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**OWLET MOTHS (*Noctuidae*) AS BIOINDICATORS
OF ECOLOGICAL PROCESSES OCCURRING
IN AGROCOENOSSES FARMLAND**

**SÓWKOWATE (*Noctuidae*) JAKO BIOINDYKATORY
PROCESÓW EKOLOGICZNYCH ZACHODZĄCYCH
W AGROCENOZACH PÓL UPRAWNYCH**

Abstract: The aim of the study was to compare the *Noctuidae* moth in the environment of farmland in four places, using ecological indices. The study was conducted from 2003 to 2005 on the fields sown with the winter wheat, sugar beets, the maize and the winter rape. The subject of the study was the imago of butterflies caught by light traps. Light traps (Polish brand) located at the Institute of Plant Protection (IPP), Agricultural Experimental Farm – Winna Góra, Sugar Beet Breeding Research Station in Wieclawice, Experimental Station in Słupia Wielka and IPP – Poznań-research garden. The collected *Noctuidae* imagines were identified and characterized qualitatively and quantitatively. Moreover, the composition of caught of butterflies and its richness was assessed using “abundance relative method”, which estimated the number of dominance of species. The *Noctuidae* imagines were analyzed using Shannon-Weaver’s diversity index (H'), Simpson’s dominance index (SJ) and Sorenson’s indices of similarity (J %). The results showed higher similarity between species composition in agrocenoses of Poznań and Wieclawice. The smallest diversity of species, reflected in the lowest value of diversity index and the high value of dominance index, was observed in a biotic community of the Winna Góra which reveals the species compensation of few *Noctuidae* kinds. In this case there were: *Agrotis segetum* (Schiff. et Den.), *A. exclamationis* (L.), *Xestia c-nigrum* (L.), whether *Discestra trifolii* (L.).

Keywords: cutworms, bioindicators, ecological index, light-trap

As many as 150.000 species belong to the *Lepidoptera* order, of which about 25.000 are Owlet moths (*Noctuidae*). The Owlet moths inhabit mainly areas in the moderate climate. Approximately 60 % of their species live on the northern hemisphere, approximately 25 % on the southern hemisphere, while the remaining 15 % in the tropics. In Poland, the Owlet moths family belongs to one of the larger taxonomical groups of insects and is represented by approximately 500 species of butterflies [1, 2].

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Majority of Owlet moth species known in Poland is characterized by a vast distribution. Due to their environmental valency they accommodate easily to any changes occurring in the environment as a result of human activity. Most Owlet moths are eurybionts that inhabit various forest and meadow biotopes as well as open areas. In agroecosystems they can constitute about 50 % of all species of butterflies; majority of them are economically important pests of cultivations. Within the Owlet moths approx. 70 % of species, of which nearly all *Noctuinae Noctuidae*, *Hadeninae Noctuidae* and many other Owlet moths, are polyphagous with a broad trophic spectrum that covers from a few dozens to several host plants [3, 4].

Large population fluctuations are an important feature of numerous species of *Noctuidae*, and these are particularly visible in agroecosystems. The quantity and quality changes repeated every year in specified seasons result from differences in their biotic cycles [1, 3]. Species with the same biotic cycles constitute phenological groups, the largest of which is composed of summer species that are active in the imago stage in July and August, while the smallest of which includes autumn and winter species flying in the autumn, and even in warmer periods of winter, and in spring following the diapause.

The paper presents barely a small part of vast data obtained in the course of works performed on the areas monitored.

Material and methods

The *Noctuidae* were caught from May to the first half of October each year from 2003 to 2005 using light traps filled with insecticide. Inspections and picking of insects caught from the traps were carried out systematically 2–3 times a week. The areas for research were determined on the following premises: in Poznan in the phenological garden of the Institute of Plant Protection (Wielkopolska province), in Winna Gora in the Agricultural Experimental Station of the IPP (Wielkopolska province, about 70 km far away Poznan) and in Wieclawice (Kujawy-Pomerania province, about 50 km from Torun) area of the former Beet Breeding Station. One trap was installed on each of the tested premises. The insects caught were assigned to species, secured and summarized [5–8].

Based on the number of species and total population of the individuals caught, the following indexes were specified that characterize the *Noctuidae* community:

– structure of the species domination in the *Noctuidae* groups expressed by the so-called relative abundance calculated according to the following formula: $D = s/S * 100$ [%]; where s – number of individuals belonging to the given species caught within 2 years in one trap on the tested area, S – total number of individuals of all species of the cenotic unit tested;

– Shannon-Weaver index that determines the species diversity. The index value is calculated basing on the following formula: $H' = -\sum_{i=1}^S p_i \log_2 p_i$; where S – number of species in the group (total), p_i – (n_i/N) of i -th species in a group composed of S species, and n_i – population of the i -th species in a team with N total number of individuals;

– species richness index acc. to the Simpson's formula; $d = (S-1)/\log N$; where: S – number of species in the community, N – total number of individuals caught.

Results and discussion

Overview of faunistic and ecological characteristics of Noctuidae

Throughout the four years of the research over 14 thousand of individuals were caught to 3 light traps (8411 individuals in 2003; 3722 in 2004 and 2188 in 2005), and they represented species from genera belonging to subfamilies.

Most species belonged to two subfamilies: *Hadeninae* (29 species) and *Noctuinae* (20 species), and they constituted about 92 % of the total number of butterflies caught. An occurrence of a large number of populous species of butterflies typical for this kind of a landscape was detected in the material. Found were also species that are generally rare in Poland such as *Gortyna flavago* Schiff. and species that had not been recorded for the areas of Poznan and Wieclawice – *Agrochola purpurea* L. Generally, 2003 was a year with the largest number of butterflies caught in comparison with 2004 and 2005. Most individuals were collected in Wieclawice (6128 butterflies caught in 2003, 2093 individuals in 2004, and 1327 individuals in 2005); in Poznan (2003 – 1732 individuals, 2004 – 1361 individuals, 2005 – 510 individuals) and the smallest number of butterflies were caught in Winna Gora (2003 – 651 individuals, 2004 – 268 individuals, 2005 – 301 individuals). In the phenological groups for one-generation species a majority consisted of the spring and summer species that are active in the imago stage in June (eg species from such genera as *Orthosia* spp., *Cuculia umbratica* L., *Apameamonoglypha* Hufn., *Melanchnra pisi* L.) and summer species (*Cosmia trapezina* L., *Mythimna conigera* Schiff., *Noctua pronuba* L.), where the flight of their butterflies took place in July and August. From multi-generation species 11 species need to be mentioned the flight of which lasted uninterruptedly from May to September, and even to the first decade of October. Majority of these species are well-known pests of crop plants of large economic significance (e.g. *Agrotis segetum* Schiff., *A. exclamationis* L., *Xestia c-nigrum* L., *Mythimna pallens* L., *Mamestra brassicae* L., *Lacanobia oleracea* L.). Observed were also two migrating species: *Agrotis ipsilon* Hufn. and *Autographa gamma* L., which occur in Poland, but probably do not winter here.

In the tested *Noctuidae* community, species characteristic for open areas related trophically to synantropic and meadow plants were the most populous group. The second group was composed of species characteristic for forest and scrub plant community connected in terms of feeding with trees and bushes, while the third of the most populous groups included species characteristic for environments linked directly with agrocenoses of fields of: beets, rape, cereal plants.

The determination of the structure of domination was applied for faunistic identification of the *Noctuidae* community. Over 80 % of all butterflies from the *Noctuidae* community caught in the phenological garden in Poznan in the period from 2003 to 2005 were recognized as dominants. In Poznan *Xestia c-nigrum* was eudominant, and within the three years of the research it reached the domination level of over 24 %. Another class of dominants at the level of 16.5 % of all moths collected was established by one species *Agrotis segetum*. The class of subdominants was represented by 11 species, the class of recedents by two species at the domination level of approximately 2 %. The class of accompanying species was composed of 36 species. In Winna Gora, two species dominated distinctly: *Agrotis segetum* – 26.4 %, *A. exclamationis* – 15.3 %, and

with *Xestia c-nigrum* about 12 %, and *Discestra trifolii* L. 10.8 %. They were all accompanied by: *Hoplodrina ambigua* Schiff., *Mythimna pallens* and *Xestia triangulum* Hufn. The class of recedents and subrecedents was composed of approximately 30 species that constituted about 14 % of all the imagines collected. In Wieclawice, alike in Poznan, the domination of a few species of the Noctuidae community was at a similar level, and so the class of eudominants included *Xestia c-nigrum* – 21.7 %, and of dominants: *Mythimna pallens* – 13.4 %. The class of subdominants was composed of 10 species, all of which represented open areas. The classes of recedents and subrecedents were represented in great numbers.

For determining the characteristics of the Noctuidae community, the Shannon-Weaver species diversity index was used. Based on the values obtained it can be shown that the higher the index the larger the species diversity of the tested community (Table 1, 2).

Table 1

Resemblance of *Noctuidae* species of two biotic communities of the Wielkopolska and Kujawy-Pomorania province in 2003–2005.

Location	No of species occurring simultaneously	Semblance of species [J %]
Poznan Winna Gora	45	50.56
Poznan Wieclawice	61	61.62
Winna Gora Wieclawice	46	51.11

Table 2

The richness, diversity and evently of *Noctuidae* species of two biotic communities of the Wielkopolska and Kujawy-Pomorania province in 2003–2005.

Place	Number of specimens	Number of species	Diversity [H']	Richness [dS]	Eaveness [J']
Poznan	3553	79	4.419	21.968	0.701
Winna Gora	1220	55	3.893	17.496	0.673
Wieclawice	9528	81	4.477	20.106	0.706

The enclosed table shows that the highest values were recorded in the areas located in Wieclawice and Poznan. The conclusion from the above is that the species diversity of the given community depends on the natural environment and, according to literature available, probably also on the habitat's humidity.

A slightly different approach that complements the conclusions from the diversity index is presented on the basis of the Simpson's richness index. The index is based on the probability theory in which the species abundance is measured by the sum of probabilities of occurrence of all species in the tested community. When the occurrence of species is considered in view of this approach, the best richness is clearly visible in Poznan and Wieclawice, while it is the worst in the area tested in Winna Gora (idle field).

Conclusions

Monitoring of the Noctuidae community can be an element of a broader environment monitoring system the objective of which is to determine the direction of changes occurring in the biocenoses tested. Despite its significant ecological valency, the Noctuidae community reacts to all anthropogenic and biotic disturbances. From the data available it is known that for the last 50 years significant changes have occurred in the Noctuidae community in the area of Warsaw City Center. Particularly in the last 20 years a considerable impoverishment of the species composition was noted. For these communities durable and constant in time was a group of 25–30 species composed of all very populous and populous species and several less populous species. A group of species having small populations that occur only occasionally in the Warsaw City Center is the element that changes in time. The group's content has decreased by at least 70 %.

Vanishing of rare species seems to be caused primarily by unfavorable environmental changes occurring as a result of intense development of that area (desertification of densely developed areas, decreased surface of urban green areas, changes in plant species composition, great pollution and other similar factors).

Monitoring of the Noctuidae community can disclose changes in the biodiversity that is expressed among others by the number species of organisms co-occurring in the given area. If detected at the right time, changes of various kinds in biocenoses can have a significant influence on undertaking adequate economic steps aiming at maintaining the ecosystem of either open areas or agrocenoses at a balanced level [4, 5, 7, 8].

The three-year-long research and observations of the Noctuidae need to be treated as a pilot study, and the results obtained as the starting point for further observations on the influence of the structure of species in the Noctuidae communities on the increasing environment degradation process.

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Zakład Metod Prognozowania i Rejestracji Agrofagów
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Abstrakt: Celem pracy było porównanie struktury sówkowatych w środowisku pól uprawnych, czterech badanych miejscowości za pomocą wskaźników ekologicznych. Badania przeprowadzono w latach 2003–2005 na polach doświadczalnych obsianych pszenicą ozimą, burakami cukrowymi, kukurydzą oraz rzepakiem ozimym. Przedmiotem badań były odłowione imagines motyli sówkowatych za pomocą pułapek świetlnych zwanych potocznie samolówkami. Określono skład jakościowy i ilościowy odłowionych motyli, obliczając strukturę dominacji gatunków wyrażoną za pomocą tzw. abundancji relatywnej. Do analizy porównawczej materiału zastosowano indeks różnorodności Shannona-Weavera (H'), dominacji Simsona (SI) oraz wskaźniki podobieństwa Sorensona (J %). Wyniki badań wykazały większe podobieństwo składu gatunkowego agrocenoz Poznania i Więclawic. Najmniejszą różnorodnością gatunków, potwierdzoną małą wartością indeksu różnorodności oraz dużą wartością indeksu dominacji, charakteryzowała się cenoza Winnej Góry, co wskazuje w strukturze dominacji gatunkowej na kompensację tylko kilku gatunków sówkowatych, w tym przypadku np. *Agrotis segetum* (Schiff et Den.), *A. exclamationis* (L.), *Xestia c-nigrum* (L.), *Discestra trifolii* (L.).

Słowa kluczowe: rolnice, bioindykatory, wskaźniki ekologiczne, pułapka świetlna