# A review of pollination of Magnolia by beetles, with a collecting survey made in the Carolinas

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## Introduction

Magnolias are of particular interest to those who study pollination because these plants are believed to be among the earliest to bear true flowers. Study of pollination systems in living magnolias gives insight into the origin of flowers and other aspects of plant-insect coevolution. The literature on pollination is quite extensive and to give even a cursory summary here would not be possible. However, the works by Real (1983), Pellmyr and Thien (1986), and Crepet (1983) to name a few, contain detailed discussions and lengthy bibliographies to lead the interested readers into greater depth.

Crowson (1981) listed five characteristics of flowers which are adapted to beetle pollination. These are (1) large size, (2) usually white, sometimes pink or purplish, (3) carpels raised and base of stamens on a smooth column, (4) lack of nectaries yet abundant pollen, and (5) open, actinomorphic. We know that magnolia flowers fit the above criteria precisely. Certain other primitive and advanced angiosperms (flowering plants) also show these characteristic features of cantharophily, i.e. pollination by beetles. Magnolia seeds are protected in tough carpels from the chewing mandibles of beetles.

It is well established that small beetles are the primary pollinators of *Magnolia* (Stone 1966). Treseder (1979: 2-3, 145-146) discussed several aspects of this topic. Four previous studies give lists of insects collected in flowers of magnolias (Heiser 1962, Thien 1974, Leppik 1975, and Lago and Miller 1986). The collections of insects, mainly beetles, which I obtained from flowers of magnolias are compared and contrasted to those found by these prior authors. There are more than 125 families of beetles, so those 17 discussed here are hardly representative of the diverse order Coleoptera.

The "behavior" (i.e. opening, closing, release of fragrance, timing of receptiveness, etc.) of *Magnolia* flowers relates directly to which insects can be collected and when. For *M. virginiana* and *M. grandiflora*, I observed that the flowers open with a receptive gynoecium on the first day and close that evening (inner tepals close, outer ones remain outstretched). On the second day the flowers reopen and stamens fall off but the gynoecium is no longer receptive. This sequence allows certain beetles (Nitidulidae, possibly Scarabaeidae) to enter and feed within the protection of a closed flower on the first night; other beetles (Mordellidae, Malachiidae, Cerambycidae, etc.) feed the second day on pollen which falls in abundance onto the tepals. Thien (1974) gave excellent and detailed descriptions of the floral biology of all North American species of *Magnolia*, including comments on self-compatibility and incompatibility. Figlar (1985) described the fragrance and sequencing of flowers of the Southeast Asian *M. coco (Lour.) DC.*

*My observations on M. coco* flowering in my home agree with those of Figlar. Incidentally, *M. coco is stated to be the only Magnolia* which has nectaries in the flowers (Stone 1966, Treseder 1979: 145). If that is true, it is a remarkable apomorphy within the genus, and brings to mind the question of whether the flowers might be pollinated predominantly by bees (Hymenoptera).

## Materials and Methods

Insects were collected from within flowers using forceps or an aspirator. For *M. fraseri* and *M. macrophylla*, insects were collected from flowers during midday hours from plants growing in the wild in western North Carolina. For the other species of *Magnolia*, insects were collected from trees growing in my yard in Greenville, South Carolina, which is over 150 kilometers from the nearest wild populations of any of these trees. For *M. virginiana* and *M. grandiflora*, I was able to collect at night as well as during the day. The following species of plants were included in the survey, cited by number under each insect in Table 1.

1. Magnolia grandiflora Linn.
2. *Magnolia virginiana* Linn.
3. *Magnolia macrophylla* Michaux
4. *Magnolia fraseri* Walter
5. *Magnolia stellata* Sieb. & Zucc.
6. *Magnolia officinalis* Rehder & Wilson (? - or an allied species)
7. *Magnolia* × *soulangiana* Soulange-Bodin
8. *Liriodendron tulipifera* Linn.

Collections from numbers 3-8 above were brief and sporadic and very incomplete. Collections from numbers 1-2 were thorough and carried out during four summers, but as mentioned above, these trees were not growing in their natural ranges and habitats. Below are listed locations and dates of collections, cited by letter under each insect in Table 1.

A. Greenville, Greenville County, South Carolina, spring/summer 1984-1987
B. Blacksburg, Cherokee County, South Carolina, 26 May 1985
C. Lincolnton, Lincoln County, North Carolina 26 May 1985
D. Highlands, Macon County, North Carolina, 19 May 1985
E. Biltmore Gardens, Buncombe County, North Carolina, 17 May 1986

Specimens of the insects were pinned and labeled. Beetles were sent to taxonomic specialists of the respective families for identification. Since the insects which were not beetles were considered to be incidental in occurrence (not significant Hpollinators if at all), these are listed only to family-level in Table 1. Voucher specimens of every insect species cited in Table 1 plus the specimens in amber and collected in *Kadsura* (see discussion below) were deposited in the Florida State Collection of Arthropods, Gainesville, Florida. Duplicates of many species were placed in the Denver Museum of Natural History, including the three specimens figured.

## Results

Among the Mordellidae which I collected, none were found by Heiser (1962). Thien (1974) collected *Mordella octopunctata* in *M. ashei* Weatherby, and I collected this large species in *M. grandiflora*. Lago and Miller (1986) found, as did I, that *Mordella marginata* (Figure 1) was abundant in sunny periods in *M. grandiflora*. It is noteworthy that *Mordella marginata* prefers *M. grandiflora* over certain other magnolias. In Greenville, SC, only a few were collected in flowers of *M. virginiana* (6 specimens in May) whereas dozens were in a *M. grandiflora* (May-July) in the same yard. In Lincolnton, NC, a wild *M. macrophylla* had none, whereas a *M.*

## Table 1: Insects Collected in Magnolia Flowers

Order COLEOPTERA - Beetles
- Nitidulidae - sap beetles
  - *Epuraea corticina* (Erichson) 1-A, 2-A abundant
  - *Epuraea depressa* Illiger 4-D
  - *Epuraea* sp. 2-A
  - *Meligethes nigrescens* Stephens 1-A, 5-A common
  - *Conotelus obscurus* Erichson 1-A, 2-A abundant
- Mycetophagidae - hairy fungus beetles
  - *Litargus* sp. 1-A, 6-E, 8-A
- Dermestidae - carpet beetles
  - *Anthrenus castanae* Melsheimer 1-A
  - *Anthrenus* sp. 3-C
  - *Orphilus ater* Erichson 1-A
  - *Cryptorhopalum triste* LeConte 1-A
- Melandryidae - false darkling beetles
  - *Anaspis rufa* Say 4-D
  - *Allopoda lutea* (Hald.) 2-A
- Curculionidae - weevils or snout beetles
  - *Anthonomus* sp. 2-A
- Oedemeridae - false blister beetles
  - *Asclera ruficollis* (Say) 8-A
- Anthicidae - antlike flower beetles
  - *Notoxus murinipennis* LeConte 3-C
- Chrysomelidae - leaf beetles
  - *Diabrotica undecimpunctata howardi* Barber (11-spotted cucumber beetle) 1-A, 3-C
- Scarabaeidae - scarab beetles
  - *Macrodactylus subspinosus* (Fabricius) (rose chafer) 1-A, 2-A
  - *Trichiotinus affinis* G. & P. 3-C
  - *Trichiotinus piger* (Fabricius) 1-A
  - *Popillia japonica* Newman (Japanese beetle) 1-A, 1-B
- Bruchidae - seed beetles
  - *Gibbobruchus mimus* Say 2-A
- Cantharidae - soldier beetles
  - *Chauliognathus marginatus* Fabricius 1-A, 2-A
- Rhizophagidae - root-eating beetles
  - Genus undetermined 1-A

Order COLEOPTERA - Beetles, cont...
- Malachiidae - soft-winged flower
  - *Malachius* sp. 1-A abundant
  - *Attalus circumscripta* (Say) 3-C
- Mordellidae - tumbling flower
  - *Mordella (Glipa) octopunctata* Fabricius 1-A
  - *Mordella marginata* Melsheimer 1-A, 1-B, 2-A abundant
  - *Mordellistena pubescens* (Fabricius) 2-A
  - *Mordellistena liturata* (Melsheimer) 2-A abundant
  - *Mordellistena* sp. 2-A
- Cerambycidae - long-horned borers
  - *Strangalia famelica* Newman 2-A
  - *Pidonia ruficollis* (Say) 4-D
- Staphylinidae - rove beetles
  - *Schistoglossa* sp. 1-C, 2-A, 6-E abundant

Order DIPTERA - True Flies
- Syrphidae - flower flies
  - Species #1 1-A, 2-A

Order HYMENOPTERA - Ants, Bees, Wasps
- Formicidae - ants
  - Species #1 (winged) 7-A
  - Species #2 (workers) 1-A
- Apidae - bees
  - *Bombus impatiens* Cresson 2-A
  - Halictinae species #1 1-A
  - Halictinae species #2 1-B, 2-A

Order HEMIPTERA - True Bugs
- Anthocoridae - minute pirate bugs
  - Species #1 1-A, 2-A
- Miridae - plant bugs
  - Species #1 2-A
  - Species #2 2-A
  - Species #3 2-A
  - Species #4 7-A
  - Species #5 1-A

Order THYSANOPTERA - Thrips
- Family undetermined (none collected) 2-A abundant

Order HOMOPTERA - Cicadas, Leafhoppers, Aphids, etc.
- Cicadellidae - leafhoppers
  - Species #1 2-A

*grandiflora* in a yard 50 meters away contained numerous *Mordella marginata*. By contrast, the three smaller species of *Mordellistena* are more nocturnally active and were collected only in *M. virginiana* (mostly night fragrant), although *M. grandiflora* was blooming nearby; two of these were cited as rare and occasional in *M. grandiflora* by Lago and Miller (1986). Mordellids are recognized easily by their wedge shape and behavior of dropping to the ground when disturbed. The sometimes abundant Malachiidae feed during sunny times on pollen which has fallen onto the tepals of flowers which are no longer receptive, just as with the Mordellidae. Nitidulidae range from rare to abundant in magnolia flowers, depending on species of beetle and tree. Plenty of *Conotelus obscurus* (Figure 2) were collected by me on *M. grandiflora* and a few on *M. virginiana*. This elongated black nitidulid (which looks more like a staphylinid than a typical nitidulid) also was found commonly by all other authors. I collected three species of *Epuraea* (Figure 3) in *M. fraseri, M. grandiflora*, and *M. virginiana*, whereas Heiser (1962) found this beetle genus in *M. tripetala* L., *M. macrophylla*, and *M. virginiana*; Thien took *Epuraea* from *M. pyramidata* Bartram, *M. tripetala, M. acuminata* (L.)L., and *M. ashei*. Species of *Epuraea* are flattened and light brown. No other authors reported the nitidulid genus *Meligethes* which I collected in *M. grandiflora* commonly and one in *M. stellata* in mid-March. The following beetles which I collected resemble Nitidulidae in size and shape and are probably significant pollinators when common: Mycetophagidae, Dermestidae, and particularly Melandryidae and Rhizophagidae. Tiny Staphylinidae were reported and figured by Thien (1974) as abundant in *M. grandiflora* and *M. virginiana*. I collected an unidentified species of *Schistoglossa* in these two magnolias. Heiser (1962) found Staphylinidae in *M. grandiflora* and *M. tripetala* but not in *M. virginiana*. The introduced Japanese beetle (a scarab), the abundant *Chauliognathus marginatus* (Cantharidae), and the abundant cucumber beetle (see Table 1) are three beetles which feed on and rest on a wide variety of plant species. Their occurrence in magnolia flowers is incidental. However, three other scarabs seem to select *Magnolia* by preference when these flowers are available. Species of *Trichiotinus* were collected by Heiser (1962), Thien (1974), and Lago and Miller (1986) and the first two authors also obtained *Macrodactylus*. The bruchid *Gibbobruchus mimus* was taken by Heiser in *M. tripetala*, by Lago and Miller in *M. grandiflora*, and a single specimen by me in *M. virginiana*.

## Discussion

The current study complements those surveys of insects in flowers of *Magnolia* in the eastern United States by Heiser (1962), Thien (1974), and Lago and Miller (1986). There are enough similarities in the findings of these four studies to give a reasonable idea of which insects are the primary pollinators of North American magnolias. As far as I am aware, however, no reports are available on insects that pollinate magnolias in nature in eastern Asia and tropical America. I assume that Nitidulidae are the most significant pollinators in flowers of *Magnolia* throughout the world. The best data are from flowers of trees growing in nature; my survey is a mixture of natural populations (*M. macrophylla, M. fraseri, L. tulipifera*) and trees growing outside their natural ranges (*M. grandiflora, M. virginiana*, etc.).

The point of whether a magnolia tree is flowering in its natural range and habitat is very important (for example, downtown New Orleans is

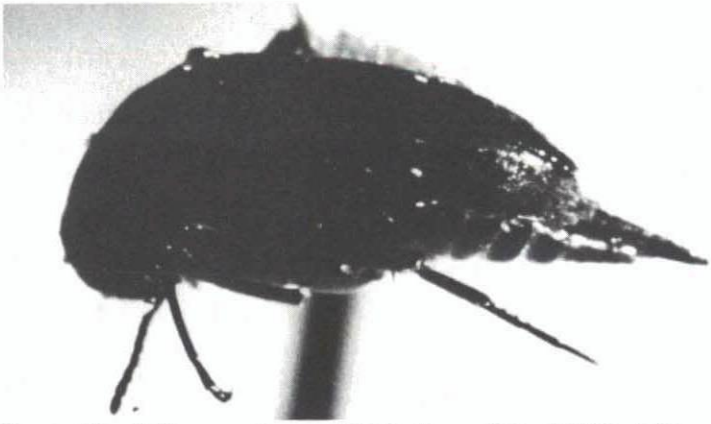

*Fig. 1.* Mordella marginata *Melsheimer (Mordellidae) Greenville, SC, 3 July 1985 in flower of* Magnolia grandiflora. *Length: 4 mm.*

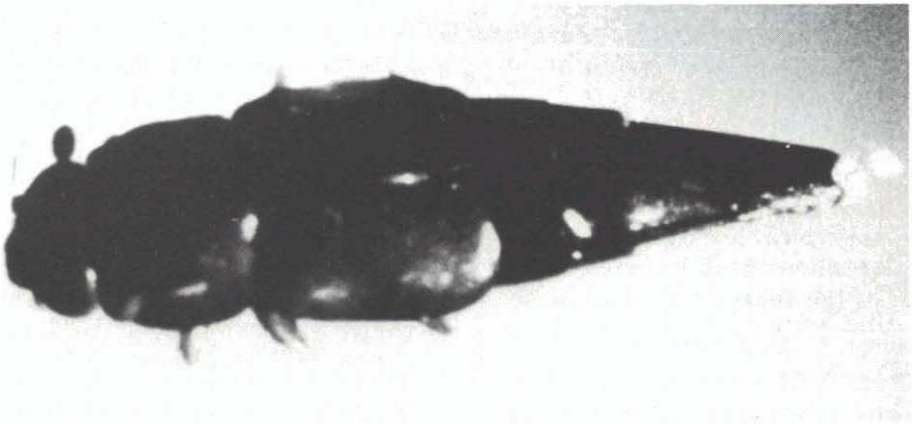

*Fig. 2.* Conotelus obscurus *Erichson (Nitidulidae) Greenville, SC, 16 June 1984 in flower of* Magnolia grandiflora. *Length: 4 mm.*

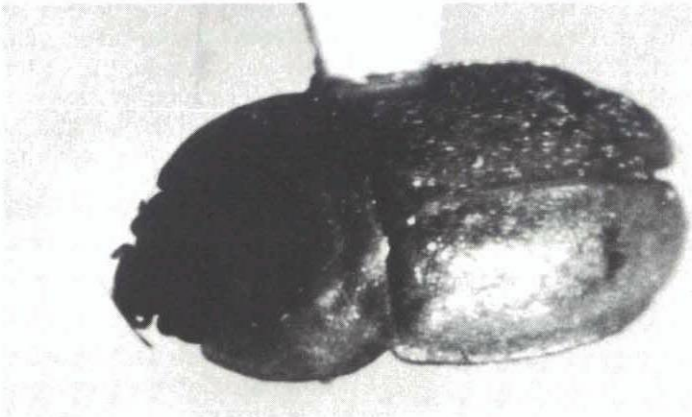

*Fig. 3.* Epuraea corticina *Erichson (Nitidulidae) Greenville, SC, 8 June 1984 in flower of* Magnolia virginiana. *Length: 3.6 mm.*

in the range of certain *Magnolia* species, but not the habitat). Treseder (1979: 197) pointed out that *M. grandiflora* fails to set seed in Britain. I have attempted to collect insects in flowers of this plant in Bryan, Texas, and Los Angeles, California, but found no insects. On the other hand, I would expect that the open, fragrant flowers of *M. grandiflora* in tropical areas such as Africa and Asia where the tree is commonly grown, would contain a large array of insects, including beetles which could effect pollination. It is believed that magnolias which flower in early spring may rarely be pollinated outside their native lands due to the fact that insects which could carry out pollination are not active or mobile in the cool spring. It may also be possible that fruit development and seed set are rare in *M.* × *soulangiana* because the hybrid origin confers a certain amount of sterility Hand incompatibility. Moreover, late freezes can destroy young fruits on such trees, even if pollination had been successful.

Philip J. Savage, Jr. informs me that he has observed wood roaches (*Parcoblatta* spp.) commonly in closed magnolia flowers in Michigan and considers that these may be true pollinators. Roaches predate angiosperms (and beetles) by more than 100 million years (Scott and Taylor 1983) and their potential as ancient and modern pollinators of magnolias should certainly be investigated. Roaches may have partially filled a role later assumed by the more mobile and successful beetles.

In my survey and the others cited, two families of beetles continue to turn up in flowers of many species of magnolias in many localities. These are Nitidulidae and Mordellidae. I found them to be more abundant in terms of numbers of individuals than any other groups. Crowson (1981) listed six adaptive features of flower-frequenting beetles. These are seen in virtually all beetle families cited in Table 1. Although the Mordellidae are quite abundant in magnolia flowers and have been considered to be major pollinators by some authors, I do not believe that they are significant in pollination of this genus of plants. They are rarely found inside closed flowers as is the case of Nitidulidae. Rather, the Mordellidae appear to me to be opportunists feeding on the plentiful pollen of flowers which are no longer receptive, nor are they likely to move from this situation to other flowers which are receptive. Within the Nitidulidae, there are two different groups in terms of their relationship to the host flowers, and my survey includes examples of both groups. Some of these floricolous beetles visit flowers only for adult feeding, whereas the second group is comprised of species whose larvae develop in the flowers or fruits (Crowson 1981, Parsons 1943).

Magnolias date back to the Upper Cretaceous in the fossil record. It is interesting to note that most of these beetles originated around the same time. Parsons (1943: 127) considered most genera of Nitidulidae to be of early Tertiary or even Cretaceous origin. Mordellidae have an even earlier beginning (Crowson 1981). I have a specimen of Mordellidae in amber from the Dominican Republic. Most Caribbean amber is considered to be of Oligocene age (Schlee 1980). The abundance of these and other beetle families cited in Table 1 during the Tertiary is documented by Wilson (1978).

Stone (1966) believed that although bees are not pollinators of *Magnolia*, they visit the flowers to take advantage of the available pollen (a food for larvae of bees). I agree with her conclusions, although I collected three species of bees in magnolia flowers. We may assume

however, that bees may be true pollinators of flowers of *Liriodendron tulipifera* since those flowers do not close once they have opened. In addition, honeybees (*Apis mellifera* L.) take nectar from tuliptree flowers, the result being the "poplar honey" sold in the mountains of the Carolinas. Since the honeybee is a species introduced from Europe, it cannot be the original or predominant pollinator for this tree species.

*Illicium* is a genus of plants having foul smelling flowers pollinated mainly by flies (Diptera). (Illiciaceae is a family of primitive angiosperms placed within Magnoliaceae in some archaic classifications of plants.) I have been unable to observe or collect any insects in the flowers of *Illicium floridanum* Ellis and *I. parviflorum* Michx, *ex* Vent. (or *I. anisatum*?) in plants flowering in my yard in Greenville, South Carolina. Thien, *et al.* (1983) collected many insects from flowers in wild populations of *I. floridanum* but concluded that the plant family may be declining toward extinction due to ineffective pollination systems. *Magnolia tripetala* also has foul smelling flowers (Treseder 1979) which, perhaps predictably, attract a different suite of insect species than is found in other sympatric species of *Magnolia* (Heiser 1962, Thien 1974).

*Kadsura japonica* is a vine which is perhaps related to Magnoliaceae. From numerous flowers in three summers on a plant in my yard in South Carolina I obtained only a single insect. It was an extremely minute beetle the size of a grain of salt: an unidentified species of *Orthoperus* (family Orthoperidae). It could have been of incidental occurrence, but its tiny size would enable it to move about in the intricate recesses of the *Kadsura* flower. Therefore, we may guess that these flowers are pollinated by minute beetles in the Asiatic homeland of the plant.

Future investigators of natural pollination of *Magnolia* should consider the potential significance of thrips (Order Thysanoptera). These slender, minute insects must be collected carefully and should be mounted on microscope slides for subsequent identification. I observed yellow ones as common in flowers of *M. virginiana* and *M. grandiflora* but my survey is delinquent in that none of these were collected. I believe, however, that they are probably effective pollinators.

By publishing this entomological survey in a horticultural journal, it is my hope that members of the Magnolia Society who are fortunate enough to observe flowering magnolias in their native lands and habitats in Asia and tropical America will take the opportunity to collect beetles in the flowers and contribute the data to our expanding store of knowledge on this intriguing subject.

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