THESES OF PhD DISSERTATION

True bug (Heteroptera) assemblages of medicinal and aromatic plants

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Budapest

2007

PhD School

name:

Doctoral School of Interdisciplinary Sciences

[1. Life Sciences (1.5. Biological Sciences),

4. Agricultural Sciences (4.1. Plant Production and Horticultural Sciences)]

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The applicant met the requirement of the PhD regulations of the Corvinus University of Budapest and the thesis is accepted for the defence process.

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1. Introduction

In Hungary, medicinal and aromatic plants are cultivated only in a small fragment of the total area of farmlands, however, the sector produces significant income in this small area. The mounting interest for natural components in medicine, food and cosmetics industry enhances the importance of medicinal and aromatic plants. In the past few years, significant increase could be observed not only in the use of traditional medicinal plants but also new plant species were introduced into cultivation.

One major requirement for the quality of the medicinal and aromatic plant products is the low level of pesticide residues. In order to successfully introduce the methods of integrated pest management assurring the high quality of the products, a basic need is to have information about the trophic communities of the cultivated plants.

Unfortunately, spite of their increasing importance, the fauna of the cultivated medicinal and aromatic plants is almost unknown. Consequently, due to the lack of information and also of licensed pesticides for these cultures in Hungary, pest management in medicinal and aromatic plants is virtually impossible.

In order to gain basic information on the heteropterous insect assemblages occurring on such plants in Hungary, regular collectings were carried out in three years, two localities and on 40 plant species.

According to my preliminary observations and literature data, it became clear that true bugs occur on several medicinal and aromatic plants in Hungary, frequently in high density. Preliminary observations suggested that some species might eventually cause considerable damage.

Since the importance of true bugs on medicinal and aromatic plants is virtually unknown, regular investigation of the bug assemblages of as many as possible cultivated plant species was decided as the main aim of study, in

order to gain basic information on the structure and dynamics of the communities and the importance of the species.

The heteropterous fauna of Central Europe is rather well investigated and there are several excellent works for identifying most groups. However, some groups are loaded with serious taxonomic problems, the identification of certain taxa are problematical, and the status and validity of quite a lots of species is doubtful.

The immatures of most of the Heteroptera in Central Europe are well known and there are many literature available for species-level identification in many families. However, immatures of several species are unknown. Since the majority of specimens of samples taken in any plant communities are immatures, their identification is of crucial importance for any faunistical, ecological, cenological or biomonitoring investigations.

Consequently, my aims were the followings:

- to explore the species composition and dominance relationships of true bugs occurring on medicinal and aromatic plants in Hungary;
- to identify the species which can cause damage actually or potentially;
- to gather information on the habits, food-preference, phenology etc. of the important true bug species;
- to examine and solve eventual taxonomic–identification problems of species occurring on medicinal and aromatic plants;
- to gain additional information about the morphology and identification of the immatures of true bugs.

2. Materials and methods

2.1. Investigation sites

Regular samplings were carried out during the vegetation period in the years 2003–2005, from end of April till end of September. Some additional samples were taken in September 2002. The sampling sites were the followings:

- **Tordas**: experimental station of Central Agricultural Office. Samples were taken in September 2002, and over the vegetation periods of the years 2003, 2004, and 2005.

  The site is at an elevation of 100–150 m a.s.l., on chernozem soil. Because of the relatively low precipitation, the cultures are regularly watered.

- **Budapest–Soroksár**: experimental station of the Department of Medicinal and Aromatic Plants, Faculty of Horticulture, Corvinus University of Budapest. Samples were taken over the vegetation periods of the years 2004 and 2005.

  The site is at an elevation of 100–150 m a.s.l., on humic sand. Because of the relatively low precipitation, the cultures are regularly watered.

- **Herencsény**: collection of medicinal plant species and cultivars of Agroherba Ltd. Samples were taken at 15th September 2005.

  The site is at an elevation of 250–300 m a.s.l., on forest soil. The average precipitation is higher, the temperature is lower compared to the above two sites.

2.2. Plant species investigated

Of the medicinal and aromatic plants cultivated at the experimental sites, regular samplings were conducted on 35 plant species at Tordas, on 18 species at Soroksár, in every second or third weeks depending on the phenology of the plants. Altogether 40 species were examined regularly, 13 of

them at two localities. At Herencsény, only five plant species could be investigated.

The examined species were the followings:

Lamiaceae: hyssop – *Hyssopus officinalis* L.; lavender – *Lavandula angustifolia* Mill.; hybrid lavender – *Lavandula* × *intermedia* Emeric; motherwort – *Leonurus cardiaca* L.; lemon balm – *Melissa officinalis* L.; peppermint – *Mentha* × *pipitera* L.; spearmint – *Mentha spicata* L. em. Huds. var. *crispata* (Benth.) Mansf.; common basil – *Ocimum basilicum* L.; oregano – *Origanum vulgare* L.; rosemary – *Rosmarinus officinalis* L.; clary sage – *Salvia sclarea* L.; common sage – *Salvia officinalis* L.; summer savory – *Satureja hortensis* L.; winter savory – *Satureja montana* L.; common thyme – *Thymus vulgaris* L.

Asteraceae: yarrow – *Achillea collina* Becker ex Rchb.; roman chamomile – *Anthemis nobilis* L.; sweet wormwood – *Artemisia annua* L.; tarragon – *Artemisia dracunculus* L.; pot marigold – *Calendula officinalis* L.; safflower – *Carthamus tinctorius* L.; eastern purple coneflower – *Echinacea purpurea* (L.) Mönch.; chamomile – *Matricaria recutita* L.; lavender cotton – *Santolina chamaecyparissus* L.; blessed milk thistle – *Silybum marianum* (L.) Gärtn.; golden rod – *Solidago virga-aurea* L.; feverfew – *Tanacetum parthenium* Schultz-Bip.

Apiaceae: dill – *Anethum graveolens* L.; garden angelica – *Angelica archangelica* L.; caraway – *Carum carvi* L.; coriander – *Coriandrum sativum* L.; fennel – *Foeniculum vulgare* Mill.; lovage – *Levisticum officinale* Koch; anise – *Pimpinella anisum* L.

Valerianaceae: valerian – *Valeriana officinalis* L.

Malvaceae: marshmallow – *Althaea officinalis* L.; mallow – *Malva sylvestris* L.

Apocynaceae: blue dogbane – *Amsonia tabernaemontana* Walt.

Scrophulariaceae: orange mullein – *Verbascum phlomoides* L.

Hypericaceae: St. John's wort – *Hypericum perforatum* L.

Caryophyllaceae: baby's breath – *Gypsophila paniculata* L.

At Tordas, in case of two plant species, two cultivars of each were also investigated and compared (peppermint: 'Mitcham' and 'Mexián', oregano: 'Alba' and 'Lilla').

2.3. Methods of collecting

Samples were taken by using leaf vacuum with internal combustion engine, equipped with a dense net for capturing insects. The content of the net was emptied into plastic bag and killed with acetic ether.

2.4. Statistics, data analysis

Similarities of the samples were compared using multivariate methods (non-metrical multidimensional scaling, cluster analysis, correspondence analysis). Diversities of samples were compared using diversity ordering by Rényi's method.

3. Results and discussion

3.1. True bug assemblages occurring on lamiaceans

No characteristic species connected to **common basil**, **rosemary**, **peppermint** and **spearmint** or to **lemon balm**, and occurring in high density could be recognized. Most probably these plants do not have important pest among Heteroptera. Although their density was always very low in the samples, most probably polyphagous pests (first of all species of the genus *Lygus*) might occasionally cause some damage on these plants.

On oregano, also only relatively few species occured, always in more or less small density. However, the seed bug species *Heterogaster artemisiae* occurred regularly in considerable number on this plant, although always of

much smaller number than on **common thyme**. According to the observation, this species is also a host plant of the bug, however, the bug's importance is certainly not significant.

Also no characteristic species specialized to **lavender** and **hybrid lavender**, as well as on **summer** and **winter savory**, occurring in high number, could be observed. The most frequent were the species of the genus *Lygus* which are considered as polyphagous pests. They occurred in significantly higher density on these plants than on the above five other plant species, however, their importance is most probably insignificant.

On the two investigated species of *Salvia* (**clary** and **common sage**), the specialized phytophagous plant bug *Dicyphus geniculatus* and seed bug *Platyplax salviae* occurred only sporadically and always in small number.

On **common thyme**, *Heterogaster artemisiae* occurred in high density over the vegetation season and certainly it is a significant pest of the plant. In every year, adults and larvae occurred in very high number from the end of Juny until the end of July (in the time of flowering and maturation of the seeds); after July, their density decreased quickly and they occurred only sporadically after mid August. Although their damage could not be clearly observed, they almost certainly cause considerable damage, occurring in very high density. The adults and larvae might decrease the seed production and set back the quality of the drug by their mass feeding.

On **motherwort**, mass occurrence of the lace bug *Tingis pilosa* was observed regularly. The species appeared on its host plant at the second half of April, and occurred in high number from the beginning of May until the end of September. Although their damage could not be clearly observed, it must be the most important pest of the motherwort, occurring in very high density. The adults and larvae might decrease the seed production and set back the quality of the drug by their mass feeding.

The damsel bug (Nabidae) species *Nabis ferus*, *N. pseudoferus*, and *N. punctatus* occurred on all of the plants, however, their relative dominance and density was always very small. Flower bugs (Anthocoridae) occurred always in insignificant number in the investigated plantations. Because of their very small number, the zoophagous bugs certainly have only insignificant importance in reducing the density of the phytophagous arthropods on the investigated medicinal and aromatic plants.

At Tordas, in case of two plant species, two cultivars of each were also investigated and compared (peppermint: 'Mitcham' and 'Mexián', oregano: 'Alba' and 'Lilla'). In both cases, it clearly could be proved by statistical methods that there is no significant difference between the assemblages captured on the two cultivars.

3.2. True bug assemblages occurring on asteraceans

No characteristic species connected to **eastern purple coneflower**, **safflower**, **blessed milk thistle**, **pot marigold**, **roman chamomile** and **lavender** cotton could be observed. In all years, only very few species were observed to occur on these plants, and almost all of them were common polyphagous species. According to the observations, most probably polyphagous species (first of all species of the plant bug genus *Lygus*) might occasionally occur in higher density, however, no significant damage can be expected in Hungary. The most important true bugs are also the *Lygus* species on **golden rod** and **feverfew**, but the seed bug species *Nysius senecionis*, feeding first of all on Asteraceans, can occur occasionally in high number.

The plant bug *Europiella artemisiae* is the most important heteropteran on both examined species of the genus *Artemisia*, **sweet wormwood** and **tarragon**. In the previous literature, *Europiella albipennis* was mentioned as important pest occurring in high density on diverse cultivated *Artemisia* species. However, in the Hungarian localities, the

overwhelming dominance of *E. artemisiae* was observed. Very probably most of the previous records of *E. albipennis* might refer to *E. artemisiae*, due to misidentifications because of long taxonomic and nomenclatural confusion of the two species.

Europiella artemisiae immigrates to the plantations in the middle of May, and is present in high density between early June and middle of August on both investigated species of *Artemisia*.

The seed bug species *Metopoplax origani* and *Nysius senecionis*, as well as the plant bug *Plagiognathus chrysanthemi*, all of them oligophagous species specialized on asteraceans, occurred regularly but always in small density on both species of *Artemisia*. Occasionally they might occur in higher density.

In each year, a most characteristic true bug assemblage was observed to occur on **chamomile**. The seed bug *Metopoplax origani* was the dominant species, *Nysius senecionis* and *Lygus* spp. occurred also in high relative dominance. Each of the above taxa starts to colonize the chamomile field in the end of May (in the beginning of the flowering time of chamomile). Density of *M. origani* culminates in the middle of June, that of *N. senecionis* and *Lygus* spp. in the end of June. After that, their density showed a quick decrease. All other species of true bugs occurred only in very small number.

Among all of the investigated medicinal and aromatic plants, chamomile is the one on which the damage caused by true bugs seems to be most important. In mass occurrence, the presence of the bugs in the field is apparent, frequently 3–4 specimens are feeding on the some inflorescence at the same time. The wilting of the plants and distortions of the inflorescences could frequently be observed. The adults and larvae might decrease the seed production and set back the quality of the drug by their mass feeding.

The damsel bug (Nabidae) species *Nabis ferus*, *N. pseudoferus*, and *N. punctatus* occurred on all of the plants, however, their relative dominance and density was always very small. Because of their very small number, the zoophagous bugs certainly have only insignificant importance in reducing the density of the phytophagous arthropods on the investigated medicinal and aromatic plants.

3.3. True bug assemblages occurring on apiaceans

On **coriander**, **anise**, **caraway**, **lovage** and **dill** plantations, true bugs occurred always only in very small number. No important pest species was observed, but most probably *Orthops* spp. and *Graphosoma lineatum* can occasionally occur in higher number. *Orthops* spp. and *G. lineatum* might be the main pests of **garden angelica** too.

The plant bug species *Orthops kalmii* occurred regularly in high density on **fennel**; among all investigated apiaceans, this is the one on which the damage caused by true bugs seems to be most important.

Zoophagous bugs (damsel bugs, flower bugs) occurred always in very small density on apiaceans and certainly their importance is insignificant.

3.4. True bug assemblages occurring on plants belonging to other families

Valerianaceae. In both sampling sites, only very few species of true bugs were captured on **valerian**. Most probably this plant has no important specialized phytophagous bug in Hungary which might cause damage.

Malvaceae. *Pyrrhocoris apterus* was the most important species on **mallow**, but *Oxycarenus lavaterae* and the polyphagous *Lygus* spp. (*L. rugulipennis* and *L. pratensis*) occurred also in rather high number. Spite of its high density, the importance of *P. apterus* is not clear.

Apocynaceae. Only **blue dogbane** was examined. The small density of true bugs as well as any other insects was apparent. This plant of North-American origin has most probably only very few phytophagous insects in Europe.

Scrophulariaceae. Only **orange mullein** was examined. Although the literature lists a considerable number of true bugs feeding on *Verbascum* spp. (lace bugs, plant bugs, stilt bugs, shield bugs, seed bugs etc.), only few species could be observed in the sampling sites; most probably none of them has importance in cultivation.

Hypericaceae — Orbáncfűfélék. Only **St Johns' wort** was examined. Usually only a few species could be captured, most probably none of them has importance in cultivation.

Caryophyllaceae — Szegfűfélék. Only **baby's breath** was examined. No specialized phytophagous bug connected to this species could be observed.

4. Summary of new scientific results

(1) Regular samplings were carried out at two sites, on 40 cultivated medicinal and aromatic plants, in most species for the first time in Hungary. The true bug assemblages of these plants were surveyed.

(2) Based on the samplings, true bug assemblages of 14 labiacean, 12 asteracean, 7 apiacean, as well as 7 species of medicinal and aromatic plants belonging to 6 other families were characterized, dominance relationships of the species were recognized. In many cases, significant differences could be proved between heteropterous assemblages of different plants.

(3) Several true bug species which were previously not recorded as pests were observed to occur regularly in very high density on vertain arimatic and medicinal plant species, and occasionally they might cause considerable damage. Such species are *Heterogaster artemisiae* on

common thyme, *Metopoplax origani* and *Nysius senecionis* on chamomile, as well as *Tingis pilosa* on motherwort.

(4) In species occurring in high density (*Heterogaster artemisiae*, *Europiella artemisiae*, *Metopoplax origani*, *Nysius senecionis*, *Tingis pilosa*), temporal population changes were observed and characterized.

(5) New data were presented to the biology, host plants, phenology, generation number, agricultural importance of several true bug species.

(6) The plant bug species *Lygus adspersus* (Schilling, 1837) was reported forst from Hungary. The shield bug *Odontotarsus robustus* Jakovlev, 1884 was deleted from the Hungarian fauna list. Problems about the identification of *Orthops* species were revealed and new identification characters were recognized.

(7) The nymph of the damsel bug species *Prostemma sanguineum* (Rossi, 1790) was described first, key was prepared for the nymphs of Central-European species of Prostemmatinae.

5. Publicationson the subject of the thesis

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