

THE SEASONAL ABUNDANCE AND FEEDING DAMAGE OF
HYPsipyla grandella (LEPIDOPTERA: PYRALIDAE) IN
SEED CAPSULES OF *SWIETENIA MAHAGONI* IN FLORIDA

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ABSTRACT

Larvae of *Hypsipyla grandella* attacked the seed capsules of West Indies mahogaines, *Swietenia mahagoni* Jacquin, in spring (March - April) after the capsules dehisced and the seeds were exposed, which occurred prior to flushing. One to 5 larvae occurred per capsule. The seeds apparently were a preferred food source and 50-96% of the seeds in capsules examined in June were damaged by larvae. Seed capsules during their period of expansion from early summer to winter were virtually free of borer attack, and during this period neither hardened-off shoots nor persistent capsule cores from previous seasons served as food sources for more than a few larvae. The hardness of the capsule valves is apparently a factor in preventing penetration by the larvae. Although the persistence of seeds in the capsules is transitory, and the availability of capsules more limited and more variable than that of shoots, the seed capsule contents appeared to be preferred as a food source, as higher percentages of dehisced seed capsules than new shoots were attacked when both were simulta-

neously available. The damage by *H. grandella* to mahogany seeds impacts regeneration of this tree species.

RESUMEN

Las larvas de *Hypsipyla grandella* atacan a las cápsulas de las semillas de la caoba de las Indias Occidentales, *Swietenia mahagoni* Jacquin, en la primavera (marzo-abril) cuando éstas se abren y las semillas están expuestas, lo cual ocurre antes del brote de nuevas hojas. De una a cinco larvas se encontraron por cápsula. Las semillas aparentemente fueron la fuente de alimento preferida. El 50-96% de las semillas en las cápsulas examinadas en junio estuvo dañado por las larvas. Las cápsulas durante su período de expansión, a comienzos del verano, y hasta el invierno estaban virtualmente libres del ataque de los barrenadores. Durante este período tanto los brotes endurecidos como los corazones persistentes de las cápsulas sirvieron como alimento a de unas pocas larvas. La dureza de las valvas de la cápsula es aparentemente un factor de impedimento a la penetración por las larvas. A pesar de que la persistencia de las semillas en las cápsulas es transitoria, y la disponibilidad de las cápsulas es más limitada y más variable que la de los brotes, el contenido de la cápsula de las semillas parece ser preferido como alimento, debido a que más porcentaje de cápsulas abiertas que de nuevos brotes fueron atacados cuando ambos estaban simultáneamente disponibles. El daño causado por *H. grandella* a las semillas de caoba afecta la regeneración de este árbol.

Two species of *Hypsipyla* are important pests of timber trees of the family Meliaceae. One species, *H. grandella* (Zeller), known as the mahogany shoot borer, is considered the major pest of mahoganies (*Swietenia* spp.) and cedros (*Cedrela* spp.) at the nursery and young plantation stage in the American tropics. The larvae kill the apical shoot, inducing a secondary shoot that results in a crooked stem and excessive side branching (Dourojeanni Ricordi 1963, Grijpma 1974, Howard & Meerow 1994, Lamb 1966, Yamazaki 1992). *Hypsipyla robusta* (Moore) plays a similar role on meliaceous trees in the Eastern Hemisphere tropics (Gray 1972). Research on the biology and control of *Hypsipyla* spp. was recently reviewed by Newton et al. (1993).

Most studies of the feeding habits of these insects have focused on injury to shoots, but both species also have been reported to infest seed capsules of meliaceous hosts (Beeson 1961, Betancourt 1987, Bruner 1936, Monte 1933, Roberts 1966, Solomon 1995, Tillmanns 1964, Wagner et al. 1991). Monte's (1933) observations indicated that *H. grandella* was highly adapted to utilizing seed capsules: larvae that hatched from eggs laid on green seed capsules of cedros penetrated into the interior of the fruit and fed on seeds. Before pupating, the mature larva made a hole in the capsule valve by which it later exited as an adult. Adults of *H. grandella* reared from larvae infesting seed capsules were larger than those obtained from shoots (Becker 1976), indicating the importance of fruits in the development of this insect. *Hypsipyla robusta* is listed as a pest of fruits of meliaceous timber trees in West Africa (Wagner et al. 1991). In northern India and Burma, where *H. robusta* attacks toon (*Toona ciliata* H. Roemer), it is known as the 'toon fruit and shoot borer' (Beeson 1961).

Some observations have been made on the seasonal occurrence of feeding on seed capsules by *Hypsipyla* spp. Hochmut & Manso (1975) reported that in Cuba *H. grandella* attacks seed capsules of meliaceous trees during the dry period when young shoots of these hosts are not available. In northern India, the first generation of the growing season of *H. robusta* feeds on flowers of *T. ciliata*, the second on seeds in the

green fruit capsule, and the remaining generations (third through fifth) in shoots of the current year (Beeson 1961). In Nigeria, *Hypsipyla* sp. feeds on flowers of African mahogany, *Khaya ivorensis* A. Chev., from September to November, on seed capsules from November to February, and on shoots during the remainder of the growing season (Roberts 1966).

In southern Florida, the host of *H. grandella* is the West Indies mahogany, (*Swietenia mahagoni* [Linnaeus] Jacquin), which is native to Florida and is the only representative of Meliaceae native to the continental United States (Harlow & Harrar 1968, Pennington 1981). Although the insect attacks exotic species of Meliaceae, few of these are planted in southern Florida. Attacks on shoots of West Indies mahogany by *H. grandella* peak in May of each year, coinciding with the spring flush (production of new leaves and shoots) at the beginning or just before the advent of the wet season (June - September). During the remainder of the wet season, shoot production is sporadic and attack by *H. grandella* diminishes greatly, and is virtually nil during the dry season (October - May) (Howard 1991). This paper elucidates the seasonal abundance and feeding damage of *Hypsipyla grandella* (Lepidoptera: Pyralidae) in seed capsules of *Swietenia mahagoni* in southern Florida.

METHODS AND MATERIALS

The study was conducted during the period March 1995-January 1996. We identified the immature stages of *H. grandella* by diagnostic characters illustrated by Ramirez Sanchez (1964). We collected 20 larvae from different seed capsules and reared them to the adult stage on excised mahogany shoots with their bases in water or on mahogany seeds. We compared the specimens of adults with illustrations in Becker 1976, Grijpma 1974, Ramirez Sanchez 1964, and Roovers 1971. For confirmation of the identification, 4 of the specimens of adults were examined and identified as *H. grandella* by J. B. Heppner (Florida State Collection of Arthropods, Gainesville).

All trees in this study were 5-20 year old West Indies mahoganies planted on the Fort Lauderdale Research & Education Center. A total of 338 trees of this species are planted on this site.

Physical characteristics of the seed capsules and seeds that might influence larval feeding were observed. The length of time that the winged seeds persisted on the capsule and thus remained available as food for larvae was determined. Capsules were marked with the date that they opened and observed on April 17 and 24 for the numbers of seeds persisting and the numbers that had been shed as indicated by placental scars.

The thickness of capsule valves were measured at their midpoints with calipers in April and in October. The diameters and lengths of capsules were measured in July, October and January. In April and October, the resistance to penetration of seed capsules and their contents was determined with a Model RP-3T Missouri Type Rind Penetrometer (Alan Machine Co., Ames, Iowa 50010). Points of penetration included seeds, cores, and valves at midpoint and seams between valves. A common bottle cork (processed bark of *Quercus suber* L.) was used as a standard.

The first field observations in this study were made on March 29, 1995, prior to the spring flush. Twenty dehisced capsules, all of which showed larval damage (gallery plus frass typical of this species), were removed from trees and dissected and examined to confirm the presence of larvae of *H. grandella* and to determine where the larvae had fed.

Between April 4 - May 8, three trees, all about 6 m in height, were selected arbitrarily among those bearing unopened seed capsules. These trees were observed every 1-3 days to determine the dates of flushing, dehiscence of the capsule, and initial dam-

age to shoots and/or seed capsules. The dates that the capsules dehisced and that borer damage was first evident were written on 2 cm × 9 cm aluminum tags fixed to the peduncles. On May 3 and May 8 the percentage of marked seed capsules and of 50 randomly selected new shoots with borer damage was determined and all marked seed capsules ($n = 26$) were dissected and examined for larvae.

From May 1995 - January 1996, West Indies mahogany trees on the Research Center continued to be examined frequently for evidence of damage to seed capsules or shoots. In January 1996, a total of 400 capsules of the current season were clipped from trees and examined in the laboratory for evidence of borer damage. One hundred of these were examined with a 10 × hand lens for eggs of *H. grandella*. We had previously observed that cores of a large portion of the seed capsules of West Indies mahogany persist after valves and seeds have been shed and may remain on the trees for up to 2 seasons. To determine whether these served as food sources for *H. grandella* larvae in winter, 78 cores of the past summer's and 22 of the previous year's seed capsule which remained on trees were examined. In addition, the stems and branches of 75 trees < 2 m in height were examined closely for larvae or damage by them.

RESULTS

Seed capsules of West Indies mahogany (Fig. 1) develop from small (5 mm diam) flowers that bloom in June-July in Florida (Howard et al. 1995), expanding rapidly in summer. By the end of July the capsules were about half their mature size of about 65 mm × 75 mm, which they reached in January when they began to dihisc. *Hypsipyla grandella* rarely penetrated the capsules until they dehisced, after which they readily attacked them. The relatively thick, hard capsule valves are no doubt a factor in preventing most *H. grandella* larvae from penetrating them to reach the food-rich seeds. Newly dehisced valves were a mean of 8.9 mm thick (range 7-15 mm, $n = 20$) measured at midpoint and 5-10 × harder than the cores, as measured by penetrometer readings. The resistance to penetration of the cores was similar to that of common bottle cork, while that of the seeds was lower (Table 1).

In both October and April, sites along the seams at the juncture of valves were generally 1/3 to half as resistant as the valves at midpoint. However, in April about 30% of the sites along the seams had about the same resistance as seeds, i. e., about 10% the resistance of tissue at valve midpoints, indicating that the seams were weakening as the capsules dehisced. However, with the exception noted below, larvae did not utilize this potentially easy entry point.

On March 29, 1995, the first day of field observations, about 30 trees had seed capsules. Only a small portion of the total capsules had dihised and all these had *H. grandella* damage. Of the 20 of these that were sampled, 11 were infested with larvae and 2 contained cocoons of this species. There was never more than one late-instar larva per capsule, but earlier instars occurred up to 5 per capsule. The 9 capsules that did not contain *H. grandella* immature stages showed evidence of their damage, but the larvae had left.

One predehisced mature capsule observed in April had a hole along a seam. The capsule was dissected and found to contain a larva of *H. grandella*. In August, a young capsule 42 × 44 mm had a hole interior to the margin of the valve about 3.6 mm in diam with frass identifiable as that of *H. grandella*. The hole was filled with the gummy exudate characteristic of wounds in mahoganies. Dissection of the capsule revealed a late instar of *H. grandella*.

West Indies mahogany seeds persisting in capsules apparently were a preferred food source for *H. grandella* larvae. They usually bored through the layers of seed wings and, upon reaching the core, attached themselves between the core and the

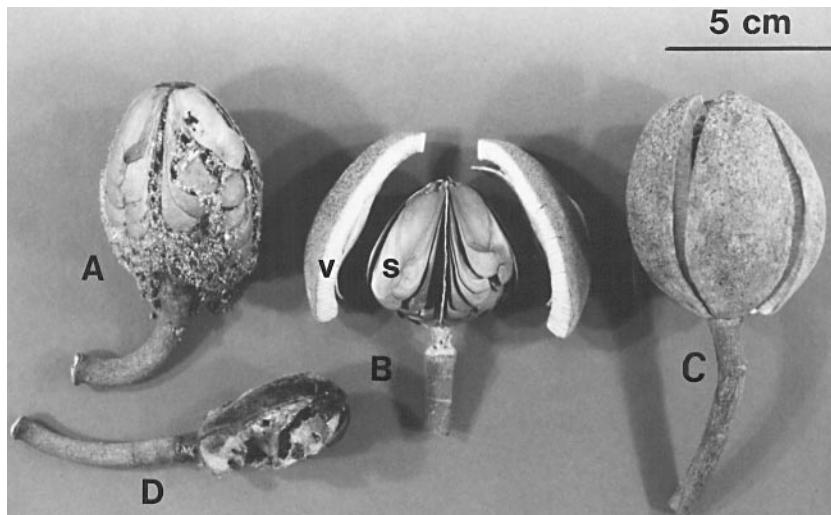


Fig. 1. Parts of seed capsules of *Swietenia mahagoni*; A) Dehisced capsule with damage and frass of *H. grandella* larvae; B) Dehisced insect-free capsule (s, seeds, which are born on a central core; v, valves); C) Capsule in initial stage of dehiscence; D) Core after seeds have been shed, with galleries made by *H. grandella* larvae.

seeds, hollowing out the seeds from their proximal sides so that from the outside of the capsule the larvae were not visible and the seeds appeared sound. Early and late instars were observed feeding on seeds, but only late instars were observed in cores, suggesting that they fed on seeds first and then bored into cores.

The seeds are susceptible to attack by *H. grandella* only as long as they persist in capsules, and this parameter is highly variable. Five of the marked capsules shed most of their 50-80 seeds in a few days. Others shed seeds more gradually. In 3 capsules observed, all of the seeds persisted 18 days after they had dehisced, in spite of winds on one day estimated at up to 25 kph that buffeted the tree branches and caused the seeds to flutter. Once larvae began to attack seeds, they enveloped them in webbing, which prevented them from falling from the capsules.

Most seed capsules on the 3 sample trees dehisced on different days between March 31 - April 13 and were attacked by *H. grandella* larvae prior to flushing of these trees. Flush occurred during the period April 14-19. *Hypsipyla grandella* larvae apparently entered 2 of the capsules the day that these split open as evidenced by frass issuing from between the seeds. In the other 24 capsules, frass was first seen 7 to 30 days after the capsules opened.

Higher percentages of dehisced seed capsules than new shoots were attacked when both were simultaneously available. When counts were made on May 3, 70 - 100% of the dehisced capsules on the 3 sample trees ($n = 26$), compared to 14 - 22% of the new shoots ($n = 150$), had been attacked. A week later, there was a slight increase in the percentage of dehisced capsules attacked but no discernible increase in shoots attacked.

Capsules ($n = 22$) dissected on June 5 revealed that larvae of *H. grandella* had fed on seeds and excavated galleries in the cores of almost all capsules and were still present in 81.8% of them. Six to 37 seeds persisted per capsule, but 50-96% of the

TABLE 1. MEAN PENETROMETER READINGS (KG PRESSURE) ON PARTS OF SEED CAPSULES AND SEEDS OF WEST INDIES MAHOGANY AND ON COMMON CORK FOR COMPARISON.

Plant Part	N	Mean ± SD
Common cork	10	3.7 ± 0.1
April, dehisced capsules:		
Valves, midpoints	25	16.4 ± 3.7
Valves, seams	15	9.3 ± 4.5
Cores	20	3.9 ± 0.6
Seeds	10	1.6 ± 0.3
October, predehisced capsules:		
Valves, midpoints	11	13.5 ± 2.9
Valves, seams	11	9.7 ± 4.3

seeds in different capsules were damaged by larvae, either with large holes or completely hollowed out from the inside. A maximum of 5 larvae were found in one capsule, these being of early instars. Most capsules had 1 or 2 larvae. A single mature (fifth instar) larva was found in each of nine capsules. Two capsules had pupae. Capsules ($n = 4$) dissected on July 31 were similarly damaged, and one contained a single pupa of *H. grandella*.

Of the 400 capsules examined in January, a total of 5 capsules had dehisced. Larvae of *H. grandella* were in 4 of the dehisced capsules and in one predehisced capsule, distributed as follows: Two capsules had apparently been dehisced at least since December and each harbored a fifth instar *H. grandella* larva. Two dehisced capsules each harbored 1 early instar of *H. grandella*. There were no entrance holes in the valves, indicating that the larvae had entered after dehiscence of the capsule. An early instar larva was on the outside of a predehisced capsule. In the laboratory, this larva bored into the valve during the next 4 days, but eventually died. There were 2 capsules with superficial feeding scars that may have been caused by *H. grandella* larvae, but larvae were not present. Two capsules had initial entrance holes with pitch tubes, which may have expelled attacking larvae.

With the exception noted, neither eggs nor borings by larvae were observed in the predehisced capsules in January. At this time, the previous summer's leaves persisted on the West Indies mahogany trees and no new leaves or shoots were produced. There was no evidence of shoot or stem attack by *H. grandella*.

Also in January 1996, 69.2% of the past summer's and 90.9% of the previous year's cores had borer damage. Many of the cores of the capsules of the current year contained deteriorated silk and frass that had persisted since the spring and one had an empty pupal case of *H. grandella*. However, no live immature *H. grandella* were found in the cores. The galleries of many of them were occupied by other arthropods, mostly predators, including *Pseudomyrma* sp. (Hymenoptera: Formicinae) workers with brood, other ant species, wasps, and spiders. The persistent cores were dry and deteriorated and of doubtful value as a food source for *H. grandella*, which is adapted to feed on living plant tissue.

None of <2 m trees ($n=75$) closely inspected in January had *H. grandella* larvae or damage to stems.

DISCUSSION

Our observations indicate that *H. grandella* larvae attack seed capsules in spring with dehiscence of the capsules and exposure of the seeds, which occurs prior to flushing. About 70-100% of the open capsules on different trees are attacked. The larvae hollow out seeds and penetrate the core. This insect's apparent preference for seed capsules is consistent with Becker's (1976) observation that larvae reared from capsules are larger than those reared from shoots. When the trees flush, < 25% of the shoots on the same trees are attacked. Larvae rarely penetrate the capsule valves, probably because of the thickness and hardness relative to that of the seeds and capsule cores. Seed capsules of the current year are virtually free of borer attack during their period of expansion from spring to early winter, as are persistent capsule cores from previous seasons. We have occasionally found larvae in shoots in late summer, but they apparently are very scarce to absent from this host plant from midsummer to the next spring flush. The question of where and under what conditions *H. grandella* passes this period in Florida remains a gap in our knowledge of their life history. Gravid females are presumably present and either abundant or efficient enough to find the few dehisced seed capsules present during January, more than 3 months before an abundant supply of dehisced capsules and new shoots are available in April. Meliaceous trees other than *S. mahagoni* are ruled out as alternate hosts, because they are extremely rare in southern Florida.

Both excised shoots and seeds of West Indies mahogany support the development of larvae to maturity in the laboratory. Although in the field a higher percentage of capsules than shoots were attacked and apparently are a richer food source, their availability is less certain than shoots. Young trees less than 5 years old do not produce seed capsules, and mature trees produce many more shoots than capsules. Annual production of seed capsules is highly variable. We have routinely observed that mature West Indies mahoganies produce from 0 to about 50 seed capsules compared to many hundreds of shoots. A maximum of about 300 capsules was observed on a tree in 1995.

The results of this study indicate that *H. grandella* may severely restrict the regeneration of West Indies mahogany in Florida. Where seed production is important, West Indies mahogany capsules should be protected against *H. grandella* attack, but methods have not been investigated.

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