

THE INVESTIGATION OF ENTOMOFAUNA IN THE CROP *Reynoutria sachalinensis* (F. Schmidt) Nakai UNDER THE VEGETATION CONDITIONS OF THE REPUBLIC OF MOLDOVA

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Abstract

Giant knotweed, *Reynoutria sachalinensis* (F. Schmidt) Nakai, is a species native to the Far East, introduced in the Republic of Moldova in the 1980s. The surveys of entomofauna and mites associated with the crop *R. sachalinensis* were carried out in the experimental sector of the Plant Resources Laboratory of the “Alexandru Ciubotaru” National Botanical Garden (Institute). The research has revealed the structure of the entomofauna on *R. sachalinensis* plants during the growing season and resulted in the identification of 31 species of insects, in various growth stages, the assessment of the phytoparasitic impact, records and analyses of morphological parameters, taxonomic affiliation, trophic specialization, frequency values and abundance of entomofauna on the entire plant and the biological and ecological significance in the regulation of the ratio of zoophagous/phytophagous insects.

Key words: biodiversity, giant knotweed, insects, trophic spectrum.

INTRODUCTION

The species has been introduced in the Republic of Moldova, and a cultivar, named 'Gigant', was officially recognized and registered in the Register of Plant Varieties of the Republic of Moldova in 2012, with the number 2492625. In 2016, it received a Plant Variety Patent, with the number 205/31.05.2016 and the common name “Hrișca-de-Sahalin”. The binomial name of giant knotweed, or Sakhalin knotweed, is *Reynoutria sachalinensis* (F. Schmidt) Nakai and it has several synonyms *Polygonum sachalinense* F. Schmidt ex. Maxim., *Fallopia sachalinensis* (F. Schmidt) Ronse Decr., *Pleuropterus sachalinensis* (F. Schmidt) H. Gross., *Tiniaria sachalinensis* (F. Schmidt) Janch. (Yonecure and Ohaschi, 1997; Войлокова, 2007; Fuentes et al., 2011; The plant list). This species, which is native to East Asia, Sakhalin and Kurile Islands, has been studied to determine its potential as medicinal and fodder plant (Schnitzler and Muller, 1998; Mandak et al., 2004; Wittenberg, 2005). It has been studied in several countries in Eastern and Western Europe as a multi-purpose plant. In the Republic of Moldova, it was introduced from

the Agricultural Institute of Vladikavkaz, North Ossetia, and until now it has been investigated as a multi-purpose research subject.

Some important aspects of this topic were studied in 2014-2019, focusing on the biological peculiarities of growth and development of this crop, introduced from another eco-geographical zone, with high potential as forage, medicinal, ornamental and energy plant in the Republic of Moldova. At the same time, the environmental conditions in our country are favourable not only for the growth of plants but also for the diverse association of insect complexes and their impact on plants is favoured by the climatic conditions throughout the growing season. An essential risk to which this crop may be subjected and which can affect its harvest is the damage and diseases caused by the species of phytophagous insects. Some of them play a special role in maintaining the biocenotic balance as very efficient pollinators during the long flowering phases. Overall, associations of numerous insects that reproduce on this plant are created by means of adaptation and resistance in the interaction with the given plant, environmental factors and anthropogenic

influence (Perju, T., 1995; Lupașcu, 1998; Busuioc M., 2004; Voloșciuc, 2009).

The main purpose of the study on the entomofauna associated with this crop consists in establishing the ways in which the associations of parasitic insects - entomophages are formed, their role in maintaining the ecological-trophic balance in the system host plant - harmful organism - environmental factors, which can progress depending on species associations, the trophic spectrum and the amount of nutrients, the growth and development phase and the relationships between them (Perju, 1995; Busuioc, 2004).

Based on the actuality of the approached topic, the purpose of the research carried out over four years was to perform the entomological phytosanitary control by estimating the diversity of the associations of insects detected in the plantation of the given species, by establishing the degree of beneficial and parasitic impact, the trophic spectrum and useful contributions as pollinating species on this plant.

MATERIALS AND METHODS

Observations were carried out during the growing season of 2016-2019, with records of the entomofauna and mite diversity on *Reynoutria sachalinensis* plants. The research was conducted in the “Alexandru Ciubotaru” National Botanical Garden (Institute), in the experimental sector of the Plant Resources Laboratory, during several successive growing seasons. Phytosanitary control observations and insect samplings were made using the entomological net, visually, in sequence of the developmental phenophases of plants, periodically, with an interval of 10-15 days, starting in May (the phase of the formation of the stem and leaves) and ending in October (full maturity of plants, ripening of seeds and partial fall of leaves). In total, over 12 observations were made with the help of visual and optical analyzes (portable binoculars and magnifying glasses) on the experimental sector of the laboratory with a surface of 0.25 ha, on perennial plants aged 4-7 years (Figure 1).

At each observation, about 100 plants were investigated at certain intervals on the diagonal of the sector under study, sampling insects by

collecting them manually and by mowing the plants, besides, we examined the plants and their organs affected by phytoparasitic insects in various stages of phenological development, their numerical densities and parasitic impact.

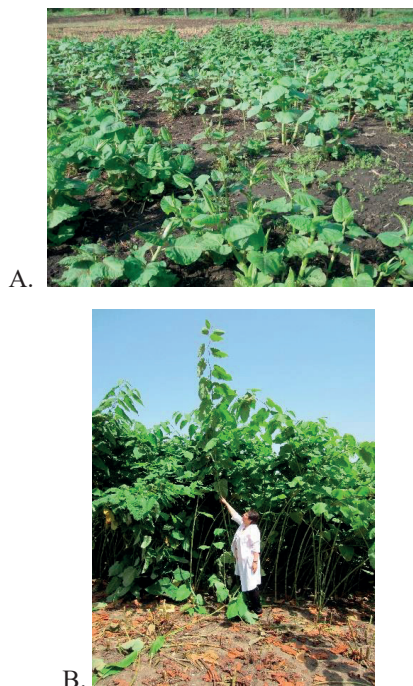


Figure 1. A - Plantation of *Reynoutria sachalinensis* (F. Schmidt) Nakai: formation of vegetative organs (April 2016); B - mature plants (July 2016), phytosanitary observations on the experimental plot of the “Alexandru Ciubotaru” National Botanical Garden (Institute)

Later, under laboratory conditions, the peculiarities of morphological structure, the taxonomic rank and the diversity of insect species detected in the plantation, found on different organs and in different development phases and trophic specialization spectrum, were established and pictures were taken for documentary purposes. The papers on general entomology of Perju, 1995; Oltean, 2001; Lazări and Busuioc, 2002; Cozari, 2010; Talmaciu, 2014, the guides for determining species written by Плавильщиков, 1994, Bei-Bienko, 1962, and the examination under the microscope MBC-10 and the binocular microscope Leica CME were used to confirm the taxonomic identity of the collected insects and mites.

RESULTS AND DISCUSSIONS

The assessment of the efficiency of using the species giant knotweed can be supplemented with investigations on entomoparasites, conducted under the environmental conditions of the Republic of Moldova, with the purpose of highlighting the presence of entomofauna and mites on plants in different growing seasons, and the phytosanitary control can elucidate the diversity of harmful and useful species, the means of reproduction of such insects and the damage caused to this crop.

The phytosanitary research on the giant knotweed plantation was carried out with a purpose and objectives that illustrate, as a result, the impact of entomofauna on the ecological integrity of adaptation of the studied crop to the environmental and biotope conditions, on the experimental sector of the "Alexandru Ciubotaru" National Botanical Garden (Institute). The biodiversity of insects and mites on the investigated plants was found to be of a mixed type, very diverse and varied, being favoured by the new and attractive biomorphological characteristics of the species for the respective fauna, related to process of adaptation of the introduced crop to the environmental factors in the territory of the Republic of Moldova.

The composition of entomofauna in the *R. sachalinensis* plantation was studied by laboratory analyses determining the numerical density, the taxonomic units and variations of the trophic spectrum, with the estimation of the diversity of the species of insects and arachnids, the parasitic impact on the plant organs, according to the abundance and frequency of the detected species, the way and the degree of impact. The mass emergence and the fast expansion of entomofauna on the plants were noticed at the end of May - the middle of July, then, when the pedological drought and high air temperatures were attested (the second half of July-August), a considerable decrease in the numerical density and the diversity of insects on the aerial organs of plants was observed. The mass flowering phase is a significant stimulus for the agglomeration of entomofauna and mites on giant knotweed, which, as a long-day species, blooms at the end of August - the middle of October. During this

period, a considerable increase in the diversity of phytophagous insect species and their numerical density, in different developmental stages (adult and larval forms), was observed on the nectar-rich inflorescences and leaves found in the apical area. At the same time, the abundant presence of predatory zoophytophages feeding on colonies of aphids and mites was noticed.

The abundance of the numerical density and the frequency of species by the presence of adult individuals and larvae are more significant in late spring, with the emergence of fragile shoots and the development of leaves, the plants being invaded by phytophagous insects, followed by entomophagous insects, in a 60/40% ratio, in favour of phytophagous species. In autumn (the mass flowering phase - the formation of seeds), entomophages with the trophic specialization: omnivorous predators, including pollenophagous and nectarivorous species, predominate more abundantly in the species diversity.

As a result of taxonomical analyses, the diversity of the entomofauna detected in the plantation varied considerably in the range with two maxima during the entire growing season, and during the spring-summer period, beetle species of the order Coleoptera, bugs of the order Hemiptera and aphids of the order Homoptera predominated. All of them behaved like parasitic species and caused damage, such as: bites, stings, embossing, discolorations and tunnels through newly formed leaves and stems. When the mature plants grow very tall, up to 5 m, and this happens in the second half of summer and in autumn, the species of the orders Diptera, Hymenoptera (especially honeybees) predominate in the plantation. The polyphagous insects of the orders Coleoptera and Lepidoptera are more numerous in the flowering phase with abundant nectar production, as an essential nutritional source, on the large inflorescences of giant knotweed plants (Busuioc, 2004; Lupaşcu, 1998; Плавильщиков, 1994).

Table 1 illustrates the diversity of species and the trophic spectrum of insects and mites found on giant knotweed plants. The complex of insects detected in the dynamics of growth stages and development phases included 31 species, with different trophic specialization

and variability of the biological development cycle, adapted to certain organs of the plant, depending on the trophic specialization and the reproductive potential (Table 1, Figure 2). By analyzes and taxonomic determinations, the insect species were identified and it was found that they belong to **8 orders**: 1. Neuroptera, 2. Coleoptera, 3. Hemiptera, 4. Mecoptera, 5. Hymenoptera, 6. Diptera, 7. Homoptera, 8. Lepidoptera; **21 families**: 1. *Chrysipidae*; 2. *Elateridae*; 3. *Cantaridae*; 4. *Curculionidae*; 5. *Coccinellida*; 6. *Pentatomidae*; 7. *Coreidae*; 8. *Codnidae*; 9. *Panorpida*; 10. *Apidae*; 11. *Scoliidae*; 12. *Formicidae*; 13. *Vespidae*; 14. *Sarcophagidae*; 15. *Califoridae*; 16. *Syrphi*; 17. *Tachinidae*; 18. *Aphididae*; 19. *Noctuidae*; 20. *Pyraustidae*; 21. *Tenthrediidae*; **28 genera**: 1. *Crysoperla*, 2. *Athous*, 3. *Chantaris*, 4.

Rhagonycha, 5. *Cratopus*, 6. *Coccinella*, 7. *Adalia*, 8. *Harmonia*, 9. *Graphosoma*, 10. *Coreus*, 11. *Tritomegas*, 12. *Panorpa*, 13. *Apis*, 14. *Scolia*, 15. *Formica*, 16. *Lasius*, 17. *Katamenes*, 18. *Sarcophaga*, 19. *Lucilia*, 20. *Syrphus*, 21. *Eristalis*, 22. *Spherophoria*, 23. *Tachina*, 24. *Aphis*, 25. *Myzodes*, 26. *Agrotis*, 27. *Margaritia*, 28. *Athalia*.

At the same time, there was a stable abundance of tiny phytoparasitic mites on the surface of the leaves and young shoots, throughout the growing season, belonging to **3 orders, 3 families, 3 genera and 3 species**, respectively, with phytoparasitic impact on the leaves and flower primordia, especially in spring and autumn, and species of entomophages feeding on aphids and other harmful insects [10, 11].

Table 1. The diversity and the trophic spectrum of insect and mite species found on *R. sachalinensis* plants

No	Species	Trophic spectrum	No	Species	Trophic spectrum
Phylum: ARTHROPODA, class: INSECTA					
1	<i>Crysoperla carnea</i>	Zoophagous	17	<i>Formica rufa</i> L.	Omnivorous, predatory
2	<i>Athous niger</i> L.	Phytophagous	18	<i>Lasius niger</i> L.	Omnivorous, predatory
3	<i>Chantaris fusca</i> L.	Zoophagous predatory	19	<i>Katamenes arbustorum</i> Penzer	Predatory
4	<i>Chantaris pellucida</i> Fabricius	Zoophagous predatory	20	<i>Athalia rosae</i> L.	Zoophagous, plant liquids
5	<i>Rhagonycha fulvu</i> Scopoli	Zoophagous predatory	21	<i>Sarcophaga carnaria</i> L.	Plant liquids
6	<i>Cratopus</i> sp.	Phytophagous	22	<i>Lucilia caesar</i> L.	Pollen and plant liquids, zoophagous
7	<i>Coccinella septempunctata</i> L.	Entomophagous, aphidophagous	23	<i>Syrphus ribesii</i> L.	Pollen, plant liquids, zoophagous
8	<i>Adalia bipunctata</i> L.	Entomophagous, acariphagous, aphidophagous	24	<i>Eristalis tenax</i> L.	Pollen and nectar
9	<i>Adalia quadrimaculata</i> L.	Entomophagous, acariphagous, aphidophagous	25	<i>Spherophoria scripta</i> L.	Pollen and nectar
10	<i>Harmonia axyridis</i> Pallas	Entomophagous, acariphagous, aphidophagous	26	<i>Tachina fera</i> L.	Pollen and nectar
11	<i>Graphosoma lineatum</i> L.	Phytophagous, nectariphagous	27	<i>Aphis pomi</i> De Geer	Occasional plant parasite
12	<i>Coreus marginatus</i> L.	Phytophagous, nectariphagous	28	<i>Aphis fabae</i> Scopoli	Occasional plant parasite
13	<i>Tritomegas bicolor</i> L.	Phytophagous, nectariphagous	29	<i>Myzodes persicae</i> Sulz.	Occasional plant parasite
14	<i>Panorpa communis</i> L.	Omnivorous, predatory	30	<i>Agrotis segetum</i> Denis & Schiffermuller	Polyphagous plant parasite
15	<i>Apis mellifera</i> L.	Pollen and nectar	31	<i>Margaritia sticticalis</i> L.	Polyphagous plant parasite
16	<i>Scolia hirta</i> Schrank	Pollen and nectar			
Phylum: ARTHROPODA, class: ARACHNIDA					
1	<i>Tetranychus urticae</i>	Plant parasite	3	<i>Tarsonemus angulatus</i>	Mycophagous
2	<i>Paraseiulus incognitus</i>	Entomophagous, predatory			



Figure 2. Insect species found on inflorescences and leaves of *R. sachalinensis*: A - *Scolia hirta*; B - *Sarcophaga carnaria*; C - *Cantharis pellucida*; D - leaves affected by insects

The graphical representation of Figure 3 highlights the maximum share of the population of insects detected on the researched crop, with the predominance of the species of insects of the order Coleoptera, which constitutes 29% of all the diversity of the species of insects collected from the field and analyzed. The species of the orders Diptera and Hymenoptera constitute 19%, followed by species of the orders Hemiptera and Homoptera with 10% each. The number of butterflies and moths of the order Lepidoptera was lower - 6%, in terms of diversity and numerical density, but individuals of the orders Neuroptera and Mecoptera belonged to a single species (Figure 3).

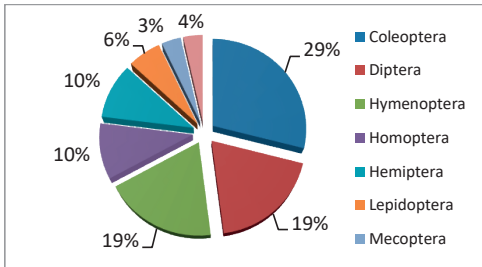


Figure 3. Comparative graphical representation of insect complexes according to the taxonomic abundance by orders

The results of the research on the determination of the taxonomic structure of insect associations in giant knotweed plantations, done by assessing the degree of invasion, by adapting biological strategies to this crop, studying their synergistic and antagonistic relationships and establishing the trophic specialization are estimated comparatively in Table 2.

The distribution through a spectrum related to the zoophagous and phytophagous nutrition differentiation, including the specializations within the groups of insects, the most abundant and frequent species are phytophagous insects

that feed on nectar, pollen and other floral exudates, in total, there are 14 such species of detected insects, and this fact denotes the high melliferous potential of the species *R. sachalinensis*.

Table 2. The graphical presentation of the comparative trophic spectrum of insect complexes related to phytophagous and zoophagous specialization

Zoophagous insects		Phytophagous insects	
Trophic type	№ of species	Trophic type	№ of species
Entomophagous	4	Nectar, pollen, plant liquids	14
Omnivorous predators	3	Occasional plant parasites	3
Zoophagous predators	5	Polyphagous	2

The leaves and the flowers are the most attractive to the wild entomofauna, including the entomophagous insects. Parasitic insects with folivorous and anthophagous specialization, represented by a diversity of aphids, ticks and caterpillars of polyphagous parasitic lepidopterans etc. predominate on these parts of the plants. The group with zoophagous specialization is represented mainly by predatory species, followed by entomophages (acariphagous and afidophagous insects) and the omnivorous predators, and it plays a significant role by determining the dynamic balance within the entomofauna of the given crop and diminishing the number of parasitic phytophagous insects. Thus, there is no need to apply chemical phytosanitary treatments because the density of parasitic species of insects is regulated with the help of predatory-omnivorous species.

Species with acariphagous, and predatory-omnivorous zootrophic specialization, such as: *Coccinella septempunctata*, *Adalia bipunctata*, *A. quadrimaculata*, *Harmonia axyridis*, *Lasius niger*, *Formica rufa*, *Panorpa communis* were found throughout the growing season, they

affected the phytophagous species and there was an antagonistic relationship between them, thus, these species play the role of living biological remedies in diminishing and regulating the number and density of phytoparasitic species and the parasitic impact on the polyphagous insect species, such as mites, aphids, beetles, lepidopterans. The diversity of insects of the order Coleoptera with a diverse trophic spectrum was significant; it included hundreds of species of insects, with phytophagous and zoophagous trophic specialization, which regulated, particularly, the presence of parasitic pests such as aphids, mites and polyphagous caterpillars in early stages (Gulii and Pamujac, 1994; Iachimciuc et al., 2012).

CONCLUSIONS

As a result of the taxonomic research and analyses on entomofauna and mites performed in a plantation of *Reynoutria sachalinensis* (F. Schmidt) Nakai, giant knotweed, under the environmental conditions of the Republic of Moldova, a diversity of 31 species of insects associated in complexes with various trophic specialization was found; these species have adapted to the succession of growth/development phenological phases in impact with environmental factors.

The morphobiological characteristics and the trophic specialization of the diversity of insects detected in the giant knotweed plantation were established taking into account their spread on the plants, with the estimation of the frequency and the abundance of the detected insects, the degree of damage caused by them, the trophic spectrum estimated by the presence of 12 zoophagous and 19 phytophagous species, with the predominance of polyphagous-parasitic species, followed by zoophages, entomophages and omnivores-predators with acariphagous and aphidophagous specialization.

Laboratory taxonomic analyzes of insect and mite samples collected from the studied plants were carried out and helped estimating the diversity of insects investigated per year and during the growing season, and, in total, we identified 34 species of insects and mites included in 31 genres, 24 families and 11 orders, with various bio-indications and

bioecological importance for giant knotweed during the adaptation time, which were influenced by the environmental conditions of the Republic of Moldova.

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