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Research Article

Effect of the Geomagnetic Disturbance Storm Time (D_{st}) on Light Trapped Caddisfly (*Trichoptera*) Species

Nowinszky L[1]*, Kiss O[2], Puskás J[1], Kiss M[1], Barta V[3] and Szentkirályi F[4]

[1]Eötvös Loránd University, Savaria University Centre, Hungary, Europe

[2]Eszterházy Károly University, Hungary

[3]Institute of Earth Physics and Space Science (EPSS), Hungary

[4]Department of Zoology, Plant Protection Institute of the Hungarian Academy of Sciences, Centre for Agricultural Research, Hungary

***Corresponding Author:** Nowinszky L, Eötvös Loránd University, Savaria University Centre, Hungary, Europe.

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Abstract

This study deals with geomagnetic disturbance storm time (D_{st}) in relation with the light-trap catch of eight caddisfly (*Trichoptera*) species. All the caddisfly species come from our own light-traps. The numbers of catching specimens by generation were calculated relative catch (RC) values. These daily relative catch data were assigned to the daily values of geomagnetic D_{st} index. The relative catch data were divided accordance with the D_{st} index values. For each species, a relationship was found between the D_{st} index and the number of caddisflies captured. However, the results were not identical. Three types of variation were identified: ascending, ascending then descending, descending then ascending.

Keywords: Caddisflies; D_{st} Index; Light-traps

Introduction

It has been known for decades that different insect species perceive geomagnetism and they are actually used it in their spatial orientation. Numerous of laboratory experiments and comprehensive studies are devoted to the physiological foundations of perception orientation [1,2]. Becker [3] found that some species of termites (*Isoptera*), beetles (*Coleoptera*), flies (*Diptera*), orthopteroids (*Orthoptera*), and hymenopterans (*Hymenoptera*) orient according to the natural magnetic field. Way of their mobility is North-South, rarely East-West. Their original way of movement could be modified by artificial magnetic field.

Iso-Ivari and Koponen [4] studied the effect of geomagnetism on the collection of light-traps by insects in the northernmost part of Finland. In their experiments, they used the K index values measured every three hours as well as the ΣK and δH values. A weak but significant correlation was found between geomagnetic parameters and specimens of different orders of captured insects.

The relationship between geomagnetic indices and light trapping of insects was mostly studied by Russian and then Hungarian researchers.

Pristavko and Karasov [5] found a correlation between geomagnetic C and ΣK values and the caught number of Spotted Ermel (*Yponomeuta rorrella* Hbn. *Lepidoptera: Yponomeutidae*).

In a later study Pristavko and Karasov [6] also established that at the time of magnetic storms ΣK had a greater influence on flying activity of the above species.

Tshernyshev [7] found that the number of light-trapped insects significantly rose at the time of magnetic perturbations. Later, however, he reported while light-trap catches of some Coleoptera and Lepidoptera species increased those of other Lepidoptera and Diptera species fell back during magnetic perturbations [8]. Tshernyshev [9] found that the number of light-trapped beetles and bugs rose many times over at the time of geomagnetic storms in Turkmenia.

Baker and Mather [10] and Baker [11] found that the Large Yellow Underwing (*Noctua pronuba* L.) and Heart and Dart (*Agrotis exclamationis* L.) are able to orient themselves with both the Moon and the Earth's magnetism, and even they are also able to integrate these two.

From our own studies we present the followings

Nowinszky *et al*. [12] found a relationship between the geomagnetic H-index and the light-trap catch of fluvial *Trichoptera* species. Nowinszky and Puskás [13] also demonstrated the influence of the geomagnetic H-index on the light-trap of Heart and Dart (*Agrotis exclamationis* L.). In our further studies, we proved the effect of the geomagnetic M-index (developed on the territory of Hungary by the Geophysical Observatory of the Geophysical Research Laboratory of the Hungarian Academy of Sciences) on the light trapping of different species: Nowinszky and Puskás [14] Number of Macrolepidoptera species catching in Szombathely Botanic Garden. Puskás., *et al*. [15] demonstrated the light-trap catch of Microlepidoptera species is influenced by the geomagnetic M-index. Nowinszky *et al*. [16] found the same for *Macrolepidoptera* species.

Materials

Large disturbances of the Earth's magnetic field, the so called geomagnetic storms, are defined by changes in the D_{st} (disturbance storm time) index. The D_{st} index determine the globally averaged change of the horizontal component of the Earth's magnetic field at the magnetic equator. It is computed once per hour based on measurements from a few stations at low latitudes (Honolulu, San Juan, Hermanus, and Kakioka [20]). The size of a geomagnetic storm is classified as moderate (−50 nT > minimum of D_{st} > −100 nT), intense (−100 nT > minimum D_{st} > −250 nT) or super-storm (minimum of D_{st} < −250 nT). While D_{st} is between +20 and −20 nanoTesla (nT) during quiet times. In our study we use the D_{st} index, what was published by WDC Kyoto Observatory.

Most of the caddisfly species are active in the evening at night, so we performed our calculations with the 24-hour D_{st} index.

All the caddisfly species come from our own light-traps.

We use Jermy type [17] light-traps in our catching. The light source of traps were 100 W normal bulbs at 2 m height. We used clear chloroform as killing material.

Modified Jermy type light-traps operated at Fülöpháza and Maroslele with compact fluorescent (Philips PL - T 42W/830/4p) bulbs. The Fülöpháza light-trap was equipped with 3 baffles around the bulb to increase the catch. The collecting funnel transfers the insects to the killing bottle with a tail-pice. The traps were used continuously throughout the night, from April to the end of October, during the insects' flight period.

The geographical coordinates of the catching sites and years can be seen in table 1.

The name of the species caught, the catching sites and years with the numbers of individuals and the nights are shown in table 2.

Methods

Basic data were the number of individuals and species caught in one night. In order to compare the differing sampling data, relative values were calculated from the number of individuals and species for each sampling night per year. The relative catch value (RC) was defined as the quotient of the number of specimen caught during a sampling time unit (1 night) per the average nightly catch of individuals within the relevant sampling period. For example, when the actual nightly catch was equal to the average nightly catch in the relevant summer, the RC was 1 [18].

Collection sites	Years	Geographical	
		Latitude	Longitude
1 Bükk, Vöröskő Valley	1982, 1983	48°34’N	20°27’E
2 Duna River at Göd	1999	47°41›N	19°08’E
3 Tisza River at Szolnok	2000	47°10’N	20°11’E
4 Maroslele	2001	46°16’N	20°21’E
5 Fülöpháza	2001, 2002	46°53’N	19°26’E
6 Tiszaroff	2002, 2003, 2004,	47°39’N	20°71’E
7 Tiszaszőlős	2002, 2003, 2004,	47°55’N	20°25’E
8 Csongrád	2002, 2003, 2004, 2005	46°71’N	20°14’E
9 Tiszakóród	2002, 2003, 2004, 2005	48°10’N	22°71’E

Table 1: The geographical coordinates of the collection sites and collection years in Hungary, Europe.

Species	Light-trap stations	Number of	
		Caddisflies	Nights
Ecnomidae			
Ecnomus tenellus Rambur, 1842	3, 6, 7, 8, 9	24,169	1,031
Polycentropodidae			
Neureclipsis bimaculata Linnaeus, 1758	1,2,3,4,5,6,7,8,9	43,879	1,003
Hydropsychidae			
Hydropsyche instabilis Curtis 1834	1	19,853	202
Hydropsyche contubernalis McLachlan, 1865	2,3,5,6	33,759	370
Hydropsyche bulgaromanorum Malicky, 1977	2,3,5,6,7,8,9	39,226	574
Brachycentridae			
Brachycentrus subnubilus Curtis, 1834	2	3,670	132
Limnephilidae			
Potamophylax nigricornis Pictet, 1834	1	9,519	174
Leptoceridae			
Setodes punctatum Fabricius, 1793	2,3	5,937	232

Table 2: The name of the species, the catching sites and the numbers of caddisflies and the nights.

In this work, we chose a slightly different solution. Separately, all catch data by species were considered as a single sample and thus relative catch values were calculated. This solution also made it possible to determine the effectiveness of trapping from the relative catch values of each year and to compare the effectiveness of the years. We made divisions using Sturges’ method [19]. Finally, we averaged within groups the D_{st} index and relative catch data pairs. In the figures are plotted the results.

Results, Discussion and Conclusion

Our results are shown in figures 1-8.

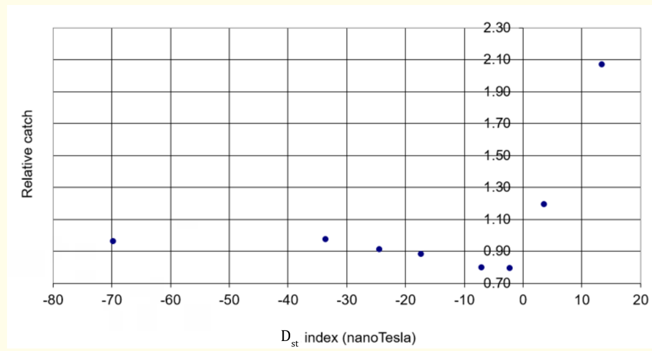

Figure 1: Light-trap catch of *Ecnomus tenellus* Rambur, 1842 in connection with the D_{st} index (Final).

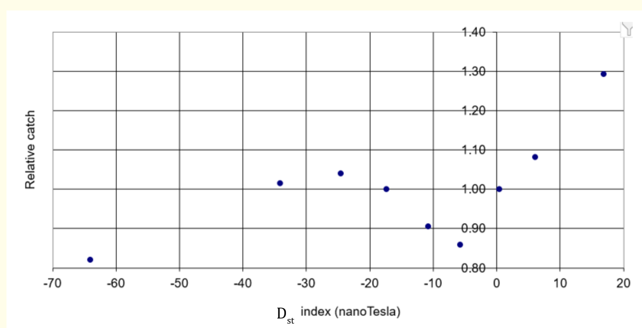

Figure 2: Light-trap catch of *Neureclipsis bimaculata* Linnaeus, 1758 in connection with the geomagnetic D_{st} index (Final).

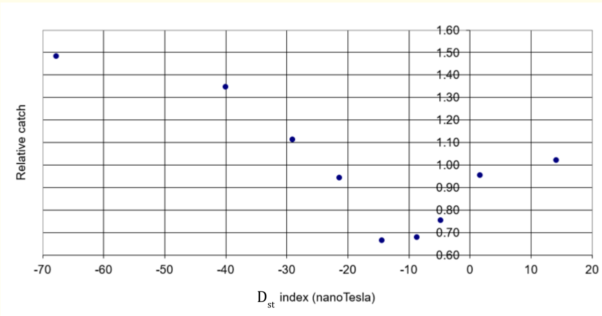

Figure 3: Light-trap catch of *Hydropsyche instabilis* Curtis, 1834 in connection with the D_{st} index (Final).

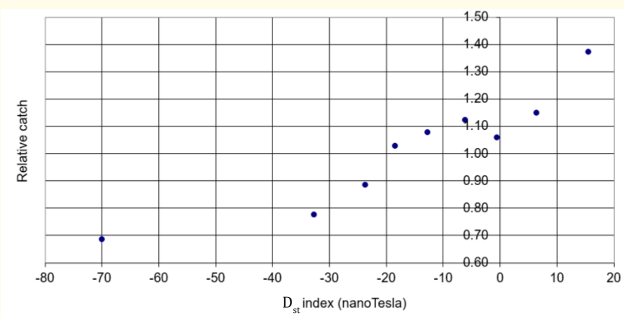

Figure 4: Light-trap catch of *Hydropsyche contubernalis* McLachlan, 1865 in connection with the geomagnetic D_{st} index (Final).

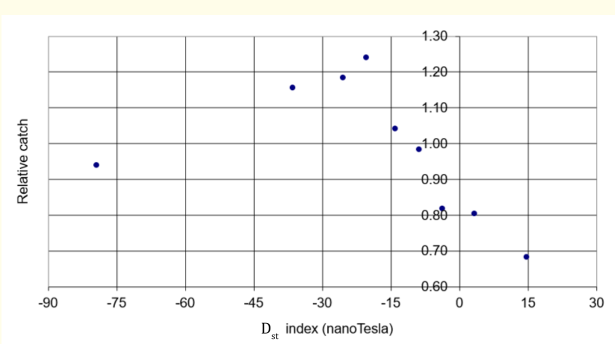

Figure 5: Light-trap catch of *Hydropsyche bulgaromanorum* Malicky, 1977 in connection with the geomagnetic D_{st} index (Final).

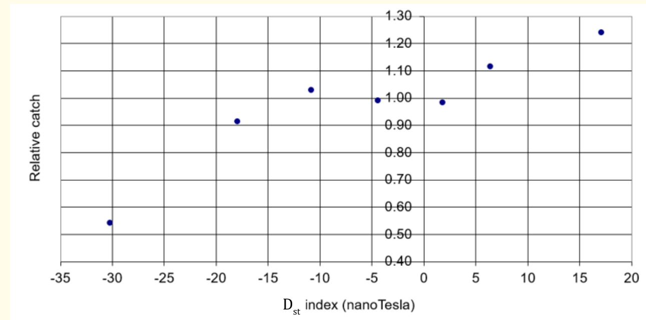

Figure 6: Light-trap catch of *Brachycentrus subnubilus* Curtis, 1834 in connection with the geomagnetic D_{st} index Final.

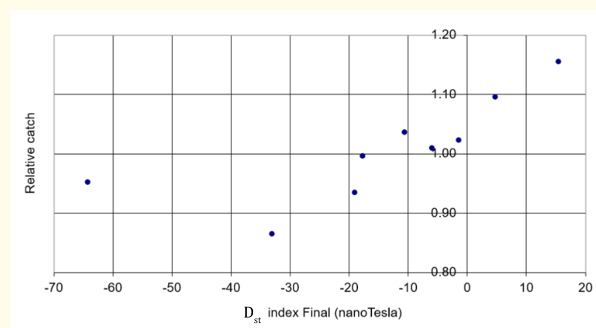

Figure 7: Light-trap catch of *Potamophylax nigricornis* Pictet, 1834 in connection with the geomagnetic D_{st} index (Final).

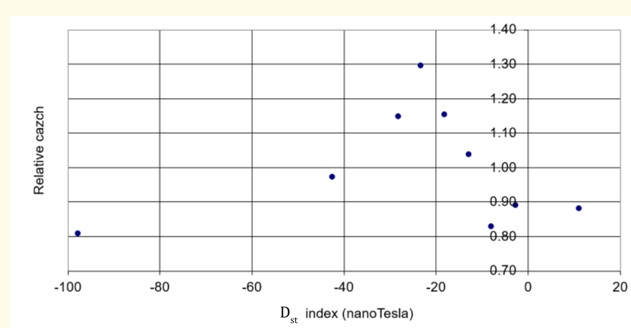

Figure 8: Light-trap catch of *Setodes punctatum* Fabricius, 1793 in connection with the geomagnetic D_{st} index (Final).

We found that different species did not respond equally to geomagnetic D_{st} index values and that catch peaks were associated with different D_{st} index values.

Three types of behaviour were identified:

- **Ascending:** *Ecnomus tenellus* Rambur, 1834, *Neureclipsis bimaculata* Linnaeus, 1758, *Hydropsyche contubernalis* McLachlan, 1865, *Brachycentrus subnubilus* Curtis, 1834, *Potamophylax nigricornis* Pictet, 1834, *Setodes punctatum* Fabricius, 1793,
- **Ascending then descending:** *Hydropsyche bulgaromanorum* Malicky, 1977,
- **Descending then ascending:** *Hydropsyche instabilis* Curtis, 1832.

It is notable that these categories are independent of the taxonomic classification of the species.

According to our hypothesis, the explanation of our results can be the following: Low relative catch values are always associated with conditions unfavourable to insect flight activity, but high values are more difficult to interpret. Major environmental changes bring about physiological adjustments in the activity of insects. The imago is short-lived, and unfavourable weather endangers the survival of not just the individual, but the population as a whole. In our hypothesis, the individual may adopt two kinds of strategies to evade the impacts hindering the function of its normal activity. It may either become more lively, increasing the intensity of its flight, copulation and egg-laying activity, or take refuge in passivity to weather or other unfavorable situation. Hence, in the present state of our knowledge we might say that favourable and unfavourable and space weather situations might equally be accompanied by a high catch Nowinszky [18].

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