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Phenology and Pollination Biology of Sabal etonia (Palmae) in Southeastern Florida

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In southeastern Florida, along the crests of Pleistocene dunes of the Atlantic Coastal Ridge, is found a unique habitat known as "scrubby flatwoods" (Abrahamson et al. 1984), in which can be found *Sabal etonia* Swingle ex Nash (Palmae: Coryphoideae). The scrubby flatwoods habitat is essentially sand pine scrub in which sand pine, *Pinus clausa* (Chapm. ex Englm.) Vassey ex Sarg., is either absent or replaced by slash pine, *Pinus elliotii* Englm. var. *densa* Little & Doorman. The characteristic xerophytic oaks (e.g., *Quercus geminata* Small, *Q. myrtifolia* Willd.) and many other associated sand pine scrub species are typically present (see Richardson 1977, Abrahamson et al. 1984, Zona and Judd 1986). A special effort was made to study this palm in southeastern Florida because the scrubby flatwoods there are threatened by urban development.

The diversity of pollinators in the Palmae has only recently become evident (Henderson 1986). For example, beetles (Henderson 1984), flies (Schmid 1970), bees (Brown 1976), and bats (Beach 1986) are now known to be pollen vectors. Wind pollination is also known in the Palmae (Read 1975). *Sabal etonia* exhibits many of the typical features of a biotic pollination "syndrome" (Faegri and van der Pijl 1979): conspicuous floral display, anthesis synchronized with potential pollinator activity, sticky pollen, floral fragrance, and nectar production. This study, however, is the first to document the insect visitors of *S. etonia*.

Materials and Methods

Field observations and collections were made of the insect visitors to *S. etonia* in a relatively undisturbed remnant of scrubby flatwoods in Boynton Beach, Palm Beach County, Florida. Continuous surveillance of four inflorescences was undertaken between 03:20 and 15:20 on 11 June 1986; observations of phenology and censuses of insect visitors were made at 20 minute intervals. Supplemental observations were made on 17 additional inflorescences from 10–19 June 1986. All times are given in 24 hour notation and in Eastern Standard Time equivalents.

Pollen loads of insects were sampled using fuchsin glycerine jelly (Beattie 1971). Bee collections are deposited at the Los Angeles County Museum of Natural History; syrphid flies are deposited in the United States National Collection of Insects, Washington, D.C. Voucher herbarium specimens are deposited at Rancho Santa Ana Botanic Garden.

Phenology

Sabal etonia is usually a low-growing palm, with 3–5 leaves arising from the subterranean stem. It flowers in late May through July. Each individual produces from 1–5, but typically 2–3, interfoliar inflorescences, which are densely branched and bear ca. 500–800 creamy white, fragrant hermaphroditic flowers. Rachillae are exserted well beyond the dry, papery peduncular bracts. The flowers have 3

minute tooth-like calyx lobes, 3 petals each ca. 3.1 mm long, 6 stamens about as long as the petals, and one gynoecium of 3 fused carpels. Anther dehiscence is latrorse, by longitudinal slits. Septal nectaries are present at the base of the gynoecium; the gynoecium and calyx lobes are heavily invested with tannins (Zona, pers. obs.).

The first flowers to open are those at the basal portion of the inflorescence, with anthesis progressing acropetally up the inflorescence. Flowers function for only one day, and all flowers in an inflorescence have opened within 5–7 days. Additional inflorescences on a plant may be at various stages of maturity and anthesis.

Anthesis begins when the buds first begin to open at approximately 02:40. Fragrance production begins around 03:00. The fragrance is sweet, pungent, and very noticeable even though the flower buds have only just begun to open. By 05:00, nectar is visible as small droplets at the base of the gynoecium. At this time the petals have not fully spread, and the stamens are held together around the gynoecium by the petals in such a way that the undehisced dorsifixed anthers obscure the stigma. At 07:00, the petals are spread, and the flowers are fully open.

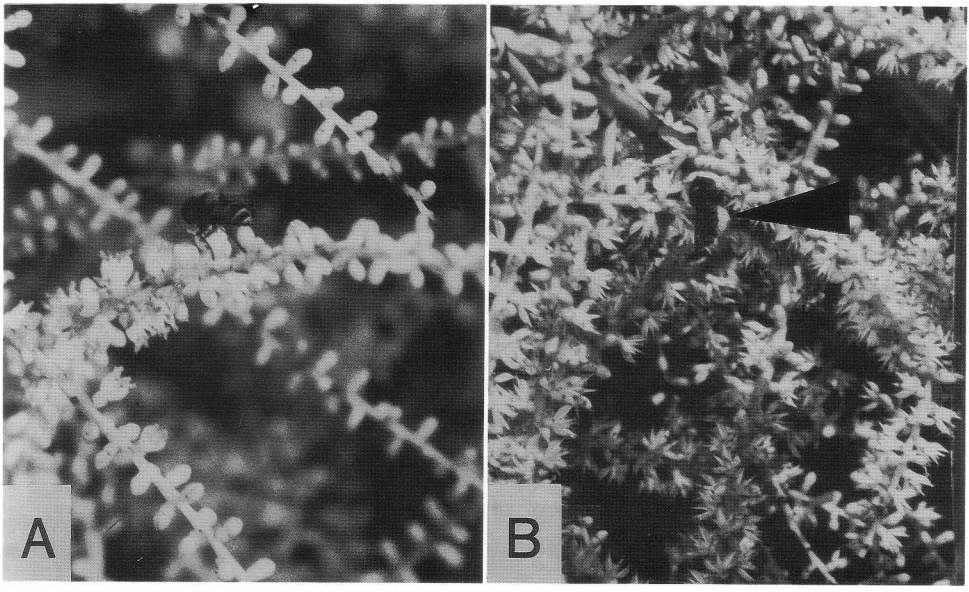
Anther dehiscence occurs at 07:20–08:00. Dehiscence occurs first in those flowers exposed to sun; shaded anthers dehisce somewhat later.

No visible change occurs in the stigma that might indicate its receptiveness. The stigmatic surface is dry and white and remains so until pollen and/or dust discolors it. Pollen was first observed on stigmas collected at 09:50, well after anther dehiscence, despite the fact that immediately after dehiscence, insects carrying pollen were seen foraging on the flowers. The pattern of pollen accumulation suggests that the flowers are weakly protandrous.

By 13:00, the anther sacs are empty, and by 14:20, nectar is detectable in only trace amounts. Fragrance production

Table 1. Insect visitors to Sabal etonia *in Palm Beach Co., Florida. Asterisk indicates the presence of* S. etonia *pollen on collected specimens.*

Orthoptera
Gryllidae
1 sp. indet. (Trigonidiinae)
Thysanoptera
Heterothripidae
1 sp. indet.
Hemiptera
Miridae
1 sp. indet.
Lygaeidae
**Lygaeus* sp.
Coleoptera
Scarabaeidae
**Euphoria sepulchralis* (Fabricius)
Elateridae
*1 sp. indet.
Lathridiidae
1 sp. indet.
Lepidoptera
Lycaenidae
Euristrymon favonius (Smith)
Diptera
Syrphidae
**Palpada agrorum* (Fabricius)
Ocyptamus dimidiatus (Fabricius)
**Ornidia obesa* (Fabricius)
**Meromacrus acutus* (Fabricius)
**Ceriana floridensis* (Shannon)
**Copestylum mexicanum* (Macquart)
Calliphoridae
Cochliomyia macellaria (Fabricius)
Bombyliidae
*2 spp. indet.
1 sp. indet.
Asilidae
Laphria sp.
Hymenoptera
Formicidae
2 spp. indet.
Scoliidae
**Scolia nobilitata* (Fabricius)
Colletidae
**Colletes mandibularis* (F. Smith)
Anthophoridae
**Xylocopa micans* (Lepeletier)
Apidae
**Apis mellifera* (L.)
Megachilidae
**Megachile albitarsis* (Cresson)
**M. xylocopoides* (F. Smith)
**Coelioxys asteris* (Crawford)
Halictidae
**Agapostemon splendens* (Lepeletier)
**Augochloropsis metallica* (Fabricius)



1. Insect visitors to *Sabal etonia*. A. *Palpada agrorum*, a common syrphid fly. B. *Megachile albitarsis*, the principal pollinator. Arrow points to a conspicuous abdominal pollen load.

ceases between 18:20 and 20:00, and by 03:00 on the following day, the flowers are brownish and attract no insects.

Insect Visitors

Insects from the following orders were collected from the flowers of *Sabal etonia*: Orthoptera, Thysanoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera, and Hymenoptera (Table 1).

The order Orthoptera is represented by only one species of nocturnal cricket (Trigonidiinae), which was observed on the inflorescences on four occasions. Its nocturnal visits were infrequent and sedentary, and it carried no pollen. Thrips (Thysanoptera) were very abundant in the flowers.

Two species of Hemiptera were collected from the inflorescences. The first, a small nocturnal species (Miridae), carried no pollen and was observed only three times. The second, a diurnal *Lygaeus* sp. (Lygaeidae), was observed on two occasions. This phytophagous insect apparently feeds on the inflorescence of *Sabal etonia* and was found to carry pollen on its body.

Three species of beetles (Coleoptera) were collected on the inflorescences. A nocturnal beetle (Lathridiidae) was observed on ten occasions, but it bore no pollen. The common phytophagous *Euphoria sepulchralis* (Scarabaeidae) was observed feeding on floral tissues on three occasions. A click beetle (Elateridae) was found only once. It actively probed the base of the gynoecium presumably seeking nectar and carried pollen on the ventral surface of its body.

The butterfly, *Euristrymon favonius* (Lepidoptera: Lycaenidae) was observed foraging for nectar on four occasions. Its visits were sporadic and haphazard, and the species carried no pollen on its body.

Diptera were very common visitors. Syrphid flies (Syrphidae) were represented by 6 species, most frequently by *Palpada agrorum* (Fig. 1A) and *Copestylum mexicanum*. Other Diptera collected from

inflorescences include: *Cochliomyia macellaria* (Calliphoridae) and 3 unidentified species of Bombyliidae. Most of these are represented by a single collection.

The order Hymenoptera is abundantly represented by two species of ants (Formicidae), one wasp (Scoliidae), and eight bees (see Table 1). The ants were frequently observed on the rachillae but never in the flowers. The wasp was observed only once but carried a significant pollen load. The bees carried large loads of pollen and were very abundant and active during the period of pollen availability.

Discussion

Several of the insect species which visited *S. etonia* were found to carry no pollen loads (see Table 1). Furthermore, all of these insects were infrequent visitors. For these reasons, they are discounted as pollen vectors. The thrips (Thysanoptera) are likewise not considered to be pollinators because they remained at the base of the gynoecium never contacting the anthers or stigmas.

The infrequent pollen-bearing visitors, *Lygaeus* sp., *Euphoria sepulchralis*, *Scolia nobilitata*, *Ceriana floridensis*, and click beetle, are probably not important pollinators of *S. etonia*. They carried appreciable amounts of pollen, but their numbers were few, their visits sporadic. Furthermore, *Lygaeus* and *Euphoria sepulchralis* were very sedentary feeders. Their contribution to the pollination of *S. etonia* is probably not significant.

The syrphids most frequently foraged on nectar during two periods, the first, before the anthers had dehisced and later, after the anthers had been cleaned of pollen by bees. Syrphids were not abundant when bees were actively foraging. The syrphids carried pollen and occasionally appeared to contact the stigmas while foraging. They are probable pollen vectors; however, their foraging behavior was more erratic compared with the behavior of bees, and their pollen loads were smaller. Syrphids probably contribute modestly to the pollination of *S. etonia*.

The pollen-gathering bees *Megachile albitarsis*, *M. xylocopoides*, *Augochloropsis metallica*, *Xylocopa micans*, *Colletes mandibularis*, and *Apis mellifera* were all observed with conspicuous corbicular or abdominal pollen loads. *Agapostemon splendens* and *Coelioxys asteris* carried less conspicuous amounts of pollen on their bodies. The pollen loads of *C. mandibularis*, *A. splendens*, and *A. mellifera* were notably homogeneous in composition. The bees forage systematically through inflorescences, spending up to six minutes (for *M. albitarsis*) in one inflorescence before flying to another. They are very abundant and frequent visitors especially in the hours immediately following anther dehiscence. Of the bees, *M. albitarsis* was the most abundant (Fig. 1B), followed by *M. xylocopoides*, *A. metallica*, and *X. micans*. *Megachile albitarsis* was the most common of all insect visitors (excluding thrips); on 11 June, one to four individuals of *M. albitarsus* were present continuously on each inflorescence from 08:00 to 13:00. The behavior, abundance, frequency, and pollen loads of the bees (especialy the Megachilidae and Halictidae) suggest that they are the most likely pollinators, and that *S. etonia* is predominantly bee-pollinated.

Wind pollination is highly unlikely because the pollen of *S. etonia* is not transported by wind. The pollen is sticky and cannot be dislodged from the anthers by wind nor by shaking the flowers.

Information is now available for comparisons to be made of phenology and pollination biology of three species of *Sabal* found in Florida. Brown (1973, 1976) provides such information for *S. palmetto* (Walt.) Lodd. ex J. A. & J. H. Schultes, and Kunth (1909), citing earlier work by Delpino, provides a very brief assessment of the phenology and pollinators of *S. minor* (Jacq.) Pers. This information sheds new

light on the phenological and ecological isolating mechanisms among these species of *Sabal*.

The phenological observations presented here for *S. etonia* differ somewhat from those of *S. palmetto* and *S. minor*. Both *S. palmetto* and *S. minor* are reported to be protogynous; whereas *S. etonia* appears to be protandrous. Couriously, protogyny, as reported for *S. palmetto* and *S. minor*, is not typical of bee-pollinated palms (Henderson 1986).

The difference in timing of stigma receptivity in *S. etonia* as compared with the other two species appears to represent an interspecific difference. Brown (1976) reports that stigma receptivity in *S. palmetto* begins at 05:00, but at that hour the stigma of *S. etonia* is obscurred beneath the undehisced dorsifixed anthers. Insect visitors would not likely contact the stigma of *S. etonia* at this stage of anthesis. The timing of anther dehiscence is similar for both species, occuring at 07:30–09:10 in *S. palmetto* (Brown 1976) and at 07:20–08:00 in *S. etonia*.

The pollinators of *S. minor*, a wasp (*Polistes*) and *Halictus* bees (Kunth 1909), differ markedly from those of *S. etonia*. This difference is not surprising given the very different habitats of these palms (mesic deciduous forests, for *S. minor*). The different pollinators and habitats are formidable barriers to hybridization between these two species. Of the 24 spp. of bees visiting *S. palmetto*, the primary pollinators are *Apis mellifera*, *Augachlora pura* (Say), *Agapostemon splendens*, and *Dialictus* spp. (Brown 1976). *Sabal palmetto* is isolated from *S. etonia* by habitat and, to a great extent, by bee pollinators, but *S. etonia* has five bees in common with *S. palmetto*. They are: *Agapostemon splendens*, *Megachile albitarsis*, *M. xylocopoides*, and *Xylocopa micans* along with the introduced *Apis mellifera* (Graenicher 1930; Brown 1973, 1976). The wasp *Scolia nobilitata* also visits both palms (Brown 1973). The shared native pollinators and the close proximity of habitats of *S. etonia* and *S. palmetto* in South Florida give credence to the hypothesis (Zona 1985) that hybridization in ancient times may have given rise to another species, *S. miamiensis* Zona.

Sabal etonia is a characteristic species of the sand pine scrub habitat of the Central Florida Ridge (Zona and Judd 1986); however, its pollination biology throughout the entirity of its range is not known. While collecting *S. etonia* in Polk County, I observed honeybees, *Apis mellifera*, lovebugs, *Plecia neartica* Hardy (Diptera: Bibionidae), and weevils (Curculionidae: Baridinae) attracted to the inflorescences in great abundance. Large populations of honeybees are maintained in the area by local citrus growers, so it is likely that the honeybee is a significant pollinator in certain locales. The roles of the lovebug and the weevil are uncertain.

Summary

In southeastern Florida, *Sabal etonia* flowers in May–July. *Sabal etonia* has many characteristics of an entomophilous palm. Its flowers are protrandrous, producing fragrance and nectar. The most common insect visitors are flies (Diptera: Syrphidae) and bees (Hymenoptera: five families). Their behavior, their abundance and frequency, and their large pollen loads suggest that bees, especially *Megachile albitarsis*, are the major pollinators.

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Warning: ROUNDUP Herbicide Can Be Harmful to Your Palms' Health

We read with interest the July article which included a study on the use of a post-emergent herbicide ROUNDUP. This chemical is a non-selective, very effective, potent plant killer. Extreme caution should be used when applying ROUNDUP for weed control. It should never be sprayed near valuable plants. This chemical is usually applied with a wick applicator which is used to "wipe" the tops of weeds. Always mix and dilute according to the label—a tiny amount will go a long way. As an example, a whole clump of bamboo can be destroyed if one leaf of one cane is dipped in undiluted ROUNDUP. The chemical spreads quickly throughout the entire plant system and provides a sure, quick kill. To eliminate irritating patches of poison ivy, fill a cup with ROUNDUP diluted by half with water and using a small paintbrush, stroke one leaf of each ivy. It is also very effective on cat-tails.

While ROUNDUP may not affect some woody ornamentals or mature palms, it is far too dangerous to use without extreme caution and complete knowledge of its potency. Be aware and beware.

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