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Light Trapping of the Caddisflies (Trichoptera) in Hungary (Central Europe) at Different Values of the Q-index Expressing the Different Intensities of Solar Flares

L. Nowinszky*, O. Kiss**, and J. Puskás*
**University of West Hungary, Savaria University Centre,*
H-9700 Szombathely Károlyi G. Square 4., Hungary
*** Eszterházy Károly College, Department of Zoology,*
H-3300 Eger Eszterházy Square 1., Hungary

(Corresponding author: L. Nowinszky)
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ABSTRACT: The Q-index is the index-number of the solar activity. The study deals with the connection Jermy-type light-traps operated in Hungary. Part of the species was collected in connection with the increasing the high values of the Q-index, but decrease were observed in part of other species. It can be experienced in some 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.

Key words: Caddisflies, light-trap, Q-index, Solar flares

I. INTRODUCTION

There are solar flares surrounding of the active parts solar surface as part of global solar activity. They are followed by intensive radiation (X-ray, gamma and corpuscular), which after obtaining Earth there is a reciprocal effect between radiation and upper part of atmosphere and the electromagnetic circumstances are changed [1].

The flares are classified according to the size of their area as compared to the total solar surface. The flares of primary importance (1) do not reach 250 times the half of on millionth part of the total solar surface. If the flare takes 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. [2] 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 [2], [3], [4], [5] and [6]. [7] 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 [8] on light-trap catches.

Most daily flare activities are characterised by Turkish astronomers [6] by index Q that expresses the significance of flares also by their duration. Its calculation is made by the following formula:

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

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

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 [8], [9], [10], [11] and [12]. Other authors did not publish studies on theme of solar activity and light trapping of insects.

II. MATERIALS AND METHODS

Our catching data were collected from registers (between 1980 and 2000) and studies of Kiss [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23]. Jermy-type light traps were used to collect of caddisflies. The light source of the applied Jermy-type light-traps was a 100W normal white light electric bulb hanged under a metal cover (Ø: 1m) at 200 cm height above the ground. The traps were operated through every night during the season from April until October [24].

The collecting stations, years, and geographical coordinates and the catching data of caddisflies species are presented in Table 1.

Table 1: The name of the species caught the trapping sites and years, number of individuals and nights.

Species and light-trap stations	Geographic coordinates	Number of individuals	Number of nights
Hydropsychidae			
Hydropsyche instabilis Curtis 1834			
Szilvásvárad Szalajka stream, 1980	48°64'N; 20°23'E	1761	89
Bükk Vöröskő-Valley, 1981	48°34'N; 20°27'E	2656	86
Bükk Vöröskő-Valley, 1982	48°34'N; 20°27'E	8135	79
Bükk Vöröskő-Valley, 1983	48°34'N; 20°27'E	11483	95
Szarvaskő, Eger brook, 1989	47°59'N, 20°51'E	3561	104
Polycentropodidae			
Neureclipsis bimaculata Linnaeus 1758			
Bükk Vöröskő-Valley, 1981	48°34'N; 20°27'E	366	85
Bükk Vöröskő-Valley, 1982	48°34'N; 20°27'E	15704	96
Bükk Vöröskő-Valley, 1983	48°34'N; 20°27'E	13282	90
Limnephilidae			
Potamophylax nigricornis Pictet 1834			
Bükk Vöröskő-Valley 1982	48°34'N; 20°27'E	3661	83
Bükk Vöröskő-Valley 1983	48°34'N; 20°27'E	5858	91
Halesus digitatus Schrank 1781			
Szilvásvárad Szalajka stream, 1980	48°64'N; 20°23'E	837	64
Bükk Vöröskő-Valley, 1981	48°34'N; 20°27'E	112	29
Bükk Vöröskő-Valley, 1982	48°34'N; 20°27'E	1287	86
Bükk Vöröskő-Valley, 1983	48°34'N; 20°27'E	1049	99
Szarvaskő, Eger brook, 1989	47°59'N, 20°51'E	714	99
Szolnok Tisza River, 2000	47°10'N, 20°11'E	1030	57
Sericostomatidae			
Sericostoma personatum Kirby & Spence 1862			
Bükk Vöröskő-Valley, 1982	48°34'N; 20°27'E	988	119
Bükk Vöröskő-Valley, 1983	48°34'N; 20°27'E	1279	119
Odontoceridae			
Odontocerum albicorne Scopoli 1763			
Bükk Vöröskő-Valley, 1982	48°34'N; 20°27'E	653	117
Bükk Vöröskő-Valley, 1983	48°34'N; 20°27'E	839	119

The Q-index daily data for the period 1980-2000 were provided by Dr. T. Ataç (Bogazici University Kandilli Observatory, Istanbul, Turkey).

The number of individuals of a given species in different light-trap stations and different years are not the same. The catching efficiency of the modifying factors (temperature, wind, moonlight, etc.) are not the same at all stations and at the time of catching, so it is easy to see that the same number of items captured at two different observing 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 [24]. From the collection data of the caddisflies (Trichoptera) 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 night or 1 hour) 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 points [24].

The Q-index values in the swarming periods of different years were quite different. Therefore we rendered them into two groups. The first includes the years in which the average value of the Q-index of the years were between 5 and 10 were added to group 1 (1983, 1984, 1988, 1992 and 1998). The second group includes the years in which the average values of the Q-index of the years were above 10 (1980, 1981, 1982 and 1989). The catching data in all two groups were processed the same way. We paired the data of the relative catch to the Q-index on every day during the collection period.

We arranged the values of the Q-index into classes using the method of Sturges [25-26] and then calculated the average relative catch data related to them within both class. We demonstrated our results and communicated the equations of the curves and significance levels too.

III. RESULTS AND DISCUSSION

Our results are shown in Figs. 1-12. The characteristic curves associated parameters are indicated in the figures and significance levels are also given.

Figure 1 The light-trap catches of the *Hydropsyche insteblis* Curtis depending on the Q-index as a function of strong solar activity years (1980, 1981, 1982 and 1989)

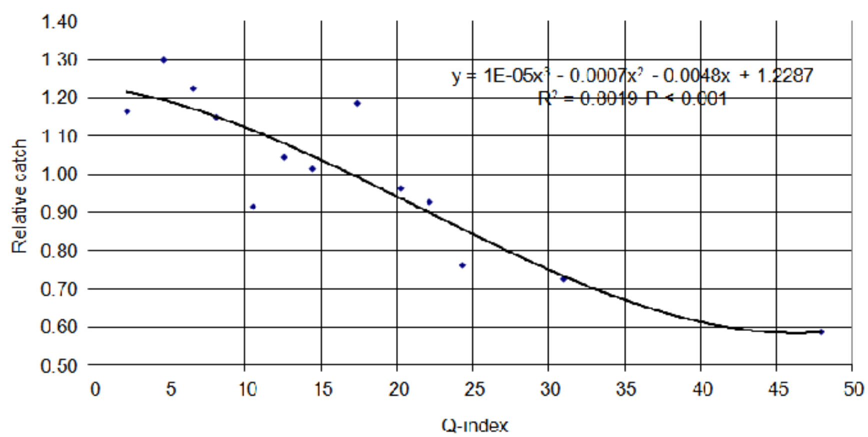


Figure 2 The light-trap catches of the *Hydropsyche instabiis* Curtis depending on the Q-index as a function of moderate solar activity year (1983)

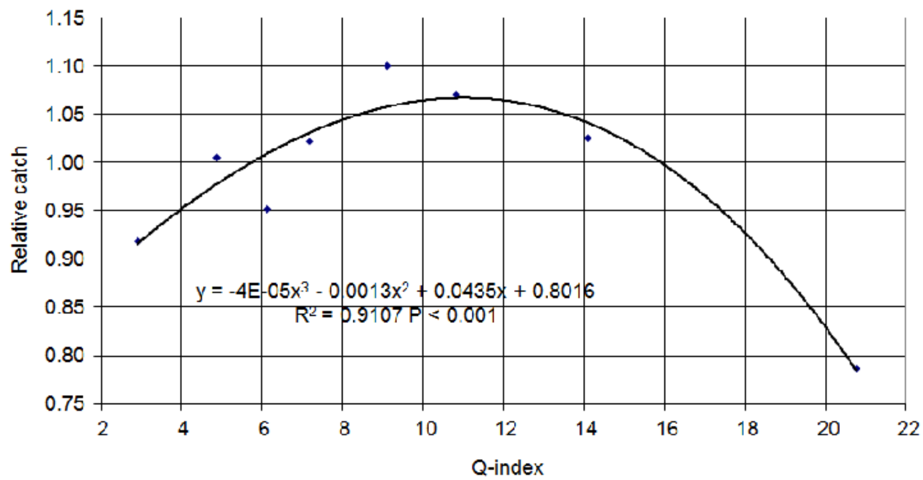


Figure 3 The light-trap catches of the *Neureclipsis bimaculata* L. depending on the Q-index as a function of strong solar activity years(1981 és 1982)

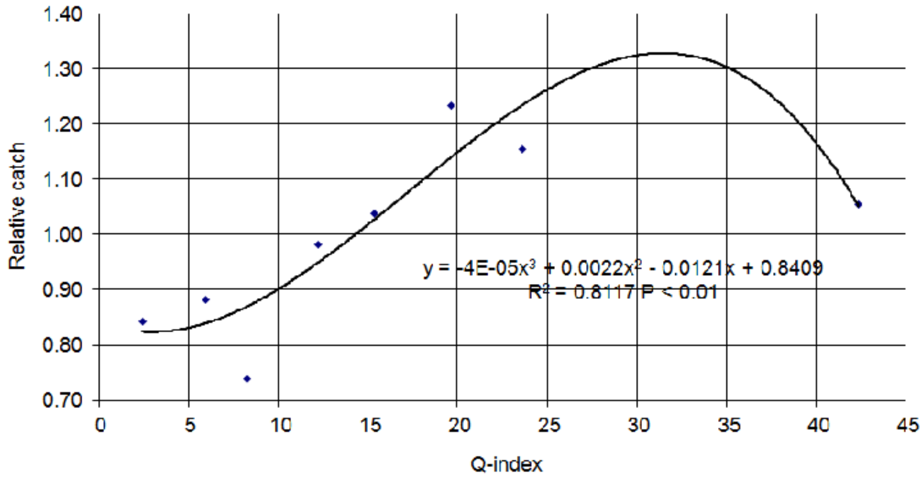


Figure 4 The light-trap catches of the *Neureclipsis bimaculata* L. depending on the Q-index as a function of moderate solar activity year (1983)

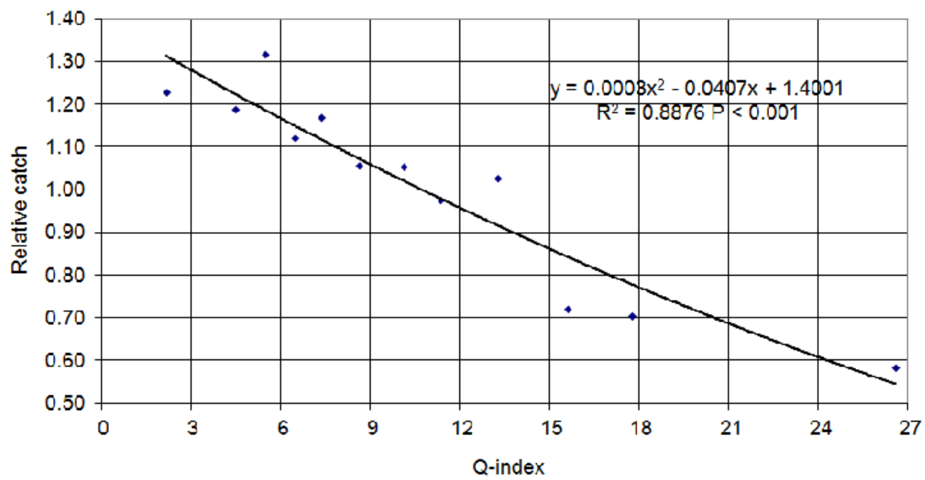


Figure 5 The light-trap catches of the *Potamophylax nigricornis* Pictet depending on the Q-index as a function of strong solar activity year (1982)

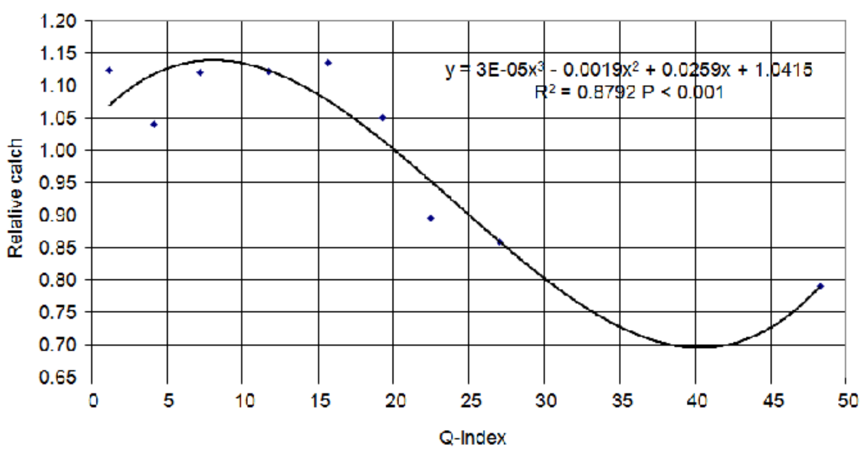


Figure 6 The light-trap catches of the *Potamophylax nigricornis* Pictet depending on the Q-index as a function of moderate solar activity year (1983)

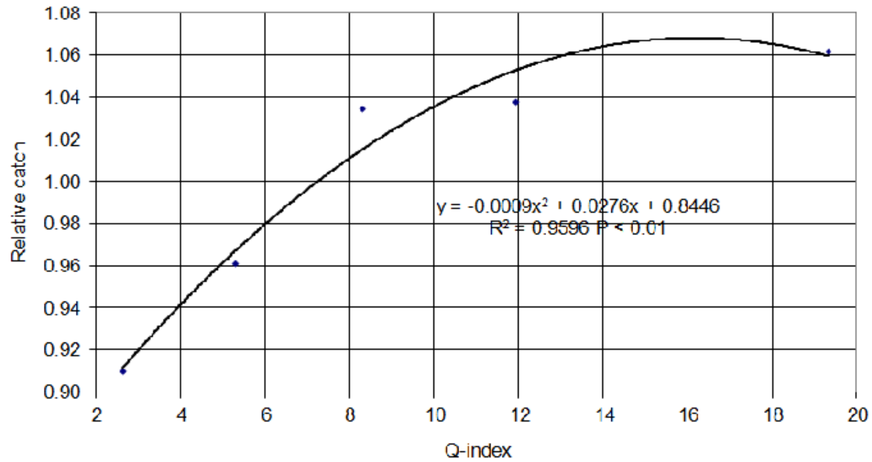


Figure 7 The light-trap catches of the *Halesus digitatus* Schrank depending on the Q-index as a function of strong solar activity years (1980-1982 and 1989)

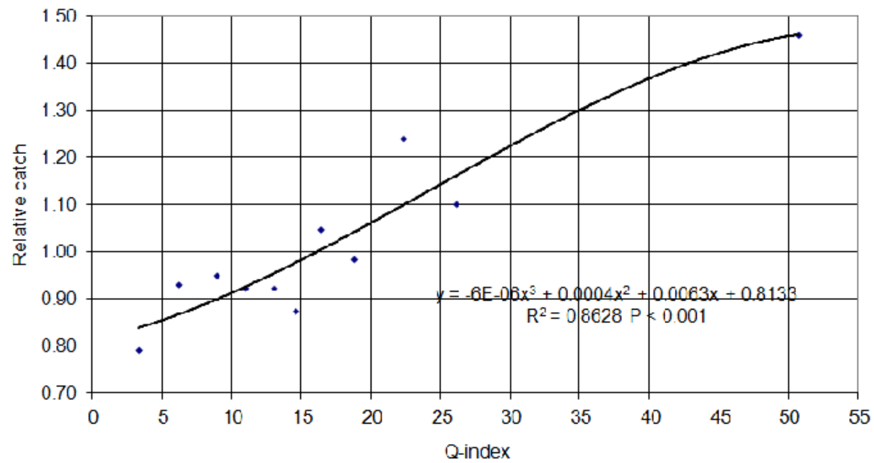


Figure 8 The light-trap catches of the *Halesus digitatus* Schrank depending on the Q-index as a function of moderate solar activity years (1983 and 2000)

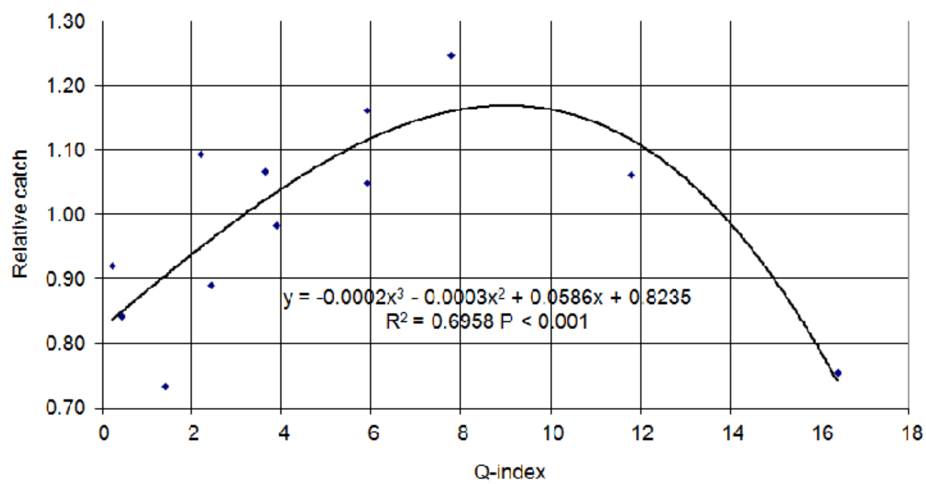


Figure 9 The light-trap catches of the *Sericostoma personatum* Spence depending on the Q-index as a function of strong solar activity year (1982)

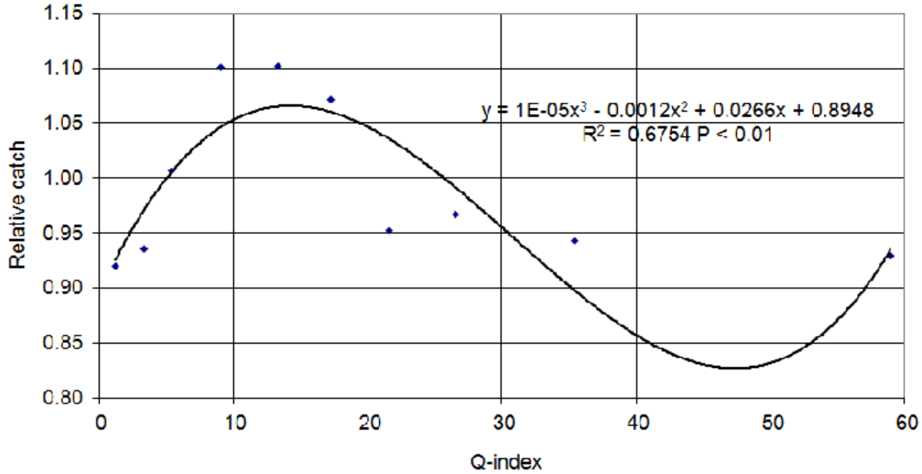


Figure 10 The light-trap catches of the *Sericostoma personatum* Spence depending on the Q-index as a function of moderate solar activity year (1983)

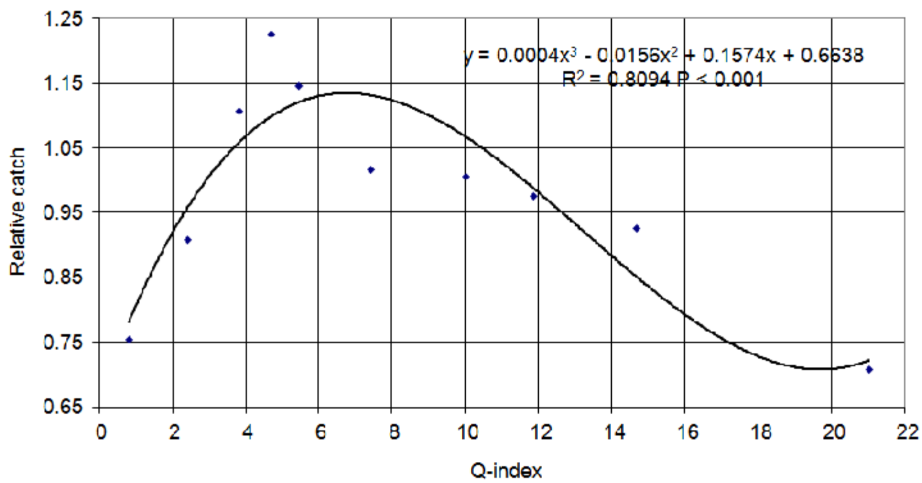


Figure 11 The light-trap catches of the *Odontocerum albicorne* Scopoli depending on the Q-index as a function of strong solar activity year (1982)

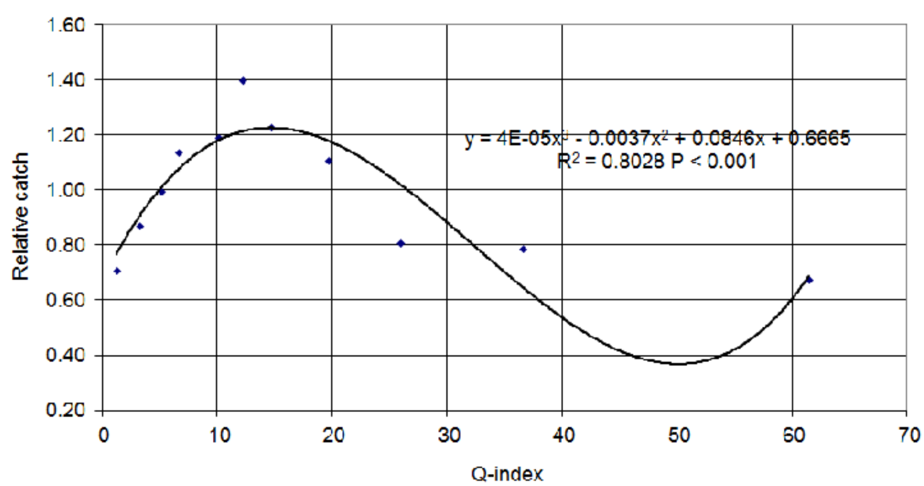
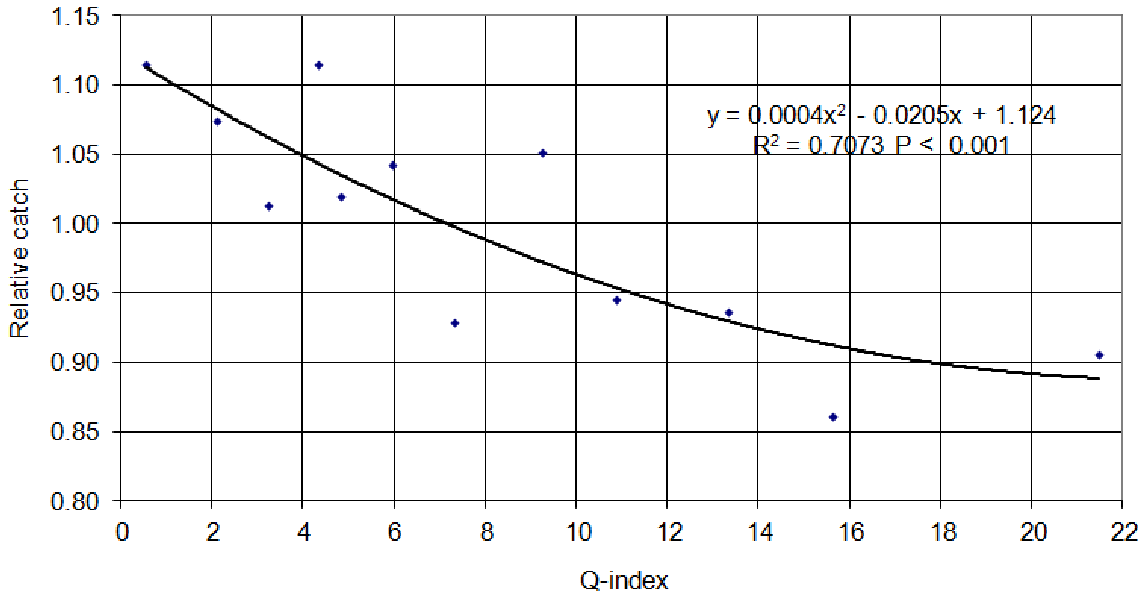


Figure 12 The light-trap catches of the *Odontocerum albicorne* Scopoli depending on the Q-index as a function of moderate solar activity year (1983)



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.

Part of the examined species was collected in connection with the increasing the high values of the Q-index, but decrease were observed in part of other species. It can be experienced in some 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.

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