

Chapter 3.

Relationship between UV-B Radiation of the Sun and the Pheromone Trap Catch of Microlepidoptera Species

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Abstract: The study deals with the influence of the solar UV-B radiation on pheromone trapping of Microlepidoptera species. The catch data pertaining to Microlepidoptera species have been provided by between 1994 and 1998 Csalomon type pheromone traps were operating in Bodrogkiszfalud (48° 10'N; 21°21'E; 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.

Keywords: UV-B radiation, moths, pheromone trapping

3. 1. 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 pheromone trapping of insects. We studied therefore that on the nights following days with catching of pheromone trap catch of moth (Microlepidoptera) species.

However, it is striking that it cannot be found such publication that deals with the UV-B radiation of the Sun and pheromone trapping of insects. We have demonstrated in our previous works that UV-B affect the light-trap effectiveness (Nowinszky et al. 1997 and 2000, Puskás et al. 2004).

3. 2. Material

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. Örményi (1991) has used physical ones in his above-mentioned study.

The world-wide known instruments applying the physical methods are the following:

- Eppley UV radiation counter (Marchgraber and Drummond, 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 $\approx 5.83 \cdot 10^{-6}$ [W/cm²] 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.

Six harmful Microlepidoptera species were caught by the Csalomon type sticky traps at Bodrogkisfalud in Borsod-Abaúj-Zemplén County (Hungary) between 1994 and 1998. The caught species were the followings: Spotted Tentiform Leafminer (*Phyllonorycter blancardella* Fabricius, 1781), Peach Twig Borer (*Anarsia lineatella* Zeller, 1839), European Vine Moth (*Lobesia botrana* Denis et Schiffermüller, 1775), Plum Fruit Moth (*Grapholita funebrana* Treitschke, 1846), Oriental Fruit Moth (*Grapholita molesta* Busck, 1916) and Codling Moth (*Cydia pomonella* Linnaeus, 1758). The catching data of examined moths (Lepidoptera) species and pheromone trapping stations are shown in Table 3. 2. 1.

3. 3. Methods

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 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.

3. 4. Results and Discussion

The results are shown in the Figures 3. 4. 1—3. 4. 6.

In the majority of examined species the solar UV-B radiation increases the catch initially; at higher values of UV-B radiation the catch is lower. Four of all species: Spotted Tentiform Leafminer (*Phyllonorycter blancardella* Fabricius, Codling Moth *Cydia pomonella* Linnaeus, European Vine Moth *Lobesia botrana* Denis et Schiffermüller, and Plum Fruit Moth *Grapholita funebrana* Treitschke) was obtained in this result, regardless of the trapping method and location of the taxonomic classification of species. One species, the Peach Twig Borer *Anarsia lineatella* Zeller we experienced continuous elevation in increasing the UV-B radiation and one spe-

cies (Oriental Fruit Moth (*Grapholita molesta* Busck) though decrease if the value of UV-B radiation will be higher. 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.

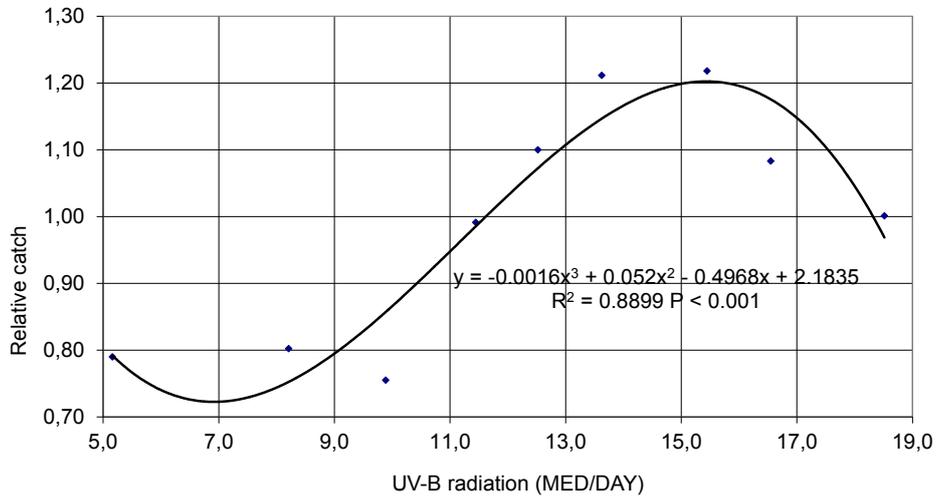


Figure 3. 4. 1.

Figure 3. 4. 1. Pheromone trap catch of the Spotted Tentiform Leafminer (*Phyllonorycter blancardella* Fabricius) in connection with the UV-B radiation of the Sun (Bodrogkisfalud, 1994–1998)

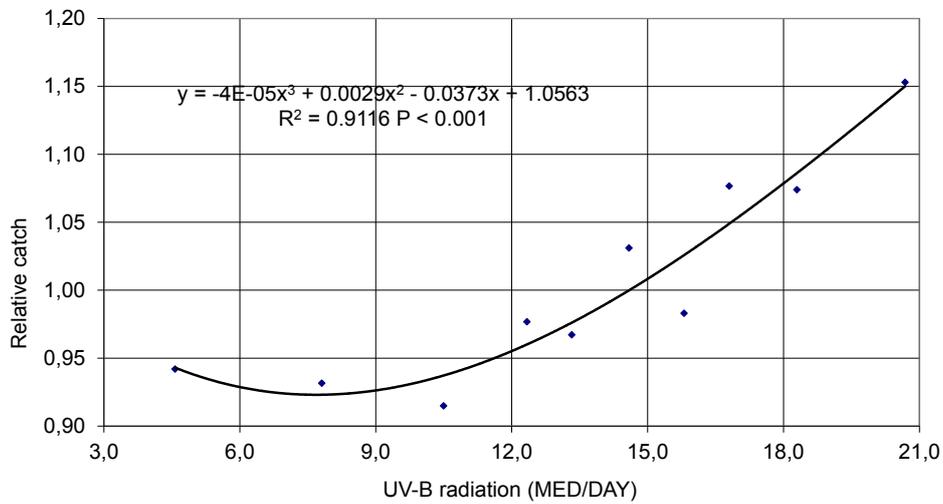


Figure 3. 4. 2.

Figure 3. 4. 2. Pheromone trap catch of the Peach Twig Borer (*Anarsia lineatella* Zeller) in connection with the UV-B radiation of the Sun (Bodrogkisfalud, 1994–1998)

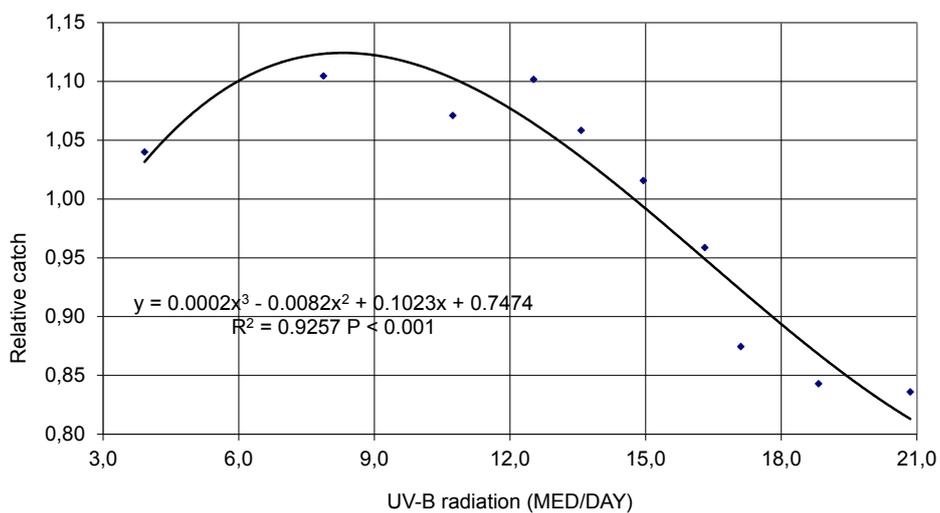


Figure 3. 4. 3.

Figure 3. 4. 3. Pheromone trap catch of the European Vine Moth (*Lobesia botrana* Denis et Schiffermüller) in connection with the UV-B radiation of the Sun (Bodrogkisfalud, 1994—1998)

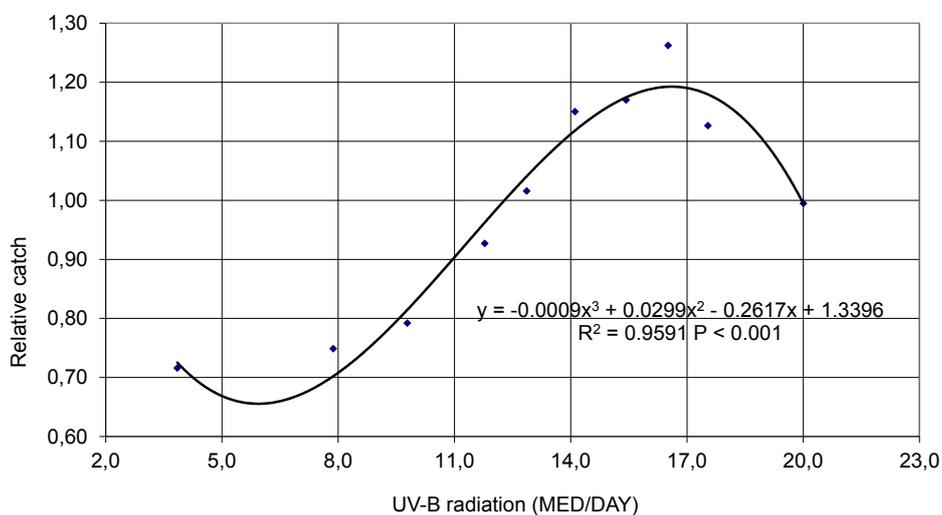


Figure 3. 4. 4.

Figure 3. 4. 4. Pheromone trap catch of the Plum Fruit Moth (*Grapholita funebrana* Treitschke) in connection with the UV-B radiation of the Sun (Bodrogkisfalud, 1994—1998)

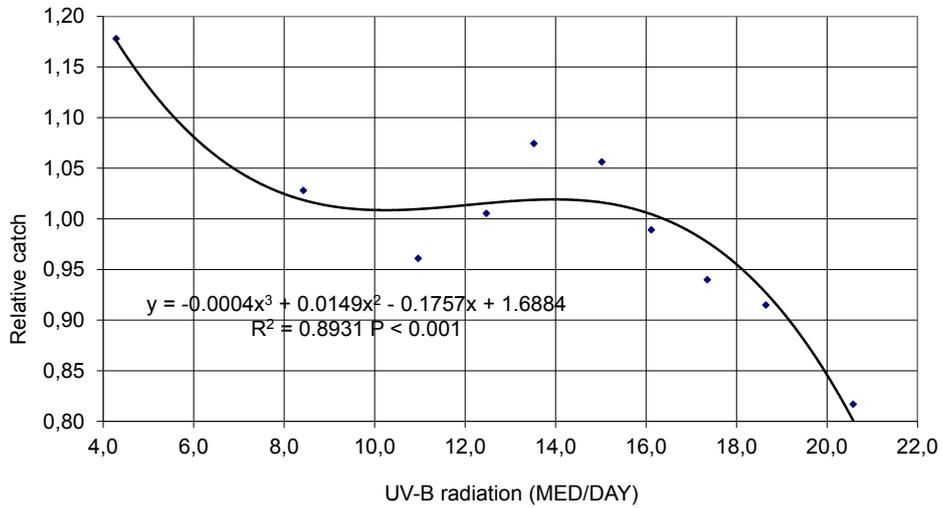


Figure 3. 4. 5.

Figure 3. 4. 5. Pheromone trap catch of the Oriental Fruit Moth (*Grapholita molesta* Busck) in connection with the UV-B radiation of the Sun (Bodrogkisfalud, 1994—1998)

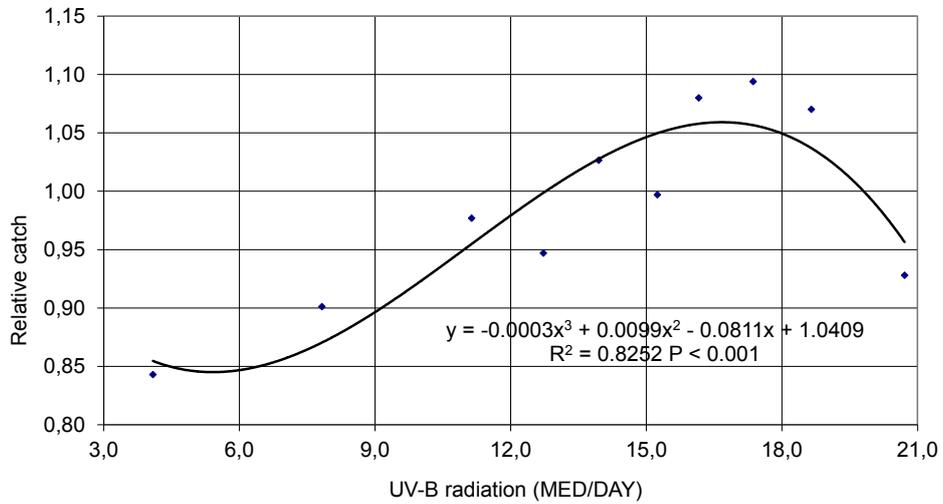


Figure 3. 4. 6.

Figure 3. 4. 6. Pheromone trap catch of the Codling Moth (*Cydia pomonella* Linnaeus) in connection with the UV-B radiation of the Sun (Bodrogkisfalud, 1994—1998)

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