Chapter 9.

Pheromone Trap Catch of the Harmful Microlepidoptera Species in Connection with the Puskás–Type Weather Fronts

J. Puskás[1], L. Nowinszky[1], G. Barczikay[2]

[1]University of West Hungary Savaria University Centre, 9700 Szombathely, Károlyi G. Square 4., Hungary; E-mail: pjanos@gmail.com; lnowinszky@gmail.com
[2]County Borsod-Abaúj-Zemplén Agricultural Office of Plant Protection and Soil Conservation Directorate, 3917 Bodrogkisfalud, Vasút Street 22., Hungary

Abstract: In this study nine new weather front types were determined from the "Daily Weather Reports" valid for the Carpathian Basin. These nine weather front types were successfully used in examinations of catch data of pheromone trap catch of eight harmful Microlepidoptera species. The Csalomon type pheromone traps were operation in Bodrogkisfalud, (Borsod-Abaúj-Zemplén County, Hungary, between 1993 and 2013.We calculated relative catch values from the total number of caught moths. We assigned the daily relative catch values for every species to the daily front types. Catches could be either successful or not according to the weather front types. Our examinations proved that the weather fronts influence the pattern of pheromone trap catch.

Key words: pheromone trap, Puskás-type weather fronts, Microlepidoptera

9. 1. Introduction

Frontal passages result in a sudden and essential transformation of the physical environment of living creatures. A simultaneous change of all the weather factors triggers off a reaction of front sensitivity symptoms in animals and human beings. As against the width and depth of comprehensive medico-meteorological research, there are remarkably few researchers to have examined the behaviour of insects and their flight activity in connection with the various types of fronts. Of Hungarian researchers, Wéber (1959) dealt with the influence of weather fronts on collecting insects by light-trap. In his view, research on the influence of frontal changes is hampered by numerous factors (fronts may follow one another in alone or two, fronts can pass through without any air mass change, the same type of front does not always have the same intensity, etc.). For this reason, in the course of his investigation, he did not make an attempt to define general regularities, instead, by analysing some concrete, typical cases, he demonstrated with a graphical method the influence of weather fronts on collecting. In consequence of the above difficulties, Járfás (1979) advised research on the influence of the different weather factors instead of the weather fronts. Kádár and Szentkirályi (1991), in their turn, showed that the light trapping efficiency of ground beetles (Coleoptera, Carabidae) diminishes on the days of the arrival of cold fronts but increases when warm fronts arrive. For their examinations they used the front and air mass calendar of the Hungarian Meteorological Service which distinguishes only between the above two fronts. Helson and Penman (1970) appraised the results of their light trapping in New Zealand in connection with cold fronts. Shortly before the arrival of the front, they experienced an ion activity peak. Yet, we have not found any studies of basic importance dealing with the relationship between fronts and light trapping in international scientific literature.

Weather fronts can be categorized according to a number of viewpoints. Berkes (1961) determined 21 types of fronts for the territory of Hungary and characterized them. However, their validity does not apply to the whole country.

In our previous work (Nowinszky et al., 1997), we applied this classification successfully in our assessment of the light trap catch results of the Heart and Dart Moth *(Agrotis exclamationis* L.).

Based on the weather features published in the "Daily Weather Reports", Puskás has developed a new, individual classification to be used in our studies. This classification was published recently (Puskás, 2001) in the form of a catalogue. Several scientists employed this classification in their studies on the activity of insects (Puskás, 1998, 1999, Kúti 2001) and birds (Gyurácz and Puskás, 1996a, 1996b, Puskás and Gyurácz, 1998). In connection with the front types worked out by Puskás (2001), Kúti (2002a, 2002b) has recently studied the light trapping efficiency of Macrolepidoptera, Microlepidoptera, Coleoptera and Heteroptera species. By an approaching cold front, he observed a decline in the case of all 4 orders, also by a staying cold front in the case of Coleoptera and Heteroptera, by an approaching warm front in the case of Macrolepidoptera and Microlepidoptera species. The number of specimens trapped increased in the case of all four orders at the time of simultaneously stay-ing cold and warm fronts.

However, in a previous article we had already investigated the pheromone trap catches of the Spotted Tentiform Leafminer (*Phyllonorycter blancardella* Fabricius) in conjunction with Puskás-type weather fronts (Puskás et al. 2011).

Table 9. 2. 1. The pheromone traps were operated in Borsod-Abaúj-Zemplén County

Villages	Years	Longitude	Latitude
Bodrogkisfalud	1982–1983, 1993–2013	48°10'41″	21°21'77″
Bodrogkeresztúr	1988	48°09'54″	21°21'64″
Bodrogszegi	1982–1983	48°26'82″	21°35'61″
Erdőbénye	1987–1988	48°15'91″	21°21'18″
Erdőbénye-Meszesmajor	1988	48°11'43″	21°22'46″
Mád	1987–1988	48°11'55″	21°16'70″
Sátoraljaújhely	1988	48°23'80″	21°39'34″
Tolcsva	1988	48°17'05″	21°27'02″
Tokaj	1990	48°06'75″	21°24'75″

9. 2. Material

Between 1993 and 2013, pheromone traps were running in Bodrogkisfalud (Borsod-Abaúj-Zemplén County, Hungary) (Table 9. 2. 1.). These traps caught 8 Microlepidoptera species.

Spotted Tentiform Leafminer (*Phyllonorycter blancardella* Fabricius, 1781), Hawthorn Red Midget Moth *(Phyllonorycter corylifoliella* Hübner, 1796), Peach Twig Borer (*Anarsia lineatella* Zeller, 1839), Vine Moth (*Eupoecilia ambiguella* Hübner, 1796), 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). Number of individuals and observing data can be seen in Table 9. 2. 2.

Observing data means the catching of one trap in one night, regard-less of the number of insects caught. But there were years in which each species were collected in two traps.

We worked out new weather front types (Puskás 2001) from the "Daily Weather Reports". This information was the basis of the analysis of meteorological events in Europe and Hungary. The synoptic maps were also used in the categorization process.

9. 3. Methods

The location of warm-, cold- and occluded fronts were determined for each day of the period 1st January 1982 - 31st December 2013, but we used the data of each year between 1st April and 31st October. We classified the fronts on the basis of their quality and location relating to the territory of Hungary. Arriving front means that the front comes close to the border or just enters the territory of Hun-

Table 9. 2. 2. The number and observing data of the examined species`

Species	*Years*	*Number of*	
		Moths	*Data*
Gracillariidae »Lithocolletinae Spotted Tentiform Leafminer *Phyllonorycter blancardella* Fabricius, 1781	1993-2013	95,610	4,023
Gracillariidae »Lithocolletinae Hawthorn Red Midget Moth *Phyllonorycter corylifoliella* Hübner, 1796	2008-2013	10,202	1,712
Gelechiidae » Anacampsinae Peach Twig Borer *Anarsia lineatella* Zeller, 1839	1993-2013	14,648	3,552
Tortricidae » Tortricinae Vine Moth *Eupoecilia ambiguella* Hübner, 1796	1982-83, 1990, 1987-1988 2000, 2002	2,266	507
Tortricidae » Olethreutinae European Vine Moth *Lobesia botrana* Denis et Schiffermüller, 1775	1982–83, 1987– 88, 1990, 1993–2013	30,270	3,964
Tortricidae » Olethreutinae Plum Fruit Moth *Grapholita funebrana* Treitschke, 1846	1982-83 1985 1993-2013	53,386	5,324
Tortricidae » Olethreutinae Oriental Fruit Moth *Grapholita molesta* Busck, 1916	1988, 1993-2013	26,867	4,375
Tortricidae » Olethreutinae Codling Moth *Cydia pomonella* Linnaeus, 1758	1982-1983, 1985, 1988 1993-2013	16,077	3,841

gary. The benefit of using these front types is that a lower level of meteorological knowledge is sufficient to appreciate the determination of different types. These types are: 1 arriving cold front (aC), 2 cold front (C), 3 arriving warm front (aW), 4 warm front (W), 5 arriving occluded front (aO), 6 occluded front (O), 7 arriving warm and cold front (aWC), 8 warm and cold fronts (WC), 9 warm-, cold- and occluded fronts (WCO).

Relative catch values were calculated from the number of caught moths. The relative catch (RC) is the quotient of the number of individual moth trapped in one unit of sampling.

If the number of the specimen trapped equals the average, the value of relative catch is 1. In our study this equated to one night, and the average number of specimen of a generation in a time unit of sampling. We assigned the daily relative catch values for every species to the daily front types. This process was also adopted on those days when no front was detected. The values were summarized and the averages together with the levels of significance were calculated. We calculated the regression equations and the differences in all cases the level of significance.

9. 4. Results and Discussion

Results are shown in Table 9. 4. 1.
We found significant high or low catch in different weather fronts. We found that the majority of fronts due to a decrease in catches. An exception is only the arriving warm front (aW), which resulted in increase in catches of two species. Quite exceptional is the Vine Moth (*Eupoecilia ambiguella* Hbn.) because the warm front (W) caused a strong increase in catch of this species. The warm front is effective only for this species.

A cold front can hardly be a favourable weather situation for a moth whose intensified flight activity at the time of such a front can be explained with a hypothesis we described in detail in an earlier work (Nowinszky et al., 1997). In brief: low relative catch values always refer to weather situations in which the flight activity of insects diminishes. However, high values are not so clear to interpret. Major environmental changes bring about physiological transformation in the insect organism. The imago is short-lived; therefore unfavourable weather endangers the survival of not just the individual, but the species as a whole. In our hypothesis, the individual may adopt two kinds of strategies to evade the impacts hindering the normal functioning of its life phenomena. It may either display more liveliness, by in-creasing the intensity of its flight, copulation and egg-laying activity or take refuge in passivity to weather an unfavourable situation. And so by the present state of our knowledge we might say that favourable and unfavourable weather situations might equally be accompa-nied by a high catch.

Table 9. 4. 1. Pheromone trap catch of harmful Microlepidoptera species in connection with the Puskás-type weather fronts

Species	1 aC	3 aW	4 W	6 O	7 aWC	9 WCO
Ph. blancardella Fabr.			0.804*	0.771*	0.856**	
Ph. corylifoliella Hbn.		0.695	0.749*	0.705		
A. lineatella Zeller				0.735		
E. ambiguella Hbn.			3.621**			
L. botrana Den. et Schiff.						
G. funebrana Tr.	1.148	0.863*	0.747**	0.629**		0.759*
G. molesta Busck	1.126		0.792	0.744*		
C. pomonella L.		0.722*		0.780		

Notes: Significance levels are: normal = P < 0.05, * = P < 0.01, ** = P < 0.001
The table includes only those fronts, which includes significant data on catches.

We have no full knowledge of the favourable and unfavourable effects of weather on insects during the stay and especially consecutive passage of different fronts. However, the frequency of weather fronts justifies the need for further examination to yield results to be used in everyday practice as soon as possible.

References

Berkes, Z. 1961: Types of air-masses and fronts in the Carpathian Basin (in Hungarian). Időjárás, 5: 289–293.

Gyurácz, J. & Puskás, J. 1996a: Effect of the cold fronts on trapping of the *Acrocephalus schoenobaenus* (in Hungarian). Proceedings of Berzsenyi Dániel College Szombathely — Natural Sciences. 10 (5): 127–131.

Gyurácz, J. & Puskás, J. 1996b: The effect of cold weather fronts on the migration activity of the Sedge Warbler *(Acrocephalus schoenobaenus)* in Hungary. Ornis Hungarica 6 (1—2): 43–45.

Helson, G. A. H. & Penman, J. E. R. 1970: Biological transformations associated with weather changes. A hypothesis on the flight activity of *Wiseana* spp. International Journal of Biometeorology 14 (3): 227–246.

Járfás, J. 1979: Forecasting of harmful moths by light-traps (in Hungarian). PhD Thesis. Kecskemét, 127 p.

Kádár, F. & Szentkirályi, F. 1991: Influences of weather fronts on the flight activity of ground beetles (Coleoptera, Carabidae). Proceedings of the 4th ECE/XIII. SIEEC, Gödöllő: 500–503.

Kúti, Zs. 2001: Effects of weather front on insects (in Hungarian). Proceedings of Berzsenyi Dániel College Szombathely Natural Science Brochures 7: 41–52.

Kúti, Zs. 2002a: The influence of weather for light trapping. Növényvédelem, 38 (8): 409–415.

Kúti, Zs. 2002b: Prognostisation of harmful insects in connection with the weather factors (in Hungarian). 1st International Conference on Application of Natural-, Technological– and Economical Sciences, Szombathely: 127–132.

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. In: Nowinszky, L. [ed.]: Light trapping of insects influenced by abiotic factors. Part II. Savaria University Press: 57–72.

Puskás, J. 1998: Investigation of weather events for development the plant protecting methods (in Hungarian). PhD Dissertation. Keszthely, 92 p.

Puskás, J. 1999: The influence of meteorological elements for harmful insects. Dissertationes Savarienses 27. 36 p.

Puskás J. 2001: New weather front types and catalogue for the Carpathian Basin. In: Nowinszky, L. [ed.]: Light trapping of insects influenced by abiotic factors. Part III. Savaria University Press, Szombathely: 87–118.

Puskás, J. & Gyurácz, J. 1998: Influence of weather fronts on the migration of the Sedge Warbler *(Acrocephalus schoenobaenus)*. Proceeding of Berzsenyi Dániel Teacher Training College, Natural History Institute, Szombathely: 17–18.

Puskás, J., Nowinszky, L., Barczikay, G. (2011): Pheromone trapping of the moth *Phyllonorycter blancardella* Fabr. In relation to Puskás-type weather fronts. Pheromones and other semio-chemicals- IOBC/wprs Bulletin 72: 23–26.

Wéber, M. (1959): Influence of the front variation on insects flying to light (in Hungarian). A Pécsi Pedagógiai Főiskola Évkönyve: 259–275.