STRUCTURAL CHARACTERISTICS OF THE THRIPS FAUNA (INSECTA: THYSANOPTERA) ON THE ASH AND STERILE WASTE DUMPS FROM ROVINARI (GORJ DISTRICT)

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Abstract. The collections carried out in July 2010 regarding the Thysanoptera praticolous fauna on the tailing dumps of Rovinari show a low specific diversity, of only 11 species. The human impact exerted over the years upon the studied sites resulted in the reduction of the Thysanoptera taxonomic spectrum and especially in the diminution of the population of certain thrips species. The Thysnoptera coenosis has been constantly composed of a characteristic species, *Haplothrips leucanthemi*, unidentified so far as typical on the previously studied dumps of Zlatna area and Retezat Massif, so we can consider this species as a bioindicator. The Shannon-Wiener diversity index presented fluctuating values in the studied sites and the differences between them were not statistically significant. The geographical distribution of Rovinari Thysanoptera indicates a dominance of the Euro-Siberian species. Such studies show that Thysanoptera species that grow on dumps differ from one another, according to the type of dumps, therefore it is necessary to carry out chemical analysis of both the substrate and insects.

Keywords: ash and sterile waste dumps, *Haplothrips leucanthemi*, specific diversity, ecological indices.

Rezumat. Particularităţi structurale ale faunei de thripşi (Insecta: Thysanoptera) de pe haldele de steril din zona Rovinari (judeţul Gorj). Colectările efectuate în luna iulie 2010 privind fauna de thysanoptere praticole de pe haldele de steril din zona Rovinari relevă o diversitate specifică mică, de numai 11 specii. Impactul antropic exercitat de-a lungul anilor asupra siturilor cercetate a determinat reducerea spectrului taxonomic al thysanopterelor şi mai ales diminuarea populaţiilor unor specii de thripşi. Cenoza de thysanoptere a fost constant alcatuită dintr-o specie caracteristică, *Haplothrips leucanthemi,* neidentificată până acum ca tipică pe haldele studiate anterior din zona Zlatna şi masivul Retezat, astfel încât putem considera această specie bioindicatoare. Indicele de diversitate Shannon-Wiener a avut valori fluctuante în siturile studiate, iar diferenţele dintre acestea nu au fost semnificative din punct de vedere statistic. Distribuţia geografică a thysanopterelor din zona Rovinari indică o pondere mare a speciilor Euro-siberiene. Astfel de studii relevă faptul că speciile de thysanoptere care se dezvoltă pe suprafeţe haldate sunt diferite în funcţie de tipul de haldă, de aceea se impune efectuarea unor analize chimice atât a substratului, cât şi a insectelor.

Cuvinte cheie: halde de steril şi cenusă, *Haplothrips leucanthemi*, diversitate specifică, indicatori ecologici.

INTRODUCTION

Polluting agents have much faster selective and disturbing action than climatic factors, which entails the disappearance or reduction of particular groups of organisms with an important role in the economy of ecosystems, disruption of trophic links of the chain, weakening the functions and composition of natural and artificial ecosystems.

The Thysanoptera fauna constitutes a very important coenotic element of the structure of all land ecosystems.

Phenological and ecological characteristics of thrips led to their use as bioindicators in studies assessing the conservation or deterioration status of different habitats, as well as environmental predictions on their evolution.

Thus, some Thysanoptera species like *Frankliniella intonsa* (TRYBOM, 1895), *Bagnalliella yuccae* (HINDS 1902), *Haplothrips niger* (OSBORN, 1883) are used in the ecological monitoring of habitats subject to environmental pollution (IONESCU et al., 1973; VASILIU-OROMULU et al., 2007).

Research carried out on old tailing dumps from the mines for the extraction of Hg, S, Au in Zlatna area have indicated the species *Chirothrips manicatus* HALIDAY ,1836 as bioindicator resistant to pollution of the area by various pollutants (VASILIU-OROMULU, 2010). On the tailing dumps of Retezat Massif *Frankliniella intonsa* was typical, being the first species that appeared after the 1999 floods (VASILIU-OROMULU, 2007).

The study of the Thysanoptera fauna carried out in Rovinari, a highly polluted area with heavy metals and radionuclides, is part of the direction to substantiate an ecological basis for species biodiversity, for their evolution in time and space, within grassland ecosystems.

MATERIAL AND METHODS

The collections were carried out during 13th -14th July 2010 from different biotopes of Rovinari dumps. The first site, grassland on tailing dumps, was located exactly near the plant. Of the approximately 60 plant species identified, few were flowering. The second site was represented by a clearing lying on dumps in the woods, about 0.5 km away from the first site, where 28 herbaceous species had been identified. The third site, grassland on tailings, within the "Experimental field of ashes and tailings Rovinari ", belongs to the Forest Research Station in Craiova, being situated at a distance of about 1 km from the plant. 38 herbaceous species were identified, the gramineae *Bromus arvensis* being dominant. The last site was represented by a very young plantation of poplars and willows on ashes, with

herbaceous vegetation between the rows, consisting of 38 plant species. That site also belongs to the "Experimental field", being located at about 300 m from the third site.

It is important to mention that during the observations, most plants were dry, temperatures far exceeding the normal values.

Setting the necessary number of samples that afford a degree of research accuracy with a statistical coverage of 95% has resulted in five mowing samples, of 50 lawn-threading on each site.

The thrips species was identified with the follow keys of determination: KNECHTEL (1951), SCHLIEPHACKE & KOCH (1980), STRASSEN (2003).

The amount of heavy metals in soil was determined with the help of a spectrophotometer with atomic absorption, using the standard methods. The radionuclides concentration in soil was determined by gamma spectrometry of high resolution, using the standard method (DUGGAN, 1988).

RESULTS AND DISCUSSIONS

a. Specific diversity. The numerical abundance reveals a total of 321 individuals (adults and larvae) collected during the mowing samples from the studied dumps, which belong only to 11 species (Table 1). Of these, most are primary consumers and are polyphagous, only *Odontothrips loti* is oligophagous. Only one species belongs to the secondary consumers, the zoophagous *Aeolothrips intermedius.*

Ecologically, the taxonomic spectrum of praticolous Thysanoptera is varied, consisting of a mixture of typical gramineous and floral forms. Among the gramineous forms we can mention *Chirothrips manicatus, Ch. ruptipennis* that preferentially grow on Poaceae. Floral forms have a wider habitat, living in inflorescences of various herbaceous plants, typical floral species being: *Frankliniella intonsa. Fr. tenuicornis, Haplothrips leucanthemi, H. niger, Thrips physapus, Odontothrips loti.* One aptera species located at the foot of the grass was the *Bolothrips bicolor* thrips.

The specific diversity is higher in the "grassland on tailings" site within the "Experimental field", site IIa (Table 2), but cannot be compared to the one of unpolluted grasslands (VASILIU-OROMULU, 1995). VASILIU-OROMULU (2007, 2010) notes the same low diversity on Zlatna tailing dumps, while Retezat dumps are characterized by a higher specific richness.

Besides the improper herbaceous substrate on the tailing dumps, the small number of collected individuals can also be caused by climatic factors: excessively high temperatures, low humidity and entry of thrips in summer diapause, as a strategy for survival.

Sex structure has special importance upon the biotic potential of populations. The main emphasis in our research has been placed on finding out the sex ratio index of all thrips species from different sites. Table 1 notes the dominance of females in most thrips species, so that the sex-ratio index stays within normal limits in the researched sites.

The presence of numerous Terebrantia larvae expresses the high level of renewal of thrips populations (Table 2).

Table 1. Specific diversity of Thysanoptera fauna on the tailing dumps in Rovinari area.
Tabel 1. Diversitatea specifică a faunei de Thysanoptera pe haldele de steril din zona Rovinari.

Suborder	Family	Species	No. ind.	Geographical distribution
Terebrantia	Aeolothripidae	*Aeolothrips intermedius* BAGNALL 1934	1♀; 1♂	PAL
	Thripidae	*Chirothrips manicatus* HALIDAY, 1836	55 ♀♀; 10 ♂♂	HOL
		Chirothrips ruptipennis PRIESNER, 1938	1♂	EUR
		Frankliniella intonsa (TRYBOM 1895)	51 ♀♀	EUS
		Frankliniella tenuicornis (UZEL, 1895)	1♀	COS
		Odontothrips loti (HALIDAY, 1852)	2 ♀♀	HOL
		Thrips physapus LINNAEUS, 1758	9♀♀; 3♂♂	EUS
Tubulifera	Phlaeothripidae	*Bolothrips bicolor* (HEEGER, 1852)	5♀♀; 1♂	EUR
		Haplothrips leucanthemi (SCHRANK, 1781)	100♀♀ ; 12♂♂	EUS
		Haplothrips niger (OSBORN, 1883)	39 ♀♀; 6♂♂	WEUS
		Haplothrips reuteri KARNY, 1907	1♀; 1♂	PON-MED

COS=Cosmopolite; EUR=European; HOL=Holarctic; EUS=Euro-Siberian; PAL=Palaearctic; WEUS=West Euro-Siberian; PON-MED = Ponto-Mediterranean.

b. Ecological indices. On the first site, tailing dumps near the plant, the association of Thysanoptera was formed by *Haplothrips leucanthemi* (Foto 1) as a eudominant species, to which there were added *Haplothrips niger, Frankliniella intonsa* and *Chirothrips manicatus* as accompanying species.

On site Ib, grassland in the woods, the specific nucleus of thrips was formed in equal parts by the species *Haplothtrips leucanthemi* and *Frankliniella intonsa*.

On site IIa, Experimental field on tailings, the species *Haplothrips leucanthemi* and *Chirothrips manicatus* were present as eudominant in the herd, to which there were added the *Frankliniella intonsa* and *Haplothrips niger* species with values of the relative abundance of 13.19%, respectively 11.54% (Fig. 1).

On site IIb, site on ashes, the Thysanoptera coenosis was composed of the characteristic species *Haplothrips leucanthemi* accompanied by the *Frankliniella intonsa*.

The *Haplothrips leucanthemi*, *Haplothrips niger, Frankliniella intonsa*, *Chirothips manicatus* species, which show abundant large numbers (Table 2, Fig. 1), have high ecological plasticity, each occupying an important ecological niche in the structural network of the grassland ecosystem. Thus, the values of the herd vary from one coenosis to another in relation to the plant association and certain climatic factors.

The structure of Thysanoptera populations with a low percentage of eu/dominant species and low number of stenotope species has also been reported in other habitats in Romania (VASILIU-OROMULU, 2002).

Table 2. The structural indices of the thrips populations, in Rovinari, July 2010.
Tabel 2. Indicatorii structurali ai populaţiilor de thripşi, Rovinari, iulie 2010.

Ia. Grassland near the plant	**Σ**	**x**	**x/m²**	**s²**	**Stdev**	**s'**	**mg.dry matter/m²**	**A%**	**C%**	**$p_i \log p_i$**
Chirothrips manicatus	12	1.2	12	4.0	2.0	0.20	1.20	12	40	-0.111
Frankliniella intonsa	14	1.4	14	5.2	2.3	0.23	1.40	14	30	-0.120
Bolothrips bicolor	2	0.2	2	0.2	0.4	0.04	0.20	2	20	-0.034
Haplothrips leucanthemi	**50**	5.0	50	30.2	5.5	0.55	5.00	51	50	-0.150
Haplothrips niger	19	1.9	19	6.5	2.6	0.26	1.90	19	50	-0.138
Larvae	2	0.2	2	0.2	0.4	0.04	0.20	2	20	-0.034
Σ	99	9.9	**99**	125.9	11.2	1.12	**9.90**	100	210	-0.587
			H(S)	**= 2**		**Hmax**	**= 3**	**E%**	**=75.45**	
Ib. Grassland in the woods										
Frankliniella intonsa	2	0.2	2	0.2	0.4	0.04	0.2	50	20	-0.151
Haplothrips leucanthemi	2	0.2	2	0.2	0.4	0.04	0.2	50	20	-0.151
Σ	4	0.4	**4**	0.5	0.7	0.07	**0.4**	100		-0.301
			H(S)	**= 1**		**Hmax**	**= 1**	**E%**	**=100**	
IIa. Grassland on sterile dump										
Aeolothrips intermedius	2	0.2	2	0.4	0.6	0.06	0.20	1.10	10	-0.022
Chirothrips manicatus	**51**	5.1	51	40.3	6.3	0.63	5.10	28.02	60	-0.155
Chirothrips ruptipennis	1	0.1	1	0.1	0.3	0.03	0.10	0.55	10	-0.012
Frankliniella intonsa	**24**	2.4	24	10.9	3.3	0.33	2.40	13.19	50	-0.116
Frankliniella tenuicornis	1	0.1	1	0.1	0.3	0.03	0.10	0.55	10	-0.012
Odontothrips loti	5	0.5	5	1.6	1.3	0.13	0.50	2.75	20	-0.043
Thrips physapus	10	1.0	10	3.6	1.9	0.19	1.00	5.49	30	-0.069
Bolothrips bicolour	4	0.4	4	0.5	0.7	0.07	0.40	2.20	30	-0.036
Haplothrips leucanthemi	**60**	6.0	60	44.9	6.7	0.67	6.00	32.97	60	-0.159
Haplothrips niger	**21**	2.1	21	7.0	2.6	0.26	2.10	11.54	50	-0.108
Larvae	3	0.3	3	0.2	0.5	0.05	0.30	1.65	30	-0.029
Σ	182	18	**182**	286.8	16.9	1.69	**18.20**	100.00		-0.762
			H(S)	**= 3**		**Hmax**	**=3**	**E%**	**=73.20**	
IIb. Grassland on ash dump										
Chirothrips manicatus	2	0.2	2	0.4	0.6	0.06	0.2	5.56	10	-0.070
Frankliniella intonsa	**11**	1.1	11	5.4	2.3	0.23	1.1	30.56	20	-0.157
Odontothrips loti	1	0.1	1	0.1	0.32	0.03	0.1	2.78	10	-0.043
Thrips physapus	2	0.2	2	0.4	0.63	0.06	0.2	5.56	10	-0.070
Haplothrips leucanthemi	**12**	1.2	12	5.7	2.39	0.24	1.2	33.33	20	-0.159
Haplothrips niger	5	0.5	5	1.2	1.08	0.11	0.5	13.89	20	-0.119
Haplothrips reuteri	2	0.2	2	0.4	0.63	0.06	0.2	5.56	10	-0.070
Larvae	1	0.1	1	0.1	0.3	0.03	0.1	2.78	10	-0.043
Σ	36	3.6	**36**	55.2	7.4	0.74	**3.6**	**100**		**-0.731**
			H(S)	**=2.43**		**Hmax**	**= 3**	**E%**	**=80.96**	

On all sites, there were observed low values of the constant. Among the species of open areas, the highest values of the constant belonged to *Chirothrips manicatus* and *Haplothrips leucanthemi,* common species of grassland sites. Low values of the constant in samples may suggest the dynamic nature of Thysanoptera coenosis due to the active movement of these insects.

The Shannon-Wiener diversity index was fluctuating between the studied sites, so differences were not statistically significant. The highest value of the diversity index was observed in Thysanoptera populations of station IIa.

Experimental field on tailings (Table 2). Higher specific diversity in case of the last mentioned site can be explained by richer food resources compared to the trophic supply of other areas, with much more flowering plant species on that site.

Larger differences noticed between the theoretical value of the diversity index and the observed one lead to the idea that Thysanoptera diversity can reach high values when the fluctuations of biotic and abiotic factors allow it.

Dry biomass values range from 0.4-18.2 mg/dry matter/m^2, indicating the food input of these insects to the flow of matter in the ecosystem.

c. Geographical distribution. The geographical distribution of thrips species in Rovinari presents: 3 Euro-Siberian, 2 European, 2 Holarctic, 1 cosmopolite, 1 Palearctic, 1 W-Euro-Siberian and 1 Ponto-Mediterranean. We can notice a higher proportion of the Euro-Siberian species, a situation encountered, for example, in the vineyard ecosystem (VASILIU-OROMULU & BĂRBUCEANU, 2010). VASILIU-OROMULU (1998) finds the prevalence of European species in Romania, these species being on the second place in this study (Table 1).

d. Content in heavy metals and radionuclides in soil and Thysanoptera fauna. The content in heavy metals and radionuclides activity, is dependent on the soil substrate, respective on the waste dump type (sterile or ash waste dumps), or Control area. The recorded values are presented in Table 3 and Table 4.

Table 3. Amount of some heavy metals in different stations from Middle Jiu valley (in mg/kg soil).
Tabel 3. Metale grele in diferite staţii din Valea Jiului mijlociu.

Heavy metal	Near plant	Forest	Sterile dump	Ash dump	Control
Zn	72.6	61.8	95.0	73.2	43.5
Cu	34.4[a]	28.0[a]	25.8[a]	27.2[a]	28.2[a]
Fe	29,331	21,256	34,081	28,856	20,073
Mn	652	238	195	419	325
Pb	27.0[a]	43.4[a]	47.2[a]	33.6[a]	43.5[a]
Ni	44.6[a]	22.0[a]	77.7[b]	22.6[a]	22.6[a]
Co	11.40	7.26	13.80	8.48	8.64
Cr	46.2[a]	11.4	14.9	45.5[a]	9.43
Cd	0.218	0.243	0.322	0.239	0.151

Legend: [a] – over normal value; [b] – over alert value.
Legendă: [a] peste valoarea normală; [b] - valoarea de avertizare.

The values recorded, in the all stations, for Cu, Pb and Ni, recorded values over the normal limit, and for Ni, in sterile waste dump in Rovinari, was recorded a value over alert limit.

Table 4. The radionuclides activity (in Bq/kg soil) in some stations from the Middle Jiu valley.
Tabel 4. Activitatea radionucleară în unele staţii din Valea Jiului mijlociu.

Radionuclide	Near plant	Forest	Sterile waste dump	Ash waste dump	Control
^{234}Th (^{238}U)	83.03 ± 9.12	47.9 ± 5.35	45.4 ± 2.19	163.6 ± 17.5	< 10.0
^{226}Ra	51.5 ± 1.2	33.3 ± 1.50	29.9 ± 1.3	229.5 ± 5.1	16.5 ± 0.85
^{210}Pb	118.8 ± 8.2	87.5 ± 4.85	47.7 ± 3.95	151.1 ± 8.42	20.8 ± 2.36
^{214}Bi	48.1 ± 2.04	32.5 ± 1.57	27.4 ± 1.41	117.1 ± 4.0	14.8 ± 0.91
^{214}Pb	54.0 ± 2.03	35.0 ± 1.47	30.4 ± 1.27	142.0 ± 5.35	18.2 ± 0.86
^{235}U	9.17 ± 0.91	4.87 ± 0.36	4.0 ± 0.46	8.99 ± 1.73	2.36 ± 0.26
^{228}Ac (^{232}Th)	55.9 ± 3.51	29.1 ± 2.17	34.8 ± 2.56	88.4 ± 5.14	26.4 ± 2.0
^{212}Pb	73.6 ± 2.38	64.1 ± 1.56	46.7 ± 1.53	137.8 ± 4.86	33.6 ± 1.27
^{40}K	616.5 ± 39.4	453.7 ± 23.1	539.9 ± 27.6	519.2 ± 40.9	446.2 ± 26.8
^{7}Be	< 19.1	< 11.6	< 14.3	< 22.8	< 11.1
^{137}Cs	183.3 ± 10.1	< 1.7	19.9 ± 27.6	77.5 ± 3.5	18.3 ± 1.01

Legend:
Limits values for Romania: ^{226}Ra: 10-90; ^{232}Th: 13-65; ^{40}K: 330-800 Bq/kg (after CHIOSILĂ et al., 1994);
Mean values for Romania: ^{226}Ra: 38; ^{232}Th: 39; ^{40}K: 540 Bq/kg (after, CHIOSILĂ et al., 1994).
Legendă:
Valori limită pentru România: ^{226}Ra: 10-90; ^{232}Th: 13-65; ^{40}K: 330-800 Bq/kg (după CHIOSILĂ et al., 1994);
Valori de risc pentru România: ^{226}Ra: 38; ^{232}Th: 39; ^{40}K: 540 Bq/kg (după CHIOSILĂ et al., 1994).

Excepting the values recorded for ^{40}K and ^{7}Be, for the all radionuclides were recorded upper value4s in comparison with Control and with media for Romania. This aspect underlined the toxic effect in these areas, the present species manifesting a natural resistance at the presence of a big amount of radionuclides and/or heavy metals. The species present in these areas can be indicator species for the presence of a big amount of heavy metals and/or radionuclides.

Previously researches performed by other authors, underlined the presence of some thrips species in the polluted areas with heavy metals and/or radionuclides (VASILIU-OROMULU et al., 2007; VASILIU-OROMULU & BĂRBUCEANU, 2008; VASILIU-OROMULU & JENSER, 2008, a/o). The analyse of the trips fauna in different stations, underlined the presence of the same genotypes, with a natural resistance at a heavy metals amount in soil and/or with resistance at a great amount of radionuclides as: *Chirothrips manicatus, Frankliniella intonsa, Haplothrips leucanthemi, Haplothrips niger*, a/o.

CONCLUSIONS

The study of thrips on the tailing dumps of Rovinari indicates a low specific diversity, consisting of 11 species.

The Thysanoptera coenosis has constantly consisted of a species characteristic to the tailing dumps of Rovinari, the tubuliferous *Haplothrips leucanthemi.*

The human impact exerted over the years on the studied sites resulted in the reduction of the taxonomic spectrum of Thysanoptera and especially in the diminution of the population of certain thrips species. Thus, the presence and evolution of the structure and function of Thysanoptera fauna is primarily related to changes in the evolution of the primary producers from the studied ecosystems.

The bioindicator species is *Haplothrips leucanthemi* for all researched sites, compared to Zlatna dumps, where the bioindicator is the *Chirothrips manicatus* species, while on the Retezat dumps, the *Frankliniella intonsa* species.

Consequently, Thysanoptera species that grow on dumps differ from one another, according to the type of dumps, therefore it is necessary to carry out chemical analysis of both the substrate and insects.

The strategies for the protection of ecosystems subject to human impact can be understood only through detailed knowledge of the structure and operating principles of all living systems, and therefore of these secondary producers, which are the insects of the Thysanoptera order.

The Thysanoptera species present in a big amount in the affected area (sterile and ash waste dumps), can be used as indicator species for the presence of a big amount of heavy metals and/or radionuclides.

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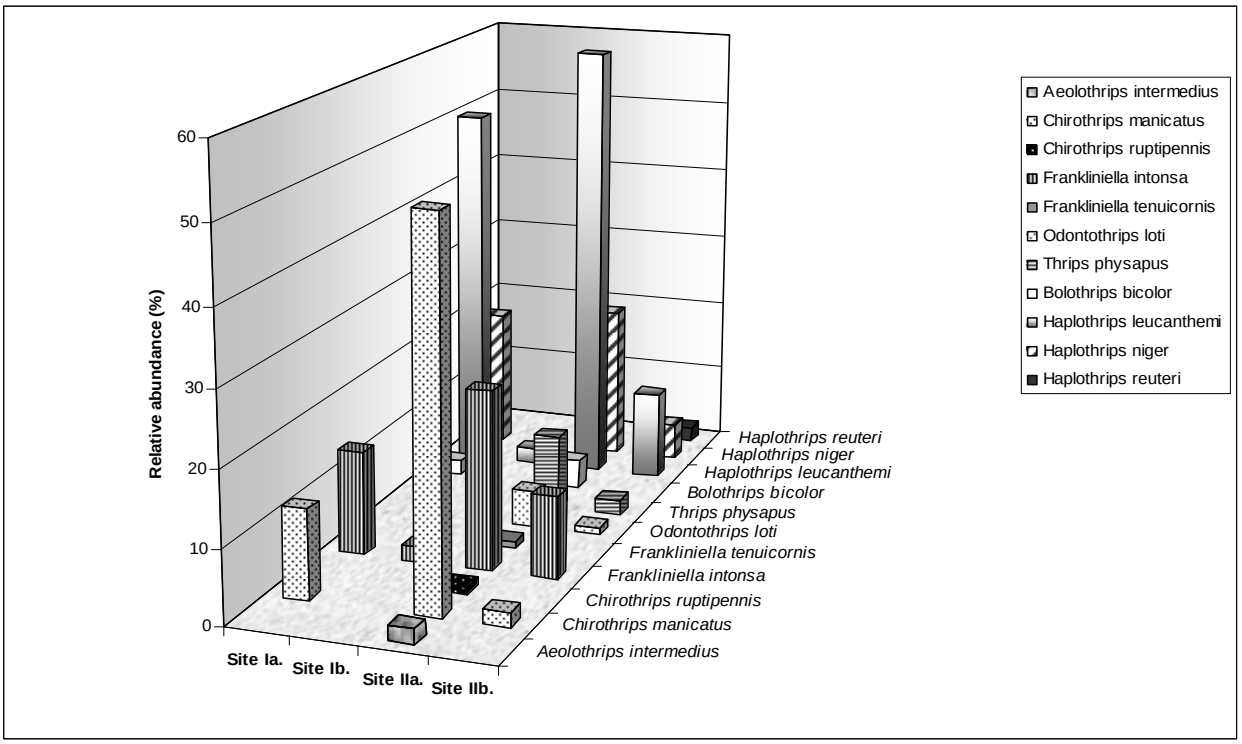

Figure 1. The relative abundance of thrips species on Rovinari tailing dumps.
Figura 1. Abundenţa relativă a speciilor de thripşi pe haldele de steril din Rovinari.

Photo 1. *Haplothrips leucanthemi*, male.
Foto 1. *Haplothrips leucanthemi*, mascul (original).

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