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FAIRY FLY DIVERSITY
(HYMENOPTERA, CHALCIDIOIDEA, MYMARIDAE) IN NATURAL AND ANTHROPIZED ECOSYSTEMS, FROM THE EASTERN PART OF ROMANIA

SUMMARY OF PhD. THESIS

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CONTENTS

INTRODUCTION 4
FIRST PART 7
1. Research history 7
   1.1. Global Research history regarding Fam. Mymaridae 7
   1.2. Research history regarding Fam. Mymaridae in Romania 21
2. The natural environment 27
   2.1. The physico-geographical characterization of Moldova 27
   2.2. The physico-geographical characterization of Dobrogea 31
   2.3. The main types of ecosystems identified in the eastern part of Romania 35
3. Materials and methods used for fairy fly research 48
   3.1. Fairy fly collecting 49
      3.1.1. Collecting the material with the sweep net and an pooter/aspirator 49
      3.1.2. Collecting the material with the yellow pan traps 51
      3.1.3. Collecting the material with the Malaise trap 52
      3.1.4. Rearing fairy fly from parasitised eggs 52
   3.2. Preparing, preservation and storage 53
      3.2.1. Mounting the fairy fly 55
      3.2.2. Slide mounting 57
      3.2.3. The synecological analysis 60
4. General morphology and taxonomy 64
   4.1. Morphology of the head 65
   4.2. Morphology of the mesosoma 84
   4.3. Morphology of the metasoma 95
   4.4. Morphology of the larvae 102
5. Aspects regarding fairy fly diversity 103
   5.1. Aspects regarding fairy fly diversity in Palaearctica 103
   5.2. Fairy fly diversity in Europa, Subfamily Alaptinae Annecke & Doutt (1961) 107
SECOND PART

6. Fairy fly systematics and diversity in the eastern part of Romania

6.1. Introduction to the fairy fly systematics and diversity
6.2. The systematics and diversity of the European genera, with a key to genera
6.3. Fairy fly diversity in the Eastern part of Romania
6.4. Diagnosis of the genera recorded from Romania, with notes regarding the collected and identified species
6.5 Diversity of the fairy fly genera depending on the altitude
6.6. Fairy fly specific diversity in different types of ecosystems from the Eastern part of Romania

7. Aspects regarding fairy fly biology and ecology from the Eastern part of Romania

7.1. Aspects regarding fairy fly biology and ecology
7.2. Contributions to the knowledge of the hosts of some species belonging to the Fam. Mymaridae
7.3. Aspects regarding the fairy fly diversity and ecology from alfalfa crops
7.4. The numerical ratio between microhimenoptera families belonging to the Superfamily Chalcidoidea in the alfalfa crops
7.5. The synecological analysis of some fairy flies from alfalfa crops

CONCLUSIONS

Published papers by the author of this thesis on the proposed theme

REFERENCES
I started to study the Mymaridae family, which are less studied in our country, years ago; the number of known species was less than 50. It was therefore necessary to fill that gap.

The purpose of our thesis is to bring contributions to the study of the fairy fly diversity in the Eastern part of Romania, and to achieve this we proposed the following general objectives: composition of the research history; collecting material and its preparation; preparing a scientific collections; material identification and presentation of genera and species; the study of morphological and biological aspects; preparation of an identification key to European genera etc. Our thesis consists of 7 chapters that treat different aspects of history, collecting methodology, taxonomy, environmental aspects, biology, morphology, ecology, systematics and diversity regarding the Fam. Mymaridae.

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1. Research history

The historical aspects of the study regarding Fam. Mymaridae are priority and are done for the first time. From all the specialists of this group, we will present only a few.

In the great genus *Ichneumon*, Linnaeus (Linné) described and published in 1758 and 1767, in his "Systema naturae", the species *Ichneumon atomus* (= *Anagrus atomus* Haliday). Haliday established this family in 1833. Walker (1846) briefly described the fairy fly species known until 1846.

Fürster (1847, 1856) published the first monograph of the Fam. Mymaridae, continuing the line proposed by Haliday (1833). Kryger (1950) published „The European Mymaridae comprising the Genera known up to c. 1930“. In 1948, Prof. Hubert Robert Debauche published the monograph „Étude sur les Mymaromnidés et les Mymaridae de la Belgique (Hymenoptera Chalcidoidea)“. Vladimir Triapitsyn (1987), from Russia, published a key for the European species. Soyka published
from 1931 to 1961 many papers regarding the taxonomy and the diversity of Fam. Mymaridae. Viggiani described some genera and species belonging to Fam. Mymaridae; he also published data regarding their biology. Huber published from 1986 until the present time (2011) many papers about the systematics, the taxonomy, the ecology and the biology of Fam. Mymaridae. Noyes (2003) published the site „Universal Chalcidoidea Database”. Serguei Triapitsyn started to study this group of parasitoids at the end of the last century and published many papers.

In România, the study of Fam. Mymaridae was started in Cluj by Prof. Varvara V. Radu and Margareta Boțoc. Boțoc (1965) made the dissertation „Studiul sistematic și ecologic al calcidoidelor din Transilvania” at the „Babeș-Bolyai” University from Cluj-Napoca. Andriescu (1996) published a work on the chalcidoid fauna from the Danube Delta and he mentioned three fairy fly species in his paper. Dimitriu (2001) recorded a few Gonatocerus species from Moldova (Romania).

Contributions to the study of Fam. Mymaridae in Romania have also been made by: Pricop (2008; 2009a, b, c; 2010a, b, c; 2011a, b), Pricop and Andriescu (2011).

![Fig. 1 The collecting sites.](image-url)
2. The natural environment

The Eastern part of Romania (Fig. 1), studied by us, is represented by the historical provinces of Moldova and Dobrogea. The fairy flies are spread in almost all the types of ecosystems belonging to this region.

3. Materials and methods used for fairy fly research

Much of the collected material was made with an entomological sweep net (Fig. 2), but we also used yellow pan traps, the Malaise trap, etc. Regarding rearing fairy flies from parasitised eggs, it was necessary to take great care to avoid both fungi and bacteria attack caused by moisture; excessive dryness, however, also harms the eggs.

Sorting and preparing the material were performed using a stereomicroscope. The fairy flies are usually mounted on microscope slides in Canada balsam. Almost all determinations were performed under the optical microscope. Preservation and storage were made after sorting and mounting the material.

In order to do a synecological analysis, some ecological indexes were calculated: abundance, dominance, frequency, constancy and the ecological significance index (Dzuba index – W).
Figs. 3 Heads and antennae: a, b – Gonatocerus; c – Anagrus; d – Erythmelus; e – Mymar; f, j – Dicopus; g – Anaphes (Anaphes); h – sensilla basiconica; i – Anaphes (Patasson) (original).
4. General morphology and taxonomy (Figs. 3, 4, 5, 6 and 7)

The Fairy flies belong to the Superfamily Chalcidoidea, Ord. Hymenoptera – Subord. Apocrita, (Insecta). Fairy flies are small, many species being smaller than 0.5 mm. Almost all are smaller than 3 mm. The general color can be black, brown or reddish brown, with various shades of yellow or white.

The head generally has a vertical disposition; its shape can be trapezoidal.

The mouth parts are for licking, breaking and sucking, some parts are generally much smaller and in a less varied form in many genera, the fluctuations involving tooth number and shape of the mandibles etc.

Antenna (in females) consists of 5 sectors: the radicle, the scapus (longer than the radicle), the pedicel, the funicle (consists in general of 5 to 8 articles) and clava or club (1, 2, 3 – segmented).

Fairy fly mesosoma has in general the characteristic appearance of Hymenoptera – Apocrita. Mesosoma shelters the phragma, which is a strong hemi-conical structure (spoon-like).

Fairy flies have large wings relative to their body size, but there are species which can be brachypterous or wingless. Wing veins are reduced.

The metasoma in males and females consists of 9 segments.

The first metasomal segment is the propodeum, fused with the mesosoma, the second segment is strongly narrowed forming the petiolus or is wide like the other metasomal segments.

Male genitalia (of different species) vary greatly from one genus to another. The female genitalia consist of a noticeable ovipositor or terebra.

5. Aspects regarding fairy fly diversity

In terms of specific diversity, Fam. Mymaridae groups worldwide around 1420 species, and 101 genera. Only 21 genera and approximately 460 species are recorded from Europe. Only 18 genera are recorded from Romania.
Figs. 4 Female antennae: a – Alaptus; b – Dicopus; c – Anagrus; d – Ooctonus; e – Stephanodes; f – Erythmelus (Parallelaptera); g – Erythmelus (Erythmelus); h – Mymar; i – Arescon (original).
Figs. 5 Female antenna with a distinct clava: a – *Gonatocerus*; b – *Dicopus*; c – *Stephanodes*; d – *Stethynium* (original).
SECOND PART
6. Fairy fly systematics and diversity in the eastern part of Romania

Before our study, only 47 fairy fly species were recorded in Romania (one species was previously misidentified). Currently, from our country, a total of 92 valid species are recorded. From the Eastern part of Romania, we were able to identify a total of 74 species, two of them being new to science and 44 new for the Romanian fauna. We also identified four new genera, recorded for the first time in the Romanian fauna: *Dicopus* Enock, *Eustochus* Haliday, *Omyomymar* Schaufl, *Pseudocleruchus* Donev & Huber. Fairy fly diversity depends on the altitude: not just the generic diversity but also the specific diversity decreases with the altitude.

Fairy fly diversity in different types of ecosystems in the Eastern part of Romania: depending on the main type of ecosystem, the highest number of identified fairy flies species was recorded in meadows (grassland) = 48 species, followed by forests with 35 species and the wetlands with 31 species. Anthropized ecosystems have fewer species. From sub-alpine areas we have identified only 10 species.

7. Aspects regarding fairy fly biology and ecology from the Eastern part of Romania

All fairy flies are egg parasitoids.

Contributions to the knowledge of the hosts of some species belonging to the Fam. Mymaridae: we obtained 9 fairy fly species from different eggs belonging to different species of insects. Many of the eggs collected from the field did not hatch in our laboratory conditions, humidity and temperature playing an important role in the development of both the host and the parasitoid. Prior to this study, only a few species were obtained in Romania by rearing: *Anaphes diana* from the eggs of *Sitona* spp. and *A. flavipes* from the eggs of *Lema melanopa*. By rearing our material we obtained from Homoptera eggs – the species: *Anagrus atomus*, *Polynema striaticorne*, *Polynema sp.*, *Stethynium triclavatum*; from Psocoptera eggs: *Alaptus fusculus*, *Alaptus miniumus*, *Alaptus tritrichosus* and from Coleoptera eggs: *Cleruchus polypori* and *Anaphes sp*. We have managed to establish 10 host – parasitoid relationships.
Figs. 6 Mesosoma, metasoma, leg and genitalia:
a, c, i – Gonatocerus; b – Ooctonus; d – Polynema; e – Anaphes;
f – Anagrus; g, h – Dicopus; j – Camptoptera (original).
Fig. 7 Fore wings: a – Gonatocerus; b, d – Anagrus; c – Alaptus; e – Dicopus; f – Erythmelus (Parallelaptera); g – Anaphes; h – Erythmelus (Erythmelus); i – Ooconus; j – Mymar (original).
Contributions to the biological study of *Polynema striaticorne*:

The biology of *P. striaticorne* is linked to that of *Stictocephala bisonia*, a species originating from America. *S. bison* is a polyphagous species attacking different plant species, generally woody. We found that *S. bisonia* attacks in Moldova, predominantly apple and walnut trees, but sometimes it also attacks vines. From the spontaneous flora, *S. bisonia* attacks species of willows (*Salix capraea, S. cinerea*), but sometimes also the hornbeam.

Following the dissections performed on the material collected from Horpaz - Iaşi (2012), we did not find many *S. bisonia* eggs. From these eggs, only 13.08% were parasitized.

The numerical ratio between microhimenoptera families belonging to the Superfamily Chalcidoidea in the alfalfa crops: all 300 individuals belonging to Fam. Mymaridae represent 6.4% (Fig. 8) of all the individuals belonging to Chalcidoidea (4677 specimens), collected by us from alfalfa in August 2011. We identified 27 species belonging to Fam. Mymaridae.

![Fig. 8 Percentage of all individuals collected in August. 2011 in alfalfa, grouped into different chalcidoid families (original).](image)

For the synecological analysis of the fairy flies from alfalfa crops collected in August. 2011, we calculated the: abundance (A), dominance (Da), constancy (Ct.) and ecological significance index (W). We present below only the ecological significance index (W).
The ecological significance index (W, Dzuba Index) indicates the following:

- **W1 (accidental species)**: Anaphes fuscipennis, Anaphes (A.) medius, Anaphes sp. A, Gonatocerus ovicenatus, Mymar pulchellum, Ooctonus notatus, Polynema aff. fumipennis, Polynema aff. striaticorne, Polynema sp. D;


- **W4 and W5 (characteristic species)**: Anagrus atomus, Erythmelus flavovarius, Gonatocerus sulphuripes.

**CONCLUSIONS**

- We realized for the first time the entire research history of Fam. Mymaridae, in chronological order;

- We presented the known and recommended methodology for: collecting, rearing, mounting, preservation and storage. We also made some additions and improvements to this methodology in order to collect fairy flies more efficiently;

- Based on our material and observations, we formulated interpretation, we expressed opinions and developed original descriptions regarding various structures that belong to: the head, the mouth parts, the antennae, the mesosoma, the wings, the legs, the metasoma and the female and male genitalia, all belonging to various genera;

- The physico-geographic conditions of the studied areas (Moldova and Dobrogea) and the ecological features of the main types of ecosystems were briefly presented. Our material was collected from more than 50 localities, belonging to a total of 10 counties;
- Fairy fly morphology was illustrated in detail with drawings, photomicrographs and scanning electron microscopy, for most of the studied characters;

- A brief review regarding 27 known fairy fly genera recorded from Palaearctic Region is presented; we insist on the geographical distribution, species richness, status and level of knowledge;

- We revealed statistics regarding the genera and species belonging to the historical subfamily Alaptinae, from Europe. We indicated, for comparison, the total number of species described until now as well as the number of valid species;

- We presented all 21 genera belonging to Fam. Mymaridae, recorded until now from Europe. Notes and diagnosis were given for the 18 fairy fly genera recorded by us in Romania. The genera Omyomymar Schauff and Ptîlomyマ Annecke & Doutt are recorded for the first time in Europe;

- We made a modern and detailed identification key for the European genera belonging to Fam. Mymaridae. The genus Pseudocleruchus Donev & Huber is inserted for the first time in an identification key. We illustrated in detail the morphology of these 21 European genera;

- Four genera are new for the Romanian fauna: Dicopus Enock, Eustochus Haliday, Omyosmy 마 Schaff and Pseudocleruchus Donev & Huber. Omyomymar is recorded for the first time in Europe. Dicopus and Eustochus are recorded for the first time in the Eastern part of Europe. Pseudocleruchus is recorded for the first time in Romania, having been previously described in Bulgaria;

- We presented a total of 74 species, belonging to Fam. Mymaridae, identified from the Eastern part of Romania, of which: two species are new to science and are described here for the first time, 44
species are new for the Romanian fauna, being recorded here for the first time;

- The two described species are: *Omyomymar andriescui* sp. nov. and *Pseudocleruchus moglani* sp. nov. An original identification key is given for all known species that belong to *Pseudocleruchus*. An identification key was adapted for all described species that belong to *Omyomymar*;

- The subgenera *Anagrella* and *Paranagrus* that belong to *Anagrus*, the subgenus *Doryclitus* that belongs to *Polynema*, the subgenus *Parallelaptera* that belongs to *Erythmelus*, and the subgenus *Sphegilla* that belongs to *Camptoptera*, are recorded for the first time in Romania;

- Data regarding the fairy fly fauna, number of specimens, the gender (sex) of each specimen, date and locality where they were collected and who collected the material are given;

- We also give some notes regarding Soyka's type material, examined at the Natural History Museum in Vienna. A review of Gonatocerus „ater” species group is given. *Gonatocerus intermedius* Boțoc remains a valid species;

- We proposed three synonyms for *Anaphes medius* Soyka, 1946: *Anaphes fuscipennis* Hal. *sensu* Debauche, 1948, *Anaphes pulchripennis* (Soyka, 1949) and *Anaphes specieosus* (Soyka, 1955);

- We found *Anaphes latipterus* Boțoc and proposed that it is synonymous with *Anaphes pectoralis* Soyka;

- We made tables with the species distribution according to the elevation gradient and the species distribution in the major ecosystem types (grasslands, forests, wetlands, crops etc.). We found a decrease in generic diversity, and also specific diversity with altitude increase;
- The most widespread species in various ecosystem types belong to the genera: Gonatocerus, Anaphes, Anagrus, Erythmelus, Ooctonus and Polynema;

- By rearing our material we managed to establish 10 host – parasitoid relationships. Alaptus tritrichosus was obtained for the first time from Psocoptera eggs, and Polynema sp. was obtained also for the first time from the eggs of Macrosiphum rosae;

- More detailed aspects were presented about the biology of Polynema striaticorne, which parasitizes the eggs of Stictocephala bisonia and presents a 13.08% parasitization ratio;

- We established the numerical and quantitative proportion of fairy flies in alfalfa crops (11 crops), which constitutes 6.41% from the total recorded chalcidoids, that belong to 12 families;

- We also did an ecological study on the fairy flies in alfalfa and we identified 27 morphospecies belonging to 8 genera;

- A synecological analysis of the fairy flies in alfalfa was also performed, the most abundant species in the crops being Anagrus atomus. The most frequent species (characteristic of these crops) are: Anagrus atomus, Erythmelus (E.) flavovarius, Gonatocerus sulphuripes. Anagrus atomus plays a very important role in the economy of this type of crop followed by other species of Gonatocerus and Anaphes.

**PUBLISHED PAPERS BY THE AUTHOR OF THIS THESIS ON THE PROPOSED THEME:**

**ISI paper:**

**B+ CNCSIS (BDI) papers:**


**PRICOP, E.,** 2010c. First record of Gonatocerus novickyi Soyka (Hym.: Mymaridae) in România, with notes on other species of Gonatocerus (litoralis group), Analele Științifice ale Universității „Al. I. Cuza” Iași, s. Biologie animală, Tom LVI, 2010, p. 77-82.

**PRICOP, E.,** 2011a. First record of Pseudocleruchus Donev & Huber (Hymenoptera: Chalcidoidea: Mymaridae) in România, with notes
The author of this thesis has accumulated until this date 5 ISI citations and other citations in international databases as: «Universal Chalcidoidea Database» and citations in some scientific journals.

**SELECTIVE REFERENCES**


http://www.nhm.ac.uk/entomology/chalcidooids/index.html


