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Influence of Weather Events on Light-Trap Catch of Moths (Lepidoptera) and Caddisflies (Trichoptera)

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Abstract. We investigated the influence of weather events (air masses, instability line, convergence zone, cyclogenesis, countrywide rain, extreme precipitation [above 50 mm] and thunderstorms) on light-trap catch of caddisfly (Trichoptera) and moth (Lepidoptera) species. The weather events were taken from the "Calendar of weather phenomena" - published monthly by National Meteorological Service. The light-trap data of *Hydropsyche instabilis* Curtis (Trichoptera) were caught by own light-trap of Ottó Kiss. The Microlepidoptera and Macrolepidoptera species were caught by light-traps of Hungarian National Light-trap Network. Relative catch (RC) values were calculated for species, generations and observation sites from the catching data. 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. We made a comparison between the relative catch values and the weather events and also the previous and following 2-2 days. Then the relative catch values were summarized and averaged daily. The differences of daily average values of significance levels were controlled with t-test. The significant results were presented in Figures.

Keywords. Weather events, Trichoptera, Lepidoptera, light-trap

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Összefoglalás. Megvizsgáltuk az időjárási események (légtömeg, instabilitási vonal, konvergenciazóna, ciklogenezis, országos esőzések, extrém csapadék [50 mm feletti] és zivatarok) hatását a tegzes (Trichoptera) és a lepke (Lepidoptera) fajok fénycsapdás fogására. Az időjárási események az Országos Meteorológiai Szolgálat által havonta megjelenő "Időjárási jelenségek naptárából" származnak. A *Hydropsyche instabilis* Curtis (Trichoptera) fénycsapda adatait Kiss Ottó saját fénycsapdájával gyűjtötte. A Microlepidoptera és a Macrolepidoptera fajokat a Magyar Országos Fénycsapda Hálózat fénycsapdái fogták. A fogási adatokból az egyes fajokra vonatkozóan relatív fogás adatokat számítottunk. Összehasonlítottuk az egyes esetek átlagolt relatív fogási értékének különbségét az összes többi eset átlagértékeivel. A szignifikancia szinteket saját t-teszt programmal számoltuk. Az egyes időjárási eseményekre fajonként kiszámítottuk az esemény napjának relatív fogás értékét a megelőző és követő 2-2 nap relatív fogás értékeivel. Az eltérések szignifikancia szintjét t-próbával számítottuk. Az eredményeket ábrákon szemléltettük.
Kulcsszavak: Időjárási események, Trichoptera, Lepidoptera, fénycsapda

Introduction

The light-trap collecting results show the mass ratio of each species with deformation because of the influence of environmental factors. If we want to use these collecting data for plant protection purposes, we have to know which factors increase or decrease the number of caught individuals, and the degree of these influences**.**
The weather elements modifying influences on light-trap catch of insects are well known, their influence the current catch with all the other factors simultaneously and

in reciprocal effect with them. Weather is one of the many abiotic factors modifying the flight activity of insects and consequently also the effectiveness of collecting by light-trap. It is the largest problem, during the examination of collecting data, to determine the influence of weather always changing in time and space.

In one of our former study (Nowinszky et al., 1994) making use of the fortunate circumstances that a principal weather observation station is located in Szombathely where a light-trap observation site was in operation from 1962 to 1970. We examined the formation of the light-trap catch, in connection with the weather elements that are only regularly measured at principal weather stations (vapour pressure, saturation deficit, wind direction, increasing or decreasing cloudiness, cloud height, fog, thunder and lightning that preceded storms).

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 weather events. These weather events express simultaneously existing for the whole Carpathian Basin.

It is well known; the meteorological factors have significant influences on our environment. One of the most important parts of these factors is the precipitation. Most of the researchers reported in the entomological literature, the light-trap catching is hindered by the rainfall. It is not easy to form an opinion of the modifying influence of precipitation in several physical conditions and intensity.

Papp and Vojnits (1976) had a collecting expedition in Korea. They had one of the most successful light-trap catching at night when there was a typical monsoon rainfall with flowing rain during some hours. The increase in number of caught insects was observed by some researchers on those days when there were thunderstorms during the day (Williams, 1940, Hosny, 1955). Wéber (1959) observed in Hungary, the maximum value of collecting was more than one day before the thunderstorm. The light-trap results confirmed that armyworm moths were flying at the time of the hailstorms in Rhodesia (Rose and Law, 1976). The supposed explanation for this is the air pressure changing before the thunderstorm increase the insects' activity (Wellington, 1946).

In opinion of Duivard (1977) a close examination of the timing of both migrations in the two main species, *Dysdercus voelkeri* Schmidt (Hemiptera: Pyrrhocoridae) and *Dysdercus mehoderes* Karsch, and of annual movements of the Inter Tropical Front leads to the only logical hypothesis that the transportation of migrating insects is effected by atmospheric convergence, prevailing wind currents and air mass displacements.

In one of our former publications (Nowinszky et al., 1994) it was shown the light-trap collecting of straw point moth (*Rivula sericealis* Scop.) increases significantly at the time of thunder and lightning before thunderstorm, but during thunderstorm the value of catching decreases about half of it and this low value remains after discontinuance of thunderstorm. In earlier times the thunderstorms arrived with heavy rainfall. There is a remarkable change in intensity of precipitation in last century. Probably this tendency can be in relationship with climate change. We examined the light trap catch of European corn borer (*Ostrinia nubilalis* Hbn.) in connection with the thunderstorms and extreme precipitation in our present paper.

The modifying influence of collecting connected with 22 kinds of air masses and 20 kinds of weather fronts and discontinuity levels, determined after Berkes (1961) were examined in our publication.

In a previous study (Puskás et al,. 1998) we found that the favourable and unfavourable influence of each weather events are the strong, gest at that time, when they have influence not only alone, but also with other effects simultaneously, or they follow one another in a short time.

In this study we examined the effect of meteorological events (weather fronts, air mass, instability line, convergence zone, cyclogenesis and countrywide rainfall) on caddisfly (Trichoptera) and moth (Lepidoptera) species. This information is part of the regular meteorological data and is valid for the whole country or overnight in Hungary.

Material

The light-trap catching results, showing its flight activity of caddisfly and moth species were examined connected with the instability line, the convergence zone, the cyclogenesis, the countrywide rain, the arctic continental (Ac), arctic maritime (Am), moderate continental (Mc), moderate maritime (Mm), subtropical continental (Tc) and subtropical maritime (Tm) air masses, the extreme precipitations (above 50 mm) and thunderstorms used the data published in “Daily Weather Report” and "Calendar of Weather Phenomena" between 1967 and 1990 by National Meteorological Service.

The instability line is a convective activity that moves in a certain band. Its passage is followed by strong winds, followed by lightning or thunderstorms. The convergence line is a horizontal line along which the convergence of the flow field is maximal. The cyclogenesis is the process of developing or enhancing cyclonic circulation.

Air mass is the vast mass of air that can cover millions of km^2 and vertically a few kilometres. The area of Hungary is 93000 km^2, so the results of our calculations with the data of the national trap network can be considered realistic. Our calculations were always done on the day of arrival of the air masses, because later they take over the surface temperature and humidity properties.

The catching results of examined species were worked up connected with these meteorological events. We used the data of light-trap network in Hungary used uniformly the

Table 1. Catching data of caught insects

Families, Species	Years	Individuals	Data	Nights
Trichoptera				
Hydropsyche instabilis Curtis, 1834	6	8,135	78	78
Lepidoptera				
Microlepidoptera spec. indet.	8	699,812	26,205	640
Crambidae, Pyraustinae				
Ostrinia nubilalis Hübner, 1796 European Corn-borer	13	56,605	15,308	1,515
Geometridae, Larentiinae				
Operophtera brumata Linnaeus, 1758 Winter Moth	11	22,846	1,605	602
Erebidae, Arctiinae				
Hyphantria cunea Drury, 1773 Autumn Webworn	13	33,568	6,708	1,252
Noctuidae, Noctuinae				
Agrotis segetum Denis & Schiffermüller, 1775 Turnip Moth	5	21,641	4,636	647
Xestia c-nigrum Linnaeus 1758 Setaceous Hebrew Character	13	57,378	24,387	1,804

Jermy type light-traps. The light source is a 100 W normal light bulb at 2 meters above the ground, colour temperature: 2900 °K, the killing material is chloroform. The traps of the plant protection 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 during 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 catching data of examined insect species are presented in Table 1.

Methods

The number of individuals trapped at different observation sites and times cannot be compared to each other even in the case of identical species, as each trap works in different environment factors constantly vary according to time as well. To solve the problem, we calculated relative catch (RC) values for observation sites, species and generations from the catch data. 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 weather evens belonging to the date. After it the relative catch values were averaged in all events 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.
We made a comparison between the relative catch values and the weather events and also the previous and following 2-2 days. Then the relative catch values were summarized and averaged daily. The differences of daily average values of significance levels were controlled with t-test.
The significant results were presented in Figures.

Results and Discussion

The results are presented in Figures 1–15.

At the time of arrival arctic continental (Ac) and moderate continental (Mc) air masses, the light-trap catch of all species is significantly reduced. The efficiency of catch on days with countrywide rain is also decreased. Catches also decrease during the stay of the mixed air masses, but significant results were found at only two species (*Operophtera brumata* L. and *Xestia c-nigrum* L.). The light-trap catch of each species is not equally low or high on the night of arrival of all other air masses. It is striking that catches are low on the night of arrival of continental air masses (Ac and Mc). The only exception is the subtropical continental air mass (Tc), which is warm. Only the catch of *Agrotis segetum* Den. et Schiff. is low at this time. Subtropical maritime air masses (Tm) cause a decrease in catch for Macrolepidoptera species, while catches of *Ostrinia nubilalis* Hbn. and caddisfly increase. As the convergence zone appears, the number of Microlepidoptera spec. indet. increases, but the number of Macrolepidoptera and Trichoptera species decrease. The instability line only increases catch of caddisfly (Trichoptera) and reduces Lepidoptera ones. Cyclogenesis reduces catches of Microlepidoptera species and increases catches of Macrolepidoptera ones.

Subtropical sea air causes a decrease in catches for Microlepidoptera spec. indet., while catches of *Ostrinia nubilalis* Hbn. and caddisfly increase. There is significant decrease in the catch of *Ostrinia nubilalis* Hbn. on those days, when extreme precipitation (above 50 mm) can be measured. According to our results the thunderstorms develop either in the afternoon or at night, the number of caught moths does not decrease.

Conclusions

Our results proved there are different influences on insects at the time of extreme weather events.

In all cases there is significant reduction in the efficiency of catch at arrival arctic continental (Ac) and moderate continental (Mc) air masses, countrywide rainfall and in the case of *Ostrinia nubilalis* Hbn. the extreme precipitation causes the same. In most cases, the instability line is unfavourable, but the subtropical continental (Tc) air mass is favorable for the catch.

According to our results the thunderstorms develop either in the afternoon or at night, the number of caught moths does not decrease. Further research is needed to explain the different results.

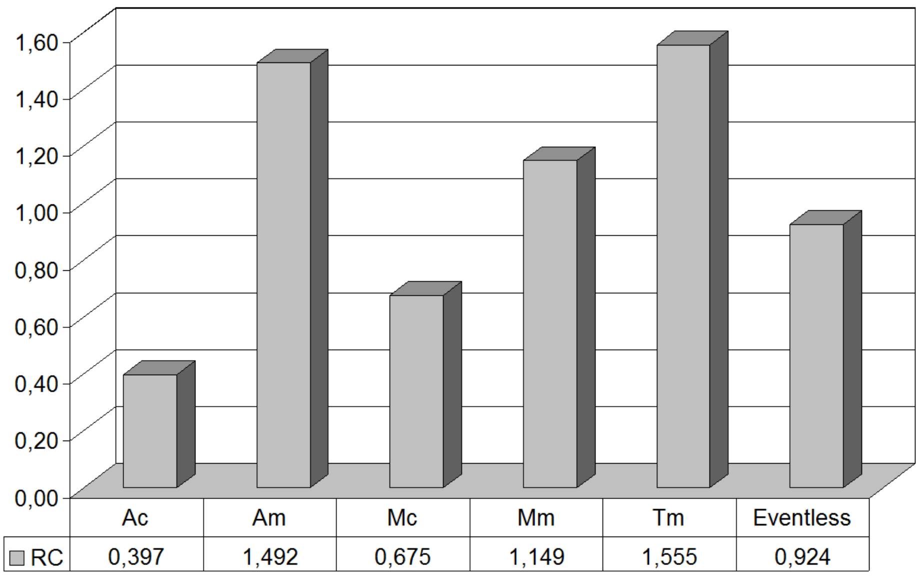


Figure 1 Light-trap catch of *Hydropsyche instabilis* Curtis in connection with air masses (Significant results only)

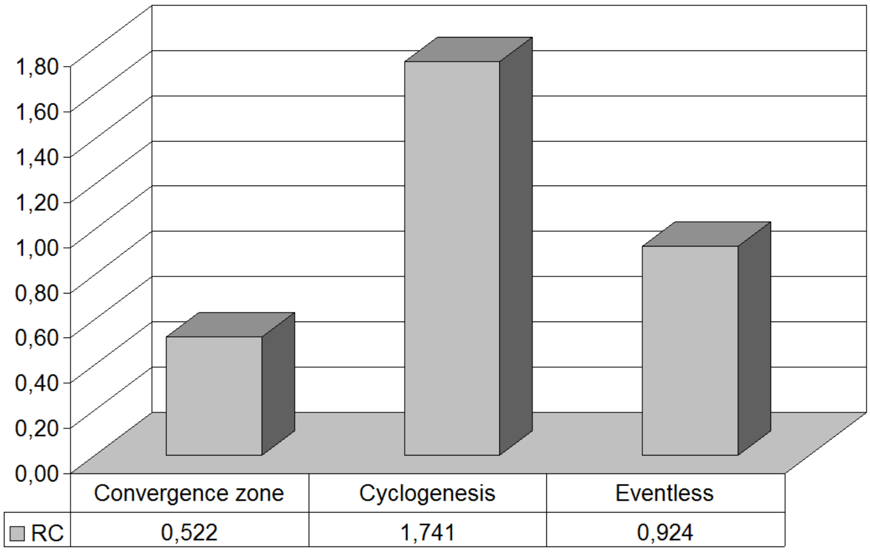


Figure 2 Light-trap catch of *Hydropsyche instabilis* Curtis in connection with weather events (Significant results only)

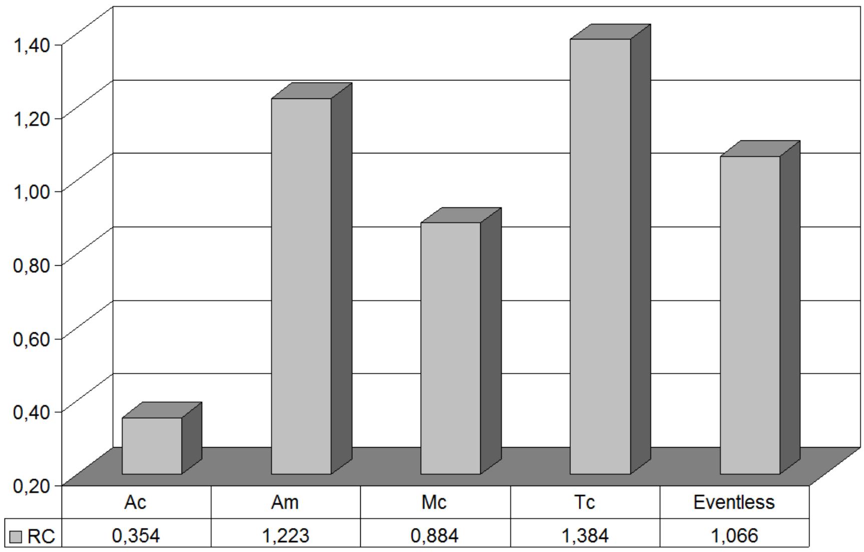
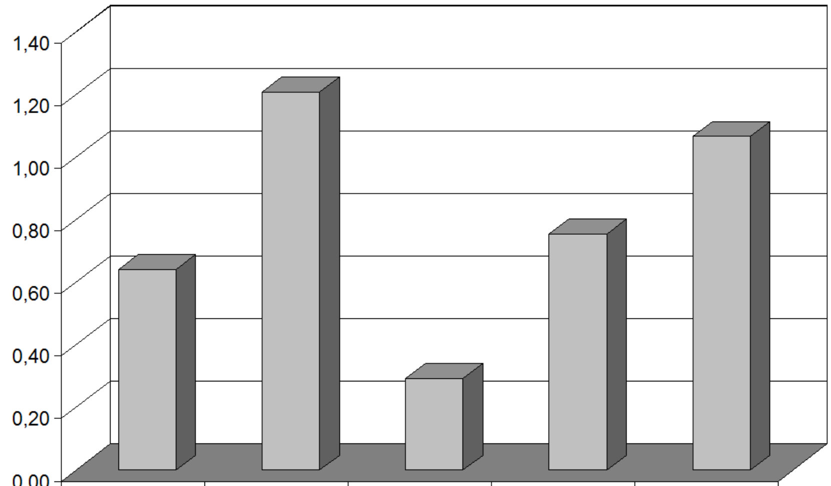
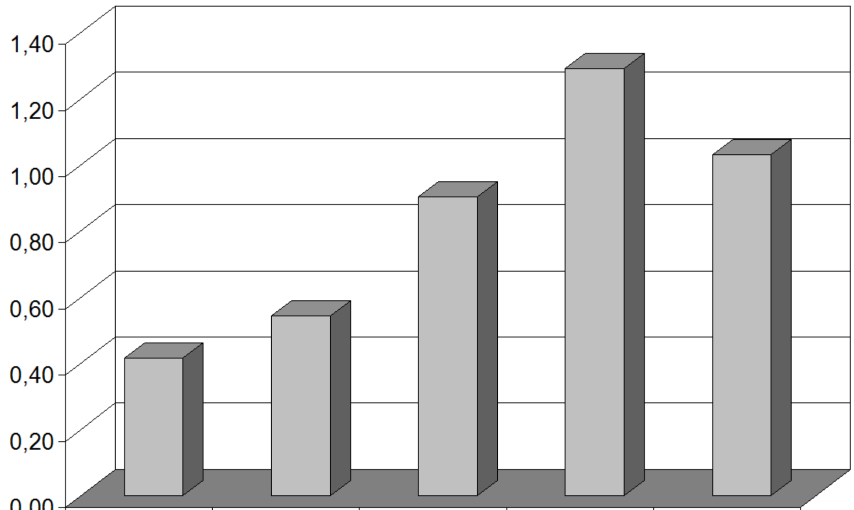


Figure 3 Light-trap catch of Microlepidoptera spec. indet. in connection with air masses (Significant results only)



	Instability line	Convergence zone	Cyclogenesis	Countrywide rain	Eventless
RC	0,641	1,207	0,292	0,754	1,066

Figure 4 Light-trap catch of Microlepidoptera spec. indet. in connection with weather events (Significant results only)



	Ac	Am	Tc	Tm	Eventless
RC	0,417	0,544	0,903	1,292	1,031

Figure 5 Light-trap catch of European Corn-borer (*Ostrinia nubilalis* Hbn.) in connection with air masses (Significant results only)

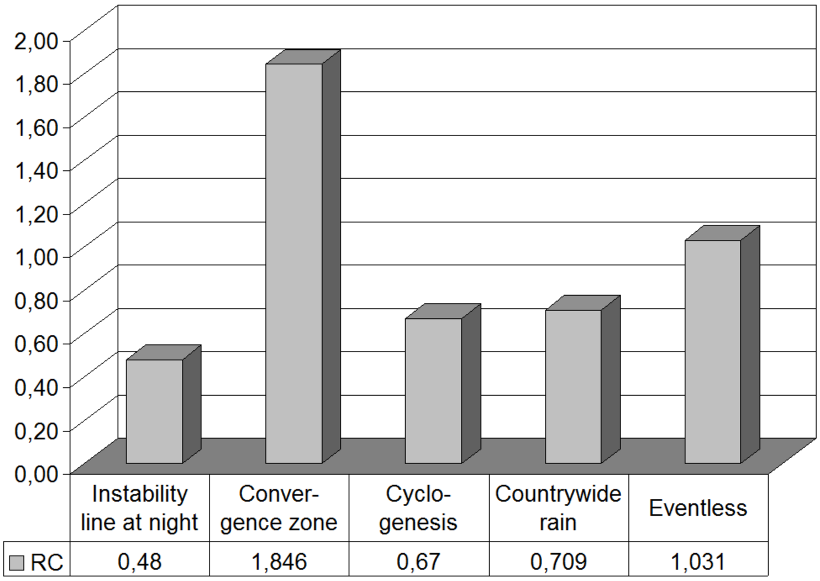


Figure 6 Light-trap catch of European Corn-borer (*Ostrinia nubilalis* Hbn.) in connection with weather events (Significant results only)

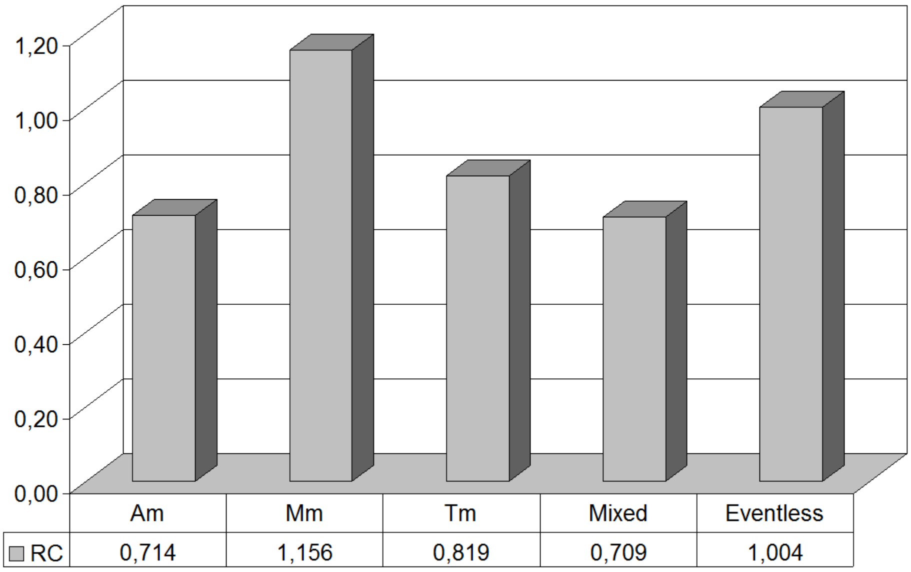


Figure 7 Light-trap catch of Winter Moth (*Operophtera brumata* L.) in connection with air masses (Significant results only)

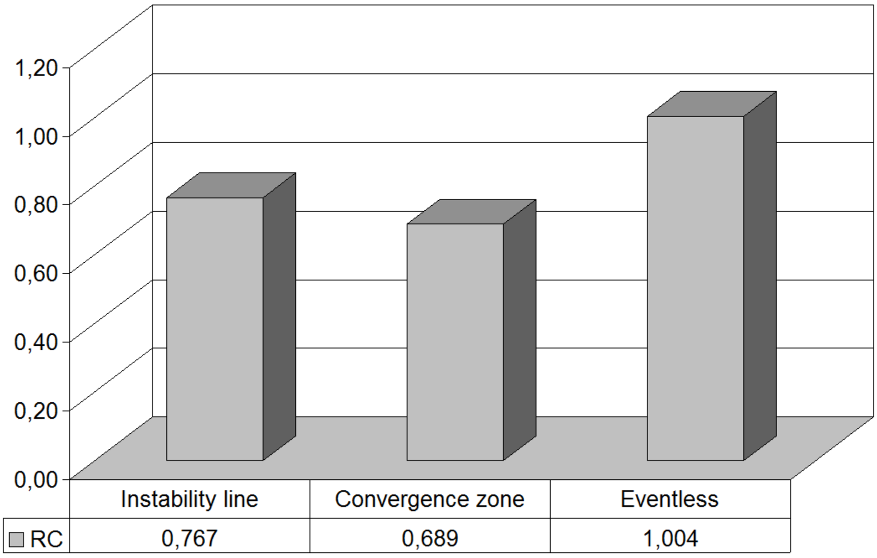


Figure 8 Light-trap catch of Winter Moth (*Operophtera brumata* L.) in connection with weather events (Significant results only)

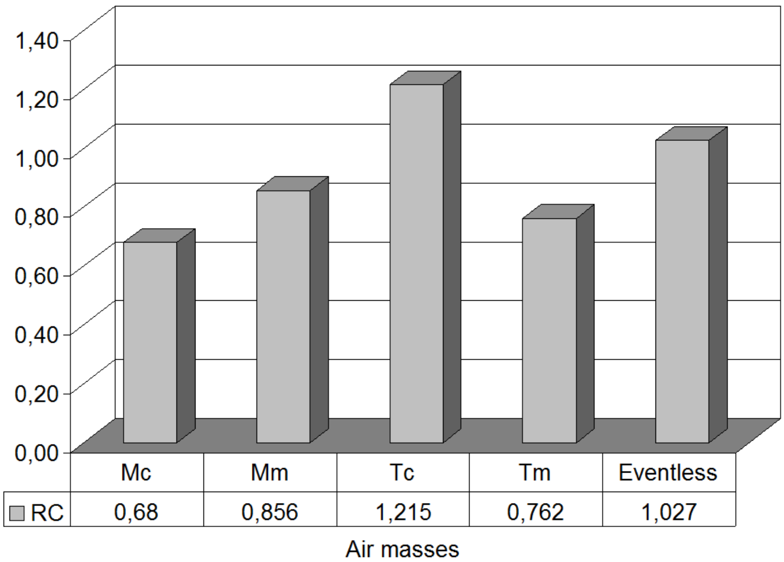


Figure 9 Light-trap catch of Fall Webworm (*Hyphantria cunea* Drury) in connection with air masses (Significant results only)

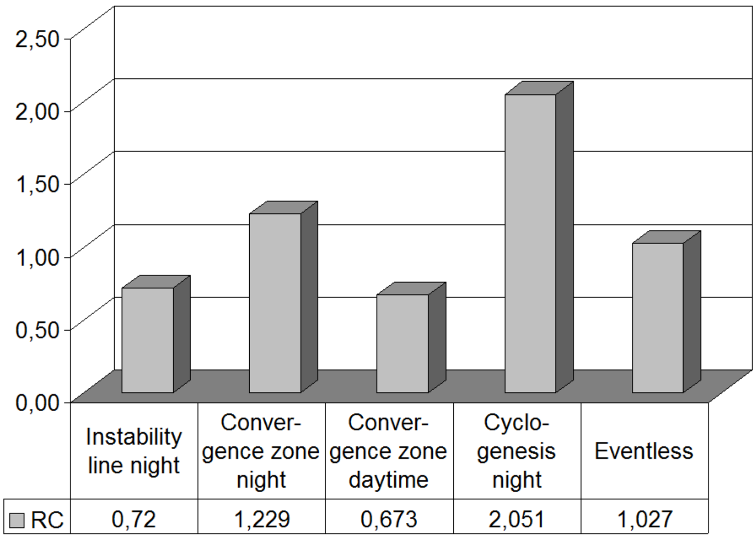
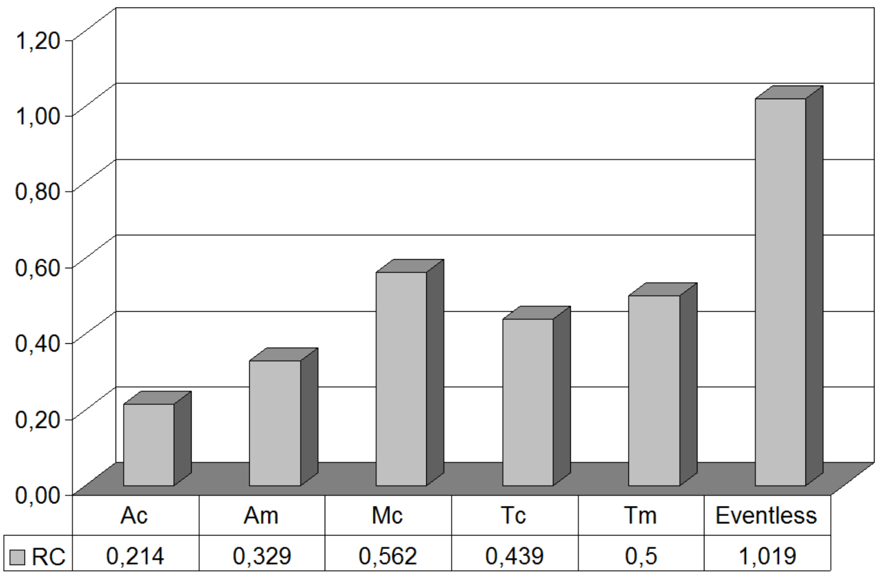


Figure 10 Light-trap catch of Fall Webworm (*Hyphantria cunea* Drury) in connection with weather events (Significant results only)



Figue 11 Light-trap catch of Turnip Moth (*Agrotis segetum* Den. et Schiff.) in connection with days of arriving air masses (Significant results only)

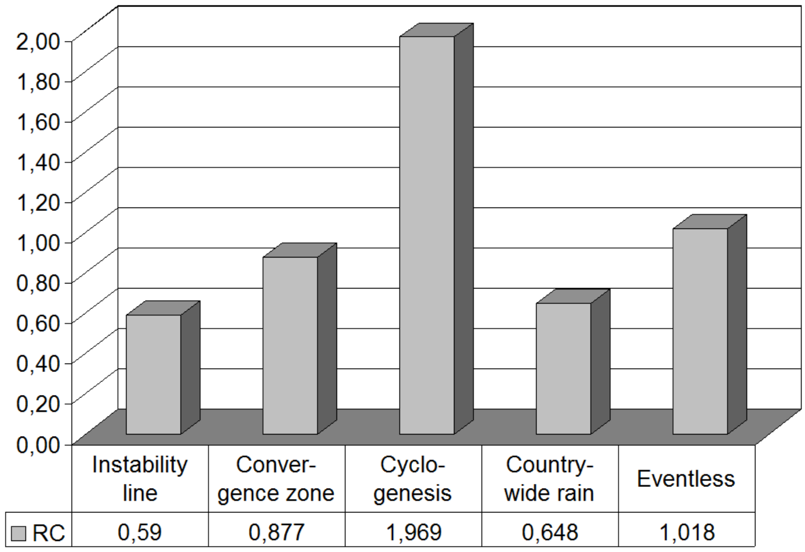


Figure 12 Light-trap catch of Turnip Moth (*Agrotis segetum* Den. et Schiff.) in connection with weather events (Significant results only)

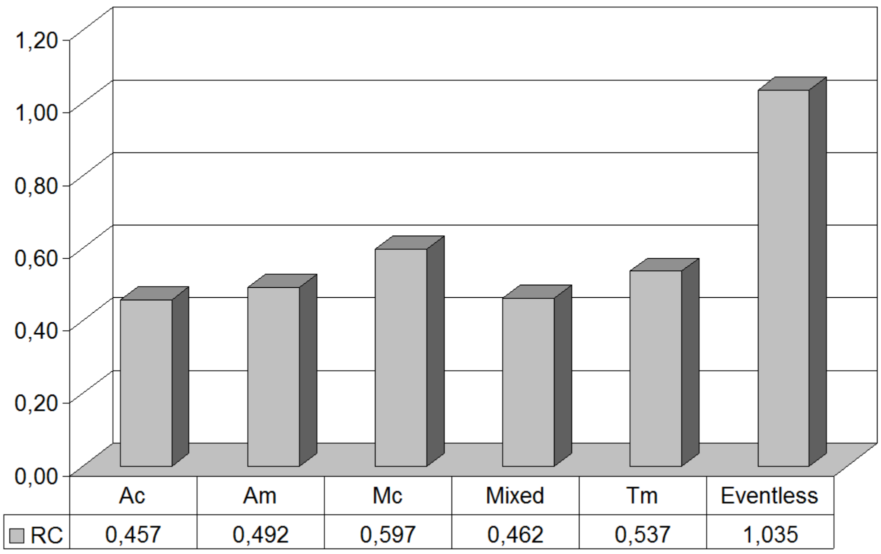


Figure 13 Light-trap catch of Setaceous Hebrew Character (*Xestia c-nigrum* L.) in connection with weather events (Significant results only)

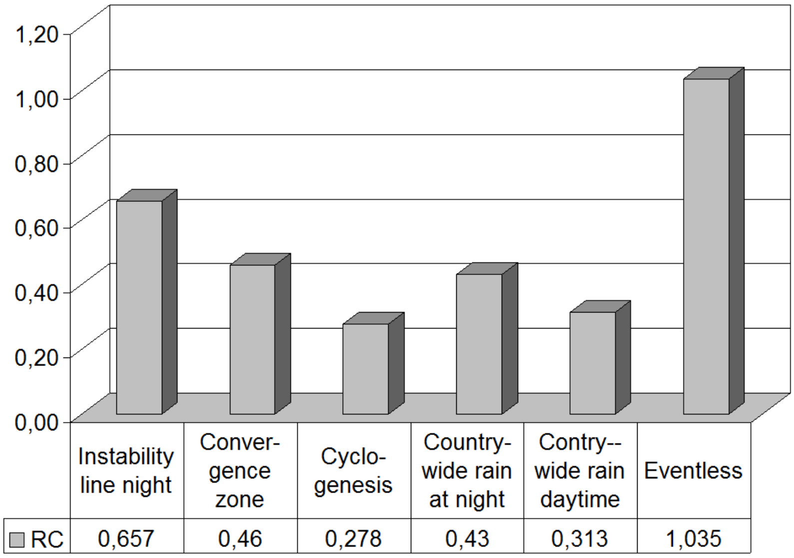


Figure 14 Light-trap catch of Setaceous Hebrew Character (*Xestia c-nigrum* L.) in connection with weather events (Significant results only)

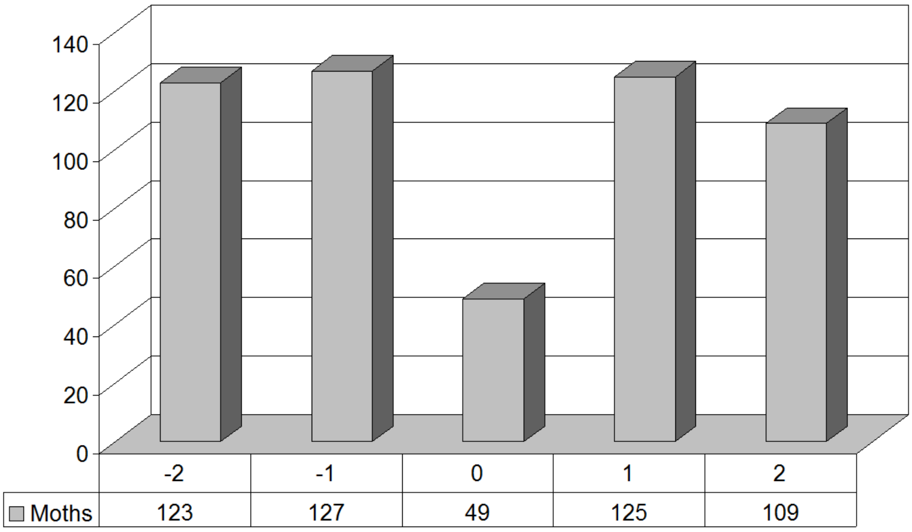
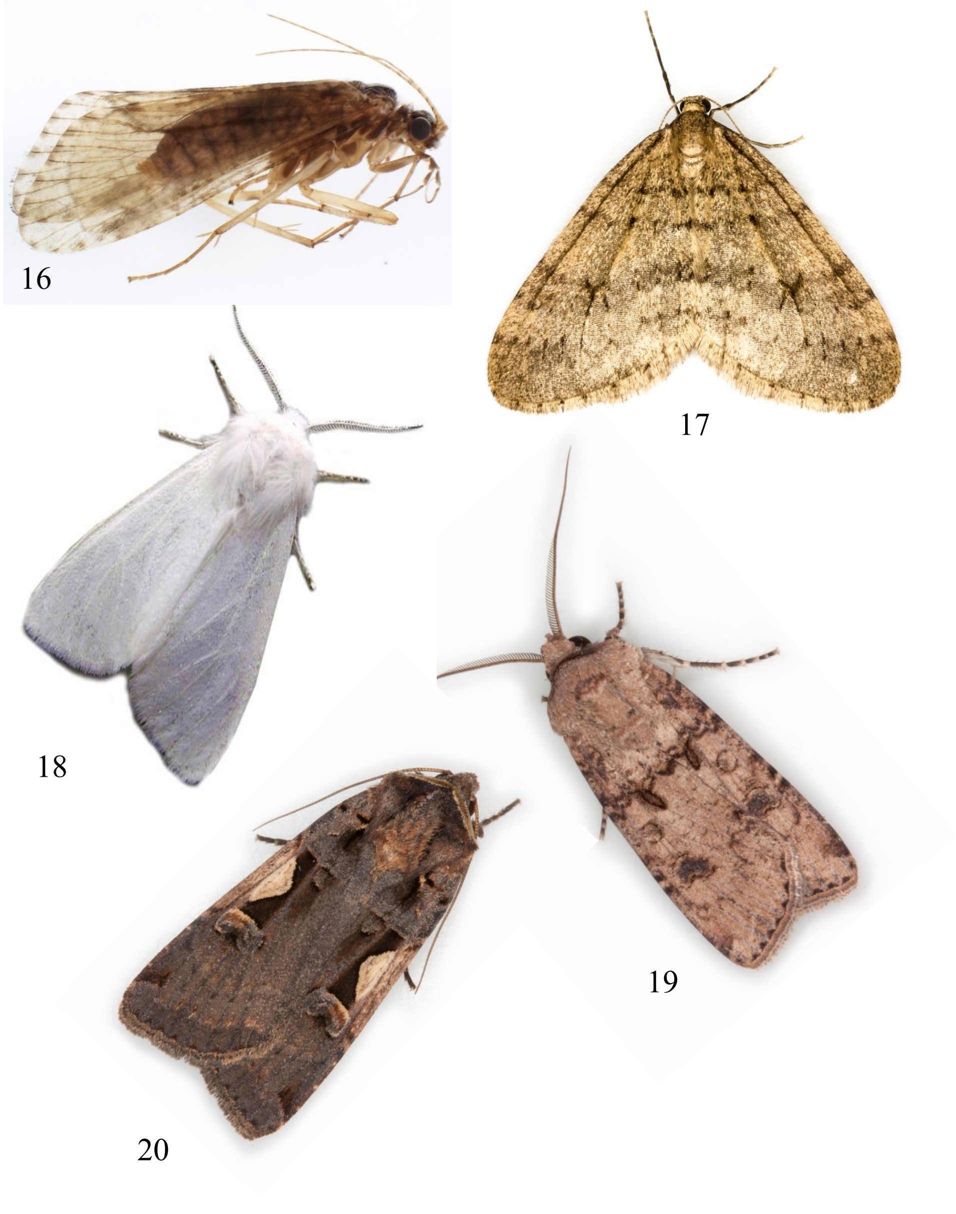


Figure 15 Light-trap catch of European Corn-borer (*Ostrinia nubilalis* Hbn.) in connection with the extreme precipitation before and after (The result is significant at 0,05 level)



Figures 16–20. The species examined: 16. *Hydropsyche instabialis*, 17. *Operophtera brumata*, 18. *Hyphantria* cunea, 19. *Agrotis segetum*, 20. *Xestia c-nigrum*.
(Image montage: Imre Fazekas)

References

Berkes Z. 1961: Air mass and weather types in Carpathian Basin (in Hungarian). – Időjárás 5: 289–293.

Duivard D. 1977: Migrations of *Dysdercus* spp. (Hemiptera: Pyrrhocoridae) related to movements of the Inter-Tropical Convergence Zone in West Africa. – Bulletin of Entomological Research 67: 185–204.

Hosny M. M. 1955: Notes on the effect of some secondary environmental conditions on the activity of nocturnal Macrolepidoptera. – Bulletin of the Entomological Society of Egypt. 39: 297–314.

Nowinszky L., Ekk I., Károssy Cs. & Tóth Gy. 1994: Weather elements. In: Nowinszky, L.[ed.]: Light trapping of insects influenced by abiotic factors. – Savaria University Press, pp. 89–94.

Papp J. & Vojnits A. 1976: Zoological collections by the Hungarian Natural History Museum in Korea. – Folia Entomologica Hungarica 19: 59–74.

Puskás J., Nowinszky L. & Makra L. 1998: The joint influence of meteorological events for light-trap collecting of harmful insects. – Acta Climatologica Universitatis Szegediensis, 31A: 17–25.

Rose D. J. W. & Law A. B 1976: The synoptic weather in relation to an outbreak of the African armyworm, *Spodoptera exempta* (Wlk.). – Journal of the Entomological Society og South Africa. 39 (1): 125–130.

Wéber M. 1959: Influence of meteorological front changes on insects attracted by light (in Hungarian). – Yearbook of Teachers' Training College Pécs, pp. 259–275.

Wellington W. G. 1946: The effects of variations in atmospheric pressure upon insects. – Canadian Journal of Research Ottawa 24: 51–70.

Williams C. B. 1940: An analysis of four years' captures of insects in light trap. Part II. The effect of weather conditions on insect activity and the estimation and forecasting of changes in the insect population. – Transaction Royal entomological Society London 40: 227–306.