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RESEARCH PAPER

Light Trapping Efficiency in Case of *Ecnomus tenellus* (Rambur 1842), (Trichoptera: Ecnomidae) Depending on the Moon Phases

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ABSTRACT
The study Ecnomus tenellus (Rambur 1842, Trichoptera: Ecnomidae) catch efficiency gains discussed in the context moon phases. The catch data of four operated light-traps near Tisza River was used in the investigation, derived from years of 2003-2005. Relative catch values were calculated from data of four light-traps, they were assigned to the moon phases, they were averaged and the results were plotted with the regression equation. We found that the light trapping of this species is most successful in vicinity of first- and last quarter of Moon and it is least of all (the last) successful at the time of full moon. Results can be utilized by the environmental research.
***KEY WORDS:** Ecnomus tenellus, caddisfly, light trapping, Moon phases*

INTRODUCTION

It has long been known that insects are capable of night under the moon light of spatial orientation. As confirmed by ancient observations and records ever since Aristotele, nocturnal insects are attracted to artificial light. The researchers used the light trap at night editing the attraction of flying insects for artificial light sources.

The collection of results, however, many environmental factors change. Most researchers noticed a significant reduction in the number of insects found around the full moon. This may be due in part to explain that the lamp's light together with the moonlight collect from a smaller distance. Periodic changes in the moonlight cause significant modifications in the activity patterns in swarming of individual species. These modifications are very important to know because otherwise it is difficult to make the right choices and the development of crop protection methods and the natural environment.

The caddisflies (Trichoptera) in one of the most important group of aquatic insects, the seasonal activity is therefore essential to understanding the ecological investigations [1], [2]. The caddisflies species are mostly active at night and fly well in artificial light. Therefore according to [1], [3], [4], and [5] the light trapping is one of the most suitable method in knowledge of their swarming time and abundance). Use of light-trap is suitable in order to monitor the seasonal activity species tested by the distribution of flight time, the beginning and end, and the length of the peak of activity, which is shown by Kiss et al.,[2].

In the present study's purpose was to determine whether the moon phases amend the dominant species in selected habitats of the Tisza River, the *Ecnomus tenellus* (Rambur 1842) (Trichoptera: Polycentropodidae) seasonal activity pattern.

MATERIALS AND METHODS

The investigated caddisfly species

The daily catch data of *Ecnomus tenellus* were analyzed which is dominant in caddisflies species in the material of light-traps. This species can be found everywhere in our country highland taking care of the plane, one of most abundant one [1,2,5,6 and 7]. Its habitat is in various natural and artificial lakes, backwaters, salt ponds, ditches, low water flow is slower and lower sections of rivers (epi-and metapotamal) hydrophyte containing coastal zones serve. It often indicates a degraded, low oxygen content water [8], [9]. The larvae have predatory lifestyle and it is typical. Abundance of food chains in aquatic ecosystems plays an important role (eg. fish food). The flight activity patterns of *Ecnomus tenellus* adults considered acyclic, which start from beginning of May and finish at the end of September, without diapause or parapause [2]. Its mass flight comes about usually from early June to the end of August [5].

Sampling sites and the light trapping method

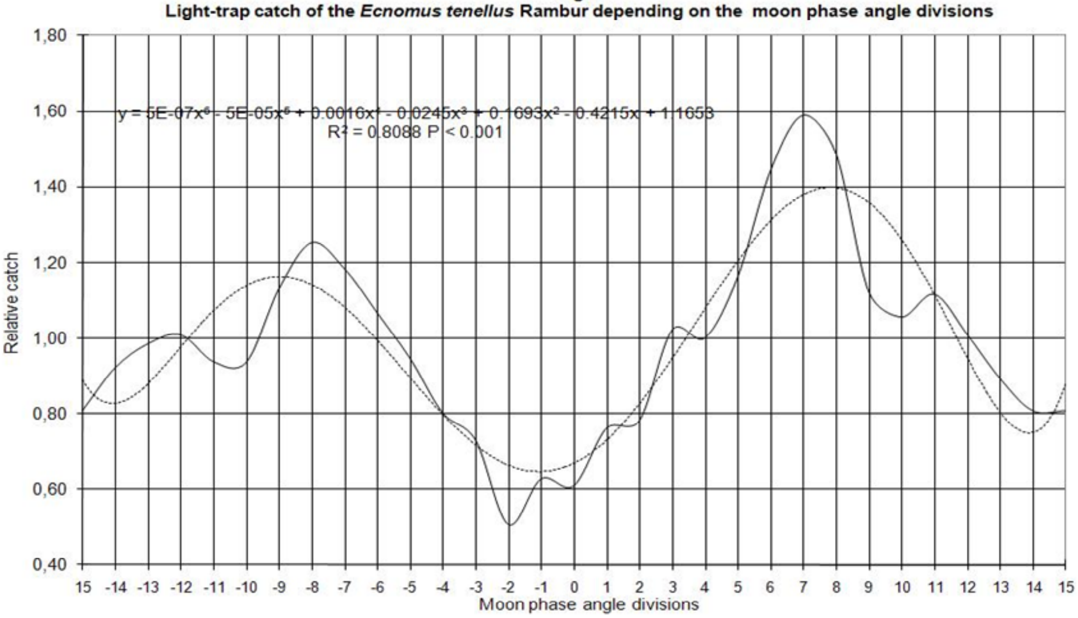
The Jermy-type light-traps were in operation between 2003 and 2005 near the Tisza River, at the following four places: Tiszakóród (48.10 N, 22.71 E), Tiszaroff (47.39 N, 20.44 E), Tiszaszőlős (47.55 N, 20.71 E) and Csongrád (46.71 N, 20.14 E). The traps were in operation every night during the season from April until October.

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 holding the funnel and a made of zinc-plated tin joins the steel frame. The cover is 100 cm in diameter. The distance between the lower edge of the cover and the higher edge of the funnel is 20-30 cm. The light source is a 100W normal electric bulb with a colour temperature of 2900°K. The lamp is in the middle of the trussing, 200 cm above the ground. The upper diameter of the funnel is 32 cm, the lower one is 5 cm, and its height is 25 cm. The female thread of the killing device joins the male thread of the 5 cm appendage at the lower part of the funnel. The killing jar of the device modified by [10] is a globe of 1.5 -2 litres in volume. At the lower edge of the appendage tube a frame made of steel wire holds the evaporating vessel fitted with a protective cap made of haircloth to prevent insects from falling into the vessel. The insects caught must not get in contact with the chloroform used for killing because of its strong fat-dissolving action. Before it is put into operation, some wadding is placed in the bottom of the vessel to reduce the danger of the collected material becoming damaged. The evaporating vessel should be filled with a generous amount of chloroform to get the maximum killing power, if not; the material might easily become unidentifiable [11]. In the morning it is practical to embark on a few hours of post killing. The lamp is turned on before dawn and is switched off after sunrise. The material collected over the night gets into the same vessel, so one night's catch makes one sample.

Data of moon-phase and polarization of moonlight

The Full Moon time data we needed to create our lunar phase classes were downloaded from the Astronomical Applications Department of US Naval Observatory [12].We have arranged data by [13] on the relative polarization of moonlight into classes of phase angle divisions (Fig. 1).

Fig. 1
Light-trap catch of the *Ecnomus tenellus* Rambur depending on the moon phase angle divisions



For every midnight of the flight periods (UT = 0 h), and – in the case of fractionating light- traps – for the 30th minute of every hour – we have calculated phase angle data of the Moon. Of the 360 phase angle degrees of the full lunation we established 30 phase angle divisions. The phase angle division including a Full Moon (0º or 360º) and values 0 ± 6º was named 0. Beginning from this group through the First Quarter until a New Moon, divisions were marked as -1, -2, -3, -4, -5, -6, -7, -8, -9, -10, -11, -12, -13 and -14. The next division is ±15, including the New Moon. From the Full Moon through the Last Quarter in the direction of the New Moon divisions, were marked as 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 and 14. Each division consists of 12 degrees [14]. These phase angle divisions can be related to the four quarters of lunation as follows: Full Moon (-2 – +2), Last Quarter (3 – 9), New Moon (10 – -10) and First Quarter (-9 – -3). The nights and hours of the periods under examination were all classed into these phase angle divisions.

Data processing and statistical analysis

During three years 16 206 individuals were collected in the traps by the four light trap stations. The number of observation data was 834. Observation data is the catch data during the whole night. Only those nights were taken into consideration when trapping was successful. According to our former investigations the moonlight can decrease the insects' flight to light, but never makes it impossible. The unsuccessful trapping always has another reason [14]. Only nights and hours with some catch were included in the calculations, as our earlier works [14], had convinced us that although the Moon has an influence on the efficiency of trapping, it never makes collecting impossible.

Therefore relative catch values were calculated from the annual number of individuals for the four light-trap stations. Relative catch (RC) is the ratio of the number of specimen caught in a given sample unit of time (1 night) and the average number of specimen caught in the same time unit calculated for the whole brood. If the number of the specimen trapped equals the average, the value of relative catch is: 1.The relative catch values by three-point running averages were calculated.

The use of moving averages is justified whenever the independent variable is made up of data representing a wide range of values that are to be contracted into classes. For the dividing line between these classes is always drawn more or less arbitrarily. Besides, extreme values in two neighbouring classes of the independent variable are always closer to each other than they are to average value of their own class. Working with moving averages ensures a degree of continuity between the data of our arbitrarily established classes and, at least in part, eliminates the disturbing influence of other environmental factors not examined in the given context [15].

We have sorted relative catch values into the proper phase angle divisions and then averaged them. The changes of daily catch the non-linear regression analysis were characterized. The results are plotted, as indicated in the figure; we made a regression curve, its parameters and the significance level.

The deviations of catch results of three-group lunar month (Full Moon, the First and Last Quarter and the other phase angle divisions) were controlled by t-tests. The relative catch values were graphed depending on the percent of polarized moonlight together with regression equation.

RESULTS AND DISCUSSION

The 3-point of moving averages of the *Ecnomus tenellus* depending on the phase angles can be seen in Fig. 2.

The deviations of catch results in three-group of lunar month can be seen below:

Lunar groups	*P*
Full Moon — First and Last Quarter	0.05
Full Moon — other phase angle divisions	0.05
First and Last Quarter — Other phase angle divisions	0.05

The catching results of the *Ecnomus tenellus* depending on the polarized moonlight were chart in Fig. 3.

Our results demonstrate that, like several other insect species, the light-trap catch of *Ecnomus tenellus* is influenced by the moon phases. At Full Moon, very few specimens were collected in light-trap, while the First and Last Quarter in particular, around a multiple.

The minimum result in catch during the Full Moon cannot be because of the relatively strong illumination. Most insects have a daily flight beginning at the time of twilight [15]. In the twilight time of exposure can be measured by several orders of magnitude larger than the moonlight.

Fig. 2
The polarized moonlight (%) depending on the moon phase angle divisions

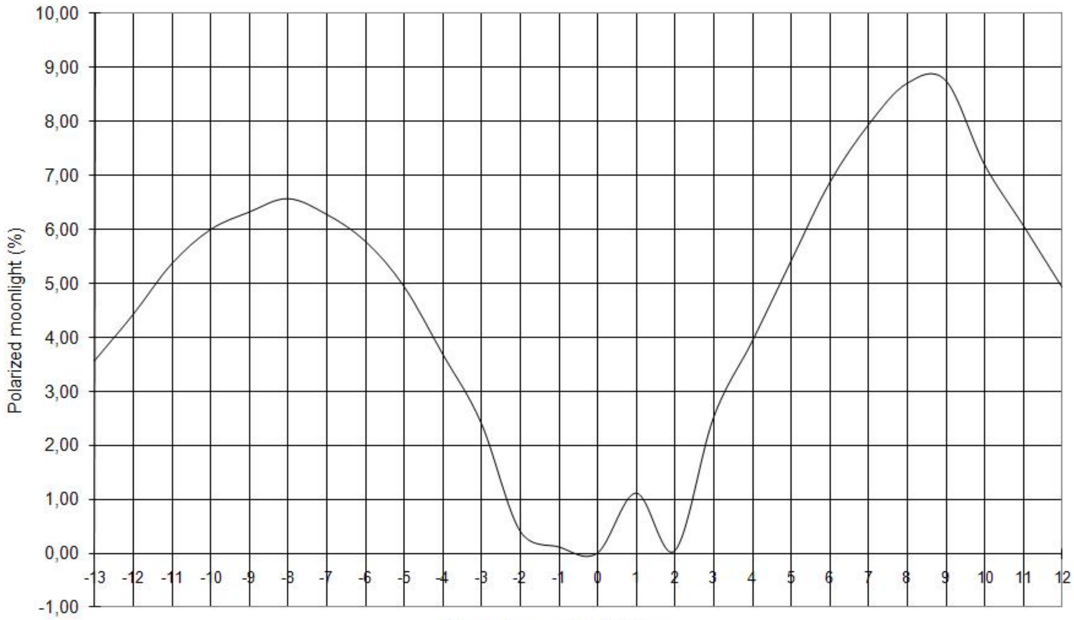
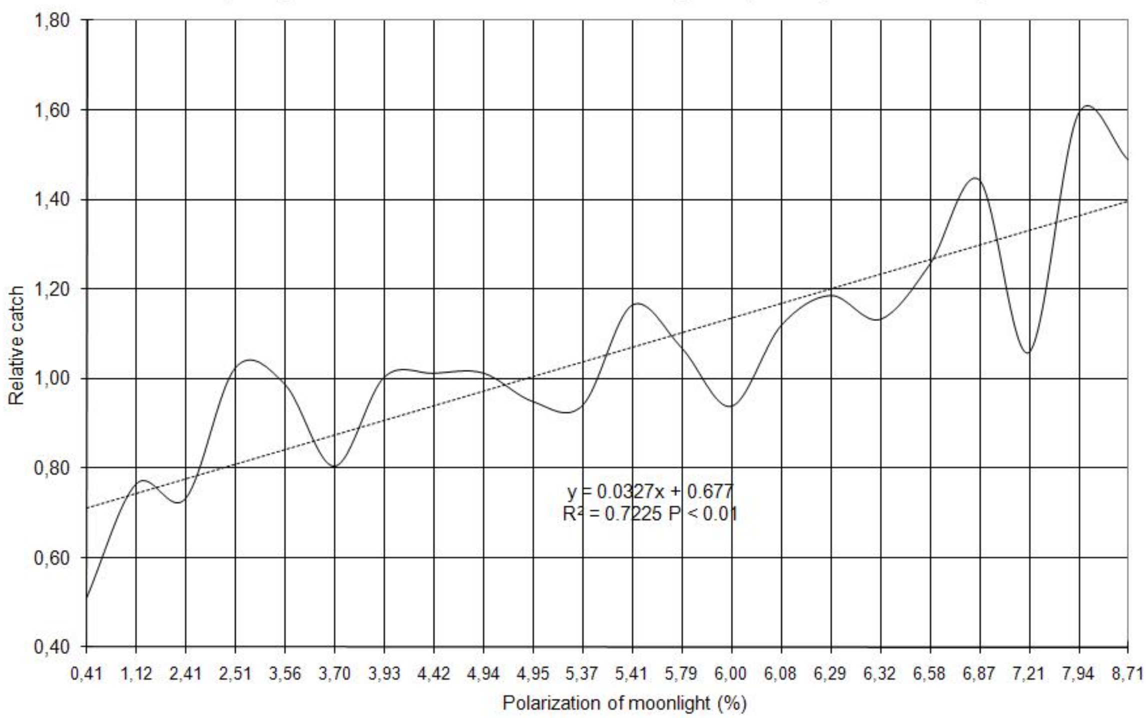


Fig. 3
Light-trap catch of the *Ecnomus tenellus* Rambur depending on the polarized moonlight



The highest proportion of polarized moonlight is the highest at First and Last Quarter. The moonlight is not polarized at the time of Full Moon, directly before and after the Full Moon the moonlight-polarized ratio is very low (Figure 2). Dacke *et al*. [16] have shown that some insects use the spatial orientation of the polarized moonlight. Hegedűs *et al*. [17] is based on recent work to assume that the polarized moonlight high proportion of more information about the orientation of insects, such as low ratio of polarized moonlight near the Full Moon. This could be due to the First and the Last Quarter experienced high and low level of catch is the Full Moon.

The illumination from moonlight at Full Moon does not reduce the activity of flying insects, general validity, such as Williams [18] assumed. Rather it is about that Full Moon, when the low-polarized moonlight, the flight activity is indeed reduced, but not the New Moon, but only the First and the Last Quarter compared.

These results complement our knowledge of the *Ecnomus tenellus* on swarming patterns. The knowledge of patterns, not only will the swarming dynamic characterization of the caddisflies (Trichoptera) is important, but also in the environmental bio indication [2].

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