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The number of Macrolepidoptera species and individuals in Kámon Botanic Garden (West Hungary) in connection with the daily minimum temperature (Lepidoptera)

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Abstract: The Hungarian Forest Research Institute operated a Jermy-type light-trap in Kámon Botanic Garden (Szombathely (47° 15'20"N 16°36'25"E) between 1962 and 1970. As the insects are poikiloterm creatures, therefore it is understandable; their body temperature is always the same as the temperature of the environment. It can be assumed, therefore, the minimum temperature values, measured in the dawn, can influence the flight activity of nocturnal Macrolepidoptera individuals and species, so we made this investigation. Different species have swarming in various aspects and the temperature is also different. Therefore, we processed separately the captured data of species and individuals in spring-, early- and late summer-, and autumn aspects, in connection with daily minimum temperature. The results were plotted and the correlations and their level of significance were determined. Our results demonstrate that all aspects on low temperature minima both the number of caught species and individuals are low. In contrast, a higher minimum value of specimens was taken and the rising number of those species is caught. The relationship is linear or exponential function characterized.

Key words: Lepidoptera, Macrolepidoptera, light-trap, species, individuals, minimum temperature, Hungary.

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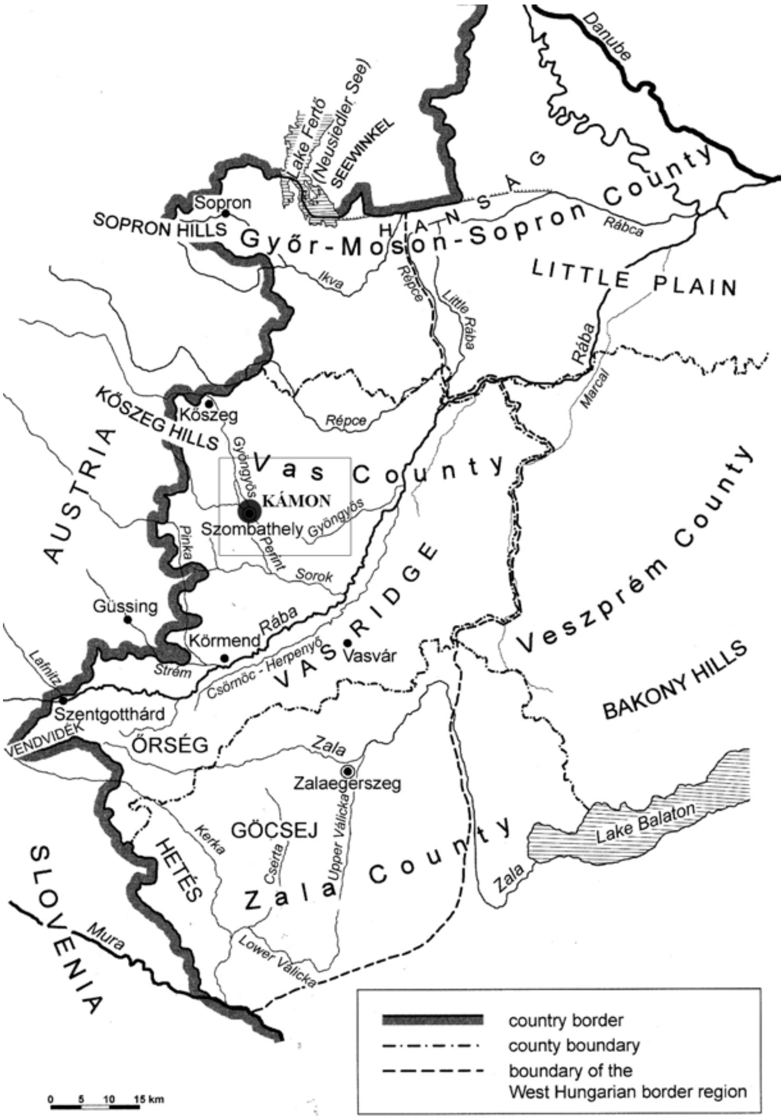
Összefoglalás: A Kámoni Arborétumban (Szombathely (47°15'20"N 16°36'25"E), 1962 és 1970 között az Erdészeti Tudományos Intézet Jermy-típusú fénycsapdát üzemeltetett. Mivel a rovarok poikiloterm lények, testhőmérsékletük mindig azonos a környezet hőmérsékletével. Feltételezhető tehát, hogy a hajnalban mérhető hőmérsékleti minimum értékek befolyást gyakorolhatnak az éjszaka aktív és fényre repülő Macrolepidoptera egyedek és fajok számára. A Kámoni Arborétumban gyűjtött felbecsülhetetlen tudományos értékű anyagból megvizsgáltuk tehát, igazolható-e ez a feltételezés. A különböző aszpektusokban különböző fajok rajzanak tömegesen és eltérő a hőmérséklet is. Ezért különválasztva dolgoztuk fel a tavaszi-, a kora nyári- és nyár végi-, valamint az őszi aszpektusban naponként befogott egyedek és fajok adatait, a napi minimum hőmérsékletekkel összefüggésben. Eredményeinket ábrázoltuk és meghatároztuk az összefüggések szignifikancia szintjét. Eredményeink azt bizonyítják, hogy minden aszpektusban alacsony hőmérsékleti minimumok mellett alacsony mind a befogott egyedek, mind a fajok száma. Magasabb minimum értékeken ezzel szemben emelkedik a befogott egyedek és fajok száma is. Az összefüggés lineáris vagy exponenciális függvénnyel jellemezhető.

Introduction and literature background

Temperature may have an important role from the point of view of flying activity. The given temperature requirements of insects can be explained by the fact that their body mass is very small compared to both its surface and the environment. That is why their body temperature, instead of being permanent and self-sufficient, follows the changing temperature of the environment. This is because the ratios of the body mass and surface of insects determine the difference between the inner heat content and the incoming or outgoing heat. The heat content of the body is proportionate to its mass, while, on the other hand, the heat energy in take or loss is proportionate to the size of the surface of the body. Therefore an external effect makes its influence felt as against the inner, small heat content of a relatively small mass. The speed and size of the effect depends on the mass and surface if the body of insects (Bacsó 1964). And so the temperature value always exerts a substantial influence on the life processes of insects. The chemical processes described as metabolism that determine the life functions of insects always follow the temperature changes in the direct surroundings. Naturally, the activity of the organs of



Location map of the study area (●), and map of the Hungarian border region (after Vig 2003, p. 3, Figure 1.1.)

locomotion also depends on the temperature of the environment which explains why we can expect a massive light-trap turnout by what is an optimal temperature for the given species (Manninger 1948). Southwood (1978), on the other hand, is of the view that the flight of insects has a bottom and top temperature threshold typical of each species. The insect flies if the temperature is above the bottom and below the top threshold and becomes inactive when the value is below the bottom or above the top threshold. In his view, other reasons explain the fluctuations in the number of specimens experienced in the interval between the low and high threshold values. However, research in Hungary has proved that in the context of a single species, too, a significant regression can be established between the temperature values and the number of specimens collected by light-trap (Járfás 1979, Nowinszky et al. 2003). Polish research has also confirmed that the number of noctuids light-trapped increases with the rise of temperature (Buszko and Nowacki 1990). Kádár and Erdélyi (1991) established positive correlation's between the temperature measured at 7 p.m. and 1 a.m. on the one hand and the number of ground beetles flying to light, on the other.

Young (2010) operated a single light trap in southern Georgia, USA, 29 times for two consecutive days over a 13-month period, captured almost 12000 moths in six body length categories. Minimum temperature during trap operation was the best single explanatory variable for the occurrence during trap operation variable for the smallest size class (<6 mm).

Holyoak et al. (1997) 14 of the 20 noctuid (Noctuidae) and geometrid (Geometridae) species were in positive correlation with temperature.

Material and Methods

The chosen light-trap, on purpose of examinations, operated in Kámon Botanic Garden at Szombathely (Hungary; 47°15'20"N 16°36'25"E) between 1962 and 1970. We used the whole Macrolepidoptera data for investigation the number of species and individuals in connection with daily minimum temperature. There were caught altogether the specimen of 549 different Macrolepidoptera species by light-trap during 9 years. The yearly catching period of light-trap, the number of caught species and swarming are shown in Table 1.

The caught individuals and species were investigated with combined data for 9 years. They were examined separately according to each aspect: spring, early- and late summer, autumn and winter (Nowinszky and Puskás 2011).

The collection data used in this investigation were supplied by material from the Szombathely forestry light-trap that belonging to the national network uniformly equipped with Jermy-type traps worked in the Kámon Botanical Gardens between 1962 and 1970. We used the complete Macrolepidoptera material of this observation site to examine the efficiency of the light-trap in a way partly outlined in earlier works (Nowinszky and Puskás 2011 and Nowinszky et al., 2012). We ignored the specimen numbers of the various species, examining only the question of whether the daily catch confirms the presence of the species. The different generations of multi-generation species were studied separately. However, all clearly recognizable vagile or migrant individuals turning up in between the swarming periods of two generations were regarded as separate generations. And in cases when it was not possible to draw a clear line of distinction between the two generations, we followed the procedure applied with one generation species. The catch data of the first trapped individual of the given generation was marked as 'appearance' and the day following the catch data of the last specimen of the same generation was labelled as 'disappearance'. The difference of the number of species appearing and the disappearing ones means the present species.

We added up by calendar days the frequency of the appearance and disappearance of every generation of all the species and after cumulating plotted them in a graph. We calculated the difference between cumulated appearance and disappearance, receiving in this way the number of species "present" in the environment surrounding the trap in the function of time. We established the number trapped species by nights and represented these together with the species "present".
Naturally the various species appear and disappear continuously; therefore it is not possible to draw a sharp line of distinction between the different aspects.

When examining the effect of the temperature problem was that the light-trap data supplied only one night. Therefore, we worked with the daily minimum temperatures. In our opinion, this value is related to flight threshold temperatures for each species.

Results and Discussion

Higher daily minimum temperature belongs to higher catching in all the aspects. Our results are shown in Figures 1–6.

Our results demonstrate that low temperature minima depress both the number of species and individuals in all aspects. In contrast, higher than the minimum value can rise in number of caught species and individuals. The relationship can be characterized with linear or exponential function.

The fact that the number of captured species is higher on those nights when the daily minimum temperature is relatively high can be explained based on the opinion of Southwood (1978). Flight threshold temperature is different for each species. It is possible that the flight threshold temperature of majority of the species is relatively high. Therefore, these species will be caught by light trap during those nights in which the daily minimum temperature is relatively high.
However, the results also show that individuals of each species fly into the light-trap in higher number on the warmer nights. This fact indicates that the flying activity of individuals of all species in warmer nights is higher. Our results apply to all aspects.

Figure 1 The average number of caught individuals of Macrolepidoptera is in the spring aspect connection with the daily minimum temperature. Kámon Botanic Garden, 1962-1970

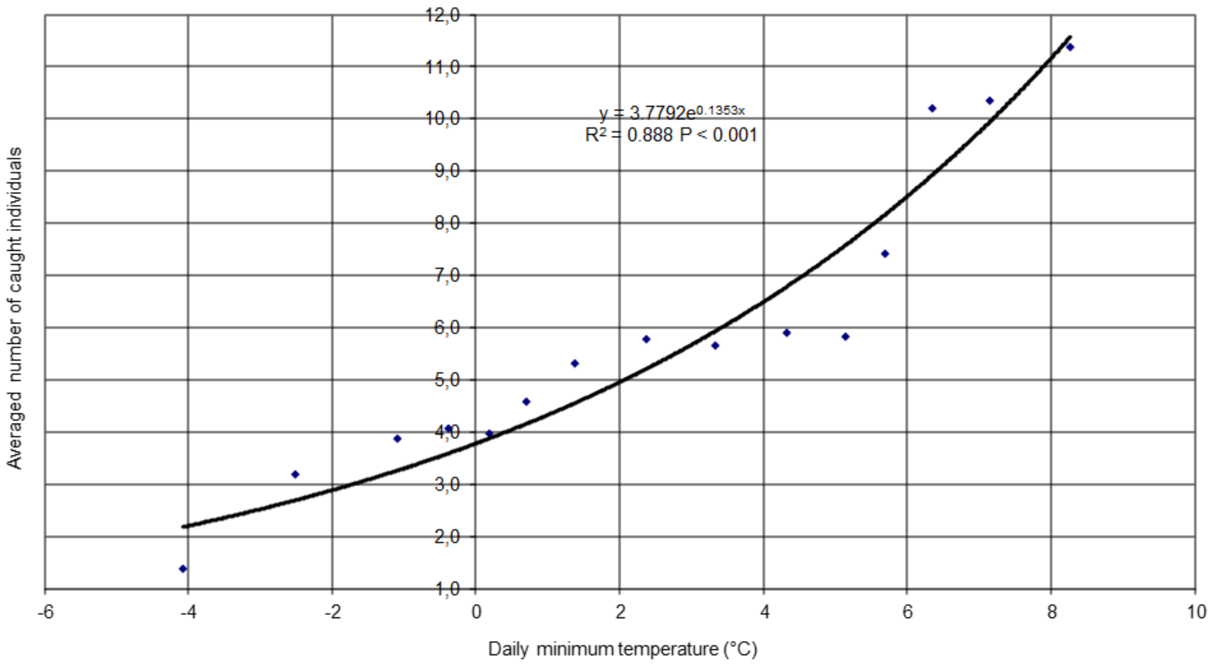


Figure 2 The average number of caught species of Macrolepidoptera is in the spring aspect in connection with the daily minimum temperature. Kámon Botanic Garden, 1962-1970

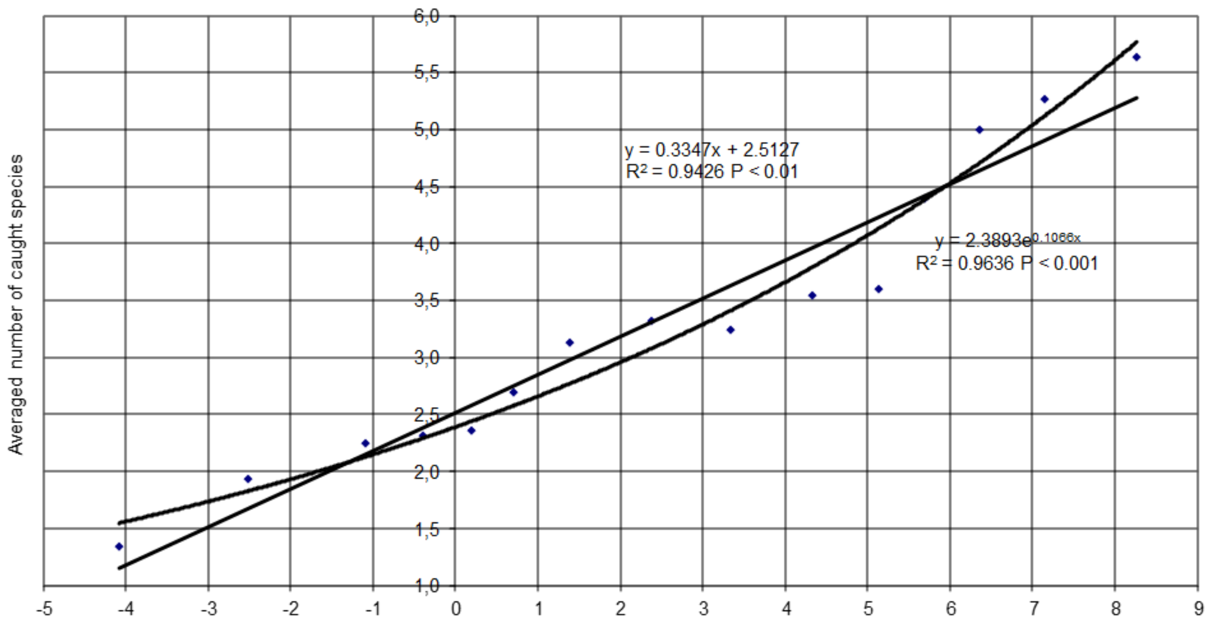


Figure 3 The average number of caught individuals of Macrolepidoptera is in the early- and late summer aspects in connection with the daily minimum temperature. Kámon Botanic Garden, 1962-1970

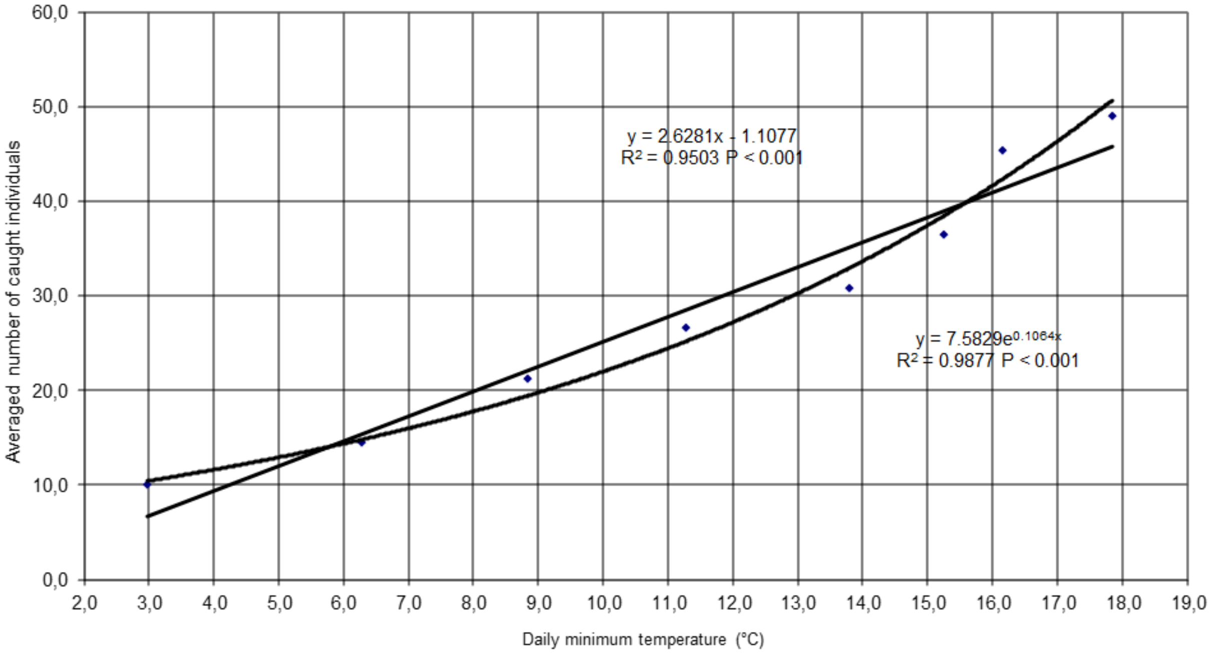


Figure 4 The average number of caught species of Macrolepidoptera is in the the early- and late summer aspects in connection with the daily minimum temperature. Kámon Botanic Garden, 1962-1970

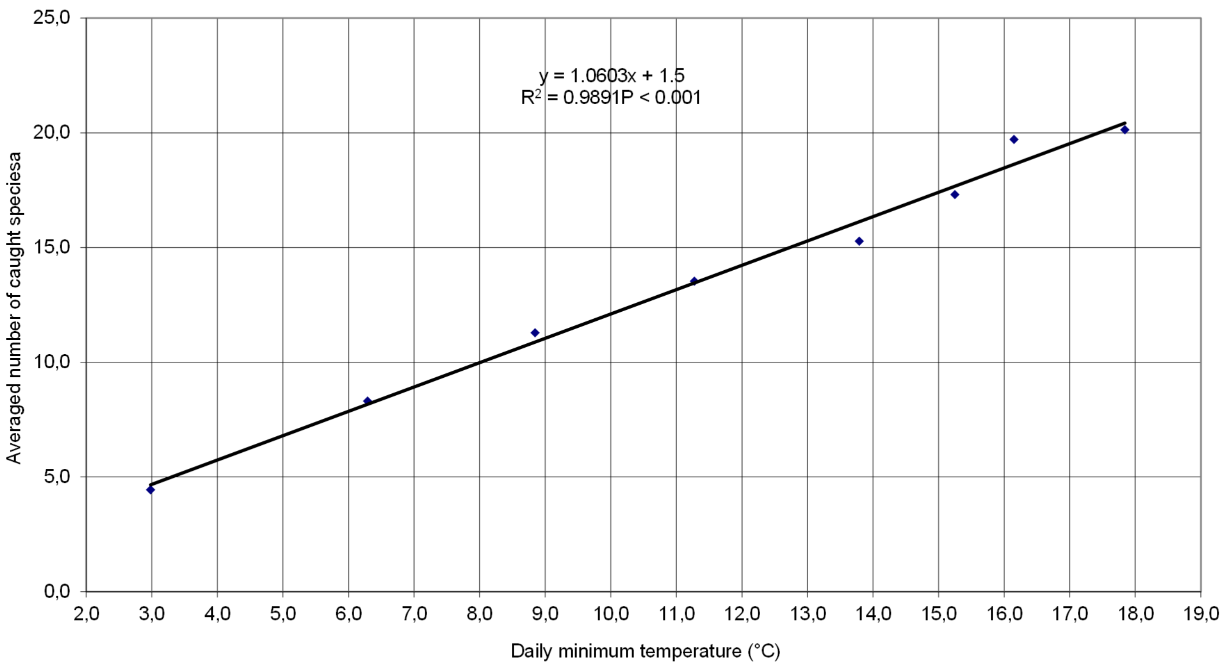
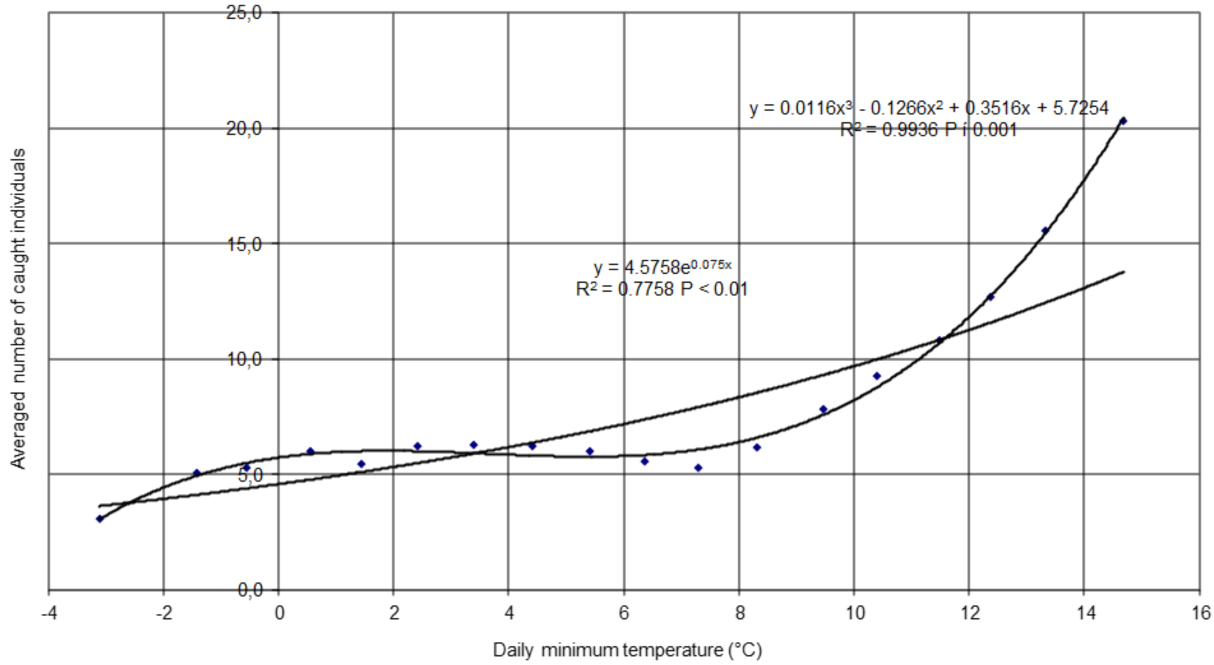


Figure 5 The average number of caught individuals of Macrolepidoptera is in the autumn aspect in connection with the daily minimum temperature. Kámon Botanic Garden, 1962-1970



Fugera 6 The average number of caught species of Macrolepidoptera is in the autumn aspect in connection with the daily minimum temperature. Kámon Botanic Garden, 1962-1970

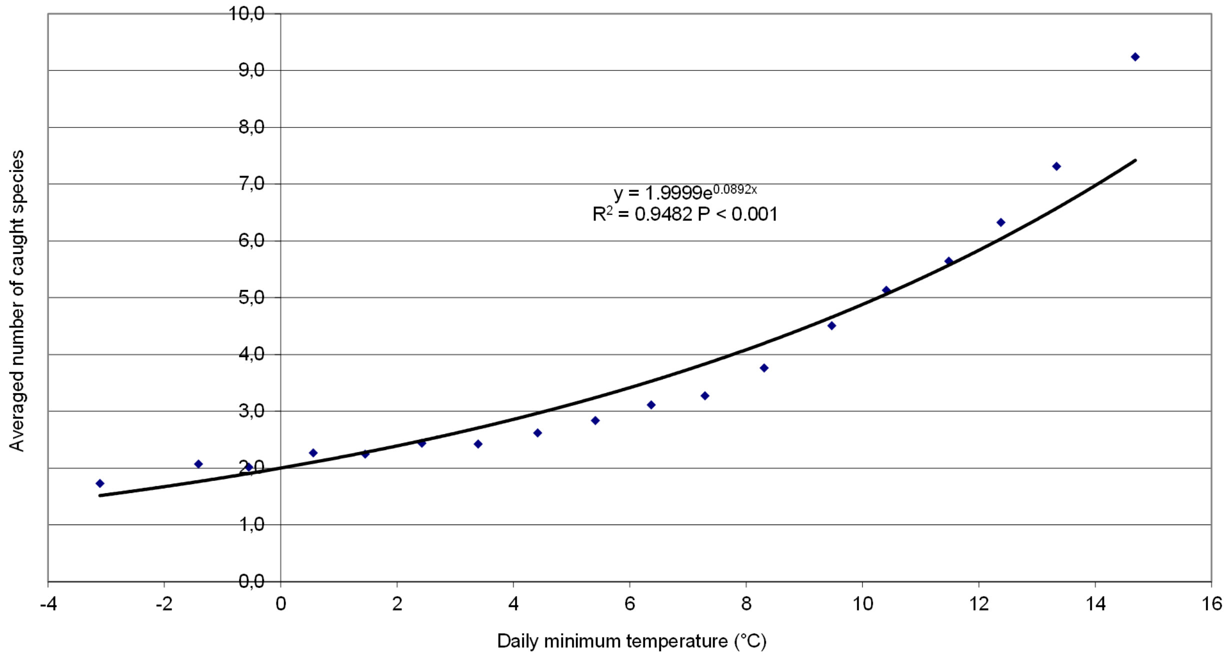


Table 1
Light-trap catching periods in Kámon Botanic Garden (Szombathely) as well as the number of caught species and swarming

Catching periods	Number of species	Number of swarming
06.03.1962 – 21.11.1962	343	435
0.8.03.1963 – 08.03.1963	349	472
23.03.1964 – 19.12.1964	354	463
14.03.1965 – 21.12.1965	205	242
02.02.1966 – 02.12.1966	153	191
03.02.1967 – 19.11.1967	261	312
20.02.1968 – 26.11.1968	296	418
13.03.1969 – 27.11.1969	316	427
03.02.1971 – 30.11.1970	323	437

Table 2
The beginning and end of aspects

Spring		Early- and late summer		Autumn	
Beginning	End	Beginning	End	Beginning	End
28.03.1962	30.04.1962	01.05.1962	31.08.1962	01.09.1962	11.10.1962
20.03.1963	30.04.1963	01.05.1963	31.08.1963	01.09.1963	06.10.1963
24.03.1964	30.04.1964	01.05.1964	31.08.1964	01.09.1964	03.11.1964
20.03.1965	30.04.1965	01.05.1965	31.08.1965	01.09.1965	30.09.1965
01.04.1966	30.04.1966	01.05.1966	31.08.1966	01.09.1966	16.09.1966
08.04.1967	30.04.1967	01.05.1967	31.08.1967	01.09.1967	12.10.1967
13.03.1968	30.04.1968	01.05.1968	31.08.1968	01.09.1968	20.10.1968
28.03.1969	30.04.1969	01.05.1969	31.08.1969	01.09.1969	17.10.1969
13.03.1970	13.04.1970	01.05.1970	31.08.1970	01.09.1970	05.11.1970

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