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Short Communication

Catching of Insects by Light and Pheromone Traps at the Time of Ground Level Enhancements (GLE)

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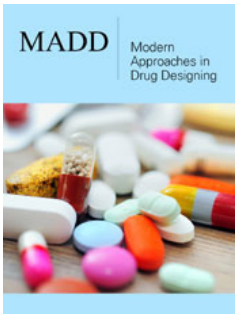

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Introduction

The Ground Level Enhancement (GLE) events are extremely rare, averaging only a dozen in the cycle of Sun, so the data set collected so far only counts 70 events. However, in terms of speed, it surpasses other types of solar winds. A Ground Level Enhancement (GLE) occurs when the energetic particles, mainly protons emitted by the Sun have enough energy to reach even the ground of the Earth, therefore the impact of them can be measured there. The formal definition of a ground level enhancement (GLE): "A GLE event is registered when there are near-time coincident and statistically significant enhancements of the count rates of at least two differently located neutron monitors including at least one neutron monitor near sea level and a corresponding enhancement in the proton flux measured by a space-borne instrument(s)" [1]. Because the effect of GLE is perceptible on the Earth's surface, we attempted to demonstrate this effect in insect activity.

Material and Methods

The GLE dates to which collection data for a species could be assigned are as follows:

1981-05-10, 1989-05-06, 1989-07-25, 1989-08-16, 1989-08-24, 1989-09-26, 1992-06-25, 1998-05-02, 2012-05-17. In Hungary, similarly to several other countries (UK, several US states, Scandinavian countries), a light-trap network has been operating for many decades [2]. From the huge amount of collection data of light-traps operating throughout Hungary, we found only three moth species that flew into traps during the GLE. Only two moth species were found from collection data on light-traps operating in two US states (North Carolina and Nebraska) that flew into the light during GLE. This data was uploaded by the operators to the internet. The caddisflies (Trichoptera) were collected by Ottó Kiss next to the streams of the Bükk Mountains between the years 1980 and 1989 and on the banks of the Danube and Tisza rivers in 1999 and 2000. He also identified and registered the captured individuals. All specimens of all captured species were processed. However, we had relatively little data of a certain species, thus we performed the calculations by summing all the data (Trichoptera spec. complex). In Hungary, in the orchards of Borsod-Abaúj-Zemplén county, biologist Gábor Barczikay operated pheromone traps between 1982 and 2013. These pheromone traps collected seven species of pest moths and the number of captured moths were registered daily by Gábor Barczikay. Counting per day is extremely rare because it is usually counted every 3-7 days worldwide [3]. From this single huge collection of data, individuals of four moth species were trapped during the GLE. The catching data are shown in Table 1. We added up by species the number of specimens caught 2-2 nights before and after the Ground Level

Enhancements (-2, -1, 0, +1, +2 nights), then expressed the catch results of the individual days in the percentage of the total number of specimens [4]. We performed the t-test calculations with our own program. This program can process any number of data. The figures were edited using excel 2016.

Table 1: Light-trap and pheromone trap data of examined species.

Species	Number of Swarming at GLE
Light-Traps, Hungary (*Trichoptera*)	
Trichoptera spec. complex	21
Light-Traps, Hungary (*Lepidoptera*)	
European Corn-borer Ostrinia nubilalis Hübner, 1796	23
Autumn (Fall) Webworm Hyphantria cunea Drury, 1773	6
Setaceous Hebrew Character Xestia c-nigrum Linnaeus, 1758	6
Light-traps, north carolina and nebraska (*Lepidoptera*)	
European Corn-borer Ostrinia nubilalis Hübner, 1796	4
Corn Earworm Heliothis zea Boddie, 1850	4
Pheromone Trap, Hungary (*Lepidoptera*)	
Gracillariidae, Lithocolletinae	
Spotted Tentiform Leaf Miner Phyllonorycter blancardella	7
Fabricius, 1781	
Tortricidae, Olethreutinae	
Codling Moth Cydia pomonella Linnaeus, 1758	4
Oriental Fruit Moth Grapholita molesta Busck, 1916	6
Plum Fruit Moth Grapholita funebrana Treitschke, 1835	11

Result and Discussion

Our results are shown in Figure 1-10. Based on our results, we find it proven that the results of light and pheromone trap catches change on the evening and night of the Ground Level Enhancements day, compared to the catch of the previous and following days. Thus, insects respond to effects during GLE by increasing or decreasing their flying activity. The catching results of the light-traps in Hungary show a decrease on that day or the next day. Catches of light-trapped moths in two US states are increasing on GLE days. It is striking, however, that the catch of European Corn-borer (Ostrinia nubilalis Hbn) is already high on the previous day. The catch of the four species collected with the pheromone trap is high on the day of GLE. The catch of Spotted Tentiform Leaf Miner (Phyllonorycter blancardella Fabr) is high even on the next day. The increase or decrease of the catch is explainable by our previous hypotheses [5]. The divergent responses of species have many reasons. The significance of and tolerance to environmental factors of the species vary. Thus, the same factor can express differently. 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. Therefore, the insects seek to "to carry out their duties in a hurry". According to our hypothesis, the explanation of our results can be the following: The low catch values always refer to situations in which the flight activity of insects diminishes. However, high values are not so clear to interpret. Major environmental changes bring about physiological transformation in the insect organism. The imago is short-lived, therefore unfavourable environmental effects the survival of not just the individual, but the population. In our hypothesis, the individual may adopt two kinds of strategies to evade the impacts hindering the normal functioning of its life phenomena. It may either display more liveliness, by increasing the intensity of its flight, copulation and egg-laying activity or take refuge in passivity to weather an unfavourable situation. And so, by the present state of our knowledge we might say that favourable and unfavourable environmental effects might equally be accompanied by a high catch [5].

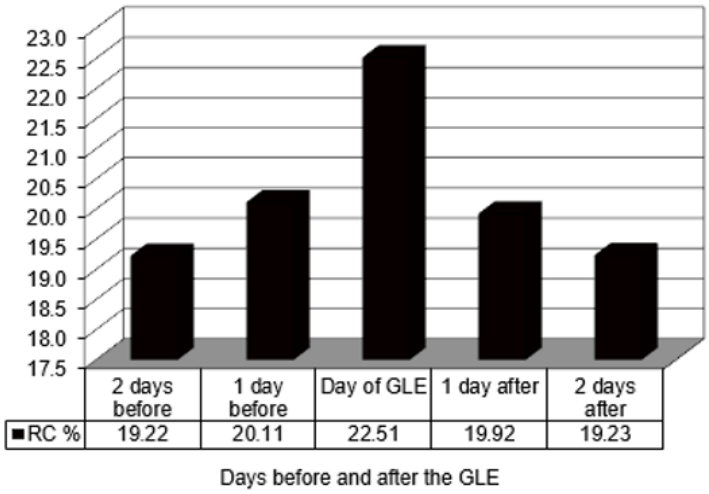

Figure 1: Light trap catch of trichoptera spec. complex in correction with the Ground Level Enhancements (GLE).

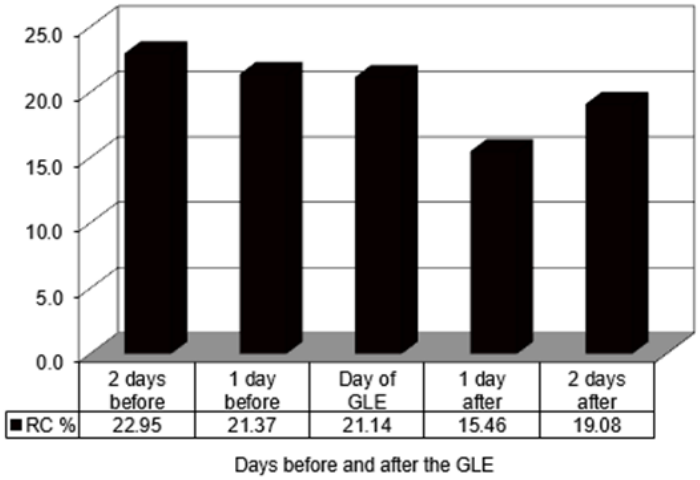

Figure 2: Light-trap catch of European Corn-borer (Ostrinia nubilalis Hübner, 1796) in connection with the Ground Level Enhancements (GLE) in Hungary.

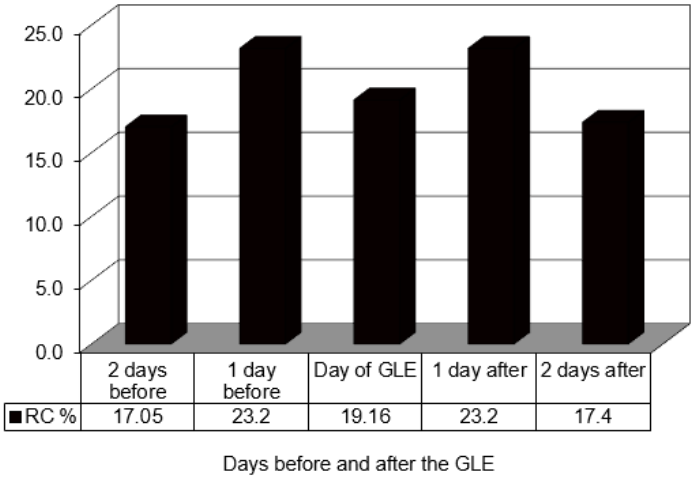

Figure 3: Light trap catch of Autumn (Fall) Webworm (Hyphantria cunea Drury, 1773) in connection with the Ground Level Enhancements (GLE).

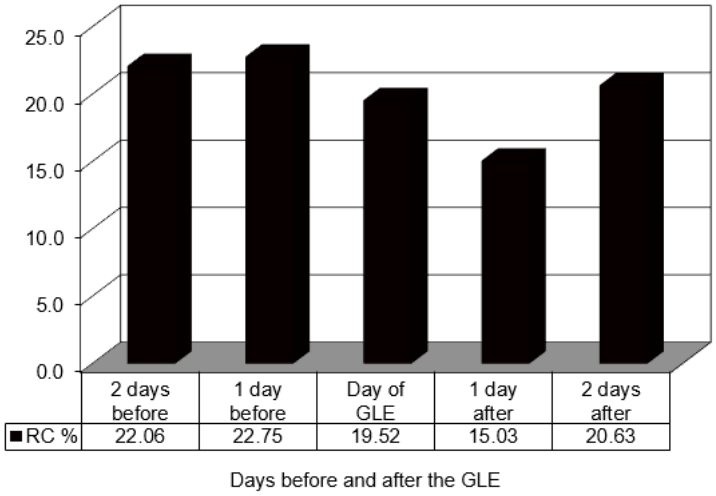

Figure 4: Light-trap catch of Setaceous Hebrew Character (Xestia c-nigrum Linnaeus, 1758) in connection with the Ground Level Enhancements (GLE).

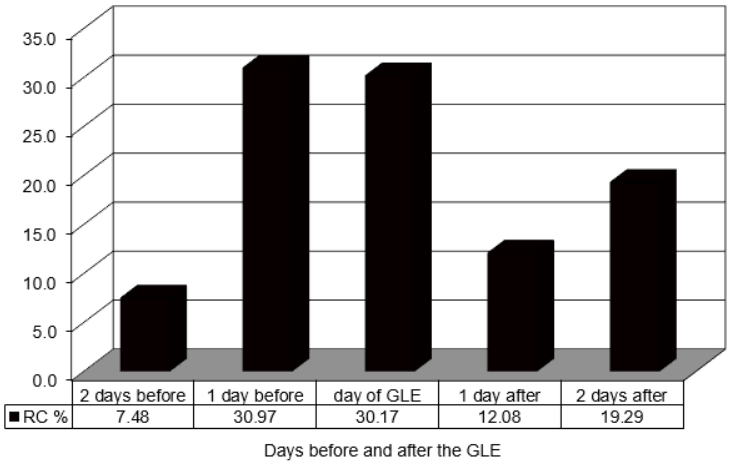

Figure 5: Light-trap catch of European Corn-borer (Ostrinia nubilalis Hübner, 1796) in connection with the Ground Level Enhancements (GLE) in North Carolina and Nebraska.

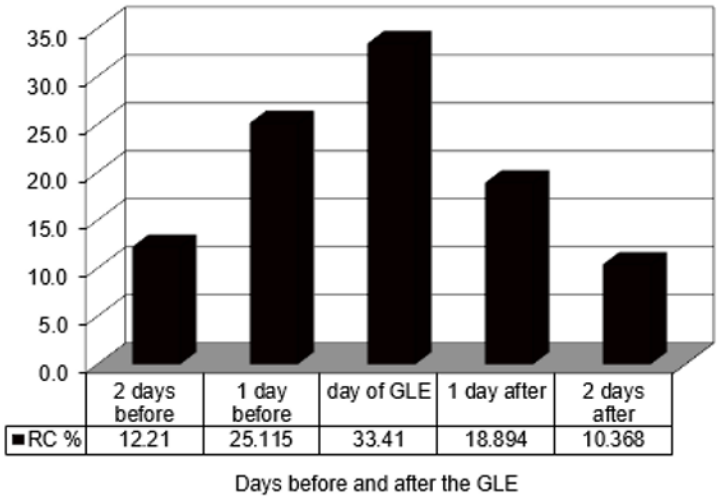

Figure 6: Light trap catch of Corn Earworm (Heliothis zea Boddie, 1850) in connection with the Ground Level Enhancements (GLE).

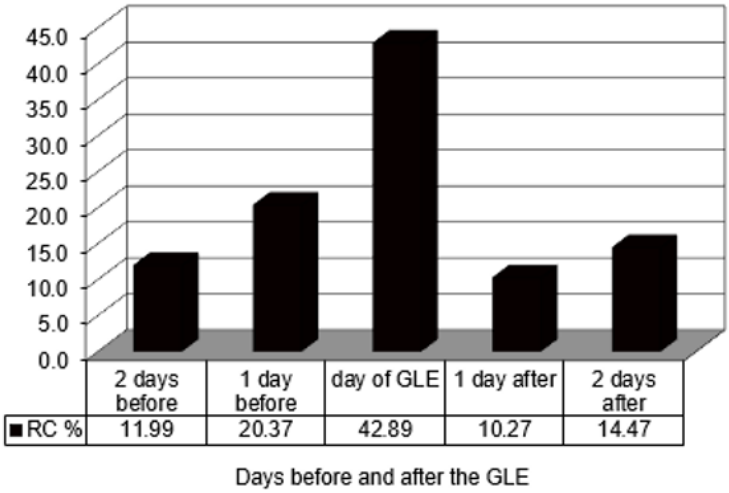

Figure 7: Pheromone trap catch of Oriental Fruit Moth (Grapholita molesta Bruck, 1916) in connection with the Ground Level Enhancements (GLE).

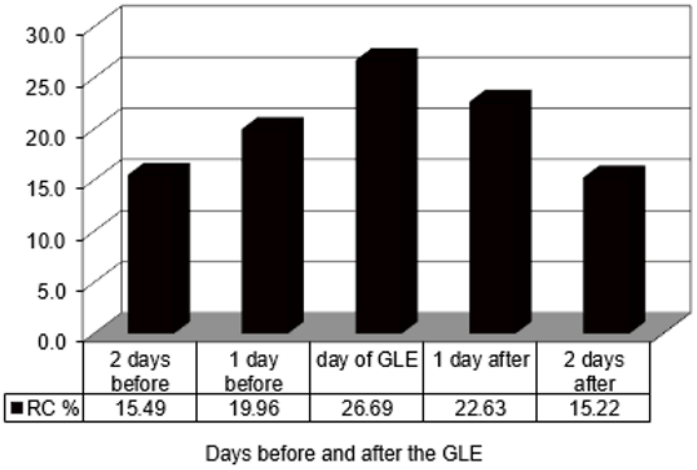

Figure 8: Pheromone trap catch of Plum Fruit Moth (Grapholita funebranaTreitschke, 1835) in connection with the Ground Level Enhancements (GLE).

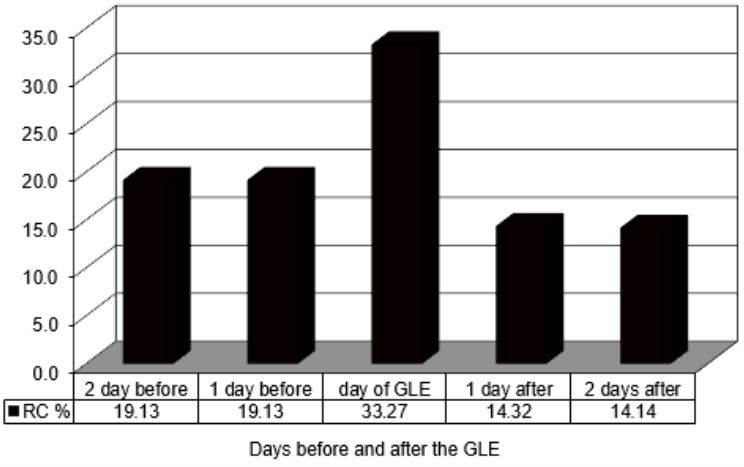

Figure 9: Pheromone trap catch of Codling Moth (Cydia pomenella Linnaeus, 1758) in connection with the Ground Level Enhancements (GLE).

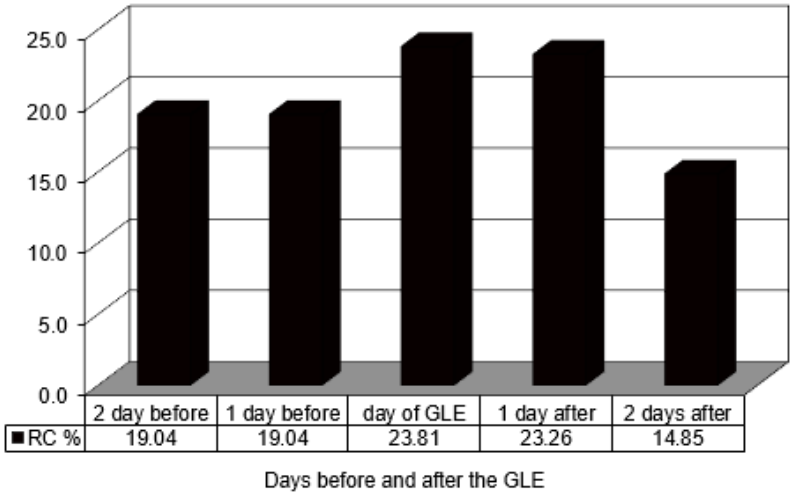

Figure 10: Pheromone trap catch of Spotted Tentiform Leaf Miner (Phyllonorycter blancardella Fabricius, 1781) in connection with the Ground Level Enhancements (GLE).

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