The bioindicator properties of oribatid mites in soil fauna of Kashkadarya region

D Z Majidova[1*], *O M* Mamarakhimov[1], *M M* Makhmudova[1], *Kh S* Turdalieva[1], and *N T* Shamuratova[1]

[1]National University of Uzbekistan, Tashkent, 61010333, Uzbekistan

Abstract. This article discusses the loss of bioindicator characteristics in oribatid mites found in the Kashkadarya region due to various anthropogenic and environmental factors. The study, conducted during the spring and summer of 2023, focused on pine and spruce gardens surrounding the Shortan gas-chemical industrial area. The results of our research identified 23 species, including *Ornithonyssus bursa, Geratoppia quadridentate, Furcoribula furcillata, Perlohmannia altaica, Liochthonius kirghisicus, Asiacarius elongatus, Liochthonius hystricinus, Cultroribula dentata, Epilohmannia cylindrica* and *Michelia paradoxa* with bioindicator properties. Changes in these indicators of species primarily occurred in the A soil layer, up to 10 cm deep. The study found that the primary factor influencing these changes was not the chemical waste from the industrial plant but rather acid gases resulting from burning companion gases, leading to acid rain formation when mixed with precipitation.

1 Introduction

The initial investigations into the taxonomy of soil-dwelling Oribatid mites within the CIS countries are attributed to Zakhvatkin, whose work led to the development of an identifier for Oribatid mites within the Galumnidae family. Zakhvatkin's research also revealed that many of these mites serve as intermediate hosts for cestodes [1].

Subsequent to Zakhvatkin's contributions, a comprehensive study of Oribatid mites in the Far East commenced in 1971 under the leadership of Academician Gilyarov. This endeavor involved extensive faunal surveys across regions such as Kamchatka, Khabarovsk, Amur, and the Kunashir Peninsula. Collaboration with 26 experts from diverse Eastern regions enabled the examination of Oribatid mite fauna in relation to dominant plant types, distribution patterns across zones, and regional faunal variations. This study also explored vertical distribution within soil, seasonal dynamics, biological and ecological characteristics, and their applicability as bioindicators for assessing environmental degradation due to economic activities [2-3].

In 1986, Koshanova investigated free-living Oribatid mites in the soil of irrigated lands in northern Republic of Karakalpakstan, identifying 46 cold mite species in agroecosystems like rice paddies, cotton fields, alfalfa farms, vineyards, and apple orchards[3].

* Corresponding author: elmurodyangiboyev20@gmail.com

A more recent study in 2016 by Mominov et al. investigated Oribatid mites in the northeastern regions of Uzbekistan. Their findings revealed 31 cold mite species within the agroecosystems of the Angren-Almaliq industrial area and in the natural ecosystem soil layer. These identified species span 20 families and 24 genera [3].

2 Materials and methods

The research conducted by the Department of Zoology at the National University of Uzbekistan in June 2023 involved gathering research materials near the Shortan gas-chemical complex situated in the Guzor district of the Kashkadarya region (Figure 1). The research conducted two study areas Main and Control. The investigation involved traversing three designated fields within the Main study areas around Shortan gas-chemical complex, each transect spanning 1050 meters in length and comprising three smaller segments of 350 meters. Within each sub-segment, three envelope points were identified, positioned at distances of 50 meters, 175 meters, and 300 meters from the starting point of the transect, respectively. These envelope points encompassed an area of 10 m^2 each, and soil samples were systematically collected from five points within each envelope [4-6, 8].

At each sampling point, which occupied an area of 1 m^2, soil layers A, B, and C were meticulously sampled in five discrete parts. Samples from layer A, obtained from five points within a 1 m^2 area, were amalgamated to form a single 1 dm^3 composite sample, as were samples from layers B and C. Consequently, a total volume of 1 dm^3 of soil was extracted from each small cover point of 1 m^2. Notably, soils collected from larger envelope points were kept segregated and stored individually. Subsequently, 405 soil samples from three distinct fields within the Shortan gas-chemical complex were transported to the laboratory for faunal analysis [4, 6].

In order to facilitate comparative analysis, an equivalent number of 405 similar soil samples were procured from Control study area located 8 kilometers away from the Main study areas.

The generally accepted "Berleze-Thulgren" apparatus was used to isolate oribatid mites from soil samples [7].

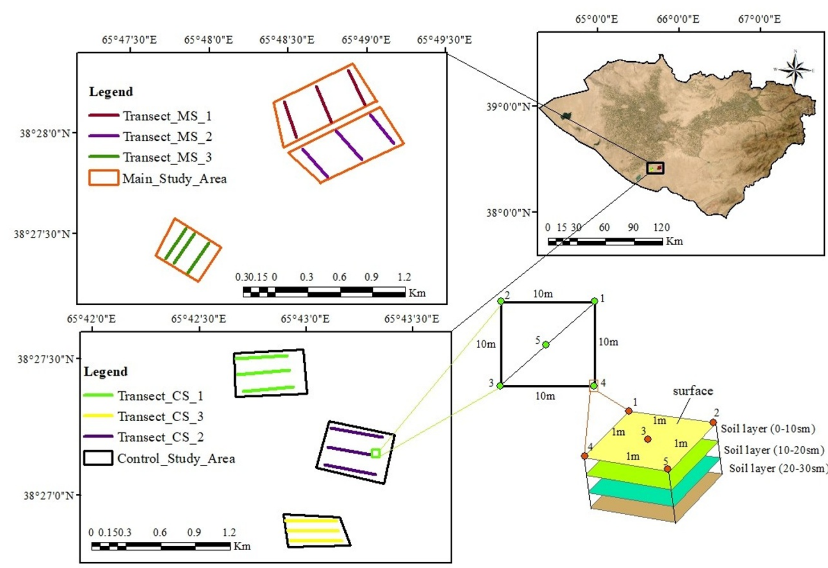

Fig. 1. The map of study areas.

 https://doi.org/10.1051/bioconf/202411802004

In order to determine the species composition, permanent preparations were prepared. Permanent preparations were made by the method of fixation.

Fixation: 70-80% ethyl alcohol is traditionally used to fix Oribatid mites. It is recommended to add 1-2% glycerine to alcohol. In this case, glycerin prevents the alcohol from drying out during the storage of the material in the test tube [7].

Dominance: To express the relative abundance of species, percentages of the total were utilized [3-7]. In our investigation, employing an index ranging from 0% to 12.94%, the Engelman scale was employed as follows:

- 0-1.99%: characterized as subresident.
- 2-3.99%: characterized as resident.
- 4-5.99%: characterized as subdominant.
- 6-7.99%: characterized as dominant.
- ≥8%: collectively considered eudominant.

3 Results

From In the research of soil fauna composition within the agroecosystem surrounding the Shortan gas-chemical complex, a total of 23 species of oribatid mites were identified from soil samples collected from both the Main and Control areas. Layer-wise analysis revealed the presence of 22 oribatid mite species in layer A of the Main area, 20 species in layer B, and 10 species in layer C. Similarly, in the Control area, 23 species were observed in layer A, 20 species in layer B, and 10 species in layer C. Notably, the species Ornithonyssus bursa Berlese,1888 was exclusively found in layer A of the soil within the Control area.

The species identified were tallied, and the mean density per 1 dm^3 of soil was computed (Table 1). Consequently, within the main area, one species was classified as eudominant, six as dominant, four as subdominant, eight as resident, and three as subresident. In comparison, within the control area, three species were categorized as eudominant, four as dominant, three as subdominant, seven as resident, and six as subresident.

In our research, diversity indices for the field oribatid mite community utilizing species densities were calculated. This approach enables us to discern the primary stratum of community alteration by comparing diversity in relation to both species and individual abundance. Our analysis reveals disproportionate changes in the Shannon index, Margalik species richness index, relative diversity, and evenness concerning the number of species and individuals within the A layer of the main research area [Figure 2].

When the density of species distributed in layers A of both study areas were analyzed to linear bivariate regression, 9 species were separated as indicator species. These species were found to cause diversity in the A layer of the main study area due to anthropogenic and abiotic factors causing soil damage [Figure 3].

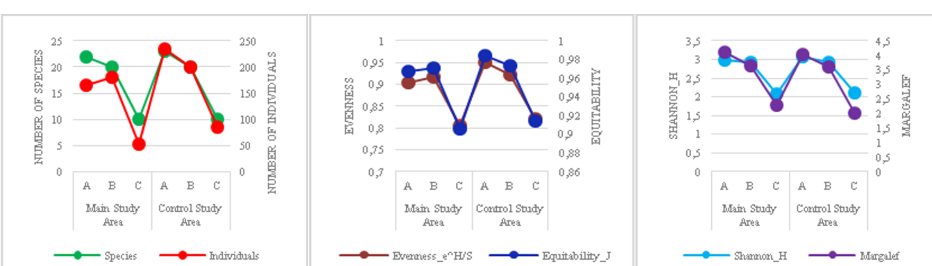

Fig. 2. The diversity indices of study areas.

 https://doi.org/10.1051/bioconf/202411802004

Table 1. Species composition of oribatid mites in study areas (SR - subresident, R – resident, SB – subdominant, D – dominant, ED – eudominant, N/A – not aviable).

		Main Study Area					**Control Study Area**				
		A	**B**	**C**	**%**		**A**	**B**	**C**	**%**	
1	*Hetrochtonius gibbus*	16.28±0.1	19.04±0.13	16±0.22	12.94	ED	17.1±0.20	19±0.211	17.1±0.21	10.28	ED
2	*Cosmochthonius lanatus*	10.2±0.51	15.2±0.30		6.41	D	16.6±0.44	16.1±0.40		6.33	D
3	*Liochthonius hystricinus*	9.2±0.26	11.9±0.41		5.32	SD	15.3±0.27	15.25±0.3		5.90	SD
4	*Brachychthonius berlesei*	14.75±0.75	15.05±0.27		7.52	D	15.5±0.50	14.7±0.44		5.83	SD
5	*Liochthonius kirghisicus*	8.85±0.33	8±0.403	7.25±0.40	6.08	D	16.1±0.45	15.3±0.32	12.5±0.25	8.49	ED
6	*Michelia paradoxa*	9.1±0.13	11.9±0.20		5.30	SD	15.2±0.21	16.2±0.43		6.04	D
7	*Lohmannida lanceolata*	14.75±0.67	16.71±0.45		7.93	D	15.5±0.90	16.3±0.74		6.10	D
8	*Cryptacarus promecus*	12.4±0.23	11.55±0.2		6.04	D	13.4±0.37	10.3±0.40		4.58	SD
9	*Asiacarius elongatus*	9.75±0.11	12±0.09	8.8±0.50	7.70	D	12.7±0.15	11.0±0.20	18±0.40	8.06	ED
10	*Epilohmannia cylindrica*	5.21±0.12	7.3±0.15	2.2±0.06	3.71	R	10.6±0.22	12.1±0.20	14.9±0.35	7.27	D
11	*Nothrus peltifer*	8.1±0.1	7.5±0.10	4.23±0.10	5.00	SD	8.21±0.19	6.8±0.31	4.6±0.20	3.79	R
12	*Hermannia dubinini*	7.51±0.099	5.8±0.11	2±0.13	3.86	R	8.15±0.12	6.03±0.10	1.5±0.10	3.03	R
13	*Hermannia reticulata*	6.65±0.07	6.2±0.07	6.2±0.45	4.80	SD	8.32±0.11	7±0.09	4.12±0.14	3.76	R
14	*Hypodameus tenuitibialis*	7.03±0.11	8±0.11		3.79	R	10.8±0.22	6.25±0.15		3.30	R
15	*Nellacarus asiaticus*	4.55±0.18	4.5±0.188		2.28	R	5.8±0.11	4.85±0.10		2.06	R
16	*Lauroppia maritima*	4.5±0.12	3.38±0.10	2±0.12	2.49	R	5.1±0.09	3±0.15	3.01±0.08	2.15	R
17	*Perlohmannia altaica*	2.5±0.09	3.15±0.10	3.01±0.20	2.18	R	5.9±0.10	6±0.07	5.5±0.07	3.36	R
18	*Cultroribula dentata*	2.2±0.105			0.55	SR	8.32±0.10			1.61	SR
19	*Furcoribula furcillata*	1.4±0.03			0.35	SR	6.25±0.05			1.21	SR
20	*Geratoppia quadridentata*	1.5±0.015	2.8±0.01	1±0.05	1.34	SR	4.5±0.01	4.5±0.05	3±0.05	2.32	SR
21	*Licheremaeus licnophorus*	3.5±0.04	5.67±0.22		2.31	R	4.8±0.02	5±0.02		1.89	SR
22	*Zygoribatula propinqua*	3.85±0.15	4.4±0.155		2.08	R	4.7±0.02	3.8±0.01		1.64	SR
23	*Ornithonyssus bursa*				0.00	N/A	5.2±0.19			1.00	SR
					100%					**100%**	

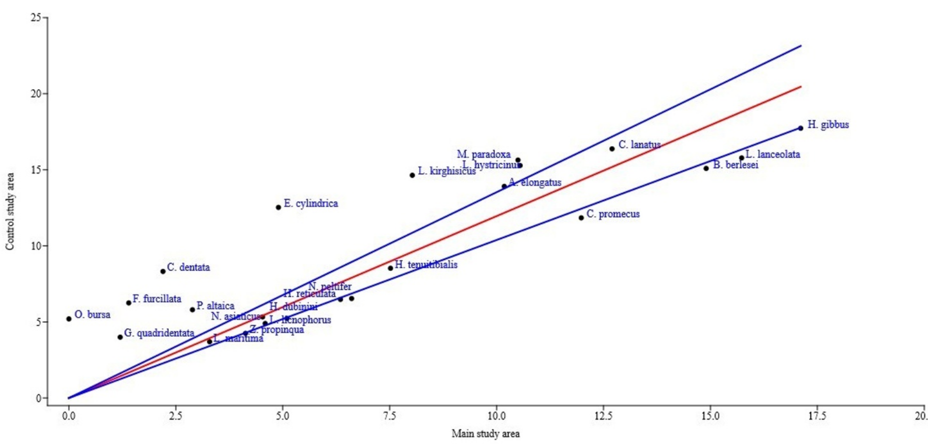

Fig. 3. The regresion analysis of Study areas.

4 Discussion

Considering the similar climate conditions and soil types between the main and control research areas, along with the establishment of agrocenosis simultaneously, one would expect the soil oribatid mite communities in these areas to exhibit nearly identical characteristics. However, our studies revealed that in layer A of the main area, there was a lower abundance of certain species compared to the control area. Consequently, this resulted in distinct differences in the abundance of eudominant, dominant, subdominant, resident, and subresident species, as well as diversity indices between the two regions.

Specifically, in the Main research area, the species *Liochthonius kirghisicus* and *Asiacarius elongatus* were dominant, while they were eudominant in the control area. *Michelia paradoxa* was subdominant in the control area, and *Epilohmannia cylindrica* was resident in the main research area. Moreover, the species *Ornithonyssus bursa* was absent in the main area. Additionally, there was a notable increase in the abundance of *Geratoppia quadridentate, Furcoribula furcillata, Perlohmannia altaica, Liochthonius hystricinus,* and *Sultroribula dentata* species in the control area, while the abundance of Engelman scale remained unchanged. Regression analysis indicated that these species possess bioindicator properties. The study found that the primary factor influencing these changes was not the chemical waste from the industrial plant but rather acid gases resulting from burning companion gases, leading to acid rain formation when mixed with precipitation.

5 Conclusion

In conclusion, it is important to highlight that within the soil fauna of agrocenoses established around gas extraction and processing centers in the Kashkadarya region, certain species such as *Ornithonyssus bursa, Geratoppia quadridentate, Furcoribula furcillata, Perlohmannia altaica, Liochthonius kirghisicus, Asiacarius elongatus, Liochthonius hystricinus, Sultroribula dentata, Epilohmannia cylindrica,* and *Michelia paradoxa* play a significant role as bioindicators. These species exhibit low abundance in soil layer A due to the presence of acidic gases resulting from the combustion of various gases, which create acidic conditions upon precipitation and enter the soil.

References

1. B. Bayartogtokh, Fauna and ecology of the armored mites of Mongolia (Acari: Oribatida), KMK, 181 (2011)
2. I.V. Zenkova, E.N. Melekhina, Armored mites (Acari: Oribatida) of the Khibiny mountain range, Ecological problems of the northern regions and ways of their solution: Materials of the V All-Russian Scientific Conference with international participation, in part 3 (Apatity, June 24-27, 2014), Apatity: Kola Research Center of the Russian Academy of Sciences, 135-140 (2014)
3. Yu.A. Zakhvatkin, Acarology –Science about mites: History of development Current state, Systematics: Textbook –Book house "LIBROKOM", Moscow, 192 (2012)
4. F.O. Shodiyeva, E.CH. Yahgiboyev, F.R. Kholboev, M.Sh. Raximov, Significance and Conservation of Birds of the Genus of Bee-eater (MEROPS) in Uzbekistan. Baghdad Science Journal Published Online First: July, 2023 P-ISSN: 2078-8665 - E-ISSN: 2411-7986, 252-260 (2023) https://dx.doi.org/10.21123/bsj.2023.7109
5. O.L. Makarova, Fauna of free-living ticks (Acari) of Greenland, Zoological journal, Circulation 93, **12**, 1404–1419 (2014)
6. E.N. Melekhina, Taxonomic diversity and arealogy of oribatids (Oribatei) of the European North of Russia, News of the Komi Scientific Center of the Ural Branch of the Russian Academy of Sciences, **2**, 30–37 (2011)
7. M.B. Potapov, N.A. Kuznetsova, Methods for studying communities of microarthropods, Partnership of scientific publications KMK, Moscow, 84 (2011)
8. E.Ch. Yangiboyev, O.M. Mamarakhimov, M.M. Makhmudova, U.A. Nabiev, G. Karamatova, The diversity of reptiles in different ecological environments of mountainous parts of Kashkadarya region, ESDCA E3S Web of Conferences, 510 (2024) https://doi.org/10.1051/e3sconf/202451003012