

Vertical Migration of Beetles (Coleoptera) and Other Arthropods (Arthropoda) on Trunks of *Aesculus hippocastanum* in Slovakia

by

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Abstract: During the years 2000 and 2001 we studied the vertical and horizontal migration of arthropods on trunks of the horse chestnut *Aesculus hippocastanum* L. Particularly we evaluated their seasonal dynamics as well as the beetle community (coleopterocoenosis) structure. Tree photoelectors (POTs), situated on a trunk at the height of 1 and 5 m, were used to collect the study material. Overall, we obtained 39 431 arthropods from 21 orders. Some quantitative differences were found comparing the two POTs: 26 350 specimens were recorded in the lower trap, and 13 081 in the upper one. The most abundant invertebrates were the springtails *Collembola* (83.0%) and the acarines *Acarina* (5.2%), which are ground-dwelling arthropods migrating vertically towards the tree canopy. Most of the Hymenoptera, Diptera and Coleoptera appeared to migrate horizontally. Migration of arthropods seems to be trophically as well as topically based. We recorded 49 beetle species with dominating phytophagous *Otiorynchus ligustici* (Linnaeus, 1758) (14.5%) and zoophagous species of genus *Opilo*. 5 beetle species (*Corticaria abietorum* Motschulsky, 1867, *Orthoperus improvissus* Bruce, 1948, *Atheta griepi* Scheerpeltz, 1951, *Chevrolatia egregia* Reitter, 1881 and *Latheticus oryzae* Waterhouse, 1880) are new for the fauna of Slovakia.

Key words: Arthropods, Coleoptera, migration, tree photoelector.

1. Introduction

Horizontal and vertical migration of arthropods has been studied for a long time, especially in the area of tree protection. The simplest method to study migration of wingless species is to use sticky straps on tree trunks. However, tree photoelectors, used for this research, appeared to be more reliable (Funke 1971). They have been used in a few projects, such as the study of arthropod communities on oak trunks in Germany (Funke & Sammer 1980). The same equipment was used by Funke et al. (1986) to sample invertebrate communities on tree trunks in a German fruit orchard. Vidlička (1993) studied a community of plant bugs on oak trees in Slovakia using photoelectors. In the same country, Majzlan & Kadaši (2001) recently focused on vertical migration of the chestnut leaf-miner *Cameraria ohridella* Deschka et Dimić, 1986 with the help of tree photoelectors.

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Using the above-mentioned traps we aimed to study a) vertical migration (landings and takings off) of arthropods; b) quantitative and qualitative attributes in structure of arthropod communities, and c) more detailed diversity of beetle communities.

2. Material and methods

Two photoelectors (POTs) as developed by Funke (1971) were used to study vertical migration of arthropods. A tree photoelector (Figs 1 & 2) consists of 3 collecting jars containing modified picric acid as conservation liquid. The acid represents a mixture of 2 l of distilled water, 15 ml of concentrated HNO_3 and 4 g of picric acid.

Two photoelectors (POTs) were exposed on trees of the horse chestnut *Aesculus hippocastanum* in the park of the village of Ivanka pri Dunaji (south-west Slovakia). They were situated 1 m (the lower POT) and 5 m (the upper POT) above the ground



Fig. 1. Photoelector fixed on a trunk of the horse chestnut.

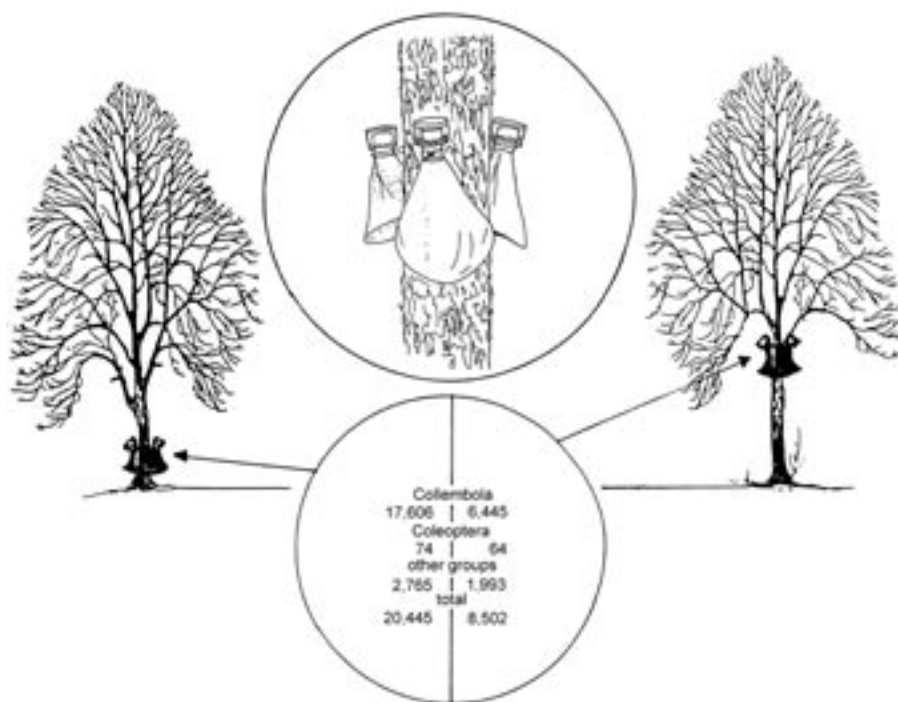


Fig. 2. A sketch of the photoelectrotraps accompanied by a detailed view and data on the arthropods captured in the year 2000 (Number of specimens).

respectively, on different trees. Both traps were fixed with a wire, and the empty space between trunk and equipment was filled with cement. Tree photoelectrotraps work on a principle of positive phototaxis, negative geotropism and outline orientation of arthropods, particularly insects.

The two POTs were exposed from 24th March to 29th December 2000 to include an entire vegetation period. The samples were collected weekly until 27th October, and thereafter monthly due to minimal activity of insects. Hence the total sampling period was 282 days, with 66 study samples.

In 2001 the samples were obtained monthly from 29th December 2000 to 30th December 2001, with an exposition period of 367 days.

For seasonal classification, we applied the seasons first used by Tischler (1955): hibernal (Jan.-15th Feb.), prevernal (16th Feb.-March), vernal (Apr.-May.), aestival (June), serotinal (July-Aug.), autumnal (Sep.-15th Oct.), postautumnal (16th Oct.-Dec.).

The obtained study material was washed with water to eliminate the picric acid, conserved in 75% ethanol and is now located at the Institute of Experimental Phytopathology and Entomology, Slovak Academy of Sciences in the village of Ivanka pri Dunaji.

The study site, situated in SW Slovakia (48°12'N, 17°15'E) at 250 m above sea level, mainly consisted of Fraxino-Populetum flood-plain forest, predominantly made

Tab. 1. Number of arthropod specimens in the tree photoelectors (lower POT/upper POT) on the trunk of the horse chestnut *Aesculus hippocastanum* in 2000.

Systematic group	Hibernal - Vernal	Aestival	Serotinal	Autumnal	Postautumnal
Isopoda	0/1	0/0	20/0	6/0	0/0
Diplopoda	20/2	4/0	15/0	31/0	10/3
Chilopoda	1/0	0/0	0/0	0/0	0/0
Araneae	114/150	47/72	50/65	18/4	13/15
Pseudoscorpiones	0/0	4/0	4/0	0/1	1/0
Opiliones	3/2	7/7	3/0	0/1	1/0
Acarina	220/256	181/191	187/28	21/6	222/193
Collembola	10096/2593	1891/1763	1285/1536	3934/396	400/157
Dermaptera	0/0	10/9	9/12	1/6	2/1
Ensifera	14/18	7/1	2/0	0/0	0/0
Psocoptera	18/5	1/3	3/1	3/1	0/0
Thysanoptera	10/5	7/7	11/9	2/37	38/30
Heteroptera	145/57	45/4	5/18	2/0	2/0
Auchenorrhyncha	96/24	147/113	156/93	54/56	13/6
Aphidoidea	6/6	3/3	0/0	2/0	1/0
Neuroptera	0/1	1/1	12/1	0/0	0/0
Coleoptera	29/33	12/15	25/15	5/1	3/0
Hymenoptera	82/70	88/62	99/70	33/43	17/14
Lepidoptera	38/17	154/133	14/39	1/5	8/4
Nematocera	58/48	39/27	73/54	34/17	14/5
Brachycera	14/6	6/2	8/4	15/18	6/13
Holometabolous larvae	7/5	3/4	1/2	0/0	3/2
Total	10969/3292	2599/2417	1986/1947	3968/593	923/253

up of trees and shrubs such as *Acer campestre* L., *Acer platanoides* L., *Carpinus betulus* L., *Ulmus carpinifolia* Gled., *Sambucus nigra* L., *Ligustrum vulgare* L. The underground includes some typical floodplain plant species, for instance *Corydalis cava* Mill., *Arum maculatum* L., *Hedera helix* L., *Viola odorata* L., *Galium verum* L., *Polygonatum odoratum* Mill., *Urtica dioica* L., *Stellaria media* L., *Chelidonium majus* L. and *Lamium purpureum* L.

3. Results and Discussion

Using the above-mentioned method of tree photoelectors we collected 28 947 arthropod specimens in 2000 (20 445 specimens in the lower POT and 8 502 in the upper one) and 10 484 specimens in 2001 (5 905 in the lower POT, 4 579 in the upper one). This represents a 63,8% decline from 2000 to 2001. This decrease could be due to the traps being located in the same place during the whole research, hence decimating the most frequent and stenotopic invertebrates through continuous trapping - springtails and acarines (Collembola et Acarina) that inhabit some small habitats only (e.g. a narrow soil strap around a trunk). The mean number arthropod specimens collected per day was 102 in 2000 and 38 in 2001.

Tab. 2. Number of arthropod specimens in the tree photoelectors (lower POT/upper POT) on the trunk of the horse chest-nut *Aesculus hippocastanum* in 2001.

Systematic group	Hibernal - Vernal	Aestival	Serotinal	Autumnal	Postautumnal
Isopoda	1/1			2/3	
Diplopoda	5/0	9/0	11/0	5/1	
Chilopoda	0/0				
Araneae	106/50	13/23	38/28	19/19	12/5
Pseudoscorpiones			1/1		
Opiliones		1/0	1/2	0/1	
Acarina	31/19	0/5	85/56	25/10	35/20
Collembola	255/132	89/88	2300/1380	1205/802	552/87
Dermaptera	3/0		1/15	0/4	2/1
Ensifera		9/8	2/1	1/1	
Psocoptera	4/1		3/4		
Thysanoptera	2/1		5/5	2/0	
Heteroptera	3/3	14/11	19/20	32/3	
Auchenorrhyncha	18/2	12/19	98/61	5/90	1/15
Aphidoidea	0/1		6/10	1/7	
Neuroptera	3/0		1/1		
Coleoptera	60/12	0/5	17/17	19/28	15/7
Raphidioptera			1/0		
Hymenoptera	49/37	185/129	103/148	22/20	25/14
Lepidoptera	7/1	4/3	19/46	2/17	1/0
Nematocera	55/75	19/77	59/45	27/6	14/15
Brachycera	43/30	33/5	70/14	12/10	5/0
Holometabolous larvae	14/4	6/1		1/0	
Total	659/369	394/374	2840/1854	1351/1050	661/164

The most frequent were the wingless springtails (Collembola) (83%) and the acarines (Acarina) (5.2%). The remaining specimens (12%) were other arthropods. A dominance of springtails had been already recorded in oak forests by Vidlička (1989) and Majzlan (1986). Moreover, Funke & Sammer (1980) mentioned a dominance of springtails (71%) in material from photoelectors situated on oak trunks in Germany.

In the present study, 4 times as many springtails were trapped in the lower POT than in the upper one; in autumn it was 10 times as many (Tabs 1 & 2). A high activity of springtails crawling upwards as well as eudominant occurrence has not yet been reliably explained. However, we can emphasise their trophic preference on trunks (bryophytes, lichens, algae) or their tolerance to soil humidity, which are supposed to influence their migration cycles. We do not have any data on their downward crawling.

Species of some of the arthropod groups (especially Isopoda, Diplopoda, Chilopoda, some of the Araneae and Heteroptera) were recorded in the lower trap in higher numbers than in the upper one. These invertebrates probably colonise trunks of the horse chestnut from the ground and lower undergrowth (up 1 m above the ground). The community of arthropods recorded included an interesting millipede *Polyxenus lagurus* (Linnaeus, 1758), usually occurring in soil, but also recorded in bird nests

(Krumpál, 1986). Its presence on bark proves its active migration on trunks to get into bird nests.

A preference for the upper POT was recorded mainly for flying arthropods, such as those of Hymenoptera and Diptera. Their orientation is usually based on silhouettes of tree trunks appearing as dark straps. For phytophagous insects (most caterpillars, weevils, etc.) a tree crown has an important role in their orientation. On tree replicas with no green crown, Majzlan (1986) recorded a lower abundance of the dominating arthropods (Collembola, Acarina, Hymenoptera, Coleoptera). However, the abundance of arthropods varies during the year, peaking in spring and autumn.

Beetles made up just 0.5-1.7% of all the captured arthropods in both the years. In 2000 we totalled 318 beetle specimens from 60 species from 23 families (Tab. 3). *Otiorhynchus ligustici* (Linnaeus, 1758) (14.5%), *Rhagonycha fulva* (Scopoli, 1763) (10.0%), *Opilo mollis* (Linnaeus, 1758) (7.2%) and *Opilo pallidus* (Olivier, 1795) (5.8%) were the most frequent species. 19 species, representing 39% of the whole beetle merocoenosis, were classified as zoophagous. 14 phytophagous species included ectopholiophagous and xylophagous beetles. 16 mycetophagous and detritophagous species (Lathridiidae, Alleculidae, Tenebrionidae) formed the group of pantophags. The composition of the beetle community collected in the present study was similar to that recorded on oaks by Vidlička (1989).

In 2001 we recorded 65 beetle species from 23 families. Only 16 species were common in both years, some of which were considered as the most frequent: *Neopristilophus depressus* (Germar, 1822), *Opilo mollis* (Linnaeus, 1758), *Opilo pallidus* (Olivier, 1795) and *Sericoderus lateralis* (Gyllenhal, 1827). Generally, the use of tree photoelectors provides good data on new elements of beetle communities. Moreover, the low number of species collected in both years (16) indicates that not all species present on these trees have been recorded and thus highlights the need for further research.

Tab. 3. Systematic presentation of the beetles (Coleoptera) captured in the tree photoelectors (month/ No. of specimens).

Taxon	2000		2001	
	Upper POT	Lower POT	Upper POT	Lower POT
Carabidae				
<i>Trechus quadristriatus</i> (Schränk, 1781)				9/3
<i>Dromius quadrimaculatus</i> (Linnaeus, 1758)	6/1	6/1		
<i>Calathus fuscipes</i> (Goeze, 1777)				5/1
<i>Microlestes minutulus</i> (Goeze, 1777)		4/1		
Scydmaenidae				
<i>Chevrolatia egregia</i> Reitter, 1881		5/1		
Staphylinidae				
<i>Anotylus tetracarinus</i> (Block, 1799)			5/1	
<i>Stenus ater</i> Mannerheim, 1830				4/1
<i>Philonthus spilotus</i>			9/1, 10/1	
<i>Quedius crunetus</i> (Olivier, 1795)			7/1	7/4, 8/4
<i>Quedius ochripennis</i> (Ménétriér, 1832)		4/1		
<i>Tachyporus hypnorum</i> (Fabricius, 1775)			10/1, 9/6	4/1, 9/5, 10/2
<i>Tachyporus nitidulus</i> (Fabricius, 1781)		12/1		10/1

<i>Atheta griepi</i> Scheerpeltz, 1951			9/1	
Helodidae				
<i>Cyphon phragmiteticola</i> Nyholm, 1955				4/3
Elateridae				
<i>Athous subfuscus</i> (Mueller, 1767)	5/1			
<i>Neopristilophus depressus</i> (Germar, 1822)	5/2	5/1, 7/2	4/3, 5/1	4/4
Throscidae				
<i>Trixagus elateroides</i> (Heer, 1841)				4/1, 7/1, 8/1, 10/1
<i>Trixagus brevicollis</i> (Bonvouloir, 1859)				8/1
Cantharidae				
<i>Cantharis rustica</i> Fallén, 1807	5/1			
<i>Cantharis fusca</i> Linnaeus, 1758				5/1
<i>Cantharis pellucida</i> Fabricius, 1792	5/1		8/1	
<i>Cantharis rustica</i> Fallén, 1807			5/1	
<i>Rhagonycha fulva</i> (Scopoli, 1763)		7/10, 6/4		
<i>Malthodes marginatus</i> (Latreille, 1806)	4/1	4/1, 5/1		
Dermestidae				
<i>Anthrenus pimpinellae</i> Fabricius, 1775	4/1			
<i>Anthrenus museorum</i> (Linnaeus, 1761)	6/1			
<i>Anthrenus fuscus</i> Olivier, 1789		5/2, 7/1	7/1	
Anobiidae				
<i>Ptinomorphus regalis</i> (Duftschmid, 1825)				7/1
Ptinidae				
<i>Ptinus fur</i> (Linnaeus, 1758)				4/1, 7/1
<i>Ptinus variegatus</i> Rossi, 1794				4/1
<i>Ptinus rufipes</i> Olivier, 179	6/1		7/1	7/1
Cleridae				
<i>Tilloidea unifasciata</i> (Fabricius, 1787)			5/1	
<i>Trichodes apiarius</i> (Linnaeus, 1758)			4/1	4/13, 5/1
<i>Clerus mutillarius</i> Fabricius, 1775			4/1	
<i>Opilo mollis</i> (Linnaeus, 1758)	4/2, 6/3	4/3, 9/2	4/1, 5/1	7/1, 8/1
<i>Opilo pallidus</i> (Olivier, 1795)	6/2, 7/3	6/2, 7/2	7/1, 8/1	
<i>Korynetes caeruleus</i> (De Geer, 1792)				4/1
Malachiidae				
<i>Axinotarsus ruficollis</i> (Olivier, 1790)	7/1	7/1		
Nitidulidae				
<i>Epuraea melanocephala</i> (Marshall, 1802)	4/1			
Cybocephalidae				
<i>Cybocephalus politus</i> (Gyllenhal, 1813)		4/1		
Rhizophagidae				
<i>Rhizophagus bipustulatus</i> (Fabricius, 1792)				5/1
Silvanidae				
<i>Ahasverus advena</i> (Waltl, 1832)				5/1
<i>Uleiota planata</i> (Linnaeus, 1761)		4/1		
Phalacridae				
<i>Phalacrus corruscus</i> (Panzer, 1797)				7/1
<i>Olibrus affinis</i> (Sturm, 1807)			6/1	
Cryptophagidae				
<i>Atomaria pusilla</i> (Paykull, 1798)				5/1
<i>Atomaria linearis</i> Stephens, 1830		3/1		
Endomychidae				
<i>Symbiotes gibberosus</i> (Lucas, 1849)				5/1
Coccinellidae				
<i>Rhyzobius litura</i> (Fabricius, 1787)	5/1			4/1
<i>Stethorus punctillum</i> Weise, 1891		10/2	8/1	
<i>Scymnus quadrimaculatus</i> (Herbst, 1783)	4/2	4/2	4/1	4/4
<i>Brumus quadrimaculatus</i> (Linnaeus, 1758)	6/1	4/3		4/1
<i>Harmonia quadripunctata</i> (Pontoppidan, 1763)			11/1	
<i>Calvia quatuordecimguttata</i> (Linnaeus, 1758)		10/1		
Corylophidae				
<i>Sericoderus lateralis</i> (Gyllenhal, 1827)	7/3	8/1	4/1, 7/3	9/2, 12/1
<i>Orthoperus improvisus</i> Bruce, 1948	4/1, 5/1			
Lathridiidae				
<i>Lathridius hirtus</i> Gyllenhal, 1827		4/1		

<i>Lathridius brevicolis</i> (Thomson, 1868)				4/1
<i>Lathridius anthracinus</i> Mannerheim, 1844		6/1	9/2	
<i>Lathridius minutus</i> (Linnaeus, 1767)		3/2, 4/1		
<i>Enicmus transversus</i> (Olivier, 1790)			4/1	
<i>Dienerella elongata</i> (Curtis, 1830)				7/1
<i>Corticaria abietorum</i> Motschulsky, 1867		4/1, 6/1		
<i>Corticaria serrata</i> (Paykull, 1798)	4/2			
<i>Corticaria bella</i> Redtenbacher, 1849		6/1		
<i>Corticaria rubripes</i> Mannerheim, 1844				4/1
<i>Corticaria gibbosa</i> (Herbst, 1793)	4/1, 10/8	4/1		
<i>Corticaria fuscata</i> (Gyllenhal, 1827)		4/1, 11/1		
Mordellidae				
<i>Mordellistena neuwaldeggiana</i> (Panzer, 1796)		7/1		
Scraphiidae				
<i>Anaspis frontalis</i> (Linnaeus, 1758)		7/1		
Salpingidae				
<i>Lissodema denticolle</i> (Gyllenhal, 1813)	5/1			
Alleculidae				
<i>Mycetochara flavipes</i> (Fabricius, 1792)		6/2		
Tenebrionidae				
<i>Tribolium castaneum</i> (Herbst, 1797)		5/1		
<i>Latheticus oryzae</i> Waterhouse, 1880		4/1		
<i>Cylindronotus aeneus</i> (Scopoli, 1863)	5/2, 6/4	4/2		
<i>Cylindronotus dermestoides</i> (Illiger, 1798)			7/2	4/1
Cerambycidae				
<i>Anaglyptus mysticus</i> (Linnaeus, 1758)		5/1		
<i>Allosterna tabacicolor</i> (De Geer, 1775)		7/1		
<i>Mesosa curculionoides</i> (Linnaeus, 1761)			7/1	4/1
<i>Pogonocherus hispidus</i> (Linnaeus, 1758)	4/1			
<i>Leiopus nebulosus</i> (Linnaeus, 1758)			5/1	7/2
Anthribidae				
<i>Tropideres albirostris</i> (Herbst, 1783)				4/1
<i>Anthribus albinus</i> (Linnaeus, 1758)				4/1, 7/1
Chrysomelidae				
<i>Oulema melanopus</i> (Linnaeus, 1758)		8/1		4/2
<i>Phyllotreta nodicornis</i> (Marsham, 1802)				4/1
<i>Phyllotreta striolata</i> (Fabricius, 1803)			6/1, 7/1	4/1
<i>Phyllotreta procera</i> (Redtenbacher, 1849)		4/1		
<i>Longitarsus luridus</i> (Scopoli, 1763)	6/3	7/1, 10/1		
<i>Longitarsus parvulus</i> (Paykull, 1799)			7/1, 7/2	
<i>Longitarsus melanocephalus</i> (De Geer, 1775)			7/2, 8/1	
<i>Psylliodes chrysocephala</i> (Linnaeus, 1758)			9/9	7/2, 9/3
<i>Psylliodes napi</i> (Fabricius, 1792)	10/1			
Apionidae				
<i>Apion gibbirostre</i> Gyllenhal, 1813				9/1
Curculionidae				
<i>Otiorynchus ligustici</i> (Linnaeus, 1758)	4/10, 5/5	5/5		
<i>Otiorynchus fullo</i> (Schrank, 1781)	7/1			
<i>Trachyploeus angustisetulosus</i> Hansen, 1915				5/2, 7/1
<i>Trachyploeus aristatus</i> (Gyllenhal, 1827)				5/1
<i>Polydrusus piceus</i> (Fabricius, 1792)			5/1	
<i>Phyllobius oblongus</i> (Linnaeus, 1758)		5/6		
<i>Liophloeus lentus</i> Germar, 1824	5/1	4/1		
<i>Sitona hispidulus</i> (Fabricius, 1776)		10/1		10/1
<i>Sitona humeralis</i> Stephens, 1831			9/1	
<i>Phloeophagus lignarius</i> (Marsham, 1802)	6/1			
<i>Dorytomus tremulae</i> (Fabricius, 1787)			4/2	
<i>Dorytomus ictor</i> (Herbst, 1795)				4/4
<i>Lignyodes uniformis</i> Desbrochers, 1894			4/1	5/2
<i>Sitophilus oryzae</i> (Linnaeus, 1758)			7/1	
<i>Mecinus pyrastrer</i> (Herbst, 1795)		3/1		
Scolytidae				
<i>Xyleborus saxeseni</i> (Ratzeburg, 1837)	4/1	6/1	4/1	
<i>Xyleborus dispar</i> (Fabricius, 1792)	9/1			

According to the recorded spectrum of beetles we were able to determine some of ecological groups: a) non-flying, crawling species: *Otiorhynchus ligustici*, *Otiorhynchus fullo*, *Liophloeus lentus*; b) terricole and ground-dwelling species: *Microlestes minutulus* and *Quedius ochripennis*; c) arboricole species: *Athous subfuscus*, *Neopristilopohus depressus*, *Malthodes marginatus*, *Opilo mollis*, *Opilo pallidus*, *Lissodema denticolle* and *Phyllobius oblongus*; d) corticicole and xylobiont species: *Ptinus rufipes*, *Uleiota planata*, *Cylindronotus aeneus*, *Anaglyptus mysticus*, *Pogonocherus hispidus*, *Phloeophagus lignarius* and *Xyleborus saxeseni*.

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