# ATTRACTION OF *MOCIS LATIPES* (LEPIDOPTERA: NOCTUIDAE) TO SWEET BAITS IN TRAPS

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ABSTRACT

Traps baited with solutions of molasses or jaggery (unrefined palm sugar) captured significant numbers of the moth *Mocis latipes* Guenee, indicating their attraction to these baits. Numbers of moths captured were affected by bait concentration and by bait age. Greatest moth captures were obtained with 20% molasses in water or 5, 10 or 20% jaggery in water. Molasses and jaggery baits aged in the laboratory for up to three days before field testing were more attractive than freshly-made baits to *M. latipes* moths. This is the first demonstration of *M. latipes* attraction to sugar-based baits.

Key Words: Insecta, moth, sugar, fermentation, microbial.

RESUMEN

Las trampas cebadas con soluciones de melaza o azúcar de palma sin refinar capturaron cantidades significativas de la polilla *Mocis latipes* Guenee, indicando su atracción a esos cebos. El número de polillas capturadas fue afectado por la concentración y edad de los cebos. Las mayores capturas de polillas fueron obtenidas con 20% de melaza en agua o 5, 10 o 20% de miel de palma en agua. La atraccción de los cebos de melaza y azúcar de plama envejecidos hasta tres días en el laboratorio antes de probarse en el campo fue superior a la de los cebos frescos. Esta es la primera demostración de la atracción de *M. latipes* hacia cebos azucarados.

Sweet baits (sugar baits) are widely used by collectors of Lepidoptera to attract moths and butterflies to a site where they may be captured, as described by Holland (1903) and Sargent (1976). The ingredients used, although varied, include sugar and sugar-rich materials, as well as fruits and alcoholic beverages. It is thought that the attraction and feeding of moths on artificial sugar baits is an indication of their tendency to feed on natural sources of sugars, such as rotting fruit, tree sap, insect honeydew, and flower nectars (Norris 1935). There are no direct comparisons of formulations of sweet baits or quantitative efforts to optimize bait effectiveness in attracting Lepidoptera, although they appear to lure a wide variety of moths and butterflies (Sargent 1976, Norris 1935 and references therein).

Although such baits are commonly used to collect non-pest species for taxonomic or life history studies, there are indications that they may be attractive to a number of important pest species of moths as well. Norris (1935) supposed that nearly all temperate Noctuidae (which would necessarily include many pests) are attracted to sugar baits, but did not provide documentation. Frost (1928) captured over 48,000 noctuid moths in 2 years of trapping tests in peach orchards using pails of molasses or syrup solutions, but did not report the identity of the species captured. Molasses and sugar syrups have been evaluated as a bait placed in pails for attracting and killing *Grapholita molesta* (Busck) moths (Frost 1926, 1928, 1929) and *Cydia pomonella* (L.) moths (Eyer 1931) in fruit orchards. Similarly, pans of poisoned vinegar and molasses were reported to attract and kill corn earworm moths, *Helicoverpa zea* (Boddie) (Glover 1855, cited by Ditman & Cory 1933). Similar materials may provide sources of useful attractants for monitoring pest populations or developing attracticidal approaches to suppress pest populations.

This paper reports the attractiveness of selected sweet baits to the moth, *Mocis latipes* Guenee, as evidenced by captures in baited traps. This species is a pest of pasture grasses, sugar cane and sorghum in the southeastern United States and throughout much of the neotropics (Ogunwolo & Habeck 1975; Strayer 1975). A sex pheromone of this species is known to be attractive to males (Landolt & Heath 1989), but there are no methods available for attracting and trapping females. Their attraction to any type of food bait would provide the basis for development of new lures for monitoring and, possibly, controlling populations. The capture of *M. latipes* in traps containing sweetened food baits was previously observed by the author in tests to evaluate food-baited traps for tephritid fruit flies. The objectives of this study were to determine if these moths could be trapped with sugar-based baits and to evaluate effects of concentration and age of selected baits on numbers of moths attracted to, and captured in, a trap. Information on the optimum concentration and age of baits would be of use in future attempts to isolate and identify attractive volatile chemicals emanating from these baits. Also, the determination of an aging effect on bait effectiveness would support previous suggestions that microbial fermentation is a crucial component of a good sugar bait for Lepidoptera (Norris 1935).

## MATERIALS AND METHODS

Four trapping tests were conducted to determine the attractiveness of baits to the moths. These were: 1) an initial comparison of moths captured with five different baits and a control, 2) an assessment of the effect of bait age on moths captured, 3) an assessment of effects of bait concentration on moths captured, and 4) a comparison of the effectiveness of two optimized baits.

Invaginated glass traps, McPhail traps (Newell 1936), were used for all tests. These traps, used for monitoring tephritid fruit flies, hold about 0.5 liters of fluid and have a 6.5-cm diam opening at the trap bottom for insects to enter. All baits were prepared and tested in 200-ml amounts per trap. Traps were hung on wire loops mounted on wooden stakes, with the trap opening above the tallest vegetation (about 50 cm above ground). This height was selected because *M. latipes* were observed in early morning flight just above the top of the grass and weed canopy. A randomized complete block design was used for the first three tests, with blocks at four different sites. Traps within a block were 10 m apart. All trap sites were in grassy areas along roads bordering crops (soybean, peanut, sugar cane).

All captured moths were sorted and counted by species and sex. However, numbers suitable for statistical analyses were obtained only for *M. latipes*, which was abundant throughout the study period (late August to early November).

### Bait Comparison

The first experiment was a preliminary comparison of six different baits. The treatment selection was based partly on unreported observations of moths in traps baited for fruit flies. Bait treatments were 1) de-ionized water; 2) fruit pectin (Sure-Jell, Kraft General Foods, White Plains, NY); 3) brewer's yeast (Fleischmann's Yeast, Specialty Brands, San Francisco, CA) and sucrose; 4) honey; 5) molasses (Grandma's Molasses, Mott's, Stanford, CT); and 6) jaggery or unrefined palm sugar (Indian Kolhapur Jaggery, House of Spices Inc., Jackson Heights, N.Y.). For treatments 2, 4, 5, and 6, 20 g of material was mixed in 200 ml of de-ionized water for each trap. For treatment three, 20 g of purified cane sugar and one packet of yeast (7 g) were added to 200 ml of water. All baits were prepared on the day they were used in traps. The experiment was set up as three blocks of traps; each block was a set of 6 traps, each trap containing a different bait. Traps were removed, emptied, cleaned, and rebaited after 48 hours. A total of 11 block replicates was accumulated over four different baiting times (three block sites by four baiting times, with one block missing due to trap breakage). Treatments were randomized within each block.

### Effects of Bait Age

The second experiment compared numbers of moths trapped in either 10% molasses or 10% jaggery solutions that were aged before placement in the field. Multiple bait samples (200 ml) were prepared 1, 2, 3, 5, and 7 days before the beginning of a trapping experiment and held in the laboratory at $23 \pm 0.5$°C in 500-ml glass jars covered with paper toweling. Bait solutions were placed in traps in the field in the afternoon, and traps were removed and emptied the following morning. Trap blocks containing one of each of the five treatment ages were set up at four different sites. For each material this test was conducted on three different days providing 12 block replicates. Treatments were randomized within all blocks.

Effects of Dose

The third experiment compared the effectiveness of a range of concentrations of molasses and jaggery on numbers of moths captured. Concentrations tested were 2.5, 5, 10, 20, and 40 g of material per 200 ml water per trap. Baits were prepared two days before traps were baited and stored in the laboratory in 500-ml glass jars covered with paper toweling. Traps were baited in the afternoon and removed and emptied the following morning. Trap blocks (five traps) were set up at four sites, with all treatments randomized within each block. For each material, treatment comparisons were conducted on three different days, providing 12 block replicates (four sites, three days).

Comparison of Molasses and Jaggery

Solutions of 10% jaggery and 20% molasses were compared directly in McPhail traps for their effectiveness as trap baits for *M. latipes*. Baits were prepared two days before placement in traps in the field and stored in the laboratory in 500-ml glass jars covered with paper toweling. Traps containing either molasses or jaggery were paired in the field; 10 pairs of traps were placed in fields in the afternoon, then removed and emptied the following morning.

Data for captures of *M. latipes* in traps from multiple comparison tests (tests 1, 2, and 3) were transformed to percentages of block totals, followed by an arcsin transformation before using an analysis of variance (Steel & Torrie 1960). Significance of differences between treatment mean percents was determined using Duncan's multiple range test (Duncan 1955) when ANOVA indicated a significant F value. Means for

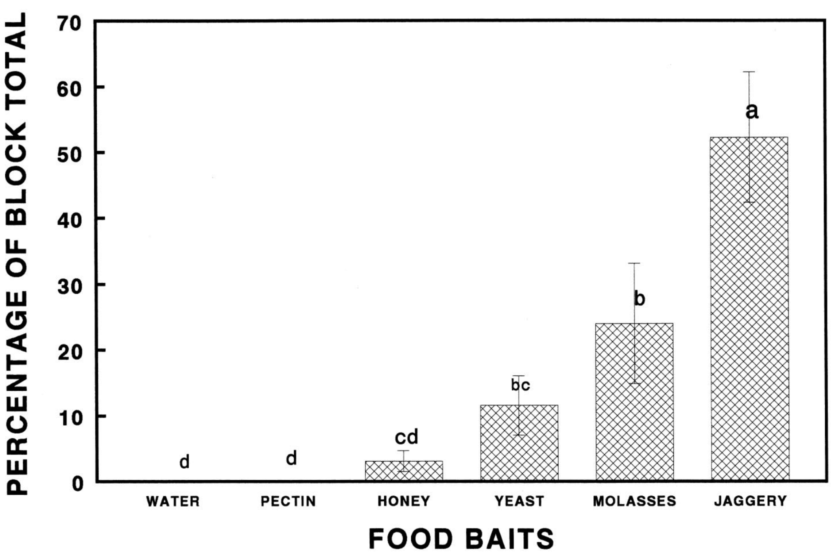


Figure 1. Mean (± SE) percentages of block totals for numbers of *M. latipes* moths captured in traps baited with water, or aqueous solutions of 10% pectin, 10% honey, 10% sugar and 3.5% brewer's yeast, 10% molasses, or 10% jaggery, with a total of 177 trapped. Percentages sharing the same letter are not significantly different by Duncan's multiple range test at $P > 0.05$.

data comparing the attractiveness of molasses and jaggery were tested for significance, without transformation, using Student's t-test (Steel & Torrie 1960). For all experiments, numbers of males and females of *M. latipes* were pooled for analyses of data.

## RESULTS

In the first experiment comparing different bait materials, significantly more *M. latipes* were captured in traps baited with yeast and sugar, molasses, and jaggery than in traps baited with water, pectin, or honey (F = 12.5, df = 5,60, $P < 10^{-6}$) (Fig. 1). Greatest numbers of *M. latipes* were captured in traps containing 10% jaggery, compared to molasses, yeast and sugar, honey, pectin, or water. (Fig. 1). Significantly more moths were caught in traps baited with 10% molasses than were captured in traps baited with honey (Fig. 1). None were captured in traps baited with pectin or with water.

For the second experiment, bait age significantly affected captures of *M. latipes* in traps baited with either molasses (F = 3.3, df = 4,45, $P$=0.02) or jaggery (F = 2.6, df = 4,49, $P$ = 0.05) (Fig. 2). Captures increased significantly from the first to the third day with both materials, followed by an apparent reduction in effectiveness, although this was not significant at the 5% level.

In the third experiment, captures of *M. latipes* in traps baited with either molasses or jaggery were significantly affected by concentration (F = 15.1, df = 4,50, $P < 10^{-6}$)


Figure 2. Mean (± SE) percentages of block totals for numbers of *M. latipes* moths captured in traps baited with either 10% molasses (open bars) or 10% jaggery (cross-hatched bars) baits of different ages, with a total of 653 trapped. Within a bait category (molasses or jaggery) mean percentages sharing a letter are not significantly different by Duncan's multiple range test at $P > 0.05$.

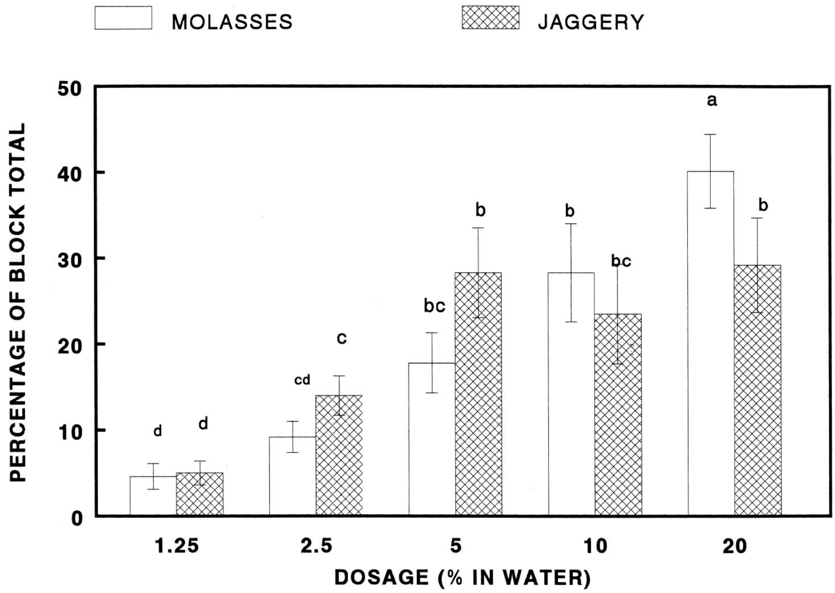


Figure 3. Mean (± SE) percentages of block totals for numbers of *M. latipes* moths captured in traps baited with either three-day-old dosages of molasses or three-day-old dosages of jaggery, with a total of 1,099 trapped. Within a bait category, mean percentages that share a letter are not significantly different by Duncan's multiple range test at $P > 0.05$.

(Fig. 3). Numbers of moths in traps baited with molasses increased with each increase in concentration and were significantly greater at 20% compared to all other tested concentrations. Numbers of moths captured in traps baited with jaggery increased with concentration increases up to 5%, with no differences in trap catches among 5, 10, and 20% solutions.

For the fourth experiment, traps baited with three-day-old 10% jaggery captured significantly more *M. latipes* than traps baited with three-day-old 20% molasses (t = 2.97, df = 9, $P = 0.016$, Mean ± SE = 8.8 ± 1.9 moths per trap per night for jaggery; Mean ± SE = 4.9 ± 1.1 moths per trap per night for molasses).

Although counts of male and female *M. latipes* were combined for statistical comparisons of bait effectiveness, total numbers of males and females trapped indicate an overall sex ratio of near 1 to 1, with 1,027 males and 1,039 females captured in all of the traps baited with molasses and jaggery for experiments 1 through 4 (Table 1). Other pest species of noctuids were also captured in these tests (Table 1), including *Anticarsia gemmatalis* Hubner, *Mocis disseverans* (Walker), and *Spodoptera frugiperda* (J. E. Smith). Three species of *Leucania* were captured but were not determined to species.

## Discussion

The results of the experiments reported here clearly indicate that *M. latipes* are attracted to sweet baits, such as molasses or jaggery. Because the sex ratio for *M. latipes* trapped with either of these two materials was near one to one, it may be possible

TABLE 1. SPECIES OF NOCTUID MOTHS CAPTURED IN TRAPS BAITED WITH UNREFINED PALM SUGAR (JAGGERY) OR MOLASSES IN SEPT./OCT. 1993. GAINESVILLE, FLORIDA.

| Species | Jaggery | | Molasses | |
|---|---|---|---|---|
| | Females | Males | Females | Males |
| *Mocis latipes* (Guenee) | 554 | 528 | 485 | 499 |
| *Anticarsia gemmatalis* Hubner | 60 | 106 | 90 | 177 |
| *Mocis disseverans* (Walker) | 26 | 36 | 36 | 43 |
| *Anomis erosa* Hubner | 30 | 7 | 15 | 4 |
| *Pseudaletia unipuncta* (Haworth) | 8 | 7 | 5 | 3 |
| *Spodoptera frugiperda* (J. E. Smith) | 16 | 8 | 14 | 12 |
| *Spodoptera exigua* (Hubner) | 3 | 0 | 2 | 0 |
| *Spodoptera ornithogalli* (Guenee) | 1 | 6 | 5 | 2 |
| *Spodoptera latifascia* Walker | 0 | 0 | 2 | 0 |
| *Leucania* sp. | 15 | 17 | 16 | 17 |
| *Agrotis subterranea* F. | 3 | 1 | 3 | 0 |
| *Agrotis ipsilon* (Hufnagel) | 1 | 0 | 1 | 0 |
| *Anicla infecta* Ochsenheimer | 12 | 8 | 5 | 8 |
| *Helicoverpa zea* (Boddie) | 4 | 0 | 1 | 1 |

to develop attractants based on these baits for monitoring the presence of females in affected crops.

Numbers of other noctuid moths trapped indicate there is some potential to develop attractants and traps based on sugar baits for other pest species of moths. It is assumed that the relatively lower numbers of these other species trapped is due to their lower populations at sites during the trapping period. The location and season for these tests were selected to maximize the presence of *M. latipes*. It will be necessary to target populations of other pest species of interest to more adequately determine their attraction to these baits.

It is unclear what ingredients are critical to the attractiveness of the tested baits for this and other species of moths. Sargent (1976) indicated that sugar (presumably sucrose, as refined cane or beet sugar) is the only ingredient required, but also added beer to attract *Catocala* species. Holland (1903) described using a solution of sugar, beer and rum. Experiments to control species of *Grapholita* and *H. zea* were conducted with molasses or sugar syrups (Frost 1926, 1928, 1929; Eyer 1931; Ditman & Cory 1933). The results reported here for *M. latipes* indicate that honey or a mixture of sugar and brewer's yeast were not effective and that additional factors present in the molasses and jaggery are important to moth attraction.

Attractiveness of sugar baits to moths is assumed to be due in part to fermentation processes necessary for the production of attractants (Norris 1935; Sargent 1976). This assumption is supported here by the significant increase in numbers of moths captured in three-day-old traps. If this effect is due to the proliferation of microbes in the baits, the differences in response among treatments observed in the first experiment could, to some extent, reflect their suitability as a broth or culture medium for a particular type of microbial agent.

Additional research is needed to isolate and identify attractive odorants emanating from these baits when placed in traps. The effectiveness of this system is limited by the aging effects on bait attractiveness, by the small capacity of the trap for captured moths, and by the fragile nature of the trap design. Ideally, a formulated lure of identified food attractants could be used to bait a dry trap design.

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