. 1A, B). The petioles are 5 cm or longer, dorsally flattened and canaliculate. The syconia are short, pedunculate, axillar, geminate and turbinate (Fig. 2A, B), and do not fill or close the cavities by elongation of the flowers after being pollinated (Fig. 2C, D). Instead, they secrete internally a translucent liquid (this character has not been reported for any other New World *Urostigma* species). They show raised, circular and reddish-brown spots before the female phase and during the other floral phases, they become purplish after being pollinated. According to Janzen (1979) the brown spots on the syconial surfaces mark the sites of torpid oviposition punctures. The ostium is slightly raised or prominent and umbonate, with three superficial bracts and two light green color basal bracts. It is of a light green color when mature, about one centimeter diameter, sometimes purplish, with mustard smell, not very juicy or sweet and usually consumed by frugivorous bats that disperse the seeds in the dejections. The exocarp is well developed and

the endocarp is bordered by muscilagenous layers. [*F. laevigata* Vahl seeds do not possess a developed muscilagenous layer]. The receptive syconia are usually penetrated by one pollinating wasp (one-foundress syconia). The peduncle is 1 cm or shorter, dorsally flattened and asimmetrically attached to the syconium. The stipules are 1.5 cm, non persistent and glabrous (Fig. 2E, F).

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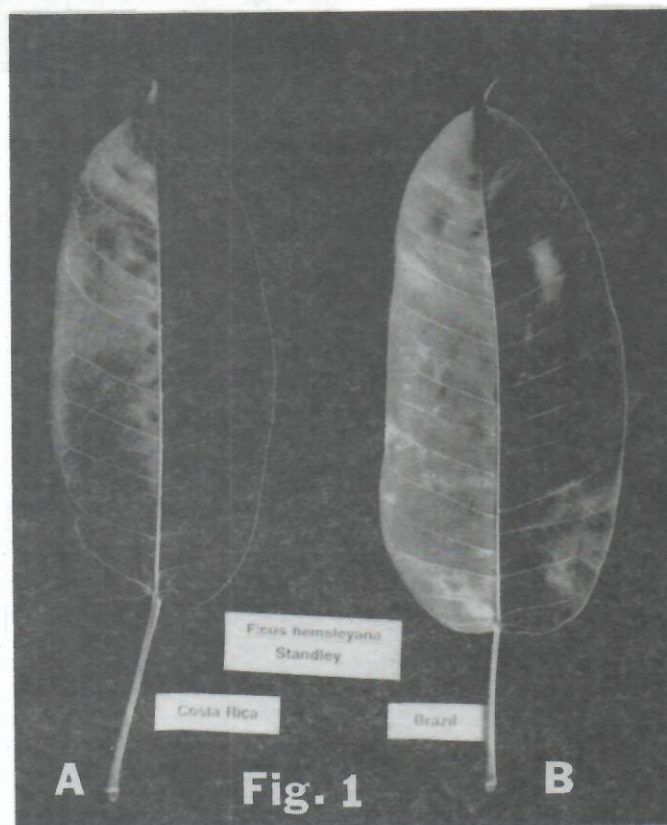


Fig. 1 *Ficus hemsleyana*, leaves: A. Specimen from Costa Rica; B. Specimen from Brazil

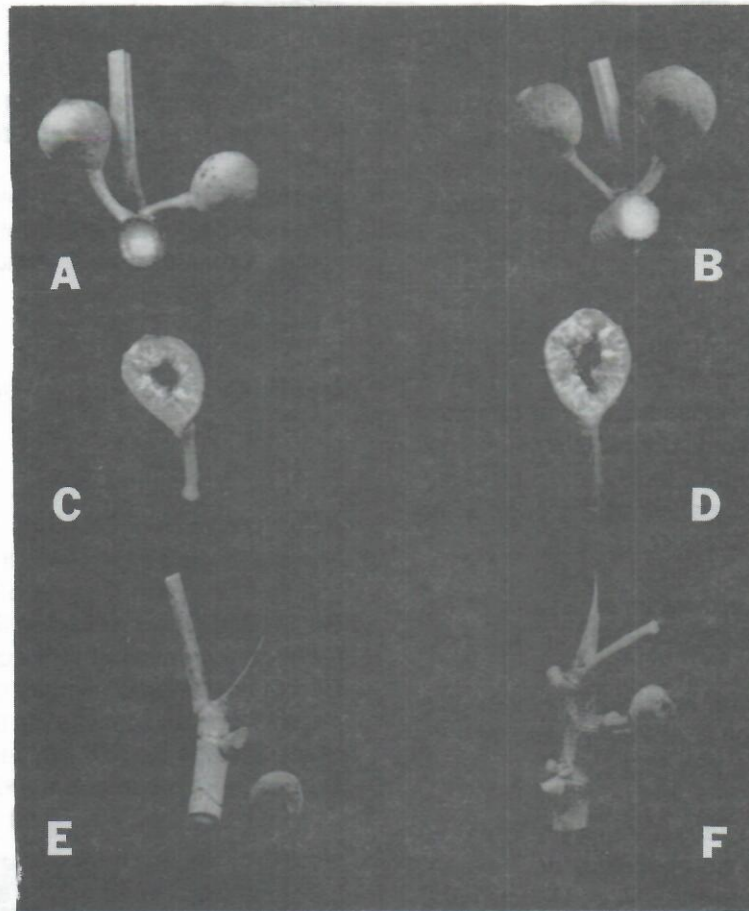


Fig. 2 *Ficus hemsleyana*. A, C, E: syconia of specimen from Costa Rica; B, D, F: syconia of specimen from Brazil.