THE INVERTEBRATE BIODIVERSITY OF SHRUBLANDS OF DOFTANA RIVER VALLEY AND PRAHOVA RIVER VALLEY (PRAHOVA COUNTY). A REVIEW OF CURRENT KNOWLEDGE

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Abstract. Complex ecological studies have been carried out along the Prahova and Doftana rivers. One of the important left-side tributaries of the Danube is the Prahova river, which, in turn, has the Doftana river as its left-side tributary. Both rivers (Prahova and Doftana) are accompanied from upstream to downstream by terrestrial ecosystems with a high importance in the structure and functioning of the regional landscapes. In this paper we will address issues related to the diversity of the terrestrial invertebrates from alluvial shrublands in the Doftana valley (Lunca Mare site) and Prahova valley (Nistoreşti and Cornu sites). We analyse the soil fauna (earthworms, enchytraeids, nematodes, springtails, mites), with a focus on Acari, where a species-level analysis was performed – Acari: Mesostigmata –, as well as the epigeous fauna (taxa superior to the species level) with a focus, at the species level, on Coleoptera: Carabidae. The species richness and Shannon-Wiener index of diversity are discussed, as well as the degree of specific similarity of invertebrates of and between the studied sites. The structural heterogeneity of the terrestrial invertebrate populations and the patterns of the seasonal dynamics of invertebrate diversity, and also the presence – during the studies – of the anthropic impact (exploitation or cutting the bushes by the population), additionally to existing climatic changes are added, impose the necessity to carry out further complex ecological studies to both update and develop the available information, by extending the studies on some cenotic elements that have not been approached previously (vertebrates).

Keywords: shrublands, Doftana valley, Prahova valley, terrestrial invertebrates, specific diversity.

Rezumat. Diversitatea nevertebratelor din tufărișurile văilor râurilor Doftana și Prahova (județul Prahova). Un review al stadiului actual de cunoaștere. Au fost efectuate studii ecologice complexe de-a lungul râurilor Prahova şi Doftana. Unul dintre afluenții importanți din stânga Dunării este râul Prahova, care are la rândul său ca afluent stâng râul Doftana. Ambele râuri (Prahova şi Doftana) sunt însoţite din amonte în aval de ecosisteme terestre cu o importanță ridicată în structura şi funcţionarea complexelor de ecosisteme. În această lucrare vom aborda aspecte legate de diversitatea nevertebratelor terestre din tufărişuri aluviale de pe valea Doftanei (situl Lunca Mare şi situl Doftana) și valea Prahova (siturile Nistorești și Cornu). Se analizează fauna solului (râme, enchitreide, nematode, collembole, acarieni), cu accent pe Acari: Mesostigmata şi Acari Oribatida unde s-a făcut o analiză la nivel de specie; de asemenea, fauna epigee a fost analizată la nivelul supraspecific, cu accent pe Coleoptera: Carabidae, unde s-a făcut o analiză la nivelul speciilor. Sunt discutate bogăția specifică, indicele de diversitate Shannon-Wiener, precum și gradul de similaritate a nevertebratelor între situsurile studiate. Heterogenitatea structurală a populațiilor de nevertebrate terestre, tiparele dinamicii sezoniere a diversității nevertebratelor și, de asemenea, prezența - în timpul studiilor - a impactului antropic (exploatarea sau tăierea tufișurilor de către populație), la care se adaugă schimbările climatice existente, impun necesitatea efectuării unor studii ecologice complexe suplimentare atât pentru actualizarea informațiilor, cât și pentru dezvoltarea acestora, prin extinderea studiilor asupra unor elemente cenotice care nu au fost abordate anterior.

Cuvinte cheie: tufărişuri, valea Doftanei, valea Prahovei, nevertebrate terestre, diversitate specifică.

INTRODUCTION

Shrublands are pioneering coenotic formations, installed on lands without vegetation, with grassy vegetation or they have developed secondary to wood clearing (PAUCĂ et al., 2008a, b).

Complex studies on shrublands in Romania were conducted since about 1999, especially in the southern area of Romania, but here, we present a synthesis of the studies conducted on shrublands along the Doftana and Prahova river valleys (HONCIUC & MANU 2008; MANU, 2008, 2010; MANU et al., 2013; PAUCĂ et al. 2000, 2004, 2005, 2008a, 2008b, 2009).

MATERIAL AND METHOD

The invertebrate fauna was analysed in each biocoenosis at the endogeous level, litter, epigeous level, grass layer and bush canopy.

Soil fauna was sampled with MacFadyen corer of 5 cm diameter (10 samples for each group of organisms).

The epigeous fauna was collected with Barber traps (9 traps in each shrubland, with 3 meters between each two traps, filled with a mixture 1:1 of 4% formaldehyde and ethylenglycol).

The invertebrates of canopy and grasses were collected with the entomological net of 60 and 30 cm diameter respectively (10 samples in each shrubland, each replicate consisting in 50 shakings or sewing).

The sampling was performed seasonally and the invertebrates were extracted from samples by methods specific to each group. The specific richness, the Shannon-Wiener diversity index as well as the constancy classes of invertebrates were analysed (Table 1).

Table 1. The location and a few data on the study sites.

Name	Shrubland type	Location	Soil type	Soil humidity
Lunca Mare (Doftana river valley)	*Salix purpurea*	N: 45°20'40.1'' E: 25°74'51.3'' 485 m. alt.	Alluvial Sandy-clay, high humidity	21.29-20.99
Doftana (Doftana river valley)	*Myricaria germanica* and *Salix purpurea*	N: 45°16'56.38'' E: 25°45'35.08'' 663 m. alt.	Alluvial Sandy-clay, high humidity	6.47-8.43
Cornu (upper Prahova river valley)	*Salix purpurea*	N: 45°08'24.6'' E: 25°42'37.6'' .440 m.alt/	Alluvial Sandy-clay, high humidity	16.39-25.57
Nistoreşti (upper Prahova river valley)	*Salix purpurea* and *Hippophae rhamnoides*	N: 45°16'56.38'' E: 25°45'35.08'' 510 m. alt.	Alluvial Sandy-clay, high humidity	21.57-22.90
Pisculeşti (lower Prahova river valley)	*Tamarix ramossissima*	At the entrance to the Pisculeşti village, Prahova county	Alluvial Sandy-clay, high humidity	See PAUCĂ et al., 2000

From the beginning it is necessary to mention that the studied datasets are not equal/ uniform for objective and subjective reasons.

RESULTS AND DISCUSSIONS

Differences are noticed between the populations of soil invertebrates. Most of the species are detritophagous (nematodes, enchytraeids, earthworms, collembola, oribatid mites) and partially predators (Acari: Mesostigmata). Species composition and the diversity index (Table 2) vary according to the species' limiting factors (humidity, litter quality, characteristics of the primary producers) and the dynamics of the invertebrate populations follows that of local abiotic and biotic limiting factors.

Table 2. Species richness (No. sp.), value of Shannon-Wiener index of diversity (S-W) and proportion (%) of constant (c), accessory (Acs) and accidental (Acd) species of some supratаxa in three studied shrublands.

	Nistoresti					Cornu					Lunca Mare				
TAXA	Nr. Sp.	S-W	C	Acs	Acd	Nr. Sp.	S-W	C	Acs	Acd	Nr. Sp.	S-W	C	Acs	Acd
LUMBRICIDAE	3	0.811				3	0.7				3	0.663			
ENCHITRAEIDAE	3	0.929				7	1.405				5	1			
ACARI - MESOSTIGMATA	18	2.41	5.55	38.88	55.57	14	2.15	33.3	66.67	0	13	2.21	0	53.85	46.15
ACARI- ORIBATIDA	43	5.6	34.88	18.61	46.51	30	1.8	43.33	16.67	40	37	2.005	35.13	21.63	43.24
CARABIDAE	8	1.59				6	1.4				6	1.6			
THYSANOPTERA CANOPY	0	0.69	0	0	0	1	0	0	0	100	1	1.398	0	0	100
THYSANOPTERA GRASSES	4	1.33	0	0	100	9	1.784	22.22	0	77.78	6	1.32	0	0	100
CURCULIONIDAE CANOPY	2	0.498	0	100	0	2	0.633	0	0	100	0	0	0	0	0
CURCULIONIDAE GRASSES	2	0.69	0	0	100	4	0.988	0	25	75	1	0	0	0	100

The previous studies on shrublands (HONCIUC & MANU 2008; PAUCĂ et al., 2004; 2005; 2008a, b) show the importance of the structure and the dynamics of primary producers for the rest of the trophic structures. These papers also emphasize the role of abiotic limiting factors on the soil invertebrates. The common invertebrate species we find for all sites we studied are quite scarce.

Earthworms are represented by 4 species, three in each biocoenosis. The common species to the three cenoses is *Octolasion lacteum* Örlei, 1885.

The Mesostigmata mite fauna is represented by 28 species; *Lysigamasus lapponicus* (Tragardh, 1910), *Veigaia nemorensis* (CLKoch, 1836), *Pachylaelops furcifer* Oudemans, 1903, *Trachytes aegrota* (CLKoch, 1841), *Uropoda* sp. are common species. The Mesostigmata population of Doftana (*Myricaria* shrubland) has seven local characteristic species (MANU 2008; 2010). Oribatida mites comprise 59 species and 14 of them are common for the studied shrublands.

The collembola fauna has values twice lower (as species richness and numerical densities) than the meadow fauna. Species with wide ecological values are dominant. In the analysed faunal material, a new species of Collembola was found for Romania (at Nistoresti): *Proisotoma minima* (Absolon, 1901).

In the litter layer, 4 species of Chilopoda were found (Geophilomorpha mainly). Chilopoda fauna is scarcely studied in riparian areas and in shrublands. The specific diversity and the average densities of the Chilopoda in the studied sites are close in value to those in arable areas and pastures but much lower than those in forests.

The epigeous invertebrates are represented by 27 supratаxa, varying differently as composition and proportions, both seasonally in each studied site and between site populations. The taxa have different degrees of dispersion, determined by factors being the limiting ones: the abiotic conditions and the food sources. It would be interesting to study the degree of competition between the groups of predators.

It is worth mentioning that the carabid fauna (Coleoptera: Carabidae) from Pisculeşti (lower sector of Prahova) differs a lot in terms of species richness and specific composition compared to the populations in the hilly shrublands.

The seasonal variations of the carabids at Pisculeşti are seen in the decrease of the number of species from spring to autumn and in changes to the specific composition; hygrophilous species are less represented in summer and autumn when eurithermic and thermophilic / xerophilous species predominate.

These seasonal variations in the specific composition (in terms of the ecological values of carabid species) are less evident in the populations of hilly shrubs. In terms of time, presence and position of the ground beetle species within the structure of dominance, only *Agonum sexpunctatum* (Linnaeus, 1758) at Cornu is eudominant, while at Lunca Mare *Abax parallelipipedus* (Piller & Mitterpacher, 1785) is a euconstant and eudominant species (Table 3).

The seasonal dynamics of the epigeous invertebrates is quite similar in the studied sites (see literature already mentioned) even if the species composition of the ground beetle populations (Coleoptera: Carabidae) of Pisculeşti is less similar to the others, due to a higher number of riparian species and macropterous ones. The common ground beetle species for Nistoreşti, Cornu, Lunca Mare and Doftana shrublands are *Abax parallelipipedus* (Piller & Mitterpacher, 1785), *Carabus violaceus* Linnaeus,1758 and *Nebria brevicollis* (Fabricius, 1792).

Table 3. The frequency of epigeous suprataxa in the studied shrublands.

TAXA	Nistoresti	Cornu	Lunca Mare	Doftana
GASTEROPODA	42.85		18.75	
OLIGOCHAETA	7.14	12.5	12.5	5.71
ACARI-Oribatida	28.75	56.25	62.5	45.71
OPILIONES		31.25	37.5	31.43
ARANEAE	14.28	18.75	31.25	62.86
MYRIAPODA- Chilopoda		18.75		11.43
MYRIAPODA- Diplopoda		37.5	12.5	17.14
COLLEMBOLA	7.14	25	43.75	22.86
CRUSTACEA-Isopoda	35.71		31.25	
CRUSTACEA-Amphypoda			18.75	
ORTHOPTERA				0.26
DERMAPTERA	7.14			
THYSANOPTERA				0.03
HETEROPTERA				28.57
HEMIPTERA-Cicadidae		6.25	25	51.43
HEMIPTERA-Aphididae				51.43
HYMENOPTERA-var.	21.42	6.25	18.75	100
HYMENOPTERA-Formicoidea	21.42	18.75	18.75	100
COLEOPTERA - Carabidae	7.14		31.25	14.28
COLEOPTERA - Coccinelidae			6.25	
COLEOPTERA - Chrysomelidae		12.5		
COLEOPTERA- Curculionidae	14.21		18.75	22.85
COLEOPTERA -Staphylinidae		6.25	12.5	34.28
COLEOPTERA- Cantharidae			12.5	5.71
COLEOPTERA - Scarabaeidae	7.14			
COLEOPTERA- Sylphidae	7.14			
DIPTERA	2	6.25		65.71

At the level of grasses and canopy, Ord. Thysanoptera is represented by twenty species (6 at Nistoreşti, 10 at Cornu and 10 at Lunca Mare). The canopy comprises 40% of all species, while the grasses layer comprises 60% of them. No common species for the four shrubland coenoses were found.

The Coleoptera Chrysomelidae fauna is represented by five species (3 at Nistoreşti, 3 at Cornu and 3 at Lunca Mare). *Chrysomela saliceti* (Weise, 1884) and *Phratora tibialis* (Suffrian, 1851) are the common species for the three shrublands mentioned above.

Coleoptera Curculionidae comprise eight species (4 at Nistoreşti, 6 at Cornu and one at Lunca Mare). The only common species found in spring season in grasses is *Phyllobius pyri* (Linnaeus, 1758).

The fauna from grasses and canopy is influenced in composition and diversity mainly by the characteristics of the primary producers. The proportions of constant species are quite low for weevils and thrips, maybe due to local anthropic factors (exploitation of vegetation by inhabitants, in a traditional way and also the pressure of grazing by domestic animals).

The degree of similarity (Table 4) between invertebrate populations is not so high; it reflects the heterogeneity of abiotic and biotic factors in each studied site and also, maybe different degrees of human pressure on the biocoenoses. These characteristics are in relation with the persistence of species over time in biocoenoses.

Table 4. The degree of similarity (Jaccard index of similarity) between the populations of a few taxa from Nistoreşti,Cornu and Lunca Mare.

TAXA	NxC	NxL.M.	CxL.M.
LUMBRICIDAE	0.5	0.66	0.66
ENCHITRAEIDAE	0.428	0.33	0.5
ACARI - MESOSTIGMATA	0.28	0.41	0.286
ACARI- ORIBATIDA	0.33	0.55	0.396
CARABIDAE	0.4	0.4	0.2
THYSANOPTERA CANOPY	0	0	0
THYSANOPTERA GRASSES	0.5	0.33	0.167
CHRYSOMELIDAE	0.5	0.5	0.5
CURCULIONIDAE CANOPY	0.33	0	0
CURCULIONIDAE GRASSES	0.5	0.5	0.25

CONCLUSIONS

The characteristics of the primary producers influence soil moisture (through the degree of soil cover) and implicitly the characteristics of the local invertebrate populations. The quality and quantity of plant biomass is mainly influenced by the size of the populations of detritophagous and phytophagous invertebrates, and further, of the other consumer populations.

The structure and dynamics of zoocoenoses in the 3 shrublands reflect the abiotic characteristics of the limiting factors on the invertebrate groups in gradient endogeous-epigeous. The seasonal variations in the numeric densities of the surveyed groups of invertebrates are determined by the micro-climatic conditions, the food source and the presence/absence of the competitors.

The specific diversity and position of species within the structure of dominance reflect their answer to ecological characteristic of shrublands. The qualitative (taxonomic composition, specific ecological values) and quantitative features (seasonal variations of numerical densities and number of species) of invertebrates in shrubs indicate the existence of stable and complex coenotic structures.

The rather low degree of similarity between the populations of the three shrublands shows the heterogeneity of this type of ecological structure.

The groups of invertebrates from the studied sites are found at all trophic levels. We consider that the need to renew the knowledge on these coenoses is obvious because:

- At this moment we have data sets which are not homogenous in terms of structure and analyses;
- When the studies were conducted, some anthropic pressures were obvious in these shrublands;
- We are talking about two decades or a little less (since the study at Pisculești was conducted) but climatic changes are obvious and for sure modified the structure and functioning of these coenoses.
- The renewal and completion of the knowledge regarding the shrublands structure and functioning would allow the approach of these ecological structures at the landscape level, especially as previously studies were carried out in the adjacent ecosystems (forests, rocks) of the above presented habitats.

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REFERENCES

HONCIUC VIORICA & MANU MINODORA. 2008. Taxonomia şi ecologia populaţiilor de acarieni edafici (Arachnida, Acari) din tufărişurile de pe Valea Prahovei şi Valea Doftanei. *Volumul Lucrărilor Conferinţei Naţionale de Ecologie “Protecţia şi Restaurarea Bio şi Ecodiversităţii”*. Edit. Ars Docendi. Bucureşti: 19-23.

MANU MINODORA. 2008. The influence of some abiotical factors on the structural dynamics of the predatory mite populations (Acari: Mesostigmata) from an ecosystem with *Myricaria germanica* from Doftana valley (Romania). *Travaux du Museum National d’Histoire Naturelle “Grigore Antipa”*. De Gruyter Publisher. Bucharest. **51**: 463-471.

MANU MINODORA. 2010. Structure and dynamics of predator mite populations (Acari – Mesostigmata) in shrub ecosystems in Prahova and Doftana valleys. *Studia Universitatis Babeş-Bolyai, Biologia*. Edit. Universitaria. Cluj-Napoca. **55**:17-30.

MANU MINODORA, BĂNCILĂ RALUCA IOANA, ONETE MARILENA. 2013. Soil mite communities (Acari: Gamasina) from different ecosystem types from Romania. *Belgian Journal of Zoology*. Societe Royale Zoologique de Belgique Publisher. Brussels. **143**(1): 30-41.

PAUCĂ-COMĂNESCU MIHAELA, TĂCINĂ AURICA, VASILIU-OROMULU LILIANA, HONCIUC VIORICA, FALCĂ M., ONETE MARILENA, PURICE DORINA, STĂNESCU MINODORA, BLUJDEA M., IONESCU M. 2000. Structure of the main biocoenotic components in *Tamarix* shrublands of Prahova and Teleajen floodplain. *Révue Roumaine de Biologie. – Biologie Végétale*. Roumanian Academy Publishing. Bucharest. **45**(2): 155-179.

PAUCĂ-COMĂNESCU MIHAELA, DIHORU G., ONETE MARILENA, VASILIU-OROMULU LILIANA, FALCĂ M., HONCIUC VIORICA, STĂNESCU MINODORA, PURICE DORINA, MATEI B. 2004. The diversity of some alluvial shrubland flora and fauna in the Neajlov floodplain. *Proceedings of the Institute of Biology*. Romanian Academy Publishing. Bucharest. **6**: 105-118.

PAUCĂ-COMĂNESCU MIHAELA, ŞTEFĂNUŢ S., ŞINCU DANIELA, VASILIU-OROMULU LILIANA, FALCĂ M., HONCIUC VIORICA, STĂNESCU MINODORA, PURICE DORINA, FIERA CRISTINA. 2005. Biodiversity of alluvial shrubs characteristic to the Câlniştea river. *Proceedings of the Institute of Biology*. Romanian Academy Publishing. Bucharest. **7**: 87-111.

PAUCĂ-COMĂNESCU MIHAELA, ONETE MARILENA, HONCIUC VIORICA, VASILIU-OROMULU LILIANA, MANU MINODORA, FIERA CRISTINA, PURICE DORINA, FALCĂ M., ŞINCU DANIELA, ION MIHAELA. 2008a. Structura unor componente biotice din tufărişurile aluviale colinare. *Volumul Lucrărilor Conferinţei Naţionale de Ecologie "Protecţia şi Restaurarea Bio şi Ecodiversităţii"*. Edit. Ars Docendi. Bucureşti: 165-170.

PAUCĂ-COMĂNESCU MIHAELA, PURICE DORINA, ONETE MARILENA, DIHORU G., HONCIUC VIORICA, VASILIU-OROMULU LILIANA, STĂNESCU MINODORA, FIERA CRISTINA, FALCĂ M., MAICAN SANDA, ION MIHAELA, MUNTEANU CRISTINA. 2008b. Alluvial *Salix purpurea* and *Hippophae rhamnoides* collinar shrublands in Prahova and Doftana zone. *Romanian Journal of Biology, Plant Biology*. Romanian Academy Publishing. Bucharest. **53**(2): 97-122.

PAUCĂ-COMĂNESCU MIHAELA, ONETE MARILENA, SANDA V., VICOL IOANA, ONUŢ I., MOGÂLDEA DANIELA, ŞTEFĂNUŢ S. 2009. Diversity and primary productivity of hill beech forests from Doftana Valley (Romanian Subcarpathians). *Annals of Forest Research*. Springer. Berlin. **52**(1): 63-76.

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