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Light-trap catch of moth species of the Becse-type light trap depending on the solar activity featured by Q-index

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Keywords:

solar flares, Q-index, moths, Becse-type light-trap

ISSN 0799-3757

http://caribjscitech.com/

ABSTRACT

The Q-index is the index-number of the solar activity. The study deals with the connection between solar flare activity featured by Q-index and light trap catch of eight Microlepidoptera and twenty two Macrolepidoptera species from a Becse-type light-trap. Nine species were collected in connection with the increasing the high values of the Q-index, but decrease were observed in case of fourteen species. It can be experienced in seven cases the increase of the catch after the decrease of it if the values of the Q-index is high. 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.

INTRODUCTION

Kleczek was the first researcher, who introduced the concept of Q-index (Q = i x t), to use the daily flare activity through quantification of the 24 hours of the day. 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 & Petrásek (1984), Ataç (1987), Ataç & Özgüç (1998), Özgüç & Ataç (1989).

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 & 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 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, considers both the intensity and period of prevalence of the flares (Nowinszky & Tóth (1987), Nowinszky (2003).

Solar flares are most powerful and explosive of all forms of solar activity and the most important in terrestrial effects. This idea led solar physicists to valuable the daily flare index (Özgüç & Ataç (1989).

Most daily flare activities are characterised by most authors by index Q that expresses the significance of flares also by their duration. Its calculation is made by the following formula:

Q = (i x t) where i = flare intensity, t = the time length of its existence.

Earlier the “Flare Activity Numbers” for years between 1957 and 1965 were worked out, based on similar theoretical basis, and published by Örményi (1966).

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 pheromone traps and light-traps.

Earlier we have published our studies and demonstrated the influence of hydrogen alpha flares No. 2. and 3. on light-trap catches (Tóth & Nowinszky (1983).

We have demonstrated in our previous works that Q-index affect both the pheromone trapping (Puskás *et al*. (2010, Nowinszky & Puskás, 2011), and light trapping effectiveness (Nowinszky & Puskás (2013).

MATERIAL AND METHODS

Data used in this study were calculated by T. Ataç and A. Özgüç from Bogazici University Kandilli Observatory, Istanbul, Turkey. Their help is gratefully acknowledged.

The light-trap was operated by Varga & Mészáros (1973a & 1973b) between 1969 and 1973 on the territory of the Agricultural and Industrial Combine in Bečej, Serbia (Geographical coordinates are: 45°37'05''N and 20°02'05''E) and collected many more insects than the Hungarian Jermy-type traps. The light source of the trap is an IPR WTF 220V, 250W mercury vapour lamp 2 meters above the ground. There is a large collecting cage under the funnel of the trap. The cage contains two perpendicular separation walls made of plastic haircloth dividing the cage into four equal parts. This solution ensured that the tougher bodied and livelier beetles staying at the bottom of the cage couldn't damage the moths and other fragile insects that have climbed up on the separation walls. In the morning the cage was placed in a chest in which a few millilitres of carbon bisulphide had been burnt. The gases thus generated killed the insects quickly and effectively. The light-trap worked every night in the breeding season even in bad weather. Several of this type of traps collecting huge masses of insect material of good quality has been operating in Yugoslavia. Regarded to be dangerous, the use of this type of trap has not been permitted in Hungary.

The moth data of Becse-type light trap were processed and published (Vojnits *et al.* 1971), Mészáros *et al.* (1971). We process 8 Microlepidoptera and 22 Macrolepidoptera species from the total catching data. The names of the species, the years of collecting and the number of individuals are shown in Table 1.

Table 1 Collection data of the examined moths (Lepidoptera) species

Families and scientific names	Collecting years	Number of	
		Individuals	Data
Tortricidae			
Aleimma loeflingiana Linnaeus, 1758 Yellow Oak Button	1969-1972	2824	52
Crambidae			
Evergestis extimalis Scopoli, 1763 Marbled Yellow Pearl	1971-1973	1149	86
Loxostege sticticalis Linnaeus, 1761 Beat Webworm Moth	1970-1973	1196	131
Sitochroa verticalis Linnaeus, 1758 Lesser Pearl	1970-1973	3002	230
Ostrinia nubilalis Hübner, 1796 European Corn-borer	1970-1973	38120	340
Nomophila noctuella Denis et Schiffermüller, 1775 Rush Veneer	1970-1973	14374	243
Pyralidae			
Etiella zinckenella Treitschke, 1822 Lima Bean Pod Borer	1970-1973	3141	129
Homeosoma nebulella Denis et Schiffermüller, 1775 European Sunflower Moth	1969 and 1971	6263	92
Geometridae			
Chiasmia clathrata Linnaeus, 1758	1970-1973	3478	258

Latticed Heath			
Ascotis selenaria Denis et Schiffermüller, 1775 Luna Beauty	1970-1971 and 1973	2159	161
Lymantriidae			
Leucoma salicis Linnaeus, 1758 White Satin Moth	1969-1973	3255	255
Arctiidae			
Hxphantria cunea Drury, 1773 Fall Webworm	1970-1973	4447	234
Spilosoma lubricipeda Linnaeus, 1758 White Ermine	1970-1971	2644	84
Spilosoma urticae Esper, 1789 Water Ermine	1970-1971 and 1973	4634	112
Phagmatobia fuliginosa Linnaeus, 1758 Ruby Tiger	1970-1973	14374	243
Noctuidae			
Agrotis segetum Denis et Schiffermüller, 1775 Turnip Moth	1970-1973	9895	301
Agrotis exclamationis Linnaeus, 1758 Heart & Dart	1970-1973	2348	177
Axylia putria Linnaeus, 1761 The Flamme	1969-1973	2914	179
Noctua pronuba Linnaeus, 1758 Large Yellow Underwing	1970-1973	1755	194

Families and scientific names	Collecting years	Number of	
		Individuals	Data
Xestia c-nigrum Linnaeus, 1758 Setaceous Hebrew Character	1970-1973	28999	326
Discestra trifolii Hufnagel 1766	1970-1973	11381	310

The Nutmeg			
Mamestra brassicae Linnaeus, 1758 Cabbage Moth	1970-1971 and 1973	4187	92
Laconobia suasa Denis et Schiffermüller 1775 Dog's Tooth	1970-1973	4434	189
Laconobia oleracea Linnaeus, 1758 Bright-line Brown-eye	1970-1973	7512	201
Mythimna vitellina Hübner, 1808 The Delicate	1970-1973	3583	180
Heliothis maritima Graslin, 1855 Shoulder-striped Clover	1970-1973	3563	215
Emmelia trabealis Scopoli, 1763 Spotted Sulphur	1970-1973	18678	312
Macdunnoughia confusa Stephens, 1850 Dewick's Plusia	1969-1973	1236	221
Autograha gamma Linnaeus, 1758 Silver Y	1970-1973	6868	349
Tephrina arenacearia Denis et Schiffermüller, 1775 Lucerne Moth	1970-1973	4457	227

From the catching data of the examined species, relative catch (RC) data were calculated for each night. The RC is the quotient of the number of individuals caught during a sampling time unit (1 night) 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).

Data on the Q-index were arranged into classes according to Sturges' method (Odor & Iglódi (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.

RESULTS AND DISCUSSION

Based on our study can be typed the examined species of three types: ascending, descending, ascending then descending.

Our results are shown in Figures 1-3 and Table 2. The characteristic curves associated parameters are indicated in the figures and significance levels are also given.

Figure 2 Light-trap catch of The Delicate (*Mythimna vitellina* Hbn.) depending on the Q-index (Bečej, 1970-1973)

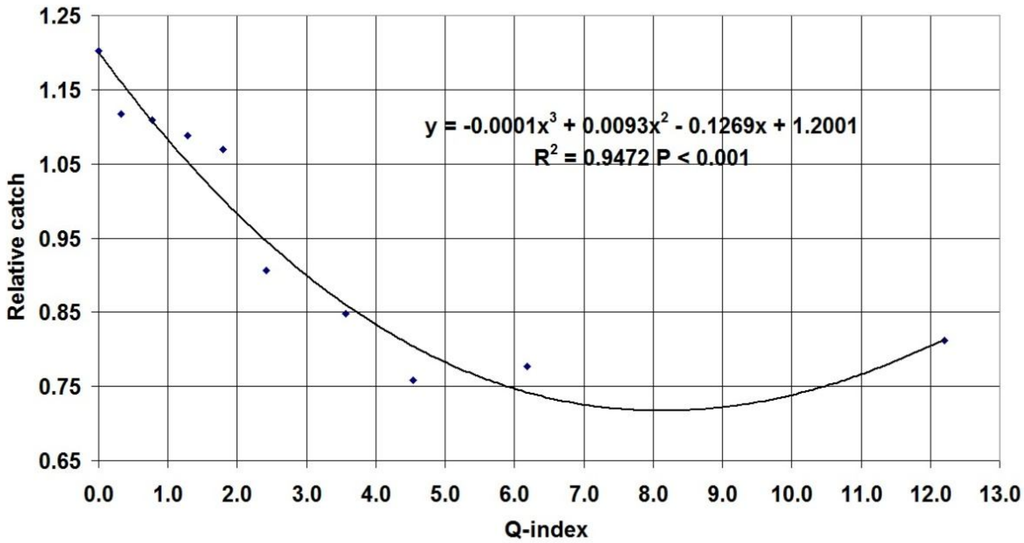
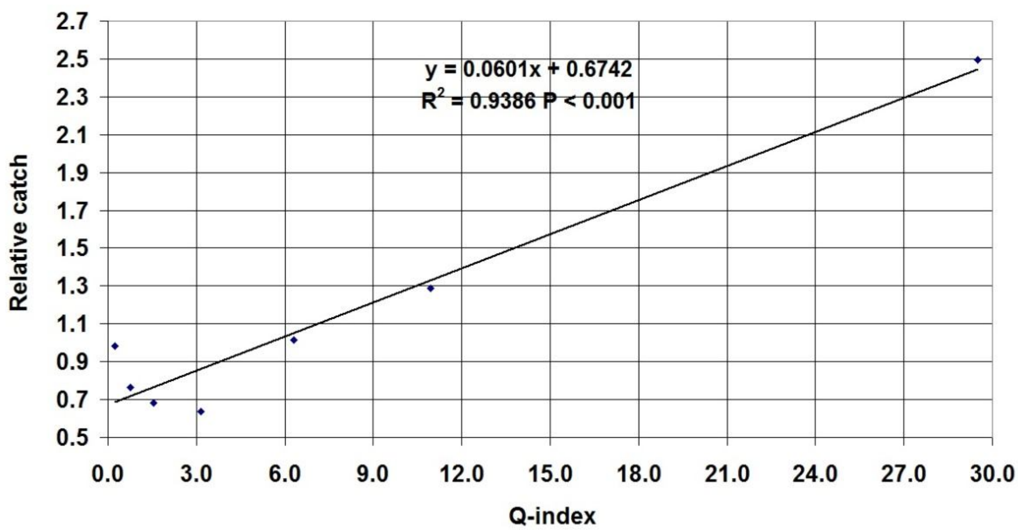


Figure 1 Light-trap catch of Yellow Oak Button (*Aleimma loeflingiana* L.) depending on the Q-index (Bečej, 1969-1972)



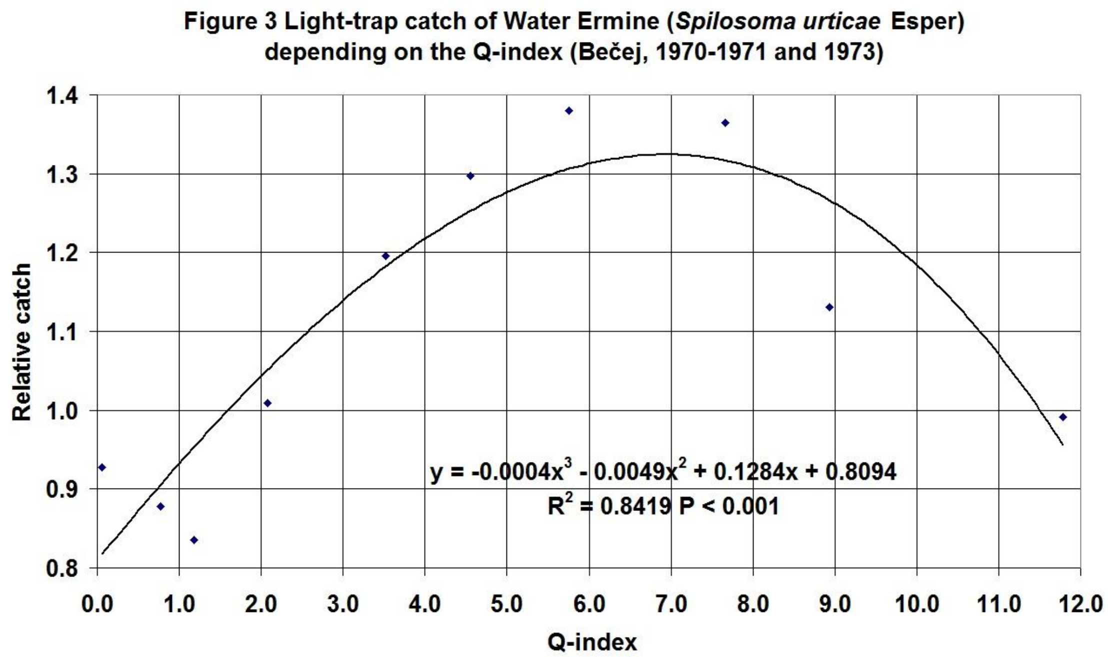


Table 2. The types of light trapping of examined species depending on the Q-index

Scientific names of examined species	Types		
	Ascending	Descending	Ascending then descending
Tortricidae			
Aleimma loeflingiana L.	X		
Crambidae			
Evergestis extimalis Scop.	X		
Loxostege sticticalis L.		X	
Sitochroa verticalis L.	X		
Ostrinia nubilalis Hbn.	X		
Nomophila noctuella Den. et Schiff.	X		
Pyralidae			
Etiella zinckenella Tr.		X	
Homeosoma nebulella Den et Schiff.	X		
Geometridae			
Chiasmia clathrata L.		X	

Ascotis selenaria Den. et Schiff.		X	
Lymantriidae			
Leucoma salicis L.			X
Arctiidae			
Hyphantria cunea Drury		X	
Spilosoma lubricipeda L.		X	
Spilosoma urticae Esp.			X
Phagmatobia fuliginosa L.			X
Noctuidae			
Agrotis segetum Den. et Schiff.	X		
Agrotis exclamationis L.	X		
Axylia putris L.			X
Noctua pronuba L.			X
Xestia c-nigrum L.			X
Discestra trifolii Hfn.		X	
Mamestra brassicae L.			X
Laconobia suasa Den. et Schiff.		X	
Laconobia oleracea L.		X	
Mythimna vitellina Hbn.		X	
Heliothis maritima Grsl.		X	
Emmelia trabealis Scop.		X	
Macdunnoughia confusa Steph.			X
Autographa gamma L.		X	
Tephrina arenacearia Den. et Schiff.		X	

Eight Microlepidoptera and twenty two Macrolepidoptera species were caught by the Becse-type light-trap. 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. Nine species are collected in connection with the increasing the high values of the Q-index but decrease were observed in case of fourteen species. Seven cases can be experienced the increase of the catch after the decrease of it if the values of the Q-index is high. 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.

Acknowledgements

The research was realized under the reference code TÁMOP-4.2.4.A/2-11/1-2012-0001, which is an emphasized project named National Excellence Program. In this convergence program a system was set up and worked that ensured the support of the national students and researchers. The project was realized by the financial support of European Union and European Social Fund.

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