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RESEARCH ARTICLE

Relationship between UV-B Radiation of the Sun and the Light- and Pheromone Trapping of Insects in Hungary (Central Europe)

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ABSTRACT

The study deals with the influence of the solar UV-B radiation on light- and pheromone trapping of Lepidoptera, Heteroptera and Trichoptera species. The catch data pertaining to Macrolepidoptera and Heteroptera species have been provided by the national light-trap network between 1994 and 1998. The Trichoptera species were caught by own light-trap. Likewise between 1994 and 1998 Csalomon type pheromone traps were operating in Bodrogkisfalud (48°10'N; 21°21E; Borsod-Abaúj-Zemplén County, Hungary, Europe). These own traps worked every day and caught 6 Microlepidoptera species. UV-B data used for examination come from measurements in the Keszthely observatory of the Hungarian Meteorological Service by Robertson-Berger UV-Biometers in the years between 1994 and 1998.

Key words: *UV-B radiation, insects, light- and pheromone trapping*

INTRODUCTION

The most important knowledge on the Sun's UV radiation can be summarised in the following (örményi, 1991). Increase in the number of sunspots increases the solar ultraviolet radiation, which mainly extracts it in the high atmosphere his effect, primarily through ionization (Saikó 1979). Atmospheric ozone absorbs considerable part of the UV radiation coming from the Sun and harmful for biosphere so only a very small part of it can reach the Earth's surface thus organisms adapted to that intensity.

The amount of UV irradiance at the earth's surface is relatively small; the photons at these wavelengths are biologically active and commonly detrimental to plant and animal health (Grant and Heisler 1997). Podstawczyńska-Bienias and Fortuniak (1998) present the analysis of measurements of UV (290-400 nm) and total solar radiation (303-2800 nm) values in Lodz in the period 1997-1999. The daily values of UV and total radiation are highly correlated with a general linear relation. The UV daily values are constituted on average 4.2 % of total daily radiation. The high values of ratio (>7%) occurred in cloudy days while the total irradiance decreased with increasing cloudiness. This shows that the clouds absorb more in near infrared than UV region of the solar spectrum.

Cloud cover influences UV-B intensity measured at the surface, aerosol content of the atmosphere and, of course the solar elevation (Németh et al. 1996). The latter causes a change in UV-B irradiance, which is regular and can be accurately given: UV-B irradiance increases with the increasing solar elevation. Cloudiness and aerosol content are very variable quantities; both can considerably change during a day.

Especially the UV-B range is detrimental in large quantities to living organisms. We could not find our studies outside their own works of other authors, which deal with the effect of the Sun's ultraviolet radiation and light- and pheromone trapping of insects. We studied therefore that on the nights following days with catching of light-trap catch of caddisflies (Trichoptera), moth (Lepidoptera) and bugs (Heteroptera) species and pheromone trap catch of moth (Lepidoptera) species.
However, it is striking that it cannot be found such publication that deals with the UV-B radiation of the Sun and light- or pheromone trapping of insects. We have demonstrated in our previous works that UV-B affect the light-trap effectiveness (Nowinszky et al. 1999 and 2000, Puskás et al. 2004).

MATERIAL AND METHOD

One of the most important ranges of sunshine is the band of ultraviolet radiation. According to the international classification of Schulze (1970) radiation on the Earth's surface can be detected in two domains, i. e. UV-A (315-390 nm) and UV-B (290-315 nm). Radiation can be measured both by physical, chemical and biological methods. In his above-mentioned study Örményi (1991) has used physical ones.
The world-wide known instruments applying the physical methods are the following:
- Eppley UV radiation counter (Marchgraber and Drummonand, 1960) and
- the Robertson (1972) and Berger (1976) UV radiation counter (sunburn-meter) working mainly in UV-B range.

UV-B data used for the study come from measurements in the Keszthely observatory of the Hungarian Meteorological Service. Measurements in Keszthely are carried out continuously by Robertson-Berger UV-Biometers which are connected to VAISALA/MILOS automatic weather station and 10 minute averages are produced by the data acquisition system from the samplings. The UV-Biometers measures biological effective ultraviolet radiation in special unit. The biological effectiveness of the UV radiation is measured in MED/h (Minimum Erythema Dose per hour). One MED/h would cause minimal redness of the average number 2 skin after an one-hour irradiation. The integral of the cross-multiplication of irradiating flux [W/cm nm] and the Erythema Action Spectrum (McKinlay and Diffey 1987), which means the wavelength distribution of sensitivity of the skin so it is a weighting function actually, gives the Effective Power. It was established that 1 MED/h -5.83*10'6 [Won2] of Effective Power for a MED of 21 mJ per cm2 effective dose. Daily totals given in MED/day are calculated by totalizing hourly values.
The catching data of examined caddisflies (Trichoptera), moths (Lepidoptera) and bugs (Heteroptera) species and they light- and pheromone trapping stations are shown in Table 1. Than the number of individuals of a given species in different places and different observation years is not the same. The collection efficiency of the modifying factors (temperature, wind, moonlight, etc.) are not the same at all locations and at the time of trapping, it is easy to see that the same number of items capture two different observers place or time of the test species mass is entirely different proportion. To solve this problem, the introduction of the concept of relative catch was used decades ago (Nowinszky 2003).
The relative catch (RC) for a given sampling time unit (in our case, one night) and the average number individuals per unit time of sampling, the number of generations divided by the influence of individuals If The number of specimens taken from the average of the same, the relative value of catch: 1 (Nowinszky 2003).
From the collection data pertaining to examined species we calculated relative catch values (RC) by light- and pheromone trap stations and by swarming. Following we arranged the data on the UV-B in classes. Relative catch values were placed according to the features of the given day, and then RC were summed up and averaged. The data are plotted for each species and regression equations were calculated for relative catch of examined species and UV-B data pairs.

RESULTS AND DISCUSSION

The results are shown in the Figure 1-14.

Figure 1 Light-trap catch of the (*Rhyacophila tristis* Pictet) depending on the UV-B radiation of the Sun (Zemplén-Mountains, Kemece brook, 1998)

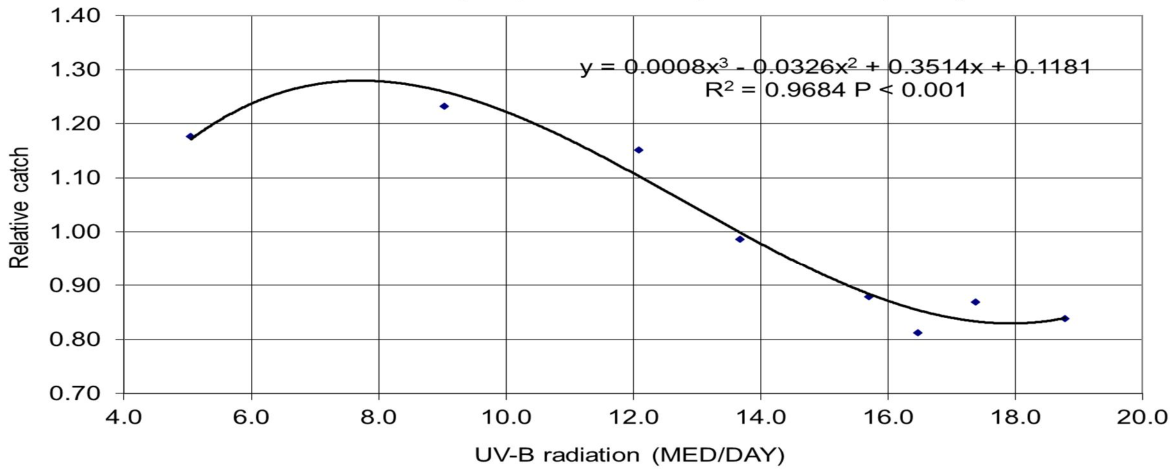


Figure 2 Light-trap catch of the (*Agapetus orchipes* Curtis) depending on the UV-B radiation of the Sun (Zemplén-Mountains, Kemence brook, 1998)

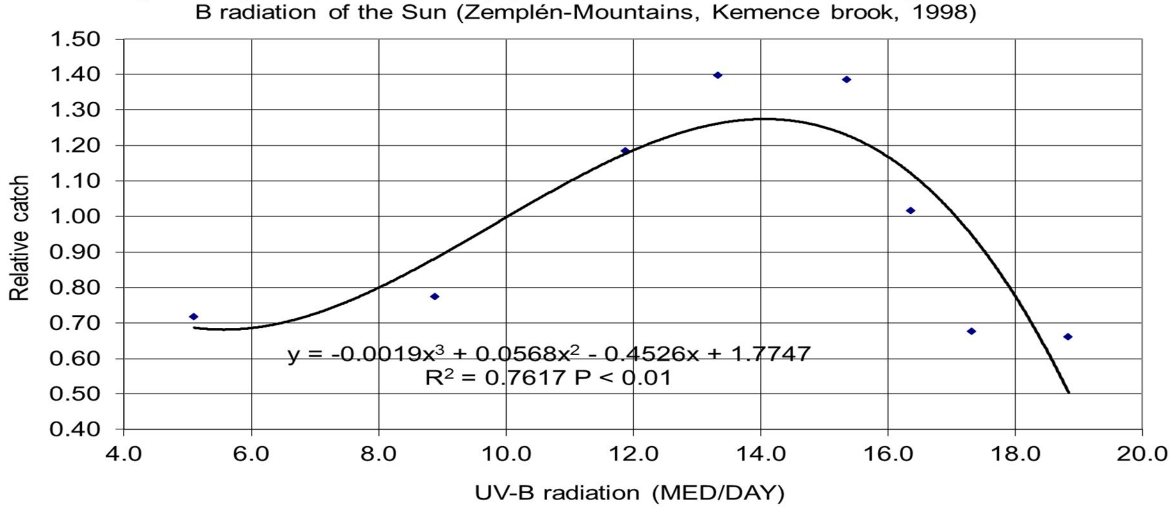


Figure 3 Light-trap catch of the (*Glossosoma conformis* Neboiss) depending on the UV-B radiation of the Sun (Zemplén-Mountains, Kemence brook, 1998)

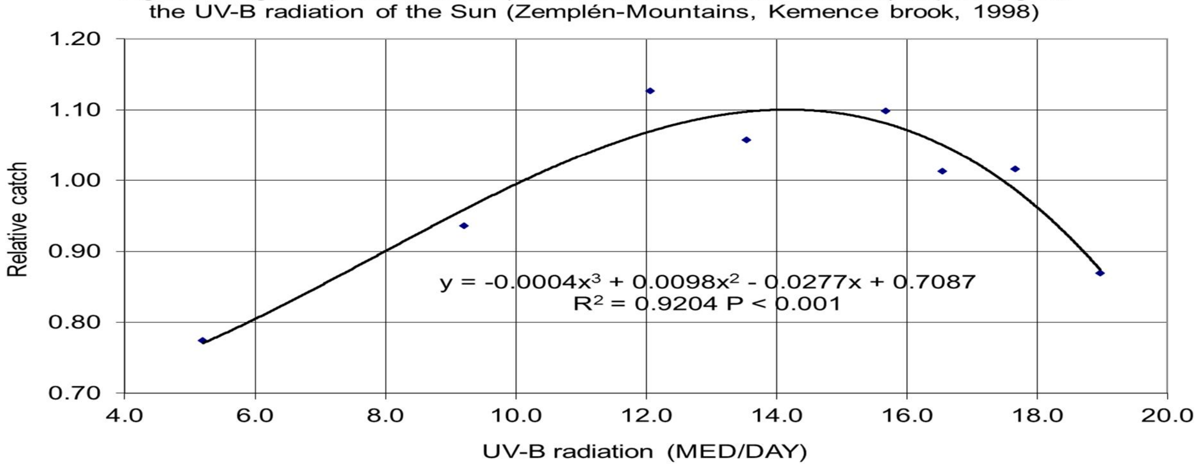


Figure 4 Light-trap catch of the (*Silo pallipes* Fabricius) depending on the UV-B radiation of the Sun (Zemplén-Mountains, Kemence brook, 1998)

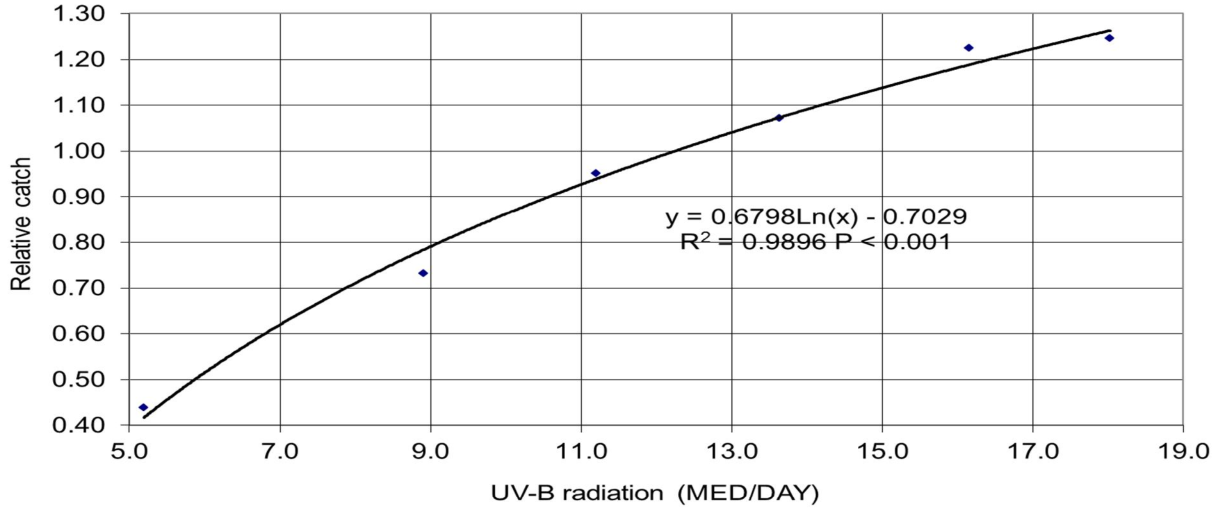


Figure 5 Light-trap catch of the Horse Chestnut Life-miner (*Cameraria ochridella* Deschka et Dimić) depending on the UV-B radiation of the Sun (Budapest, 1997 and 1998)

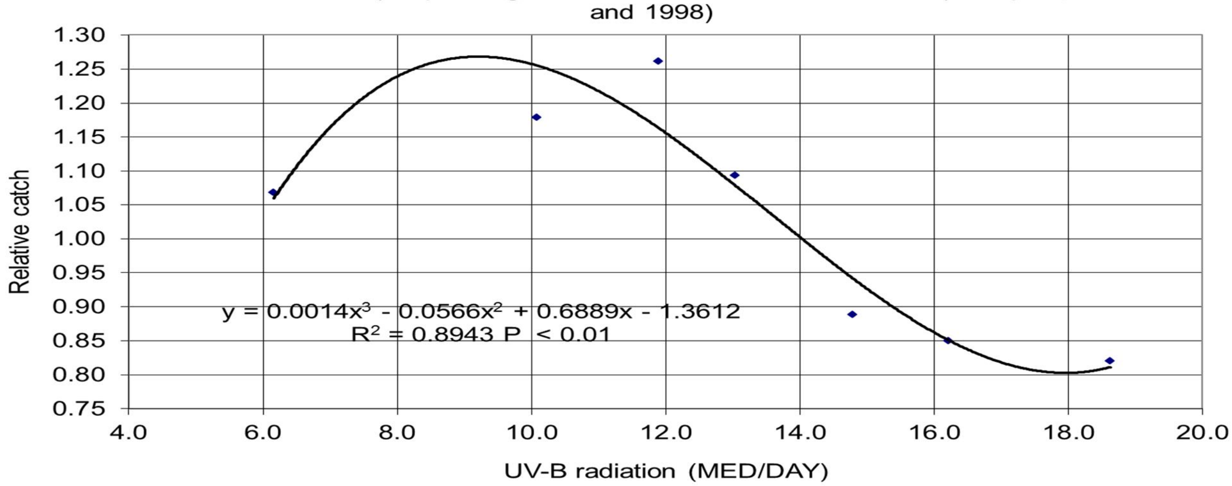


Figure 6 Light-trap catch of the European Corn-borer (*Ostrinia nubilalis* Hübner) depending on the UV-B radiation of the Sun (Sukoró, 1994—1998)

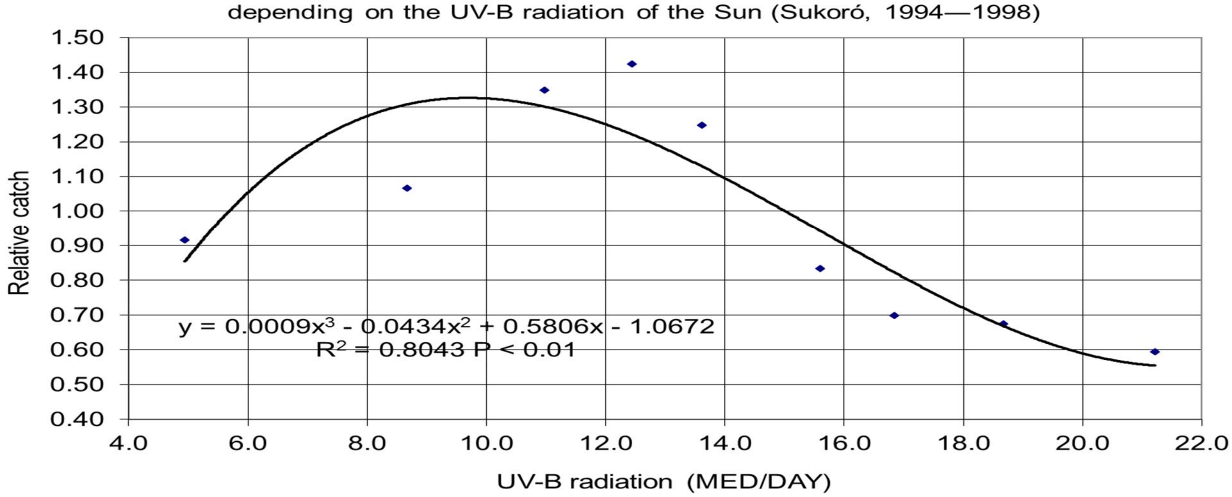


Figure 7 Light-trap catch of the Fall Webworm (*Hyphantria cunea* Drury) depending on the UV-B radiation of the Sun (Szabadbattyán, 1997 and 1998)

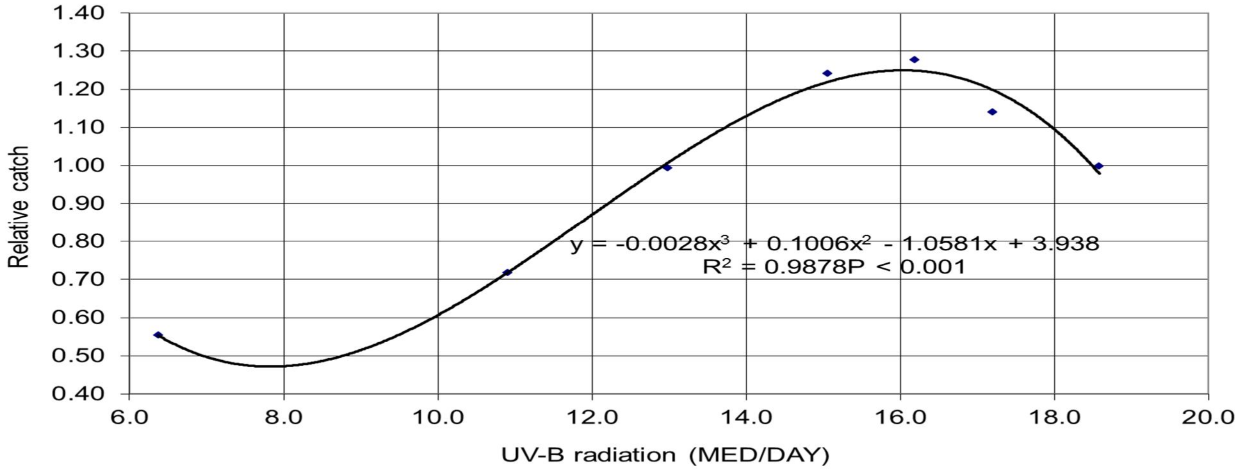


Figure 8 Light-trap catch of the *Lygus* sp depending on the UV-B radiation of the Sun (Five light-traps of Fejér County, 1994—1998)

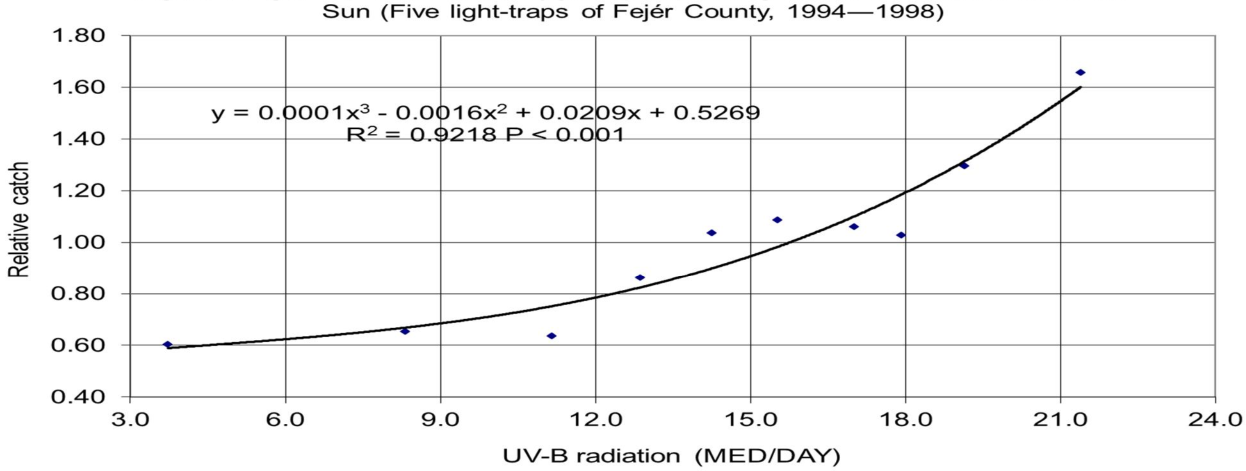


Figure 9 Pheromone trap catch of the Spotted Tentiform Leafminer (*Phyllonoricter blancardella* Fabricius depending on the UV-B radiation of the Sun (Bodrogkisfalud, 1994—1998)

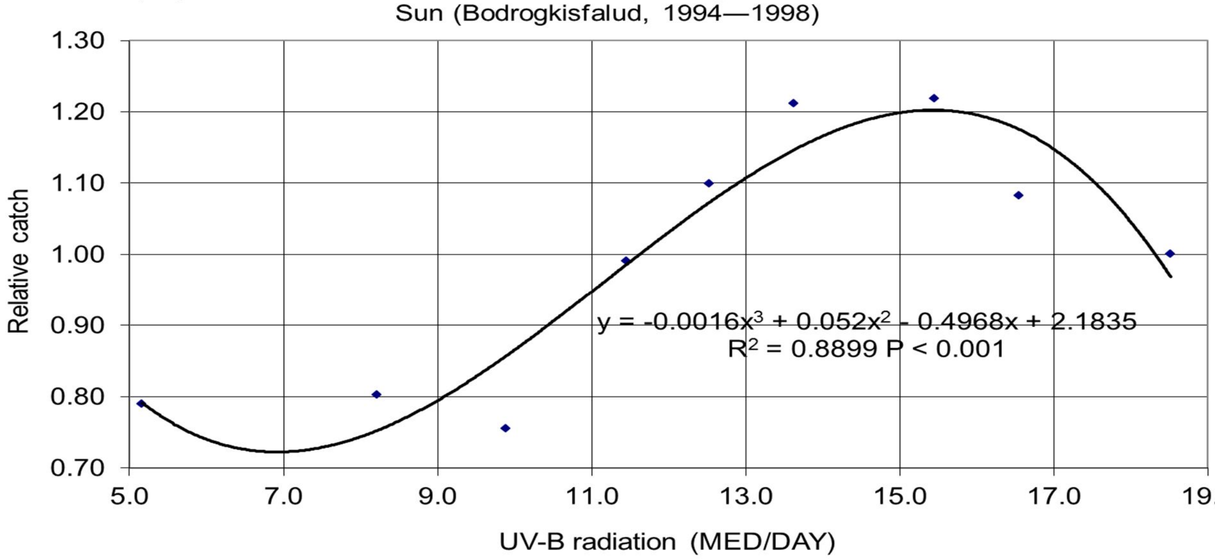


Figure 10 Pheromone trap catch of the Peach Twig Borer (*Anarsia lineatella* Zeller) depending on the UV-B radiation of the Sun (Bodrogkisfalud, 1994—1998)

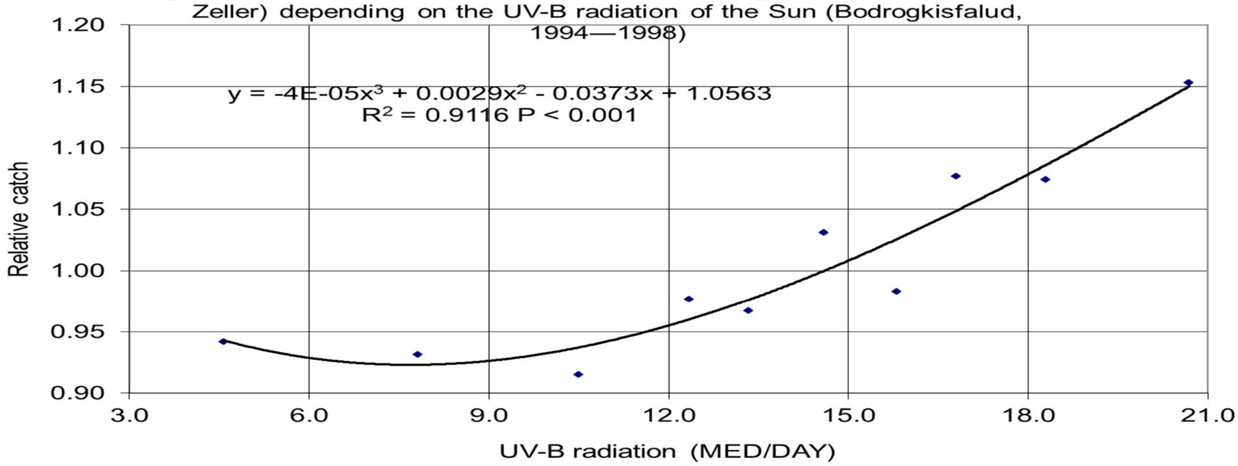


Figure 11 Pheromone trap catch of the European Vine Moth (*Lobesia botrana* Denis & Schiffermüller) depending on the UV-B radiation of the Sun (Bodrogkisfalud, 1994—1998)

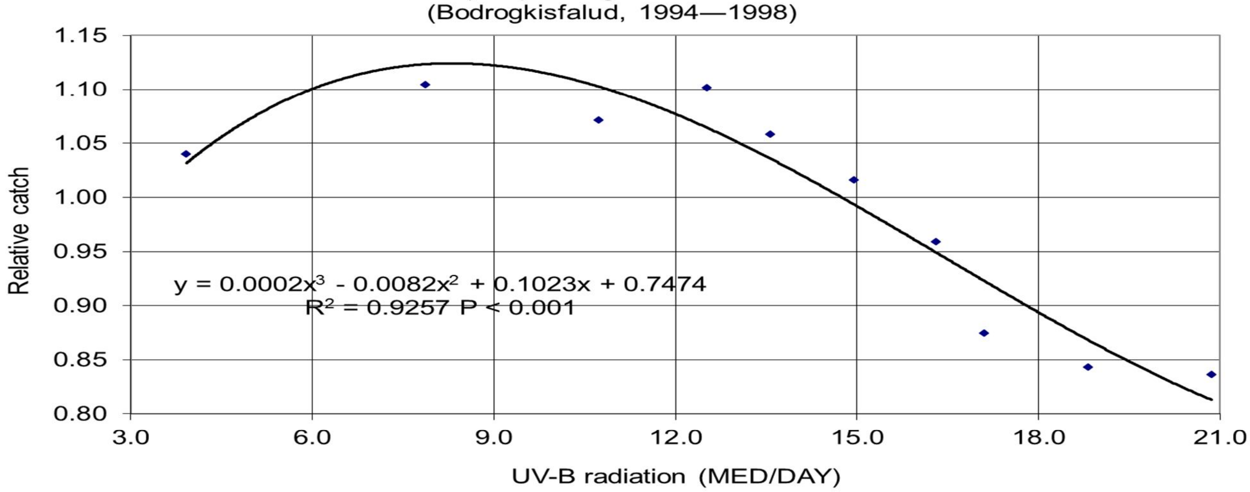
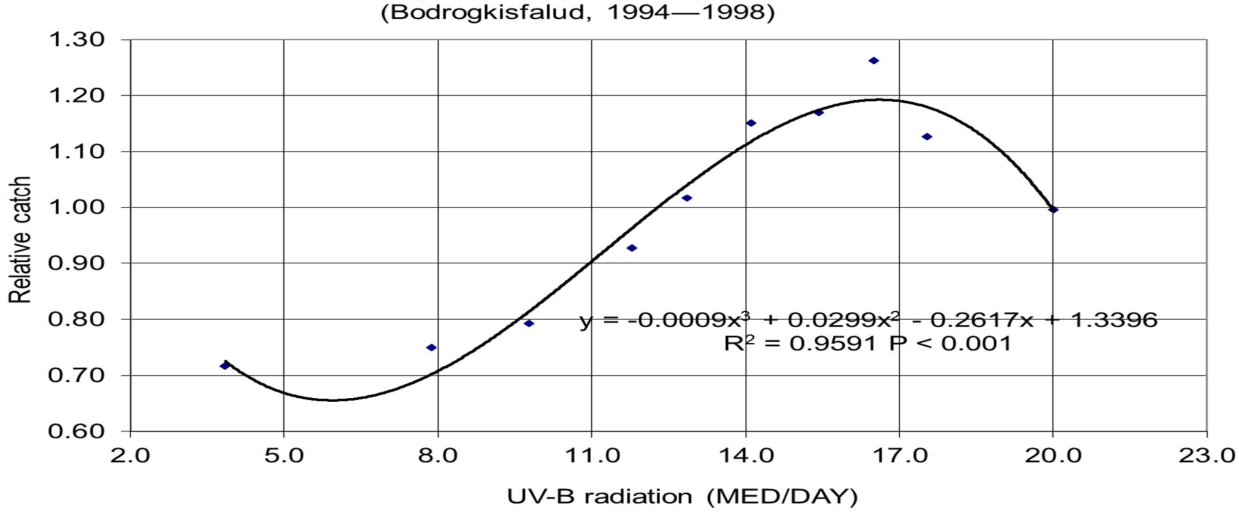
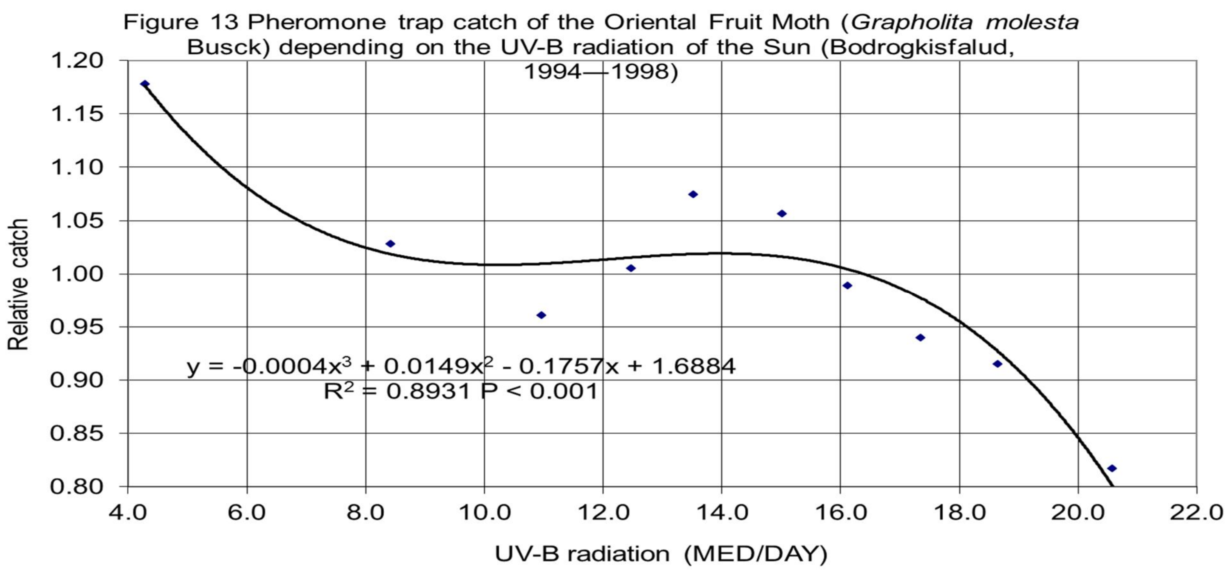
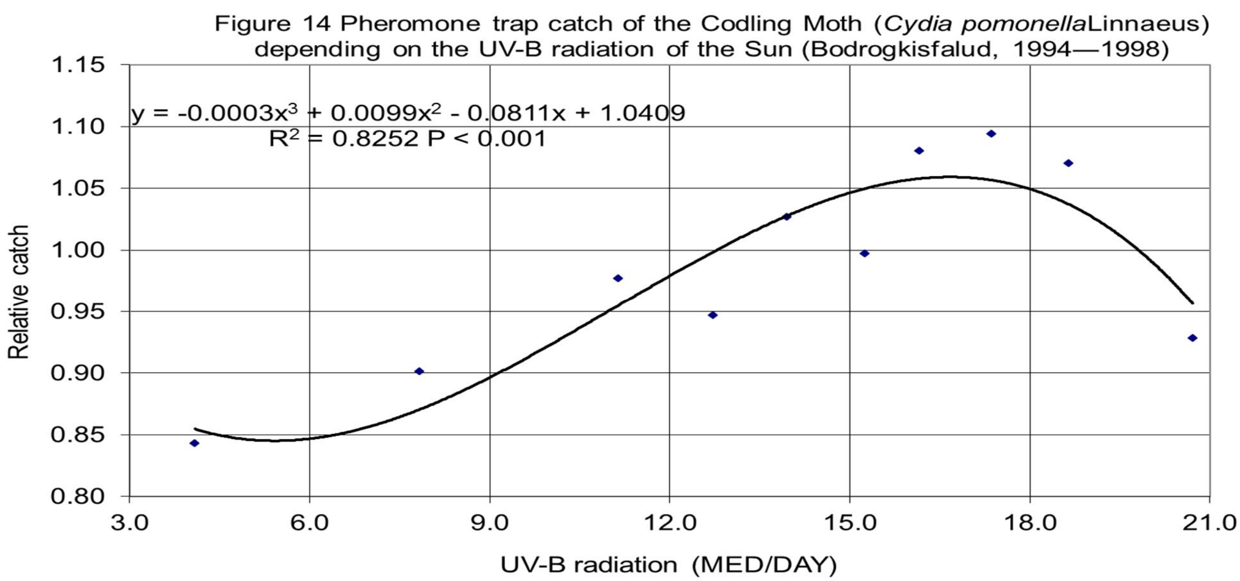


Figure 12 Pheromone trap catch of the Plum Fruit Moth (*Grapholita funebrana* Treitschke) depending on the UV-B radiation of the Sun (Bodrogkisfalud, 1994—1998)







In the majority of examined swarming the solar UV-B radiation increases the catch initially; at higher values of UV-B radiation the catch is lower. Ten of all swarming was obtained in this result, regardless of the trapping method and location of the taxonomic classification of species. Three times we experienced continuous elevation in swarming in one case though decrease if the value of UV-B radiation increasing values.

The increase or decrease of the catch is explainable by our previous hypotheses.

Low relative catch values always refer to environmental factors in which the flight activity of insects diminishes. However, high values are not so clear to interpret. Major environmental changes bring about physiological transformation in the insect organism. The imago is short-lived; therefore unfavourable environmental endangers the survival of not just the individual, but the species as a whole. In our hypothesis, the individual may adopt two kinds of strategies to evade the impacts hindering the normal functioning of its life phenomena. It may either display more liveliness, by increasing the intensity of its flight, copulation and egg-laying activity or take refuge in passivity to environmental factors of an unfavourable situation. By the present state of our knowledge we might say that unfavourable environmental factors might be accompanied by both high and low catch (Nowinszky 2003).

It can be explained on the basis of our hypothesis of the first rising and then falling catch results. But however their answer is already the passivity for the additional increase of the radiation. However, it is striking that the taxonomic place of the single species is not attached to by this response, so may be widespread in the world of the insects widely presumably.

It is a remarkable fact, that the swarming peaks of different species can be experienced at totally different UV-B values.

Table 1: The locality of light- and pheromone traps, catching data of the examined species

Light trapping data		
Trichoptera		
Own light-trap: Zemplén Mountains, Kemence brook (48°28′29"N; 21°48′ 03"E), 1998		
Species	Nº Individuals	Nº Data
Rhiacophilidae» *Rhyacophila tristis* Pictet, 1834	566	100
Glossosomatidae» *Agapetus orchipes* Curtis, 1834	2485	95
Glossosoma conformis Neboiss, 1963	504	99
Goeridae» *Silo pallipes* Fabricius, 1781	1204	101
Lepidoptera		
Species	Nº Individuals	Nº Data
National light-trap network: Budapest (47°30′04"N; 19°03′11"E) 1997 and 1998		
Gracillariidae » Lithocolletinae» Horse Chestnut Leaf-miner (*Cameraria ochridella* Deschka & Dimić, 1986)	943	130
National light-trap network: Sukoró (47°14′40"N; 18°35′99"E), 1994 — 1998		
Crambidae » Pyraustinae» European Corn-borer (*Ostrinia nubilalis* Hübner, 1796)	1899	269
National light-trap network: Szabadbattyán (47°07′00"N; 18°22′00"E), 1997 and 1998		
Arctiidae » Fall Webworm (*Hyphantria cunea* Drury, 1773	1240	125
Heteroptera		
Species	Nº Individuals	Nº Data
National light-trap network: Szabadbattyán (47°07′00"N; 18°22′00"E), Sukoró (47°14′40"N; 18°35′99"E), Nadap (47°15′44"N; 18°37′17"E), Pusztaegres (46°49′49"N; 18°32′37"E), Rácalmás (47°01′51"N; 18°56′60"E), 1994 — 1998		
Lygus sp. Overwhelmingly (*Lygus rugulipennis* Poppius, 1911 and *Lygus pratensis* Linnaeus, 1758), Miridae	15665	830
Pheromone trapping data		
Lepidoptera		
Species	Nº Individuals	Nº Data
Own pheromone traps: Bodrogkisfalud (48°10′41"N; 21°21′77"E), 1994 — 1998		
Gracillariidae » Lithocolletinae» Spotted Tentiform Leafminer *Phyllonorycter blancardella* Fabricius, 1781;	7808	327
Gelechiidae » Anacampsinae» Peach Twig Borer *Anarsia lineatella* Zeller, 1839	2013	484
Tortricidae » Olethreutinae» European Vine Moth *Lobesia botrana* Denis & Schiffermüller, 1775;	2937	364
Plum Fruit Moth *Grapholita funebrana* Treitschke, 1835	5369	760
Oriental Fruit Moth *Grapholita molesta* Busck, 1916	1623	457
Codling Moth *Cydia pomonella* Linnaeus, 1758	1367	492

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