Chapter 4.

Pheromone Trap Catch of Harmful Microlepidoptera species of the Csalomon Type Pheromone Traps in Connection with the Height of the Tropopause

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Abstract: In present study we examined the connection between height of tropopause and the pheromone trap catch of moth species. The data of 6 Microlepidoptera species were caught from the material of the Csalomon-type pheromone traps between 1993 and 2000. Groups were made from data of the height of tropopause. The relative catch values of the examined species were categorised according to the characteristics of tropopause on each day, after it these values were summarised, averaged and depicted. We defined the parameters of the regression equations. Five species were collected in a rising quantity initially and then after further increasing of height of the tropopause there was a decrease. In connection with the increasing the height of the tropopause, decrease was observed only in case of three species. The different form of behaviour, however, is not linked to the taxonomic position.

Keywords: Microlepidoptera, tropopause, pheromone trap, moths.

4. 1. Introduction

The changes in midlatitude air mass circulation are caused by a rise in the height of the tropopause, and other factors as increased moisture content in the atmosphere (Lorenz and DeWeaver 2007). If there are changes in the air mass circulation it must be changes in the elements of the weather such as temperature, air humidity, air pressure, wind speed and direction.

The tropopause is a surface separating the lower layers of the atmosphere (troposphere) from the upper layers (stratosphere). It is of varying height. The changes in tropopause height more weather elements contains a complex way: air temperature, humidity, strength of wind, air pressure, precipitation. In the presence of very cold air masses from the Arctic it may be a mere 5 kilometres, while in the presence of subtropical air it may grow to 16 kilometres. Sometimes there are two or three tropopauses one above the other.

A low tropopause is related the presence of cold and high tropopause the presence of warm types of air, while insect activity is increased by warm and reduced

by cold air. An over 13 km height of the tropopause often indicates a subtropical air stream at a great height. This has a strong biological influence. These results may lead us to assume that the electric factors in the atmosphere also have an important role to play, mainly when a stream of subtropical air arrives at great height. On such occasions the 3Hz aspheric impulse number shows a decrease, while cosmic radiation of the Sun will be on the increase (Örményi, 1984). The preponderance of negative ions in polar air reduces activity, while the preponderance of positive ions in subtropical maritime air may spur flight activity (Örményi, 1967). The warm air increases the activity of the insects; the cold reduces it on the other hand. As the changes in tropopause height causes also changes in the weather in the lower layers of air in large areas, we examined the efficiency of the catch of the light traps in connection with changes in the tropopause height. We did not find communications dealing with this topic in the literature apart from our own works.

In earlier, a few studies have been published, which deal with the efficiency of the light trap and the altitude of the tropopause of the Heart and Dart (*Agrotis exclamationis* L.), the Common Cockchafer (*Melolontha melolontha* L.), the Turnip Moth (Agrotis segetum Den. et Schiff.) and Fall Webworm Moth (*Hyphantria cunea* Drury) (Puskás and Nowinszky, 2000), (Örményi et al., 1997) and Puskás and Nowinszky (2011). It has been stated that the subtropical air masses, observed in the high altitudes, differently affect the efficiency of light-trap collection according to whether they come from that route over Hungary. The light-trap catch of Turnip Moth (Agrotis segetum Den. et Schiff.) and Heart & Dart (Agrotis exclamationis L.) is high during subtropical residence time of air masses, but during the Saharan air mass residence time it is low. It is just opposed the results to the Fall Webworm Moth (*Hyphantria cunea* Drury) light trapping catch.

In our earlier works we have examined the light-trap catch of European Cornborer (*Ostrinia nubilalis* Hübner) and Setaceous Hebrew Character (*Xestia c-nigrum* L.) and the caddisfly (Trichoptera) species as a function of the height of the tropopause, too (Nowinszky and Puskás, 2013 and Nowinszky et al., 2015).
We found in our former studies that the light trapping efficiency of parallel increases if the tropopause height is about 13 kilometres. However, the catch of the different species is not growing already longer on the higher values of the tropopause, but decreasing.

Therefore, we refer to our earlier studies where the effects of air masses influencing the collection were investigated (Nowinszky et al, 1997; Örményi et al, 2003). In these studies the subtropical air masses were divided on the basis of their origin and the path as follows:

Subtropical air; Azores air moving from W and WSW; Continental subtropical air arriving from the Middle East from SE; Saharan air from the Middle East from SE (observing in the upper layers only); Saharan air from across the Mediterranean Sea; Saharan air from across the Black Sea and Warm air from the Black Sea.

4. 2. Material

Data for Budapest on the height of the tropopause have been collected from the Annals of the Central Meteorological Institute of the Hungarian Meteorological Service. Because area of Hungary is 93 036 km² only, so this data is valid for the entire territory of the country (Örményi et., 1997).

Between 1993 and 2000 Csalomon type pheromone traps were operating in Bodrogkisfalud (48°10' N, 21°21' E; Borsod-Abaúj-Zemplén County, Hungary, Europe). These traps attracted 6 Microlepidoptera species. Every year 2-2 traps per species were collected; one night after a 2-2 catching, data were available.

Six harmful Microlepidoptera species were caught by the Csalomon type sticky traps at Bodrogkisfalud in Borsod-Abaúj-Zemplén County (Hungary) between 1993 and 2000. The caught species were the followings: Spotted Tentiform Leafminer (*Phyllonorycter blancardella* Fabricius, 1781), 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). The catch data of the collected species is displayed in Table 4. 2. 1.

4. 3. Methods

The traps near each other worked all year. They were placed on leafy trees of the same branches and vines at a distance of 50 meters between the traps. The height of each species was different, from 1.5 to 2 meters. The traps operated from the beginning of April to the end of September. According to Tóth (2003) the proposed capsules exchange was in a 6-8 week period. The number of moths captured per day was recorded, which is different from the general practice of counting the catch two or three days together.

The pheromone traps operated in the same orchards and vineyards in every year. There were no performed chemical pest control treatments.

Than the number of individuals of a given species in different places and different observation years is not the same. The collection efficiency of the modifying factors (temperature, wind, moonlight, etc.) are not the same at all locations and at the time of trapping, it is easy to see that the same number of items capture two different observers place or time of the test species mass is entirely different proportion. To solve this problem, the introduction of the concept of relative catch was used decades ago (Nowinszky, 2003).

The relative catch (RC) for a given sampling time unit (in our case, one night) and the average number individuals per unit time of sampling, the number of generations divided by the influence of individuals If the number of specimens taken

from the average of the same, the relative value of catch: 1. The relative catch allows the processing of collecting aggregate data from different years and observation locations (Nowinszky, 2003).

From the collection data pertaining to examined species we calculated relative catch values (RC) by light-trap stations and by swarming. Following we arranged the data on the height of the tropopause in classes.

Relative catch values were placed according to the features of the given day, and then RC were summed up and averaged. The data are plotted for each species and regression equations were calculated for relative catch of examined species and tropopause data pairs. We determined the regression equations, the significance levels which were shown in the figures.

4. 4. Results and Discussion

Our results are shown in Figures 4. 4. 1.-6. The characteristic curves and associated parameters are indicated in the figures and significance levels are also given.

Our results show that the pheromone trap catch of Spotted Tentiform Leafminer (*Phyllonorycter blancardella* Fabricius), Codling Moth (*Cydia pomonella* Linnaeus), European Vine Moth (*Lobesia botrana* Denis et Schiffermüller), Oriental Fruit Moth (*Grapholita molesta* Busck) and Plum Fruit Moth (*Grapholita funebrana* Treitschke) rising to near 11 km tropopause height increases, but higher values have been greatly reduced.

The tropopause height in the lower air layers is associated with different weather situations. Insects, such as moths also change the flight activity of responding to changing weather conditions. Low tropopause is linked to the presence of cold, but high tropopause with hot air masses. The hot air can decrease the insect activity and very cold air causes the same effect. If there is a link to tropopause height other factors may have an influence.

Only one species (Peach Twig Borer (*Anarsia lineatella* Zeller) was caught the highest during the moderately cool temperatures (tropopause height is 9 km).

The optimum air temperature of this species for flight can be lower than the other examined species.

The reason can be explained, that in subtropical air masses residence at the time of very hot nights have reduced flight activity.

The tropopause height above 13 km often indicates the type of subtropical air inflow at high altitude and it has a strong biological effectiveness. Atmospheric electrical factors may also have a role, especially during the high-altitude subtropical air inflow. In this case, for example, 3 Hz spherics pulses are reduced, while the solar cosmic rays increase (Örményi 1984). The atmospheric ions may also have a significant role (Örményi 1967). The arctic air may decrease flight activity factor due to the dominance of negative ions, but the dominance of positive ions

in the subtropical air could be a factor in increasing flight activity.
We do not know yet every detail of how effects the height of the tropopause the catch results.

The connection between weather and tropopause is not completely known; therefore we hope later investigations will provide a fuller explanation about the causes of the results we obtained. Further researches will hopefully lead to a clear answer.

Our results show that the pheromone trap catch of five Microlepidoptera species rising to near 11 km tropopause height increases, but higher values have been greatly reduced. Only one species was caught the highest during the moderately cool temperatures (tropopause height is 9 km).

Table 4. 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	16,630	533
Gelechiidae » Anacampsinae Peach Twig Borer *Anarsia lineatella* Zeller, 1839	2,100	564
Tortricidae » Olethreutinae European Vine Moth *Lobesia botrana* Denis et Schiffermüller, 1775	3,738	264
Tortricidae » Olethreutinae Plum Fruit Moth *Grapholita funebrana* Treitschke, 1846	7,594	929
Tortricidae » Olethreutinae Oriental Fruit Moth *Grapholita molesta* Busck, 1916	2,597	615
Tortricidae » Olethreutinae Codling Moth *Cydia pomonella* Linnaeus, 1758	1,915	632

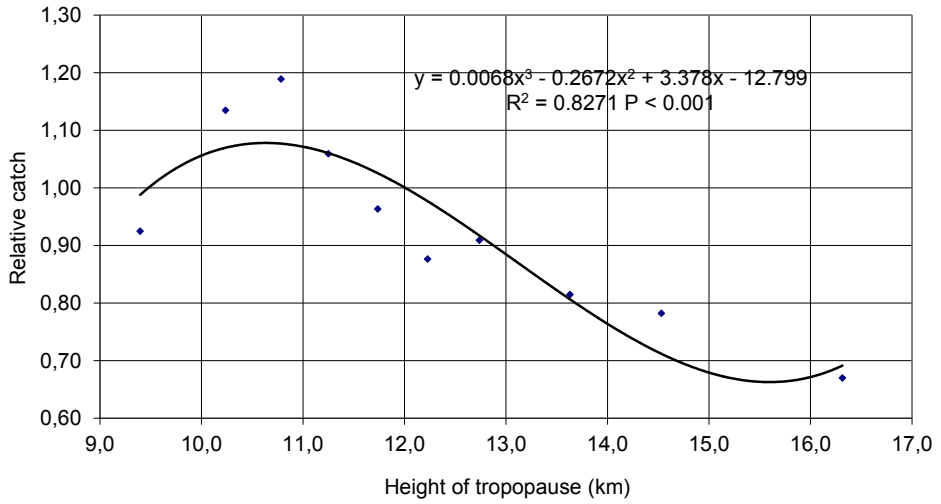

Figure 4. 4. 1.

Figure 4. 4. 1. Pheromone trap catch of Spotted Tentiform Leafminer (*Phyllonorycter blancardella* Fabricius) in connection with the height of tropopause (Bodrogkisfalud, 1993-2000)

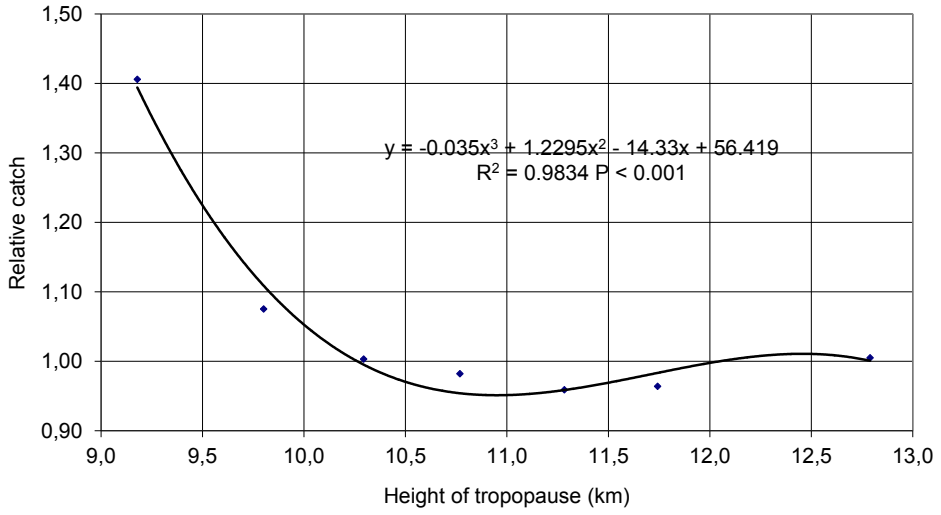

Figure 4. 4. 2.

Figure 4. 4. 2. Pheromone trap catch of Peach Twig Borer (*Anarsia lineatella* Zeller) in connection with the height of tropopause (Bodrogkisfalud, 1993-2000)

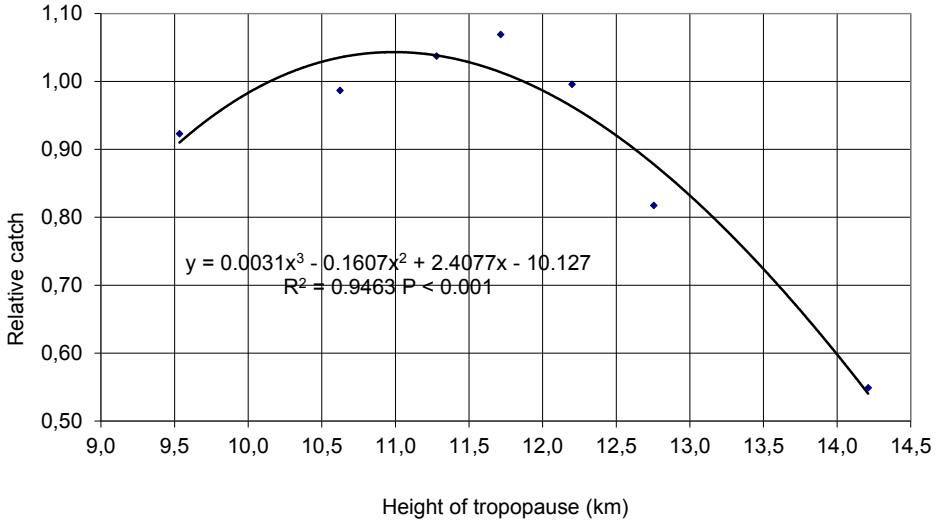

Figure 4. 4. 3.

Figure 4. 4. 3. Pheromone trap catch of European Vine Moth (*Lobesia botrana* Denis et Schiffermüller) in connection with the height of tropopause (Bodrogkisfalud, 1993-2000)

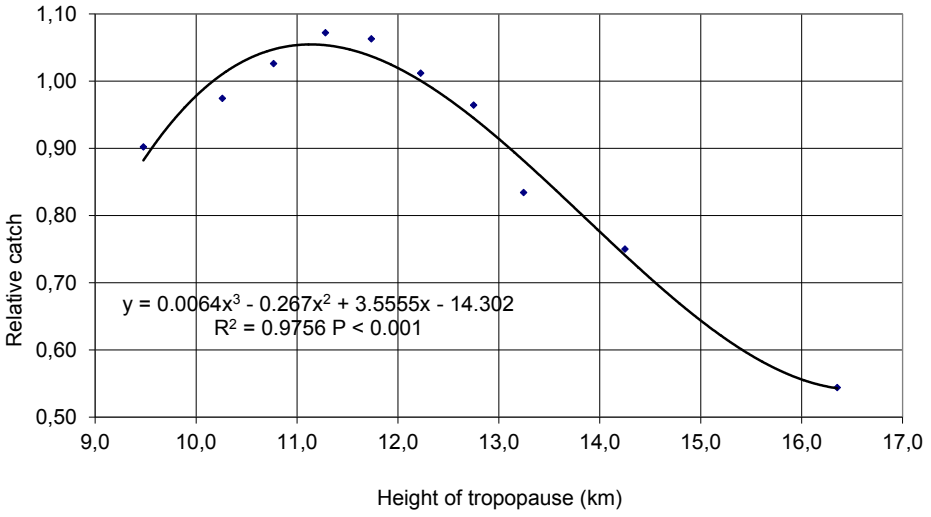

Figure 4. 4. 4.

Figure 4. 4. 4. Pheromone trap catch of Plum Fruit Moth (*Grapholita funebrana* Treitschke) in connection with the height of tropopause (Bodrogkisfalud, 1993-2000)

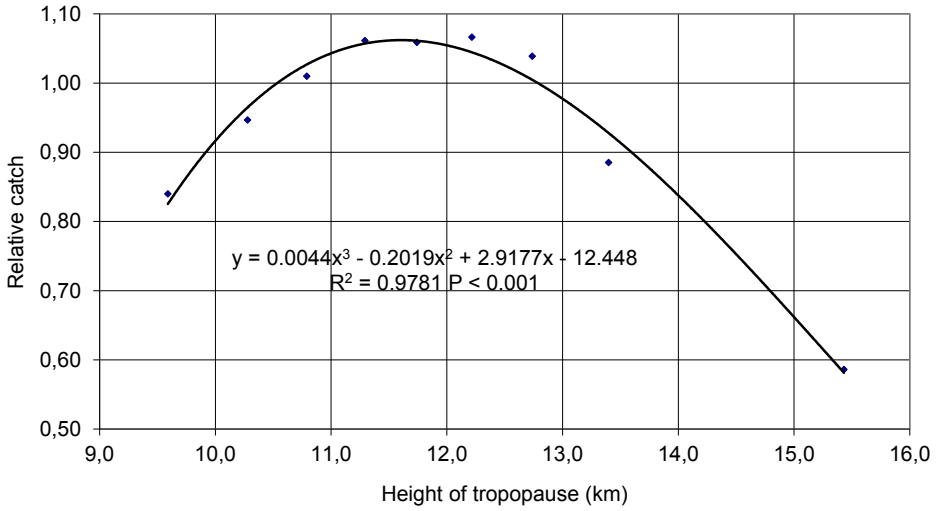

Figure 4. 4. 5.

Figure 4. 4. 5. Pheromone trap catch of Oriental Fruit Moth (*Grapholita molesta* Busck) in connection with the height of tropopause (Bodrogkisfalud, 1993-2000)

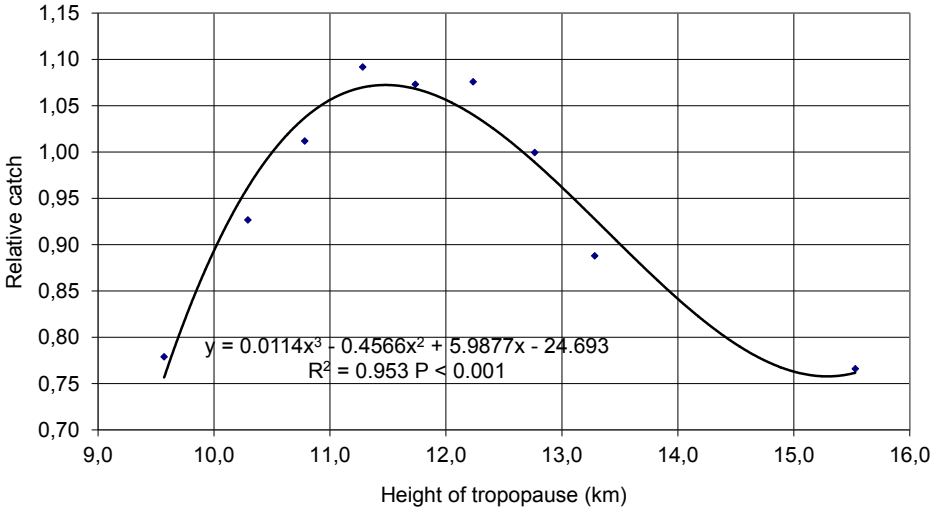

Figure 4. 4. 6.

Figure 4. 4. 6. Pheromone trap catch of Codling Moth (*Cydia pomonella* Linnaeus) in connection with the height of tropopause (Bodrogkisfalud, 1993-2000)

References

Lorenz, D. J. & DeWeaver, E. T. 2007: Journal of Geophysical Research: Atmospheres (1984–2012), 112, 10, DOI: 10.1029/2006JD008087

Nowinszky, L. 2003: The Handbook of Light Trapping. – Savaria University Press, Szombathely, 276 p.

Nowinszky, L. Puskás, J. & Örményi, I. 1997: Light trapping success of heart-and-dart moth (*Scotia exclamationis* L.) depending on air masses and weather fronts. – Acta Phytopathologica et Entomologica Hungarica, 32. 3–4: 333–348.

Nowinszky, L. & Puskás, J. 2013: Light-trap catch of the European Corn-borer (*Ostrinia nubilalis* Hübner) and Setaceous Hebrew Character (*Xestia c-nigrum* L.) in connection with the height of tropopause. – Global Journal of Medical Research Veterinary Science and Veterinary Medicine, 13 (2): 41–45.

Nowinszky, L. Puskás, J. & Kiss, O. 2015: The efficiency of light-trap catches of caddisfly (Trichoptera) species in connection with the height of tropopause in Hungary (Central Europe). – Molecular Entomology, 6 (3): 1–7.

Örményi, I. 1967: Atmospheric ionization examinations surrounding of Lukács bath (in Hungarian). – Magyar Balnoklimatológiai Egyesület Évkönyve, 105–129.

Örményi, I. 1984: Influence of 3 Hz atmospheric electromagnetic radiation for people on same territories of life (in Hungarian). – Ph. D. Thesis. Budapest.

Örményi, I. Nowinszky, L. & Puskás, J. 1997: Light trapping the adults of Heart and Dart (*Agrotis exclamationis* L.) (Lep.: Noctuidae) in relation to different air types and heights of the tropopause (in Hungarian). – Növényvédelem, 33 (9): 463–471.

Örményi, I. Nowinszky, L. & Puskás, J. 2003: Air masses In. Nowinszky, L (ed.) (2003): The Handbook of Light Trapping. – Savaria University Press. 143–154.

Puskás, J. & Nowinszky, L. 2000: Light trapping of Common Cockchafer (*Melolontha melolontha* L.) in connection with the characteristics of tropopause (in Hungarian). – Proceedings of Berzsenyi Dániel College Szombathely Natural Science Brochures, 5: 5–8.

Puskás, J. & Nowinszky, L. 2011: Light-trap catch of harmful insects in connection with the height of tropopause. – Advances in Bioresearch, 2 (2): 101–103.

Tóth, M. 2003: The pheromones and its practical application. In: Jenser, G. (ed.): Integrated pest management of pests. – Mezőgazda Kiadó, Budapest, 21–50. (in Hungarian).