"ALEXANDRU IOAN CUZA" IAŞI UNIVERSITY

FACULTY OF BIOLOGY

PH.D SCHOOL OF CHEMISTRY AND SCIENCES OF LIFE AND EARTH

# THE DIVERSITY OF PENTATOMIDAE (HETEROPTERA: PENTATOMIDAE) OF THE NATURAL RESERVES OF IASI COUNTY AND INTERACTIONS OF CERTAIN TAXA WITH THE HOST PLANTS

**ABSTRACT OF THE PhD THESIS**

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**SUMMARY**

## Introduction

The purpose of this thesis was that of contributing to the knowledge on Pentatomidae bugs from the natural reserves of Iasi County. The objectives of the thesis are: determining the entomological material from the reserves based on their morphological characteristics, including the external genitalia of the male and female, investigating the diversity of the Pentatomidae family in the study area, realizing a synecological analysis for the reserves in research and investigating certain biological aspect of the Pentatomidae.

## CHAPTER I: RESEARCH HISTORY

Pentatomidae family Leach, 1815 is part of the Pentatomoidea suprafamily, Pentatomorpha infraorder, Heteroptera suborder, Hemiptera order (Schuh and Slater, 1995; Derjanschi and Péricart, 2005).

The bases of the systematics of this family were set by Carl von Linnaeus. J. C. Fabricius (1775, 1803) and M. Olivier (1789) continue the classification started by Linnaeus.

In the 19th century, the most famous heteroptologists are: W. E. Leach (1815), C. F. Fallén (1829), P. A. Latreille (1831), F. Laporte (1833), Amyot and Serville (1843), G. Flor (1860), F. X. Fieber (1861), C. Stål (1864, 1865, 1870-1876), Puton (1899), Lethierry and Severin (1893-1896).

In the 20th century, the research on this Family becomes more diverse. Research on fauna, morphology and biology are being published. With the development of the molecular biology, the taxonomic research appeals to the techniques of this new field.

As for the study of the heteropteres in Romania, the first research papers were published by C. Fuss (1853, 1862). At the end of the 19th century and beginning of the 20th century, G. Horváth and A. L. Montandon contribute to the knowledge on heteropters from Transylvania, Banat, Dobrogea, Muntenia and Moldavia. In the 20th century, I. Sienkiewicz, E. Schneider and B. Kis continue the research on this group.

In Romania there are 74 species belonging to the Pentatomidae family and in the department of Iasi, prior to our research, there were only 19 species identified (Kis, 1984).

## CHAPTER II. PHYSICO-GEOGRAPHICAL CHARACTERISTICS OF THE RESEARCH AREA

The protected areas of the department of Iasi where we collected our entomological material are: “Poiana cu Schit”, “Pădurea Gheorghiţoaia”, “Pădurea Uricani”, “Făgetul secular Humosu”, “Pădurea Tătăruand”, “Pădurea and pajiştile de la Mârzeşti”, “Sărăturile de la Valea Ilenei”, Fâneţele seculare de la “Valea lui David”, “Dealul lui Dumnezeu”, Pădurea Ciric, “Lunca Mirceşti”.

## CHAPTER III. MORPHOLOGICAL CHARACTERISTICS OF THE PENTATOMIDAE FAMILY

The Pentatomidae family includes almost 900 genii and over 4700 species all over the world (Rider, 2006). The species included in this family acre characterized by the following aspects: generally, the antennae consisting of 5 articles (Derjanschi and Péricart, 2005), the existence of trichobotria behind the stigma (Kis, 1984, Schuh and Slater, 1995); the triangular scutellum doesn’t generally cover the abdomen, except for the species of the Podopinae family; the tarsus consisting of three articles (Vinokurov et al., 1988), and rarely out of two (Cyrtocorinae); the chtinization of the invagination of the spermatech ampoule; this is seen as the most common family trait (Derjanschi and Péricart, 2005; Rider, 2006).

In order to identify the species, we need to analyse the external genitalia pieces, especially in the case of the male. The structure of the genital capsule and the shape of the parameres are the main characters used (Figure 1). In the case of more difficult genera, we resort to the morphological analysis of the female external genitalia (Figure 2) (Derjanschi and Péricart, 2005; Grazia and Schwertner, 2008; Gapon, 2010).

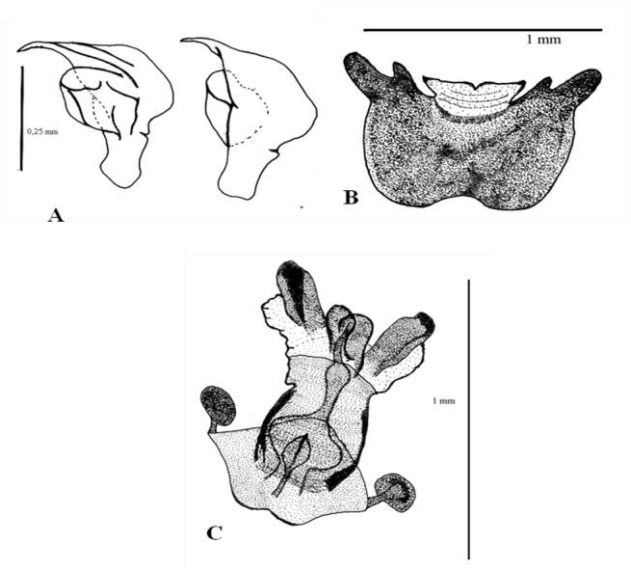


**Figure 1. *Eurydema oleracea* L. – male genitalia. A - paramere; B - genital capsule; C - penis (Original).**

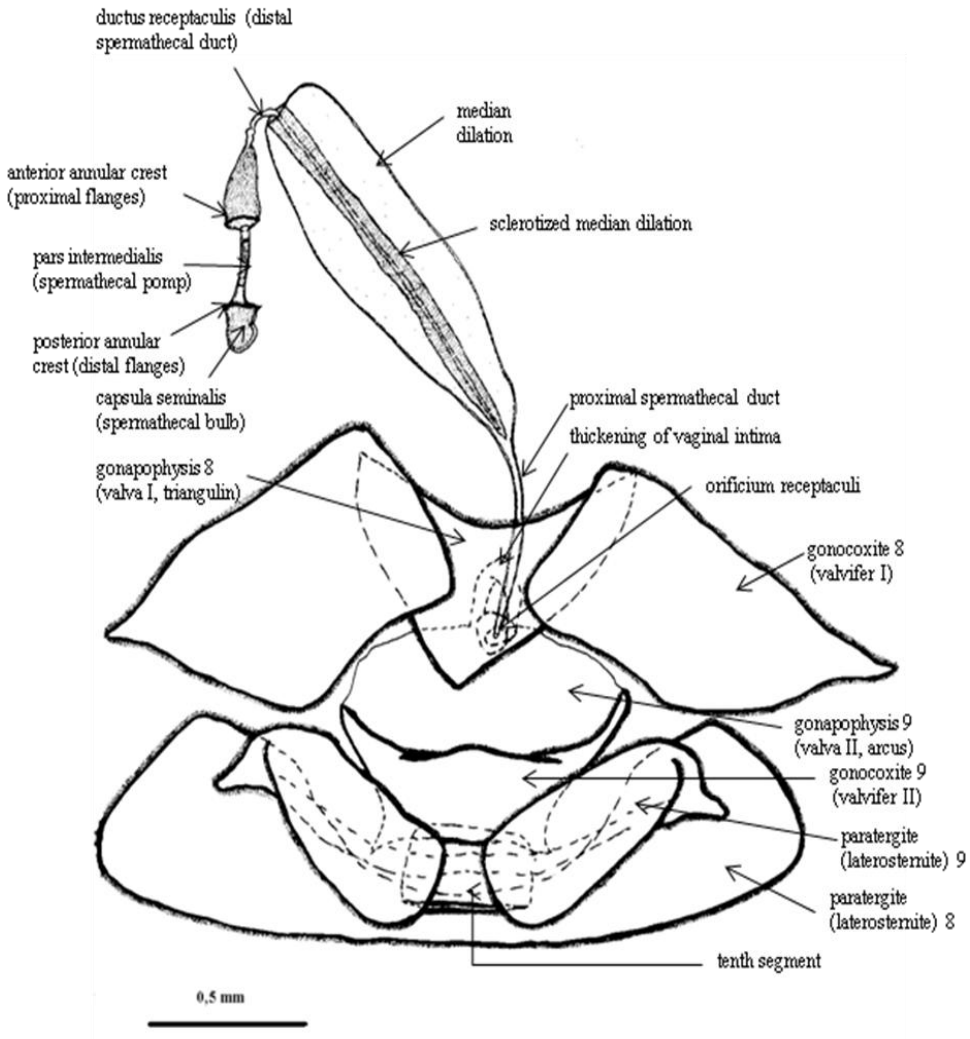


**Figure 2. Female external genitalia (*Eurydema ornata* L.) (Original)**

## CHAPTER IV. MATERIALS AND METHODS

### 4.1. Entomological study material

The entomological material examined from the personal collection comes from 11 protected areas of the department of Iasi, but also from the Botanical Garden "Anastasie Fătu" and its surroundings. From these areas we collected 338 specimens belonging to 25 species of the Pentatomidae family.

Moreover, we analysed 873 specimens belonging to the *Eurydema* genus, coming from the collections of 5 museums: The National Museum of Prague, The Moravia Musem of Brno (Czech Republic), The "Grigore Antipa" National History Museum, The National History Museum of Sibiu, The Museum Complex of Sciences of Nature "Ion Borcea" Bacău.

In order to write the chapter on the biology of the Pentatomidae and their interactions with the host plant we made lab and field observations. The field observations were made during the summer of 2012 and 2013, between 10 a.m. and 2 p.m.

In order to conduct the lab observations the specimens were introduced in special breeding boxes. In order to observe the preferences in terms of host plant, a box contained 6 to 8 specimens of the same species were fed a single kind of plant. The mating specimens were isolated till the oviposition and reintroduced in the breeding boxes.

### 4.2. Collecting, preparing, breeding

For the collecting of the heteropters we generally used the entomological net0 The heteropters can be conserved either set on sequins in an insectarium, or in 70% alcohol. In order to correctly identify the species the examination of the genitalia is required, especially for the male (Gapon, 2001; Derjanschi and Péricart, 2005). The pieces of the genitalia for the males of the Pentatomidae family can be drawn on a clear camera, immersed in glycerin on a wells blade. In the case of the female, the external genitalia has a plane structure amd can be set in order to be drawn on a clear camera or to be photographed. In order to highlight the semi-dark structures we used Chlorazol Black E.

In order to breed the insect, one needs special boxes. The lid and side walls are partially cut out to allow the air in. The feeding source generally changed every two days. We also need a source of humidity. The temperature for breeding insects must be maintained between 20° and 30°C.

### 4.3. Synecological analysis

In order to conduct a synecological analysis we computed the analytical indexes (abundance, dominance, frequency, constancy) and the ecological indexes (the ecological significance index (W), the Simpson diversity index and the Shannon Wiener index)

## CHAPTER V. SYSTEMATIC INDEX OF THE SPECIES OF THE PENTATOMIDAE FAMILY COLLECTED FROM THE NATURAL RSESRVES OF THE DEPARTMENT OF IASI DURING THE STUDY PERIOD

In this chapter we described the 26 species we identified in the investigated reserves and we organized them systematically by using the determining keys of Kis (1984) and Derjanschi and Péricart (2005). Next, we analysed the situation of the Pentatomidae family for each reserve.

As a result of the collection of entomological material between 2007 and 2013 from the natural reserves of the department of Iasi and of the analysis of the collection material of three museums in Romania, we identified 26 species belonging to 17 genera of the Pentatomidae family present in Iasi County. The material we collected comes from 5 forest reserves, 3 flower reserves, a special forest protected area, two sites of community importance and the "Anastasie Fatu" Botanical Garden and its surroundings. We note in the (Table 1) below the species we identified and reserves where we collected them.

**Tabel 1. Species of Pentatomidae collected from Iasi County during the study period.**

| Species | Denumirea rezervației | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Poiana cu Schit | Valea lui David | Valea Ilenei | Pădurea Gheorghi-țoaia | Făgetul secular Humosu | Pădurea Uricani | Pădurea Tătărași | Lunca Mircești | Dealul lui Dumnezeu | Pădurea și pajiștile de la Mârzești | Pădurea Ciric | Municipiul Iași (Grădina Botanică și împrejurimi) |
| ***Graphosoma lineatum* (Linnaeus, 1758)** | X | | X | | | | | X | X | | | X |
| ***Sciocoris distinctus* Fieber, 1851** | | | | | | | | | | | | X |
| ***Sciocoris deltocephalus* Fieber, 1861** | | | | | | | | | | | | X |
| ***Sciocoris (Aposciocoris) homalonotus* Fieber, 1851** | X | | | | | | | | | | X | X |
| ***Sciocoris (Aposciocoris) microphtalmus* Flor, 1860** | | | | | | | | | | | | X |
| ***Aelia acuminata* (Linnaeus, 1758)** | X | | X | X | | | | | | | X | X |
| ***Aelia rostrata* (Boheman, 1852)** | X | X | | | | | | | | | | |
| ***Neottiglossa leporina* (Herrich-Schaeffer, 1830)** | X | | | | | | | | | | | |
| ***Eysarcoris aeneus* (Scopoli, 1763)** | X | | | | | | | | | | | X |
| ***Eysarcoris venustissimus* (Schrank, 1776)** | X | | | | | | | | | X | | |
| ***Eysarcoris ventralis* (Westwood, 1837)** | | | | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Stagonomus amoenus* (Brullé, 1832)** | | | | **X** | | | | | | | | **X** |
| ***Rubiconia intermedia* (Wolff, 1811)** | **X** | | | | | | | | | **X** | | **X** |
| ***Carpocoris purpureipennis* (De Geer, 1773)** | **X** | **X** | **X** | | **X** | **X** | | | | | **X** | **X** |
| ***Dolycoris baccarum* (Linnaeus, 1758)** | **X** | | **X** | **X** | **X** | **X** | **X** | **X** | | | **X** | **X** |
| ***Peribalus strictus* (Fabricius, 1803)** | **X** | **X** | | **X** | | | | | **X** | **X** | | **X** |
| ***Palomena prasina* (Linnaeus, 1761)** | **X** | | | | **X** | **X** | | **X** | | **X** | | |
| ***Piezodorus lituratus* (Fabricius, 1794)** | | | | **X** | | | | | **X** | | | **X** |
| ***Pentatoma rufipes* (Linnaeus, 1758)** | **X** | | | | | | | | | | | |
| ***Rhaphigaster nebulosa* (Poda, 1761)** | | | | | | | | | | | | **X** |
| ***Eurydema ornata* (Linnaeus, 1758)** | **X** | | | | | | | | **X** | | **X** | |
| ***Eurydema oleracea* (Linnaeus, 1758)** | **X** | | | **X** | **X** | | | **X** | **X** | **X** | **X** | **X** |
| ***Eurydema dominulus* (Scopoli, 1763)** | | | | | | | **X** | | | | | |
| ***Eurydema ventralis* Kolenati, 1846** | | | | | | | | | | | | |
| ***Picromerus bidens* (Linnaeus, 1758)** | | | | | | | | | | | **X** | **X** |
| ***Zicrona caerulea* Amyot & Serville, 1843** | | | | | | | | | | | **X** | |

Our research contributes to the enriching of the list of insect species present in the protected areas of the department of Iasi. Before our research there werre 19 species identified belonging to 17 genii of Pentatomidae. We are able to confirm the existance of 16 of these species and to complete the existing date we 10 new species (*Sciocoris distinctus* Fieber, 1851, *Sciocoris deltocephalus* Fieber, 1861, *Sciocoris (Aposciocoris) homalonotus* Fieber, 1851, *Sciocoris (Aposciocoris) macrocephalus* Fieber, 1851, *Sciocoris (Aposciocoris) microphtalmus* Flor, 1860, *Neottiglossa leporina* (Herrich-Schaeffer, 1830), *Eysarcoris ventralis* (Westwood, 1837), *Eysarcoris venustissimus* (Schrank, 1776), *Eurydema dominulus* (Scopoli, 1763), *Eurydema ventralis* Kolenati, 1846, *Picromerus bidens* (Linnaeus, 1758)). The genera *Sciocoris* Fallén, 1829 and *Neottiglossa* Kirby, 1837 are new to this area.

## CHAPTER VI. SYNECOLOGICAL ANALYSIS OD THE PENTATOMIDAE OF THE NATURAL RESERVE OF POIANA CU SCHIT AND FROM THE BOTANICAL GARDEN "ANASTASIE FĂTU" IASI

For this chapter we collected entomological material from the natural reserve of Poiana cu Schit during the years 2007 (June-August), 2009 (June-August), and 2013 (June) and from the Botanical Garden "Anastasie Fătu" in 2007 (July-September) and 2008 (May-August). Each sample is represented by the totality of the individuals of the Pentatomidae family collected in a unit of time (2 hours). The samples were collected between 11 a.m. and 1 p.m.

We will present the results of the synecological analysis obtained for the natural reserve of "Poiana cu Schit". We worked in a similar manner for the Botanical Garden "Anastasie Fătu" Iasi.

### 6.1. Ecological indexes computed for the species of the Pentatomidae family collected from the natural reserve of Poiana cu Schit

For the species of the Pentatomidae family identified in the natural reserve of Poiana cu Schit in June-August 2007, June-August 2009 and June 1013 we computed the following ecological indexes: Abundance (A), Dominance (D), Constancy (C) and the index of ecological signification (W).

Of the 15 species identified in the reserve of Poiana cu Schit, one species is subrecedent (6,66%), 2 are recedent (13,33%), 4 subdominant (26,66%), 4 dominant (26,66%) and 4 eudominant (26,66%).

The index of ecological significance (W) reveals that the species *Aelia acuminata, Carpocoris purpureipennis, Dolycoris baccarum* and *Eurydema oleracea* are characteristic for the reserve "Poiana cu Schit" and best adapted to the ecological factors of this habitat. The rest of the species are accessory and accidental.

## 6.2. The diversity of the Pentatomidae registered in the natural reserve of Poiana cu Schit during the study period

In order to estimate the diversity in the natural reserve of "Poiana cu Schit", we computed the Simpson index and the Shannon Wiener index.

The Simpson diversity index takes values close to 1 for this reserve, which indicates a well expressed diversity. The highest values were registered in June 2007 and June 2009 and the lowest in July 2009.

The Shannon Wiener index indicates the largest real diversity for the reserve "Poiana cu Schit" in July 2007 and the lowest value in July 2009 (Figure 3).

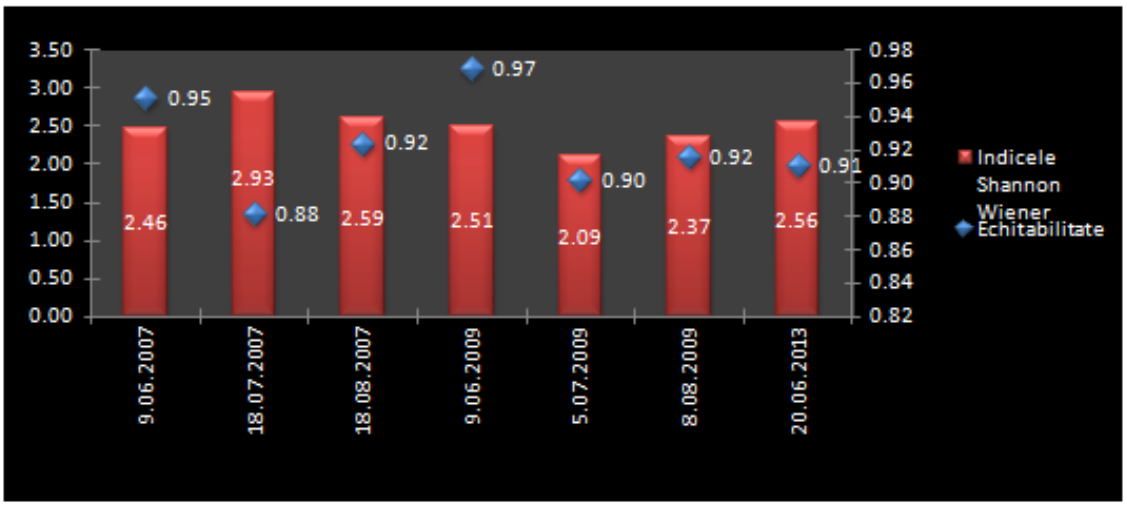


**Figure 3. The Shannon-Wiener diversity index ant the equality of the Pentatomidae identified in the natural reserve of "Poiana cu Schit" along the study period**

## CHAPTER VII. BIOLOGY OF THE SPECIES FROM THE PENTATOMIDAE FAMILY COLLECTED FROM IASI COUNTY AND INTERACTIONS WITH THE HOST PLANTS

The Pentatomidae, like the other hemipters, establish relationships with different species of plants, especially on a food basis (Ward and colab., 2003). However, the hemipters use the plants also for shelter or support for the oviposition (Derjanschi and Péricart, 2005).

Of the species we identified in Iasi County, we conducted observations on five species: *Dolycoris baccarum, Aelia acuminata, Carpocoris purpureipennis, Graphosoma lineatum* and *Eurydema oleracea*. The research's purpose was to analyse the relationship with the host-plants, the relationship between genders and the oviposition. The species *Dolycoris baccarum* and *Carpocoris purpureipennis* are polyphagous, and as such can be easily bred in a lab, with a variety of plants. They feed especially in fruit (cherries, berries, apricots, peaches) but they also eat leaves (cabbage, radish) and roots (carrots). The species *Eurydema oleracea, Aelia acuminata* and *Graphosoma lineatum* are oligophagous.

As for the ovisposition, the females of *Carpocoris purpureipennis* produce the largest number of eggs (between 18 and 34) (Figure 4), and the oviposition of the species *Eurydema oleracea* is characterized by the highest stability (12 eggs mostly laid in 2 sets of 6). (Figure 5).

In the light of our observations we noted that the data obtained concerning the host plants are in accordance with the ones existing in the literature, the polyphagous species being easier to breed in a lab, as they are more adaptable.

As for the oviposition of the species under our observation, the number of eggs concords with the observations of other authors. We notice that the percentage of hatching in lab conditions is higher than the one in natural conditions as a result of the removal of the parasites danger. Also, the shape and disposition of the eggs confirm the literature data.

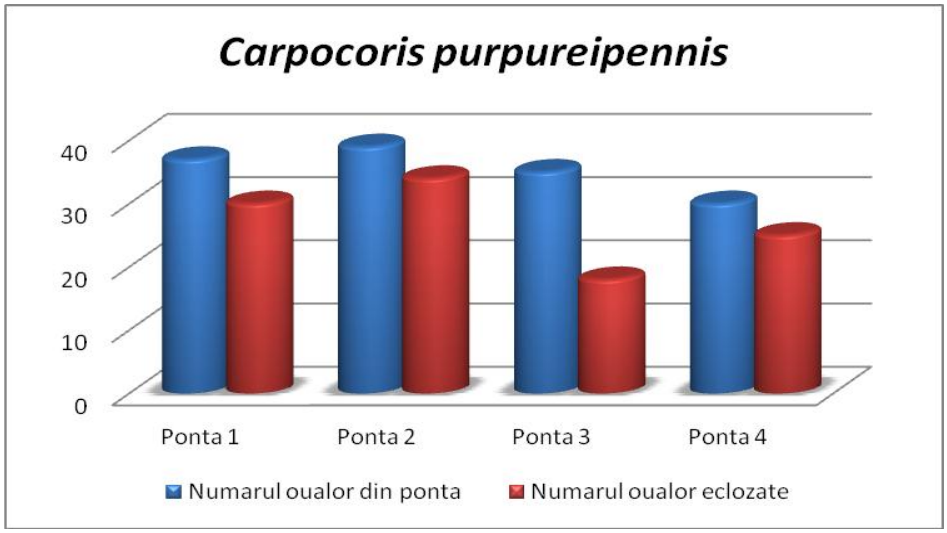


**Figure 4. The oviposition and the percentage of hatching in lab conditions (*Carpocoris purpureipennis*)**

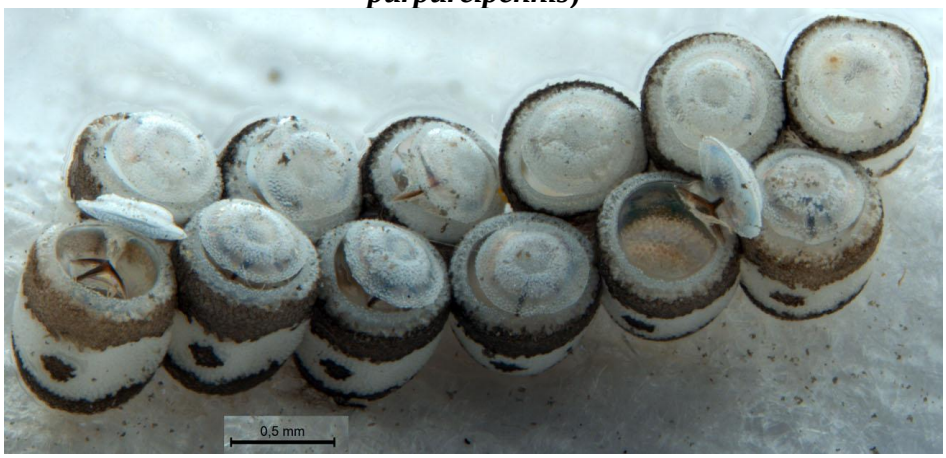


**Figure 5. The disposition of the eggs on *Eurydema oleracea* (Original)**

## Conclusions

- The entomological material we analysed for the present thesis was collected from 11 protected areas of Iasi County ("Poiana cu Schit", "Pădurea Gheorghiţoaia", "Pădurea Uricani", "Făgetul secular Humosu", "Pădurea Tătărusi, "Pădurea si pajiştile de la Mârzeşti", "Sărăturile de la Valea Ilenei", Fâneţele seculare de la "Valea lui David", "Dealul lui Dumnezeu", Pădurea Ciric, "Lunca Mirceşti"), and form the city of Iasi (the Botanical Garden "Anastasie Fătu"). Also, we analysed entomological material from the collections of the "Grigore Antipa" National History Museum, The National History Museum of Sibiu, The Museum Complex of Sciences of Nature "Ion Borcea" Bacău, The National Museum of Prague and The Moravia Museum of Brno.

- As a result of the collecting from the natural reserves investigated of Iasi County, we identified 26 species of Pentatomidae. The majority of species were collected from the natural reserve of "Poiana cu Schit" (15 species).

- After determining the entomological material, we identified 2 genera (*Sciocoris* and *Neottiglossa*) and 10 new species for this part of the country (*Picromerus bidens* (Linnaeus, 1758), *Neottiglossa leporina* Kirby, 1837, *Eysarcoris ventralis* (Westwood, 1837), *Eysarcoris venustissimus* (Schrank, 1776), *Eurydema dominulus* (Scopoli, 1763), *Eurydema ventralis* Kolenati, 1846, *Scicoris deltocephalus* Fieber, 1861, *Sciocoris distinctus* Fieber, 1851, *Sciocoris (Aposciocoris) homalonotus* Fieber, 1851, *Scicocoris (Aposciocoris) microphtalmus* Fieber, 1860).

- Prior to our research, for Iasi County, there had been identified 19 species, out of which we identified 16 species. Nowadays, in Iasi County there are 29 species.

- As a result of the analysis of the genus *Eurydema* from the collections of The "Grigore Antipa" National History Museum, The National History Museum of Sibiu, The Museum Complex of Sciences of Nature "Ion Borcea" Bacău we enrich the list of the parts of the country where the species of this genus had been identified before.

- The synecological analysis applied to the heteropters from the natural reserve of "Poiana cu Schit" reveals that the species *Aelia acuminata, Carpocoris purpureipennis, Dolycoris baccarum* and *Eurydema oleracea* are characteristic for

this reserve. The Simpson and Shannon Wiener diversity indexes indicate a well expressed diversity.

- Regarding the biology of the species of the Pentatomidae family we collected, we analysed 5 species: *Graphosoma lineatum, Aelia acuminata, Carpocoris purpureipennis, Dolycoris baccarum* and *Eurydema oleracea*. We conducted field and lab observations on the host plants these species feed on and we analysed the oviposition and the hatching percentage in lab conditions. The *Graphosoma lineatum* species is difficult to breed in lab conditions, the *Carpocoris purpureipennis* and *Dolycoris baccarum* species were bred in the lab and fed on cherry, peach, apricot and berry fruits, on fragments of cabbage, broccoli, cauliflower and radish seedlings. The *Eurydema oleracea* species is oligophagous, being fed on cabbage, broccoli, cauliflower and radish seedlings. The *Aelia acuminata* species prefers the Poaceae species, being fed on ears of wheat.

- The larvae hatching percentage is higher compared to the one obtained in nature. Regarding the number of eggs, the *Eurydema oleracea* stands out by a significant constancy, the females usually lay 12 eggs.

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