Chapter 2.

# Pheromone Trap Catch of Harmful Microlepidoptera Moth Species Depending on the Solar Activity Featured by Q-index

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**Abstract:** The Q-index is a measure of the solar activity. The study deals with the solar flare activity featured by Q-index in connection with pheromone trap catch of six Microlepidoptera species from Hungary. The increase of the catch can be experienced in five cases and the decrease can be seen, when the value of the Q-index is high. There was once an increase parallel with increase of Q-index values. The results can be written down with second- or third-degree polynomials. Our results proved that the daily catches were significantly modified by the Q-index, expressing the different lengths and intensities of the solar flares. The different form of behaviour, however, is not linked to the taxonomic position. Further testing will be required to fuller explanation of the results.

**Keywords:** solar flares, Q-index, harmful moths, pheromone trap

## 2. 1. Introduction

As part of the global solar activity, accompanied by intensive X-ray, gamma and corpuscular radiation, outbreaks (flares) appear in the vicinity of the active regions on the surface of the Sun. Reaching the Earth, and getting into interaction with its upper atmosphere, these flares change the existing electromagnetic relations (Smith and Smith, 1963). The flares, these temporary flashes in the chromosphere of the Sun in the vicinity of sunspots can be observed for a maximum of 10-20 minutes. They can be observed mainly in the 656.3 nm wavelength red light of the H-α line. During the appearance of intensive solar flares, corpuscular emission can be one thousand times stronger than in a quiet state of the Sun. The corpuscles consist mainly of electrons and spread in all directions, including that of the Earth, at a maximum speed of 1 500 km*s$^{-1}$. These electrically charged particles form are the so-called solar wind, which, unlike electromagnetic radiation that arrives in 8 and half minutes, reaches the Earth in 26-28 hours. Flair particles, on their way to the Earth, must also pass through interplanetary space. In its turn, the magnetic field of the latter generated by general galactic cosmic radiation can significantly modify the effect of flares on the magnetosphere of the Earth' atmosphere. So not every flare will be induce changes in the physical state of the upper atmosphere. If and when, however, such changes occur, they lead to temporary weather modification and the magnetic field of the charged particles will also affect the quiet daily trend of the magnetic field of the Earth. The intensity of the flares is determined by the area they are observed to occupy in relation to the solar disk as a whole. Flares of first importance are less than 250 times the half of the one millionth of the global surface of the Sun. A flare is of second importance if its area is 250-600 times the unit and it is of importance three if it is more than 600 times the unit. Following from the greater intensity of the flux of energy, second and third importance flares have the most significant cosmic impact. The daily activity of the flares is characterized by the so-called Q index that, used by several researchers.

The flares are classified according to the size of their area as compared to the total solar surface. The flares of primary importance: 1; 250-600 times this size, it receives an index number of 2; if greater 600 times than that, it has a significance of 3. Because of their significant energy emissions, the cosmic influence of the flares No. 2 and 3 is the most considerable. Kleczek (1952) was the first researcher, who introduced the concept of Q-index to use the daily flare activity through quantification of the 24 hours of the day.

$$Q = (i \times t)$$

where i = flare intensity, t = the time length of its existence.

He assumed that this relationship gives roughly the total energy emitted by the flares. In this relation, "i" represents the intensity scale of importance and "t" the duration (in minutes) of the flare. Some researchers of flare activity using Kleczek's method are given for each day by Kleczek, 1952, Knoška and Petrásek, 1984, Ataç, 1987, Ataç and Özgüç, 1998, Özgüç and Ataç, 1989. Örményi (1966) calculated and published the flare activity numbers based on similar theoretical principles ("Flare Activity Numbers") for the period of 1957-1965. The solar activity also exerts influence on life phenomena. In the literature accessible to the authors, however, no publication can be found that would have dealt with the influence of flares on the collection of insects by light-traps. Earlier we have published our studies and demonstrated the influence of hydrogen alpha flares 2 and 3 (Tóth and Nowinszky, 1983) on light-trap catches.

Most daily flare activities are characterised by Turkish astronomers, Özgüç and Ataç (1989) by index Q that expresses the significance of flares also by their duration.

The solar activity also exerts influence on life phenomena. In the literature accessible to the authors, however, no publication can be found that would have dealt with the influence of flares on the collection of insects by light-traps. Earlier we have published our studies and demonstrated the influence of Hα flares No. 2. and 3. and the Q-index on light-trap catches (Tóth and Nowinszky, 1983, Nowinszky and Puskás, 1999, 2001 and 2013, Puskás et al., 2010). Other authors did not publish studies on theme of solar activity and light trapping of insects.

## 2. 2. Material

Flare Index Data used in this study were calculated by T. Ataç and A. Özgüç from Bogazici University Kandilli Observatory, Istanbul, Turkey.

In Bodrogkisfalud village Borsod-Abaúj-Zemplén County, Hungary-Europe (Geographical coordinates are: 48°10'41″N and 21°21'77″E), pheromone traps were operated between 1993 and 2010. These traps attracted 6 harmful Microlepidoptera species altogether, in some of the years using 2-2 pheromone traps for each species, however, in other years not all six species were monitored. 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). Catch data of the collected species is displayed in Table 2. 2. 1. We examined the trapping data of these species depending on the Q-indexes.

## 2. 3. Methods

From the catching data of the examined species, relative catch (RC) data were calculated for each observation posts and days. The RC is the quotient of the number of individuals caught during a sampling time unit (1 day) per the average number of individuals of the same generation falling to the same time unit. In case of the expected average individual number, the RC value is 1. The introduction of RC enables us to carry out a joint evaluation of materials collected in different years and at different traps (Nowinszky, 2003).

At the values of Q-index showed considerable differences in course of the respective years, they were preferably expressed as percentages of the averages of swarming periods (this was named relative Q-index). We studied the influence of flare activities on the daily catches. To disclose the latter, the Q/Q average values were co-ordinated with the relative catch data of different observation posts for each day of the catch period. The Q/Q means (relative Q-index) values have been contracted into groups (classes), and then averaged within the classes the relative catches data pertaining to them.

Data on the relative Q-index were arranged into classes according to Sturges' method (Odor and Iglói (1987). The relative catch values were assigned into the classes of the Q-index belonging to the given day and then they were summarized and averaged. We determined the regression equations, the significance levels which were shown in the figures.

## 2. 4. Results and Discussion

The connections between relative Q-index (Q/Q) averages and daily catches of examined species are presented in Figures 2. 4. 1.–2. 4. 6. The characteristic curves associated parameters are indicated in the figures and significance levels are also given.

From the results several important consequences could be drawn. Based on our results, we proved that the light-trap catch of examined species is affected by the solar activity featured by Q-index. However, some species may not react the same way.

One species, the Codling Moth (*Cydia pomonella* Linnaeus) was collected in connection with the increasing the high values of the Q-index. The increase of the catch can be experienced in five cases and the decrease can be seen, when the value of the Q-index is high.

The number of Spotted Tentiform Leafminer *(Phyllonorycter blancardella* Fabr.), Peach Twig Borer (*Anarsia lineatella* Zeller), and European Vine Moth (*Lobesia botrana* Den. et Schiff.), begins to decrease when Q values are higher than averages for swarming periods. As opposed to this the number caught of the Oriental Fruit Moth *(Grapholita molesta* Busck) and Plum Fruit Moth (*Grapholita funebrana* Tr.) starts decreasing already when the Q value attains the half of average value of the swarming period.

The results can be written down with second- or third-degree polynomials. Our results proved that the daily catches were significantly modified by the Q-index, expressing the different lengths and intensities of the solar flares. The different form of behaviour, however, is not linked to the taxonomic position. This fact is notable for the plant protection prognostic. Further testing will be required to fuller explanation of the results.

**Acknowledgements:** Flare Index Data used in this study were calculated by T. Ataç and A. Özgüç from Bogazici University Kandilli Observatory, Istanbul, Turkey. The Q-index daily data for the period 1980 and 2000 were provided by Dr. T. Ataç. His help is here gratefully acknowledged.

Table 2. 2. 1 The number and observing data of the examined species
(Bodrogkisfalud, 1993-2010)

| Species | Number of | |
|---|---|---|
| | moths | data |
| *Gracillariidae » Lithocolletinae*<br>Spotted Tentiform Leafminer<br>*Phyllonorycter blancardella* Fabricius, 1781 | 51,805 | 1,766 |
| *Gelechiidae » Anacampsinae*<br>Peach Twig Borer<br>*Anarsia lineatella* Zeller, 1839 | 6,873 | 1,913 |
| *Tortricidae* » *Olethreutinae*<br>European Vine Moth<br>*Lobesia botrana* Denis et Schiffermüller, 1775 | 20,240 | 2,320 |
| *Tortricidae » Tortricinae*<br>Plum Fruit Moth<br>*Grapholita funebrana* Treitschke, 1846 | 27,679 | 3,250 |
| *Tortricidae*<br>Oriental Fruit Moth<br>*Grapholita molesta* Busck, 1916 | 14,112 | 2,629 |
| *Tortricidae* » *Olethreutinae*<br>Codling Moth<br>*Cydia pomonella* Linnaeus, 1758 | 4,813 | 1,288 |

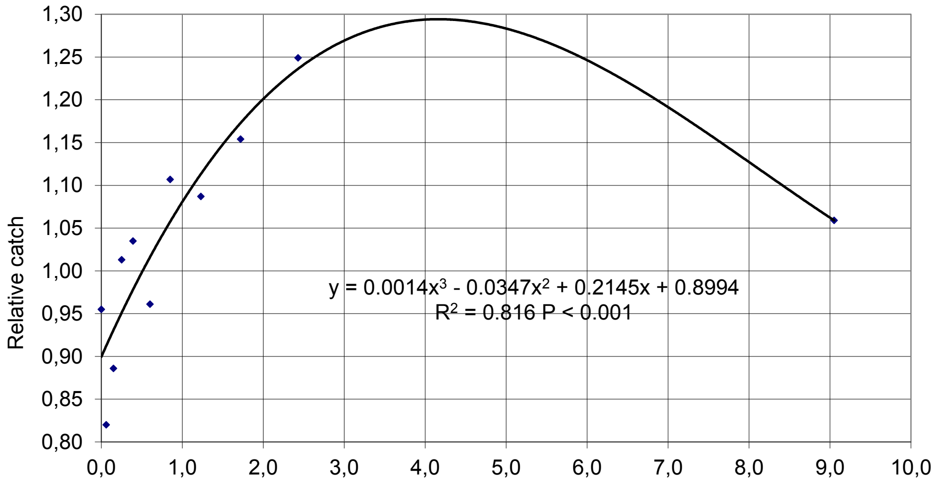


Figure 2. 4. 1.

Figure 2. 4. 1. Pheromone trap catch of Spotted Tentiform Leafminer *(Phyllonorycter blancardella* Fabricius) in connection with relative Q-index Bodrogkisfalud, 1993-2007)

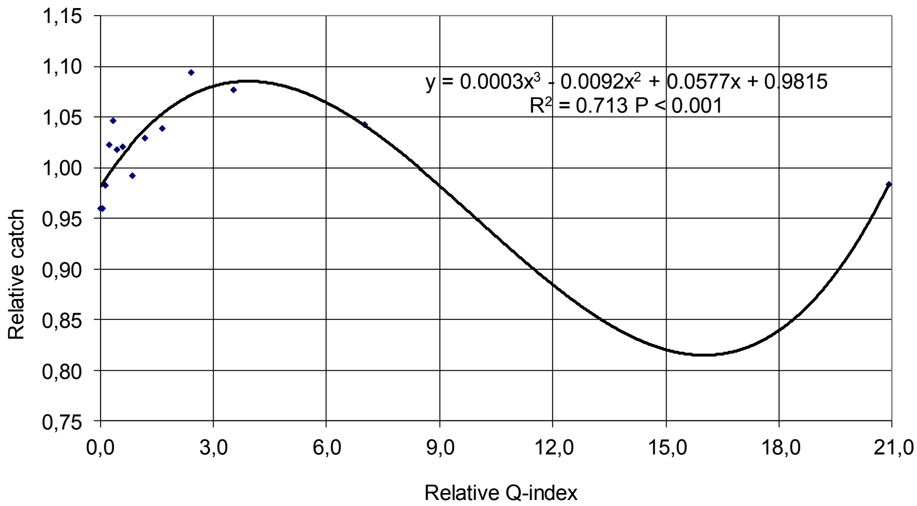


Figure 2. 4. 2.

Figure 2. 4. 2. Pheromone trap catch of Peach Twig Borer (*Anarsia lineatella* Zeller) in connection with relative Q-index (Bodrogkisfalud, 1993-2007)

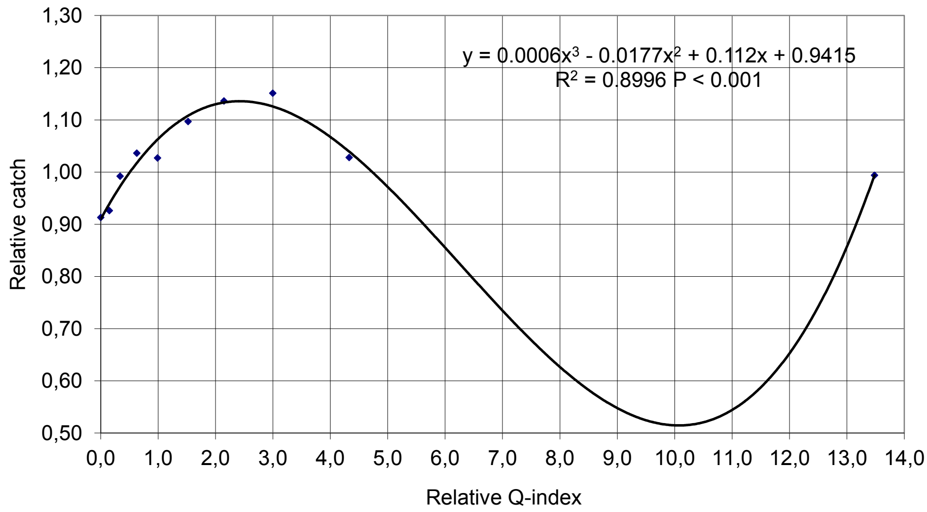


Figure 2. 4. 3.

Figure 2. 4. 3. Pheromone trap catch of European Vine Moth (*Lobesia botrana* Denis et Schiffermüller) in connection with relative Q-index (Bodrogkisfalud, 1993-2007)

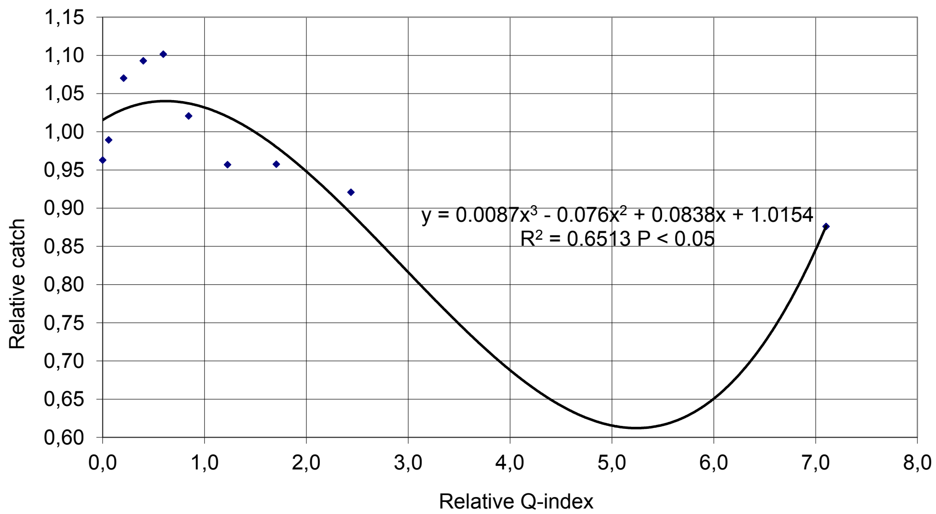


Figure 2. 4. 4.

Figure 2. 4. 4. Pheromone trap catch of Plum Fruit Moth (*Grapholita funebrana* Treitschke) in connection with relative Q-index (Bodrogkisfalud, 1993-2007)

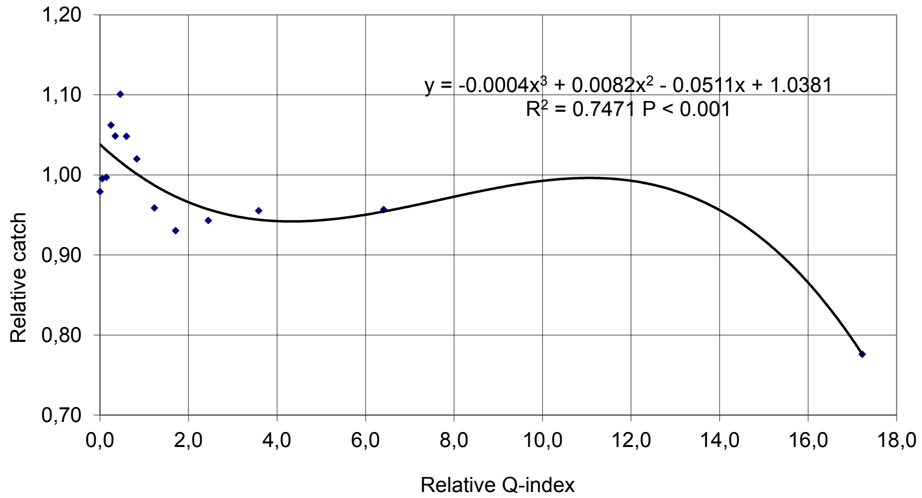


Figure 2. 4. 5.

Figure 2. 4. 5. Pheromone trap catch of Oriental Fruit Moth (*Grapholita molesta* Busck) in connection with relative Q-index (Bodrogkisfalud, 1993-2007)

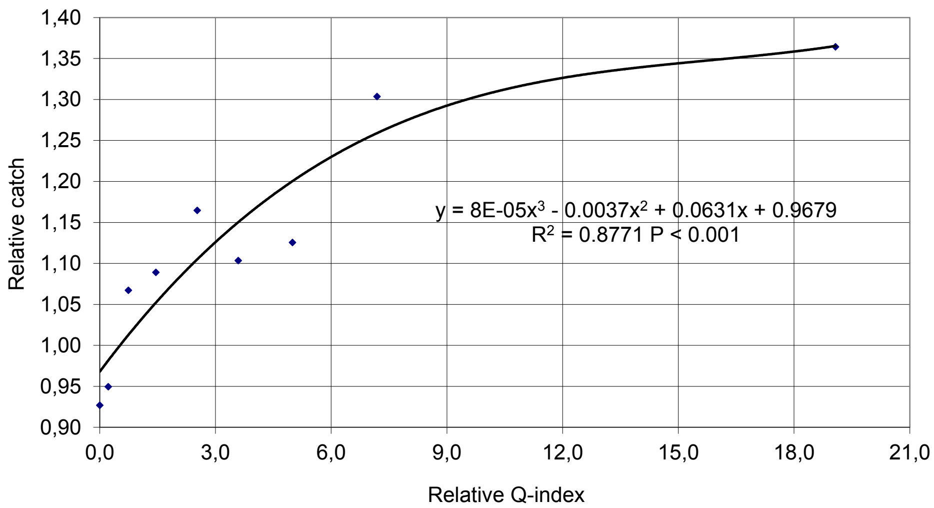


Figure 2. 4. 6.

Figure 2. 4. 6. Pheromone trap catch of Codling Moth (*Cydia pomonella* Linnaeus) in connection with relative Q-index (Bodrogkisfalud, 1996-2010)

**References**

Ataç, T. 1987: Time variation of the flare index during the 21st solar cycle. – Astrophysics and Space Science, 135: 201–205.

Ataç, T. & Özgüç, A. 1998: Flare index of solar cycle 22 – Solar Physiscs., 180: 397–407.

Kleczek, J. 1952: Catalogue de l'activite' des e'ruptions chromosphe' riques. Publications of Institute Central Astronomy of Prague., No 22 Chechoslovakia. – Prague Insitute of Central Astronomy

Knoška, S. & Petrásek, J. 1984: Chromosphere flare activity in solar cycle 20. – Contributions of the Astronomical Observatory Skalnaté Pleso, 12 165–260.

Nowinszky, L. 2003: The Handbook of Light Trapping. – Savaria University Press, Szombathely, 276 p.

Nowinszky, L. & Puskás, J. 1999: Light-trap catch of European Corn Borer (*Ostrinia nubilalis* Hbn.) on different Q-index values of Hα flares. – Biometeorology and International Urban Climatology at the turn of the Millennium. Sydney Australia, 88–89.

Nowinszky, L. & Puskás, J. 2001: Light-trapping of the European corn borer (*Ostrinia nubilalis* Hbn.) at different values of the Q-index expressing the different intensities of solar flares. – Acta Phytopathologica et Entomologica Hungarica, 36 (1–2): 201–205.

Nowinszky, L. & Puskás, J. 2013: The Light-trap Catch of Horse Chestnut Leaf Miner (*Cameraria ohridella* Deschka et Dimić, Lepidoptera: Gracillariidae) Depending on the Solar Activity Featured by Q-Index. – International Journal of Geology, Agriculture and Environmental Sciences, 1 (1): 32–35.

Odor, P. & Iglói, L. 1987: An introduction to the sport's biometry (in Hungarian). – ÁISH Tudományos Tanácsának Kiadása. Budapest. 267 p.

Örményi, I. 1966: The relationship between geomagnetic activity and chromospheric Hα flares. – Acta Geodaetica*,* Geophysica et Montanistica Scientiarum Hungariae, 1 (1–2): 121–136.

Özgüç, A. & Ataç, T. 1989: Periodic behaviour of solar flare index during solar cycles 20 and 21. – Solar Physics, 73: 357–365.

Puskás, J. Nowinszky, L. Barczikay, G., & Kúti, Zs. 2010: The pheromone trap catch of harmful moths in connection with solar activity featured by Q-index. – Applied Ecology and Environmental Research, 8 (3): 261–266.

Smith, H. J. & Smith, E. V. P. 1963: Solar flares. – Macmillan Co., New York. 426 p.

Tóth Gy. & Nowinszky, L. 1983: Influence of solar activity on the outbreaks and daily light-trap catches of *Scotia segetum* Schiff. – Zeitschtrift für angewandte Entomology, 45: 83–92.