Chapter 10.

Influence of Daily Temperature on the Pheromone Trap Catch of Harmful Microlepidoptera Species

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Abstract: Seven species of pheromone trap collection of Microlepidoptera pest presents the results of the everyday function of the daily temperature range in the study. Between 2004 and 2012 Csalomon type pheromone traps were operating in Bodrogkisfalud (48°10'N; 21°21'E; Borsod-Abaúj-Zemplén County, Hungary, Europe). The data were processed of following species: Spotted Tentiform Leafminer (*Phyllonorycter blancardella* Fabricius, 1781), Hawthorn Red Midget Moth (*Phyllonorycter corylifoliella* Hübner, 1796), Peach Twig Borer (*Anarsia lineatella* Zeller, 1839), European Vine Moth (*Lobesia botrana* Denis et Schiffermüller, 1775), Plum Fruit Moth (*Grapholita funebrana* Treitschke, 1846), Oriental Fruit Moth (*Grapholita molesta* Busck, 1916) and Codling Moth (*Cydia pomonella* Linnaeus, 1758). Our results suggest that pheromone trap catches of the species examined are in positive correlation with the daily maximum-, minimum-, daily averaged temperature ranges. The relation can be characterized with tertiary polynomials functions.

Keywords: Microlepidoptera, pests, pheromone traps, daily temperature parameters.

10. 1. Introduction

Temperature and precipitation may have an important role from the point of view of flying activity. The given temperature requirements of insects can be explained by the fact that their body mass is very small compared to both its surface and the environment. That is why their body temperature, instead of being permanent and self-sufficient, follows the changing temperature of the environment. This is because the ratios of the body mass and surface of insects determine the difference between the inner heat content and the incoming or outgoing heat. The heat content of the body is proportionate to its mass, while, on the other hand, the heat energy intake or loss is proportionate to the size of the surface of the body. Therefore an external effect makes its influence felt as against the inner, small heat content of a relatively small mass. The speed as well as the size of the impact follows from the ratio between the mass and surface of the body of the insect (Bacsó, 1964). And so the temperature value always exerts a substantial influence on the life processes of insects. The chemical processes described as metabolism that determine the life functions of insects always follow the temperature changes in the direct surroundings. Naturally, the activity of the organs of locomotion also depends on the temperature of the environment which explains why we can expect a massive light-trap turnout by what is an optimal temperature for the given species (Manninger 1948). According to Tsuji et al. (1986) the air temperature often has a very strong influence to the activity of insects. Such as small butterfly species under certain temperature are not able to fly. Southwood (1978), on the other hand, is of the view that the flight of insects has a bottom and top temperature threshold typical of each species. The insect flies if the temperature is above the bottom and below the top threshold and becomes inactive when the value is below the bottom or above the top threshold. In his view, other reasons explain the fluctuations in the number of specimens experienced in the interval between the low and high threshold values. However, research in Hungary has proved that in the context of a single species, too, a significant regression can be established between the temperature values and the number of specimens collected by light-trap (Járfás 1979, Nowinszky et al. 2003). Kádár and Erdélyi (1991) established positive correlation's between the temperature measured at 7 p.m. and 1 a.m. on the one hand and the number of ground beetles flying to light, on the other. Polish research has also confirmed that the number of noctuids light-trapped increases with the rise of temperature (Buszko and Nowacki, 1990).

Larsson and Svensson (2011) found that temperature was a dominating factor affecting the temporal flight patterns of the Hermit Beetle (*Osmoderma eremita* Scopoli) and the Red Click Beetle (*Elater ferrugineus* Linnaeus).

The temperature is constantly changing significantly and accordingly during the day and it may cause change relatively quickly in the phenomena of insect life as well. Presumably, therefore, that not only the current temperature exerts influence for their vital functions, but the temperature changes as well. The daily temperature ranges – the 24 hour period noted between the highest and lowest temperature difference – are in the temperate zone more important than in the tropics, this can lead to living in insects daily activity is strongly dependent on the daily temperature range than in the tropics living species. There are only a few studies in home and international literature which are in connection with the temperature oscillation and the phenomena of insect life.

According to Yi Liu et al. (1998) the circadian rhythm can be extremely sensitive to temperature changes; in insects, lizards, and fungi, clocks can be entrained by temperature cycles that oscillate only 1 °C to 2 °C. Ferenczy et al. (2010) found it surprising that the highly important factor is the average daily temperature range. This fact was so unexpected, because it is used as phenology models are generally more similar to the amount of heat temperature, or average kind of parameters are taken good results.

We assume that the temperature range rate is faster, and their effect is great. Therefore, we presented our research to the daily temperature range in pheromone trap collections. Our choice was justified by the fact that the studied species can fly during the whole day and night in pheromone traps, so the whole course of daily activity to sense the temperature changes and they adapt well to these conditions.

10. 2. Material

Between 2004 and 2012 Csalomon–type pheromone traps were operating in Bodrogkisfalud (48°10'N; 21°21'E; Borsod-Abaúj-Zemplén County, Hungary, Europe). These traps attracted 7 Microlepidoptera species were the followings: Spotted Tentiform Leafminer (*Phyllonorycter blancardella* Fabricius, 1781), Hawthorn Red Midget Moth *(Phyllonorycter corylifoliella* Hübner, 1796), Peach Twig Borer (*Anarsia lineatella* Zeller, 1839), European Vine Moth (*Lobesia botrana* Denis et Schiffermüller, 1775), Plum Fruit Moth (*Grapholita funebrana* Treitschke, 1846), Oriental Fruit Moth (*Grapholita molesta* Busck, 1916) and Codling Moth (*Cydia pomonella* Linnaeus, 1758). Data on the Hawthorn Red Midget Moth *(Phyllonorycter*

Table 10. 2. 1. The number and observing data of the examined species

Species	Number of	
	moths	data
Gracillariidae »Lithocolletinae Spotted Tentiform Leafminer *Phyllonorycter blancardella* Fabricius, 1781	64,546	2,709
Gracillariidae »Lithocolletinae Hawthorn Red Midget Moth *Phyllonorycter corylifoliella* Hübner, 1796	8,418	1,308
Gelechiidae » Anacampsinae Peach Twig Borer *Anarsia lineatella* Zeller, 1839	8,138	2,005
Tortricidae » Olethreutinae European Vine Moth *Lobesia botrana* Denis et Schiffermüller, 1775	8,913	1,976
Tortricidae » Tortricinae Plum Fruit Moth *Grapholita funebrana* Treitschke, 1846	28,913	2,746
Tortricidae Oriental Fruit Moth *Grapholita molesta* Busck, 1916	16,226	2,615
Tortricidae » Olethreutinae Codling Moth *Cydia pomonella* Linnaeus, 1758	8,961	2,156

corylifoliella Hbn.) were collected between 2008 and 2011 only.

Every year 2-2 traps per species were collected. So one night after a 2-2 catching data were available. Catch data of the collected species is displayed in Table 10. 2. 1.

10. 3. Methods

The distance between the traps were 50 meters and they were in operation all the year on the same branch of leafy trees or vines. The height of each species was different from 1.5 to 2 meters. The traps operated from start of April to the end of September. The capsules exchange was in every 6-8 weeks as it was proposed by Tóth (2003). The number of caught moths was daily recorded. This is different from the general practice, because generally the catch of the traps is counted two or three days together in most cases.

The weather data in the orchard was measured by meteorological instruments located 2 meters height. We measured the actual temperature daily at 7, 14 and 21 o'clock and we also determined the daily maximum and minimum temperature values. We calculated the daily temperature ranges, which was used in our calculations. The daily relative catch values were assigned to the daily temperature ranges data.

From the catching data of the examined species, relative catch (RC) data were calculated for each observation posts and days. The RC is the quotient of the number of individuals caught during a sampling time unit (1 day) per the average number of individuals of the same generation falling to the same time unit. In case of the expected averaged individual number the RC value is 1. The introduction of RC enables us to carry out a joint evaluation of materials collected in different years and at different traps.

The number of daily temperature ranges and the moths caught was calculated with consideration to the method of Sturges (Odor & Iglói 1987).

The RC values of a species from all sites and years were arranged into the proper classes. The results obtained are plotted. We determined the regression equations, the significance levels which were shown in the figures.

10. 4. Results and Discussion

The results are shown in Figures 10. 4. 1.–10. 4. 7.
Our results are without antecedents in the literature. Partly because the temperature can be found almost daily temperature ranges context for the insect releases. On the other hand the collecting results of the pheromone traps (with counted only in 2-3 days) are not suitable for investigations.

Our results clearly show the effectiveness of increasing the daily temperature range, on the pheromone trap catches of the examined species. The relations can be described with exponential (in one case), linear (in two cases) and logarithmic function (in four cases).

In the first two cases, the rise of daily temperature ranges increases with the number of captured moths. The logarithm function can be described by relationships but suggest that the growth of the catch has an upper limit. The highest values of daily temperature range belong to decreasing catch. It needs to be explained that when the daily temperature range is small, why is low to moderate activity, indicated by the low catch?

Otherwise, when the daily temperature range is high, why increase the number of captured moths, although some species have reduced the catch of the highest temperature range values? We hypothesize that this phenomenon may be due to those days when the daily temperature range is large, the temperature is relatively rapidly and significantly rise in body temperature rises as the insects as well. The significant increase in body temperature and locomotor activity also increases, which can result in an increase in the catch. The daily temperature range is lower to a lesser extent the increase in body temperature of insects, such as locomotor activity to a lesser extent increases. However, further studies probably confirm our hypothesis.

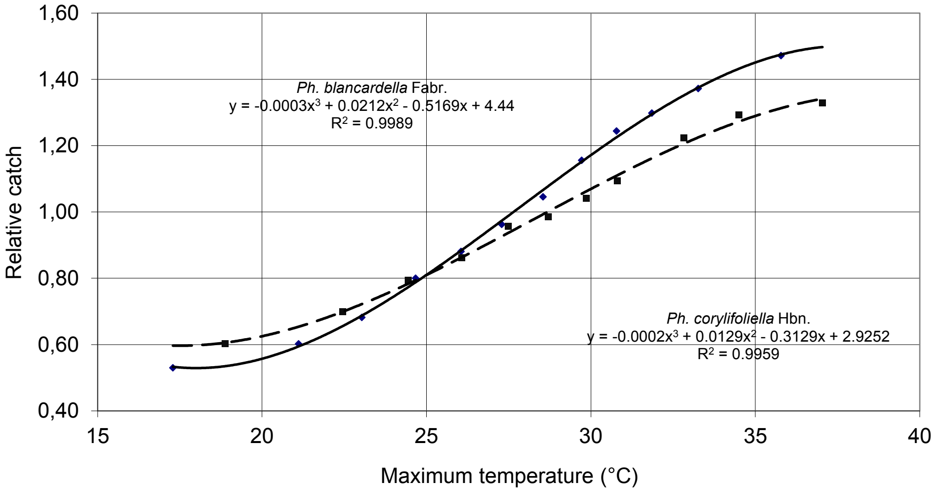

Figure 10. 4. 1.

Figure 10. 4. 1. Pheromone trap catch of the *Phyllonorycter blancardella* Fabricius and *Phyllonorycter corylifoliella* Hübner in connection with the maximum temperature

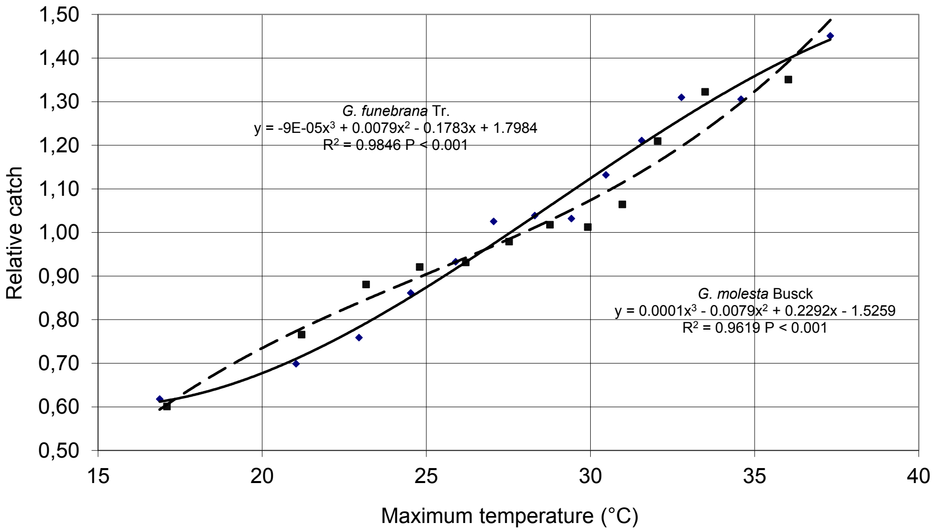

Figure 10. 4. 2.

Figure 10. 4. 2. Pheromone trap catch of the *Grapholita funebrana* Treitschke and *Grapholita molesta* Busck in connection with the maximum temperature

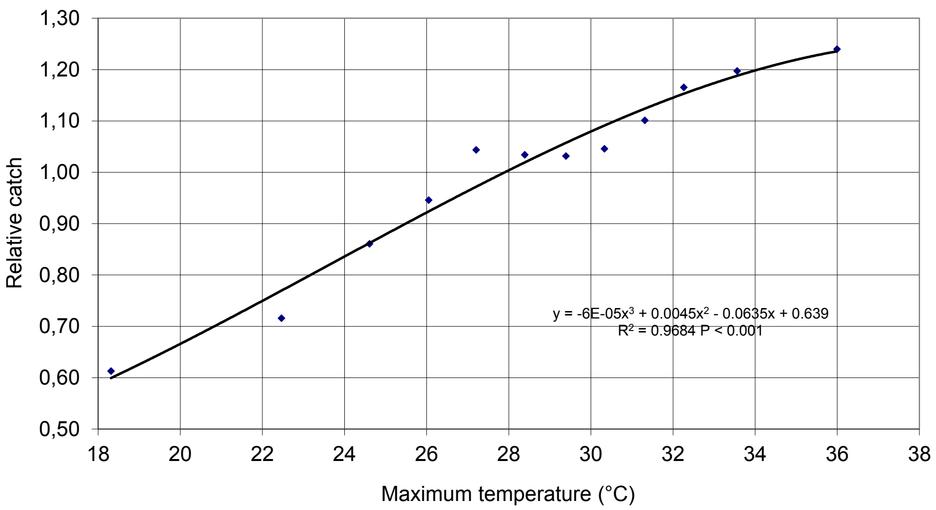

Figure 10. 4. 3.

Figure 10. 4. 3. Pheromone trap catch of *Cydia pomonella* Linnaeus in connection with maximum temperature

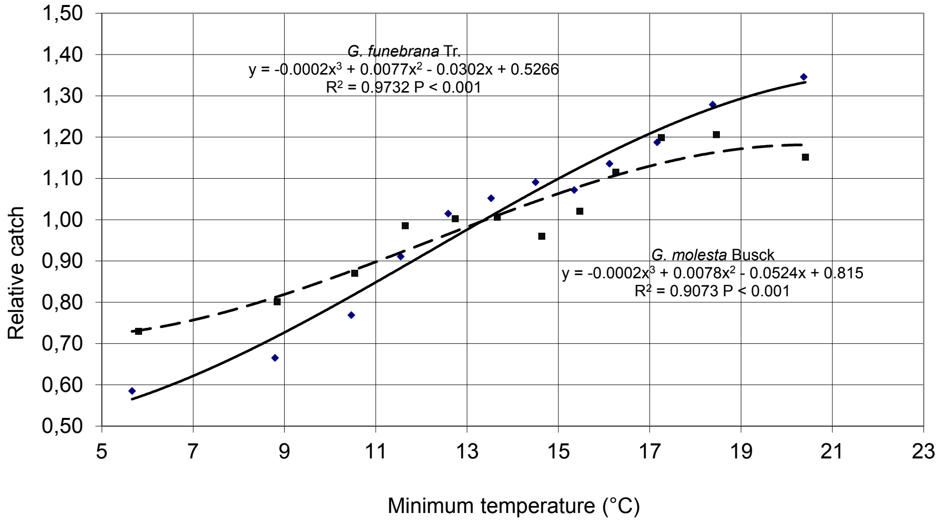

Figure 10. 4. 5.

Figure 10. 4. 5. Pheromone trap catch of the *Grapholita funebrana* Treitschke and *Grapholita molesta* Busck in connection with the minimum temperature

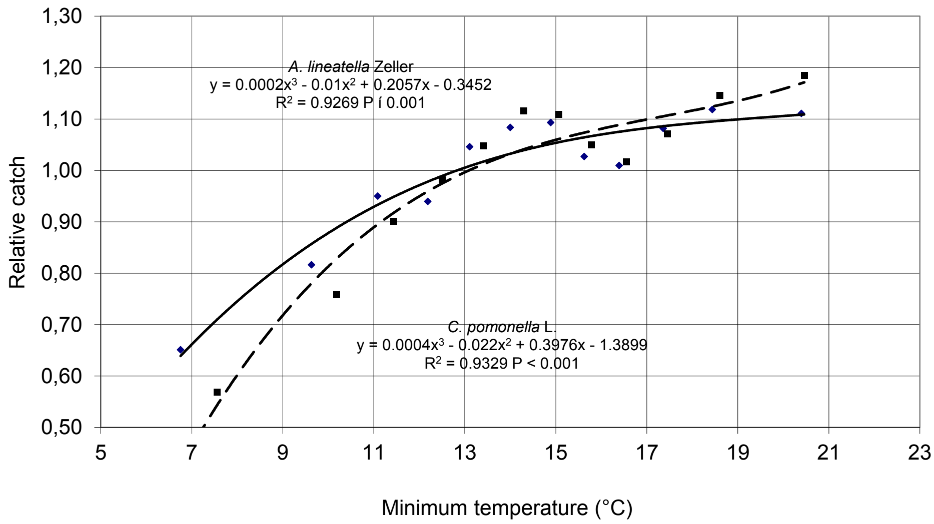

Figure 10. 4. 6.

Figure 10. 4. 6. Pheromone trap catch of the *Anarsia lineatella* Zeller and *Cydia pomonella* Linnaeus in connection with the minimum temperature

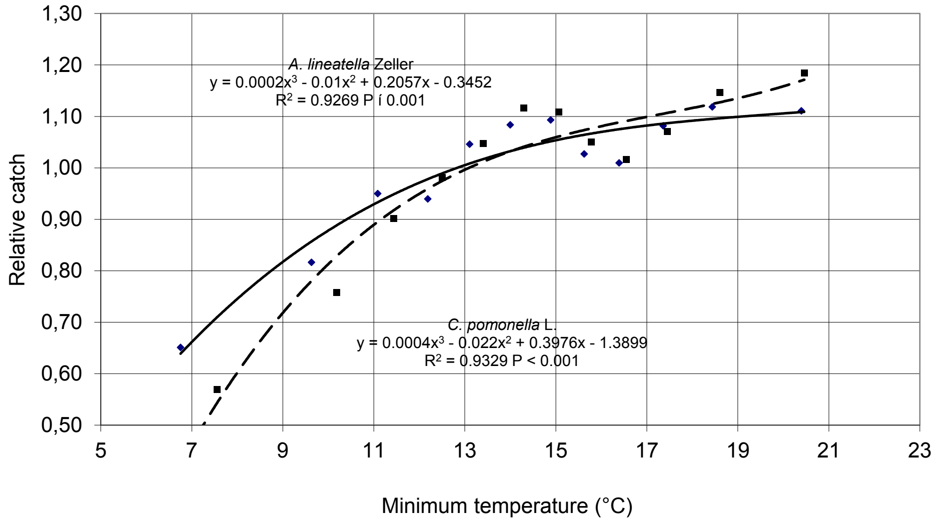

Figure 10. 4. 6.

Figure 10. 4. 6. Pheromone trap catch of the *Anarsia lineatella* Zeller and *Cydia pomonella* Linnaeus in connection with the minimum temperature

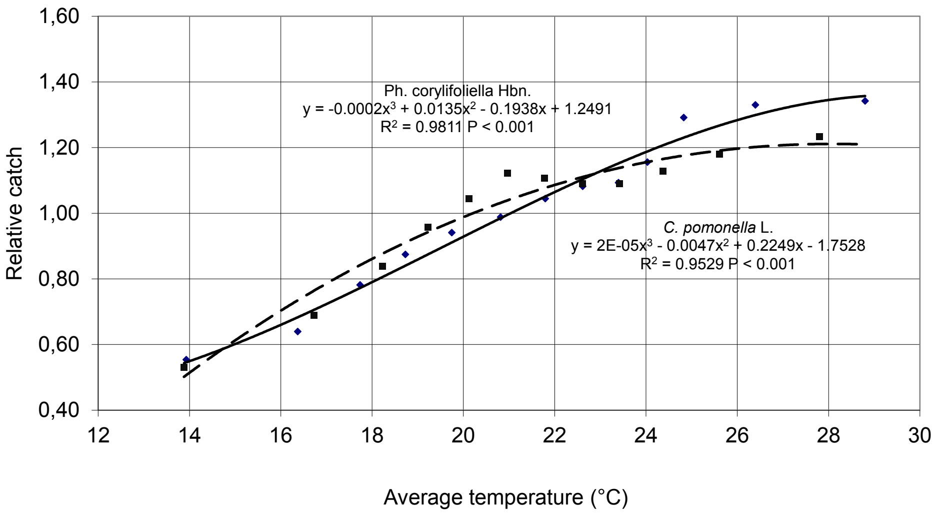

Figure 10. 4. 7.

Figure 10. 4. 7. Pheromone trap catch of the *Phyllonorycter corylifoliella* Hübner and *Cydia pomonella* Linnaeus in connection with the average temperature

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