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Application of time-lapse camera situated near a light source, for registration insects' rhythm of attraction to light (Lepidoptera: Noctuidae)

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Abstract

Camera traps are an efficient means of biodiversity assessments, however, the employment of camera traps for the study of insects is still in its beginning. Accurate counting and recognition of flying insects are also of great importance in pest control. In this paper, we present a new method combining a time-lapse camera, and a light source, designed to estimate macro-Lepidoptera species composition, occurrence and also daily rhythms of their attraction to light. The advantage of the system is that it enables to monitor the species assemblages distantly. The rhythms to light attraction discussed for six Noctuidae species.
KEY WORDS: Lepidoptera, Noctuidae, camera trap, Israel.

Aplicación de las cámaras trampa de tiempo situadas cerca de un recurso luminoso, para el registro del ritmo de atracción a la luz de los insectos (Lepidoptera: Noctuidae)

Resumen

Las cámaras trampa son un medio eficiente para la valoración de la biodiversidad, sin embargo, el empleo de las cámaras trampa, para el estudio de los insectos, todavía está en su comienzo. Contar los insectos voladores y su reconocimiento exacto, son también de gran importancia para el control de plagas. En este trabajo, presentamos un nuevo método que combina el tiempo obtenido con la cámara y una luz, diseñado para calcular la composición de especies macro-Lepidoptera, la presencia y también los ritmos diarios de su atracción a la luz. La ventaja del sistema es que permite el monitoreo del agrupamiento de especies a distancia. Se discuten los ritmos de la atracción a la luz para seis especies de Noctuidae.
PALABRAS CLAVE: Lepidoptera, Noctuidae, camera trampa, Israel.

Introduction

There is evidence that insect populations worlds-wide are suffering declines (SANCHEZ-BAYO & WYCKHUYSBCD, 2019). The reasons are still poorly understood but climate change and human activity had been implicated as drivers. Due to this, there is increasing need for monitoring the dynamics of insect populations and its interactions with environmental factors. Manual data collection is limited because it requires costly expert manual labor and it is limited in space and time.

Modern photographic equipment allows researchers access into wildlife habitats using cameras. Camera traps are an efficient means of conducting species inventories, biodiversity assessments, estimating site occupancy, and observing behavior (O'BRIEN, 2011). Recent attempts to use remote photography for the detecting the presence of rare species or ones that are presumed extinct are particularly valuable (KUCERA *et al.,* 2011).

Scientific use of camera traps had increased notably over the past several years (NICHOLS *et al.*, 2011) including studies on carnivores, birds, reptiles, and amphibians (MEEK *et al.,* 2014). However, employment of camera traps for the study of insects is still in its naissance and attempts were made with various setups. One example comes from a study aimed to monitor the biodiversity of various insect groups in the Netherlands and used a camera directed to a vertical white screen (HOGEWEG *et al*., 2019a; HOGEWEG *et al*., 2019b). COLLETT & FISHER (2017) offered to replace pitfall trapping for monitoring small leaf litter arthropods with a short focal distance vertically placed time-lapse camera. In addition, time interval photography of yellow sticky screens (known as "yellow traps") had also been suggested for insect monitoring and biodiversity estimation (ZHONG *et al*., 2018). MARTIN *at al.* (2008) offered to photograph the surface of yellow traps to assisting the early detection of pests the greenhouses. A few commercial applications for monitoring pests in agriculture have also been developed. The commercial "Trapview" system is based on photographing insect trapped on sticky pheromone traps, which allows monitoring of specific pests in the field in real.

Accurate counting and recognition of flying insects are also of great importance in pest control. Recently, attempts were made to use cameras to track insect pest populations in agriculture (ZHONG *et al*., 2018; MANOUKIS *et al*., 2019). Many insects, including important pests, are night active and show light attraction behavior. Therefore, light traps have been used extensively to obtain information about their occurrence, seasonal dynamics and species assemblages (SZENTKIRÁLYI, 2002; EPSKY *et al*., 2008; JONASON *at al*., 2014). In this paper, we present a new method combining a time-lapse camera, and a light trap, designed to estimate macro-Lepidoptera species composition, occurrence, and daily rhythms in light attraction.

Methods

Electric devices and light trap design

In order to attract insects we used weak light sources, which are considered to have remarkably local moth attraction ranges, resulting in samples that are highly representative of the local habitat (MERCKX & SLADE, 2014). The light source consisted of a 12v 8w fluorescent light tube (30 cm of length) attached vertically to horizontal white plastic screen of 100 x 100sm. (Fig. 1). A Canon EOS 700D camera was situated 50sm above the white screen surface. This camera is equipped with a high-resolution sensor, and a zoom lens, which allows choosing the optimal view area on the screen. During the daytime, the camera was automatically turned off by a light sensor.

Study sites

We recorded light trapped moth abundance in two different localities representing Mediterranean (Tel-Aviv University Botanical and Zoological gardens, Tel Aviv, Israel) and extreme desert (Qetura, the southern Arava desert, Israel) habitats. Recordings were performed during night time on April 5-6, 2019 and November 5-6, 2019, respectively. On both recordings, we selected dates corresponding to new moon, given that under these conditions the moth attraction to the light is largest (NEMFC, 1971). During the recordings at the Mediterranean locality, the times of sunset and sunrise were at 18:20 (April 5, 2019) and 5:00 (April 6, 2019), respectively. Air temperatures at sunset and sunrise measured at 27ºC and 22ºC, respectively. On the desert locality recordings, sunset and sunrise times were 16:30 (November 5, 2019) and 6:00 (November 6, 2019), respectively, with air temperatures measuring at 32ºC and 26ºC at sunset and sunrise, respectively.

Monitoring macro-Lepidoptera light attraction

In order to obtain temporal data on the moths' attraction to light, we set the light source to turn on and off every 30 minutes. This resulted in insects accumulating on the horizontal screen during the "on" phase and being released during the subsequent "off" phase, enabling to monitor the change in insect light attraction throughout the night.

The camera photographed one frame every 7.5 minutes, during both the on and off phases of the light. To synchronize the operation of the camera and the lamp, a control unit had been developed consisted of a Lm555 timer (Fig. 1), a CD4020B*2 frequency divider, a key to turn on the camera shutter and a lamp control relay.

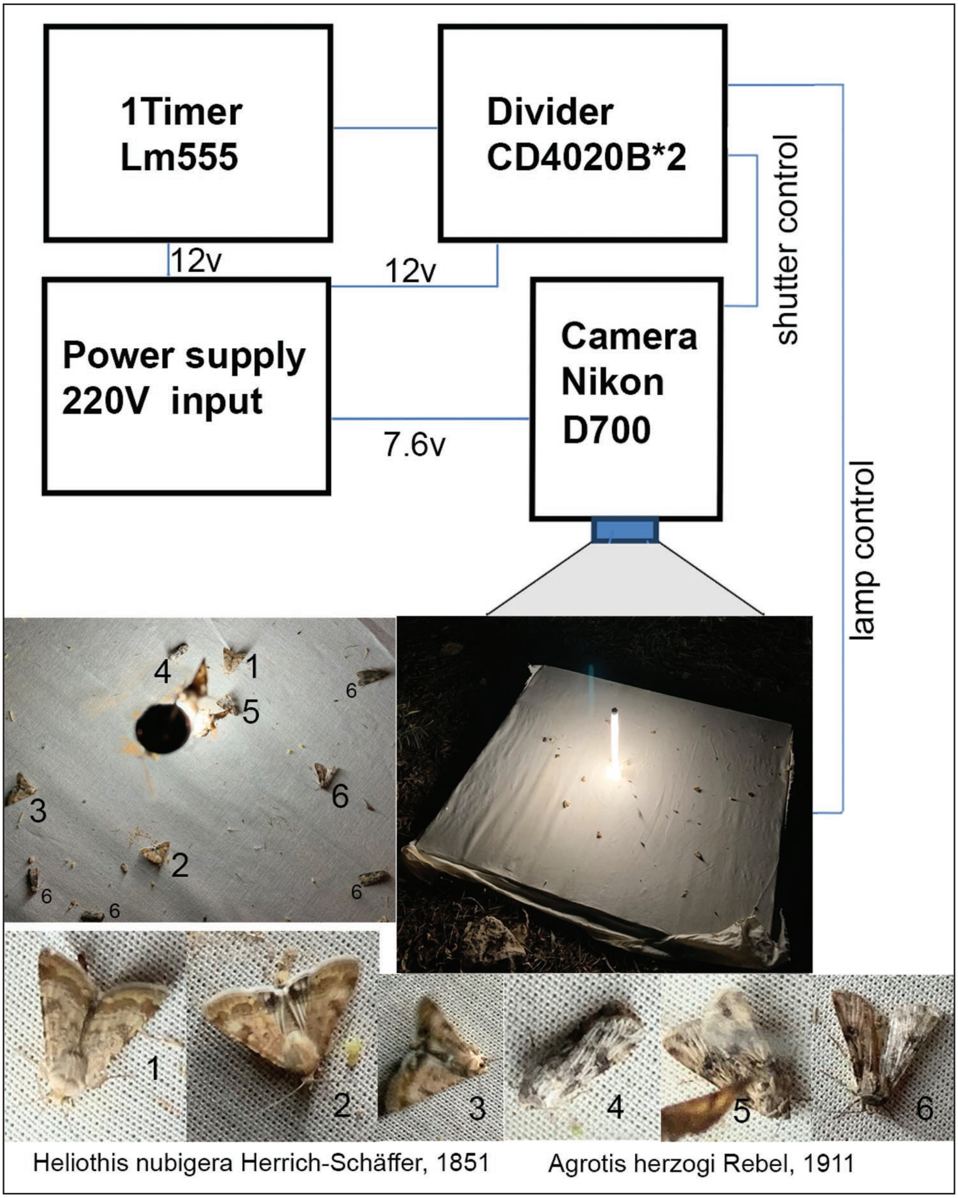

Fig. 1.– Electric devices and light trap design.

Results

To validate our system, we focused on the family Noctuidae (Lepidoptera) as the Israeli fauna of this family was taxonomically described in detail (KRAVCHENKO *et al*., 2007a; KRAVCHENKO *et al*., 2007b) and its members are easy to identify and relatively abundant (see Fig. 1 for examples of Noctuid moth samples caught on camera during the monitoring session). For example, on pictures taken in the Arava desert (kibbutz Qetura) at nights of 7 November 2019 (Fig. 1) two noctuid species represented on the pictures: *Heliothis nubigera* Herrich-Schäffer, 1851 (numbers 1, 2, 3) and *Agrotis herzogi* Rebel, 1911 (numbers 4, 5, 6).

Using our monitoring system, we were able to sample and identify individuals from several common species and observe temporal changes in the numbers of trapped individuals during the night (Figs 2, 3). Graphs show the number of specimens identified in frames taken over one hour interval.

In the Quetura locality, we recorded 32 samples of *Heliothis nubigera* Herrich-Schäffer, 1851, which is species common all over Israel. In the desert, this species occurs only on oases and settlements. The distribution of *H. nubigera* specimens over the night showed a bimodal pattern, with the first peak taking place ~3 hours after sunset (around 20:00) and the second one around midnight (Fig. 2).

Specimens of *Heliothis peltigera* ([Denis & Schiffermüller], 1775) showed one peak, occurring at the same time as the first peak in *H. nubigera* abbudance (Fig. 2). The species is common, locally even abundant all over Israel. In the desert, it occurs only on oases and settlements and it is bivoltine. We also recorded 59 specimens of *Agrotis herzogi* Rebel, 1911, which is univoltine and autumnal and it is common all over the Israeli arid region. All specimens were recorded after midnight, and the number of recorded specimens peaked between 1;00-2:00 (Fig. 2).

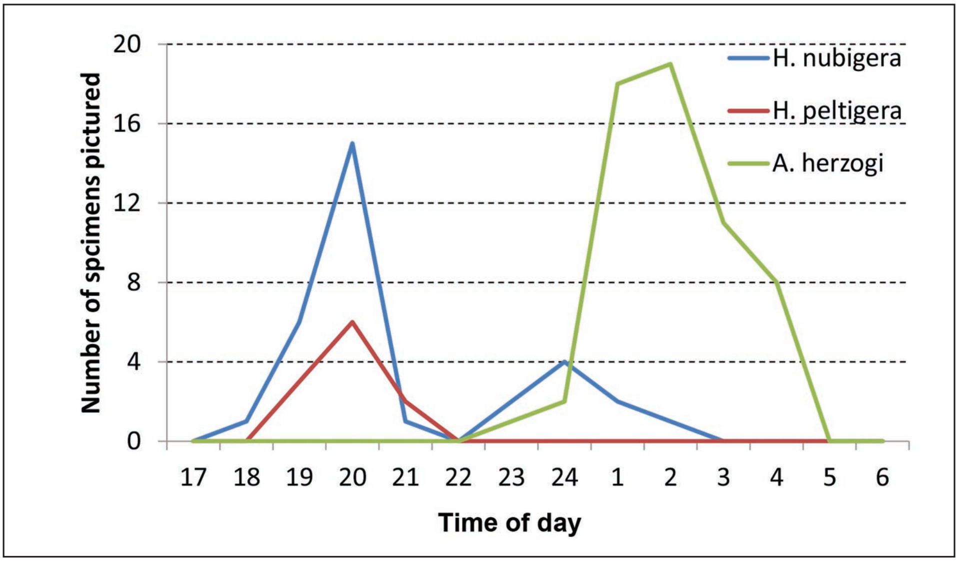

Fig. 2.– The rhythm of the moth's attraction on light source in Qetura locality.

At the Botanical Garden in Tel-Aviv University, we found that; most of the sampled specimens (71%) belonged to 3 species. We recorded 20 specimens of *Autographa gamma* (Linnaeus, 1758). This species is common all over Israel, concentrates in oases in the arid regions and is multivoltine. The occurrence of this species, as recorded in our light trap, peaked between 21:00-22:00 (Fig. 3).

Eighteen specimens of *Spodoptera exigua* (Hübner, [1808]) were recorded. This is a multivoltine species, which is abundant all over Israel. The peak of trapped specimens occurred soon after sunset between 20:00 and 22:00 (Fig. 3). Lastly, we recorded 36 specimens of the *Agrotis ipsilon* (Hufnagel, 1766). This species is multivoltine and abundant throughout Israel as well, except for the desert area where it concentrates mainly in oases. Most of these species specimens were recorded between 22:00 and 2:00 (Fig. 3).

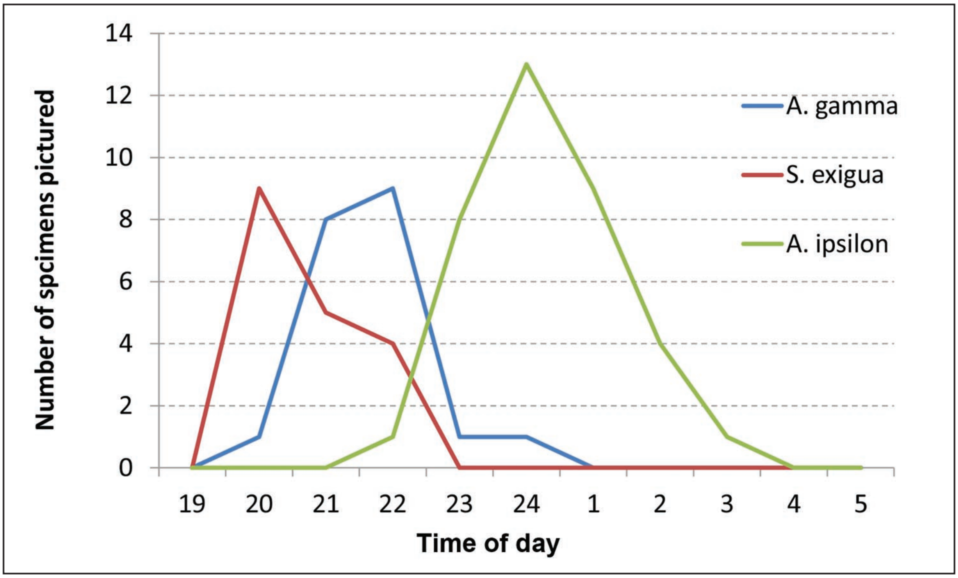

Fig. 3.– The rhythm of the moth's attraction on light source in Botanical garden in Tel Aviv.

Discussion

Here we show that using a camera established near a light source, it is possible to monitor not only species assemblages of the macro-moths but also the rhythm of their attraction to light. The advantage of the system is that it enables to monitor the species assemblages distantly.

The peak attraction time of insects to light is not directly correlated to their peak mobility time (KRAVCHENKO, 1981, 1984, 1986). Mobility is linked with some vitally important aims in insects like mating, egg-laying, feeding and so on, which are more motivating than light attraction. Therefore, light attraction is considered to be the final stage of any mobility period (CHERNYSHEV, 1984).

Among the species studied in our work, both representatives of genus *Agrotis* tended to attract to light around midnight, or alightly later. This timing is common for many cutworms of the subfamily Noctuinae and is inline with their high attraction to pheromone traps before midnight (KRAVCHENKO, 1987).

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