Chapter 8.

Pheromone Trap Catch of Harmful Microlepidoptera Species in Connection with the Péczely–Type Macrosynoptic Weather Situations

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Abstract: The pheromone trapping success of the examined 8 harmful Microlepidoptera species connected with of Péczely-type macrosynoptic weather situation was examined in our present paper using the collecting data of Csalomon type pheromone traps operating in nine villages in Borsod-Abaúj-Zemplén County Hungary between 1982 and 2013. The value of relative catch (RC) was calculated for each observing stations and generations using the catching data. There was made a comparison between the relative catch values and the Péczely-type macrosynoptic weather situations belonging to the date. After it the relative catch values were averaged in all the 13 macrosynoptic situations. We compared the difference of the averaged relative catch value of each case with the averaged ones of the sum of all other cases. The significance levels were calculated by t-test. We can conclude from our results, the Péczely-type macrosynoptic weather situations influenced the pheromone trap catch of examined individuals of species. This effect causes an increase or decrease in various species. However, most of the Péczely-type situations will not cause any change in the catching of a certain species.

Keywords: Microlepidoptera, pheromone trap, Péczely-type, Hungary.

8. 1. Introduction

Weather is one of the many abiotic factors modifying the flight activity of insects and consequently also the effectiveness of collecting by pheromone trap or pheromone ones. Unfortunately, however, the overwhelming mass of the catch results supplied by the pheromone trap network cannot be examined in its relationship with the various weather constituents. This is because most posts of observation, especially in the first decades, fell far from meteorological stations, and the operators of pheromone traps and pheromone ones did not carry out any meteorological measuring in the vicinity. Unfortunately, we no measurement weather elements between 1993 and 2003 in the garden, where we worked our pheromone traps. We measured only but the minimum and maximum temperatures between 2004 and 2013.

The daily macrosynoptic weather situations which were determined on the basis of the baric field at ground level Therefore we have examined the relationship be-

tween the weather and the effectiveness of collecting by pheromone trap in the context of the Péczely-type macrosynoptic weather situations which express complex simultaneously existing weather conditions interpreted for the whole of the Carpathian Basin. The system was worked out by Péczely (1957 and 1983) who identified and characterized 13 types of daily macrosynoptic weather situations for the Carpathian Basin taking into account the surface baric field (Péczely, 1961). Since 1983, typifying has been continued and Károssy (1987, 1994, 1997 and 2001) has published the daily code numbers. The interpretation period for each type is the 24 hours of each calendar day. The only criterion for coding is the definition of the type prevailing for a longer period in the course of a day, so the switch-over from one type to the other may precede or lag behind by as much as $\pm$ 12 hours the time of the change of the calendar date. The progression of the changes in time, the tendency of the various types to last and the empirical frequency of successive situations show significant differences. Following Péczely's work of typifying macrosynoptic weather situations (1957 and 1983), his associates elaborated on the individual weather situations with regard to some weather elements by use of a detailed climatic database. Subsequently, with the continuity of typifying ensured, certain combinations of elements were also examined in the context of macrosynoptic situations. In recent years, the examination of the connection between the flight activity of harmful insects and the prevailing macrosynoptic weather situation has become an important, in fact decisive part of the above line of research. In this, we first examined pheromone trap effectiveness in connection with the macrosynoptic weather situations prevailing at the trapping time of harmful insects flying at dusk or in the first half of the night.

Insect flight activity, and similarly, the effectiveness of their pheromone trap collection, is considerably modified by weather, together with a number of abiotic factors. Unfortunately, a decisive majority of the catch results provided by the pheromone trap network cannot be examined in connection with the particular weather elements, as most observation sights are situated far from meteorological stations, and those operating the traps did not take any meteorological measurements. Therefore, we revealed the connection between weather and effectiveness of collecting with a pheromone trap using a different method. For the purposes of our investigations we found those Péczely's macrosynoptic weather situations to be suitable which express complex weather conditions simultaneously existing and pertaining to the whole area of the Carpathian Basin.

In the last few years the examination of the connection between the flight activity of harmful insects and the various macrosynoptic weather situations has become an important and determining trend in the above mentioned research. During this research we examined the effectiveness of trapping in connection with the macrosynoptic weather situations pertaining to the trapping time of harmful insects flying at dawn or in the first part of night.

We precede to our investigation the Winter Moth (*Operophtera brumata* L.) the flies late in the autumn (Nowinszky and Károssy, 1986).

In subsequent years, pheromone trap catch of several other species were ex-

amined in connection with Péczely-type weather situations: Károssy (1987), Károssy and Nowinszky (1987a, 1987b), Károssy et al., 1990, 1992, 1996), Nowinszky and Károssy (1988), Nowinszky et al. (1995), Puskás et al. (1996).

8. 2. Material

Between 1982 and 1990 pheromone traps were operating in Borsod-Abaúj-Zemplén County (Hungary-Europe) at 9 villages (Table 8. 2. 1.)

Table 8. 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″

An additional one trap operated between 1993 and 2012 at Bodrogkisfalud. These traps attracted 8 Microlepidoptera species altogether, in some of the years using 2-2 pheromone traps for each species, however, in other years not all 8 species were monitored. The traps were operated through every day during the season from April until October. The caught 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), 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).

Catch data of the collected species is displayed in Table 8. 2. 2. We examined the trapping data of these species depending on the moon phases.

The daily data of the Péczely-type of macrosynoptic weather conditions we used up from the personal catalogues and personal communications of Károssy.

Characterization of the Péczely's macrosynoptic weather situations (Károssy, 2001) can be seen in the Appendix.

Table 8. 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

8. 3. Methods

We have calculated the relative catch values of the number of specimens trapped by species and broods. Relative catch (RC) is the ratio of the number of specimen caught in a given sample unit of time (1 hour or 1 night) and the average number of specimen caught in the same time unit calculated for the whole brood. If the number of the specimen trapped equals the average, the value of relative catch is: 1. (Nowinszky, 2003 and 2008).

We have sorted relative catch values into the proper Péczely-type macrosynoptic weather situation. We have arranged data regarding macrosynoptic situations together with the relating relative catch values into classes.

There was made a comparison between the relative catch values and the Péczely-type code number belonging to the date. After it the relative catch values were averaged in all the 13 macrosynoptic situations. We compared the difference of the relative catch value of each case with the averaged ones of the sum of all other cases. The significance levels were calculated by t-test. The results are plotted.

8. 4. Results and Discussion

The relative catch values of examined species in connected with of Péczely-type macrosynoptic weather situations are shown in Table 8. 4. 1.

Table 8. 4. 1. Pheromone trap catch of the harmful Microlepidoptera species in connection with the Péczely-type macrosynoptic weather situations

	Ph. blancardella Fabr.	*Ph. coryliifoliella* Hbn.	*A. lineatella* Zeller	*E. ambiguella* Hbn.	*L. botrana* Den. et Schiff.	*G. funebrana* Tr.	*G. molesta* Busck	*C. pomonella* L.
1 mCc			1.091**					
2 AB	0.827**	0.773*						
3 CMc					0.679			
4 mCw						0.877	0.779**	1.212
5 Ae		1.119					1.196**	1.119
6 CMw	0.661**	0.673**						
7 zC								
8 Aw	1.092*							
9 As	1.151							
10 An							0.917	
11 AF				1.477				
12 A	1.085*	1.215**	0.904					
13 C			0.806	0.426				0.843

Notes: Significance levels are: normal = $P < 0.05$, * = $P < 0.01$, ** = $P < 0.001$

High and law catching results also belong to changing weather situations. After examining these situations we cannot declare clear regularity.

We think the practical importance is very small, because it is very infrequent. We can conclude from our results, the significant changing of weather increases the flight activity of examined individuals of species. This fact does not mean favourable weather conditions for the flying of insects. The low values of relative catch mean those weather situations in all cases, when the flight activity of insects decreased, but the meaning of high values are not so equivalent. The significant environmental changes cause physiological changes in the organism of insects. The life of imago is short the unfavourable weather endangers not only the continuance of individual but also the continuance of the total species. According to our supposition the individuals can use two kinds of strategies to prevent the hindering influences of normal function in phenomenon of life. First is the increased activity. It means the growing of intensity in flying, copulation and oviposition. The second strategy is to hide and ride out in passivity the unfavourable situation. Seeing the above-mentioned facts, according to our present knowledge high pheromone trapping results can belong to both favourable and unfavourable situations.

Seeing that the Péczely's macrosynoptic situations are valid simultaneously in the whole Carpathian Basin, our results can be utilized not only in Hungary, but also in one part of territory in neighbouring countries for the purpose of making plant protecting prognosis. We can declare is spite of that case we cannot give the correct explanation of high or law catching results in all the changing situations according to our knowledge.

Further agrometeorological researches are necessary to find how can be modified the insect's comfort feeling and flight activity by different type changing situations.

Using the Péczely's macrosynoptic weather situations offers a possibility for investigating the insect's life-phenomena in connection with weather also in those cases where the measuring of certain elements for some reasons comes up against difficulties.

The collecting data of the national pheromone trap network, which is invaluable for science, has also become employable to insect ecological and ethological investigations. On the basis of our work it is also proved that Péczely's macrosynoptic situations are reliable not only from the point of view of climatologically typification, but also with regard to agrometeorological research. We think it essential to elaborate a similar typification for other geographical regions, and other harmful species of insects.

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Appendix

Meridional, northerly oriented situations

mCc (1) Cold front from the meridional situations
A situation is with meridional direction and northern stream. Hungary belongs to the rear cold front current system of the cyclone, which stays east or north-east of it, over the Balticum or the Ukraine. This situation causes changeable, windy and wet weather in the Carpathian Basin. In summer a version without a cold front may also arise, when a termic depression effect from South-West Asia spreads over South-East Europe. In summer, this situation is favourable for forming local showers, thunderstorms, in winter snowstorms are frequent. In summer the temperature is above average, in winter it is below average, in spring the deviation is not significant. Cloudiness surpasses the average level, visibility is good, and in winter the tendency for fog is smaller. Air pollution is usually insignificant. Typically, the northerly and the north-westerly winds are strong while the westerly and south-westerly winds are strong beyond the Tisza River. There is more precipitation in the eastern half of the country. Atmospheric temperature layers are stabile, the lower layers are warmer. The daily temperature fluctuation is small and aperiodic.

AB (2) Anticyclone over the British Isles
This is a meridionally directed situation with northerly current. Partly because of the Azores cyclone moving to the north, partly because of the anticyclones moving from the arctic basins to the south, high-pressure air masses develop over the British Isles or the North Sea. Its appearance in the Carpathian Basin is usually connected to the passing of a cold front, and results in intensive north-, north-westerly air currents in our region. When the above situation stabilises in summer, the baric gradient is a lot lower over Central Europe; on such occasions, dry, prolonged warm weather evolves in the Carpathian Basin. It is a misty situation in autumn, winter and spring as well. During the greater part of the year it is characterised by colder air masses of arctic origin and average cloudiness, with higher degrees of cloudiness in summer. There is a strong tendency for fog in winter. There is a north-westerly, westerly wind; over the Tisza River it is westerly, south-westerly, and relatively strong. The temperature stratification of the air is stabile.

CMc (3) Cold front arising from a Mediterranean cyclone
A situation is with meridional direction and northern current. It is the current-system of the back-side of the cyclone. The situation emerges by way of a Mediterranean cyclone moving towards the Balkan Peninsula or the region of the Black Sea, so the Carpathian Basin falls in the rear, cold front current system of the cyclone. The movement of air is in a northern, north-west direction. Its speed, mainly in the Transdanubia, may even reach storm intensity. Especially in summer, precipitation may increase, in different amounts at various locations. Snow

showers are frequent in winter, storms in spring. Cloudiness is definitely extensive, especially in the summer half of the year. Air pollution is low; the tendency for fog is also low in winter. The temperature is lower in spring and autumn and higher in winter than on the days preceding this weather situation. The daily fluctuation of the temperature is aperiodic.

Meridional situations with a southern direction

mCw (4) Warm front arising from a meridional cyclone
This is a situation of meridional direction, with flow toward the south; it is the frontal current system of the cyclone. The current over the Carpathian Basin is directed by a cyclone with its centre either in the region of North-Western Europe or in Western Europe. Hungary's territory is under the effect of the cyclone's warm front, or falls into its warm sector. In autumn it is cooler, in winter and spring milder than the average temperature of the given season. Cloudiness is more extensive, mainly in spring and autumn. Prolonged, slow rains and snowfalls are equally frequent from autumn to spring. Visibility is bad; the frequency of fog is high in winter. In summer it is characterised by sultriness and high degree of air pollution. The southern air current brings considerable precipitation, especially in the winter half of the year.

Ae (5) Anticyclone located east of the Carpathian Basin
This is a meridional situation with southern current. A dry, southerly, or southwesterly air current dominates in an anticyclone located east of Hungary with its centre over the Ukraine. The weather fronts range west of the Carpathian Basin. This situation is characterised by dry, warm, bright weather in summer, and in winter, after snowy days by bitter cold, frequent rime and fog. In autumn and spring, temperature fluctuation is large with a strong rise in temperature. In the cold season the range of the Eastern Carpathians often modifies the direction of the isobars, and in this way the cold, surface level air masses invade the territory of the country passing round the Southern Carpathians (Kossava effect). It is characterised by a temperature surpassing the average prevalent during the greater part of the year. Cloudiness, mainly in summer, is smaller and dry, droughty weather is frequent at this time. In accordance with the weak, southerly current, the amount of precipitation is small, visibility is bad, and air pollution is considerable. The air shows inverse temperature stratification.

CMw (6) Warm front arising from a Mediterranean cyclone
This situation has a meridional direction and southerly current. The cyclone's frontal system of current asserts itself in Hungary. The system is defined by a cyclone which arises over the central part of the Mediterranean Sea and moves toward the Adriatic region. It's warm front passes over the Carpathian Basin causing substantial rains in the winter and spring months, as well as snowfalls in winter. In summer its temperature is lower than the national average temperature. Visibility

is low, cloudiness strong, and the fluctuation of the temperature is aperiodic.

Zonal situations with western direction

zC (7) Zonal cyclone
There is a zonal, westerly flow. While it prevails the European stretch of the frontal zone ranges near the 50° latitude. The air flow is westerly. Northern Europe is affected by fast moving cyclones. The weather is windy and changeable. The temperature, characteristically, is cool in autumn, mild in winter, and in summer it is colder than the average for that season. In spring the fluctuation in temperature is low. Cloudiness is strong, especially in the spring and autumn months. The yield of precipitation is larger at the beginning of autumn and in winter. The lower air strata are warmer. Colder, arctic air strata flow in the higher layers.

Aw (8) Anticyclone located west of the Carpathian Basin
It has zonal current with a western direction. When the Azores cyclone travels north (mainly in summer), its protrusion advances as far as the Central-European region. Its formation usually takes place in connection with a cold front which passes through and results in an intense westerly or north-westerly current in the Carpathian Basin. It is characterised by pleasant, warm and bright weather which however, is misty in autumn and spring, and mild, misty and foggy in winter. In winter it is colder than the temperature typical for that season. Its cloudiness is average, yet it is overcast in summer. Visibility is good, air pollution is low. The lower stratum of air is usually warmer than the one over it, in which there is a cold air current.

As (9) Anticyclone located south of the Carpathian Basin
This situation has a zonal, western current. The northern fringe of the anticyclone situated over the basin of the Mediterranean Sea protrudes into the Carpathian Basin. The northern edge of the frontal zone moves upward, so the cyclone moves along a more northern trajectory, and their frontal system does not effect Hungary. During the greater part of the year this situation-type is warmer than the average and is characterised by a lower degree of cloudiness. In winter, autumn and spring the bright, warm days are followed by mild nights. In winter cloudiness is somewhat stronger, and the frequency of fog is higher. In summer it brings about sultry weather. The air flow is weak, and precipitation is low. The lower stratum of air is colder than the upper; however the opposite may also occur.

Zonal situation eastern direction

An (10) Anticyclone located north of the Carpathian Basin
This situation has an eastern, zonal current. The anticyclone stays north of Hungary over the Baltic or Poland, and forms a high-pressure ridge from the British Isles as far as Eastern Europe. In summer it is warmer than the temperature typical for that season. It causes a strong fall in temperature in autumn and in spring,

but after the cold night a rise in temperature follows about midday. It is characterised by clean air and northern winds. In winter it is connected with the invasion of very cold air masses. On such occasions it is easy to observe how the Carpathian ranges modify the movement of ground level cold air masses and their passage through mountain passes. Many times characteristic, embracing isobars develop along the Carpathians, and the cold invasion from either side sometimes may result in and occlusion front inside the Basin. The weather is windy and foggy even in winter with average cloudiness, and a sky which is a bit more overcast in the spring and autumn months. Sometimes air pollution is high. The air-flow is typically of north-eastern direction. The stratification of air characterised by warmer lower and colder higher strata.

AF (11) Anticyclone located over the Scandinavian Peninsula
This situation has a zonal eastern air-flow. The characteristic orientation of the longitudinal axis of the anticyclone which stays in the Fenno-Scandinavian region has a north-easterly direction. This weather situation brings about a northern or north-eastern flow in Hungary. During its existence, the weather, especially in autumn, winter and spring is bright and clear, but the air is very cold. It is characterised by northerly winds, wide fluctuation in temperature, average cloudiness, and little precipitation. The Icemen (the three chilly days in May) are usually connected to this macrosynoptic type.

Central anticyclone

A (12) Anticyclone located over the Carpathian Basin
The whole region of Central Europe is dominated by a centrally situated anticyclone which rises above the Carpathian Basin. It can be of smaller size, even just a few hundred kilometres in diameter, but it can also be a so called intermediate anticyclone, which moves fast separating other cyclone systems. In most cases, however, it remains for a longer period over the Carpathian Basin. Its duration gets prolonged in winter by a cold air-cushion stuck on the bottom of the Basin (inversion). Its prolonged existence ensures undisturbed radiation weather. In winter it is accompanied by a strong fall in the temperature, and considerable inversions of temperature, and in summer by a great rise in temperature, heat waves and thunderstorms. One frequent feature is an air-flow in diverse directions which originates from the centre. During the greater part of the year it can be characterised by a temperature of radiation effect - i. e. warm during the day and in summer, cold during the night and in winter. The weather is warm and pleasant either in spring or in autumn, while it is foggy, frosty and rimes in winter. Temperature fluctuation is great. Cloudiness is slight. It is a bit more overcast in winter and brighter in summer. Precipitation is small, showing large regional variability. Visibility is bad. There is a high frequency of fog, and air pollution may be strong. The air is usually dry. The wind has no uniform or characteristic direction.

Central cyclone

C (13) Cyclone located above the Carpathian Basin
The centre of the cyclone is located over the Carpathian Basin. It is in a great majority of cases, Mediterranean cyclones which pass over Hungary from this type. There may, however, be cases when a cyclone develops having local, orographic causes along a front that has grown stagnant. A sharp contrast in temperature evolves in Hungary. The north-western parts of the country fall in the rear flow system of the cyclone, so the temperature there is much lower than in the eastern part of the country, which fall into the frontal flow system. In the western, north-western and south-western regions of the country, because of what was said above, the frequency of fronts is higher than in the rest of the country. When this type is present, in winter the temperature is higher, in summer it is lower than during the preceding days. In autumn this type is characterised by cold, windy, overcast and rainy weather and in winter by stormy weather. In spring it is characterised by rainy weather. In all three seasons temperature fluctuation is small. Cloudiness is greater in summer, smaller in winter. Visibility is bad, and air pollution is low. A strong field of flow is characteristic, although its direction is not homogeneous. Precipitation is markedly large.