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The first study on the beetle fauna in the Giumalau spruce primeval forest (Eastern Carpathians, Romania), mainly based on a quantitative analysis of terrestrial and saproxylic species

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ABSTRACT

In 2006 and 2007 we carried out quantitative seasonal sampling on Coleoptera in the primeval spruce forest of the Giumalau Mountains (Eastern Carpathians). The scientific reserve Giumalau was founded in February 1932 and has a total area of 309.5 ha. We captured and identified 190 species belonging to 33 families. Of these, 46.3% represent xylobiont species. We inventoried, expressed in trophic categories, 11 (5.8%) foliophagous/seminivorous species, 12 (6.3%) mycetophagous, 8 (4.2%) mixophagous, 17 (8.9%) xylophagous, 14 (7.4%) cambiophagous/ xylemophagous, 41 (21.6%) saproxylophagous and xylomycetophagous, 57 (30%) detritophagous/coprophagous/necrophagous, and 38 (20%) predators. The following rare and representative species for spruce primeval forests were found: *Cornumutila quadrivittata* Gebler 1830 (Cerambycidae), *Nemozoma elongatum* (Linnaeus, 1761) (Trogositidae), *Salpingus ruficollis* (Linnaeus 1761) (Salpingidae). *Leiodes rhaeticus* Erichson, 1845 (Leiodidae) is recorded for the first time in Romania.

Key words: Coleoptera, saproxylic, edaphic, spruce primeval forest, Romania.

INTRODUCTION

Although some of the oldest natural forests in Central and Eastern Europe are to be found on Romanian territory, prior to the present study no quantitative and seasonal studies have been carried out on the coleopteran fauna in these forests. In 2006 and 2007, on the initiative of the Romanian Institute of Forest Research, we started the first complex study in one of Romania's best preserved primeval spruce forests, investigating the beetle fauna because this represents an important component in all animal trophic categories (phytophagous, decomposers, predators). The scientific reserve Giumalau was founded in February 1932 and has a total surface area of 309.5 ha. The principal structural indicators of the forest showed considerable differences between the initial phase (1200 trees/ha, with 55 m^2 basal area and 600m^3/ha volume) and the decomposition phase (350 trees/ha, 39 m^2 basal area and 445 m^3/ha volume).

Our principal purpose was to estimate the species richness of the soil and saproxylic species, the faunal resemblance and the representativeness of trophic categories in different sectors of this primeval forest. However, our initial task was to decide on the most efficient methodology for collecting samples. This first study should be regarded as a starting point for a larger program including all Romanian primeval forests and aimed at updating the information on European arthropod fauna, following the models of other zoologists (Cerretti et al 2003, Nardi et al 2007).

METHODS

We sampled fauna in 8 sectors (sampling sites) of 100 m^2 each, situated at different elevations and in forested areas in different phases of development in an area covering 165 ha in total. For each sampling site we recorded the elevation and volume of living (healthy and damaged/ill trees) and dead wood (standing and lying trunks/stumps) (Table 1).We used two trapping methods: pitfalls (Barber traps) of 110 mm diameter and window traps (9 pitfalls at 1 window trap in each area). Where possible, the pitfalls were placed near or under fallen stumps. The samples were verified and emptied weekly; the sampling periods were: May 15-30; July 15-30 and September 1-15.

The selectivity of sampling methods and the faunal differences between the investigated areas were analyzed using cluster analysis based on species abundance (Bray-Curtis and Euclidean distance methods), followed, to enable better interpretation, by correspondence analysis (according to Ludwig & Reynolds 1988, Krebs 1989). The species richness was estimated using the Jack-knife method. For statistical analysis we used COA.BAS, CLUSTER.BAS (Ludwig and Reynolds 1988) and Biodiversity Professional V.2 (McAleece 1997) programs.

Table 1. Recorded values for altitude (in meters) and volume of dead and living wood per hectare computed for each sampling area (data from Dr. Marius Theodosiu – ICAS). T = total; V= Volume

Grid terms of sampling area	Elevation (meters)	V/ha healthy trees	V/ha ill trees	T.V/ha living trees	V/ha logs	V/ha snags	T.V stumps
F11	1240	192.05	573.77	765.82	191.6	20.99	212.59
F13	1268	534.4	255.5	789.9	253	0	253
G11	1296	115.52	90.59	206.11	223.4	15.80	239.2
G13	1272	543.97	268	811.97	49.6	3.67	53.27
N11	1496	168.22	83.93	252.15	175.8	53.1	228.9
N13	1500	194.45	0	194.45	295	164.83	459.83
O11	1527	354.57	0.23	354.8	92	118.01	210.01
O13	1524	38.22	199.91	238.13	113.7	47.66	161.36

RESULTS

We collected and identified 190 species belonging to 33 families of Coleoptera, making a total of 1893 individuals (836 captured with pitfalls and 1057 with window traps) (Annex 1). These represent 76.23% of the number of soil and saproxylic species predicted using the Jack-knife 2 estimator (239 estimated species) (Fig. 1). For other species which live on leaves, flowers, or in the forest canopy, other sampling methods are more efficient.

We inventoried species from the following trophic categories: 11 (5.8%) foliophagous /seminivorous, 12 (6.3%) mycetophagous, 8 (4.2%) mixophagous, 17 (8.9%) xylophagous, 14 (7.4%) cambiophagous/xylemophagous, 41 (21.6%) sapro-xylophagous and xylo-mycetophagous, 57 (30%) detritophagous /coprophagous /necrophagous, and 38 (20%) predators, 46.3% of all identified species being xylobiont (Fig. 2).

The distribution of trophic categories, each represented by a number of species, among ecological groups (according to the terminology proposed by Bouget et al 2005) collected using both methods is given in Fig. 3. The x-axis shows the ecological groups (species living on soil/edaphic, bark/corticolous etc). The y-axis shows the number of species included in trophic categories. Among the fungicolous (species inhabiting mushrooms), only the trophic category of fungivorous (mycetophagous) species was found. The specific details are given in Annex I.

Based on the abundances of species captured in pitfalls and window traps we tested the selectivity of the collection methods (33 species collected by both methods) using cluster analysis. According to Ludwig and Reynolds (1988), correspondence analysis could be useful as a subdata set of cluster analysis when the similarity between clusters is not conclusive. In our case, however, the dissimilarities between clusters including pitfalls and window traps are obvious (Fig. 4).

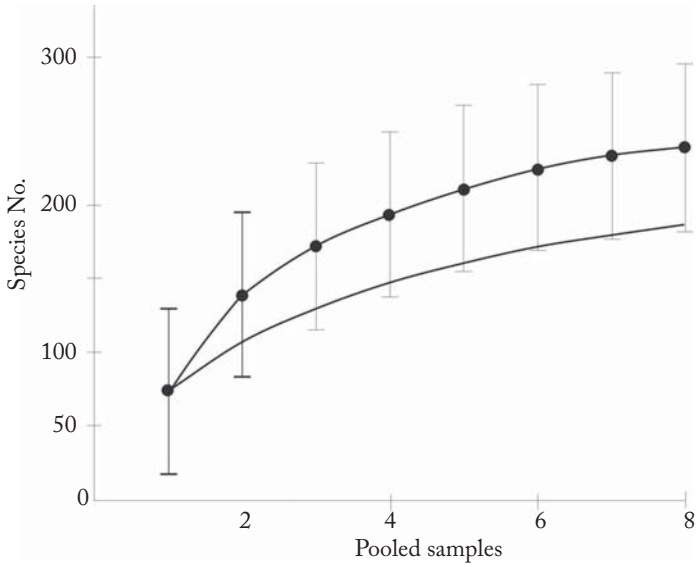

Figure 1. Accumulation curve (smooth line) and predicted number of soil and saproxylic species (line with filled circles) using the Jack-knife2 estimator (±1σ)

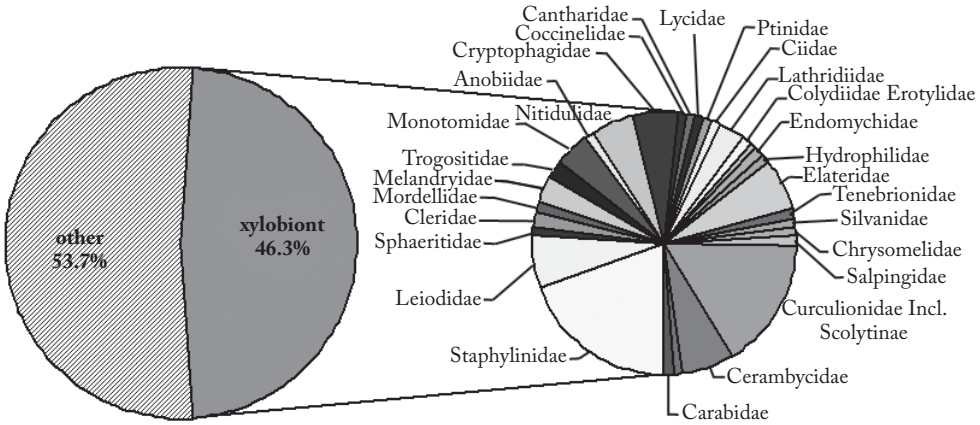

Figure 2. Proportion of xylobiont species and their distribution per family

The cluster analysis for the sampled areas based on cumulated data for the vernal, aestival and autumnal seasons (Fig. 5) illustrates the general similarity between areas. It was observed that area F13 presents the greatest faunal dissimilarities among all investigated sectors. The seasonal data subsets were used to point out the differences between areas depending on sampling period.

The most homogenous clusters were found for the vernal season, the period when most of the recorded species occurred (139 species). The first cluster groups the sectors O-N at high altitude and the second cluster groups the sectors F-G at low altitude.

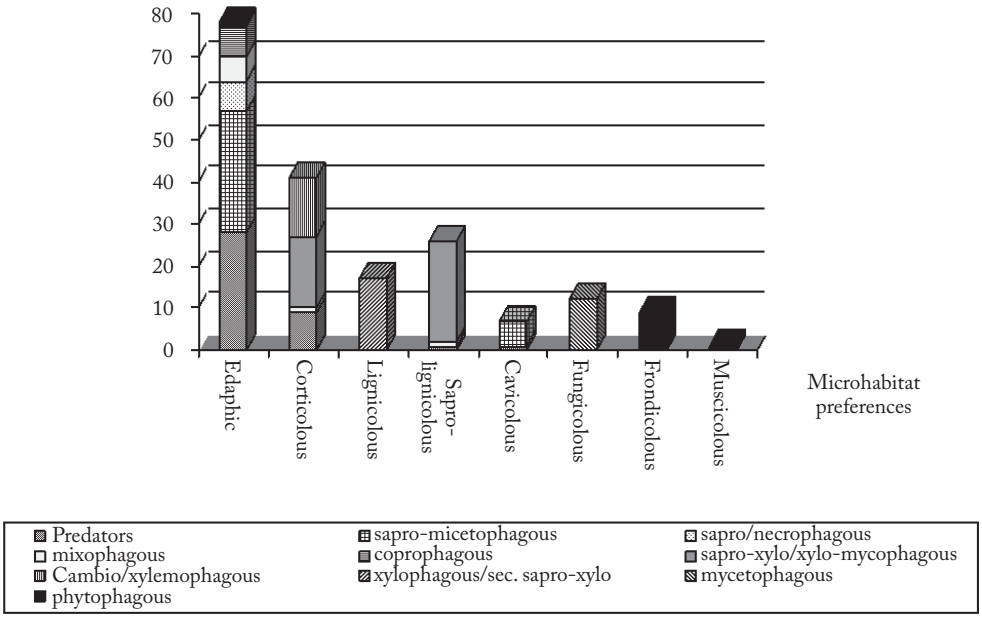

Figure 3. Distribution of trophic categories, (on the y-axis), among ecological groups (on the x-axis)

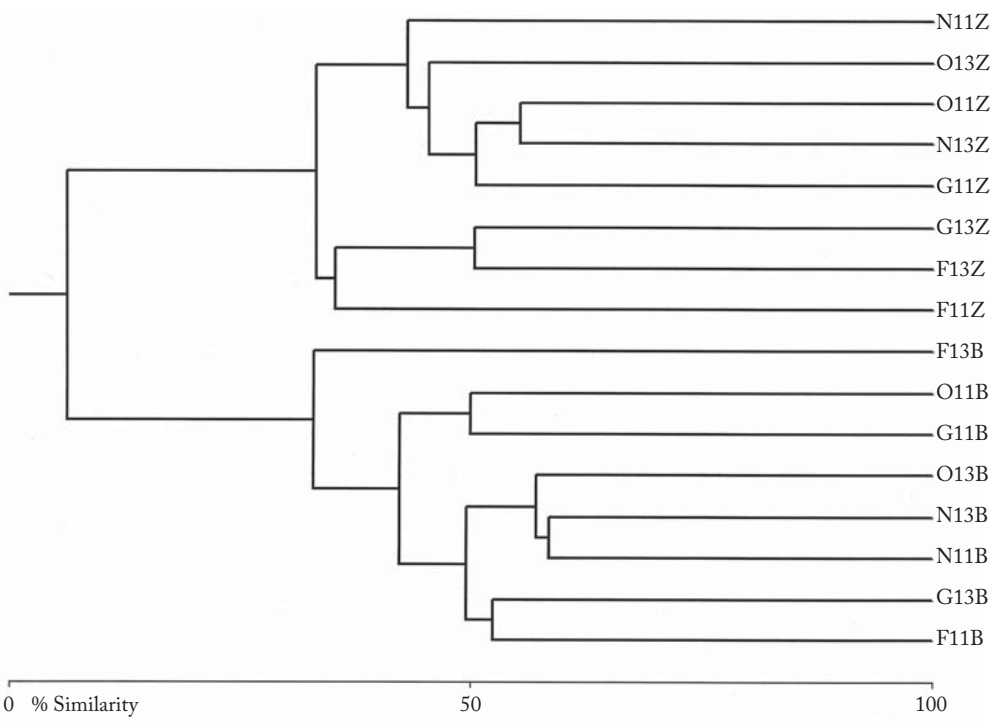

Figure 4. Dendrogram of sampling sectors based on abundance of species in window (Z) and Barber (B) traps (N11-O13 – the terms of sampled areas)

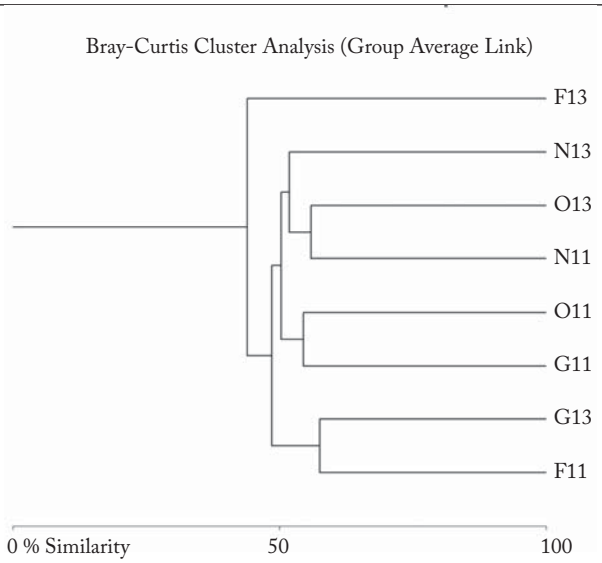

Figure 5. Dendrogram of sampled areas based on cumulated data for vernal, aestival and autumnal seasons

Correspondence analysis was performed for all samples collected in 8 sampling sites for three seasons (Fig. 6) in order to improve data interpretation.

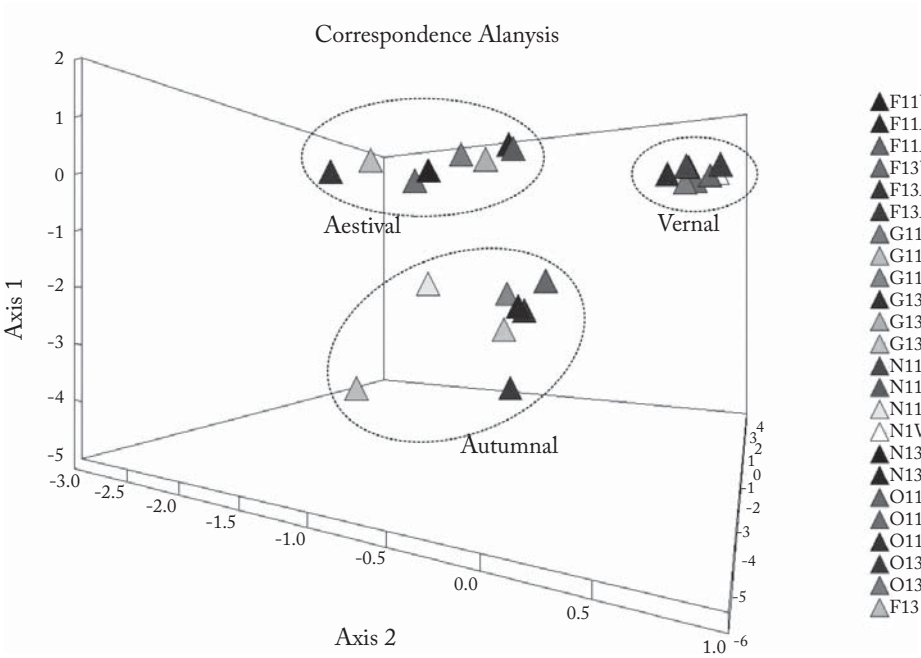

Figure 6. Correspondence analysis for 8 sampled areas in the vernal, aestival and autumnal seasons.

DISCUSSION

The large number of species collected in 8 sampling sites only (190 species belonging to 33 families) shows the great species richness of the Giumalau spruce primeval forest with respect to the soil and saproxylic species. Other species such as *Cryphalus saltuarius* Weise 1891, ș*Hylastes brunneus* Erichson 1836, *Crypturgus pusillus* (Gyllenhal 1813) (Curculionidae), *Judolia sexmaculata* (Linnaeus 1758), *Monochamus sartor* (Fabricius, 1787), *Prionus coriarius* (Linnaeus, 1758) (Ceramycidae), *Calopus serraticornis* (Linnaeus, 1758) (Oedemeridae), *Xestobium rufovillosum* (De Geer 1774) (Anobiidae) and *Ceruchus chrysomelinus* (Hochenwarth, 1785) (Lucanidae) were collected using qualitative direct catching methods only and underline the necessity of using all possible methods for improved faunal investigation.

The cluster analysis clearly differentiates the faunal composition collected using pitfall traps from that collected using window traps, although 33 species were caught using both methods (Annex 1). Pitfall traps are more efficient in collecting soil beetle fauna or sapro-xylic/xylo-mycetophagous species living on or under logs (Carabidae, Geotrupidae, Leiodidae), while windows traps are more efficient in catching vagile flying species, most of which are xylobiontic, on living trees or snags (Curculionidae, Cerambycidae, Melandryidae, Salpingidae). Thus, the dendrogram in Fig. 5 shows not only the selectivity of the sampling methods used; it also offers an image of the faunal resemblance between the areas based primarily on soil fauna and those based on xylobiont fauna living on snags or living trees. The pitfall traps show a great dissimilarity between area F13 and other areas. The highest number of species (80) was observed in edaphic habitat (soil), all of these species being predators and decomposers (saprophagous, sapro-mycetophagous, coprophagous, necrophagous). All collected cambiophagous / xylemophagous species (14 species) are corticolous (living on or under the bark). The saproxylic species are both corticolous (17 species) and saprolignicolous (24 species living on wood in different stages of decomposition) (Annex 1). Of the cavicolous species (living in burrows or hollows) it is worth mentioning *Phloeonomus (Xylostiba) monilicornis*, *Epuraea pygmaea*, *Glischrochilus quadripunctatus*, all of which live in burrows of Scolitinae. The xylobiont species represent 46.3% of all collected species, over a half of which are saproxylic.

From the faunistic point of view the best represented families are Staphylinidae and Curculionidae. Some species which are characteristic (typical) for primeval spruce forest were observed: *Tachinus marginellus* (Fabricius, 1781), *Agaricophagus cephalotes* W. L. E. Schmidt, *1841* (Leiodidae), *Xylita livida* Sahlberg, 1834 (Melandryidae), *Salpingus ruficollis* (Linnaeus, 1761 (Salpingidae), *Cornumutila quadrivittata* Gebler 1830 (Cerambycidae).

Leiodes rhaeticus Erichson, 1845, which has been considered a very rare species since 1900 (Kuhnt 1912) and is characteristic for old, primeval forests is recorded for the first time in Romanian fauna.

The dissimilarity between sector F13 and the other sectors can be observed in the general dendrogram which includes the data subsets for all seasons. The faunal particu-

Plate 1. Study sites in the Carpathian Mountains, Romania.

larities that generate this clustering are given by the larger number of coprophagous (*Agrilinus ater, Acrossus depresus),* detritophagous (*Omalium validum, Deliphrosoma prolongatum)* followed by necrophagous species *(Fissocatops westi)* in sectors O-N, compared with the cluster that includes sectors F-G, and the greater abundance of *Athous bicolor* in the F-G areas clustered together. Area F13 is most dissimilar, due to the lower number and abundance of ground beetles, the greater number of detritivorous species associated with a greater number and abundance of mycetophagous species. The potential causes are:

1. The higher altitude sectors (the sectors situated between 1496 and 1527 m) are frequented by large mammals (stags, bears) that avoid the lower altitudes (sectors F-G situated between 1240 and 1296 m) near to the forest road. These mammals determine the higher abundance of coprophagous and necrophagous species mentioned.
2. The smaller quantity of fallen dead wood in F13 (used as a microrefuge for ground beetles), probably accentuated by the illegal extraction of dead wood from the area (area is near to the forest road, and we also observed some traces of extraction).
3. The greater quantity of vegetable debris in F13 that explains a greater abundance of detritivorous and mycetophagous species in this sector compared with the others.

The comparison of 24 samples collected from 8 different locations (F11 – O13, as above), in 3 different seasons (vernal, aestival and autumnal) shows a decrease in similarities between clusters from spring to autumn and an increase of heterogeneity, facts also suggested by correspondence analysis (Fig. 6). This situation could be a result of the inactivity period of adults (aestival, hibernal diapauses) or by migrations of active vagile species between sectors, but we do not have sufficient data to give a concrete answer on this issue because, to quote Tykarski 2008, "what you know is what you catch". However, the cluster analysis and correspondence analysis (Fig. 6) based on our two sampling methods illustrate significant differences between faunal composition between seasons.

CONCLUSIONS

As final conclusions, we observed that:

(1) the simultaneous use of different sampling methods, such as pitfalls and window traps, improves the efficiency of faunal investigation and provides more information about trophic categories and their relation to microhabitats (including dead wood).

(2) the study of saproxylic beetles together with soil beetle fauna (including detritivorous and predator species which depend on downed dead wood) is able to offer more information concerning dead wood distribution or disturbances.

(3) the data obtained, including the soil beetle species in the faunal study, has significantly increased the volume of information on the relation between dead wood and faunal diversity and has facilitated ecological interpretation. A decrease in species occurrence was observed from spring (160 species) to autumn (64 species)

(4) the quantity and quality of dead wood and its distribution influence not only the "saproxylic" beetles but also other large groups, such as ground beetles (Carabidae) or detritivorous/mycetophagous species which use dead wood as microrefuges.

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ANNEX 1. Coleoptera species collected in pitfall and window traps (species collected using window traps are marked „+") (some species collected by both methods). The terms F11-O13 are those from the sampling sites established by ICAS (Fig. 1). Abbreviations for ecological categories (habitat preferences): (E)-edaphic, (Cr) –corticolous, (Slg) – saprolignicolous, (Lgn) – lignicolous, (Fu) - fungicolous, (Cav) – cavicolous, (Fr) – frondicolous.

Species	**Trophic categories and preferences for microhabitats**	**F11**	**F13**	**G11**	**G13**	**N11**	**N13**	**O11**	**O13**	**T**
Fam. Carabidae										
Calathus metallicus Dejean, 1828	Predator (E)								3	**3**
Carabus auronitens escherii Palliardi, 1825	Predator (E)	1			4		1	1		**7**
Carabus linnei Panzer, 1810	Predator (E)		2	2	2		2		1	**9**
Carabus violaceus Linnaeus, 1758	Predator (E)			1	1					**2**
Cychrus caraboides (Linnaeus, 1758)	Predator (E)			2						**2**
+ *Harpalus atratus* Latreille, 1804	Predator/ Mixophagous (E)					1		2		**3**
Pterostichus jurinei (Linnaeus, 1758)	Predator (E)	23	1	12	15	12	35	9	16	**123**
Pterostichus foveolatus (Duftschmid, 1812)	Predator (E)	8			7		1	3	1	**20**
Pterostichus pillosus	Predator (E)	10	4	3	17	4	8	3		**49**
Pterostichus rufitarsis (Duftschmid, 1812).	Predator (E)	2		2	2	7	3	2	3	**21**
Pterostichus unctulatus (Duftschmid, 1812)	Predator(E)	13	1	5	11	10	4	7	3	**54**
Trechus striatulus Putzeys, 1847	Predator (E)	2	1	1	1		1	2	3	**11**
Fam. Staphylinidae										
+*Acrulia inflata* (Gyllenhal, 1813)	Mycetophagous/ Saprophagous (Slg)	3	4	1	5	1	2	2	1	**19**
.Aleochara diversa. Sahlberg, 1876	Saprophagous (E)		1	1				2		**4**
+					2				1	**3**
Aleochara laevigata Gyllenhal, 1810	Saprophagous (E)		1		3		1		2	**7**
+		1					1			**2**
+*Amphichroum canaliculatum* (Erichson, 1840)	Saprophagous (E)	1					2	2		**5**

Species	**Trophic categories and preferences for microhabitats**	**F11**	**F13**	**G11**	**G13**	**N11**	**N13**	**O11**	**O13**	**T**
+*Antophagus (Dimorphoschelus) omalinus arrowi* Koch, 1933	Saprophagous (Slg)						3	2		**5**
Atheta sp.					1		1			**2**
Atheta boletophila Thomson, 1856	Mycetophagous/ Saprophagous (Fu)				7					**7**
+		2						1		**3**
Atheta contristata Kraatz, 1856	Saprophagous/ Mycetophagous (E)					1				**1**
+*Atheta (Anopleta) corvina* (C.G.Thomson, 1856)	Mixophagous							3		**3**
Atheta cf. *gyllenhalii* Thomson, 1856	Saprophagous/ Mycetophagous (E)	1	3			2			2	**8**
Atheta luridipennis (Mannerheim, 1830)	Saprophagous/ Mycetophagous (E)								4	**4**
+								1		**1**
+*Atheta (Besobia) occulta* Erichson, 1837	Saprophagous/ Mycetophagous (E)							2		**2**
+				1	2	1	4	5	1	**14**
Atheta paracrassicornis Brundin, 1954	Saprophagous/ Mycetophagous (E)			2	2			3		7
+*Atrecus (=Baptolinus) pilicornis* Paykull, 1790	Predator (E)		2	4	4	1	1	1	2	**15**
+*Bisnius (=Philonthus) fimetarius* (Gravenhorst, 1802)	Pradator (E)							1	1	**2**
Bolitobius castaneus Stephens, 1832 =*Bryocharis analis*	Saprophagous (E)		3							**3**
+			2							**2**
Bryophacis rufus Erichson, 1839	Saprophagous/ Mycetophagous (Slg)	1							2	**3**
+		5	4	16	7	8	2	8	1	**51**
Parabolitobius inclinans Gravenhorst, 1806	Saprophagous (E)			1						**1**
+*Coprophilus striatulus* Fabricius, 1793	Saprophagous (E)							1		**1**
+*Deliphrosoma prolongatum* Rottenberg, 1873	Saprophagous (E)		1			2	1	1	4	**9**
+			1			2	1	1	4	**9**
Dinaraea linearis Gravenhorst, 1802	Saprophagous/ Mycetophagous (Cr)				1		1		1	**3**

Species	Trophic categories and preferences for microhabitats	F11	F13	G11	G13	N11	N13	O11	O13	T
+*Eusphalerum limbatum* Erichson, 1840	Mixophagous (E)					2			1	**3**
+*Eusphalerum longipenne* Erichson, 1839	Mixophagous (E)			1					1	**2**
+*Eusphalerum ophtalmicum* Paykull, 1800	Mixophagous (E)						2	1		**3**
+*Ischnoglossa prolixa* Gravenhorst, 1802	Mixophagous (E)		2					1		**3**
+*Leptusa carpathica* Weise, 1877	Saprophagous/ Mycetophagous (Slg)		2		2	2			1	**7**
Leptusa eximia Kraatz, 1856	Mycetophagous (Fu)	1								**1**
+*Leptusa fuliginosa* Aubé, 1850	Mycetophagous/ Saprophagous (Slg)	3	7	1	7	5	2	1		**26**
+*Leptusa pulchella* Mannerheim, 1830	Saprophagous (Slg)	2	2		4	2	3	3	3	**19**
Leptusa (Pachygluta) ruficollis (Erichson, 1839)	Mycetophagous, (Cr)			1			1			2
+*Lesteva longoelytrata* Goeze, 1777	Saprophagous (E)						11		4	**15**
+*Lordithon (=Bolitobius) lunulatus* Linnaeus, 1760	Mycetophagous, sapro-xylophylous (Fu)		1					1		**2**
+*Megarthrus sinuatocollis* (Boisduval et Lacordaire, 1835)	Mycetophagous (probable) (Fu)						2			**2**
+*Mycetoporus lepidus* (Gravenhorst, 1802 (= *brunneus* (Marsh.)	Mycetophagous/ sapro-xylophagous (Fu)	1								**1**
Mycetoporus mulsanti Ganglbauer, 1895	Mycetophagous (Fu)	1						1		**2**
+*Mycetoporus splendens* Marsham, 1802	Mycetophagous (Fu)						1	1		2
Ocypus megalocephalus Nordmann, 1837	Predator (E)								1	**1**
Omalium validum Kraatz, 1857	Saprophagous/ Mycetophagous (E)			1	5	2		4	6	**18**
+							1		2	**3**
Othius crassus Motschulsky, 1858	Predator (E)	1			1	1				**3**
+*Othius lapidicola* Kiesenwetter, 1848	Pradator (E)							1		**1**

Species	**Trophic categories and preferences for microhabitats**	**F11**	**F13**	**G11**	**G13**	**N11**	**N13**	**O11**	**O13**	**T**
Othius transsilvanicus Ganglbauer, 1895	Predator (E)	1			1				1	**3**
Oxypoda opaca Gravenhorst, 1802	Saprophagous/ Mixophagous (E)								1	**1**
Philonthus decorus Gravenhorst, 1802	Predator (E)				2					**2**
Philonthus fumarius Gravenhorst, 1806	Predator/ Necrophagous (E)	1								**1**
Philonthus laevicollis (Boisd. Lacordaire, 1835).	Predator (E)				1					**1**
Philonthus (Onychophilonthus) marginatus Fabricius, 1775	Predator (E)					1				**1**
+*Phloenomus (Xylostiba) monilicornis* Gyllenhal, 1810	In borrows of Scolitinae (Cav)						1			**1**
+*Phyllodrepa floralis* Paykull, 1789	Saprophagous/ Mixophagous/ pholeuophyl (E/Cor)								4	**4**
+*Phyllodrepa (Dropephylla) linearis* Zetterstedt, 1828	Mixophagous (Cr)		4	5	1		1	3	1	**15**
+*Phyllodrepa melanocephala* (Fabricius, 1787)	Saprophagous/ Mixophagous (Cr)	1								**1**
Proteinus brachypterus Fabricius, 1792	Saprophagous/ Mycetophagous (E)	3	2	1	1	1				**8**
+*Proteinus brachypterus* Fabricius, 1792	Saprophagous (E)								1	**1**
+*Quedius alpestris* Heer, 1839	Predator (Cr)							1		**1**
Quedius cincticollis Kraatz, 1857	Predator (E)						1		4	**5**
+*Quedius collaris* Erichson, 1840	Predator		1							**1**
Quedius fumatus Stephens, 1833	Predator (E)			1	1		1		2	**5**
Quedius mesomelinus Marsham, 1802	Predator/ necrophagous (E)		1	1	3			1		**6**
+				1	1	1		4	1	**8**
Quedius ochropterus Erichson, 1840	Predator (E)	1				1				**2**

Species	Trophic categories and preferences for microhabitats	F11	F13	G11	G13	N11	N13	O11	O13	T
+*Quedius paradisianus* Heer, 1839	Predator (Cr)			1	5	1	2		1	**10**
+*Quedius (Quedionuchus) plagiatus* Hochhuth, 1849	Predator (Cr)	5	2	5	2	3	9		3	**29**
+*Quedius (Quedionuchus) punctatellus* Heer, 1839	Predator (Cr)					1		3	2	**6**
Quedius transsilvanicus Weise, 1875	Predator (E)	4	1	3	3		3	1	1	**16**
+*Quedius xanthopus* Erichson, 1839	Predator (Cr)	1	1	4			1			**7**
+*Scopaeus cognatus* Mulsant & Rey, 1855	Mixophagous (E)						1			**1**
Silusa rubra Erichson, 1839	Mycetophagous (Fu)	1								**1**
+*Stichoglosa gobanzi* Reitter, 1891	(E)					1				**1**
+*Tachinus marginellus* (Fabricius, 1781)	Saprophagous/ Coprophagous (E)						1			**1**
Tachinus pallipes Gravenhorst, 1806	Saprophagous/copro/ necrophagous (E)	23	16	11	31	34	28	10	51	**204**
+		1	1	1	3	1		4	3	**14**
Tachinus proximus Kraatz, 1855	Saprophagous/ necrophagous (E)					3				**3**
Tachinus rufipennis Gyllenhal, 1810	Cadavericol (E)							1	3	**4**
Tachinus subterraneus Linnaeus, 1758	Saprophagous/ necrophagous (E)			1						**1**
+							2			**2**
Subfam Pselaphinae										
+*Bryaxis ruthenus* (Saulcy, 1877)	Saprophagous (Slg)						1			**1**
+*Euplectus kirbyi revelierei* Reitter, 1884	Saprophagous (Slg)			5	3	3	3	5	3	**22**
+*Bibloporus bicolor* Denny, 1825	Saprophagous (Slg)				1	5	1	4	2	**13**
Fam. Leiodidae										
Agaricophagus cephalotes W. L. E. Schmidt, 1841	Mycetophagous (Fu)							1		**1**
Agathidium convexum Sharp, 1866	Saproxylofag/ Mycetophagous (Slg)								1	**1**
+*Agathidium nigrinum* Sturm, 1807	Sapro-xylophagous/ mycetophagous (Slg)	5	7	26	7	14	26	26	19	**130**

Species	**Trophic categories and preferences for microhabitats**	**F11**	**F13**	**G11**	**G13**	**N11**	**N13**	**O11**	**O13**	**T**
+*Agathidium nigripenne* Fabricius, 1792	Saprophagous/ Mycetophagous (Slg)	4	3	1	1	3	9	5	9	**35**
+*Anisotoma castanea* Herbst, 1792	Saprophagous/ Mycetophagous (Slg)			1			1			**2**
+*Anisotoma glabra* Fabricius, 1787	Saprophagous/ mycerophagous(Slg)	2								**2**
+*Anisotoma humeralis* Fabricius, 1792	Saprophagous/ Mycetophagous (Slg)			1		1			1	**3**
Apocatops nigrita Erichson, 1837	Saprophagous/ necrophagous (E)				2	1				**3**
Catops subfuscus Kellner, 1846	Saprophagous/ necrophagous (E)			1						**1**
Catops tristis Panzer, 1794	Saprophagous/ necrophagous (E)	1		1	1					**3**
+		2						2	2	**6**
Fissocatops westi Krogerus, 1931	Saprophagous/ necrophagous (E)		1	1			1			**3**
+*Leiodes rhaeticus* Erichson, 1845	Mycetophagous (Fu)		1						1	**2**
Fam. Spaheritidae										
+*Sphaerites glabratus* Fabricius, 1792	Sapro-xylophagous (Slg)				2		1			3
Fam. Hydrophilidae										
Megasternum concinuum (Marsham, 1802)	Mycetophagous/ Saprophagous (Slg)			1				1		**2**
+					6	1	4	8		19
Fam. Geotrupidae										
Anoplotrupes stercorosus (Hartmann in L.G.Scriba, 1791)	Coprophagous (E)	7	1	3	22	5	8	7	21	**74**
Fam. Scarabaeidae (Aphodiinae)										
+*Agrilinus ater* (De Geer, 1774)	*Coprophagous* (E)					1	1	2	7	**11**
+*Acrossus depressus* (Kugelann, 1792)	*Coprophagous* (E)					1			1	**2**
+*Agolius abdominalis* (Bonelli, 1812) *(=Aphodius mixtus)*	*Coprophagous* (E)		1							**1**
+*Planolinus uliginosus* (Hardy, 1847) *(=Aphodius) putridus* Herbst.	*Coprophagous* (E)								1	**1**

Species	**Trophic categories and preferences for microhabitats**	**F11**	**F13**	**G11**	**G13**	**N11**	**N13**	**O11**	**O13**	**T**
+*Acrossus rufipes* (Linnaeus, 1758)	*Coprophagous* (E)				1		1	1		3
Fam. Byrrhidae										
Byrrhus pilula (Linnaeus, 1758)	Saprophagous (E)			1						1
Fam. Elateridae										
Athous bicolor (Goeze, 1777) *(longicollis)*	Xylophagous/sapro-xylo. (larva) (Lgn)	4								**4**
+		9	3	5	3	2	1	2		**25**
+*Athous niger* (Linnaeus, 1758)	Larva sapro-xylophagous		1	1		3	2	6	5	**18**
+*Athous zebei* Bach, 1854	Larva sapro-xylo/ xylophagous (Lgn)	2								**2**
+*Melanotus villosus* (= *rufipes)* (Fourcroy, 1785)	Lasrva sapro-xylophagous (Slg)	1		1						**2**
+*Eanus (=Paranomus) guttatus* (Germar, 1817)	Larva sapro-xylophagous (Slg)								1	**1**
+*Procraerus tibialis* (Lacordaire, 1835)	Larva xylopahous in stubs of old coniferals (Lgn)	3		3	1	2	2	2		13
Fam. Lycidae										
Dictyoptera aurora (Herbst, 1784)	Predator. Larva sapro-xylobiontic (Lgn)		3							**3**
+		5		4			3	1	3	**16**
Fam. Cantharidae										
+*Rhagonycha nigripes* W.Redtenbacher, 1842.	Mixophagous (Slg –Larva)						1			1
Fam. Anobiidae										
+*Microbregma emarginatum* (Duftschmid, 1825)	Xylophagous (in coniferal woods) (Lgn)	1	1		2					4
Fam. Ptinidae										
Ptinus dubius Sturm, 1795	Sapro-xylophagous (Cr)	1								**1**
+						6		3	3	**12**
Fam. Trogositidae										
+*Nemosoma elongatum* (Linnaeus, 1761)	Predator Corticolous – hunt the larvae of Scolitinae	1					1			**2**
+*Ostoma ferruginea* (Linnaeus, 1758)	Sapro-xylophagous (Cr)					1				1
+		3		1	2		1		1	**8**

Species	Trophic categories and preferences for microhabitats	F11	F13	G11	G13	N11	N13	O11	O13	T
Fam. Cleridae										
+*Thanasimus formicarius* (Linnaeus, 1758)	Pradator xylobiont (hunt Scolytidae, larvae) (Cr)				1	1				2
Thanasimus Thanasimus femoralis (Zetterstedt, 1828)	Pradator xylobiont (Cr)	1								**1**
+		1	1	2	1	1	1		1	**8**
Fam. Momotomidae (Rhizophaginae)										
Rhizophagus dispar (Paykull, 1800)	Sapro-xylophagous (Cr)					1		1		**2**
+			6	3			4	4	5	**22**
+*Rhizophagus paralleocollis* Gyllenhal, 1827	Sapro-xylophagous (Cr)		3		1	1		1	2	**8**
+				1						1
Fam. Nitidulidae										
+*Epuraea boreela* (Zetterstedt, 1828)	Sapro-xylophagous (Cav)						1	2	1	**4**
+*Epuraea marseuli* Reitter, 1872	Sapro-xylophagous (in rooted woods in burros of Scolitinae) (Cav)				1					**1**
+									1	**1**
Epuraea pygmaea (Gyllenhal, 1808)	Sapro-xylophagous (Cav)	2	2	1	1				2	**8**
+		2	2	2	3	3		4		**16**
Epuraea terminalis Mannerheim, 1843	Sapro-xylophagous (Cav)		3							**3**
+		1					1			**2**
+*Glischrochilus quadripunctatus* (L.) [quadripusulatus (L.) (Linnaeus, 1758)	Pradator in burrows of Ipidae (Cav)								1	**1**
Fam. Silvanidae										
+*Dendrophagus crenatus* (Paykull, 1799)	Corticolous, sapro-xylophagus in coniferous wood (Cr)	3		1		2		1	1	8
Fam. Cryptophagidae										
+*Antherophagus nigricornis* (Fabricius, 1787)	Saprophagous – in borrows of Bombus (E)							1		**1**
+*Atomaria carpathica* Reitter, 1875	Saprophagous/ saproxylophagous(Cr)		1	2	1	8	2		2	**16**

Species	**Trophic categories and preferences for microhabitats**	**F11**	**F13**	**G11**	**G13**	**N11**	**N13**	**O11**	**O13**	**T**
+*Cryptophagus cylindus* Kiesenwetter, 1858	Saproxylophagous (Slg)						1		1	**2**
+*Cryptophagus dentatus* (Herbst, 1793)	Saprophagous/sapro-xylophagous (Slg)		1		2		1			**4**
Cryptophagus deubeli Ganglbauer, 1897	Saprophagous (E)					1		2		**3**
Cryptophagus pseudodentatus Bruce 1936	Saprophagous (Slg)	1								**1**
Cryptophagus transsilvanicus	Saprophagous (E)							2		**2**
+*Micrambe abietis* (Paykull, 1798)	Saproxylofag (Slg)		1	1	1	2		1	1	**7**
Fam. Erotylidae										
+*Triplax aenea* (Schaller, 1783)	Sapro-xylophagous (Cr-Slg)	1			1	1				3
Fam. Byturidae										
+*Byturus ochraceus* (L.G.Scriba, 1790) (= *fumatus*)	Larva xylophagous in Rubus (Lgn)				1			1		2
Fam. Coccinelidae										
Rhizobius chrysomeloides (Herbst, 1792)	Predator/ Mixophagousa (E- Cr)							1		**1**
Scymnus (Pullus) suturalis Thunberg, 1795	Predator (E)					1				1
Fam. Endomychidae										
+*Mycetina cruciata* (Schaller, 1783)	Mycetophagous (Fu)		2	1						3
Fam Alexiidae										
Sphaerosoma punctatum Reitter 1897	Mycetophagous/ Saprophagous (Fu)				1					**1**
Sphaerosoma pilosum (Panzer, 1793)	Mycetophagous /Saprophagous (Slg)			1						1
Fam. Lathridiidae										
+*Corticarina fuscula* (Gyllenhal, 1827)	Saprophagous (Cr)		2					1		**3**
Corticaria longicollis (Zetterstedt, 1838)	Saprophagous, myrmecophilous (E)							2		2
+				1		1				**2**
+*Latridius (=Enicmus) minutus* (Linnaeus, 1767)	Sapro-xylophagous (Cr)	1			1	1	1	2	3	**9**

Species	**Trophic categories and preferences for microhabitats**	**F11**	**F13**	**G11**	**G13**	**N11**	**N13**	**O11**	**O13**	**T**
Fam. Ciidae (=Cisidae)										
+*Cis punctulatus* Gyllenhal, 1827	Xylophagous (Lgn)		1						1	**2**
Fam. Melandryidae										
+*Abdera flexuosa* (Paykull, 1799)	Myceto/ Saprophagous (in tinder) (Fu)							1		**1**
Hylecoetus dermestoides (Linnaeus, 1761)	Sapro-xylophagous (Lgn)		1	1						2
+		2	5	2	1	1	2	2	2	**17**
+*Xylita buprestoides* (Fabricius, 1792)	Sapro-xylophagous on coniferous (Lgn)	2	1			2		1	3	**9**
+*Xylita livida* Sahlberg, 1834	Sapro-xylophagous (Lgn)				1				1	**2**
Fam. Mordellidae										
+*Anaspis pulicaria* Costa, 1854	Sapro-xylophagous (Cr)	1				1		1		3
Fam. Colydiidae										
+*Cerylon deplanatum* Gyllenhal, 1827	Sapro-xylophagous corticicoous and in burrows of Scolytitdae (Cr)		1				1			2
Fam. Tenebrionidae (Alleculini)										
+*Hymenalia rufipes* (Fabricius, 1792)	(Lgn)						1			1
Fam. Salpingidae										
+*Salpingus (=Rhinosimus) ruficollis* (Linnaeus, 1761)	Parasitoid Larvae on Scolitinae (Cr)		2		1					3
Fam. Cerambycidae										
+*Alosterna tabacicolor* Degeer, 1775	Xylophagous (Lgn)			1				1		**2**
+ *Cornumutilla quadrigutatta* Gebler 1830	Xylophagous (Lgn)								2	**2**
+*Evodinus clatrathus* Fabricius,1792	Xylophagous (Lgn)	3		1	2	3	4	8	1	**22**
+*Oxymirus cursor* (Linneaus, 1758)	Xylophagous (Lgn)			1						1
+*Rhagium mordax* Degeer, 1775	Xylophagous (Lgn)			1						**1**
+ *Tetropium castaneum* (Linnaeus, 1758)	Xylophagous (Lgn)	1						1		2

Species	**Trophic categories and preferences for microhabitats**	**F11**	**F13**	**G11**	**G13**	**N11**	**N13**	**O11**	**O13**	**T**
Fam. Chrysomelidae										
Mniophyla muscorum	Phytophagous/ muscicolous		1			1				**2**
Sclerophaedon carinolicus (Germ.)	Phytophagous/ saproxylophagous(Fr)								1	**1**
Fam. Curculionidae										
+*Anthonomus phyllocola* (Herbst, 1795)	Phytophagous (Fr)	2	3	3	3	1		1		**13**
Hylobius abietis (Linnaeus, 1758)	Xylofag (Lgn)	1								**1**
Hylobius excavatus (Laicharting, 1781) = *H. piceus* Deg.	Xylofag (Lgn)							1		**1**
Notaris aterrima (Hampe, 1850) (Fam Erirhinidae ?)	Phytophagous/ Saprophagous (Fr)							1		**1**
Bryodaemon (=Omiamima) hanakii (Frivaldszkyi, 1865)	Phytophagous/ Saprophagous (E)	5	11	17	1	2		1	5	**42**
Otiorhynchus desertus Rosenhauer, 1847	Phytophagous (Fr)					2				**2**
Dodecastichus (=Otiorhynchus) geniculatus (Germar, 1817)	Phytophagous (Fr)	1								1
Otiorhynchus proximus Stierlin, 1861	Phytophagous (Fr)			4						**4**
Otiorhynchus scaber (Linnaeus, 1758)	Phytophagous (Fr)		1	1						**2**
Phyllobius transsylvanicus Stierlin, 1894	Phytophagous (Fr)	1								**1**
Plinthus tischeri Germar, 1824	Phytophagous (on *Rumex*) (Fr)		1							1
Fam. Curculionidae (Scolytinae)										
+*Cryphalus abietis* (Ratzeburg, 1837)									1	**1**
+*Crypturgus cinereus* (Herbst, 1793)	Cambiophagous/ sapro-xylophagous (Cr)	1			1				1	**3**
Dryocoetes autographus (Ratzeburg, 1837)	Sapro-xylophagous/ xylophagous (Cr)		1	1	1					**3**
+		4		5	1	2	6	4	4	**26**
+*Dryocoetes hectographus* Reitter, 1913	Sapro-xylpopagous/ cambiophagous (Cr)	2			2	2	1	2		**9**

Species	**Trophic categories and preferences for microhabitats**	**F11**	**F13**	**G11**	**G13**	**N11**	**N13**	**O11**	**O13**	**T**
Hylastes cunicularius Erichson 1836	Sapro-xylophagous/ xylophagous (Cr)	2	2		2	3		1		10
+		4		3	8	5	6	6	10	**42**
+*Hylurgops glabratus* (Zetterstedt, 1828)	Saproxylpopagous/ cambiophagous (Cr)		1	3	1	2	6	4	5	**22**
+*Hylurgops palliatus* (Gyllenhal, 1813)	Sapro-xypo/ cambiophagous (Cr)	1		1			2		1	**5**
+*Ips typographus* (Linnaeus, 1758)	Idem. Cr-Xy						2	1		**3**
+*Pityophthorus micrographus* (Linnaeus, 1758)	Idem (Cr)			1			1		1	**3**
+*Pityophthorus pityographus* (Ratzeburg, 1837)	Idem (Cr)				1					**1**
+*Pityogenes chalcographus* (Linnaeus, 1761)	Idem (Cr)								2	**2**
+*Polygraphus polygraphus* (Linnaeus, 1758)	Idem (Cr)	1	1			1	1	1	1	**6**
+*Trypodendron lineatum* (Olivier, 1795)	Idem (Cr)		3	8	3	1	2	2	1	**20**
T		222	156	220	267	216	264	249	299	**1893**