

**DATA CONCERNING THE DIVERSITY OF SCARABEOID LARVAE
(COLEOPTERA: SCARABEOIDEA:
DYNASTIDAE, MELOLONTHIDAE, CETONIDAE AND LUCANIDAE)
IN FOREST NURSERIES FROM IAȘI COUNTY, ROMANIA**

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Abstract. The researches regarding the diversity of scarabeoid larvae in the forest nurseries from Iași County were made in 2010. The material (88 coleopterans) was collected from the soil (60 samples of 1 m x 1 m x 0.5 m); systematically, it belongs to four families: Dynastidae, Melolonthidae, Cetoniidae and Lucanidae; four subfamilies: Dynastinae, Melolonthinae, Sericinae and Cetoniinae, 9 genera and 10 species. *Melolontha melolontha* (Linnaeus 1758). *Pentodon* sp., *Amphimallon solstitiale* (Linnaeus 1758) and *Holocheilus (Miltotrogus) aequinoctialis* (Herbst 1790) were eudominant species. The characteristic species identified for the studied forest nurseries were represented by *Pentodon* sp., *A. solstitiale* and *H. (M.) aequinoctialis*. The largest number of species, individuals and the largest density of larvae were registered in district alluvial soil, at 46 m altitude. A high level of infestation was recorded for *M. melolontha* in Coasta Teiului forest nursery (Pașcani Forest District). In the other forest nurseries (Galata, Pietrosu, Bivolari and Bodești), four species: *Pentodon* sp., *A. solstitiale*, *Holocheilus (Miltotrogus) caucasicus* (Gyllenhal 1817) and *H. (M.) aequinoctialis* registered low levels of infestations.

Keywords: Scarabeoids, larvae, forest nurseries, Iași County.

Rezumat. Date privind diversitatea larvelor de scarabeoidee (Coleoptera: Scarabeoidea: Dynastidae, Melolonthidae, Cetoniidae și Lucanidae) în pepiniere din județul Iași, România. Cercetările privind diversitatea larvelor de scarabeoidee în pepiniere din județul Iași au fost realizate în 2010. Din punct de vedere sistematic, cele 88 de coleoptere (insecte) colectate din 60 de sondaje de sol aparțin la patru familii: Dynastidae, Melolonthidae, Cetoniidae and Lucanidae; patru subfamilii: Dynastinae, Melolonthinae, Sericinae și Cetoniinae, 9 genuri și 10 specii. Analiza sinecologică a indicat 4 specii eudominante: *Melolontha melolontha* (Linnaeus 1758). *Pentodon* sp., *Amphimallon solstitiale* (Linnaeus 1758) și *Holocheilus (Miltotrogus) aequinoctialis* (Herbst 1790); trei specii: *Pentodon* sp., *A. solstitiale* și *H. (M.) aequinoctialis* au fost identificate ca specii caracteristice pentru cele cinci pepiniere cercetate. Cel mai mare număr de specii și cele mai mari densități de coleoptere (insecte) s-au înregistrat în solul de tip aluviosol district, la 46 m altitudine. Pentru pepiniera Coasta Teiului rezultatele au indicat o infestare puternică cu *M. melolontha*. În cazul celorlalte specii dăunătoare s-au constatat grade scăzute de infestare.

Cuvinte cheie: Scarabeoidee, larve, pepiniere, județul Iași.

INTRODUCTION

Since 2010, the authors were interested in studying the diversity of the scarabeoid larvae in forest nurseries from Romania. Many scarabeoid larvae are root feeders – disturbing biotic agents. The researches regarding the occurrence of the root feeders in the soil are important for forest management. It is necessary to mention that not all the scarabeoid species identified in the samples from forest nurseries are disturbing biotic agents. The aim of this paper is to present the results of our researches regarding the diversity of scarabeoid larvae and also the levels of infestation in forest nurseries from Iași County.

MATERIAL AND METHODS

The material analysed in this paper was collected in 2010. Five forest nurseries were investigated: Galata (Ciurea Forest District), Pietrosu (Dobrovăț Forest District), Bivolari (Iași Forest District), Coasta Teiului (Pașcani Forest District) and Bodești (Pădureni Forest District) – Fig. 1. All of them belong to the Romanian National Forest Administration, Iași Forest Direction (Iași County). The characteristics of the five forest nurseries are presented in table 1.

For this study, the scarabeoid larvae were sampled from soil blocks of 1 x 1 x 0.5 m.

For analysing the data, it was necessary to establish the density of the insects (no. of individuals / m²).

In order to make a synecological analysis, some ecological indexes were calculated: abundance, frequency, constancy, dominance and the ecological significance index (W) (VARVARA et al., 2001).

Also, for establishing the level of infestation, for all the species that were recorded, it was necessary to calculate the average number of *Melolontha melolontha* (Linnaeus 1758) in the third larval instar, using the critical number of larvae / m² established for each species (SIMIONESCU et al., 2000 – Table 2).

Weighted average linkage method was used for hierarchical classifications of the species. The Bray-Curtis' index was used for similarity measure. The calculations were carried out by the programs Past (HAMMER et al., 2001).

All the larvae have been preserved in alcohol. The material was identified using the keys by PANIN (1955, 1957) and KLAUSNITZER (1978). The taxonomy and nomenclature used in this paper is in accordance with Fauna Europaea (<http://www.faunaeur.org>).

Table 1. The characteristics of the five forest nurseries (Romanian National Forest Administration, Iași Direction).

No.	Forest District	Forest nursery	No. of samples	Geographical coordinates			Type of station	Type of the soil
				Altitude - m -	Latitude N	Longitude E		
1	Ciurea	Galata	16	140	47°8'40.24"	27°32'58.83"	7420	typical eutricambosoil
2	Dobrovăț	Pietrosu	9	260	46°59'30"	27°40'56"	5153	mollic preluvisol
3	Iași	Bivolari	20	46	47°30'41"	27°27'2"	9613	dystric alluvial
4	Pașcani	Coasta Teiului	10	350	47°17'32"	26°50'38"	6153	typical luvisol
5	Pădureni	Bodești	5	200	46°55'38"	27°36'19"	7430	typical luvisol

Legend: type of station:
 5153 – hilly, sessile oak forests with inferior productivity, brown, large edaphic, with *Asarum-Stellaria*
 6153 – hilly, oak forest, with inferior-medium productivity, brown and grey, large edaphic
 7420 – hilly, oak forest, brown, II with medium-inferior productivity
 7430 – hilly, oak forest, with medium-inferior productivity, brown, large edaphic
 9613 – forest-steppe, meadow poplar forest, with inferior-medium productivity, humiferous moderately alluvial, deep phreatic wet, very briefly flooded

Table 2. The critical number of larvae for the scarabeoid species identified for the forest nurseries from Iași County (SIMIONESCU et al., 2000).

No.		Species					
		<i>Melolontha melolontha</i> (Linnaeus 1758)			<i>Pentodon</i> sp. <i>Amphimallon solstitiale</i> (Linnaeus 1758) <i>Holochelus (Miltotrogus) caucasicus</i> (Gyllenhal 1817) <i>Holochelus (Miltotrogus) aequinoctialis</i> (Herbst 1790)		
1	The larval instar	L ₁	L ₂	L ₃	L ₁	L ₂	L ₃
2	The critical number of larvae / m ²	5	3	1	10	6	3
3	The formula for calculating the average number of <i>M. melolontha</i> (in the third larval instar)	L ₁ x 1/5 + L ₂ x 1/3 + L ₃			L ₁ x 1/10 + L ₂ x 1/6 + L ₃ x 1/3		

RESULTS AND DISCUSSIONS

For studying the diversity of scarabeoids by analysing the populations of larvae present in the soil, 60 samples from five forest nurseries were analysed. The coleopterological material (88 coleopterans) was studied for identifying the species and the larval instar. Systematically, it belonged to four families: Dynastidae, Melolonthidae, Cetoniidae and Lucanidae; four subfamilies: Dynastinae, Melolonthinae, Sericinae and Cetoniinae, 9 genera and 10 species (Table. 3).

According to the results presented in Table 3, *M. melolontha* was represented by the largest number of individuals – 21 larvae (10 samples) recorded only in Coasta Teiului (Pașcani). It was followed by three species recorded for Galata and Bivolari forest nurseries (36 samples): *Pentodon* sp. (with 18 individuals), *Amphimallon solstitiale* (Linnaeus 1758) with 14 larvae and *Holochelus (Miltotrogus) aequinoctialis* (Herbst 1790) with 12 larvae (Fig. 2).

The largest number of individuals was recorded in the Bivolari forest nursery (Iași Forest District): 53 coleopterans in 20 samples and Coasta Teiului forest nursery (Pașcani Forest District): 21 larvae in 10 samples.

The largest number of species was also registered for Bivolari forest nursery (8 species). Three species were identified for Galata forest nursery. Only one species was identified for two forest nurseries: Pietrosu and Coasta Teiului.

Table 3. Survey of species, number of individuals and density of scarabeoid species identified for the forest nurseries from Iași County.

No.	Species	Galata	Pietrosu	Bivolari	Coasta Teiului	Bodești	Total
Dynastidae / Dynastinae							
1	<i>Pentodon</i> sp.	The larval instar					2L ₁ + 7L ₂ + 6L ₃ + 2P+ 1A
2		Total individuals	3		15		18
3		Density (no. indiv. / m ²)	0.19		0.75		
Melolonthidae / Melolonthinae							
4	<i>M. melolontha</i>	The larval instar			21 L ₂		21 L ₂
5		Total individuals			21		21
6		Density (no. indiv. / m ²)			2.1		
7	<i>A. solstitiale</i>	The larval instar	2 L ₂		1L ₁ + 11L ₂		1L ₁ + 13L ₂
8		Total individuals	2		12		14
9		Density (no. indiv. / m ²)	0.12		0.6		
10	<i>H. (M.) caucasicus</i>	The larval instar			4 L ₁		4 L ₁
11		Total individuals			4		4
12		Density (no. indiv. / m ²)			0.2		
13	<i>H.(M.) aequinoctialis</i>	The larval instar	8 L ₂		1L ₁ + 1L ₂ + 2L ₃		1L ₁ + 9L ₂ + 2L ₃
14		Total individuals	8		4		12
15		Density (no. indiv. / m ²)	0.5		0.2		

	Melolonthidae / Sericinae							
16	<i>M. (M.)</i>	The larval instar			1 L		1 L	
17	<i>holosericea</i>	Total individuals			1		1	
18		Density (no. indiv. / m ²)			0.05			
	Cetoniidae / Cetoniinae							
19	<i>C. aurata</i>	The larval instar			1 L ₃	2 L ₃	3 L ₃	
20		Total individuals			1	2	3	
21		Density (no. indiv. / m ²)			0.05	0.4		
22	<i>Protaetia</i> sp.	The larval instar				3 L ₃	3 L ₃	
23		Total individuals				3	3	
24		Density (no. indiv. / m ²)				0.6		
25	<i>T. (E.) hirta</i>	The larval instar	1 L ₃		6 L ₃		7 L ₃	
26		Total individuals	1		6		7	
27		Density (no. indiv. / m ²)	0.11		0.3			
	Lucanidae							
28	<i>L. cervus</i>	The larval instar			1L ₁ + 4L ₃		1L ₁ + 4L ₃	
29		Total individuals			5		5	
30		Density (no. indiv. / m ²)			0.25			
31	No. samples		16	9	20	10	5	60
32	No. species		3	1	8	1	2	10
33	No. individuals		13	1	48	21	5	88
34	Density / m ²		0.81	0.11	2.4	2.1	1	1.47

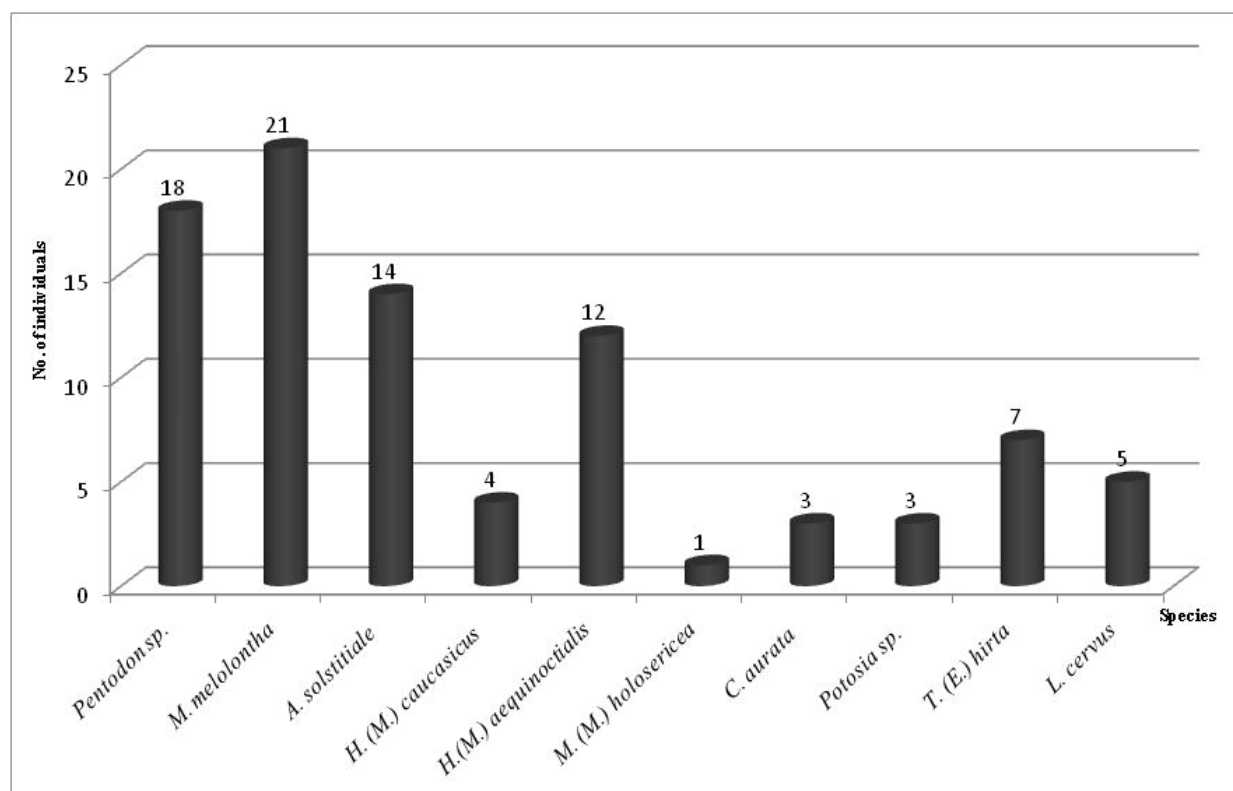


Figure 2. Survey of species, the abundance of scarabeoid species identified in the forest nurseries from Iași County.

According to the data presented in Table 3, the distribution of the 10 scarabeoid species in the investigated forest nurseries from Iași County is presented in Fig. 3. Comparing the densities of species, the results indicate that the largest densities were registered for *M. melolontha*: 2.1 larvae / m² for Coasta Teiului forest nursery, for *Pentodon* sp.: 0.75 individuals / m² in Bodești forest nursery, for *A. solstitiale*: 0.6 larvae / m² in Bivolari forest nursery and for *Protaetia* sp.: 0.6 larvae / m² in Bodești forest nursery (Fig. 3).

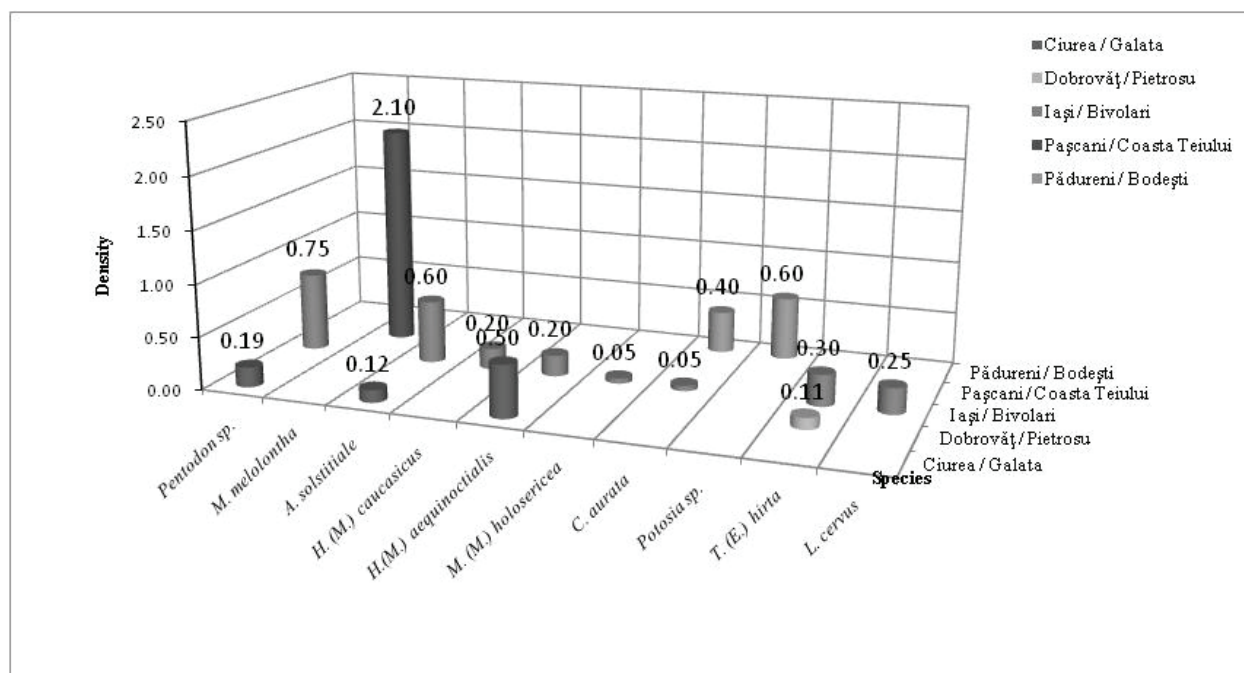


Figure 3. Survey of species, the density of scarabeoid species identified for the forest nurseries from Iași County.

For the synecological analysis, the authors used the densities data – Table 4. Thus, *M. melolontha*, *Pentodon* sp., *A. solstitialis* and *H. (M.) aequinoctialis* are eudominant species. Other two species: *Tropinota (Epicometis) hirta* (Poda 1761) and *L. cervus* are included in the dominant class. According to the same index, *Holochelus (Miltotrogus) caucasicus* (Gyllenhal 1817), *Cetonia aurata* (Linnaeus 1761) and *Protaetia* sp. are subdominant species. Only one species is recedent – *Maladera (Maladera) holosericea* (Scopoli 1772).

Table 4. The synecological analysis for the scarabaeoid species, collected from forest nurseries (Iași County).

No.	Species	Galata	Pietrosu	Bivolari	Coasta Teiului	Bodești	A	C	D	W			
1	<i>M. melolontha</i>				2.1		2.1	20	C1	23.81	D5	4.76	W3
2	<i>Pentodon</i> sp.	0.19		0.75			0.5	40	C2	20.41	D5	8.16	W4
3	<i>A. solstitialis</i>	0.12		0.6			0.39	40	C2	15.65	D5	6.26	W4
4	<i>H.(M.) aequinoctialis</i>	0.5		0.2			0.33	40	C2	13.61	D5	5.44	W4
5	<i>T. (E.) hirta</i>		0.11	0.3			0.24	40	C2	8.16	D4	3.26	W3
6	<i>L. cervus</i>			0.25			0.25	20	C1	5.44	D4	1.09	W3
7	<i>H. (M.) caucasicus</i>			0.2			0.2	20	C1	4.76	D3	0.95	W2
8	<i>C. aurata</i>			0.05		0.4	0.12	40	C2	3.40	D3	1.36	W3
9	<i>Protaetia</i> sp.					0.6	0.6	20	C1	3.40	D3	0.68	W2
10	<i>M. (M.) holosericea</i>			0.05			0.05	20	C1	1.36	D2	0.27	W2

The values of the ecological significance index (W) indicates that the ten scarabeoid species identified for the forest nurseries from Iași County belonged to two groups: *Pentodon* sp., *A. solstitialis* and *H.(M.) aequinoctialis* – the characteristic species, and the other seven species – accessory.

According to the cluster analyse (Fig. 4) *M. melolontha* appears separately from the rest of the species: it was found only in Coasta Teiului forest nursery (no other species were collected in this forest nursery). *Lucanus cervus* (Linnaeus 1758) and *H. (M.) caucasicus* form a subcluster (0.89 similarity) – these two species were collected only from Bivolari forest nursery and their densities registered similar values (0.25 respectively 0.2 individuals / m₂). Another subcluster includes other two species: *Pentodon* sp. and *A. solstitialis* – 0.87 similarity: they were identified for two forest nurseries: Galata and Bivolari (and also they registered similar densities). *C. aurata* and *Protaetia* sp. form a subcluster (0.76 similarity): both of them were collected from Bodești forest nursery (similar densities: 0.4, respectively 0.6 individuals / m₂), but *Cetonia* was also found in Bivolari forest nursery.

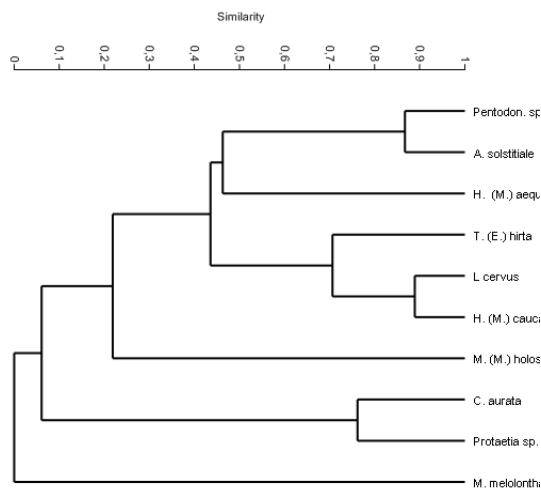


Figure 4. Hierarchical classification of the species collected from forest nurseries (Iași County), using Bray-Curtis' index of similarity.

The largest number of species and individuals (8 species – 48 coleopterans (insects), and also the largest density of larvae (2.4 individuals / m²) were in dystric alluvial soil (Bivolari forest nursery – Table 5).

The largest densities of the species in different types of soil were recorded as follows: *M. melolontha* – typical luvisol, *Pentodon* sp. and *A. solstitialis* in dystric alluvial soil (Fig. 5).

Table 5. Survey of species, number of individuals and density of scarabeoid species identified for different types of soil from Iași County.

No.	Species	typical eutricambosol			mollic preluvisol			dystric alluvial			typical luvisol		
		No. of individuals	No. of samples	No. of indiv. / m ²	No. of individuals	No. of samples	No. of indiv. / m ²	No. of individuals	No. of samples	No. of indiv. / m ²	No. of individuals	No. of samples	No. of indiv. / m ²
1	<i>Pentodon</i> sp.	3	16	0.19				15	20	0.75			
2	<i>M. melolontha</i>										21	15	1.4
3	<i>A. solstitialis</i>	2	16	0.12				12	20	0.6			
4	<i>H. (M.) caucasicus</i>							4	20	0.2			
5	<i>H.(M.) aequinoctialis</i>	8	16	0.5				4	20	0.2			
6	<i>M. (M.) holosericea</i>							1	20	0.05			
7	<i>C. aurata</i>							1	20	0.05	2	15	0.13
8	<i>Prottaetia</i> sp.										3	15	0.2
9	<i>T. (E.) hirta</i>				1	9	0.11	6	20	0.3			
10	<i>L. cervus</i>							5	20	0.25			
	Total	13	16	0.81	1	9	0.11	48	20	2.4	26	15	1.73

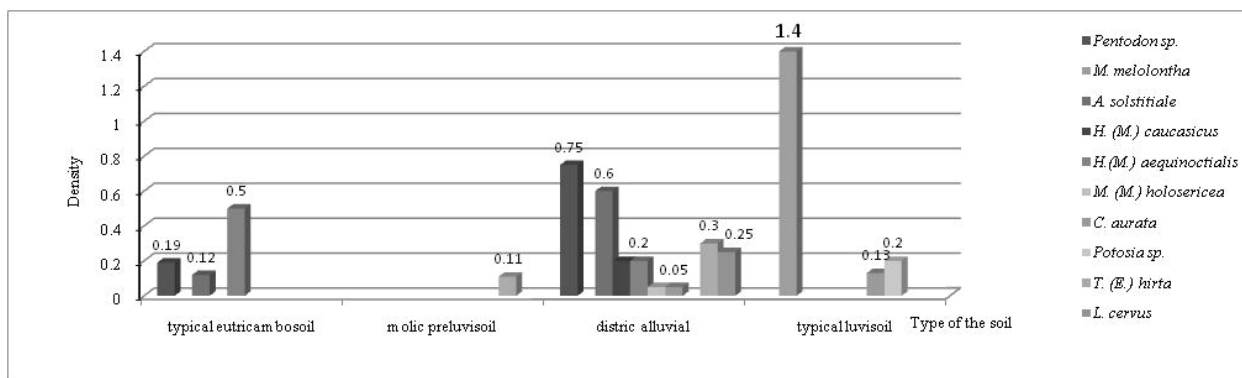


Figure 5. Survey of species, the density of scarabeoid species identified for different types of soil from Iași County.

As to the habitat types (Table 6), *M. melolontha* was found only in hilly region, oak forest, with inferior-medium productivity (a high density: 2.1 individuals / m²); *Pentodon* sp. presented a high density (0.75 individuals / m²) in, forest-steppe, meadow poplar forest, with inferior-medium productivity; *A. solstitialis* and *Prottaetia* sp. registered the same density (0.6 individuals / m²) in, forest-steppe, meadow poplar forest, with inferior-medium productivity, respectively in hilly region, oak forest, with medium-inferior productivity, brown, large edaphic (Fig. 6).

Table 6. Survey of species, number of individuals and density of scarabeoid species in different habitats from Iași County.

No.	Species	7420			5153			9613			6153			7430		
		No. of individuals	No. of samples	No. of indiv. / m ²	No. of individuals	No. of samples	No. of indiv. / m ²	No. of individuals	No. of samples	No. of indiv. / m ²	No. of individuals	No. of samples	No. of indiv. / m ²	No. of individuals	No. of samples	No. of indiv. / m ²
1	<i>Pentodon</i> sp.	3	16	0.19				15	20	0.75						
2	<i>M. melolontha</i>										21	10	2.1			
3	<i>A. solstitialis</i>	2	16	0.12				12	20	0.6						
4	<i>H. (M.) caucasicus</i>							4	20	0.2						
5	<i>H.(M.) aequinoctialis</i>	8	16	0.5				4	20	0.2						
6	<i>M. (M.) holosericea</i>							1	20	0.05						
7	<i>C. aurata</i>							1	20	0.05				2	5	0.4
8	<i>Protaetia</i> sp.													3	5	0.6
9	<i>T. (E.) hirta</i>				1	9	0.11	6	20	0.3						
10	<i>L. cervus</i>							5	20	0.25						
	Total	13	16	0.81	1	9	0.11	48	20	2.4	21	10	2.1	5	5	1

Legend: 5153, 6153, 7420, 7430 and 9613 – according to table 1.

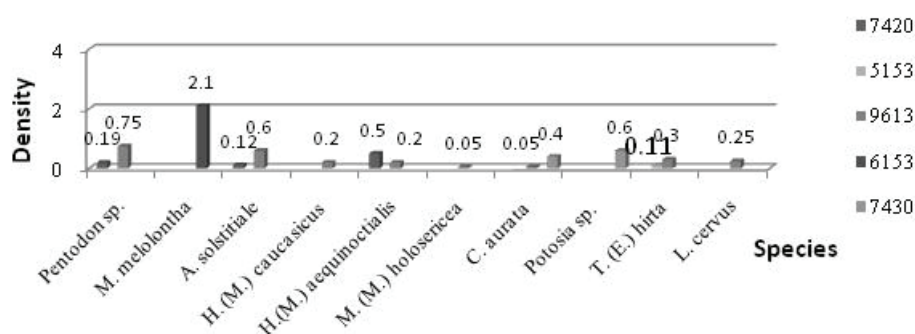


Figure 6. Survey of species, the density of scarabeoid species identified for different types of station from Iași County: 5153, 6153, 7420, 7430 and 9613 – according to table 1.

The forest nurseries are situated at different altitudes: Bivolari – 46 m; Galata – 140 m; Bodești – 200 m; Pietrosu – 260 m; Coasta Teiului – 350 m. The largest number of species and individuals were registered for 46 m altitude: Bivolari (Iași Forest District) – eight species, respectively 48 insects (Table 7). Thus, *M. melolontha* was found only at 350 m altitude; *H. (M.) caucasicus*, *M. (M.) holosericea* and *L. cervus* were found only in Bivolari forest nursery (46 m altitude); *T. (E.) hirta* was collected from two forest nurseries, Bivolari (46 m altitude) and Pietrosu (260 m altitude) (Fig. 7).

Table 7. Survey of species, number of individuals and density of scarabeoid species found for different altitudes (Iași County).

No.	Species	0-100 m			100-200 m			200-300 m			300-400 m		
		No. of individuals	No. of samples	No. of indiv. / m ²	No. of individuals	No. of samples	No. of indiv. / m ²	No. of individuals	No. of samples	No. of indiv. / m ²	No. of individuals	No. of samples	No. of indiv. / m ²
1	<i>Pentodon</i> sp.	15	20	0.75	3	21	0.14						
2	<i>M. melolontha</i>										21	10	2.1
3	<i>A. solstitialis</i>	12	20	0.6	2	21	0.1						
4	<i>H. (M.) caucasicus</i>	4	20	0.2									
5	<i>H.(M.) aequinoctialis</i>	4	20	0.2	8	21	0.38						
6	<i>M. (M.) holosericea</i>	1	20	0.05									
7	<i>C. aurata</i>	1	20	0.05	2	21	0.1						
8	<i>Protaetia</i> sp.				3	21	0.14						
9	<i>T. (E.) hirta</i>	6	20	0.3				1	9	0.11			
10	<i>L. cervus</i>	5	20	0.25									
	Total	48	20	2.4	18	21	0.86	1	9	0.11	21	10	2.1

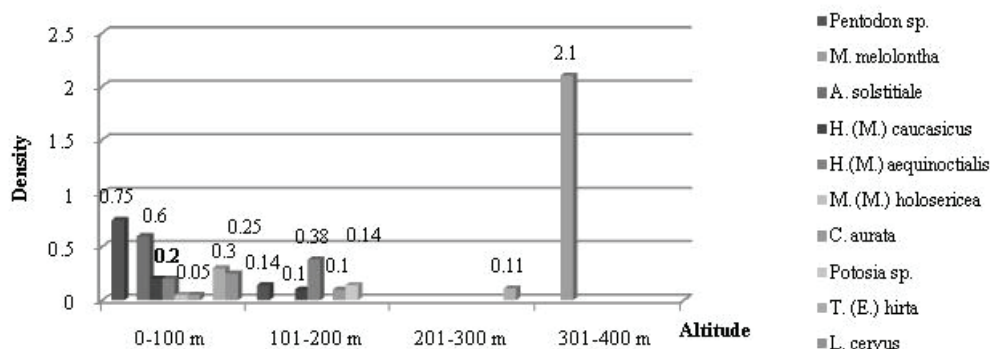


Figure 7. Survey of species, the density of scarabeoid larvae identified for different altitudes – Iași County.

Regarding the infestation of forest nurseries with disturbing biotic agents, *M. melolontha* was the only species that recorded a high level of infestation for Coasta Teiului (Pașcani Forest Department). Three species: *Pentodon* sp. *A. solstitiale* and *H. (M.) aequinoctialis* registered low levels of infestation in Galata and Bivolari forest nurseries; *H. (M.) caucasicus* was found only in Bivolari forest nursery – low level of infestation (Table 8).

Table 8. The level of infestation with scarabeoid larvae in the studied forest nurseries from Iași County.

No.	Forest Department	Forest nursery	Species	Number of individuals	No. of samples	Infestation (the average number of <i>M. melolontha</i> transformed in the third larval instar - L_3/m^2)	Level of infestation
1	Ciurea	Galata	<i>Pentodon</i> sp.	2 L_2 + 1 L_3	16	0.04	L
2			<i>A. solstitiale</i>	2 L_2	16	0.02	L
3			<i>H. (M.) aequinoctialis</i>	8 L_2	16	0.08	L
4	Dobrovăț	Pietrosu	<i>T. (E.) hirta</i>	1 L_3	9	-	-
5	Iași	Bivolari	<i>Pentodon</i> sp.	2 L_1 + 5 L_2 + 5 L_3 + 2P+ 1A	20	0.13	L
6			<i>A. solstitiale</i>	1 L_1 + 11 L_2	20	0.09	L
7			<i>H. (M.) caucasicus</i>	4 L_1	20	0.02	L
8			<i>H. (M.) aequinoctialis</i>	1 L_1 + 1 L_2 + 2 L_3	20	0.05	L
9			<i>M. (M.) holosericea</i>	1 L	20	-	-
10			<i>C. aurata</i>	1 L_3	20	-	-
11			<i>T. (E.) hirta</i>	6 L_3	20	-	-
12			<i>L. cervus</i>	1 L_1 + 4 L_3	20	-	-
13	Pașcani	Coasta Teiului	<i>M. melolontha</i>	21 L_2	10	0.7	H
14	Pădureni	Bodești	<i>C. aurata</i>	2 L_3	5	-	-
15			<i>Protaetia</i> sp.	3 L_3	5	-	-

Legend: Level of infestation: L – low infestation; H – high infestation;

Observation: *M. (M.) holosericea*, *C. aurata*, *Protaetia* sp., *T. (E.) hirta* and *L. cervus* do not attack the roots of the plant (they are not disturbing biotic agents)

CONCLUSIONS

For studying the diversity of scarabeoid larvae in the forest nurseries, five forest nurseries from Iași County were analysed in 2010 (60 soil samples).

Systematically, the biological material belonged to four families, four subfamilies 9 genera and 10 species.

The synecological analysis indicates that *M. melolontha*, *Pentodon* sp., *A. solstitiale* and *H. (M.) aequinoctialis* are eudominant species; *Pentodon* sp., *A. solstitiale* and *H. (M.) aequinoctialis* are the characteristic species for the investigated forest nurseries.

The cluster analyse reveals two subclusters with significant values of similarity index (they were collected from the same forest nurseries and they also registered similar densities): *L. cervus* – *H. (M.) caucasicus* (0.89 similarity), respectively *Pentodon* sp. – *A. solstitiale* (0.87 similarity).

The largest density of individuals was registered for dystric alluvial soil – Bivolari forest nursery, at 46 m altitude. *M. melolontha* was the only species that recorded a high level of infestation for Coasta Teiului (Pașcani Forest Department).

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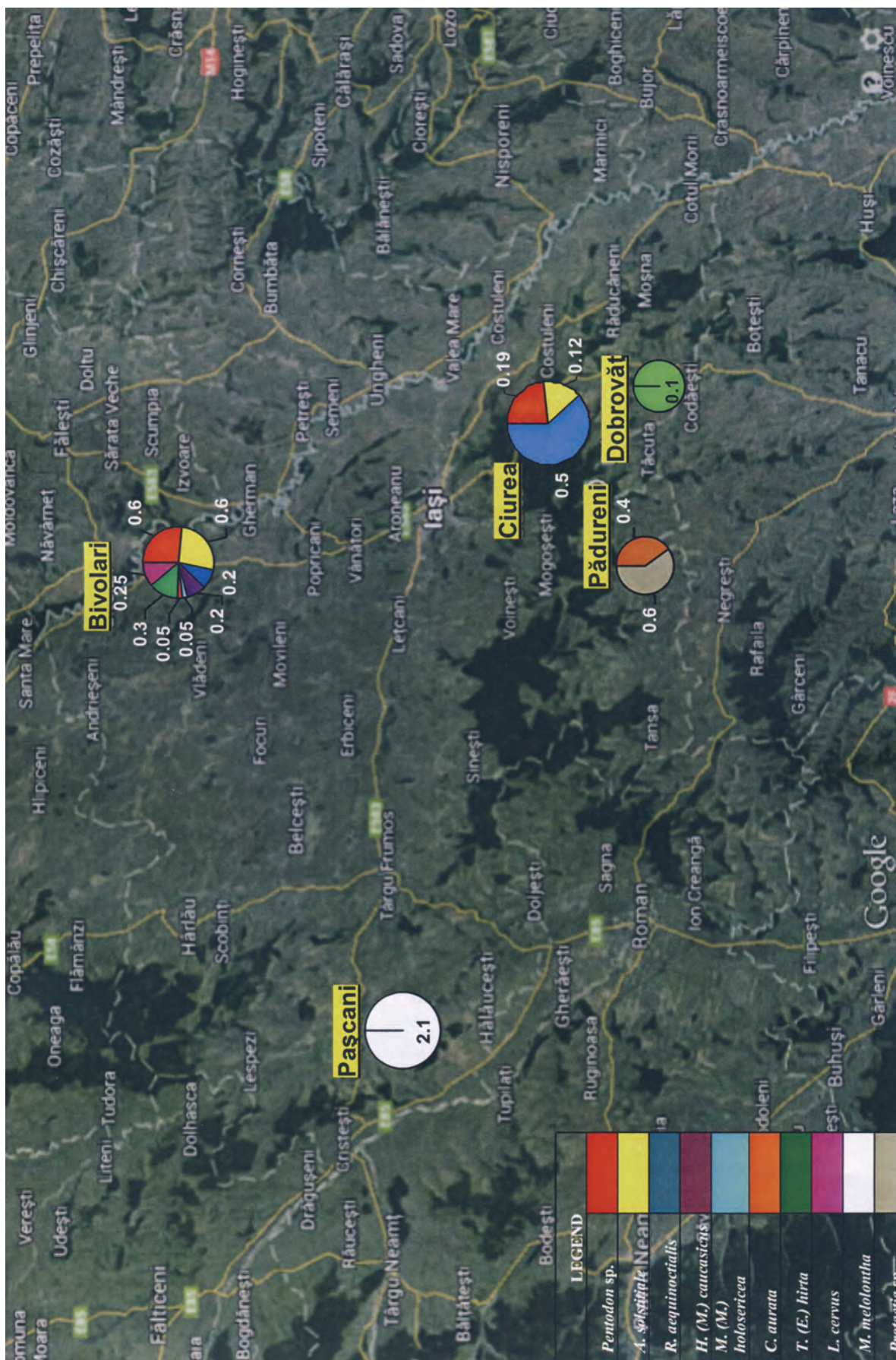


Figure 1. The studied forest nurseries and the distribution of scarabeoid species (Iași County) (the map: <https://www.google.ro/maps/place/Iași/>).