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LIGHT TRAPPING OF HARMFUL INSECTS IN PÉCZELY'S MACROSYNOPTIC WEATHER SITUATIONS

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Összefoglalás - Vizsgálatainkhoz az országos fénycsapda hálózat anyagából a Budapest környékén üzemelő 6 fénycsapda adataiból a felkiáltójeles bagolylepke (Scotia exclamationis L.) gyűjtési eredményeit dolgoztuk fel az ugyanerre a térségre megállapított *Péczely*-féle makroszinoptikus időjárási helyzetekkel összefüggésben. A fogási eredményeket a helyzetek változásával összefüggésben is vizsgáltuk. Először valamennyi változás hatását megvizsgáltuk, így azonban a viszonylag kevés megfigyelési adat miatt csak néhány esetben kaptunk szignifikáns eredményt. A továbbiakban ezért a 13 helyzetet a rájuk jellemző áramlási rendszerek alapján 6 típusba vontuk össze.

Summary - We used the collecting results of the heart-and-dart moth (Scotia exclamationis L.) for our examination. We got the data of 6 light-traps from the national light-trap network operating in the surrounding of Budapest. We examined this data connected with the *Péczely's* type macrosynoptic weather situations determined for the same territory. We also examined the catching results connected with the changes of macrosynoptic weather situations. First we examined the effects of all changes but we got significant results only sometimes, because of the relatively small number of observing data. That is why we later made 6 types from the 13 situations on the basis of their typical streaming system.

Key-words: insects, light trapping, Péczely's macrosynoptic situations

INTRODUCTION

Insect flight activity - and similarly, the effectiveness of their light-trap collection - are considerably modified by weather, together with a number of abiotic factors. So, it is understandable why researchers all over the world are engaged in revealing the effects of weather elements. In Hungary, for more than 3 decades a uniform, Jermy-type light-trap network has been in operation, which so far has already provided an unvaluable mass of information both for entomological basic research and plant protection prognostication. Unfortunately, a decisive majority of the catch results provided by the light-trap network can't

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 light-trap by using a different method. For the purposes of our investigations we found those *Péczely's* macrosynoptic weather situations suitable which express complex weather conditions simultaneously existing and pertaining to the whole area of the Carpathian Basin. The macrosynoptic typifying which can be considered as pertaining to the area of the Carpathian Basin was elaborated by *Péczely* (1957, 1983). The daily macrosynoptic weather situations which were determined on the basis of the baric field at ground level were classified into 13 types by him. Since 1983, typifying has been continued, and the daily code numbers are published by *Károssy* (1987, 1994).

The data interpretation period for each type is 24 hours belonging to a calendar day. The one and single criterion for coding is the definition of the type which pertains for a longer period of time during a day, so the type-shift may as well differ ±12 hours from the time of the change of the calendar date. The progression of the changes in time as well as the tendency of particular types to endure and the empiric frequency of the occurrence of situations replacing each other differ significantly.

Following *Péczely's* work (1957, 1983) in the field of typifying macrosynoptic weather situations, his collaborators elaborated on the particular weather situations with regard to some weather elements and included a detailed data-base. In the following, with the continuity of the typifying ensured, the examinations of the element-sets relating to the macrosynoptic situations were also performed.

In the last few years the examination of the connection between the flying 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 the night. We extended our investigations to the cockchafer (Melolontha melolontha L.) which swarms in spring, to the winter moth (Operophthera brumata L.) which flies late in autumn, and to two species of moths which are although insignificant from an economical point of view, are easy to trap in autumn, winter and spring, too, the common chesnut (Conistra vaccinii L.) and the satellite moth (Eupsilia transversa Hfn.) (*Nowinszky and Károssy*, 1986, 1988; *Károssy and Nowinszky*, 1987a; *Károssy et al.*, 1990a; *Nowinszky [ed.]*, 1994).

When investigating species which are active all night, we employed a different method since macrosynoptic situations pertain to one calendar day only; so in those cases when one macrosynoptic type pertained to the date of the evening and another to that of the dawn, we had to examine the formation of the flying activity during the periods when the changes occurred.

In the beginning we analysed the effect of any possible situation-shifts on the flight activity of the turnip moth (Scotia segetum Schiff.) and the fall webworm moth (Hyphantria cunea Drury), both of which fly in the summer months (*Károssy and Nowinszky*, 1987b; *Nowinszky and Károssy*, 1988; *Károssy et al.*, 1990a), although certain changes occurred rarely. This method provided a lot of information; however, it was difficult to survey, and too intricate to use for plant protection prognosis. Therefore, in the following, we applied a simpler and more easily manageable method, which in any case, is just as valuable for prognostication purposes.

We contracted the 13 macrosynoptic situations typified by *Péczely* on the basis of their characteristic wind patterns into 6 types. The changes of these types form 36 transitional types, so far uncharacterised even from climatological points of view. We examine the effectiveness of light trapping the turnip moth (Scotia segetum Schiff.), the fall webworm moth (Hyphantria cunea Drury) and the gipsy moth (Lymantria dispar L.) in relation to these 36 types (*Károssy et al.*, 1990b; *Károssy et al.*, 1992; *Nowinszky [ed.]*, 1994; *Nowinszky et al.*, 1995).

In our present study we tried to correct our examination with the processing of collecting data coming from this territory and *Péczely's* macrosynoptic weather types working out for the surroundings of Budapest. We couldn not find such publications neither in Hungarian nor in international special literature to examine the success of light trapping connected with macrosynoptic weather situations except our publications.

MATERIAL AND METHODS

We used for our examinations the collecting results of the heart-and-dart moth (Scotia exclamationis L.) from the collecting data provided by the 6 light-trap stations operating around Budapest. We chose this species because the swarming of heart-and-dart moth (Scotia exclamationis L.) is twice a year, and this pest can be caught in great number regulary between May and September. We used the data coming from the collecting stations mentioned below: Budakeszi (1962-1970), Budatétény (1960-1967), Budapest-Rókushegy (1959-1967), Nagytétény (1959-1976), Martonvásár (1960-1961) and Érd (1977-1979). We had 3461 observing data and 7239 specimen coming from 1762 nights. We mean on observing data the catching result at one night at one observing station independently from the number of the caught individuals.

The code numbers and moments of changes of *Péczely's* macrosynoptic weather situations - valid for surrounding of Budapest - were determined by *Imre Örményi* Ph. D. biometeorologist. He gave this data for us, we thank for his selfless help. 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 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, thunderstroms, in winter snowstorms. In summer the temperature is above the average, in winter it is below the 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 Azori anticyclone 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 mentioned 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 back-side of the cyclone. The situation emerges by way of a Mediterranean cyclone moving towards the Balcan 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 center over the Ukraine. The weather fronts range from 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 izobars, 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. Visiblility is low, cloudiness is 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 500 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 Azori anticyclone 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 effect 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 with 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 Balticum 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 izobars 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 characterized by warmer, lower and colder higher strata.

AF (11) Anticyclone located over the Skandinavian peninsula

This situation has a zonal eastern air-flow. The characteristic orientation of the longitudinal axis of the anticyclone which stays in the Fenno-Skandinavian 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 air-cushion stuck on the bottom of the Basin (inversion). Its prolonged existence ensures undisturbed radiant 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 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 the great majority of cases, Mediterranean cyclones, which pass over Hungary, are 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 is much lower there 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.

In the previous chapter we have already stated that the number of the individuals trapped at different observation sites and times can't be compared to each other even in the case of identical species, as each trap works in different environment, and the environmental factors constantly vary according to time as well. 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 or 1 hour), 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.

In the course of processing we made a comparison between the values of relative catches and *Péczely's* code number, if the same macrosynoptic weather situation was during whole night. After it, we made catches in all the 13 macrosynoptic weather situations. We controlled the difference of catches in each weather situation type with variance analysis, and we calculated also significance level compared to the expectable values of relative catches. We also had an examination to make a comparison between the catching results and the changes of macrosynoptic weather situations. First the effects of all changes were examined, but we got significant results in few cases, because of the relatively small number of observing data. That is why we contracted the 13 *Péczely's* macrosynoptic groups into 6 types on the basis of their characteristic flow systems:

Meridional types with northern direction: mCc (1), AB (2) and CMc (3),
Meridional types with southern direction: mCw (4), Ae (5) and CMw (6),
Zonal types with western direction: zC (7), Aw (8) and As (9),

Zonal types with eastern direction: An (10) and AF (11),
Central anticyclone: A (12),
Central cyclone: C (13).

The changes of these types form 36 transitional types which have not been satisfactorily characterized even from a climatic point of view.

When one of the *Péczely* type macrosynoptic situations changed during the night, we averaged the values of relative catches into 36 transitional types. We determined the significance level of changes in these cases also in the above-mentioned way.

RESULTS

Our results are shown in *Table 1*, *2* and *3*.

Péczely's types	*Péczely's* codes	Number of observing data	Relative catches	Significance level %
mCc	(1)	337	0.795	99.0 %
AB	(2)	122	0.761	95.0 %
CMc	(3)	76	0.792	90.0 %
mCw	(4)	179	1.245	99.0 %
Ae	(5)	220	1.070	
CMw	(6)	72	1.437	95.0 %
zC	(7)	44	0.598	95.0 %
Aw	(8)	404	0.895	90.0 %
As	(9)	104	0.671	95.0 %
An	(10)	269	1.381	99.9 %
AF	(11)	112	0.957	
A	(12)	89	1.246	95.0 %
C	(13)	416	1.060	

Table 1 Relative catch of heart-and-dart moth (Scotia exclamationis L.) from the material of light-trap stations in the surrounding of Budapest, in the whole night unchanged *Péczely's* macrosynoptic weather situations determined for this territory *Péczely's* types

Former situations	Following situations	Relative catches	Number of observed data	Significance level %
mCc (1)	Aw (8)	0.588	71	99 %
CMw (6)	C (13)	1.525	34	99 %
Aw (8)	As (9)	1.454	24	95 %
Aw (8)	A (12)	1.761	37	99 %
As (9)	Aw (8)	1.754	24	95 %
An (10)	C (13)	1.616	13	95 %
C (13)	mCc (1)	0.640	62	99 %
C (13)	CMc (3)	0.469	19	95 %
C (13)	Ac (5)	0.491	22	95 %
C (13)	Aw (8)	0.435	41	99 %

Table 2 Relative catch of heart-and-dart moth (Scotia exclamationis L.) from the material of light-trap stations in the surrounding of Budapest, in the *Péczely's* macrosynoptic weather situations changing during the night

Former and following situations	Meridional northern	Meridional southern	Zonal western	Zonal eastern	Central anticyclone	Central cyclone
Meridional northern	**0.665** (30)	**1.441** (21)	**0.603** (101)	**1.290** (52)	**0.594** (20)	*0.855* (21)
Meridional southern	0.920 (42)	*0.842* (52)	**1.202** (43)	1.802 (42)	0.998 (16)	**1.183** (101)
Zonal western	1.027 (29)	1.075 (56)	**1.364** (84)	1.111 (62)	**1.668** (42)	**0.585** (22)
Zonal eastern	0.910 (4)	0.960 (65)	0.991 (25)	**1.212** (17)	**1.237** (13)	**1.720** (19)
Central anticyclone	0.564 (5)	*1.136* (27)	0.869 (15)	0.514 (8)	-	**1.050** (13)
Central cyclone	**0.617** (93)	**0.577** (38)	**0.673** (56)	1.032 (33)	1.088 (10)	-

Table 3 Relative catch of heart-and-dart moth (Scotia exclamationis L.) from the material of light-trap stations in the surrounding of Budapest, in the *Péczely's* macrosynoptic weather situations contracted according to the direction of streaming

Notes: If the difference are in relative catches 0.165 and 0.125, significance levels are 99 % or 95 % in contracted situations. We used bold numbers if difference of relative catch is significant at 99 % level, and italic ones, if the level is 95 %.

CONCLUSIONS

The meridional northern directed situations are the most unfavourable ones from the point of view of collecting among unchanged macrosynoptic situations during the whole night, but the meridional southern and zonal western directed ones are favourable. The An (10) and A (12) are the only favourable from anticyclonic situations, but neither Ae (5) and AF (11) situations nor central cyclon (13) has significant influence on catching. It is interesting, if we examine without contractions the changing situations during the night and the difference of catchings are significant, the catching is favourable in all cases if C (13) changes for anything else, the collecting is unfavourable. Similar phenomena can also be found connected with Aw (8) situation, but here is favourable, if this situation changes. If we make a contraction according to the air current direction among the changing situations during the night, because of the relatively small number of observing data, we got the same above mentioned results for the most part. Those effects of changes are favourable from the point of view of catching success as was exoected, where the air current direction changes are significant (from meridional northern situations to zonal eastern ones and from zonal western situations to zonal eastern ones). We got the same results connected with other species in our earlier examinations (*Károssy et al.*, 1992; *Nowinszky [ed.]*, 1994), but of course the difference of catching results belonging to each types were smaller, because at that time we used types valid for the whole country.

Our method offers a possibility of investigating the insect's life-phenomena in connection with weather also in those cases where the measuring of certain elements for some reasons come up against difficulties. The collecting data of the national light-trap network, which is invaluable for science, has also become employable to insect ecological and etological investigations. On the basis of our work it is also proved that *Péczely's* macrosynoptic situations are reliable not only from the points of view of climatological typization, but also with regard to agrometeorological research. We think it essential to elaborate a similar typization for other geographical regions and other harmful species of insects as well.

REFERENCES

Károssy, Cs., 1987: Catalogue of Péczely's macrosynoptic types 1983-1987 in Hungary (in Hungarian). *Légkör, 32, No.3.*, 28-30.

Károssy, Cs., 1994: Péczely's classification of macrosynoptic types and the catalogue of weather situations (1951-1992). In: *Nowinszky, L. [ed.]*, 1994: *Light trapping of insects influenced by abiotic factors*. Savaria University Press, 155p.

Károssy, Cs. and Nowinszky, L., 1987a: A connection between the sum of turnip moth (Scotia segetum Schiff.) collected by light-trap and the various macrosynoptic types (in Hungarian). *Időjárás, 91*, 246-252.

Károssy, Cs. and Nowinszky, L., 1987b: The flying activity of harmful insects at various macrosynoptic situations (in Hungarian). *Légkör, 32, No.2.*, 33-35.

Károssy, Cs., Nowinszky, L. and Tóth, Gy., 1990: The seasonal variation of light-trap catches of Conistra vaccinii L. and Eupsilia transversa Hfn. (Lepidoptera: Noctuidae) in connection with the Péczely's macrosynoptic meteorological situations (in Hungarian). *A Berzsenyi Dániel Tanárképző Főiskola Tudományos Közleményei. VII. Természettudományok. No.2*, 53-61.

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

Nowinszky, L. and Károssy, Cs., 1986: The results of light-trap catches of winter moth (Operophthera brumata L.) at various macrosynoptic situations (in Hungarian). *Kertgazdaság, 18, No.6.*, 31-38.

Nowinszky, L. and Károssy, Cs., 1988: Investigations of the effectiveness of light-trap catches of insects connected with macrosynoptic situations (in Hungaria). *Növényvédelem, 24, No.1.*, 10-17.

Nowinszky, L. [ed.], 1994: *Light trapping of insects influenced by abiotic factors.* Savaria University Press, 155p.

Nowinszky, L., Károssy, Cs. and 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, No.4.*, 186-190.

Péczely, Gy., 1957: Grosswetterlagen in Ungarn. (Macrosynoptic types for Hungary). *Kleinere Veröff. Zentralanst. Meteorol.*, Budapest.

Péczely, Gy., 1961: Characterizing the meteorological macrosynoptic situations in Hungary (in Hungarian). *Az Országos Meteorológiai Intézet Kisebb Kiadványai, No.32.*, Budapest.

Péczely, Gy., 1983: Catalogue of macrosynoptic situations of Hungary in years 1881-1983 (in Hungarian). *Az Országos Meteorológiai Szolgálat Kisebb Kiadványai, No.53.*, Budapest.