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Research Article

Light-trap Catch of Moths (*Lepidoptera*) in Connection with the Ionospheric f_0F_2 Parameter

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Abstract

The study deals with the light trapping of three moth species in connection with the ionospheric *f*0F2 parameter of solar activity. We found the ionospheric f_0F_2 parameter influence the effectiveness of light trapping catch of insect. However, different species do not respond in the same way to this effect.

Keywords: Ionospheric f_0F_2; Light Trapping; Moths

Introduction

Solar outbreaks are accompanied by intensive X-ray, gamma and corpuscular radiation that, reaching the Earth, get into interaction with the upper atmosphere and change electromagnetic conditions [1]. In the course of this electromagnetic storms might break out and the ionization relations of the ionosphere might also undergo transformation.

The corpuscular radiation of the Sun leads to the formation of layers (ion concentration) at varying heights of the ionosphere parallel to the surface of the Earth. At the temperate zone latitudes, there are three well discernible ionospheric layers. Layers D and E are in the low regions (60-160 km) of the ionosphere while layer F is classed with the high regions (160-250 km, even 1000 km at the time of big storms). Layer F is split into two (F_1 and F_2) at daytime. At night, layers D, E and F_1 disintegrate, and only layer F_2 remains [2]. The ionospheric disturbances caused by corpuscular radiation appear during solar flares when the Sun emits a vast amount of electrically charged and uncharged particles which entering the atmosphere of the Earth, change the conditions of the ionospheric layers. The changes in layer F_2 appear mainly in fluctuations of ion density and height. Ionospheric layer density is characterized by the boundary frequency of the given layer.

When ionospheric recordings are made, impulses of radio waves of continuously growing frequency are emitted into the atmosphere. The highest frequency reflected by the layer under examination is called boundary frequency (f_0F_2). Influenced by the geomagnetic field, a change takes place in the frequency and polarization of the radio wave emitted (Zeeman effect) which divides into two, sometime three electromagnetic oscillations of different frequencies. The component of a frequency identical to that of the generator is called regular frequency, marked f_0 [2]. We speak of an ionospheric storm when the boundary frequency of layer F_2 (f_0F_2) in a given moment digresses at least by 20% from the hourly median value of the given point of time. After Saikó [3] it is calculated like this:

$$\Delta f_0F_2 = \frac{100(f_0F_2 - f_0F_2\,\text{med})}{f_0F_2\,\text{med}}$$

According to Saikó’s account [4], Δf_0F_2 value trends were examined simultaneously at six ionosphere observation stations. They were: Freiburg (48°03’N, 07°35’E), Pruhonice (49°59’N, 14°33’E), Belgrade (44°48’N, 20°31’E), Békéscsaba (46°40’N, 21°11’E), Dourbes (50°06’N, 04° 36’E), Juliusruh (54°38’N, 13°23’E). The examinations have clearly shown a sudden increase of the Δf_0F_2 value after the effect occurred at all six stations. This fact has led to the conclusion that radiation from the flares can bring about ion condensation also in the F_2 layers over larger areas. Of the impacts of ionospheric storms on the Earth, those influencing the weather have been subjected to closer investigation. In Hungarian literature, Saikó’s works [5,6] provide information on these. Research into disturbances that suddenly make their presence felt in the lower ionosphere is of significance. Investigation is carried out first of all with absorption measuring, as radio waves are greatly absorbed in this layer.

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In our dissertation [7] we have the data needed for our calculations (border frequency of the F_2 layer of the ionosphere (f_0F_2) were provided by publications released by the Panská Ves Observatory of the Geophysics Research Institute of the Czechoslovak Academy of Sciences. This observatory is about 25-30 kilometres from Prague. In the view of personal communication of Béla Szudár (Main Meteorological Station, Békéscsaba), it is scientifically justified to cross-check the values measured there with those of the light-trap catches in Hungary.

From the material of the national light-trap network we compared the border frequency (f_0F_2) of layer F_2 with the catch data for Winter Moth (*Operophthera brumata* Linnaeus, 1758) and Scarce Umber (*Agriopis aurantiaria* Hübner, 1799) [7].

Data related to the former species come from the period between 1961 and 1976. We had at our disposal 3,712 observation data of 46,290 individuals from 18 observation sites over 837 nights. Regarding the latter species, we processed 1,322 observation data of 8,614 individuals collected at 44 observation stations over 403 nights in the years 1962-1970.

Using Saikó's method (1966), we calculated the difference in the value of the boundary frequency (f_0F_2) of layer F_2 expressed in the percentage of the hour-median (Δf_0F_2) for each hour of each night of the collecting period. Differences over 20% were considered as ionospheric storms. These were given, also after Saikó (1966), character numbers (K) as follows: an observed storm of a negative or positive sign between 20-30% is listed in the 1st, between 30-40% in the 2nd and above 40% in the 3rd class of intensity. The character numbers were summed up by nights (Σ K f_0 F_2) and were then considered as independent variables. We averaged by nights the relative catch values (RC) from the various observation sites then correlated these to the sum-totals of the character numbers. We arranged the pairs of values in classes, then averaged them. To reveal the assumed connection, we made correlation calculations. For both species, a high positive correlation was found between f_0F_2 and the relative catch. We have recently reported our research in a study that the atmospheric radio noise (SEA) affects the efficiency of light-trap catch [8].

Material and Methods

The Hungarian National Light-trap Network was equipped uniformly with Jermy type light-traps, and it has been operating from 1958 to the present day. There were selected the collection data of the three moths (*Lepidoptera*). The catching data are shown in table 1.

Species	**Number of**		
	Moths	**Data**	**Nights**
Crambidae, Pyraustinae			
European Corn-borer (*Ostrinia nubilalis* Hübner, 1796)	12,695	4,440	424
Erebidae, Arctiinae			
Fall Webworm (*Hyphantria cunea* Drury, 1773)	11,844	4,767	472
Noctuidae, Noctuinae			
Setaceous Hebrew Character (*Xestia c-nigrum* Linnaeus, 1758)	5,870	4,590	467

Table 1: Catching data of investigated species.

The data we have needed for our calculations (border frequency of the F_2 layer of the iono-sphere (f_0F_2) were provided by publications released by the Main Meteorological Station, Békéscsaba of the Hungarian Meteorological Service. Geographical coordinates of Békéscsaba are the follows: 46°40'N, 21°11'E.

The data of f_0F_2 was available to us from the years we studied between 1971 and 1976.

The number of individuals of a given species in variant years and villages or towns is not the same. Therefore, we computed relative catch (RC) values. The RC was defined as the quotient of the number of caught individuals during a sampling time unit (1 night) per the average catch of individuals within the same swarming relating to the same time unit. For example, when the actual catch is equal to the average individual number captured in the same swarming, the RC is 1.

The relative catch data of the species were examined every night in connection with the measured value of 23 hours. Since moths caught throughout the night were counted in the morning, we had one catch data per night. This was assigned to the f_0F_2 data measured at 23 hours. This is because most moths fly around midnight.

The values of f_0F_2 values were put into groups. The number of groups was determined according to Sturges method [9]. The corresponding relative catch data of the investigated species were arranged into these groups and afterwards the values were summarized and averaged. Relative catch values were placed according to the given day, then were summed up, averaged and depicted. Figures 1-3 also show the confidence intervals.

Results and Discussion

Our results can be seen in figures 1-3.

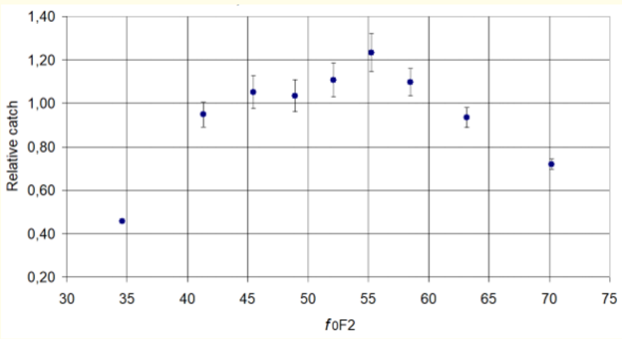

Figure 1: Light-trap catch of European corn-borer (*Ostrinia nubilalis* Hubner 1796) in connection with the f_0F_2.

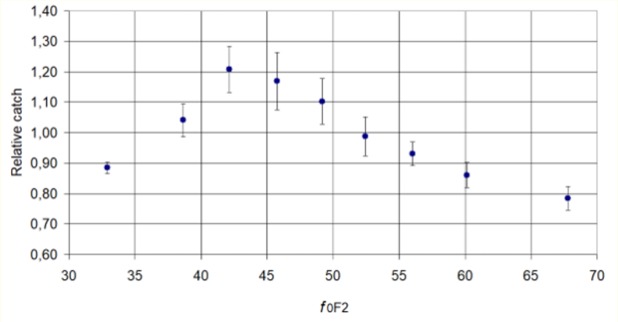

Figure 2: Light-trap catch of Fall webworm (*Hyphantria cunea* Duury 1773) in connection with the f_0F_2.

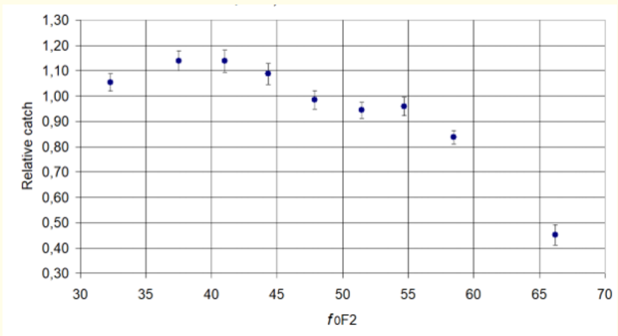

Figure 3: Light-trap catch of Setaceous Hebrew Character (*Xestia c-nigrum* Linnaeus, 1758) in connection with the f_0F_2.

Catches of all three species decrease after the initial rise. The catch peak is observed for all three species at different f_0F_2 values.

We have already shown in our previous studies that individuals of each species respond differently to the same environmental effects. Our current results show this as well.

According to our results the ionospheric f_0F_2 parameter influence the effectiveness of light-trapping catching of insect. However, different species do not behave in the same way at for the same environmental effect.

Our recent work calls attention of entomologists to new and perhaps even more influential environmental factors, the ionospheric f_0F_2 parameter.

Conclusion

According to our results the catch of all three moth species in inchoative stage rise after it decrease. The catch peak is observed for all three species at different f_0F_2 values. Established the ionospheric f_0F_2 parameter influence the effectiveness of light trapping catch of insect. However, different species do not behave in the same way at for the same environmental effect.

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