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Research Article

Light-Trap Catch of Macrolepidoptera Individuals and Species in Connection with the Geomagnetic Disturbed (D), Quiet (Q) and Usual (U) Nights

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Abstract

This paper engages in relationship with geomagnetism and light-trap catch of moths (Lepidoptera). We found correspondence between disturbed (D), quiet (Q) and usual (U) days and light trapped individuals and species.

The light trap caught the most individuals on disturbed nights and the number of species was also the highest in the spring and summer aspects. They were unfavourable, however, for catching the quiet nights. Individuals of the autumn aspect species flew to the light in larger amounts on the usual nights.

Keywords: Geomagnetic D, Q, U Nights; Moths; Light-trap

Introduction

It has been known for decades that insects sense the earth's magnetism. We refer only to those studies that examined the trapping of insects in the context of magnetism.

Iso-Iivari and Koponen [1] investigated the geomagnetic influence on trapped insects in the northernmost part of Finland. K index values, estimated every three hours, and ΣK and δH values were also used in their research. They discovered significant correlation between geomagnetic values and specimens of beetles caught with light-traps.

Tshernyshev [2] found that the catch of light-traps by beetles and bugs increased several times in Turkmenistan during geomagnetic storms. Tshernyshev established a correlation examining the relationship between the number of caught insects and the horizontal component. The investigation also found that the number of insects caught with a light-trap increased significantly during magnetic disturbances.

He later found when magnetic disturbances occurred, the catch of light-traps by some beetles (Coleoptera) and moth (Lepidoptera) species increased, while the number of other moth and fly species (Diptera) decreased during the period of magnetic disturbances [3].

Baker and Mather [4,5], although not using a light trap for their research, but an orientation cage, they made extremely important findings. They conclude that the Large Yellow Underwing moth (*Noctua pronuba* L.) makes use of the Earth's magnetic field in maintaining compass orientation on overcast nights. They obtained that specimens are also influenced by the Moon and geomagnetism in their orientation and are even able to consider both of these sources of information.

As a result of our previous research, we have found the value of H-index effects the efficiency of a light trapping [6,7]. A relationship was found between Microlepidoptera spec. indet. and C9 index [8]. We also investigated the effect of changes in the number of Macrolepidoptera individuals and species with the Kp and M index [9,10].

In a previous study, we demonstrated the relationship between caddisfly (Trichoptera) species and the geomagnetic H-index that were trapped in light. For different species, the research showed different results. Both increasing and decreasing results were observed equally with increasing values of the H index [11]. A study by Puskás., *et al*. [12] presents the relationship between Microlepidoptera spec. indet. and the geomagnetic M-index. Catches of Microlepidoptera species were found to decrease if the M-index values were high.

In our current work, we examined the light trapping of some moth species in the context of the unexamined geomagnetic parameters, the quiet (Q), disturbed (D) and usual (U) days.

Materials

The geomagnetic quiet (Q) and disturbed (D) day data were measured at Nagycenk, near Sopron in the Geodetical and Geophysical Research Institute of the Hungarian Academy of Sciences. The geographical coordinates of observatory are 47° 38’ (N); 16° 43’ (E).

The observatory is situated about 10 km to E from the city Sopron, 43 km from Szombathely and 60 km from Vienna, on the southern shore of Lake Fertő. The observatory lies on thick conductive sediment and it is surrounded by the Fertő-Hanság National Park. Data of local Q and D days for our research have been taken from a series of observations carried out at Nagycenk (Western Hungary) description of which can be found in: Observatoriums Berichte des Geophysikalischen Forschungslaboratoriums der UAdW in Sopron, 1962-1966 and Geophysical Observatory Reports of the Geodetical and Geophysical Research Institute of the Hungarian Academy of Sciences in Sopron, 1967-1970.

The list of disturbed (D) and quiet (Q) days selected by the following rule: A day is taken as disturbed on the basis of all magnetic and earth current activity indices, if the greatest of the simultaneous character figures decreases only in one of the three hour intervals to 3, in the other intervals they are greater. A day is taken as quiet, if the greatest of all activity indices has not reached 3. Five activity indices (two of the earth currents and three of the magnetism) are always taken into account.

Data were collected and obtained from the material of a forestry light-trap in Szombathely, is one of the uniformly equipped national Jermy-type light-trap network. The catching data of Macrolepidoptera individuals and species are present in table 1.

Years	Individuals	Species
1962	4,562	347
1963	6,780	349
1964	6,548	354
1965	1,304	205
1966	756	153
1967	4,544	261
1968	3,313	296
1969	4,501	316
1970	5,403	323

Table 1: The total number of individuals and all species caught per year.

Note: The number of species includes all species of which at least one specimen was caught by the light trap.

The Jermy-type light-trap is a modified version of the Minnesota-type from which the gatherer sheets are missing. Its light source is a normal 100 W bulb displayed at 2 m height, with colour temperature of 2900 ºK, the killing substance is chloroform.

The trap operated the whole year round, irrespective of weather, sunset or sunrise conditions all day from 18 p.m. to 4 a.m. The traps do not operate on days when temperature does not rise over 0 ºC, or if the area is covered with snow. Insects get the whole night into a single collecting glass, thus the results of collection per night means one data. The light-trap chosen for our investigation was operated in Szombathely between 1962-1970 in the Kámon Botanic Garden [47° 25’ (N); 16° 60’ (E)].

Methods

The Jermy type light-trap operates with a 100 W standard electric bulb, using chloroform as the killer material [13]. The frame holds the lattice holder, the lid, the light source, the funnel and the killer tool. All parts are painted black except for the funnel. Its colour is white. Before placing the device, cotton pads are placed on the bottom, which reduces the damage to the trapped insects. Trapped insects are frequently unsuitable for species identification because the destructive influence of chloroform is not immediate and small insects (Microlepidoptera species) in particular are many times damaged.

Three aspects were isolated per year. These are: spring, early- and late summer and autumn aspects. We counted and averaged the number of moths and species were caught in all three aspects. The results were plotted on bar graphs.

The significance level of the results was calculated with our own t-test program. This program is suitable for processing a large number of data and the significance level was accepted at $P \leq 0.05$.

Results and Discussion

Our results can be seen in figures 1-6 and table 2.

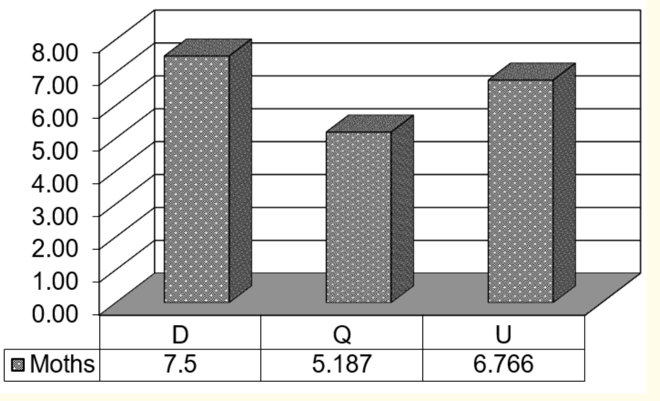

Figure 1: Averaged light trapped Macrolepidoptera moths in connection with the geomagnetic disturbed (D), quiet (Q) and usual (U) days (Spring aspect).

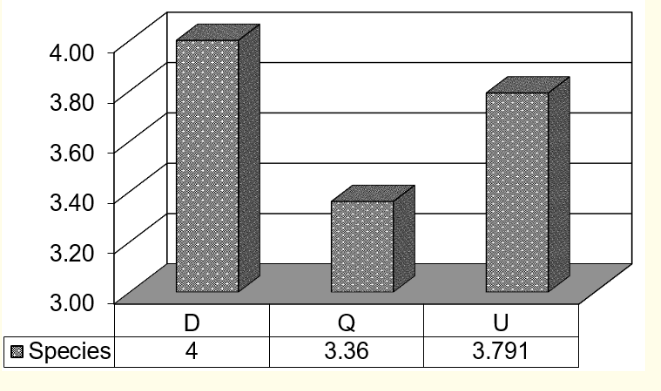

Figure 2: Averaged light trapped Macrolepidoptera species in connection with the geomagnetic disturbed (D), quiet (Q) and usual (U) days (Spring aspect).

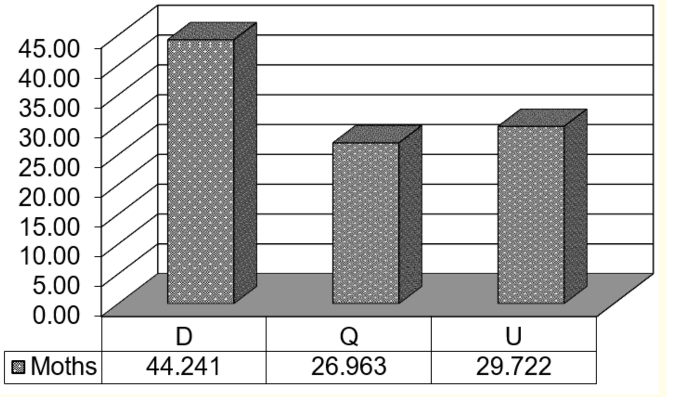

Figure 3: Averaged light trapped Macrolepidoptera moths in connection with the geomagnetic disturbed (D), quiet (Q) and usual (U) days (Summer aspects).

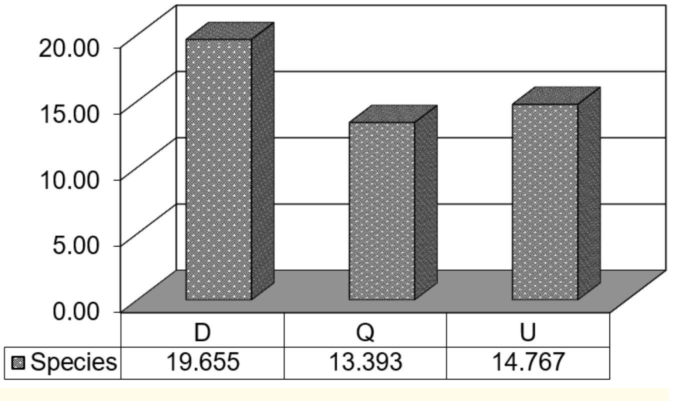

Figure 4: Averaged light trapped Macrolepidoptera species in connection with the geomagnetic disturbed (D), quiet (Q) and usual (U) days (Summer aspects).

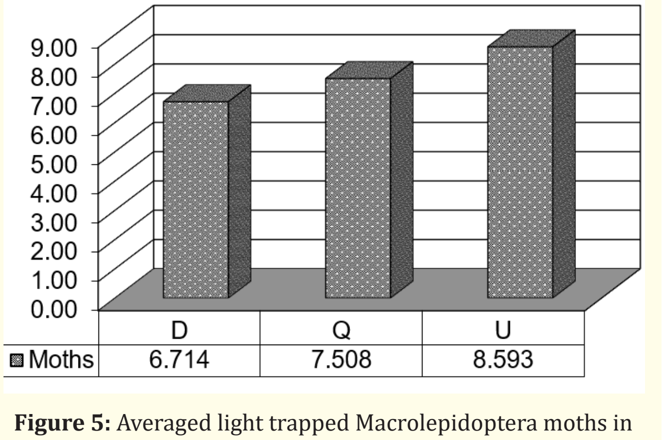

Figure 5: Averaged light trapped Macrolepidoptera moths in connection with the geomagnetic disturbed (D), quiet (Q) and usual (U) days (Autumn aspect).

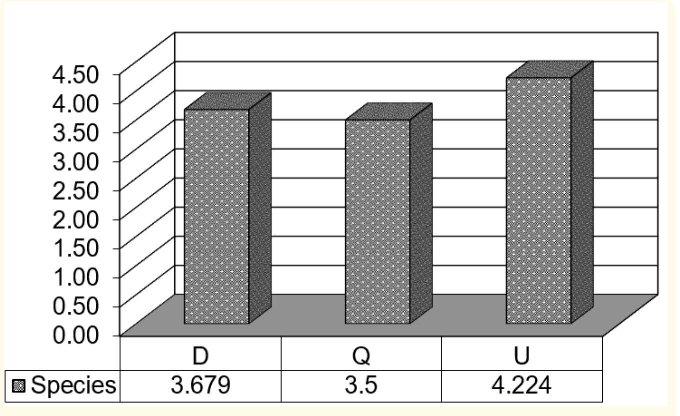

Figure 6: Averaged light trapped Macrolepidoptera species in connection with the geomagnetic disturbed (D), quiet (Q) and usual (U) days (Autumn aspect).

Aspects	D-Q	D-U	Q-U
Spring-individuals	Significant		Significant
Spring-species	Significant		Significant
Summer-individuals	Significant		Significant
Summer-species	Significant		Significant
Autumn-individuals		Significant	
Autumn-species		Significant	

Table 2: Significant level (P≤0.5) of the examined aspects and geomagnetic situations.

Most of the spring and summer individuals and species were caught by the light-trap on disturbed nights, but they were unfavourable for catching during quiet nights. Moths in the autumn aspect species flew to the light in larger amount on the usual nights.

Wajnberg., *et al*. [14] found the bees and ants can be use the geomagnetic field to orient and navigate in areas around their nests and along migratory paths.

Esquiel., *et al.* [15] write a surprising statistically significant response of the honeybee *Schwarziana quadripunc tata* (Meliponini) was obtained on a unique magnetic storm day.

Fleischmann., *et al.* [16] suggest that in insects, a geomagnetic compass cue is both necessary and sufficient for accomplishing a well-defined navigational task.

The relationship between the different geomagnetic indices (vertical component of geomagnetic field intensity, geomagnetic field strength, geomagnetic H-index, geomagnetic C9 index, geomagnetic Kp and M-index, geomagnetic ΣKp, Ap, Cp-index, geomagnetic AP-index) and insects there is no study showing the relationship in the literature (Nowinszky., *et al*. (2001, 2003, 2015, 2016a, 2016b), Nowinszky and Puskás (2012, 2015, 2016a, 2016b), Puskás., *et al*. (2016, 2018). This research is only known from our own previous work, so we cannot compare this with other research findings [17-21].

The grow or reduce in catch can be explained with our former hypotheses [20]. The divergent responses of species have many reasons. The importance of the species and its tolerance to environmental factors vary. Environmental factors interact and work together differently in the influences. So, the equal element can be expressed not the same form. The species have different survival strategies in response to adverse effects such as passivity, or hiding versus increased activity, to ensure the survival of species. Thus, insects try to "perform their duties in a hurry".

Conclusion

Most individuals were much less on quiet nights. The individuals and species of autumn aspect were caught in light-trap in larger amounts on usual nights. Our study is unprecedented in both Hungarian and international literature.

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