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Light Trapping of Coleoptera, Lepidoptera and Heteroptera Species in Relation to the Altitude of the Tropopause

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Abstract

The subject of our study is the success of light-trap catch of some insects (Coleoptera, Lepidoptera and Heteroptera) in Relation to the Altitude of the Tropopause. Groups were formed according to the height of the tropopause. The relative catch values of the investigated insects were grouped according to the heights of tropopause every day. Then we summarised, averaged and showed these values. We found a strong positive correlation between all of the investigated species and the altitude of tropopause.

Keywords: Tropopause; Light trapping; Coleoptera; Lepidoptera; Heteroptera

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Introduction and Literature Background

Different changes can be noticed in the moderate zone air mass circulation, because there is a rise in altitude of the tropopause, and other factors also cause changes in the atmosphere (temperature, humidity, air pressure, speed and direction of wind) [1].

Troposphere is the separation surface between the troposphere and the stratosphere. Its height is greatly changeable at different times. The changes in altitude of tropopause contain more weather elements in accumulated form: air temperature, humidity, strength and direction of wind, air pressure and precipitation. In the presence of very cold air masses from the Arctic it may be five kilometres only, while in the presence of sub-tropical air it may grow to 16 kilometres. If the height of tropopause is more than 13 km, this fact often comes with subtropical air stream in the high. In this case very strong biological influence can be seen.

According to Örményi [2] the electric factors in the atmosphere have a significant influence, when subtropical air stream arrives at great altitude. During those days the 3Hz aspheric impulse number decreases, but cosmic radiation of the Sun will increase.

This fact will cause changes in the number of caught insects. It is well known that the activity of insects always increase in warm air, but decrease in cold one.

The predominance of negative ions cause decrease in the insect activity in the polar air, while the predominance of positive ions may increase the flight activity in the subtropical marine air [3].

As the changes in tropopause height cause significant changes in the weather in the lower part of atmosphere, we examined the efficiency of light-trap catch in relation with changes in the tropopause altitude.

In recent times we published some results about the relation between the efficiency of the light trapping and the height of the tropopause. We published the results with next insects: the Heart and Dart (*Agrotis exclamationis* L.), the Common Cockchafer (*Melolontha melolontha* L.), the Turnip Moth (*Agrotis segetum* Den. et Schiff.) and Fall Webworm Moth (*Hyphantria cunea* Drury) [4-6]. According to our results the subtropical air masses influenced differently the efficiency of trapping if these masses were found in the high. The result of light trapping of Turnip Moth (Agrotis segetum Den. et Schiff.) and Heart & Dart (Agrotis exclamationis L.) is high when subtropical air masses can be found, while the opposite influence can be seen if Saharan air mass arrived, because the catch is low. The catch result of Fall Webworm (Hyphantria cunea Drury) is the opposite. We made former investigations with light-trap catch of some species (European Corn-borer (*Ostrinia nubilalis* Hübner), Setaceous Hebrew Character (*Xestia c-nigrum* L.) and caddisfly (Trichoptera) species) to examine the connection with the tropopause height [7,8].

We could find only our publications in the literature which deals with similar investigations.

The height of the global-mean tropopause shows a steady increase since 1979 in re-analyses of numerical weather forecasts. In model simulations with anthropogenic forcing, changes in tropopause height can be detected roughly 20 years earlier than changes in surface temperature [9].

We think it is important to investigate the insects's response in relation with the changes of the height of tropopause.

Material

Data of the height of tropopause in Budapest were found in the Annals of the Central Meteorological Institute of the Hungarian Meteorological Service.

We used the catch data of the Hungarian Agricultural and Forestry light-trap network. All the catch was made with Jermy-type light traps. The collection data are shown in **Table 1.**

The *Serica brunnea* Linnaeus is widespread species in the Carpathian Basin [10] wrote in his study the forest species of Hungarian forestry light-trap network were detected in the Bakony and Vértes Mountains and the sand in Danube-Tisza.

It can be found everywhere in the Carpathian Basin, but their damage is only significant in some regions.

The *Rhisotrogus aestivus* Olivier is collectible en masse mainly at sandy soils in Hungary (Kiskunság, Nyírség and around Budapest). Its swarming is expected in May [11,12]. It is mainly spread on sand soils. The larvae cause damage to sugar beet and potatoes.

The *Plutella xylostella* L. spread all over the world [13]. The most important host plants are the cabbages and rape.

The *Hypomecis punctinalis* ScopoliIt is very common in places in Hungary. The most important host plants are the oak (Quercus) and birch (Betula).

The material of caught bug species was not determined yet, but the majority belonged to these species: *Lygus rugulipennis* Poppius, 1911 (European Tamished Plant Bug) and *Lygus pratensis* Linnaeus, 1758 (Tamished Plant Bug) [14].

Methods

The Jermy-type light trap consists of a frame, a truss, a cover, a light source, a funnel, and a killing device. All the components are painted black, except for the funnel, which is white. A metal ring holds the funnel and a zinc coated tin are attached to the steel frame. The lid has a diameter of 100 cm. The top diameter of the funnel is 32 cm, the bottom is 5 cm and the height is 25 cm. The light source was a 100W normal light bulb which was laid under a metal cover (0:1 m) at 200 cm above the ground. Most traps were operated without a bow and the insect material was fed by a funnel under the bulb into a bowl. In each case, chloroform was used as a killer. Traps were held every night from April to October. An automatic turn-on/switched-off technique provided the capture of both twilight and night insects. The light-traps are operational from 6 pm. (UT) to 4 a.m. every night of the year, regardless of weather, or the time of sunrise and sunset. All the insects trapped during the course of a night go into the same collecting jar [15]. So a single set of data will represent the nightly catch result at the given observation site [16].

Basic data were the number of individuals caught by one trap in one night. The number of basic data exceeded the number of sampling nights because in most collecting years more light-traps operated synchronously [16].

The size of the populations of different observers are in different places, and the modifying factors are not the same all the time and location of the trapping, it is easy to see that the same number of items you can capture an entirely different proportion of two different observers place or time, the population studied. To solve this problem, the application offers to the relative catch values [16]. The relative catch (RC) is for a given sampling unit time (one hour or one night) and number average equivalent-time sampling unit relative to the number of generations before-bassoon individuals divided. If the number of specimens is equal to the average value of the relative catch is 1.

The relative catch data were classified into the appropriate phase angle groups. The phase angle groups and the corresponding catch data were organized into classes. Their number was determined according to Sturges' method [17] using the following formula:

k=1+3.3 * 1g n

Where: k=the number of groups, n=the number of observation data.

The relative catch values were sorted according to the respective diurnal values of the height of tropopause and then averaged and depicted. The figures also show the confidence intervals.

Results and Discussion

Our results are visible in **Figures 1-5**. The illustrated Figures show that the collection results of the different species are similar in connection with the height of the tropopause. Various tropopause heights have different weather conditions in the lower air layers [18]. In summer the cool air decreases the flying activity of insects in contrast, it is growing in warm air.

We have discovered a close positive correlation between the height of the tropopause and the number of light trapped of all

Table 1 The number and observing data of the examined species.

Species	Years	Traps	Individuals	Data	Nights
Coleoptera, Scarabaeidae *Serica brunnea* Linnaeus, 1758 Brown Chafer	1969-1974	8	7,713	499	288
Coleoptera, Scarabaeidae *Rhizotrogus aestivus* Olivier, 1789	1969-1974	8	1,820	223	139
Lepidoptera, Plutellidae *Plutela xylostella* Linnaeus, 1758 Diamond-back Moth	1962-1966	26	4,602	534	353
Lepidoptera, Geometridae *Hypomecis punctinalis* Scopoli, 1763 Pale Oak Beauty	1962-1969	1	11,818	797	797
Heteroptera, Miridae *Lygus sp.*	1980-1998	14	51,953	3,339	1,728

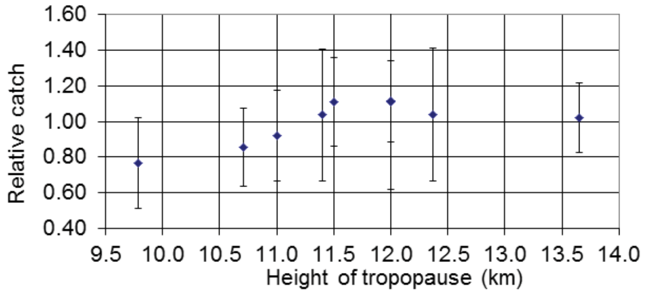

Figure 1 Light-trap catch of Brown Chafer (*Serica brunnea Linnaeus*) in connection with the height of tropopause.

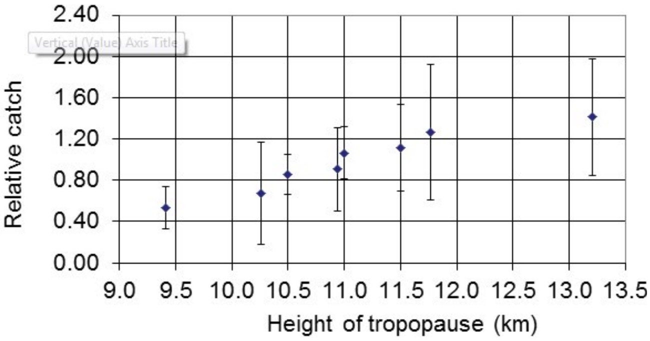

Figure 2 Light-trap catch of *Rhizotrogus aestivus* Olivier in connection with the height of tropopause.

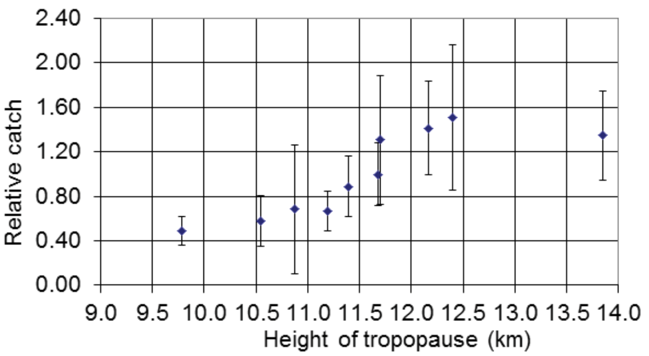

Figure 3 Light-trap catch of Diamond-back Moth (*Plutella xylostella Linnaeus*) in connection with the height of tropopause.

five species. The catch, however, is slightly different from species to species and peaks ranged from 10.5-13.6 km. This behaviour is not linked to the taxonomic position. However, our previous works gave somewhat different results in the current one. The higher values of tropopause cause higher catching results for the following species:

Lepidoptera: Noctuidae: *Xestia c-nigrum* L., First rising then falling: Lepidoptera: Crambidae: *Ostrinia nubilalis* Hbn [7].

Coleoptera: Melolontidae: *Melolontha melolontha* L., Lepidoptera: Noctuidae: *Agrotis exclamationis* L., Trichoptera: Limnephilidae: *Goera pilosa* Fabr [19].

Conversely, the higher values of tropopause were lower for the following species: Lepidoptera: Crambidae: *Loxostege sticticalis* L., *Nomophila noctuella*, Den. et Schiff. [19], Trichoptera: Limnephilidae: *Limnophilusa affinis* Curtis [8].

The relationship between the height of the tropopause and the weather of lower air is not fully known. Our past works results are partially contradicted by our present results. The cause of this controversy must be further explored.

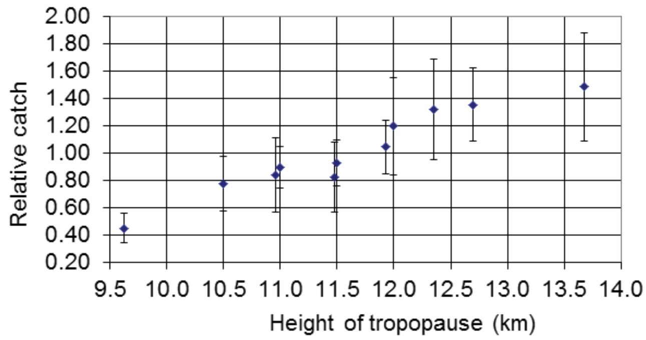

Figure 4 Light-trap catch of Pale Oak Beauty (*Hypomecis punctinalis* Scopoli) in connection with the height of tropopause.

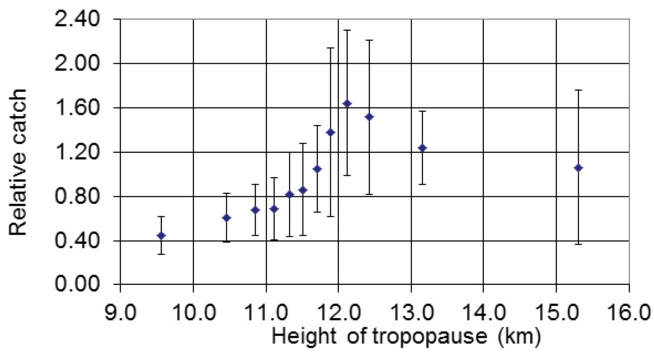

Figure 5 Light-trap catch of Lygus sp. in connection with the height of tropopause.

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