SEASONAL FLIGHT DYNAMICS OF THE APPLE CLEARWING MOTH (*Synanthedon myopaeformis* BORKH., Lepidoptera: Sesiidae) BASED ON CATCHES IN PHEROMONE TRAPS

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ABSTRACT

Recently, the apple clearwing moth, *Synanthedon myopaeformis* Borkh. (Lepidoptera: Sesiidae), proved to be an economically important pest in Bulgaria. Possibilities for monitoring of the pest by pheromone traps were studied in the years 2003-2005. The investigations were carried out in experimental apple orchards of the Fruit Growing Institute and Agricultural University in Plovdiv. The effectiveness of Delta sticky traps and dry funnel traps were tested. Dry traps and pheromone dispensers were products of Csalomon® (Institute of Plant Protection, Hungarian Academy of Sciences, Budapest) while Delta sticky traps were home-made in Bulgaria. The pheromone traps showed a satisfactory effectiveness and selectivity. The flight of apple clearwing moth began in the middle of May and lasted from three to three and half months. Mass flight occurred between the middle of June and the end of July. Sticky and funnel traps may be successfully used for monitoring flight activity of apple clearwing moth.

Key words: apple clearwing moth, pheromone traps, seasonal monitoring, flight dynamics

INTRODUCTION

The apple clearwing moth (*Synanthedon myopaeformis* Borkh., Lepidoptera: Sesiidae) is a very common pest in Bulgaria. Until recently, it

was considered to be a pest of secondary importance. However, the population of apple clearwing moth has significantly increased, and it has become a serious pest of apple trees in the main fruit growing regions of the country. The larvae bore galleries 20-25 cm long in the tree trunk. They damage the phloem, thereby weakening the trees, which are then susceptible to infestation by bark beetles and other pests. Damaged trees die earlier than healthy trees.

Until now, the flight of the apple clearwing moth in Bulgaria has been investigated only with visual methods, which are imperfect and inefficient. Pheromone traps present an alternative tool for the seasonal monitoring of flight activity. Pheromone traps have been used to study other fruit pest species. With pheromone traps, infestation can be detected while the population level is still very low. By monitoring pest populations with pheromone traps, it is possible to establish the optimal time for applying different control measures, including biological measures such as chitin synthesis inhibitors and plant growth regulators (Balazs et al, 1996). Pheromone traps have also been successfully used to control the apple clearwing moth by mass trapping or by disrupting mating (Harzer, 1991; Zeki et al., 1996; Hapke et al., 2000; Bosc et al., 2001).

In a field evaluation of active pheromone preparations, a 10:1 mixture of (Z,Z)-3,13-octadecadienyl acetate and (E,E)-3,13-octadecadienyl acetate was determined to be a potent sex attractant for apple clearwing moth males (Voerman et al., 1978).

The aim of this study was to investigate seasonal flight dynamics of the apple clearwing moth in the Plovdiv region of Bulgaria by using pheromone traps and to use the data obtained for forecasting.

MATERIAL AND METHODS

The experiment was carried out from 2003 to 2005 in four full-bearing apple orchards in the Plovdiv region.

The first and second orchards were located at the Fruit Growing Institute. The first orchard covered an area of 1.8 hectares and was planted mainly with 'Golden Delicious' and 'Red Delicious'. The second orchard was an intensive orchard covering an area of four hectares and consisted of two adjacent plots. The first plot was planted with twenty-two scab resistant cultivars grafted on EMLA 9 rootstock. Trees were spaced 4.0 × 2.0 m apart. The second plot was planted with fifteen cultivars grafted on MM.106 rootstock: 'Tydeman's Early', 'Paulared', 'Ivakami', 'Bonza', 'Anna', 'McIntosh Wijik', 'Avrora', 'Tavriya', 'Fiesta', 'Elstar', 'Royal' 'Gala', 'Chadel', 'Jonagold', 'Charden' and 'Golden Delicious'. Trees were spaced 4.5 × 2.5 m apart. In both plots, trees were trained as spindles. In the first plot, the number of fungicide treatments applied was reduced.

The third and fourth orchards were located in the Training and Experimental Fields of the Agricultural University. The third orchard belonged to the Department of Entomology. It covered an area of 1.2 hectares and was planted with nine cultivars: 'Primrouge', 'Vista Bella', 'Granny Smith', 'Mutsu', 'Melrose', 'Bell Golden', 'Starkrimson', 'Cooper 4' and 'Mosper'. Chemical control was carried out regularly (chemical variant). The fourth orchard belonged to the Agro-ecological Center of the Agricultural University. It covered an area of 0.5 hectares, and was planted mainly with 'Golden Delicious' and 'Red Delicious'. Biological pest control was carried out and no pesticides were used (biological variant).

The pheromone baits used for attracting apple clearwing moths were produced by Csalomon® at the Institute of Plant Protection in Budapest. Two types of pheromone traps were used: home-made Delta sticky traps made of transparent PVC; and dry funnel traps (VARs) manufactured by Csalomon® product. An insecticide was used as the lethal agent.

In the first and second orchards, traps were placed diagonally, with three sticky traps alternating with three dry traps. In the third and fourth orchards, two sticky traps and two dry traps were placed in each orchard only in 2004 and 2005. Traps were placed two weeks before the expected flight period of the over-wintering moth population. Traps were checked every day until the first moths were caught, after which they were checked three times a week. Pheromone capsules were replaced every four weeks, and the sticky layers were replaced when their surfaces got dirty.

Data collected in the first and second orchards were statistically elaborated using analysis of variance, after transformation to log (x+1). Significance of differences between the means for the two kinds of traps was evaluated using the t-test at $P \leq 0.05$.

RESULTS AND DISCUSSION

Data on flight dynamics of the apple clearwing moth, based on the numbers of adult males caught in the pheromone traps from 2003 to 2005 are presented in Figures 1 to 11.

In the first orchard, the first moths of the over-wintering population were detected on May 15 in 2003, May 14 in 2004 and May 17 in 2005. In the second orchard, the first moths were detected on May 30 in 2003, May 23 in 2004, and May 24 in 2005. (Fig. 1, 2, 4, 5, 8 and 9). The flight period lasted until August 6 in 2003, August 25 in 2004 and August 15 in 2005. Therefore, the flight period of the clearwing moth in the Plovdiv region lasted more than three months. During the three-year observation period, there were several peaks of flights which were not always well expressed. Variations in flight intensity were probably caused by changes in weather conditions such as precipitation and temperature. The mass flight of the apple clearwing moth was long-lasting, from the middle of June until the end of July.

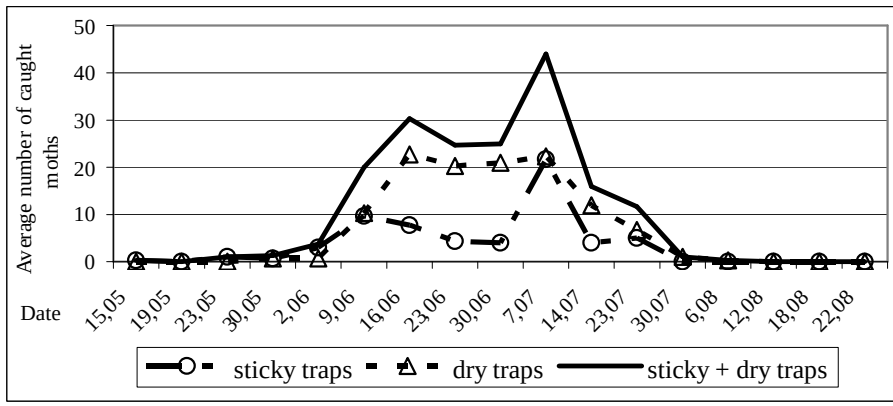

Figure 1. Flight dynamics of apple clearwing moth in the first orchard in 2003

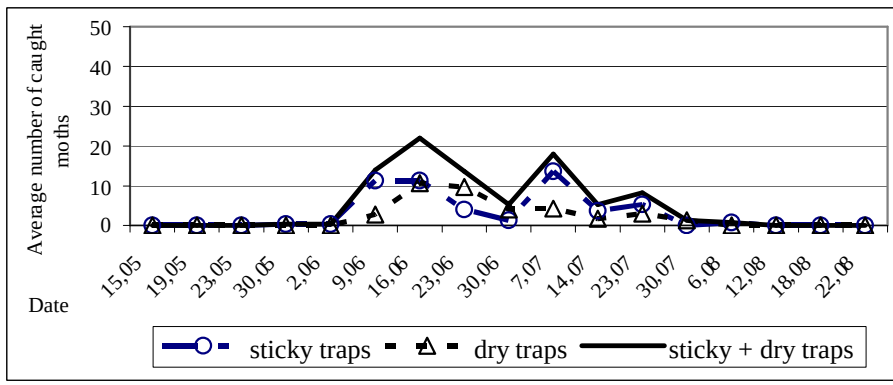

Figure 2. Flight dynamics of apple clearwing moth in the second orchard in 2003

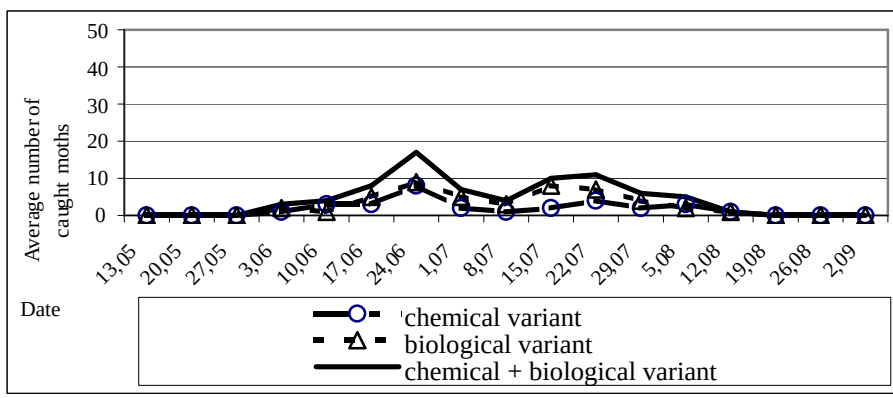

Figure 3. Flight dynamics of apple clearwing moth in the third and fourth orchards in 2003

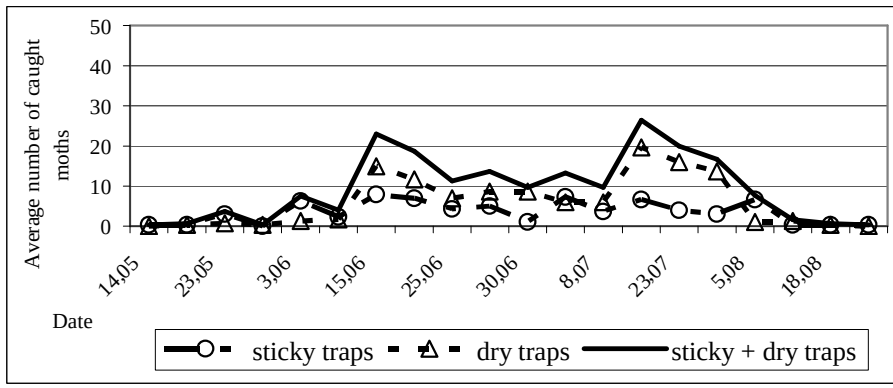

Figure 4. Flight dynamics of apple clearwing moth in the first orchard in 2004

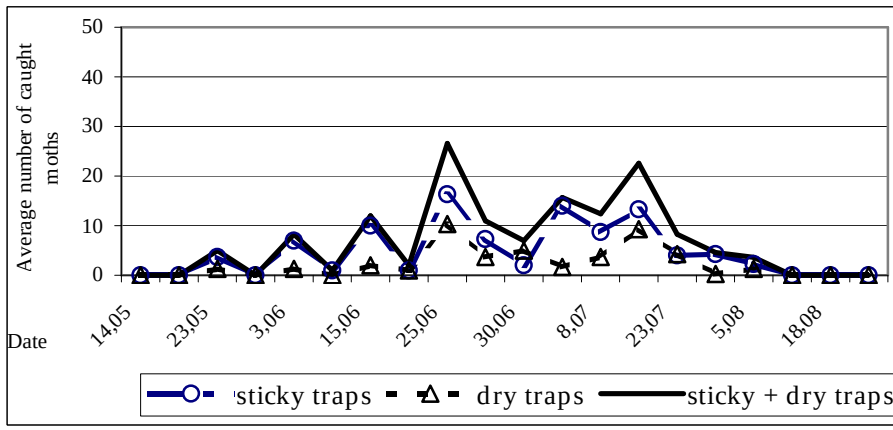

Figure 5. Flight dynamics of apple clearwing moth in the second orchard in 2004

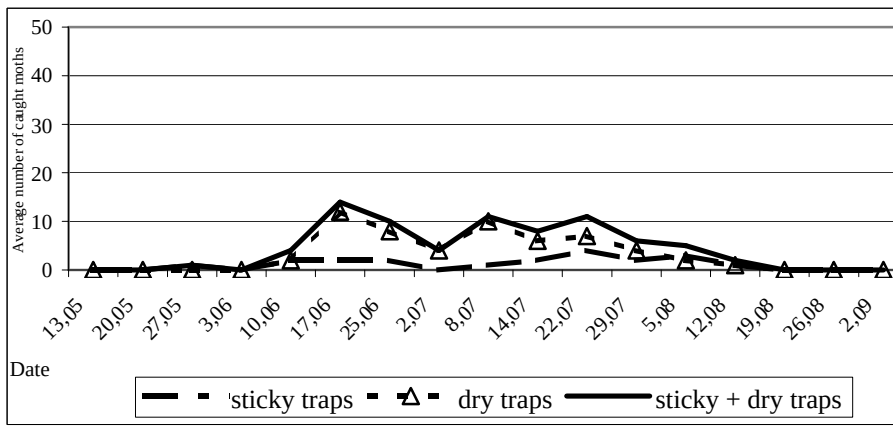

Figure 6. Flight dynamics of apple clearwing moth in the third orchard (chemical variant) in 2004

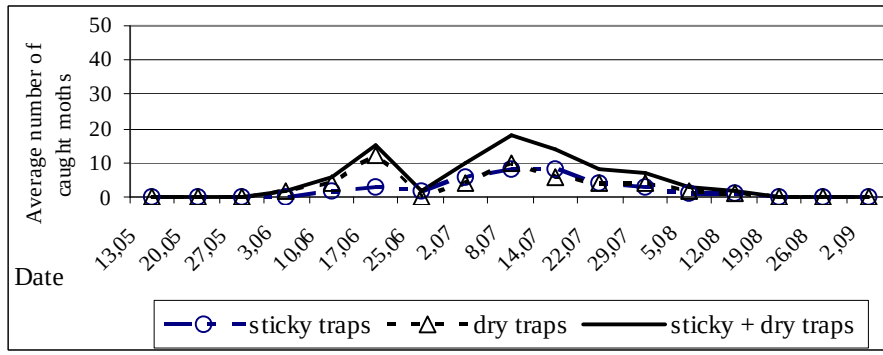

Figure 7. Flight dynamics of apple clearwing moth in the fourth orchard (biological variant) in 2004

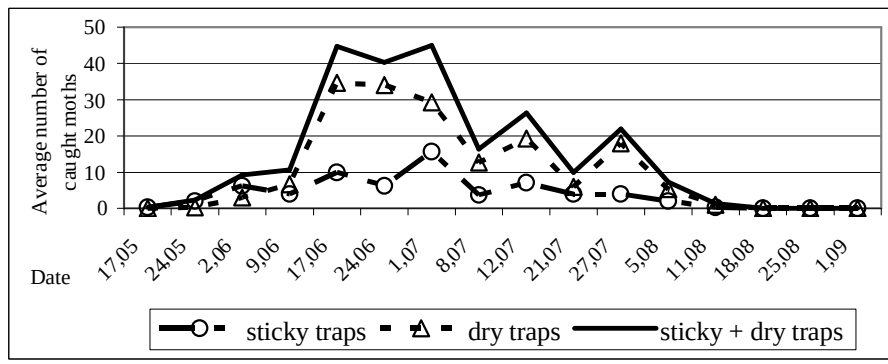

Figure 8. Flight dynamics of apple clearwing moth in the first orchard in 2005

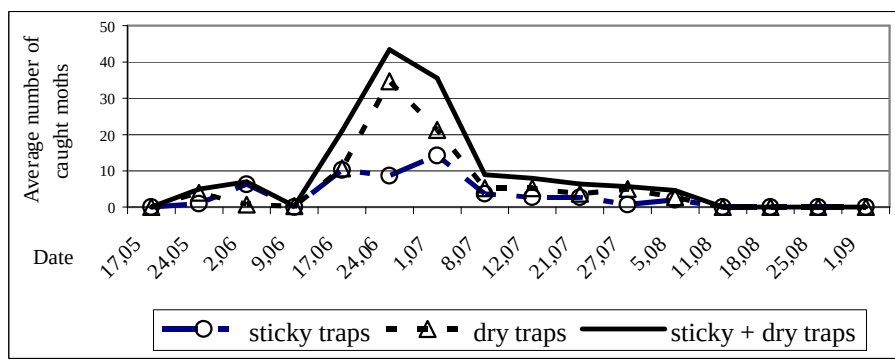

Figure 9. Flight dynamics of apple clearwing moth in the second orchard in 2005

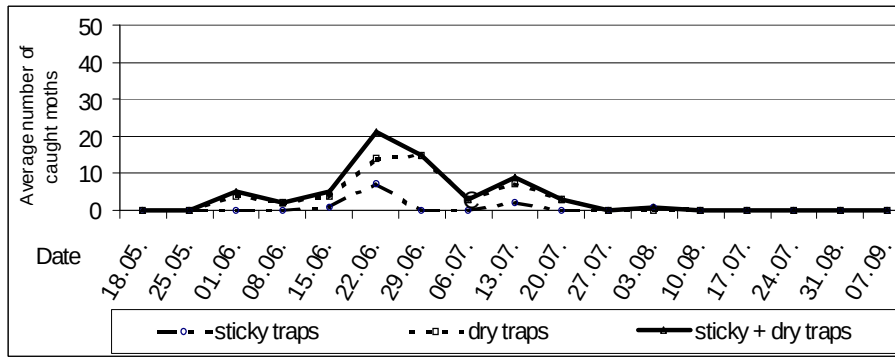

Figure 10. Flight dynamics of apple clearwing moth in the third orchard (chemical variant) in 2005

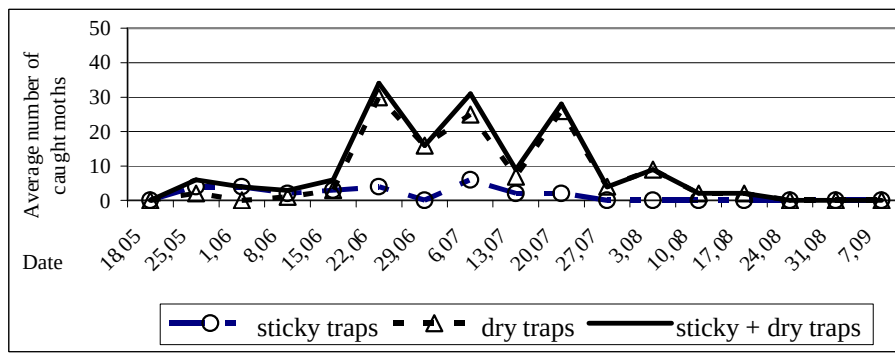

Figure 11. Flight dynamics of apple clearwing moth in the fourth orchard (biological variant) in 2005

Flight dynamics in the third and fourth orchards followed a similar pattern. During the three-year study, the flight period lasted from the second half of May until the middle of August. Several peaks were usually recorded, especially in June and July (Fig. 3, 6, 7, 10 and 11).

Apple clearwing moth density was higher in the first and second orchards. More adult male moths were trapped in the first and second orchards than in the third and fourth orchards.

In 2003, in the first orchard, 187 moths were caught in the sticky traps, and 354 were caught in the dry traps with insecticide. In the second orchard, 162 moths were caught in the sticky traps, and 109 in the dry traps.

In 2004, in the first orchard, 211 moths were caught in the sticky traps, and 353 were caught in the dry traps. In the second orchard, 293 moths were caught in the sticky traps, and 136 in the dry traps.

In 2005, in the first orchard, 191 moths were caught in the sticky traps, and 544 were caught in the dry traps. In the second orchard, 155 moths were caught in the sticky traps, and 282 in the dry traps.

In 2004, in the third orchard, 20 moths were caught in the sticky traps, and 56 were caught in the dry traps with insecticide. In 2005, 11 moths were caught in the sticky traps, and 52 in the dry traps.

In 2004, in the fourth orchard, 38 moths were caught in the sticky traps, and 49 were caught in the dry traps with insecticide. In 2005, 27 moths were caught in the sticky traps, and 127 in the dry traps.

When comparing data, one should keep in mind that three traps were used in the first and second orchards, and two traps were used in the third and fourth orchards (see also Tab. 1).

Table 1. Mean (non-transformed) values of *S. myopaeformis* males caught per trap from 2003 to 2005

Location - trap type	2003		2004		2005	
Fruit Growing Institute (3 + 3 traps in each orchard)	*First*	*Second*	*First*	*Second*	*First*	*Second*
Sticky dry with insecticide	63.3^{ns} 117.7	52.7^{ns} 39.0	64.3^{ns} 124.7	98.3* 45.0	63.7* 181.3	51.7^{ns} 94.0
Agricultural University (2 + 2 traps in each orchard)	*Third*	*Fourth*	*Third*	*Fourth*	*Third*	*Fourth*
Sticky dry with insecticide	- -	- -	10* 28	18.5^{ns} 24.5	5.5* 26.0	13.5* 63.5

^{ns} No significant difference between trap types

*The difference between trap types was significant at $\alpha \leq 0.05$

Flight dynamics and population density differed from orchard to orchard. This should be taken into account when determining the best time to apply pest control measures.

The synthetic pheromones were very effective and highly selective. Other insect species were very rarely found in the traps. Probably they wandered in there by chance, and were not specifically attracted by the pheromone itself.

Both types of traps provided accurate information on seasonal flight dynamics. It is difficult to say which trap type was more effective. Sometimes more moths were caught in the sticky traps, and sometimes more in the dry traps (Tab. 1).

The number of moths caught in each orchard apparently depended on population density in the orchard, which in turn depended on which control measures had been taken in the past or on some other unknown factors.

In our study, the flight period began in the middle of May, earlier than had been previously reported in other studies, in which the flight period of the

apple clearwing moth started at the end of May or at the beginning of June (Grigorov, 1972). In our study, the mass flight period lasted from the middle of June until the end of July, longer than in previous studies, in which the mass flight occurred in the middle of July (Grigorov, 1972).

CONCLUSIONS

1. Pheromone bait traps (Csalomon®, Hungary) were very effective and highly selective in capturing apple clearwing moths.
2. The flight period of the apple clearwing moth (*S. myopaeformis)* in the Plovdiv region of Bulgaria lasts about three to three-and-a-half months, from the second half of May until the middle or end of August. Mass flight occurs between the middle of June and the end of July.
3. Pheromone traps can be successfully used for determining the best time of application of pest control measures against the apple clearwing moth.

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BADANIE DYNAMIKI LOTU PRZEZIERNIKA JABŁONIOWEGO (*Synanthedon myopaefermis* BORKH., Lepidoptera: Sesiidae) NA PODSTWIE ODŁOWÓW W PUŁAPKI FEROMONOWE

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STRESZCZENIE

Przeziernik jabłoniowy (*Synanthedon myopaeformis* Borkh.) (Lepidoptera: Sesiidae) jest w ostatnich latach ekonomicznie ważnym szkodnikiem w Bułgarii. W latach 2003-2005 prowadzono obserwacje nad możliwością monitorowania tego szkodnika z użyciem pułapek feromonowych. Badania prowadzono w doświadczalnym sadzie jabłoniowym Instytutu Uprawy Owoców i Uniwersytetu Rolniczego w Plowdiw. Badano efektywność lepowych pułapek typu Delta i suchych pułapek tunelowych. Pułapki suche i dyspensery feromonowe były produktem Csalmon^{R} (Instytut Ochrony Roślin, Węgierskiej Akademii Nauk, Budapeszt), natomiast lepowe pułapki typu Delta były wytwarzane sposobem domowym w Bułgarii.

Pułapki feromonowe wykazały efektywność i selektywność działania. Lot motyli przeziernika jabłoniowego rozpoczął się w połowie maja i trwał 3 lub 3,5 miesiąca. Masowy lot notowano między połową czerwca i końcem lipca. Pułapki lepowe i tunelowe mogą być z powodzeniem używane do monitorowania lotu motyli przeziernika jabłoniowego.

Słowa kluczowe: *Synanthedon myopaefermis,* Sesiidae, dynamika lotu, pułapki feromonowe