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CURRENT STATUS AND IMPORTANCE OF BUTTERFLIES OF THE NOCTUIDAE FAMILY (*LEPIDOPTERA*) IN NATURAL AND ANTHROPIZED ECOSYSTEMS IN THE REPUBLIC OF MOLDOVA

165.04 – ENTOMOLOGY

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PURPOSE AND OBJECTIVES OF THE RESEARCH

The Noctuidae family is one of the largest families of the Lepidoptera order. Approximately 25 000 noctuid species are recorded in the world fauna, and in Europe – about 1300 species [27]. Before our research, 408 species of moths were registered in the Republic of Moldova, taxonomically classified in 17 subfamilies. Previous collections were made mainly in the vicinity of Chisinau at the beginning of the last century, that is why the research on moths in various regions is necessary to highlight the fauna, ecological structure and peculiarities of noctuids communities in natural ecosystems and agrobiocenoses.

Although the lepidopterological studies in the Republic of Moldova are of a considerable age, the first references to moth fauna were provided by L. C. Crulicovschii as early as 1906 [29], the approximately 30 works existing so far, most of them dealing with species harmful to agricultural crops, do not form a clear picture of the specific composition, the spread of moths at local and regional level, seasonal activity, etc.

The importance of noctuids as a component of food chains is difficult to underestimate, as they constitute food both in adulthood and as a larva, egg, pupa, for insectivorous mammals, birds, reptiles, other insects, etc. Noctuids, in turn, serve as hosts for a number of parasites. Recent studies have shown a link between the decrease in the number of nocturnal butterflies that are a key component in the diet of bats and the reduction of the activity of bats in agrocenosis [5].

A significant problem is the economically important moths and the results of losses caused to agricultural or environmental plants. Some species are listed worldwide as economically important pests of agricultural crops [26, 30], such as the noctuida *Helicoverpa armigera* (Hübner, 1808), or the fruit bush - annual crop losses of vegetables, corn and other crops are between 15 -80% [27, 31].

On the other hand, some species of noctuids are used in biological or integrated control, which is one of the main factors in solving priority ecological problems. For example, the noctuida *Acontia candefacta* (Hübner, 1831), a new species in the fauna of the Republic of Moldova, was introduced from North America to Russia in the biological fight against the invasive plant *Ambrosia artemisiifolia*, considered one of the most dangerous plants in our country. Successful acclimatization of *A. candefact*a species in agroecosystems can save a lot. Other species, such as *Calophasia lunula* (Hufnagel, 1766), *Leucapamea ophiogramma* (Esper, 1794), *Hydraecia micacea* (Esper, 1789), *Cerapteryx graminis* (Linnaeus, 1758), have been introduced to North America from Europe to combat some invasive plants [27]. Biological control is much more economical than chemical control, because the effectiveness is higher and the cost much lower. Unfortunately, at the present stage its use is very low due to

the complete ignorance of the biology of many species, this method requiring additional knowledge from specialists.

Despite the fact that moths are most often viewed only from the point of view of pests, as a result of the large number of published works on this subject, a number of factors have contributed to the decrease of the species number population which has led to the increase of the number of endangered species. According to a study published in the journal Biological Conservation, we have witnessed an alarming decline in lepidopteran fauna over the past 30-40 years. The total number of insects is decreasing by 2.5% per year, and the most affected group of insects are Lepidoptera [16]. Until our research, there were no studies on the condition of noctuids that need protection and conservation in the Republic of Moldova. In the Red Book of the Republic of Moldova there are no mentions about the species from the Noctuidae family.

Recent studies attribute to noctuids an important role in pollination, but there is little research on this topic because conducting research on pollination at night is difficult [24].

Despite the importance of noctuids in nature and in human life, this group of insects is still poorly studied in many European countries. In addition to the difficult determination of many noctuid species that involve the study of genital armature, another cause is determined by the nocturnal way of life of noctuids, so that research at night is difficult to perform.

The insufficient study of this group of insects hinders the detailed analysis and does not give a complete picture of the biodiversity of the regional fauna. This study aims to evaluate the diversity of moth fauna in various natural and anthropogenic ecosystems of the Republic of Moldova. Performing an ample and systematic study on the specific composition of moths in the Republic of Moldova has made significant contributions to the enrichment of the database and the collection of moths with new scientific data.

The purpose of the research: to highlight the current status and estimate the importance of butterflies from the Noctuidae family (Lepidoptera) in the natural ecosystems and agrobiocenoses of the Republic of Moldova.

Objectives: to identify the composition of noctuid species on the territory of the Republic of Moldova; to establish the belonging of noctuid species to the main zoogeographical groups; to perform the biotopic distribution of noctuids depending on ecological preferences; to analyze the trophic spectrum in the larval stage of the identified noctuids; to estimate the ecological significance of moths in the natural ecosystems and agrobiocenoses; to make the annotated list of noctuids in the Republic of Moldova.

The research hypothesis is aimed at establishing the composition noctuid fauna (Lepidoptera, Noctuidae) in the Republic of Moldova and estimating the ecological significance of this group of insects in the natural and agrocenose ecosystems.

Scientific novelty and originality. It is for the first time that an extensive study of noctuids from 17 subfamilies was performed on the entire territory of the Republic of Moldova, being collected and analyzed over 11,000 specimens from 24 collection sites. Thus, it was established that the fauna of moths (Noctuidae) in the Republic of Moldova consists of 425 species, taxonomically classified into 169 genera and 17 subfamilies, of which 4 genera and 17 species are new to the country's fauna. The list of 11 species of butterflies from the Noctuidae family, which needs protection and conservation at national level, was made for the first time. The biotopic, geographical distribution and the trophic spectrum of noctuids were analyzed, the seasonal dynamics of the flight to the trap with white and ultraviolet light was monitored and the annotated list of noctuids from the Republic of Moldova was drawn up.

The scientific problem consisted in establishing the specific composition, ecological structure and peculiarities of the functioning of noctuid communities in the natural ecosystems and agrobiocenoses of the Republic of Moldova.

Theoretical importance. The results of the study of fauna, ecology, importance of noctuids in the Republic of Moldova have an important contribution to the knowledge of this taxonomic group of lepidoptera. The data on the species registered as new for the country's fauna constitute a significant contribution to the completion of the information database in Europe.

The applicative value of the paper. The main results of the thesis are part of the fundamental and applicative scientific research topic "Diversity, structure and functioning of natural and anthropized faunal complexes in the context of strengthening the national security strategy of the Republic of Moldova", №15.817.02.12F. (2016-2019) of the Institute of Zoology.

The conducted investigations will improve the theoretical and empirical heritage in terms of fauna diversity, spatial structure, trophic spectrum and dynamic range of moths in natural ecosystems and agrobiocenoses. The results can be used by entomologists, foresters, ecologists, specialists in plant protection, as well as in the elaboration of university courses and as methodological support in the elaboration of bachelor's and master's theses.

The scientific results obtained are published in 13 scientific papers (6 individual), of which: 1 chapter in a monograph, 6 articles in reviewed scientific journals (1 in journals from the ISI database, 3 from the national register of category B profile journals) 6 articles in scientific collections.

The scientific results obtained in the thesis were implemented within the "Codrii" Natural Reserve.

KEYWORDS

Lepidoptera, Noctuidae, diversity, new species, rare species, natural ecosystems, agrocenoses, trophic relationships, pests, seasonal activity.

RESEARCH METHODOLOGY

The noctuids were collected by the following methods: manual collection, with the entomological net, at the standard electric lamp (100 W), with the help of an illuminated white cloth and by installing traps with white and ultraviolet light.

The collection of moths was performed by the following methods: manual collection, using an entomological net and a standard electric lamp (100 W), with the help of an illuminated white cloth and by installing traps with white and ultraviolet light. The nomenclature and classification was given according to Fibiger and Hacker (2004) [6]. The identification of the taxonomic belonging was made on the basis of the determination keys [3, 9, 10, 13, 27, 30]. The new species for the fauna of the Republic of Moldova have been confirmed by Prof.Laszlo Rakosy, from Babes-Bolyai University, Cluj-Napoca, Romania.

The analysis and statistical processing of the material were performed according to contemporary methods of identification and interpretation of the results obtained by using the program STATISTICA 6.0 and the graphical presentation of the material was executed by using Microsoft Excel programs.

SUMMARY OF CHAPTERS

1. HISTORY OF THE STUDY, SYSTEMATIC POSITION AND GENERAL DESCRIPTION OF NOCTUIDS IN EUROPE AND THE REPUBLIC OF MOLDOVA

1.1. Brief history of the study of moths in Europe

At the European level, the systematic study of lepidopterans begins in 1735 with the work by Carl Linné, entitled "Systema Naturae". A number of species, currently considered moths, have been cited in the 12th edition, in which the author introduces the genus Noctuae. The name Noctuidae was introduced in 1809 by the French zoologist Pierre André Latreille.

In the 19th century, the lepidopterologists: Audouin (1824), Baer (1826), Herrich-Schäffer (1845; 1947), Rambur (1848), Lederer (1857), Grotes (1875) , Smith (1893), Hulst (1894) and Meyrick (1895) and others contributed greatly to the study of butterflies of the Noctuidae family.

In the 20th century, contributions to the study of moths at European level have been made by the authors: Staudinger (1901), Hampson (1903-1910), Spuler (1908), Warren (1914), Bang-Haas (1928-1930), Кожанчиков (1937, 1950) , Bergman (1954), Kostrowicki (1956-1961), Beck (1960), Boursin (1953, 1964), Мержеевская (1967, 1971), Hartig, Heinicke (1973),

Fibiger, Hacker (1990, 2004) and others. The most significant works of the last century on moths fauna belong to И. В. Кожанчиков (1937, 1950).

Contemporary lepidopterologists such as Laszlo Rakosy (Romania), Fibiger Michael (Denmark), Зоя Ключко (Ukraine), et al. have had a special contribution to the study of noctuids.

1.2. History of the study of noctuids in the Republic of Moldova

The first faunistic and systematic data on the fauna of lepidoptera in Bessarabia are provided by L. C. Crulicovschii (1906), who cites 2 species of moths.

A great value for moth fauna is the work of E. Miller and N. Zubovschi, later joined by A. Ruscinschi, who between 1908-1937publish a series of articles with a major impact on the study of moths, indicating 253 species. This is the first and most valuable taxonomic works up to the present moment.

After a break of 25 years, the studies are continued by L. Borodina, who publishes a series of works in the period 1964-1973 and also by M. Tkach eho described 49 species of moths [36]. In the 60s and 80s of 20th century, the biology of harmful moths and their control methods have been studied by researchers, including T. G. Zavarueva, V. A. Stareţ, N. A. Filippov, S. M. Pospelov and others. In the last 4 decades investigations on noctuids have not been carried out regularly [23].

1.3. Systematic position and general description of noctuids

This subchapter presents the general description of butterflies of the Noctuidae family: the morphology of adults (cephalic capsule and appendix, thorax and appendix, abdomen) and their biology. Noctuidae are nocturnal and twilight insects. According to their morphological structure, they have a body length of 15-20 mm and a wingspan of 35-45 mm. The head, thorax and abdomen are covered with scales and hairs. The antennae are filiform, setiform, and sometimes pectinate. On the brown or gray background of the front wings, very characteristic spots and contoured or diffused drawings are distinguished.

2. MATERIALS, RESEARCH METHODS AND PHYSICAL-GEOGRAPHICAL CHARACTERISTICS OF THE STUDIED TERRITORY

The materials underlying this work were obtained from the research made during the years 2012-2019 on the faunal diversity, the ecological and biological aspects of the lepidoptera of the Noctuidae family in different natural and anthropic ecosystems of the Republic of Moldova. As a result of the research, 760 specimens were analyzed, which included over 11,000 moth specimens belonging to 164 species from 104 genera and 17 subfamilies. The noctuids from the entomological collection of the Institute of Zoology, the collection of insects from the

endowment of the Museum of Ethnography and Natural History in Chisinau, and the collection of the State Agrarian University of Moldova were also studied.

2.1. Methods and sites for collecting noctuids

Moths were collected by the following methods: manual collection, with the help of an entomological fillet, a usual electric bulb (100 W), and an illuminated cloth and by installing traps with white and ultraviolet light developed by the Institute of Genetics, Physiology and Plant Protection.The noctuid collections were carried out on 24 sites in the north, center and south of the Republic of Moldova, including the entire territory and all habitats of moths (figure 2.1.1). The site search was conducted in the period between March and November.

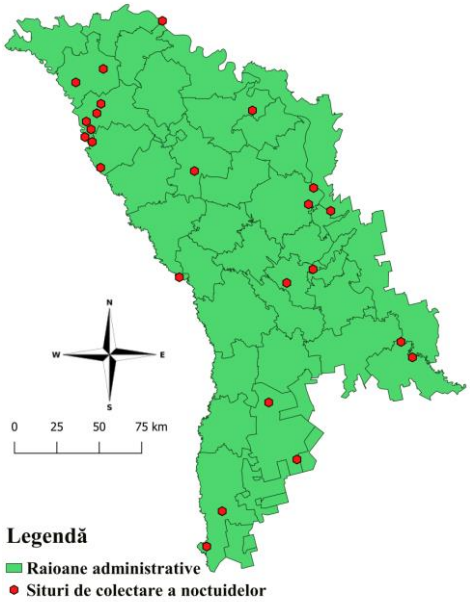


Fig. 2.1.1. Diagram of the location of noctuid collection sites on the territory of the Republic of Moldova

2.2. Research materials and techniques: preparation, fixation and storage

The techniques of research and processing of the collected material consisted of the following stages: softening, mounting on display units, labeling, preservation in boxes or on entomological mattresses and storage in the collection [14, 28]. For difficult-to-identify species, genital fittings were analyzed, which are stored in Ependorf tubes with glycerin.

2.3. Methods of analysis and statistical processing

The following ecological indices were used in the analysis and interpretation of the data: analytical indices (abundance, frequency, dominance, constancy) and synthetic indices (ecological significance, Shannon-Wiener diversity, Simpson index, fairness). The dendrogram was made using STATISTICA 6.0 software, and the graphical presentation of the material was executed using Microsoft Excel programs. The calculation of synthetic indices was performed in

the program "Environment coeff." (Author: M. Kotyacy). Similarity indices of the faunal complexes were calculated according to Sörensen's formula [15]. The specific wealth concentration index was calculated according to A. Andreev [25].

2.4. Characteristic of the physical-geographical conditions of the studied territory

In this compartment, based on the studied bibliography, the physical-geographical characteristic of the Republic of Moldova is exposed: the relief, climate, soils, flora, fauna, etc. The Republic of Moldova is located in the south-east of Europe, between the northern latitudes 45^{o} and 48^{o} and the east longitudes 26^{o} and 30^{o}, at the junction of Central Europe with Eastern and Southern Europe. The distances between the extreme points are about 350 km between Naslavcea and Giurgiuleşti and only 120 km from west to east, on the latitude of Chisinau. The surface of the Republic of Moldova is 33,800 km2 [2].

3. DIVERSITY, GEOGRAPHICAL SPREADING AND BIOTOPIC DISTRIBUTION OF NOCTUIDS IN THE REPUBLIC OF MOLDOVA

3.1. The faunal diversity of noctuids in the Republic of Moldova

The noctuid fauna of the Republic of Moldova at the moment consists of 425 species, taxonomically classified in 169 genera and 17 subfamilies: Plusiinae (23 species), Eustrotiinae (5), Acontiinae (6), Pantheinae (1), Dilobinae (1), Acronictinae (21), Metoponiinae (5), Cuculliinae (24), Oncocnemidinae (5), Amphipyrinae (7), Psaphidinae (5), Heliothinae (11), Condicinae (3), Bryophilinae (10), Xyleninae (141), Hadeninae (84) and Noctuinae (73 species) (figure 3.1.1).

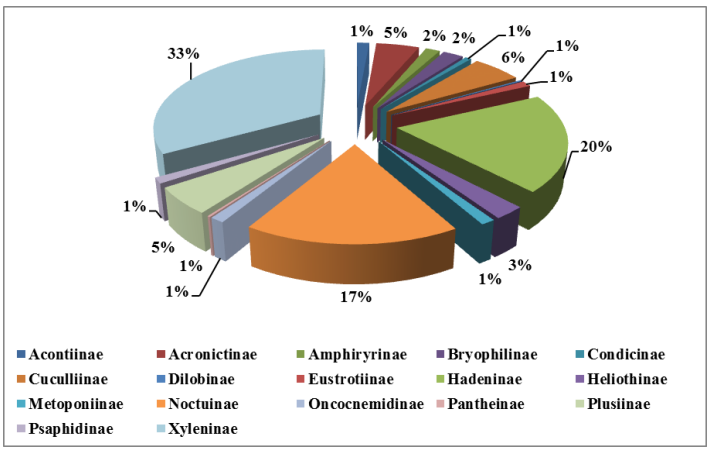


Fig. 3.1.1. The share of noctuid families in the Republic of Moldova

Of the 169 genera and 425 moths species reported, 4 genera (*Eucarta*, *Aedophron*, *Dasypolia*, *Atypha)* and 17 species (*Acontia candefacta*; *Eucarta amethystina* (Hübner, 1803); *Eucarta virgo* (Treitschke, 1835); *Cucullia fraterna* Butler, 1878; *Aedophron rhodites* (Eversmann, 1851); *Hadena capsincola* (Denis & Schiffermüller, 1775); *Euxoa birivia* (Denis &

Schiffermüller, 1775); *Euxoa cos* (Hübner, 1824); *Euxoa recussa* (Hübner, 1817); *Euxoa temera* (Hübner, 1808); *Chersotis margaritacea* (Villers, 1789); *Chersotis rectangula* (Denis & Schiffermüller, 1775); *Noctua tertia* Mentzer & al., 1991; *Xestia sexstrigata* (Haworth, 1809); *Dasypolia templi* (Thunberg, 1792); *Atypha pulmonaris* (Esper, 1790); *Abrostola asclepiadis* (Denis & Schiffermüller, 1775) are new for the fauna of the Republic of Moldova [18-21].

3.2. Zoogeographic analysis of noctuids in the Republic of Moldova

From the zoogeographical point of view in the noctuid fauna of the Republic of Moldova, the palearctic elements predominate with 273 species (64%), followed by the mediterranean elements with 141 species (33%) and only 1% form the cosmopolitan (6 species), European (3 species) and subtropico-tropical with 2 species (figure 3.2.1.).

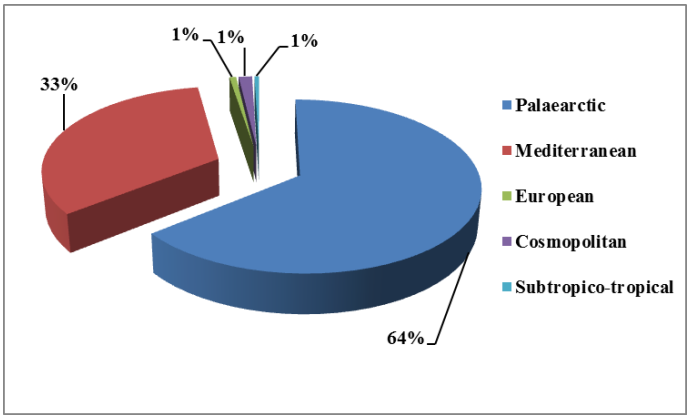


Fig. 3.2.1. Zoogeographic structure of noctuid fauna in the Republic of Moldova.

The palearctic species are best represented by the Euro-Asian elements that include 233 species (85%), followed by the holarctic elements with 23 species (9%), and a small number of species register the East-Euro-Asian elements (7 species), Euro-Siberian (3 species), palearctic (3 species), Euro-West-Asian (2 species), paleo-subtropical and East-Euro-Trans-caspian (figure 3.2.2.).

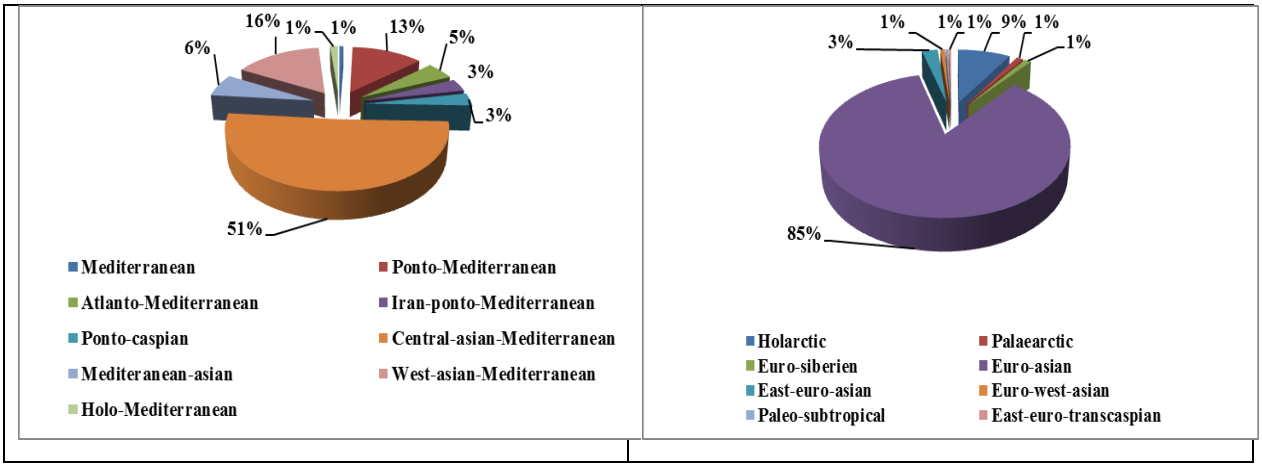


Fig. 3.2.2. Classification of Mediterranean (a) and Palearctic (b) elements of noctuid fauna of the Republic of Moldova.

In the Mediterranean species group, the Central-Asian-Mediterranean elements make up 51% (72 species), being the most representative. A little more numerous are the Mediterranean-West-Asian elements with 22 species (16%) and Ponto-Mediterranean - with 18 species (13%). The other subdivisions have a small number of species: Mediterranean-Asian with 9 species (6%), Atlantic-Mediterranean - with 7 species (5%), Iran-Ponto-Mediterranean and Ponto-Caspian - 5 species each (3%), and the Holo-Mediterranean and Mediterranean elements with 1% each (figure 3.2.2.).

Comparative analysis of noctuid fauna in the Republic of Moldova and some European countries. Although the surface (33.8 thousand km2) of the territory of the Republic of Moldova is small compared to other European countries, the faunal diversity of the country is high due to certain particularities such as the diversity and structure of the soils, the variety of the relief, the climate, the thermal regime, the rainfall, the variety of the flora and evolution of vegetation at the junction of the three geobotanical regions: European, Mediterranean and Eurasian [25].

For the comparative analysis, the faunal diversity of moths from 11 European countries (Romania, Ukraine, Belarus, Slovenia, France, Russia, Czech Republic, Bulgaria, Hungary, Austria, and Poland) was studied. In total, 287 genera from 21 subfamilies were identified.

The study and the values of the index of similarity of noctuid fauna in the Republic of Moldova with that of some European countries are shown in figure 3.2.3.

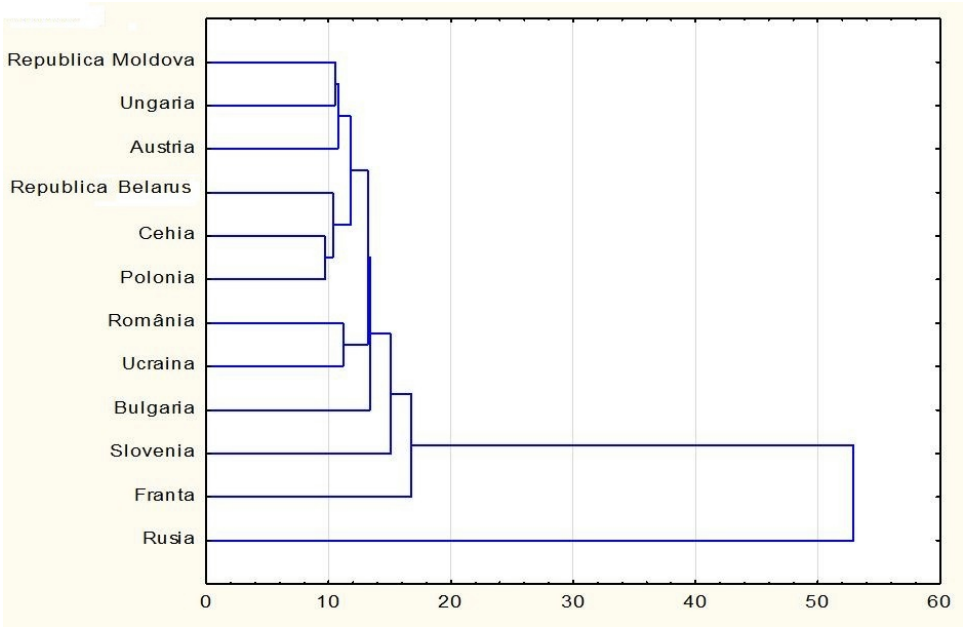


Fig. 3.2.3. Dendrogram of the similarity of moth fauna of the Republic of Moldova with that of some European countries.

The main cluster, which relates the moth fauna of the Republic of Moldova to that of European countries (Hungary, Austria, Belarus, Czech Republic, Poland), expresses their location on similar latitudes and the predominance of the species with the Euro-Asian

spreading area. The moth fauna of the Republic of Moldova, together with that of Hungary, forms a unique sub-cluster being adjacent to that of Austria, and of the Republic of Belarus, which is adjacent to the sub-cluster: the Czech Republic and Poland. Neighboring countries, Romania and Ukraine form a unique sub-cluster that is adjacent to the sub-clusters mentioned above. Russia forms a separate cluster due to the large number of species.

According to the comparative analysis of the moth fauna diversity in the Republic of Moldova with that of 11 European countries, the following similarity indexes (decreasing) were established: with Hungary – 82.50% (363 common species), Romania – 82.12% (402), Ukraine – 82.01% (408), Czech Republic – 81.11% (350), Poland – 80.00% (346), Austria – 78.91% (365), Belarus – 77.11% (305), Slovenia – 75.23% (354), Bulgaria – 75.02% (380), France – 66.23% (360) and with Russia – 61.00% or 402 communes.

The moth fauna of the Republic of Moldova is more similar to that of Hungary, Romania and Ukraine. The lowest similarity rates were obtained by comparing the moth fauna of the Republic of Moldova with that of France and Russia.

According to the index of specific richness concentration (table 3.2.1.), the highest value of the index, among the surveyed countries, is characteristic for Slovenia (394.78), Bulgaria (287.53) and the Republic of Moldova (277.77).

Table 3.2.1. Indices of specific richness concentration of noctuids in the Republic of Moldova and some European countries

No. d/o	**Country**	**Total area (thousands km^2)**	**Number of moth species recorded**	**Specific richness concentration index Icr.**
1.	Republic of Moldova	33,80	425	277, 77
2.	Romania	238,40	554	233,07
3.	Ukraine	603,70	570	205,03
4.	Republic of Belarus	207,60	366	157,96
5.	Slovenia	20,27	516	394,80
6.	France	543,97	662	241,60
7.	Russia	17075,40	893	211,11
8.	Czech Republic	78,87	438	230,89
9.	Bulgaria	110,91	588	287,53
10.	Hungary	93,03	455	231,08
11.	Austria	83,88	500	259,88
12.	Poland	312,68	440	176,35

3.3. The structure of noctuid communities in some investigated ecosystems

An image of the relationships established between the different species of a biocenosis and the hierarchies between them can be provided by a set of ecological indices.

The ecological indices of moths collected from various areas of the Republic of Moldova: north (Brînzeni station), center (the Forest Reserve "Cobîleni") and the south (the Forest Reserve "Flămînda") have been analyzed. The results of the calculations are summarized in Table 3.3.1.

Table 3.3.1. Synthetic indices and dominant noctuid species in the researched sites of the Republic of Moldova

No.	Ecosystems	No. of species	I_s	I_{sh}	ε	The dominant species (D_4-D_5)
1.	**Brînzeni station**	135	0,066	1,432 (0,024)	0,093	*Anarta trifolii* *Xestia c-nigrum* *Acontia trabealis* *Agrotis exclamationis*
2.	**Res. "Cobîleni"**	136	0, 076	1,316 (0,028)	0,051	*Agrotis exclamationis* *Anarta trifolii* *Acontia trabealis*
3.	**Res. "Flămînda"**	21	0,080	1,158 (0,066)	0,344	*Hoplodrina ambigua* *Acontia trabealis* *Anarta trifolii* *Tholera decimalis* *Mythimna albipuncta*

The maximum value of the Shannon index (Ish) was recorded in the Brînzeni station - 1, 432, and the minimum value - in the Forest Reserve "Flămînda" (1,158). The Simpson (Is) index reached the major value in the Forest Reserve "Flămînda", as well as the equitability - 0, 344. The minimum value of the Simpson (Is) index was in the station Brînzeni, and of the equitability - in the "Cobîleni" Forest Reserve.

The following dominant species were highlighted during the study: *Hoplodrina ambigua* (Denis & Schiffermüller, 1775), *Acontia trabealis* (Scopoli, 1763), *Anarta trifolii* (Hufnagel, 1766), *Tholera decimalis* (Poda, 1761), *Mythimna albipuncta* (Denis & Schiffermüller, 1775), *Xestia c-nigrum* (Linnaeus, 1758) and *Agrotis exclamationis* (Linnaeus, 1758).

3.4. Biotopic distribution of noctuids in natural ecosystems and agrobiocenoses

Moths populate both natural and anthropogenic ecosystems. The specific diversity of moths is explained by the landscape variety of the Republic of Moldova, where, at relatively small distances, different types of ecosystems (forest, aquatic, steppe, meadow, rocks) and morphological structures of the relief (rocks, terraces, valleys) are found.

In the investigated ecosystems, the number of species with a high frequency (17) is practically equal to the number of species that have a low frequency – 15 species. Most species have a frequency of 71.43% (44 species), 43% (35 species) and 57.14% (34 species), possessing an average ecological valence of adaptability to environmental conditions (figure 3.4.1).

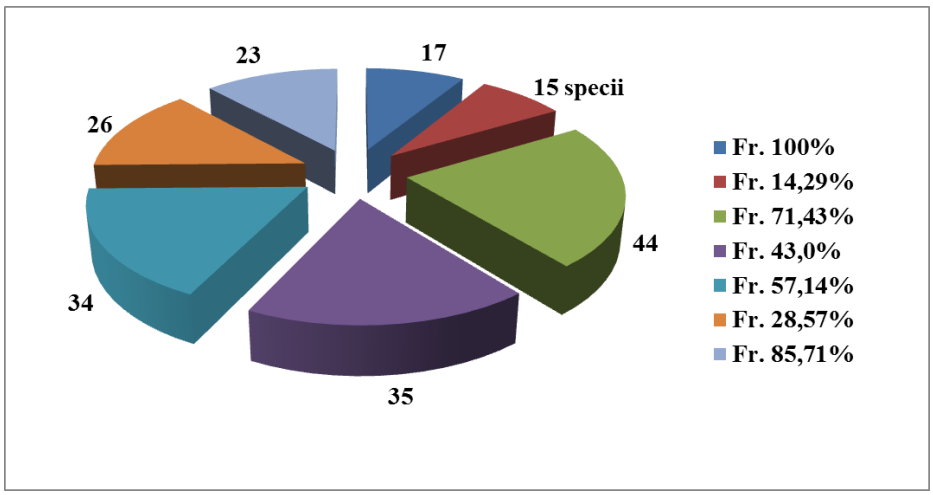


Fig. 3.4.1. Frequency-dependent distribution of noctuids

It was found that the forest edge (164 species) and the meadow (157 species) are the most populated biotopes by noctuids. The steppe meadow is an attractive biotope for 101 species of noctuids. The fewest noctuids populate the limestone canyons (49 species), especially if the canyon is bordered by another type of biotope. Approximately 60 species of noctuids can be found in agricultural crops, and derelict land or ponds are populated by about 100 species.

During the research period, the following species with a narrow ecological valence were reported: *Nonagria typhae* (Thunberg, 1784), *Rhizedra lutosa* (Hübner, 1803), *Archanara geminipuncta* (Haworth, 1809), *Chilodes maritima* (Tauscher, 1806), *Oxytripia orbiculosa* (Esper, 1799), *Leucania obsoleta* (Hübner, 1803) – species that populate only river banks, streams, wetlands, floodplains and meadows. The species: *Gortyna cervago* (Eversmann, 1844), *Episema tersa* (Denis & Schiffermüller, 1775), *Ulochlaena hirta* (Hübner, 1813), *Oxicesta geographica* (Fabricius, 1787), *Euxoa cos* și *Hecatera cappa* (Hübner, 1809) populate dry steppe meadows and sandy soil areas. *Sideridis implexa* (Hübner, 1809) prefers steppe areas with salted soils and *Panolis flammea* (Denis & Schiffermüller, 1775) develops only in mixed or coniferous forests.

Species of moths with a wide spectrum of adaptability to environmental conditions, and populate all types of biotope include: *Acontia trabealis* (Scopoli, 1763), *Anarta trifolii* (Hufnagel, 1766), *Mamestra brassicae* (Linnaeus, 1758), *Mythimna pallens* (Linnaeus, 1758), *Pyrrhia umbra* (Hufnagel, 1766), *Tyta luctuosa* (Denis & Schiffermüller, 1775), *Xestia c-nigrum* (Linnaeus, 1758), *Autographa gamma* (Linnaeus, 1758), *Diachrysia chrysitis* (Linnaeus, 1758), *Diachrysia stenochrysis* (Warren, 1913), *Macdunnoughia confusa* (Stephens, 1850), *Hoplodrina octogenaria* (Goeze, 1781), *Oligia latruncula* (Denis & Schiffermüller, 1775), *Oligia strigilis* (Linnaeus, 1758).

4. BIOECOLOGICAL SPECIFICATIONS AND THE IMPORTANCE OF NOCTUIDS IN THE REPUBLIC OF MOLDOVA

4.1. The influence of ecological factors on noctuid development

The following ecological factors influence the development of moths: abiotic – climatic, orographic and edaphic; biotic - food and its abundance, intraspecific and interspecific relationships, parasites and predators; anthropic - the impact of harmful substances on the environment, intensification of agriculture, elements of agricultural technologies, changes in forest management, etc.

4.1.1. The influence of abiotic factors

Climatic factors have the greatest influence on moths' life, and between them the essential role is played by the temperature and humidity of the air which acts on the seasonal activity of the moths. In Figure 4.1.1.1, we can see the oscillations of the moth flight in the period April-May of 2017, when there was a sudden drop in the temperature and abundant snowfalls.

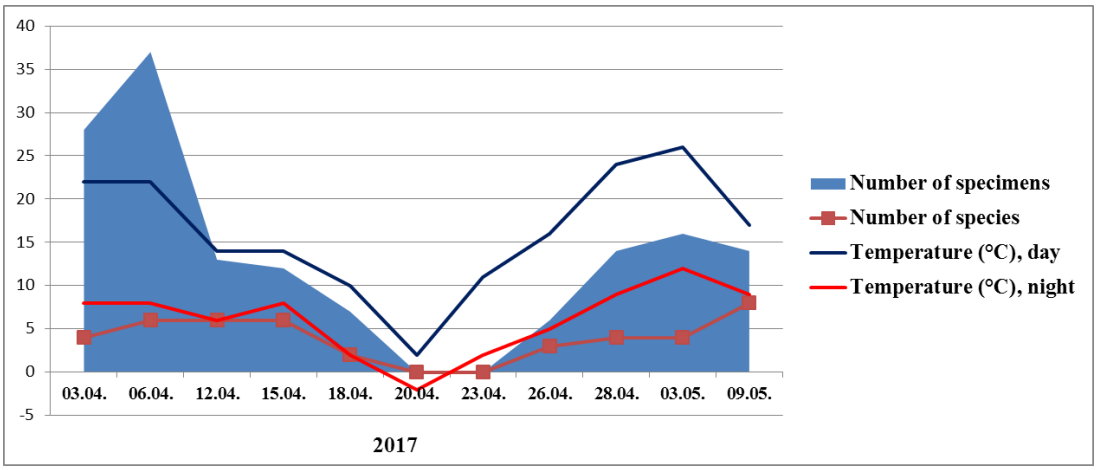


Fig. 4.1.1.1. Dynamics of moth flight in the period April-May, 2017

A study was conducted in the period July - October 2016, in which the moth flight hours were monitored. The research was carried out in the Nature Reserve "Cobîleni". The traps were used 6 hours in July-August and 8 hours in September-October for 8 days. In total, 595 moth specimens were analyzed. The species *Acontia trabealis* Scop. had a high numerical population, the individuals of this species accounting for 44% of the total number of the collected individuals.

During the period 25.07-29.08, individuals from the Noctuidae family were collected during the time periods: 22:00-24:00 p.m., 24:00-02:00 a.m. and 02:00-04:00 a.m. The moths collected on the night of 11.09, 19.09 and 29.10 were divided into four categories according to the time intervals: 20:00-22:00 p.m, 22:00-24:00 p.m, 24:00-02:00 a.m and 02:00-04:00 a.m. In figure 4.1.1.2, data on the distribution of moths per hour interval, accompanied by air temperature values during day and night are presented.

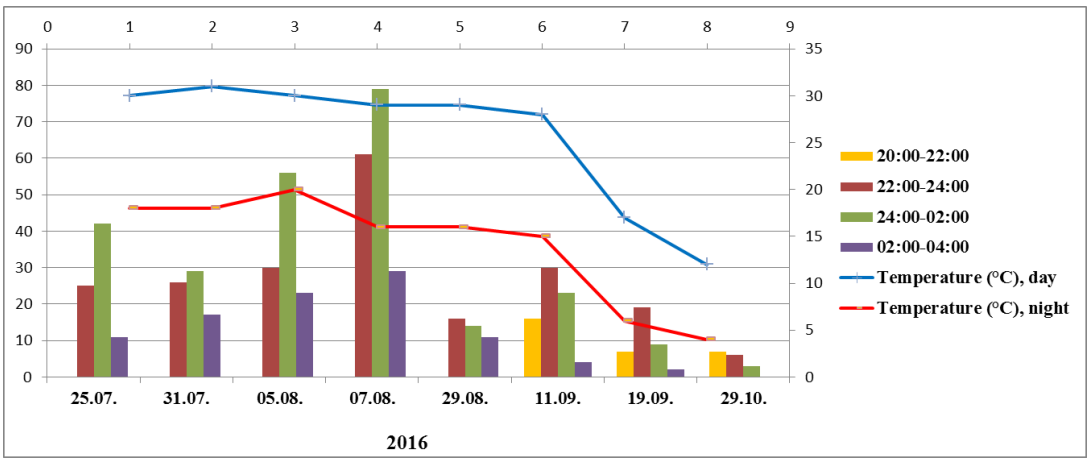


Fig. 4.1.1.2. Hourly distribution of noctuids' activity in the Nature Reserve "Cobîleni"

It has been found that during the summer, moths are more active between 24:00 a.m and 02:00 a.m. After 02:00 a.m, the number of individuals collected decreased gradually. In the autumn, most moths fly in the interval 22:00-24:00 p.m, which is explained by the influence of the decrease of the temperature at night and the increase of the duration of the night, which causes the moths to start their activity earlier.

In order to observe the influence of the ecological factors, especially of the climatic ones, on the development of noctuid populations, the the flight dynamics and the numerical population of the species *Mythimna albipuncta* were studied (table 4.1.1.1., figure 4.1.1.3.). The lack and prolonged insufficiency of precipitation during the spring-autumn of 2015 explains the absence of the first generation specimens, while the second generation appeared late, on August 04, compared to 2012, when the first individuals of the second generations were collected on July 17th. Although the flight of the second generation individuals in 2018 started early, it lasted until the end of August, unlike in 2013, when the last individuals were collected on October 14th. This is explained by the high temperature and the considerable deficit of precipitation, observed on the territory of the Republic from the first decade of August to the first decade of November, which contributed to the dehydration of the soil and to the difficulty of the adult noctuid flight [4].

Table 4.1.1.1. The dynamics of the flight of the species *Mythimna albipuncta* at the light trap (v. Brînzeni, d. Edineț)

Year	Month and decade																
	May			June			July			August			September			October	
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II
2012																	
2013																	
2014																	
2015																	
2016																	
2017																	
2018																	

Note: generation 1 – blue; generation 2 – green.

The ecological factors of a certain region favor or prevent the evolution of moth species, as a result of which population dynamics oscillate to different degrees.

Comparing the data shown in figure 4.1.1.3 with those in figure 4.1.1.4 for the 2012-2018 study years, of the *Mythimna albipuncta* species collected in different areas of the Republic of Moldova and at a different latitude: Brînzeni village (Edineț district) and the Reserve "Cobîleni" (Orhei district), an earlier appearance of the given species individuals in the area of north of the country was observed.

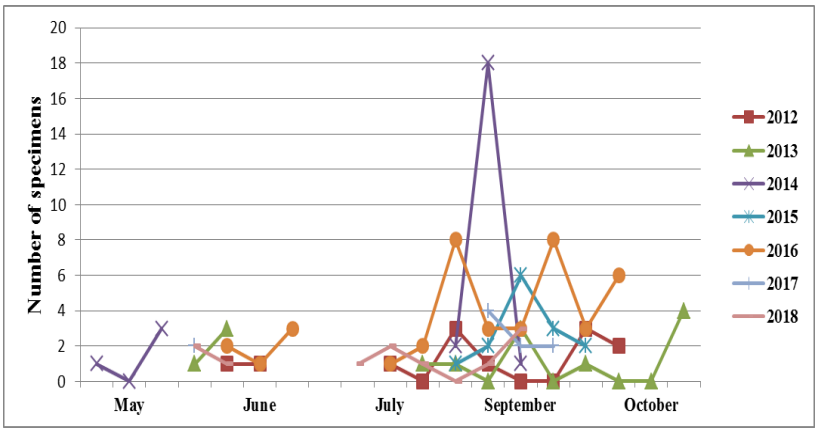


Fig. 4.1.1.3. Flight dynamics of the species *Mythimna albipuncta* (village Brînzeni, district Edineț, 2012-2018).

In the research years 2016-2018, the first generation individuals, in the "Cobîleni" Reserve appeared a decade later, than the individuals captured in the northern area of the Republic; the individuals of the second generation, appeared two decades, later, thus extending the flight period to October, while the species flight period in the northern part of the country ended 1 or 2 decades earlier.

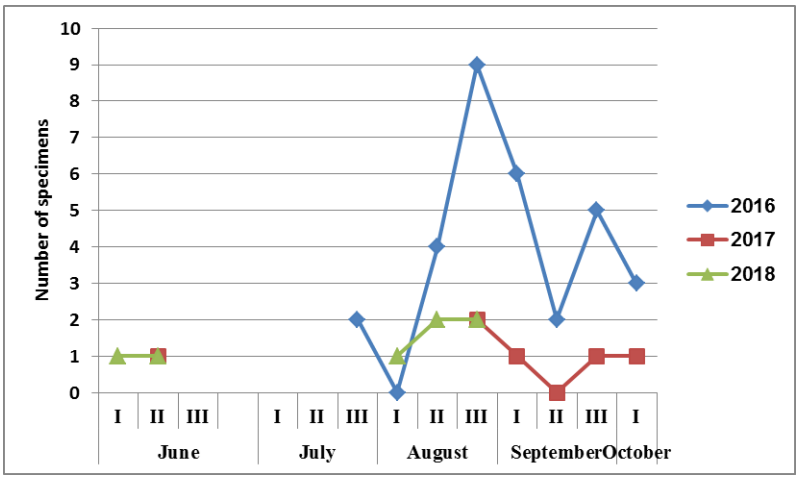
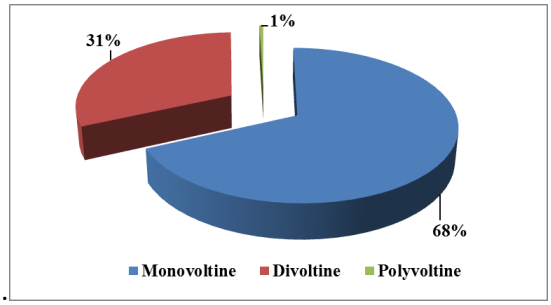


Fig. 4.1.1.4. Dynamics of *Mythimna albipuncta* flight ("Cobîleni" Nature Reserve, 2016-2018)

Abiotic factors influence the number of generations and the biological cycle of moths. It has been found that the time required for the development of a generation varies widely from species to species. Most moths in the Republic of Moldova spend the winter in the pupa and larva stage, accounting for 79% of all species (42% –in the larva stage and 37% – in the pupa stage) and are univoltine (68%), producing one brood of offspring per year (figure 4.1.1.5). Some species, especially harmful ones, can have 3 or 4 generations per year.

a. 

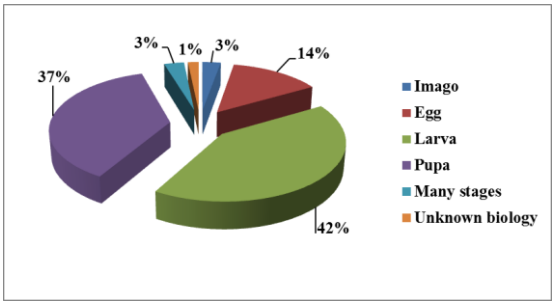
b. 

Fig. 4.1.1.5. Distribution of moths in the Republic of Moldova by biological cycle: a - the type of species by number of generations per year, b - wintering stage of moths.

4.1.2. The influence of biotic factors

Following the research, the following biotic factors limiting the density of moth populations were recorded:

Vertebrate predators. A lot of larvae become food for different species of birds, such as the great tit (*Parus major*) or the common starling (*Sturnus vulgaris*). The most dangerous pests for noctuids in the imago stage are the chiropterans (Chiroptera order). Noctuid-eating chiropterans include: the common big bat (*Myotis myotis*), the western barbastelle (*Barbastella barbastellus*), the twilight bat (*Nyctalus noctula*), the broad-winged bat (*Eptesicus serotinus*) and the small horseshoe bat (*Phinolophus hipposideros*).

Invertebrate predators and parasites. Based on the literature study, 71 species of moths have been identified serving as host for various parasites. In egg, larval and pupa stage, moths are parasitized by over 100 species of hymenoptera from the families Ichneumonidae, Braconidae, Chalcidae, Scelionidae, Trichogrammatidae, Pteromalidae, Eulophidae, Elachertidae and Encyrtidae. Larvae, sometimes pupae, are parasitized by over 70 species of flies in the Tachinidae, Bombyliidae, Sarcophagidae and Calliphoridae families. Moths are preyed on by beetles of the Carabidae family, some wasps (Vespidae) and ants (Formicidae) but also by some fleas of the Reduviidae family [27].

The numerical quantity of moths is regulated by the epizootics caused by various parasites of fungal, bacterial or viral nature.

4.1.3. The influence of anthropogenic factors

The main causes of the decline of butterfly species are: intensification of agriculture, abandonment of traditional land use, changes in forest management and pollution of the environment [1, 7]. Among the anthropogenic factors that lead to the decline of moths are the increase in light pollution. Artificial light is considered one of the driving forces for population decline of the moths [8, 11]. There are few studies on the preferences of different moth species for a certain type of light [8]. From the data shown in figure 4.1.3.1. it is observed that the number of moths collected at two light sources (white and ultraviolet) differs. The research carried out during the years 2012-2018, in the Brînzeni village (district Edineț) demonstrates the preference of moths for ultraviolet light. In total, 4719 individuals were collected by light trap, of which 3187 by ultraviolet light trap, which represents 68% of the total number of individuals collected, and the white light attracted 1532 individuals, representing 32%.

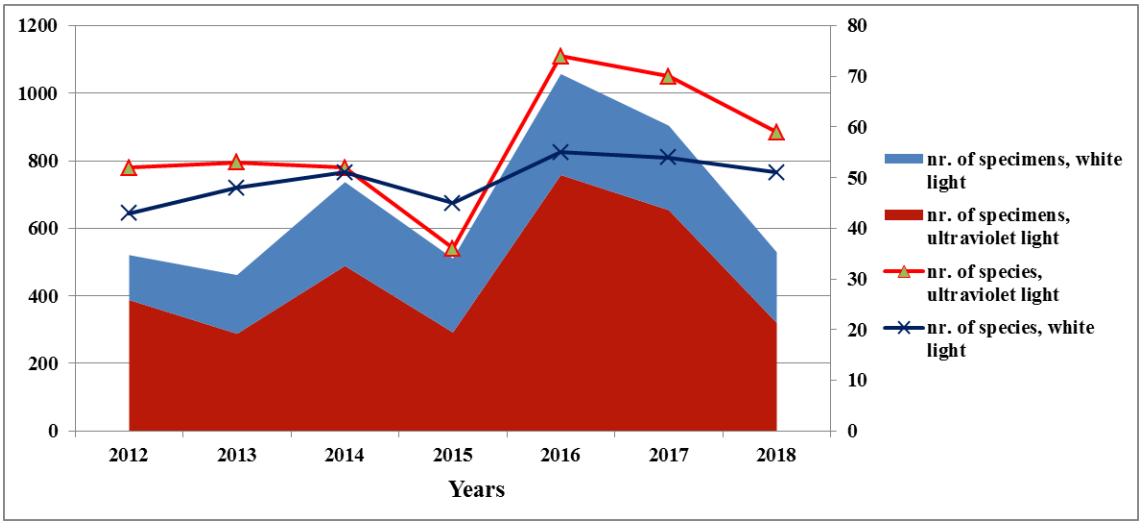


Fig. 4.1.3.1. Dynamics of moth flight to the light trap (v. Brînzeni, Edineț district).

4.2. Seasonal activity of moths

Based on the collected material, the maximum and minimum seasonal activity of moths and their frequency were established. Research has established that moth flight starts from the first decade of March (*Orthosia* sp.) to the last decade of November (*Asteroscopus sphinx* (Hufnagel, 1766). The species *Acontis trabealis* was distinguished by a high frequency.

The analysis of the frequency of the species collected in the Forest Reserve "Cobîleni" in 2017 (figure 4.2.1.), denotes the dominance of very rare species (59%), followed by relatively frequent (20%), rare (18%) and frequent (3 %). High frequency (FF) species have not been recorded (Table 4.2.1). The ratios between the established frequency coefficients reveal a great specific diversity.

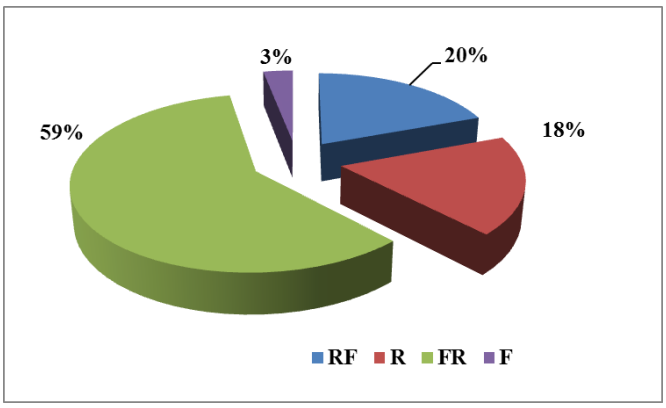


Fig. 4.2.1. Distribution of species collected in the Nature Reserve "Cobîleni" by frequency (year 2017).

During the study period, the species *Acontia trabealis* presented the largest number of individuals collected at the light trap. The number of individuals of the species *Acontia trabealis* reached 170. The flight of butterflies to the white (98 specimens) and ultraviolet (72 specimens) light showed a well-defined numerical stability of the population of this species. The appearance of the adults took place in the third decade of May. A numerical increase was registered in the second and third decades of June, after which their number decreased, so that in the first decade of July, no butterfly was collected in the light trap. Their number begins to increase in the second and third decades of August. In the second decade of August, the number of moths starts to decrease significantly, the last individuals being collected on September 2 (figure 4.2.2.).

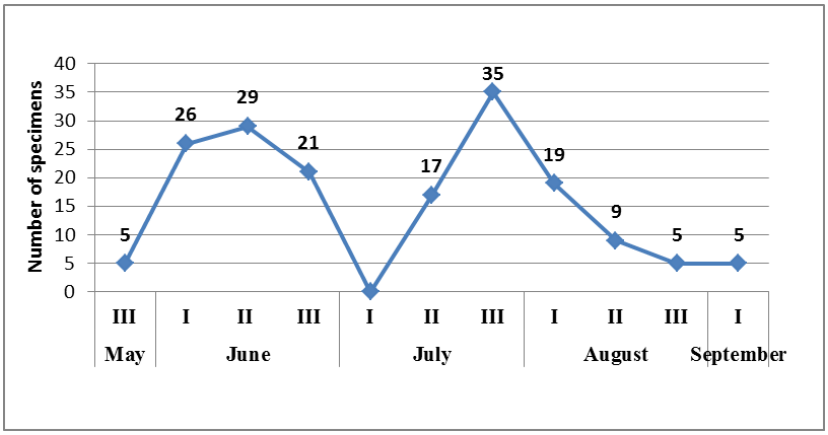


Fig. 4.2.2. Dynamics of the flight of the species *Acontia trabealis* ("Cobîleni", 2017).

The number of the population of this species was higher in 2016. The butterflies started flying in the first decade of June. Most individuals were collected in the second decade of July (108 specs), with a numerical explosion in the first decade of August (470 specs), after which their number decreased considerably (figure 4.2.3.).

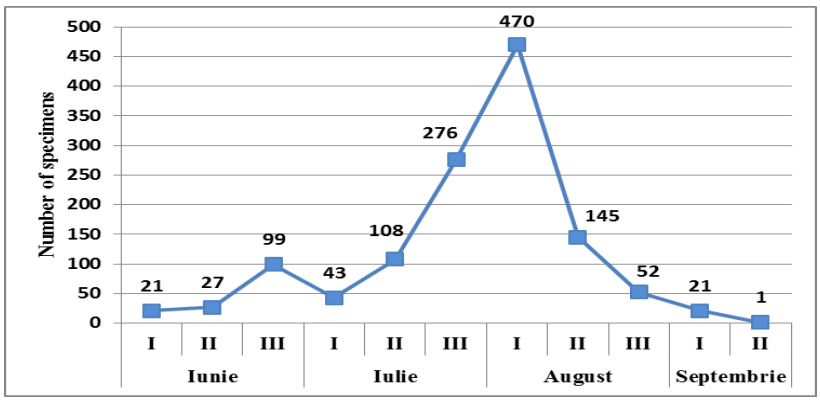


Fig. 4.2.3. Dynamics of the flight of the species *Acontia trabealis* ("Cobîleni", 2016).

The analysis of the flight dynamics of the species *Acontia trabealis* during the years 2012-2018 at Brînzeni Station is presented in figure 4.2.4. The flight dynamics for this species is more pronounced in 2017 (229 specs); the minimum (45) was recorded in 2014.

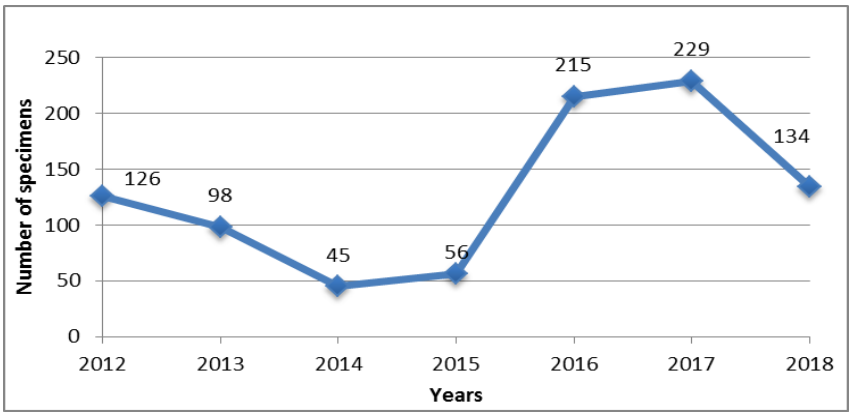


Fig. 4.2.4. Dynamics of the flight of the species *Acontia trabealis* (“Brînzeni” station).

The flight curves of the species *Agrotis exclamatonis* during the period 2012-2018 in the collection site "Brînzeni" station were analyzed. The species *Agrotis exclamationis*, or the heart and dart moth, is an important pest of agricultural crops. In the period 2012-2014, there is observed a stability of the number of individuals caught in the light traps. Starting with 2015, the number of individuals is increasing, the maximum share (169 individuals) being registered in 2017 (figure 4.2.5.).

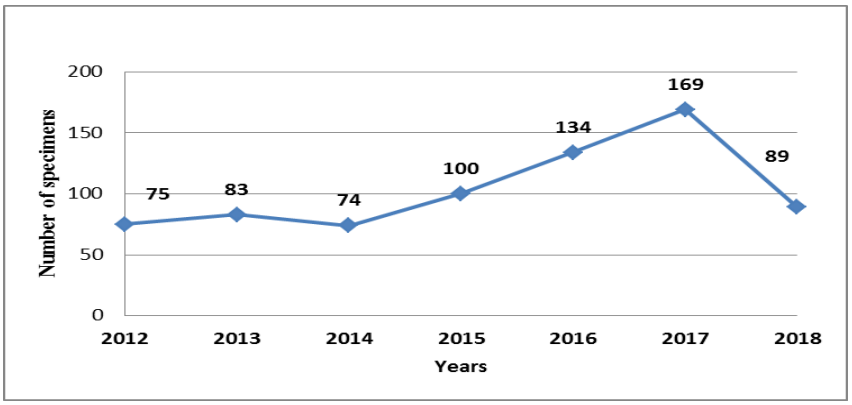


Fig. 4.2.5. Dynamics of the flight of the species *Agrotis exclamationis* (“Brînzeni” station).

4.3. The ecological spectrum of noctuids in the Republic of Moldova

The analysis of the ecological spectrum of the 425 moth species finds the predominance of mesophilic and xerothermophilic elements that make up 28% each. The mesohygrophil species register 15%. The share of mesothermophilic moths constitutes 9%, and in descending order follow the groups: mesoxerothermophilic - 5%, ubiquitous and hygrophilic - 4%, thermophilic - 3%, mesotermohigrophile - 2% and halophilic, thermohygrophilic and xerophilic - 1% each (figure 4.3.1.).

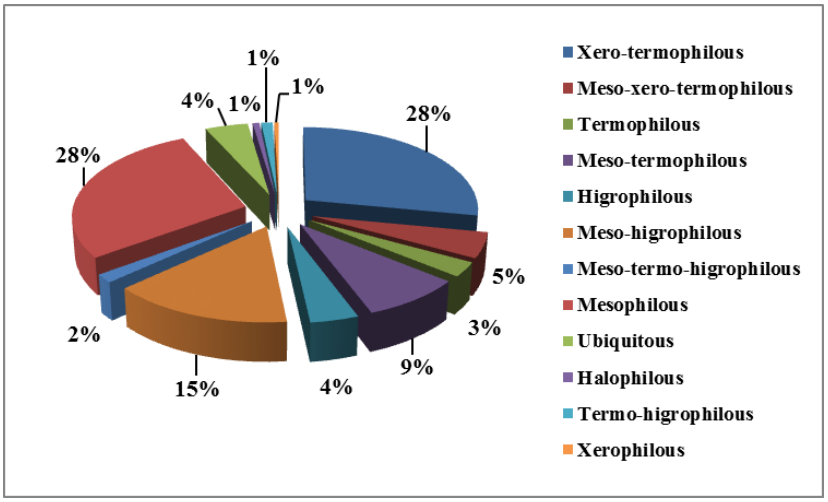


Fig. 4.3.1. The ecological spectrum of moths in the Republic of Moldova,%.

4.4. Trophic specialization of noctuids after the larval stage

Most of the species reported during the study period are polyphagous (66%), the oligophagous group constitutes 26% of the total number of species and only 7% belongs to the monophagous. The latter category includes the species: *Oxicesta geographica* monophagous relative to *Euphorbia sequieriana* and *E. cyparissias*; *Cucullia fraudatrix* – monophagous to *Artemisia* sp. (especially *A. vulgare*); *Phyllophila obliterata* – to *Artemisia annua, A. campestris* and *A. coerulescens*; *Auchmis detersa* – monophagous to *Berberis vulgaris*; *Oxytripia orbiculosa* – monophagous to *Iris pseudacorus*, *I. pumila* and *I. sandstone*; *Panolis flammea* – monophgous of *Pinus silvestris*; *Aedophron rhodites* – from *Phlomis* sp.; *Aegle kaekeritziana* – to *Delphinium* sp.; *Chloantha hyperici* – to *Hipericum* sp. (especially *H. perforatum*); *Dasipolia temples* – to *Heracleum* sp. (especially *H. sphondyleum*); *Leucania obsoleta*, *Archanara geminipuncta* and *Rhizedra lutosa* – monophagous from the species *Phragmites communis*.

Representatives of the genus *Cryphia* are the only ones in the family Noctuidae that feed on lichens and algae, and *Panolis flammea* is the only species of moths that grows on conifers.

The results obtained show the dominance of herbaceous species (other than grasses) (53%), grassy species representing 12%. Defoliating species make up 30%, of which 19% are leaf defoliators, 10% are shrub defoliators and only 1% of all the species form the defoliators of

softwoods. The root-consuming species represent 5%. The following groups include low share categories: species consuming lower plants (mosses, algae and lichens) and species with unknown diet, which make up 1% each (figure 4.4.1.).

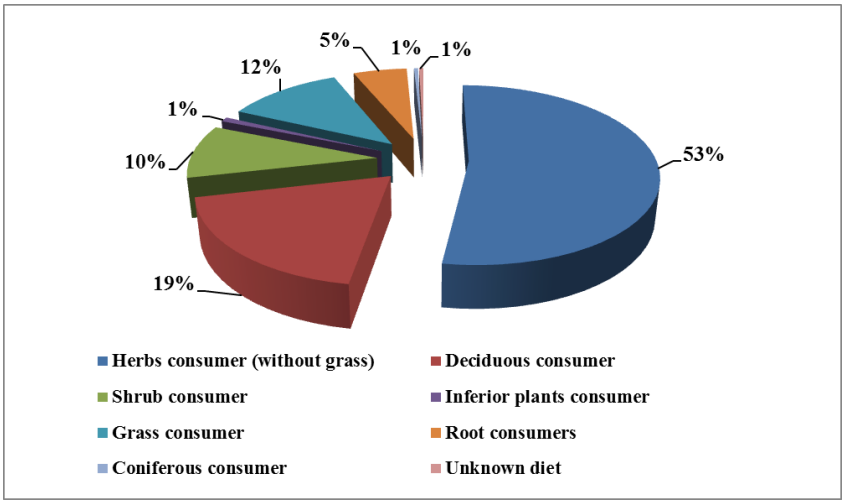


Fig. 4.4.1. The trophic spectrum of noctuids (larval stage) in the Republic of Moldova.

4.5. The importance and role of noctuids in natural ecosystems and agrobiocenoses

The moths, together with other groups of insects, serve as a major component in the circuit of substances in nature and play an important role in the food chain, serving as food in both adult and larval, egg, pupa stages, for insectivorous mammals, birds, reptiles, other insects, etc. The moths, in turn, serve as hosts for a range of parasites. Therefore, the decline of moths populations can have severe consequences on the ecosystem functioning [5, 27].

Recent studies attribute to moths an important role in pollination, but there is little research on this topic because conducting research on pollination at night is difficult [24].

It was found that about 50 species of noctuid from 8 subfamilies, which constitutes 12% of all species reported on the territory of the Republic of Moldova, cause damage to agricultural crops or they can be considered as potential pests, but 88% of moths have no economic value as pests.

About 20 species form the list of harmful pests both in the Republic of Moldova and in neighboring countries. The moths cause damage to agricultural crops, trees, shrubs, orchards, forests or vineyards, decorative plants, etc. The most important pests, which when exceeding the economic damage threshold (P.E.D) can cause considerable damages are: *Agrotis segetum*, *Agrotis exclamationis*, *Mamestra brassicae*, *Helicoverpa armigera*, *Autographa gamma*, *Xestia c-nigrum*, *Heliothis viriplaca*, *Agrotis ipsilon*, *Apamea sordens*, *Euxoa tritici*, *Anarta trifolii*, *Lacanobia oleracea*, *Spodoptera exigua*, *Oria musculosa*, *Apamea anceps*, *Ceramica pisi*, *Lacanobia suasa*, *Heliothis maritima*, *Schinia scutosa* and *Melanchra persicariae* [12].

Most species of harmful moths belong to the subfamily Noctuinae - 17 species, followed by the subfamily Xyleninae - 12 species, Hadeninae - 11, Heliothinae - 4, Plusiinae - 5, Acronictinae - 2 and the subfamilies Amphipytinae and Dilobina with one species each (figure 4.5.1.).

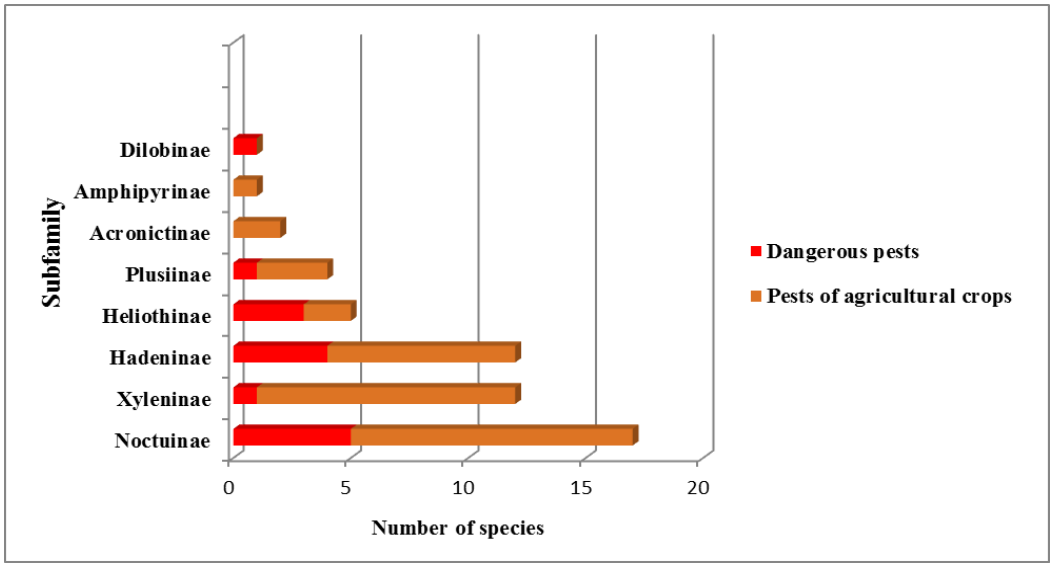


Fig. 4.5.1. Distribution by subfamilies of moth species with pest status in the Republic of Moldova

Vegetable crops, followed by technical and cereal crops, are affected by most noctuid species. Fewer noctuid species damage trees in forests, parks and forest strips (Figure 4.5.2.).

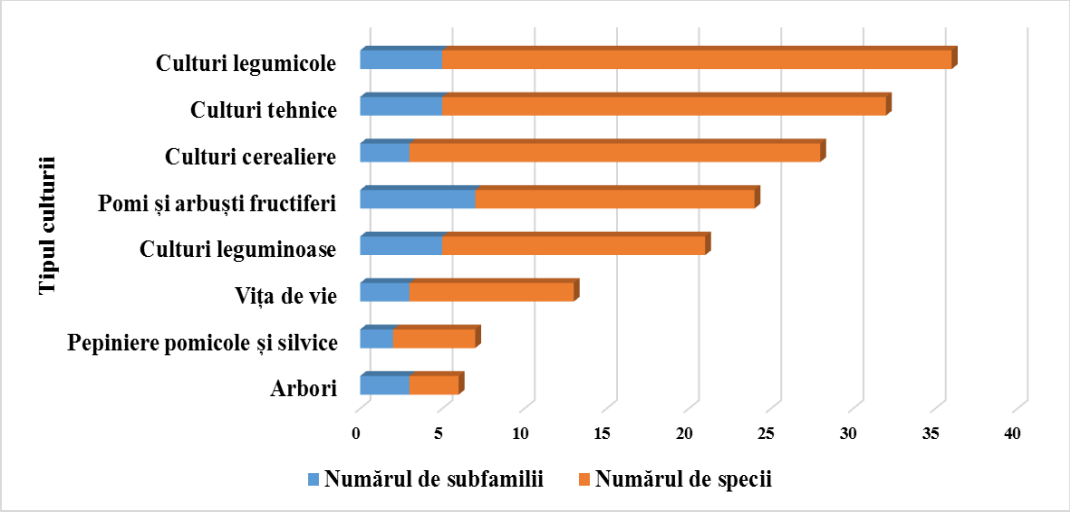


Fig. 4.5.2. Distribution of harmful moth species according to the type of affected plants.

In recent years, great attention has been paid to the study of invasive species and methods of combating them. The moth *Helicoverpa armigera*, or cotton bollworm, is an invasive species of Asian origin, spread throughout the Republic of Moldova. Since 1999, *H. armigera*, after being depressed for over 40 years, has taken first place in the list of pests of vegetable plants (tomatoes, peppers and eggplants), corn and tobacco in the Republic of Moldova, and in some

years they attackted the peas as well. Annual crop losses of vegetables, corn and other crops amount to 15-80%. The larvae consume over 120 species of plants.

Moths used in biological control. Known as economically important pests, some moth species are used in biological or integrated control, which is one of the main factors in solving priority ecological problems. For example, *Acontia candefacta*, a new species in the fauna of the Republic of Moldova, was introduced from North America to Russia in the biological fight against the dangerous invasive plant *Ambrosia artemisiifolia*, considered one of the most invasive plants in our country. The plant is dangerous not only because of allergenic pollen, but also because of the ecological, social and economic impact, including the potential to capture the habitats of other species.

Other species, such as *Calophasia lunula, Leucapamea ophiogramma, Hydraecia micacea, Cerapteryx graminis*, have been introduced to North America from Europe to combat invasive plants [26].

4.6. Species of endangered noctuids

The small number of moths species present on various lists such as the IUCN Red List, Bern Convention, Habitats Directive, CITES is due to the inefficient study of this group of insects, both nationally and internationally, which does not allow for risk assessment disappearance based on population distribution or status. Insufficient data and lack of information on the distribution, abundance, bioecological particularities classify many moth species in the endangered category. Before our investigations, there were no data on the status of butterflies of the family Noctuidae in the Republic of Moldova.

Endangered moths were analyzed in various countries and regions of Europe: Romania, Ukraine, Belarus, Hungary, Slovakia, Luxembourg, Poland, Carpathian Mountains, Great Britain, Czech Republic, Sweden, Austria, Lithuania, Estonia, Germany, Bulgaria. The distribution by subfamilies of endangered noctuid species in the Republic of Moldova in Europe is presented in figure 4.6.1.

Following our research we have identified the following species that require special protection and conservation measures: *Aedophron rhodites* (Eversmann, 1851), *Eucarta amethystina* (Hübner, 1803), *Polyphaenis viridis* (Villers, 1789), *Oxytripia orbiculosa* (Esper, 1799), *Gortyna cervago* (Eversmann, 1844), *Periphanes delphinii* (Linnaeus, 1758), *Xestia sexstrigata* (Haworth, 1809), *Dasypolia templi* (Thunberg, 1792), *Euxoa birivia* (Denis & Schiffermüller, 1775), *Meganephria bimaculosa* (Linnaeus, 1767) și *Euxoa vitta* (Esper, 1789).

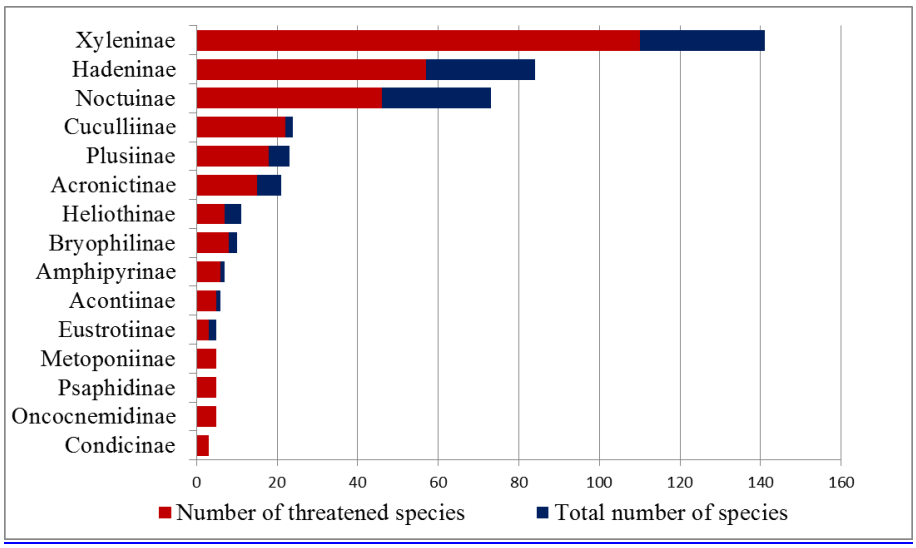


Fig. 4.6.1. Distribution by subfamilies of noctuid species in the Republic of Moldova protected at European level.

GENERAL CONCLUSIONS

The results obtained in correlation with the hypotheses issued, the purpose and the objectives formulated in the doctoral thesis "**The current state and importance of butterflies of the family Noctuidae (Lepidoptera) in the natural and anthropic ecosystems of the Republic of Moldova**", led to the following general conclusions:

1. As a result of the investigations, 425 species of moths were identified in the fauna of the Republic of Moldova, taxonomically classified in 169 genera and 17 subfamilies: Plusiinae – 23 species, Eustrotiinae – 5, Acontiinae – 6, Pantheinae – 1, Dilobinae – 1, Acronictinae – 21, Metoponiinae – 5, Cuculliinae – 24, Oncocnemidinae – 5, Amphipyrinae – 7, Psaphidinae – 5, Heliothinae – 11, Condicinae – 3, Bryophilinae – 10, Xyleninae – 141, Hadeninae – 84 and Noctuinae – 73 species.

2. During the research, 4 genera were reported (*Eucarta* Lederer, 1857*; Aedophron* Lederer, 1857*; Dasypolia* Guenée, 1852*; Atypha* Hübner, 1821*)* and 17 species (*Acontia candefacta* (Hübner, 1831); *Eucarta amethystina* (Hübner, 1803); *Eucarta virgo* (Treitschke, 1835); *Cucullia fraterna* Butler, 1878; *Aedophron rhodites* (Eversmann, 1851); *Hadena capsincola* (Denis & Schiffermüller, 1775); *Euxoa birivia* (Denis & Schiffermüller, 1775); *Euxoa cos* (Hübner, 1824); *Euxoa recussa* (Hübner, 1817); *Euxoa temera* (Hübner, 1808); *Chersotis margaritacea* (Villers, 1789); *Chersotis rectangula* (Denis & Schiffermüller, 1775); *Noctua tertia* Mentzer & al., 1991; *Xestia sexstrigata* (Haworth, 1809); *Dasypolia templi* (Thunberg, 1792); *Atypha pulmonaris* (Esper, 1790); *Abrostola asclepiadis* (Denis & Schiffermüller, 1775) new for the fauna of the Republic of Moldova [18, 19, 20, 23].

3. The zoogeographic analysis of moth areas in the fauna of the Republic of Moldova demonstrated the dominance of the palearctic elements (64%), followed by the mediterranean species (33%) and the moths with cosmopolitan, European and subtropical-tropical spread - 1% each.

4. It was found that the moth fauna of the Republic of Moldova is more similar to that of Hungary, Romania and Ukraine. The lowest similarity rates were obtained by comparing moth fauna of the Republic of Moldova with that of France and Russia. It was found that, although the surface of the Republic of Moldova is small compared to the other analyzed countries, the value of the specific richness concentration index is high, differing by a rich and diverse lepidopterological fauna. [17].

5. It has been shown that in the researched ecosystems, most species have a frequency of 71.43% – 44 species, 43% – 35 species and 57.14 % – 34 species, presenting an average ecological valence of adaptability to environmental conditions. The high frequency (100 %) has 17 species, and a low frequency (14.29 %) is characteristic for 15 moth species, which have a narrow ecological valence.

6**.** The analysis of the trophic spectrum in the larval stage shows the dominance of the species consuming herbaceous plants – 65% (non-grass consumers – 53% and consuming grasses – 12%), followed by the defoliating species that make up 30% (19% - defoliators of deciduous trees), 10% – defoliators of shrubs and 1% – defoliators of softwoods), root consuming species – 5%, and species consuming inferior plants and with unknown biology –1%.

7. It was established that about 50 species of moths from 8 subfamilies, which constitutes 12% of all species reported on the territory of the Republic of Moldova, can cause damage to various cultivated and spontaneous plants, so they can be considered as potential pests. Of these, about 20 species are included in the list of economically important pests both in the Republic of Moldova and in neighboring countries. About 88% of moths have no economic value as pests [12].

8. According to the ecological spectrum of the moth fauna of the Republic of Moldova, it was stated that the mesophilic and xerothermophilic elements predominate, which form groups of 28% each, followed by the mesohigrophile species – 15%, mesotermophile – 9%, mesoxerothermophile – 5%, ubiquitous and hygrophilic – of 4%, thermophilic – 3%, mesotermohigrofiles – 2% and halophiles, thermohygrophiles and xerophiles – 1% each.

9. The species *Aedophron rhodites, Eucarta amethystina, Polyphaenis viridis, Oxytripia orbiculosa, Gortyna cervago, Periphanes delphinii, Xestia sexstrigata, Dasypolia templi, Euxoa birivia, Meganephria bimaculosa* and *Euxoa vitta* are rare and endangered and need to be included in the 4th edition of the Red Book of the Republic of Moldova [22].

10. It was found that the flight of moths in seasonal dynamics extends from the first decade of March (*Orthosia* sp.) to the last decade of November (*Asteroscopus sphinx*), and in nocturnal dynamics they are more active between 24:00 - 2:00 a.m. in the summer period and between 22:00 - 24:00 p.m. in autumn.

RECOMMENDATIONS

1. It is recommended to continue specialized research on the process of acclimatization, local distribution and trophic relations of the new species for the fauna of the Republic of Moldova - *Acontia candefacta* (Hübner, 1831), introduced in Eastern Europe (Russia) in 1967-1968 from North America as a biological control agent of invasive plant species - *Ambrosia artemisiifolia*.

2. It is recommended to monitor the numerical population of the invasive species *Helicoverpa armigera* (cotton bollworm) - a dangerous pest with the potential to cause significant damage to crops in all regions of the Republic of Moldova.

3. In conditions of arid climate and desertification of landscapes, it is recommended to monitor xerothermophilic moth species (119 species) with the potential to cause damage to crops, especially species that have damaged different crops in neighboring countries.

4. It is recommended to use traps with ultraviolet light to control harmful moths in agricultural crops, this method being quite effective and harmless to human health and non-polluting for the environment.

5. The moth species *Aedophron rhodites, Eucarta amethystina, Polyphaenis viridis, Oxytripia orbiculosa, Gortyna cervago, Periphanes delphinii, Xestia sexstrigata, Dasypolia templi, Euxoa birivia, Meganephria bimaculosa and Euxoa vitta* have been proven to be rare and endangered and are proposed to be included in the National Operational List and the 4th edition of the Red Book of the Republic of Moldova.

6. It is proposed to extend the area occupied by the forest Nature Reserve “Cobîleni”, so as to occupy the meadow area, the coniferous forest, the steppe area and the limestone canyon on the banks of the Dniester River, taking into account the large number of moths but also other endangered species of animals and plants, reported on the Reserve territory.

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ADNOTARE

Țugulea Cristina. „Starea actuală şi importanţa fluturilor din familia Noctuidae (*Lepidoptera*) în ecosistemele naturale şi antropizate din Republica Moldova”, teză de doctor în științe biologie, Chişinău, 2020.

Teza constă din introducere, 4 capitole, concluzii generale şi recomandări, bibliografie din 326 titluri, 10 anexe, 139 pagini de text de bază, 58 figuri, 12 tabele. Rezultatele obținute sunt publicate în 13 lucrări științifice.

Cuvinte cheie: Lepidoptera, Noctuidae, diversitate, specii noi, specii rare, ecosisteme naturale, agrocenoze, relații trofice, dăunători, activitate sezonieră.

Domeniul de studiu: 165.04 – entomologie.

Scopul lucrării: evidenţierea stării actuale şi estimarea importanţei fluturilor din familia Noctuidae (Lepidoptera) în ecosisteme naturale şi agrobiocenoze din Republica Moldova.

Obiectivele: identificarea componenţei de specii a noctuidelor pe teritoriul Republicii Moldova; stabilirea apartenenţei speciilor de noctuide la principalele grupe zoogeografice; repartizarea biotopică a noctuidelor în dependenţă de preferinţele ecologice; analiza spectrului trofic în stadiul de larvă al noctuidelor identificate; estimarea importanței ecologice a noctuidelor din ecosistemele naturale şi agrobiocenoze; elaborarea listei adnotate a noctuidelor din Republica Moldova.

Noutatea şi originalitatea ştiinţifică. Pentru prima dată a fost efectuat un studiu amplu al noctuidelor din 17 subfamilii pe teritoriul Republicii Moldova, fiind colectați și analizați peste 11000 specimeni din 24 situri de colectare. Astfel, s-a stabilit că fauna noctuidelor (Noctuidae) din Republica Moldova constă din 425 specii, taxonomic încadrate în 169 genuri şi 17 subfamilii, dintre care 4 genuri şi 17 specii sunt noi pentru fauna ţării. Pentru prima dată a fost întocmită lista speciilor rare din familia Noctuidae, în număr de 11, care necesită protecție și conservare la nivel național. În premieră a fost analizată distribuţia biotopică, geografică şi spectrul trofic al noctuidelor, monitorizată dinamica sezonieră a zborului la capcana cu lumină albă şi ultravioletă şi a fost întocmită lista adnotată a noctuidelor din Republica Moldova.

Problema ştiinţifică a constat în stabilirea componenţei specifice, structurii ecologice şi particularităţilor funcţionării comunităţilor de noctuide în ecosistemele naturale şi agrobiocenozele din Republica Moldova.

Semnificaţia teoretică. Rezultatele studiului faunei, ecologiei, importanței noctuidelor din Republica Moldova au o contribuţie valoroasă la cunoaşterea acestui grup taxonomic de lepidoptere. Datele despre speciile înregistrate pentru prima dată în fauna ţării constituie un aport semnificativ la completarea bazei de date informaţionale din Europa.

Valoarea aplicativă. Rezultatele principale ale tezei sunt parte componentă a temei de cercetare ştiinţifico-fundamentală şi aplicativă a Institutului de Zoologie. Rezultatele investigaţiilor vor îmbogăţi patrimoniul teoretic şi empiric, privind diversitatea faunistică, structura spaţială, spectrul trofic şi dinamica sezonieră a noctuidelor în ecosistemele naturale şi agrobiocenoze.

Implementarea rezultatelor ştiinţifice. Datele despre speciile de noctuide cu statut de dăunătoare culturilor agricole pot fi utilizate de către specialişti ca suport metodologic la elaborarea măsurilor de combatere. Informația despre acest grup de insecte este utilă la pregătirea tezelor de licență și de masterat. Rezultatele obţinute sunt utilizate ca suport metodologic la realizarea planurilor de supraveghere a dăunătorilor și cercetărilor efectuate în cadrul rezervației științifice ”Codrii”, totodată pot fi utilizate la elaborarea şi redactarea ediţiei a IV-a a Cărţii Roşii a Republicii Moldova.

ANNOTATION

Tugulea Cristina. „Current status and importance of butterflies of the Noctuidae (Lepidoptera) family in the natural and anthropogenic ecosystems of the Republic of Moldova", PhD thesis in Biology, Chisinau, 2020.

The thesis consists of Introduction, 4 chapters, general conclusions and recommendations, bibliograpgy of 326 titles, 10 appendices, 139 basic text pages, 58 figures, 12 tables. The results are presented in 13 publications.

Keywords: Lepidoptera, Noctuidae, diversity, new species, rare species, natural ecosystems, agrocenoses, trophic relationships, pests, seasonal activity.

Field of study: 165.04 - Entomology.

Purpose: highlighting the current status and estimating the importance of butterflies of the Noctuidae family (Lepidoptera) in natural ecosystems and agrobiocenoses of the Republic of Moldova.

Objectives: to identify the composition of noctuid species on the territory of the Republic of Moldova; to determine the association of the noctuids in order to establish their belonging to the main zoogeographical groups; to perform the biotopic distribution of noctuids, depending on ecological preferences; to analyze the trophic spectrum in the larval stage of the noctuids identified; to estimate the ecological significance of noctuids in the natural ecosystems and agrobiocenoses; to make the annotated list of noctuids in the Republic of Moldova.

Scientific novelty and originality. It is for the first time that an extensive study of noctuids from 17 subfamilies was performed on the entire territory of the Republic of Moldova, being collected and analyzed over 11,000 specimens from 24 collection sites. Thus, it was established that the fauna of noctuids (Noctuidae) in the Republic of Moldova consists of 425 species, taxonomically classified into 169 genera and 17 subfamilies, of which 4 genera and 17 species are new for the country's fauna. The list of 11 species of butterflies from the Noctuidae family, which need protection and conservation at national level, has been made for the first time. The biotopic, geographical distribution and the trophic spectrum of noctuids were analyzed, the seasonal dynamics of the flight to the trap with white and ultraviolet light was monitored and the annotated list of noctuids from the Republic of Moldova was drawn up.

The scientific problem consisted in establishing the specific composition, ecological structure and peculiarities of the functioning of noctuid communities in the natural ecosystems and agrobiocenoses of the Republic of Moldova.

Theoretical importance. The results of the study of fauna, ecology, importance of noctuids in the Republic of Moldova have an important contribution to the knowledge of this taxonomic group of lepidoptera. The data on the species registered as new for the country's fauna constitute a significant contribution to the completion of the information database in Europe.

The applicative value of the paper. The major findings of this thesis are part of the fundamental and applicative scientific research topic of the Institute of Zoology. The conducted investigations will improve the theoretical and empirical heritage in terms of fauna diversity, spatial structure, trophic spectrum and dynamic range of noctuids in natural ecosystems and agrobiocenoses.

Implementation of scientific results. The data on the species of noctuids that are harmful to agricultural crops can be used by specialists as methodological support for the elaboration of control measures. The information about this group of insects is useful in the elaboration of bachelor's and master's theses. The obtained results can be used as methodological support for the implementation of pest monitoring plans and research conducted within the Natural Reserve "Codrii", at the same time they can be used in the elaboration and writing of the 4th edition of the Red Book of the Republic of Moldova.

CURRENT STATUS AND IMPORTANCE OF BUTTERFLIES OF THE NOCTUIDAE FAMILY (*LEPIDOPTERA*) IN NATURAL AND ANTHROPIZED ECOSYSTEMS IN THE REPUBLIC OF MOLDOVA

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