EFFECTIVENESS OF CONE EMERGENCE TRAPS FOR DETECTING *PHYLLOPHAGA VANDINEI* EMERGENCE OVER TIME

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ABSTRACT

Cone emergence cages are used to monitor populations of soil-borne insects, particularly beetles, during adult emergence. Because the cone emergence cage presumably denies access to adult beetles, including adult females, it is thought that a cone emergence cage left in place for longer than the lifecycle of the insect will have few or no beetles emerge in it. The authors tested the premise that a cone emergence cage left in place for 1 year or longer would no longer be useful as a tool to monitor the emergence of adult *Phyllophaga vandinei* Smyth. Our results indicate not only that cone emergence cages left in place for more than a year (*P. vandinei* is reported to be univoltine) are still effective at monitoring *P. vandinei* emergence, but often yield even more adult beetles than cone emergence cages that have been in place for a shorter time. It is not clear if this is a result of when the trap is placed or where the trap is placed. This also raises the question of whether the larvae of *P. vandinei* may take 1 or more years to complete development.

Key Words: monitoring, soil insects, scarab

RESUMEN

Las trampas de cono se utilizan para monitorear las poblaciones de escarabajos de suelo. Como supuestamente la trampa de cono no permite el acceso a escarabajos adultos, se cree que cuando las trampas son colocadas en un mismo lugar por periodo más largo que el ciclo de vida de un escarabajo, estas son poco efectivas en atrapar adultos emergiendo del suelo. Los autores examinaron la premisa que una trampa de cono dejada en un mismo lugar por un ano o mas, no es útil para monitorear la emergencia de adultos de *Phyllophaga vandinei* Smyth. Nuestros resultados indican no solo que la trampa de cono dejada en un mismo lugar por mas de un ano es efectiva para monitorear la emergencia de *P. vandinei* (*P. vandinei* completa una generación por ano), sino que en estas se atrapan mas adultos que en trampas que han estado en un mismo lugar por periodos mas cortos. Se ameritan estudios subsiguientes para determinar si estos resultados son debidos a la fecha en que se localizaron las trampas o debido al lugar donde están fueron localizadas.

Translation provided by the authors.

Phyllophaga vandinei Smyth (Coleoptera: Scarabaeiadae), although restricted to the western half of Puerto Rico (Martorell 1945), is an important pest of a wide variety of crops, including sugarcane, bananas, pineapple, citrus, and coffee (Martorell 1976). The adults gather on host plants at dusk to mate and feed, returning to the soil at dawn (Wolcott 1948). The females deposit eggs in the soil, often at the base of host plants. The larvae feed at first on organic material in the soil, but soon begin to feed on the roots of the host plant. Development is reported to take less than a year (Martorell 1945); adults emerge at the beginning of the rainy season (anytime between Mar and May), feeding nocturnally on foliage and ovipositing in the soil. The grubs feed on organic matter in the soil and, as they grow, feed on the roots of host plants (Wolcott 1948). Grubs pupate and emerge during the rainy season of the subsequent year. Young trees are especially susceptible to the combination of defoliation by the adults and the root-feeding larvae. Additionally serial mortality of seedlings planted in locations where *P. vandinei* populations are high has been recorded (Jenkins, unpublished data).

Mamey sapote, *Pouteria sapota* (Jacq.) H. E. Moore & Stearn (Sapotaceae) is a fruit tree native to southern Mexico and northern Nicaragua (Morton 1987). The fruit is prized throughout the Caribbean and Central America and is cultivated in Puerto Rico. Small acreage (108 ha) of this crop in Florida is estimated to be valued at $1.5 million (Balerdi et al. 1996). We have recently found that mamey sapote seedlings are especially susceptible to feeding by adult *P. vandinei*; young trees may be completely defoliated several times during the season, not allowing them to accumulate enough carbohydrate reserves to survive (Jenkins, unpublished data). Although the adults begin to emerge during the spring rainy season (Mar through May), emergence, like the beginning of the rainy season, is unreliable and difficult to predict. In some locations a second peak of adult emergence may be observed in Aug or Sep, but many locations only have the single peak of adult emergence in the spring (Jenkins, unpublished data). The difficulty in predicting the emergence of adult *P. vandinei* hinders the development of effective biological control strategies to reduce reliance on conventional insecticides that are often ineffective against *P. vandinei* and are detrimental to the environment. One method of monitoring adult emergence of *P. vandinei* is the use of cone-emergence traps (Mulder et al. 2000). The cone-emergence trap is a cone-shaped piece of galvanized screening that covers a known area of soil with the larger opening of the cone. The edges of the cone are buried to prevent entry or exit of beetles. Larvae that live in the soil within the area covered by the trap will pupate and emerge as adults within the cage. Emerging adults exhibit a negative geotactic response, rising up in the cage to a boll-weevil trap where they can be easily removed and counted. Because it is assumed that the cone prohibits outside adults from burrowing into the ground, conventional practice has been to remove the traps each year and place them in a new location over soil that adults, especially ovipositing females, have had access to. In other words, soil that has been covered by a cone-emergence trap for more than a year should yield lower numbers of emerging adults of this univoltine species than a trap that has been in place for less than a year. Our objective was to determine if the cone emergence trap would be an effective tool for monitoring the emergence of *P. vandinei*, even if they had been in place for a year or longer.

Materials and Methods

The study site is located in an orchard of mamey sapote at the USDA-ARS Research Farm in Isabela, PR. Trees of 6 cultivars ('Copan,' 'Magaña,' 'Mayapan,' 'Pace,' 'Pantin,' and 'Tazumal') grafted on 'Pantin' rootstock were planted in a randomized complete block design in Feb 2000. Trees and rows were 6.1 m apart. Cone emergence cages were placed at the base of 30 trees (on the west side) in the orchard in Apr 2005 and the number of adult *P. vandinei* collected from each trap was recorded weekly. In Feb 2006, an additional cone emergence cage was placed at the base of the same 30 trees (on the south side) and monitored for the emergence of *P. vandinei* adults weekly. In Jan 2007, an additional cone emergence cage was placed at the base of each of those same 30 experimental trees (on the north side), for a total of 3 traps per tree. The number of beetles that emerged in each cage was totaled for the entire year. Within each year (2006 and 2007) the number of beetles emerging was compared between cages placed in 2005, 2006, and 2007. The mean number of beetles emerging in cages placed in different years was compared by ANOVA (SAS Institute 2006). Means separation was done with Student-Newman-Keuls Multiple Range Test procedure ($P \le 0.05$).

Results and Discussion

The number of beetles emerging in traps differed significantly according to the year when the traps were placed in both years of the study (Table 1). In 2006, traps placed in 2005 collected an average of 38.9 beetles, while traps placed in 2006 yielded 16.1 beetles ($F = 11.36$; $df = 1, 59$; $P > F = 0.0013$). In 2007, traps left in place from 2005 collected an average of 17.8 beetles; traps placed in 2006 collected an average of 8.5 beetles, and traps placed in 2007 collected an average of 8.3 beetles ($F = 5.54$; $df = 2, 89$; $P > F = 0.0054$). A Student-Newman-Kuels means separation test revealed that traps placed in 2005 collected significantly more beetles than traps placed in 2006 or 2007, but the number of beetles collected in traps placed in 2006 or 2007 did not differ significantly from each other. Also, it should be noted that for traps placed in both 2005 and 2006, one third of the population emerged the second year of trapping. The placement of the traps also may have influenced the number of beetles collected.

In 2006 there was a significant difference between the number of beetles emerging in traps placed in 2005 and 2006 for most dates; this was not true for 2007 (Fig. 1). Our study confirms previous observations indicating that *P. vandinei* adults have 2 seasonal emergence peaks, mainly from Mar through May and from Aug through Oct

Table 1. Mean number and SEM (n = 30) of *Phyllophaga vandinei* adults emerging in cone emergence cages at Isabela, PR, in 2005, 2006, and 2007, by year of trap placement.

Date of trap placement	No. of collected adult *P. vandinei* 2006	2007
Apr 2005	38.9 ± 2.9 a	17.8 ± 3.5 a
Feb 2006	16.1 ± 2.9 b	8.5 ± 1.6 b
Jan 2007	—	8.3 ± 1.3 b

Means followed by the same letter within columns are not statistically different by SNK Multiple Range Test ($P \le 0.05$).

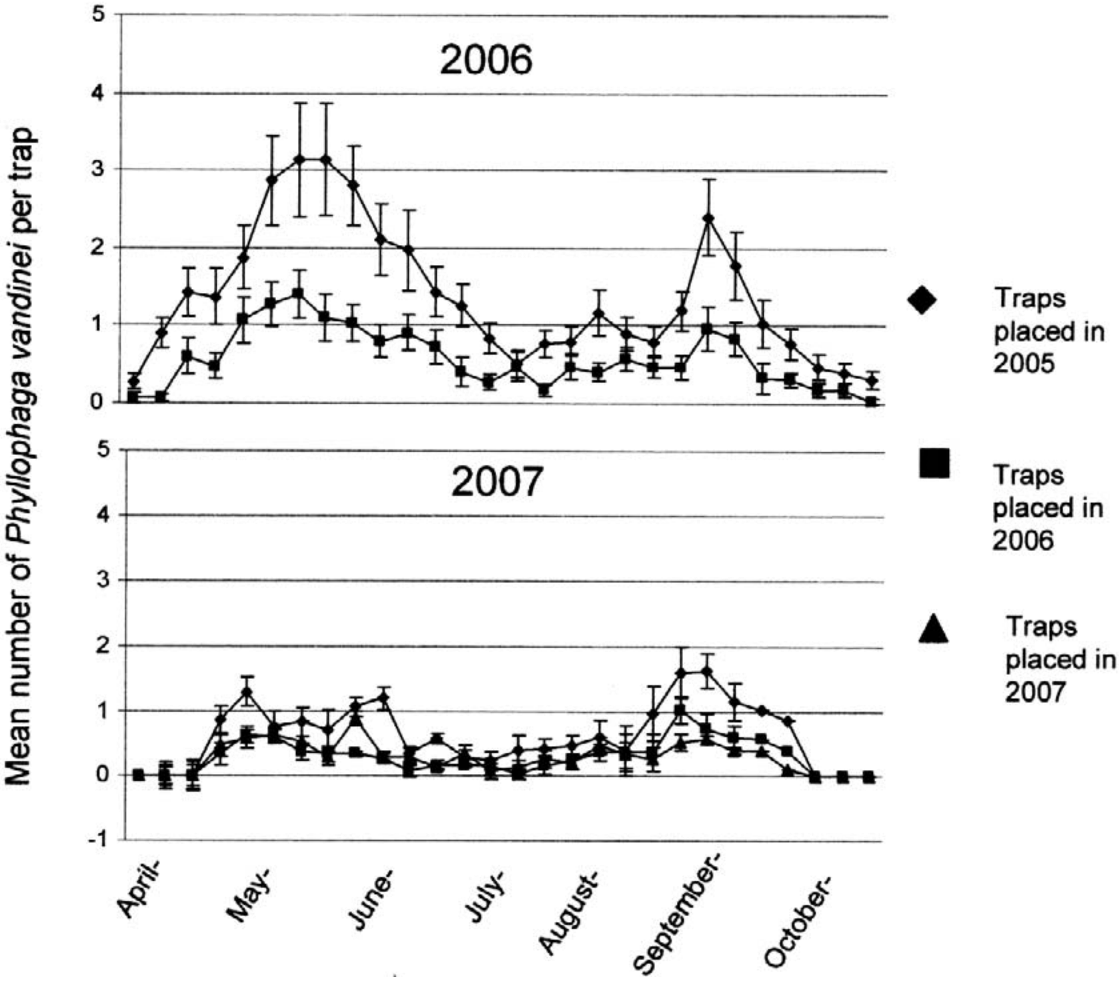

Fig. 1. The mean number of *Phyllophaga vandinei* adults emerging in cone emergence cages placed in 2005, 2006, or 2007 at Isabela, PR. Error bars equal SEM (n = 30).

(Fig. 1). However, nightly observations and foliar damage indicate that *P. vandinei* has a single emergence peak from Mar through May in Mayaguez, P.R. This may be due to different rainfall patterns at the 2 sites or the presence of sprinkler irrigation at the Isabela site. It is also notable that we recovered fewer beetles in the second year of the study. This may be due to an application of granular carbaryl to the study site in an effort to rescue experimental trees. Regardless, the numbers of *P. vandinei* remained high, illustrating the inefficacy of this product.

Our results indicate that traps left in place for a year or longer remain effective tools for monitoring the emergence of adult *P. vandinei*. However, we did not expect that traps that had been in place for the longest period would consistently produce significantly more adult *P. vandinei* than traps placed later. The authors have noted that *P. vandinei* adults show a strong tendency to burrow into the soil at dawn adjacent to vertical objects such as the tree trunk, irrigation stakes, or the cone emergence traps themselves. This is evidenced by the distinctive holes found around such objects and the number of adults found in these holes. This suggests that at least some adult emergence in cone emergence cages are adults that have burrowed into the soil immediately adjacent to the trap, tunneled under the trap and emerged in the cage later. If the vertical contrast of the cage is attractive to burrowing adult beetles, we might expect that traps that had been in place for a longer period would have more adults in subsequent years because females had oviposited disproportionately in soil adjacent to the cone emergence cage in the previous year. However, it remains unexplained why, in the 2007 experiment, the traps placed in 2006 did not produce significantly more beetles than traps placed in 2007 as we would expect if traps placed earlier had accumulated more larvae than traps placed later. Another conclusion is that *P. vandinei* may have a third of the population that takes longer than 1 year to complete development.

It is possible that there is a directional influence to our results. All of the traps placed in 2005 were on the west side of the trees, while the traps placed in 2006 and 2007 were on the south and north sides, respectively. Also, the wind is primarily from the east at this location and may be a factor in the distribution of the beetles predominantly on the western side of host trees. Finally, all of the irrigation sprinklers are located to the northeast of the host trees in this orchard and may be a factor as well.

The cone emergence cage is an important tool in monitoring *P. vandinei* emergence. Our results indicate that cone emergence cages left in place for multiple years function as well as or better than traps placed only for single year. Further research is needed to determine if and how the trap's position in relation to the host tree affects beetle capture, and whether or not this insect may take multiple years to develop.

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