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Light-trap catch of insects in connection with the Péczely-type macrosynoptic weather situations (Trichoptera, Lepidoptera)

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Abstract. The study deals with light-trapping of caddisfly (Trichoptera) and moth (Lepidoptera) species in connection with the Péczely's macrosynoptic weather conditions. Our results show that different macrosynoptic situations are favourable and unfavourable for different insects.

Keywords. Trichoptera, Lepidoptera, Light-trap, Péczely-type macrosynoptic situations

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Összefoglalás. A tanulmány a tegzes (Trichoptera) és a lepke (Lepidoptera) fajok fénycsapdás fogásával foglalkozik Péczely makroszinoptikus időjárási viszonyaival összefüggésben. Eredményeink azt mutatják, hogy a különböző makroszinoptikus helyzetek kedvezőek és kedvezőtlenek a különböző rovarok számára.

Kulcsszavak. Trichoptera, Lepidoptera, fénycsapda, Péczely-típusú makroszinoptikus helyzetek

Introduction

Weather is one of the many abiotic factors modifying the flight activity of insects and consequently also the effectiveness of collecting by light-trap. Unfortunately, however, the overwhelming mass of the catch results supplied by the light-trap network cannot be examined in its relationship with the various weather constituents. This is because most observation station fell far from meteorological stations, and the operators of light-traps cannot measure any meteorological data in the vicinity. Therefore, we have investigated the relationship between the weather and the effectiveness of light-trap catch in the context of the Péczely-type macrosynoptic weather situations. These types express complex simultaneously existing weather conditions which are valid for the whole Carpathian Basin. The macrosynoptic weather types were worked out by Péczely (1957 and 1983) who determined 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 validity of each type is limited to 24 hours on each calendar day. 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 light-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. We have included in our investigation the cockchafer (*Melolontha melolontha* L.) which swarms at spring (Károssy & Nowinszky 1987, Nowinszky & Károssy 1988), the winter moth (*Operophtera brumata* L.) which flies late in the autumn (Nowinszky & Károssy 1986), and the gypsy moth (*Lymantria dispar* L.) (Károssy et al. 1992). We have extended our research to two other species of moths, which although insignificant from an economic point of view, are easy to trap in the winter, in the autumn and at spring. They are the common chestnut (*Conistra vaccinii* L.) and the satellite moth (*Eupsilia transversa* Hufn.) (Károssy et al. 1990a). We employed a different method to examine the species active throughout the night, since the various macrosynoptic situations pertain to only one calendar day, so in cases when an evening and an early morning date were characterized by two different macrosynoptic types, we also had to examine flight activity in the period of transition from one to the other. We contracted the 13 macrosynoptic weather situations typified by Péczely into 6 types on the basis of their characteristic wind patterns. Contraction was necessary, as not even the vast number of observation data at our disposal would have been sufficient to examine all the possible forms of change. The changes of these 6 types form 36 transitional types, so far uncharacterized even from a climatological point of view. We examined light trapping effectiveness pertaining to the Turnip Moth (*Agrotis segetum* Den. et Schiff.) and the fall webworm moth (*Hyphantria cunea* Drury) in relation to these types (Károssy et al. 1990b, 1992, Károssy & Nowinszky 1987, Nowinszky et al. 1992, 1995). We have recently published a comprehensive study of the outcome of our research into the subject (Károssy et al. 1994). Subsequently we examined the catch results of the heart-and-dart moth (*Scotia exclamationis* L.) with regard to the situations defined for the vicinity of Budapest using material supplied by the 6 light-traps operating there (Károssy et al. 1996a, 1996b). We have also established a connection between the Péczely-type macrosynoptic situations and the number of light-trapped Macrolepidoptera species (Nowinszky et al. 1990).

Material

We have received data of Péczely's macrosynoptic weather situations from Csaba Károssy PhD, who has been typing in recent decades.

The 13 macrosynoptic weather situations is given as the following:

Meridional Northerly Oriented Situations
mCc (1) Cold front from the meridional situations
AB (2) Anticyclone over the British Isles
CMe (3) Cold front arising from a Mediterranean cyclone
Meridional Situations with a Southern Direction
mCw (4) Warm front arising from a meridional cyclone
Ae (5) Anticyclone located east of the Carpathian Basin
CMw (6) Warm front arising from a Mediterranean cyclone
Zonal Situations with Western Direction
zC (7) Zonal cyclone
Aw (8) Anticyclone located west of the Carpathian Basin
As (9) Anticyclone located south of the Carpathian Basin
Zonal Situation Eastern Direction

An (10) Anticyclone located north of the Carpathian Basin
AF (11) Anticyclone located over the Scandinavian Peninsula
Central Anticyclone
A (12) Anticyclone located over the Carpathian Basin
Central Cyclone
C (13) Cyclone located above the Carpathian Basin

The characterization of macrosynoptic weather situations can be found in Supplement.

The light-trap data of examined insects were taken from the registers of Hungarian national light-trap network. Ottó Kiss collected the caddisfly species along different streams and rivers.
The data of examined insects can be seen in Table 1.

Table 1. Catching data of examined insects

Species	Years	Data of		
		Specimen	Data	Nights
Trichoptera spec. complex	10	180,183	5,753	1,722
Microlepidoptera spec. indet.	8	699,812	26,205	1,693
Lepidoptera: Noctuidae, Heliothinae				
Scarce Bordered Straw *Helicoverpa armigera* Hübner, 1808	19	25,531	6,754	1,835
Lepidoptera: Noctuidae, Noctuinae				
Setaceous Hebrew Character *Xestia c-nigrum* Linnaeus, 1758	43	104,348	54,757	4,990

Methods

The Jermy type light-trap is a modified version of the Minnesota type, which the guide-sheets have been removed from. The light source is a 100 W norm al light bulb at 2 meters above the ground, colour temperature: 2900 K, the killing material is chloroform. The traps of the plant protection institutions worked from 1st April to 31st October, while the forestry ones all the year round, independently of the time of sunrise and sunset, every night from 6 p.m. to 4 a.m. All time data are given in universal time (UT). The insects trapped for one night were stored in one bottle, so the whole catch of one night at one observational site is interpreted as one observational datum.

The environmental factors are not the same at all places and in all times of trapping, because of this it is sure, catching of the same number of individuals at two different observing stations or in two periods mean other proportion of examined populations.

To solve the problem, from the catch data we calculated relative catch (RC) values for observation sites, species and generations. RC is the quotient of the number of individuals caught during the sampling interval (1 night), and the mean values of the number of individuals of one generation counted for the sample interval. In this way, in the case of expected mean number of individuals, the value of relative catch is 1.

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 separated daily according to their time. 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 own t-test program.

The comparisons were made between the meridional, zonal and central situations.

Results and Discussion

The results are given in Figures 1-4 and Table 2.

Table 2. Significant differences in the light-trap catches of insects in relation to Péczely's Meridional, Zonal directional air flow and Central macrosynoptic weather situations

Trichoptera spec. complex				
Weather situations	RC	Weather situations	RC	P
Meridional cyclone	1,032	Zonal cyclone	0,487	0,5
Zonal cyclone	0,487	Central cyclone	0,985	0,5
Zonal cyclone	0,487	Central anticyclone	0,976	0,5
Zonal anticyclone	0,933	Zonal cyclone	0,487	0,5
Microlepidoptera spec. indet.				
Weather situations	RC	Weather situations	RC	P
Meridional anticyclone	0,988	Central anticyclone	1,296	0,5
Zonal cyclone	0,952	Central cyclone	0,769	0,5
Zonal cyclone	0,952	Central anticyclone	1,296	0,5
Zonal anticyclone	1,023	Central anticyclone	1,296	0,5
Central anticyclone	1,296	Central cyclone	0,769	0,5
Helicoverpa armigera Hbn.				
Weather situations	RC	Weather situations	RC	P
Meridional cyclone	0,854	Meridional anticyclone	1,053	0,5
Meridional cyclone	0,854	Zonal cyclone	0,639	0,5
Meridional cyclone	0.854	Central cyclone	0,728	0,5
Zonal cyclone	0,639	Central anticyclone	1,147	0,5
Zonal anticyclone	1,047	Zonal cyclone	0,639	0,5
Central anticyclone	1,147	Central cyclone	0,728	0,5
Xestia c-nigrum L.				
Weather situations	RC	Weather situations	RC	P
Meridional cyclone	0,965	Zonal cyclone	1,175	0,5
Meridional cyclone	0.965	Central cyclone	0,761	0,5
Zonal cyclone	1,175	Central cyclone	0,761	0,5
Central anticyclone	1,055	Central cyclone	0,761	0,5

The light-trap catch of the Trichoptera species is extremely low during the presence of zonal cyclones. The difference of catch (0.487) is significant compared to catches of both meridional and central anticyclones and zonal and meridional anticyclones.
In the case of Microlepidoptera spec. indet. the catch is high during the stay of the anticyclones and it is low during the stay of the cyclones. In most cases the catch of *Helicoverpa armigera* Hbn. is also high at anticyclones and low at cyclones.

The catch of *Xestia c-nigrum* L. is extremely low during the central cyclone. Data of Figures 1-4. and Table 2 show that the same macrosynoptic situations are not always favourable and unfavourable for different insects.

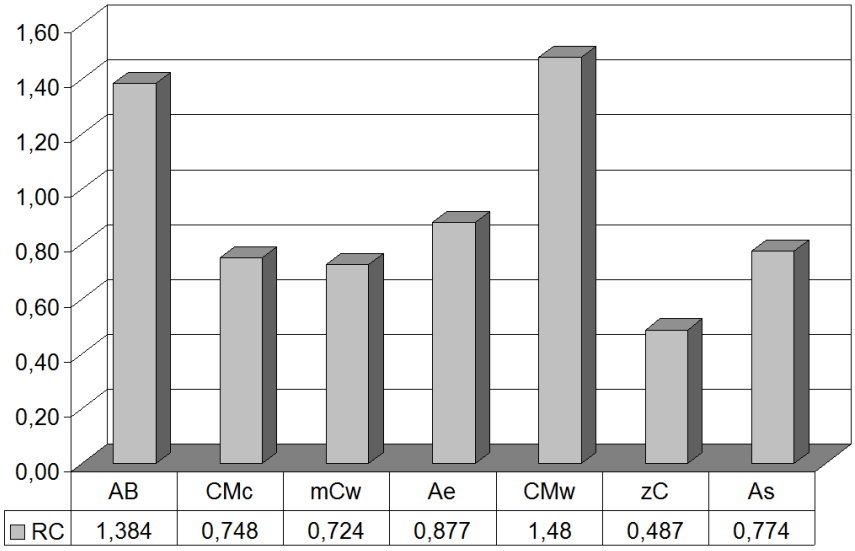

Figure 1 Light-trap catch of *Trichoptera* spec. complex in connection with the Péczely-type macrosynoptic weather situations
(Significant research only)

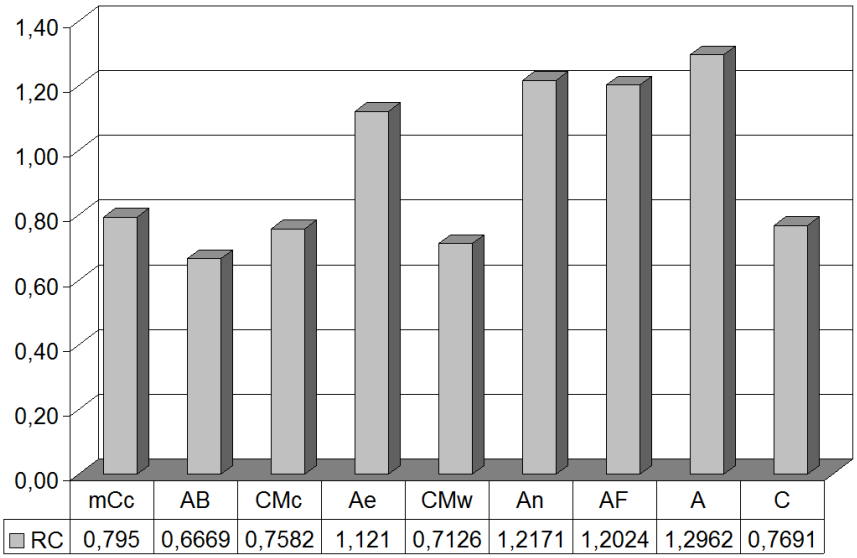

Figure 2 Light-trap catch of *Microlepidoptera* spec. Indet. in connection with the Péczely-type macrosynoptic weather situations
(Significant results only)

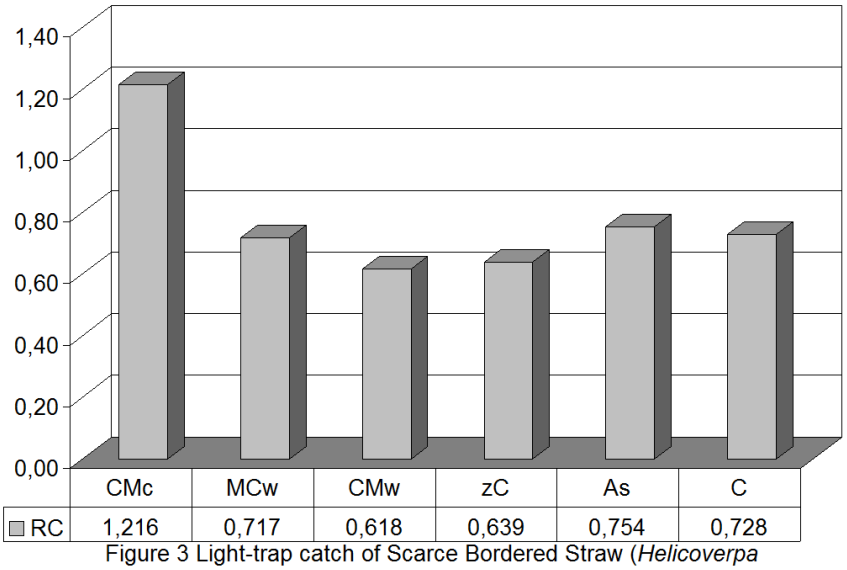

Figure 3 Light-trap catch of Scarce Bordered Straw (*Helicoverpa armigera* Hbn.) in connection with Péczely-type macrosynoptic weather situations (Significant results only)

Helicoverpa armigera
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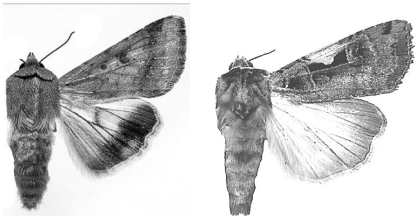

Xestia c-nigrum
© I. Fazekas

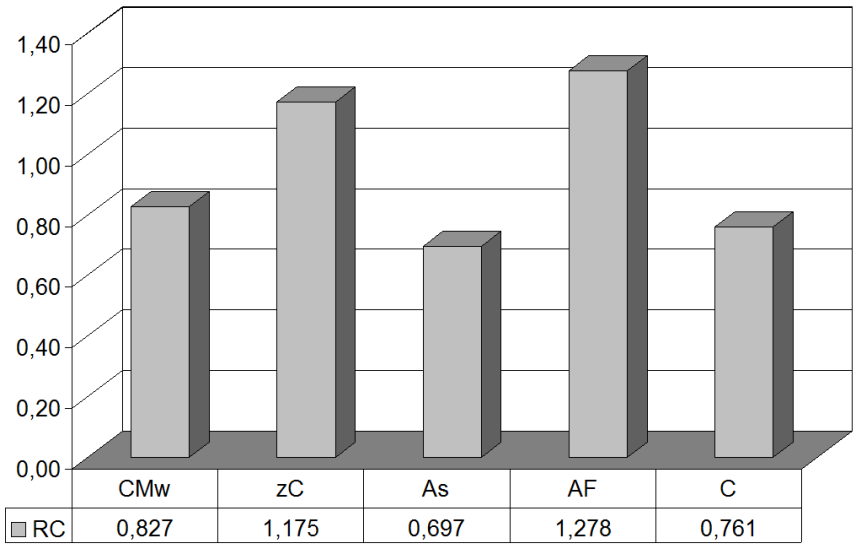

Figure 4 Light-trap catch of Setaceous Hebrew Character (*Xestia c-nigrum* L.) in connection with the Péczely-type macrosynoptic weather situations (Significant results only)

Supplement

A short characterization of the 13 macrosynoptic weather situations is given in the following:

Meridional, northerly oriented situations
mCc (1) Cold front from the meridional situations
A situation 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 Baltic 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, 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 stable 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 stabilizes 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 characterized 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 stable.

CMc (3) Cold front arising from a Mediterranean cyclone
A situation with meridional direction and northern current. It is the current system of the backside 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 characterized 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
A meridional situation with southern current. A dry, southerly, or south-westerly 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 characterized 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 characterized 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. Its 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 characterized 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 affect Hungary. During the greater part of the year this situation-type is warmer than the average and is characterized 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 characterized 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 airflow is typically of north-eastern direction. The stratification of air characterized by warmer lower and colder higher strata.

AF (11) Anticyclone located over the Scandinavian peninsula
This situation has a zonal eastern airflow. 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 characterized 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 aircushion 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 airflow in diverse directions which originates from the centre. During the greater part of the year it can be characterized 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 rimy 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. 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 characterized by cold, windy, overcast and rainy weather, and in winter by stormy weather. In spring it is characterized 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.

References

Károssy Cs. 1987: Catalogue of Péczely's macrosynoptic types 1983-1987 in Hungary (in Hungarian). – Légkör 32 (3): 28−30.

Károssy Cs. & Nowinszky L. 1987: A connection between the sum of Turnip Moth (*Scotia segetum* Schiff.) collected by light-trap and the various macrosynoptic types (in Hungarian). – Időjárás 91 (4): 246−252.

Károssy Cs. 1994: Péczely's Classification of macrosynoptic types and the catalogue of Weather situations (1951−1992). In: Nowinszky L.: Light trapping of insects influenced by abiotic factors. Part I. – Savaria University Press, Szombathely, pp. 117–131.

Károssy Cs. 1997: 15 Catalogue of Péczely's macrosynoptic weather situations (1993-1996). In: L. Nowinszky [ed.] (1997): Light trapping of insects influenced by abiotic factors. In: Nowinszky L.: Part II. – Savaria University Press, Szombathely, pp. 159−162.

Károssy Cs. 2001: Characterisation and catalogue of the Péczely's macrosynoptic weather types (1996-2000). In. Nowinszky L. (ed.): Light trapping of insects influenced by abiotic factors. Part III. – Savaria University Press, Szombathely, pp. 75−86.

Károssy Cs., Nowinszky L. & Tóth Gy. 1990a: The seasonal variation of light-trap catches of *Conistra vaccinii* L. and *Eupsilia transversa* Hufn. (Lepidoptera: Noctuidae) in connection with the Péczely's macrosynoptic meteorological situations (in Hungarian). – Scientific Publications of Berzsenyi Dániel Teachers Training College 7. Natural Sciences 2: 53− 61

Károssy Cs., Nowinszky L. & Tóth Gy. 1990b: Die Flugaktivität der Saateule (*Scotia segetum* Schiff.) während des Wechsels von Grosswetterlagen. – Wetter und Leben Wien 42 (3−4): 189−194.

Károssy Cs., Nowinszky L., Tóth Gy. & Puskás J. 1992: Flying activity of the agricultural harmful insects and the connection of macrosynoptic weather types. – Boletin de la Sociedad de Lima 105: 57−58.

Károssy Cs., Nowinszky L & Tóth Gy. 1994: 10. Péczely-type macrosynoptic weather situations. In Nowinszky L. [ed.] (1994): Light trapping of insects influenced by abiotic factors. – Savaria University Press pp. 95−106.

Károssy Cs., Nowinszky L. & Puskás J. 1996a: Success of light trapping in connection with the Péczely-type macrosynoptic weather situations defined for a trapping site (in Hungarian). – A Berzsenyi Dániel Tanárképző Főiskola Tudományos Közleményei X. Természettudományok 5: 81−90.

Károssy Cs., Nowinszky L., Puskás J. & Makra L. 1996b: Light trapping of harmful insects in Péczely's macrosynoptic weather situations. – Acta Climatologica Universitatis Szegediensis 30: 49−60.

Nowinszky L. & Károssy Cs. 1986: The results of light-trap catches of Winter Moth (*Operophtera brumata* L.) at various macrosynoptic situations (in Hungarian). – Kertgazdaság 18. 6: 31−38.

Nowinszky L. & Károssy Cs. 1988: Investigations of the effectiveness of light-trap catches of insects connected with macrosynoptic situations (in Hungarian). – Növényvédelem 24 (1): 10−17.

Nowinszky L., Károssy Cs. & Tóth Gy. 1990: The connection of the number of catches by light-trap with the Péczely's macrosynoptic situations (in Hungarian). – A Berzsenyi Dániel Tanárképző Főiskola Tudományos Közleményei. VII. Természettudományok 2: 41−52.

Nowinszky L., Károssy Cs. & Tóth Gy. 1992: Flying activity of fall webworm moth (*Hyphanria cunea* Drury) during the changes of Péczely-type macrosynoptic weather situations (in Hungarian). – Proceedings of Berzsenyi Dániel College Szombathely 8th Natural Sciences 3: 249−256.

Nowinszky L., Károssy Cs. & Tóth Gy. 1995: Actividad de vuelo de insectos dañinos para la agricultura y su relacion con los cuadros macrosinopticos del tiempo. – Cuadernos de Fitopatologia 12. 47. 4: 186−190.

Péczely Gy. 1957: Grosswetterlagen in Ungarn. Kleinere Veröffentlichungen der Zentralanstalt für Meteorologie, No. 30, Budapest

Péczely Gy. 1961: Climatological description of macrosynoptic situations for Hungary. Minor Contributions of the Hungarian Meteorological Service 32. Budapest

Péczely Gy. 1983: Catalogue of the macrosynoptic types for Hungary (1881−1983). – Publicated of the Hungarian Meteorological Service vol. 53, Budapest