

## ECOLOGICAL AND FAUNISTIC ARTHROPODS COMPLEXES OF MUSTARD AGROBIOCENOSSES IN LOWER VOLGA REGION

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### Abstract

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Results of long-term ecological and faunal researches of complexes of the arthropods living in the in agroecosystems of *Brassica juncea* (Sarepta mustard) in Lower Volga area are presented in article, the specific structure of insects – phytophages and entomophages is established, the structure of dominance and ecological structure of entomocenosis is defined. Researches of fauna of arthropods carried out during 1996-2015 systematically throughout all vegetation of Sarepta mustard with use of the standard methods.

In mustard agroecosystem of Lower Volga area as a result of our researches 108 species of insects – phytophages are revealed. The dominating specie in crops of mustard is *Plutella maculipennis* Curt. – 44.93% of the total number, subdominating – *Phyllotreta* sp. (14.10%), *Meligethes aeneus* L. (13.50%), *Euridema* sp. (12.92%) and *Colaphellus hofii* Men. (11.01%). *Athalia colibri* Christ. is least small – 3.53%. In mustard agroecosystem the Coleoptera group prevails by quantity of species of phytophages. It is established that in the conditions of Lower Volga area the greatest harm to *Brassica juncea* by *Phyllotreta* sp., *Euridema festiva* L., *Colaphellus hofii* Men., *Plutella maculipennis* Curt. And *Athalia colibri* Christ is done. The complex of mustard pests caused decrease in productivity of culture on average for years of researches for 31.6-56.2%. Leaf damages decreased the content of aliphatic oil in seeds for 4.3%.

The greatest number of species of entomophages (84) falls into to Hymenoptera ordo; the Coleoptera includes 78 species, Diptera – 21 species, Hemiptera – 11. Several species presented ordos Neuroptera (3), Mantoptera (2), Orthoptera (2). As a part of entomocenosis of Sarepta mustard the entomophages from Hymenoptera ordo making 41.79% of all species of entomophages prevail. They are presented by 84 species from 13 families.

Phytophages and entomophages are most richly presented in the entomofaunistic communities – 314 species, or 82.4% of total of species are presented. The share of phytophages in mustard agroecosystem makes 27.03% of the common structure of entomocomplex. 55.38% of the revealed types in communities of insects – inhabitants of mustard agroecosystem belong to entomophages. Most variously as a part of the useful biota predatory insects – 130 species (34.12%) are presented.

*Key words:* *Brassica juncea*, entomofauna, herbivores, entomofags, Lower Volga region

## Introduction

*Brassica juncea* is a traditional oilseed of Volga Region. Mustard oil is used in baking, canning, confectionery, margarine, chemical industries, perfume, in soap making, textile and leather industries, as well as in metallurgy and the medical practice.

Materials related to the fauna and ecology of insects in agroecosystems oilseed cruciferous crops (mustard, rape) in the conditions of the Lower Volga region are sparse. Description of individual species *Brassica juncea* pests are represented in the works of Prof. Dr. N. L. Sakharov (1934, 1947). The faunistic researches of pollinators on cultivated crucifers in Lower Volga region are represented in the works of Mukhin (1986, 2003). Fragmentary data on mustard pests and measures of struggle against them in the conditions of the Volgograd region are given by Labuzina (1956), Bondarenko (1973), Belitskaya (2004), Smirnov (2000). The use of world experience and the latest achievements in this field are of great importance (Sarrazin et al., 2007, Heinen et al., 2016). The knowledge about the ecological value of herbivorous insects in cultivated crops is constantly expanding, allowing to reveal the mechanisms of interaction between the various elements of the agro-ecosystem and establish a base for the development for soft-ecosystem management (Lucas-Barbosa et al., 2014; Cusumano et al., 2015, Müller and Müller, 2016).

The harmful fauna of mustard sereptsy is quite numerous on specific structure. The list of harmful insects made on the basis of literary data of A.G. Labuzina (1956) includes 87 species, from which Coleoptera – 51 species, the Hemiptera – 14 species, Lepidoptera – 11 species, Diptera – 5 species, Orthoptera – 4 species, in Hymenoptera and Homoptera orders – each one species.

## Materials and Methods

An arthropods fauna was being researched during 1996-2015 systematically throughout all vegetation of mustard sereptsy with use of the standard methods. The insects were collected manually at the stationary areas by soil excavation with soil traps and standard entomological scoop-net. Entomological material collected was analyzed at the Department of Agroecology and Plant Protection of the Volgograd State Agricultural University, in the Department of Biology, Ecology and Nature Management, Volgograd State University and plant protection laboratory All-Russian Research Institute of agroforestry. Analysis of herbivores on the infestation of parasitic insects were carried out in two ways: by the immediately autopsy of the insects after sampling to establish

the individuals infected with parasites, and by elimination of parasites of the pest in the lab to full exit of the parasites from the host.

## Results and Discussions

As a result of the research we have discovered 108 species of insects – phytophagous in the mustard agroecosystems of Lower Volga region. For mustard crops the dominating species is *Plutella maculipennis* Curt. – 44.93% of the total mass of species, the subdominant – *Phyllotreta* sp. (14.10%), *Meligethes aeneus* L. (13.50%), *Euridema* sp. (12.92%) and *Colaphellus hofii* Men. (11.01%). The least small numbers *Athalia colibri* Christ. – 3.53%. Ratio quantity species by detachments from common quantities looking to follows way: *Coleoptera* ordo – 47.57%, Orthoptera – 17.47%, Hemiptera – 14.56%, Lepidoptera – 10.67%, Diptera – 5.82%, Homoptera – 1.94%, Thysanoptera – 0.97%, Hymenoptera – 0.97%.

The Coleoptera is ordo dominating in mustard agroecosystems by the number of species of herbivore. It is represented by 49 species of 9 families. Chrysomelidae species dominate quantitatively among families. The second largest ordo is Orthoptera – 18 species. Prevails an Acrididae family – 13 species, 2 species refers to Tettigoniidae family, 2 types – family Gryllotalpidae. From gregarious species of locusts are most dangerous *Locusta migratoria* L. and *Caloptamus italicus* L.). Nongregarious pests of grain crops are: *Oedipoda coerulea* L., *Docostaurus kraussi* Ing., *Celex variabilis* Pall., *Podisma pedestris* L., *Stauroderus scalaris* F.- W., *Euchorthippus pulvinatus* F.- W., and other species. The third place in the number of species belongs to the Hemiptera ordo – 15 species. This taxon is more diverse presented cruciferous bugs from Pentatomidae – 12 species. As the number and prevalence rates dominate *Euridema festiva* L. and *Eu. oleracea* L., as well as *Poeciloscytus cognatus* Fierb. of the Miridae family. Other species are sporadically. There 8 species of herbivores of 5 families from the Lepidoptera order are mentioned. The most dangerous pest among Lepidoptera is *Plutella maculipennis* Curt. from the Plutellidae family. The mustard pods are slightly damaged by larvae *Evergestis frumentalis* L. and *E. extimalis* Scop. Damage from larvae *Pieris brassicae* L., *P. rapae* L., *Synchoe daplidice* L., *Euchloe belia* Cr., *Aporia crataegi* L. is the eating of the leaves, buds, pods and, as rule, is small. The economic importance of pests of the order Diptera for the serepta mustard is slightly. In rare instances marked representatives Agromyzidae family. From the order Homoptera marked some *Cicadellidae* – *Cicadella viridis* F and *Aphididae* – *Brevicoryne brassicae* L. From the representatives of the order Thysanoptera on crops of mustard in single copies

found *Thrips tabaci* Lind. from the Thripidae family. The only representative of the order Hymenoptera is *Athalia colibri* Christ. of the Tenthredinidae family.

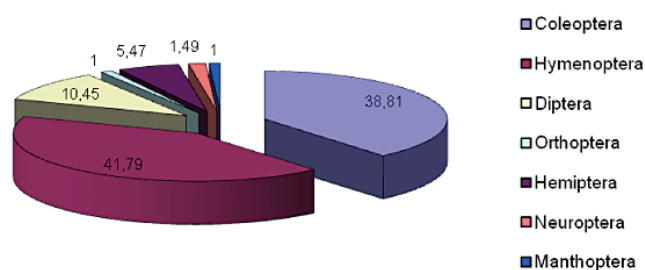
As a result long-term researches it is established that in the conditions of the Lower Volga region the greatest harm to Brassica juncea caused by *Phyllotreta sp.*, *Euridema festiva* L., *Colaphellus hofii* Men., *Plutella maculipennis* Curt. and *Athalia colibri* Christ.

The complex of mustard pests decreases crop yields by an average of years of research on 31.6 – 56.2%. This led to damages of the leaf structure of plants to decrease in content of aliphatic oil in seeds for 4.3%. Mustard pests especially strongly dropped the percentage of fat in the seeds in case of damage of the upper tier of leaves. On versions with protective measures against pests, damaging to the culture of the budding phase, seed oil was at 38.42%, while versions with protection against herbivores throughout the growing season seed oil reached a value of 39.55%.

As a result of long-term researches of mustard agroecosis in various soil climatic zones of area 212 species of entomophages, including 11 sp. of arachnoid and 201 species of predatory and parasitic insects are registered. There is no doubt that with further research list can be significantly augmented.

The studies found that the greatest number of species entomophages (84) belongs to the order Hymenoptera; Coleoptera order includes 78 species, Diptera – 21 species, Hemiptera – 11, a few rows in represented groups Neuroptera (3), Mantoptera (2), Orthoptera (2).

The ratio of units of beneficial insects (predators and parasites) in mustard agroecosis by quantity of species is shown in Figure 1.



**Fig. 1. The ratio of orders of entomophages (predators and parasites) in mustard agroecosis in the number of species, %**

As a part of entomocenosis of mustard agroecosis the entomophages from Hymenoptera group making 41.79% of all species of entomophages prevail. They are represented by 84 species of 13 families. The most represented species

of the family Ichneumonidae – 30 species, also numerous enough for the number of species the Braconidae family – 17 species. Ants are represented by 7 species of the Formicidae family, Myrmicidae – 3 species. Pteromalidae include 7 species. Other families are presented by 1-5 species. The second is the number of species of the order Coleoptera – 78 species of 9 families of most species of predatory beetles (50) belongs to the family Carabidae. In our research we have 7 species of Coccinellidae been registered. The dominant species are ubiquitous *Coccinella septempunctata* L. and *Coccinella quatuordecimpunctata* L. Meloidae family presented by 6 species: *Mylabris quadripunctata* L., *M. 10-punctata* Oliv., *M. 14-punctata* Pall., *M. Maculata* Oliv., *M. Floralis* Pall., *M. Grisescens* Tausch. Other families of Coleoptera are presented by slight quantity of species. From order Diptera – 21 species of predatory flies. *Syrphidae sp.* and *Tachinidae sp.* were the most numerous, especially during mustard flowering. Solitary on crops met *Asilus albiceps* Mg., *A. rufinervis* Mg., *A. crabroniformis* L. and al.

From the order Neuroptera mentioned 3 species, among which the most often met *Chrysopacarne* Steph. Predatory bugs of the order Hemiptera in mustard agroecosis represented by 11 species of 4 families – Nabidae, Anthocoridae, Miridae, Reduviidae. Most often found is *Nabis ferus* L., little less – *N. pseudopherus* Rem. and *Coranus tuberculifer* Reut. and other species. Participation of other groups (Mantoptera, Orthoptera) as a part of the useful entomocomplexes sporadically, value in controlling pests of small numbers.

It should be noted that mustard crops is a significant accumulation of parasitic insects attracted to supply pollen, as the majority of adults in need of carbohydrate foods (Sarfraz et al., 2007).

Therefore, from the standpoint of increasing the efficiency of entomophages mustard greens should be widely introduced into the crop rotation.

Of great interest is the question of the possibilities of using natural enemies of *Plutella maculipennis* Curt. There are 100 species of parasites and 20 species of predators, for the Russian Federation and CIS countries, respectively 53 and 5 species for its areal indicated in the literature (Razumov, 1972). By the course, they are not equal in their significance. The most common and effective pest entomophages are three or four species, constantly associated to this phytophagy. Others are much less and, apparently, have other more preferred hosts. In many cases, entomophages destroy 70-90% of individuals *Plutella maculipennis* Curt. This, no doubt, prevents an excessive increase in the number of pests. We derived following parasites from the moth larvae and pupae: from the family Ichneumonidae – *Nitobia fenestralis* Holmgr., *N. Chysostictos* Gmel., *Netelia sp.*, *Exetastes cinctipes*

Retz., *Phaeogenes plutellae* Kurd., *Itopectis* sp., *Diadegma* sp., *Campoletis* sp, from the Braconidae family – *Apanteles sessilis* Bouc., *A. Plutellae* Kurd., *A. Congestus* Nees., *Dio-spilus* sp, the Pteromalidae family – *Pteromalus puparum* Sven., *Eupteromalus* sp., *Eu. Peregrines* Gracham., *Eu. Nidulans* Thoms., from Eulophidae – *Tetrastichus* sp. The dominant specie is the *Nitobia fenestralis* Holmgr. – 90.1-96.0% of the total number of parasites derived. All other species have little or no economic value. In addition to parasitic insects, larvae had a mycosis, caused by microorganisms *Entomophthora sphaerosperma* Fres. Dead larvae darken and mummified.

On *Pieris brassicae* L. and *P. Rapae* L. are parasitizing larvae an *Apanteles glomeratus* L., and on their pupae – *Pteromalus puparum* Sven. Parasites are capable of infect up to 45% larvae hatch from the eggs of the first, from 3 to 34% of the pupae of the pest.

From insects, parasitizing on the Eurydema representatives, we discovered species from Scelionidae family: *Trisolcus viktorovi* Kozl., *T. Grandis* Thoms., *T. Festivae* Vikt., *T. Chlorops* Thoms., *Telenomus eurydema* Vas. *Clytiomyia continua* Panz. parasitizing on chinch during the growing season, but of its host is infected does not exceed 2% in the conditions of the Lower Volga region.

A rapeseed sawfly is parasitized by *Perilampus italicus* Fabr., *P. Splendidus* Darm., *Cleptus semiaratus* L., *Monob-latus brachyacanthus* Gmel. of Ichneumonidae family. Noting also the fly-tahina *Meigenia mutabilis* Fall. Contamination of sawfly larvae and reeks may reach 87-90%.

Complex of entomophags destroying cabbage aphids, is quitenumerous. Under field conditions, including the Volgograd region to the colonies of cabbage aphids occurred up to 38% of mummified animals, from that the *Diaetriella rapae* M 'Int., *Aphidius matricariae* Hal., *A. Ervi* Mal. are derived. The *Praon simulans* Prov. larvae do not form a classic mummy; each weaves a cocoon for an empty cloth aphid, in which pupating.

Flowering mustard attracts a significant number of pollinators from different families. Currently, the list of pollinators from the family of bees in the south-west of Russia has about 600 species. However mustard pollinators have been poorly studied. According to Mukhin (1986), the fauna of wild pollinators mustard greens in Volgograd Region is represented in 45 species of 5 families – *Colletes caspicus* F. Mor., *C. lebedevi* Nosk., *C. marginatus* Sm., *Prosopis bisinuata* F. Mor., *P. variegata* F., *Andrena athenensis* War., *A atrata* Friese., *A. carbonaria* L., *A. dentiventris* F. Mor., *A. dorsata* Kby., *A. figurate* F. Mor., *A. flavipes* Panz., *A. haemorrhhoa* F., *A. chysopyga* Schck., *A. labialis* Kby., *A. labiata* F., *A. nanaeformis* Nosk., *A. nobilis* F. Mor., *A. oralis*

F. Mor., *A. ovatula* Kby., *A. pectoralis* Kby., *A. scita* Ev., *A. thoracica* F., *A. tibialis* Kby., *A. truncatilabris* F. Mor., *A. ventralis* Schenck., *Panurginus lactipennis* Friese., *Melitturga clavicornis* Latr., *Halictus calceatus* Scop., *H. maculatus* Sm., *H. politus* Schck., *H. quadricinctus* F., *H. xanthopus* Kby., *Melitta leporine* Panz., *Megachile argentata* F., *M. melathoracica* Imh., *Eucera clypeata* Er., *Anthophora erschowi* Fedt., *A. radoszkowskii* Fedt., *Crocisa affinis* F. Mor., *C. histrionica* Ill.

Wild pollinators are well adapted to the timing of flowering of culture and climate of the area. They are always present in the entomological collections for flowering mustard. In our entomological collections were most frequently identified *Andrena atrata* Friese., *A. Carbonaria* L., *A. Figurata* F. Mor., *A. Flavipes* Panz., *A. Nobilis* F. Mor., *Eucera clypeata* Er., *Apis mellifera* L. and *Dasygoda plumipes* Panz. we observed on flowers of all cruciferous, including the mustard. From Bombidae family we noted these species: *Bombus terrestris* L., *B. agrorum* F., *B. hortorum* F., *B. serratigama* L.

## Conclusion

The preservation and revitalization of natural entomophags populations is extremely important in regulated ecosystems. The useful insects in nature are usually characterizing in high mass and high adaptability to specific agrobiocenoses. There need to pay more attention to determine their value in specific crops, to control their quantity, along with the dynamics of the number of harmful insects, in whose spread restriction they in some cases can have crucial importance.

The association of mustard agrocenoses insects to certain ecological groups allows us to adequately assess the diversity of the insect fauna. Therefore, we carried out the analysis of biota on this aspect. As a result there are 11 groups of insects in mustard agrocenoses lives.

The phytophages and entomophages group is most richly presented in entomofaunistic communities – 314 species, or 82.4% of the total number of species. The percentage of phytophages in mustard agrocenoses is 27.03% of the total composition of entomocomplexes. They are divided into 6 ecological groups: leaf-eating, sucking, intrastem, pests of generative organs (flowers, buds and pods), miners, and pests of the root system.

The most represented groups are: the leaf-eating phytophages – 47 species or 45.63% of the total number of herbivores; sucking – 18 species (17.48%); pests of generative organs – 17 species. Several smaller species are considered as pests that damage the root system – 15 (14.56%). Miner-flies (5 species) make up 4.85% of the total number of herbivores.



There is 1 specie of intrastem pests marked, which is 0.97%.

A group of entomophages applies, i.e. 55.38% of species in insect communities, inhabitants mustard agrocoenosis. Most variously as a part of the useful biota predatory insects – the 130 species (34.12%) – are presented. The main core of this group consists of Coleoptera species. Among them, first of all it should be noted families, such as Carabidae and Coccinellidae. The rest of the orders are presented more poorly. The share of parasitic insects (81 species) has 21.25% of the total species diversity of the entomofaunistic community of mustard agrocoenosis. The most represented families are: Ichneumonidae, Braconidae, Syrphidae, Asilidae. The ratio of predators to parasite species is about 1: 1.3. Quite a significant role in the structure of the complex played by pollinators – for 13.38% of the total number of species. According to the method of pollination *Brassica juncea* (*Sarepta mustard*) is facultative cross-pollinated with slight depression by self-pollination. Deficiency of pollinators is one of the reasons for the instability of crop yields. At pollination by bees of mustard crop increased by 27-36%, but the unevenness of a honey yield during a season creates unfavorable conditions for the existence of beekeeping, especially in the southern areas of the region, where the main crops of this culture.

A small representation of a group saprophages and necrophages, its participation in the entomocomplexes does not exceed 1.31% from the general structure of the complex. The share of other species are also insignificant – 2.88%.

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