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ACARIDID MITES SPECIES COMMUNITIES IN AGRICULTURAL AND INDUSTRIAL OBJECTS OF STORING AND CONCENTRATION OF NUTRITIVE SUBSTRATES IN ZHYTOMYR POLISSIA

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Acaridid Mites Species Communities in Agricultural and Industrial Objects of Storing and Concentration of Nutritive Substrates in Zhytomyr Polissia. Oksentiuk, Ya. R., Liashevych, A. M., Lupaina, I. S. — This work presents the results of long-term complex study of acaridid mites' fauna and ecology in different biotopes (agricultural and industrial objects) in Zhytomyr Polissia. There were 30 species identified, which belong to five families: Suidasidae, Acaridae, Glycyphagidae, Chortoglyphidae, Aeroglyphidae. The results showed that acarocomplex of industrial objects, like mills, granaries and warehouses, includes the 11 Acaridae species, and that of compound fodder factories — three species. Acarofauna of agricultural objects was shown to consist of 30 species: 21 in barns with animal feed (grains, compound feeds, hay and straw), 12 in outbuildings with livestock and poultry, 9 in beehives, 13 in vegetable storages. The qualitative differences of mentioned acarocomplexes were established, and the factors to possibly influence their dynamics were discussed.
Key words: acaridid mites, agricultural and industrial places, Zhytomyr Polissia.

Introduction

The most of acaridid mites (Acariformes, Acaridia) are free-living small arthropods, inhabiting the assemblages of different organics in soil, in forest duff, in nests and holes of different animals. They play an important role in plant biodestruction, feeding on the organic remains (Akimov, 1985). Family Acaridae are common pests. The life cycle includes a brief larval stage typically followed by three nymphal stages before the reproductive adult stage. Their rate of increase is unparalleled by any insect, with only 14 days being needed to complete development under optimal conditions and with a single female being able to produce 5–600 eggs. Eggs are cold tolerant and in some species development can proceed down to 5^0 C, but in all species low humidity prevents development. (Bell, 2014). The deutonymphs in the biggest family Acaridae are able, under some unfavorable conditions, to metamorphose to the specific fase "hypopus" which is better adapted to unfavorable environment. The significant number of acaridid mites prefer for the life and fast reproduction those sites, where humans store or process the supplies, food, fodder, technical cultures or else. The most of synanthropic acaridid species have high ecological valence and inhabit the numerous substrates (Kadzhaia, 2009).

In the studied samples from agricultural and industrial sites the different combinations of acaridid species occur. And the acarocomplexes of agricultural and industrial sites are quite dynamic systems, being influenced by many biotic and abiotic factors, changing their species composition (Dudynska, 2008). Complexes of species from agricultural and industrial objects differ from each other in species composition. The species diversity of acaridid mites in agricultural sites is greater than industrial ones.

The perfect conditions for food preservation and minimization of pests appearance are the low temperature, low absolute and relative humidity, the absence of food sources available for pests. But none of these parameters can be controlled permanently, especially at the agricultural objects. Perpetuating transportation of food substrates in the industrial objects into and out of storage spaces makes the additional danger of pest contamination (Bell, 2014). The acaridid mite contamination of nutritious substrates occurs as well as in the transport, in the storage and processing buildings, and at the processing equipment, if the sanitary and hygienic norm is not adhered.

The aim of our study was to investigate the faunistic composition of acaridid mites in the agricultural and industrial objects of storage and concentration of nutritious substrates in Zhytomyr Polissia; as well as to establish the qualitative difference between these complexes, and the possible factors to condition their species composition dynamics.

Material and methods

Material included the samples collected from agricultural (barns with stored animal feeds, outbuildings, beehives and vegetable storages) and industrial (mills, granaries, warehouses, compound fodder factories) objects. The samples were taken from crop and oilseeds supplies, from litter, ambrosia and death bees in hives of *Apis mellifera* Linnaeus, 1758, from hay and straw, compound fodder, and from damaged vegetables. The taxonomic variety of acaridids in Zhytomyr Polissia was studied during 2014–2020, with the most of material collected in 2015–2017. There are samples from Zhytomyr Region (Olevsk, Ovruch, Narodychi, Lugyny, Yemilchine, Korosten, Malyn, Khoroshiv, Novohrad-Volynskyi, Pulyny, Cherniakhiv, Radomyshl, Zhytomyr, Brusyliv, Popilnia, Ruzhyn, Chudniv, Romaniv districts) and Rivne Region (Rokytne, Berezne, Sarny, Kostopil, Dubrovytsia, Zarichne districts).

In total, the 80 collection sites were studied; from 63 the results were obtained. The material collection and analysis were performed in accordance with methods having been adapted to acarological studies (Giljarov, 1975). Mite sampling from the substrate samples was performed by hands using the МБС-9 binocular; the eclection method (following Berlese with Tullgren modification) was applied for the massive quantitative collection. To identify the species compositions, mites were mounted on slides using the gum arabic Hoyer's medium. In total, around 2000 slides were made and 12,834 acaridid individuals were examined.

To describe the acaridid mites communities from different substrates, the Paliy-Kovnatsky domination index (species present more than 10 % in samples considered as dominants, 1 to 10 % — sub-dominant species; 0.1 to 1 % — first-stage subdominant species; up to 0.1 % — secondary species (Shitikov et al., 2003), occurrence index (Pesenko, 1982) and density index were applied. Following the S. Pohrebniak method (1990), observed species composition was separated into the "core", "surrounding" and "trace". The comparative analysis of acarid mites complexes in the studied substrates was performed using Sørensen and Jaccard (Kj) indexes (Pesenko, 1982).

Results and discussion

Among the working industrial objects in Zhytomyr Polissia, the faunistic communities of acaridid mites in mills, granaries, warehouses and compound fodder factories, different by age and building condition, were studied. It is typical for industrial objects to have more artificial, optimized for storage purpose, conditions, which synanthropic pests are adapted for (since the product storage building usually have more stable humidity and temperature).

It was established that acaridid mites complex from industrial sites contains the 11 species (table 1), among which the *Acarus siro* Linnaeus, 1758 and *Glycyphagus domesticus* (De Geer, 1778) are the dominants. The sub-dominants in studied buildings are *Tyrophagus putrescentiae* (Schrank, 1781), *Acarus farris* (Oudemans, 1905) and *Lepidoglyphus destructor* (Schrank, 1781). Abovementioned acaridids present the "core" of acarocomplex of mills, granaries, warehouses and compound fodder factories. In this complex, the first-stage subdominants and mites of "surrounding" group are the *Tyrophagus perniciosus* Zachvatkin, 1941, *Tyrophagus molitor* Zachvatkin, 1941 and *Tyrolichus casei* Oudemans, 1910. The only 3 acaridid species (*Lepidoglyphus fustifer* (Oudemans, 1903), *Tyrophagus humerosus* (Oudemans, 1923) and *Neoacotyledon sokolovi* (Zachvatkin, 1940)) are the secondaries in this complex. They present a "trace"-species group and, perhaps, are the random or temporary habitants in studied biome.

The acarofauna of agricultural objects contains 30 acaridid mite species (table 2). The samples were collected in barns with stored animal fodder, vegetable storages, outbuildings with livestock and poultry, and beehives. The agricultural objects typically have more diverse conditions, resembling those in nature, with lower anthropogenic pressure comparing to industrial buildings.

Two species were dominants in studied substrates: *L. destructor* та *Gl. domesticus*. The only subdominant species was *A. siro*. Thus, *L. destructor*, *Gl. domesticus* and *A. siro* make the "core" of pest complexes in studied objects. In barns, outbuildings, vegetable storages and beehives, the first-stage subdominants presenting the "surrounding"-group are *T. putrescentiae*, *T. molitor* and *Sancassania berlesei* (Michael, 1903). The "secondaries" and "trace"-species here were 24 acaridid species: *Suidasia nesbitti* Hughes, 1948, *A. farris, Acarus tyrophagoides* (Zachvatkin, 1941), *Mycetoglyphus fungivorus* Oudemans, 1932, *T. casei, T. perniciosus, T. humerosus, Tyrophagus longior* (Gervais, 1844), *Tyrophagus formicetorum* Volgin, 1948, *Tyrophagus mixtus* Volgin, 1948, *Schwiebea nova* (Oudemans, 1906), *N. sokolovi, Sancassania sphaerogaster* (Zachvatkin, 1937), *Sancassania rodionovi* (Zachvatkin, 1935), *Sancassania mycophagus* (Megnin, 1874), *Sancassania oudemansi* (Zachvatkin, 1937), *Rhizoglyphus echinopus* (Fumouze and Robin,1868), *L. fustifer, Lepidoglyphus burchanensis* (Oudemans, 1903), *Lepidoglyphus michaeli* (Oudemans, 1903), *Lepidoglyphus pilosus* Oudemans, 1906, *Gohieria fusca* (Oudemans, 1902), *Chortoglyphus arcuatus* (Troupeau, 1879), *Aeroglyphus peregrinans* (Berlese, 1892).

Table 1. The species composition, Paliy-Kovnatsky domination index, occurrence frequency and density of acaridid mites in the samples from industrial objects in Zhytomyr Polissia

No	Species	Di, %	Is, %	V, ind.
1.	*A. siro*	17.76	37.5	0.17
2.	*A. farris*	4.45	25	0.094
3.	*T. casei*	0.14	12.5	0.012
4.	*T. putrescentiae*	1.04	25	0.022
5.	*T. molitor*	0.47	12.5	0.04
6.	*T. perniciosus*	0.12	12.5	0.01
7.	*T. humerosus*	0.07	12.5	0.006
8.	*N. sokolovi*	0.024	12.5	0.002
9.	*Gl. domesticus*	10.6	87.5	0.018
10.	*L. destructor*	7.22	62.5	0.024
11.	*L. fustifer*	0.047	12.5	0.004

Table 2. The species composition, Paliy-Kovnatsky domination index, and occurrence frequency of acaridid mites in the samples from agricultural objects in Zhytomyr Polissia

No	Species	Di, %	Is, %
1.	*S. nesbiti*	0.00008	1.1
2.	*A. siro*	3.18	39.1
3.	*A. farris*	0.032	7.6
4.	*A. tyrophagoides*	0.01	7.6
5.	*M. fungivorus*	0.0061	2.2
6.	*T. casei*	0.002	4.3
7.	*T. putrescentiae*	0.26	18.5
8.	*T. molitor*	0.12	14.1
9.	*T. perniciosus*	0.04	13
10.	*T. humerosus*	0.004	3.3
11.	*T. longior*	0.0023	2.2
12.	*T. formicetorum*	0.00008	1.1
13.	*T. mixtus*	0.00008	1.1
14.	*S. nova*	0.00008	1.1
15.	*N. sokolovi*	0.07	4.3
16.	*S. berlesei*	0.11	4.3
17.	*S. sphaerogaster*	0.08	4.3
18.	*S. rodionovi*	0.007	3.3
19.	*S. mycophagus*	0.0002	1.1
20.	*S. oudemansi*	0.00008	1.1
21.	*Rh. echinopus*	0.001	2.2
22.	*Gl. domesticus*	18.34	75
23.	*L. destructor*	43.4	77.2
24.	*L. fustifer*	0.02	5.43
25.	*L. burchanensis*	0.005	4.3
26.	*L. michaeli*	0.002	3.3
27.	*L. pilosus*	0.00008	1.1
28.	*G. fusca*	0.01	5.4
29.	*Ch. arcuatus*	0.0009	1.1
30.	*A. peregrinans*	0.03	9.8

Thus, the agricultural collection sites with animal fodder storages include the whole acaridid species composition presented in the samples exactly due to long-term storage in the same place.

The analysis of obtained results showed that there is plenty of acaridid mite species with quite narrow ecological valence (table 3). Particularly, *S. nesbiti*, *T. formicetorum, T. mixtus, S. nova, L. pilosus, Ch. arcuatus* occur only in the barns with the animal fodder storage. *A. peregrinans* was found only in the honey bee beehives. *S. berlesei, S. sphaerogaster, S. rodionovi, S. mycophagus, S. oudemansi, Rh. echinopus* are typical for vegetable storages acarocomplex. In the rest of the studied industrial and agricultural objects, no species inherent only for them were found. The species common for all studied sites are *A. siro, L. destructor* та *Gl. domesticus*. The widespread species found in all faunistic complexes, excepting the compound fodder factories, is the *T. molitor*.

The level of similarity of acaridid mites species compositions between agricultural and industrial objects: Qs = 0.54, and Kj = 0.36. All the 11 acaridid species found in the industrial sites are common for both object types.

Generally, according to Sørensen and Jaccard indexes (table 4), the most similar are the mills, granaries, warehouses and beehives (Qs = 0.7; Kj = 0.53); there were 7 common

Table 3. The acaridid mites (Acariformes, Astigmata) species communities of agricultural and industrial objects in Zhytomyr Polissia

Family	Species	Collection sites					
		1	2	3	4	5	6
Suidasidae	*Suidasia nesbiti*	–	–	+	–	–	–
Acaridae	*Acarus siro*	+	+	+	+	+	+
	A. farris	+	–	+	+	–	–
	A. tyrophagoides	–	–	+	+	–	–
	Mycetoglyphus fungivorus	–	–	–	+	–	+
	Tyrolichus casei	+	–	+	–	–	–
	Tyrophagus putrescentiae	+	–	+	+	+	–
	T. molitor	+		+	+	+	+
	T. perniciosus	+		+		+	+
	T. humerosus	+	–	+	+	–	–
	T. longior	–	–	+	–	+	–
	T. formicetorum	–	–	+	–	–	–
	T. mixtus	–	–	+	–	–	–
	Schwiebea nova	–	–	+	–	–	–
	Neoacotyledon sokolovi	+	–	–	–	–	+
	Sancassania berlesei	–	–	–	–	–	+
	S. sphaerogaster	–	–	–	–	–	+
	S. rodionovi	–	–	–	–	–	+
	S. mycophagus	–	–	–	–	–	+
	S. oudemansi	–	–	–	–	–	+
	Rhizoglyphus echinopus	–	–	–	–	–	+
Glycyphagidae	*Glycyphagus domesticus*	+	+	+	+	+	+
	Lepidoglyphus destructor	+	+	+	+	+	+
	L. fustifer	+		+		+	
	L. burchanensis			+	+	–	–
	L. michaeli	–	–	+	+	–	–
	L. pilosus	–	–	+	–	–	–
	Gohieria fusca	–	–	+	+	–	–
Chortoglyphidae	*Chortoglyphus arcuatus*	–	–	+	–	–	–
Aeroglyphidae	*Aeroglyphus peregrinans*	–	–	–	–	+	–
Total species number		11	3	21	12	9	13

Note. 1 — mills, granaries and warehouses; 2 — compound fodder factories; 3 — barns with animal fodder storage; 4 — outbuildings; 5 — honey bee beehives; 6 — vegetable storages.

species. The lowest similarity indexes were for acarocomplexes of mills, granaries, warehouses and compound fodder factories (Qs = 0.43; Kj = 0.27) — however, all 3 species found in compound fodder are common. The similarity of beehives' species composition was the lowest comparing to that of outbuildings (Qs = 0.48; Kj = 0.31). Only 5 species occurred in 2 studied collection sites in agricultural objects.

The highest similarity of acaridid species composition in compound fodder factories was found with honey bee beehives (Qs = 0.43; Kj = 0.27), and the lowest — with animal fodder storages (Qs = 0.25; Kj = 0.14). Despite all three species from the fodder are common, the species number in the animal fodder storage is higher than that in the litter, ambrosia and trash from the beehives bottom.

Similarity index between acaridid species composition of animal fodder storage and outbuildings: Qs = 0.67; Kj = 0.5. These are the highest values for two agricultural objects.

Table 4. The indexes of faunistic similarity of Sørensen and Jaccard for acaridid mites in agricultural and industrial collection sites
Sørensen similarity index

Collection sites	1	2	3	4	5	6
1	11	0.43	0.56	0.61	0.7	0.5
2	0.27	3	0.25	0.4	0.5	0.38
3	0.39	0.14	21	0.67	0.53	0.29
4	0.44	0.25	0.5	12	0.48	0.4
5	0.53	0.33	0.36	0.31	9	0.45
6	0.33	0.23	0.17	0.25	0.29	13

Jaccard similarity index

Note. 1 — mills, granaries, warehouses; 2 — compound fodder factories; 3 — barns with animal fodder storage; 4 — outbuildings; 5 — honey bee beehives; 6 — vegetable storages. Grey cell-filling denotes the acaridid species number found in respective nutritious substrate

Ten species are common. The lowest similarity is between barns and compound fodder factories (Qs = 0.25; Kj = 0.14), and vegetable storages (Qs = 0.29; Kj = 0.17). There were three common species for barns and factories, and five common species for barns and vegetable storages. The acaridid species composition of outbuildings is the less similar to compound fodder factories acarofauna (Qs = 0.4; Kj = 0.25; three common species) and to vegetable storages (Qs = 0.4; Kj = 0.25; five common species).

Similarity of vegetable storage acarocomplex is the highest with acarocomplex of mills, granaries and warehouses (Qs = 0.5; Kj = 0.33), and the lowest with the animal fodder storages (Qs = 0.29; Kj = 0.17). Despite the 5 common species in studied sites, the number of acaridid species in barns is twice more than that in mills, granaries and warehouses (Oksentiuk, 2020).

Obtained results can be explained by similarity of conditions in collection sites. For instance, there are no large year temperature and humidity amplitudes in mills, granaries, warehouses and beehives; these indexes are maintained at approximately the same level. There are approximately identical (by composition) substrates, nutritious for acaridid mites, and conditions, close to natural, in barns with animal fodder storages and in outbuildings. Noticeable, the insignificant similarity with all other studied sites is inherent for acarocomplex of compound fodder factory and vegetable storage. The scarce acaridid fauna at the compound fodder factories shows the recently resume of work after a long break, and adherence to the sanitary and hygienic norms. The acaridid mite species of private vegetable storages more tend to inhabit the humid substrates and prefer to feed on the nematodes, microscopic fungi, mold and yeasts, i.e. on more nutritious objects.

The significant difference of species and quantitative composition of acaridid mites between agricultural and industrial objects can be explained by the difference in structural features of buildings, in adherence to sanitary and hygienic norms, and in product pest control methods. The most of industrial objects storing the nutritive substrates are hermetic and repaired. Unlike the agricultural objects, which do not have the ventilation, and the buildings have the cracks and potholes serving as the ways for pests from the outside. In agricultural buildings the storing norms are not usually adhered, like storage preparing for new products, old products removing, regular sanitary examining of storage, products control during the storing period. The pest control is more successful in the industrial objects, being based on as the prophylactic, as the neutralizing methods in the integrated systems of products defense. Pest control in the private buildings is usually based on the chemical treating using fumigants and contact insecticides.

Therefore, the more number of acaridid species in the agricultural objects comparing to industrial ones can be explained by non-adherence of sanitary and hygienic norms that favors here acaridid mites living. Also, the anthropogenic impact on the microclimate there is insignificant; in most cases it correspond the outside conditions. The temperature at the surface of the storage imitates the conditions of surround environment, the humidity change at the surface lags by approximately 4 hours behind the surrounding humidity (Sinha, 1973; Burrell, 1979 as cited in Armitage, Cook, 1999). In addition, as the literature sources say, barn mites occur more frequently in the regions with moderate, cool humid climate (Palyvos et al., 2008). Climate with mild winters and high humidity is the especial problem in products defense against mite infection.

Conclusions

1. As the result of the study of acaridid mites species complexes in industrial and agricultural objects of storage and concentration of nutritive substrates in Zhytomyr Polissia, the 30 species were found: 11 in industrial objects, 30 in agricultural objects.

2. The common species for studied sites were *A. siro, L. destructor* and *Gl. domesticus*. The widespread species found in all sites excepting compound fodder factories was *T. molitor*. But there were also many species with very narrow ecological valence. In particular, *S. nesbiti, T. formicetorum, T. mixtus, S. nova, L. pilosus, Ch. arcuatus* occur in the barns with animal fodder storage only; *A. peregrinans* was found in the honey bee beehives only; *S. berlesei, S. sphaerogaster, S. rodionovi, S. mycophagus, S. oudemansi, Rh. echinopus* were typical for vegetale storages.

3. The more acaridid species variety in the agricultural objects can be explained by the more variable conditions, close to the nature ones, and by the lower anthropogenic pressure comparing to industrial objects. In the industrial objects, the conditions are more stable (without temperature and humidity year amplitude) and optimized for nutritive substrate storage, that limits mites' development.

4. The significant difference in species and quantitative composition of acaridid mites between agricultural and industrial objects can be explained by structural features of buildings, by adherence to sanitary and hygienic norms, and by product pest control methods.

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