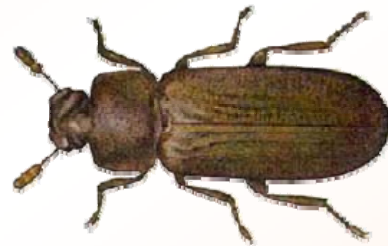


National & Kapodistrian University of Athens



RELATIONSHIPS BETWEEN THE DIVERSITY OF EPIGEAN COLEOPTERA (CARABIDAE, TENEBRIONIDAE) AND HABITAT CHARACTERISTICS ON MT. TAYGETOS



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Introduction

- Mountains of Greece → well defined habitat types

- Phrygana
- Maquis
- Deciduous Forests
- Coniferous Forests
- Mixed Forests
- Alpine Vegetation

- Epigeic invertebrate fauna $\xrightarrow{\text{Palaeogeographic history}}$ Same Differentiation
of Mountains

- Mt. Taygetos is the southernmost mountain of continental Greece with a large number of endemic taxa BUT its invertebrate fauna has not been studied sufficiently.

The present study looks into the structure of the communities of the two major soil coleopteran families (Carabidae, Tenebrionidae) and assesses the effects of a number of environmental parameters.

Methods

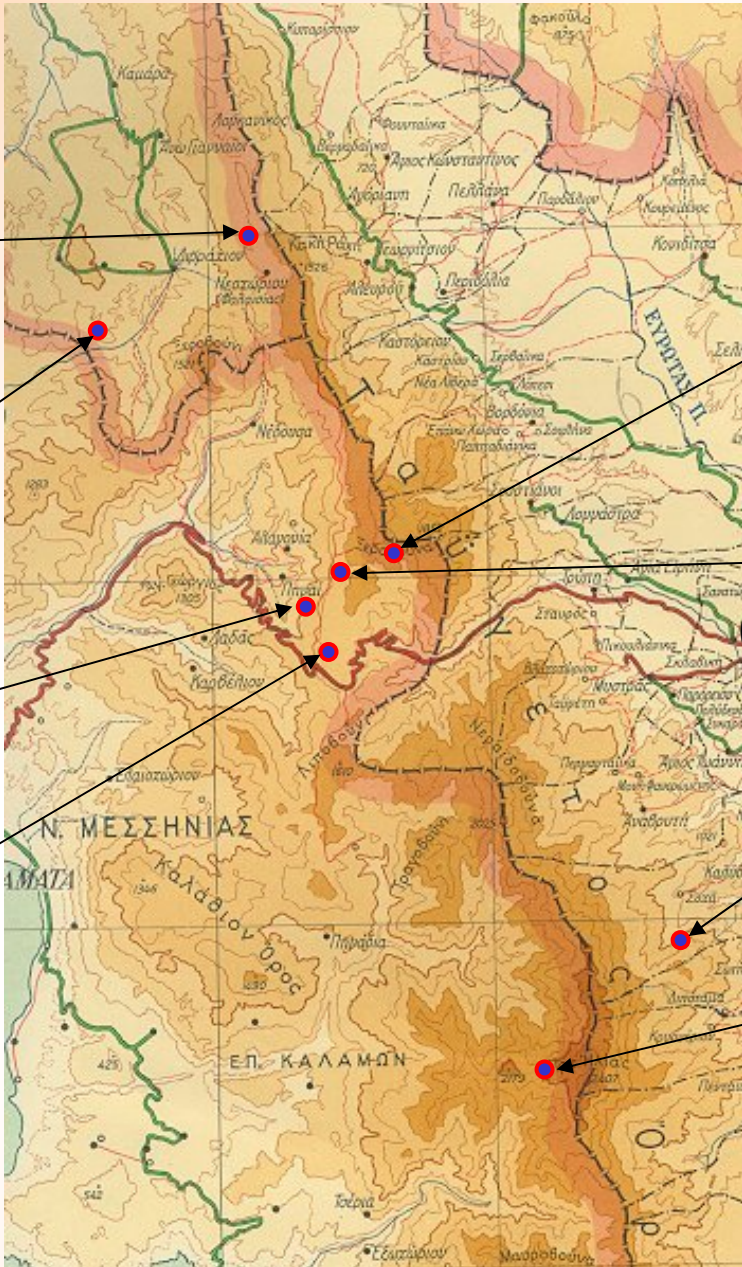
Sampling Period March - November 1997

Sampling Frequency Seasonally

Sampling Method

- Standard Pitfall Traps (plastic cups of 250ml containing about 50ml of ethylene glycol)
- 30 traps per biotope (distance between them → 15m) laying on two transect lines (distance between lines → 50m)

Study Area



DF 1
(Deciduous Forest)

AL 2
(Sub - Alpine)

MA 1
(Maquis)

MF 1
(Mixed Coniferous Forest)

PF 2
(Pinus Forest)

FR 1
(Phrygana)

PF 1
(Pinus Forest)

AL 1
(Sub - Alpine)

Biotores

AL 1



AL 2



- **Altitudinal Range:** $\cong 1800$ m.
- **Coverage:** Rocks, Bushes, Shrubs, Bare Soil.
- **Vegetation:** *Juniperus communis*, *Astragalus* sp., *Calycotome villosa*, *Echinops* sp., *Euphorbia* sp., *Daphne oleoides*, Boraginaceae, Gramineae.

- **Altitudinal Range:** $\cong 1650$ m.
- **Coverage:** Rocks, Bushes, Shrubs, Bare Soil.
- **Vegetation:** *Juniperus communis*, *Astragalus* sp., *Poa* sp., *Daphne oleoides*, *Abies cephalonica*, *Ranunculus* sp., Compositae, Gramineae.

Biotoques

PF 1



- **Altitudinal Range:** $\cong 1350$ m.
- **Coverage:** Trees, Leaf Litter, Shrubs.
- **Vegetation:** *Pinus nigra*, *Pteridium aquilinum*.

PF 2



- **Altitudinal Range:** $\cong 1400$ m.
- **Coverage:** Trees, Leaf Litter, Shrubs.
- **Vegetation:** *Pinus nigra*, *Pteridium aquilinum*.

Biotoques

MF 1



- **Altitudinal Range:** \cong 1500 m.
- **Coverage:** Trees, Leaf Litter, Shrubs.
- **Vegetation:** *Pinus nigra*, *Abies cephalonica*, *Pteridium aquilinum*, *Fragaria* sp., Gramineae.

DF 1



- **Altitudinal Range:** \cong 1000 m.
- **Coverage:** Trees, Leaf Litter, Shrubs.
- **Vegetation:** *Quercus frainetto*.

Biotoques

FR 1



- **Altitudinal Range:** $\cong 640$ m.
- **Coverage:** Shrubs, Bushes, Soil, Rocks.
- **Vegetation:** *Spartium junceum*, *Astragalus* sp., *Sarcopoterium spinosum*, *Asparangus acutifolius*, *Teucrium capitatum*, *Phlomis fruticosa*, *Calycotome villosa*, *Saturejia* sp., *Cistus creticus*, *Euphorbia* sp.

MA 1

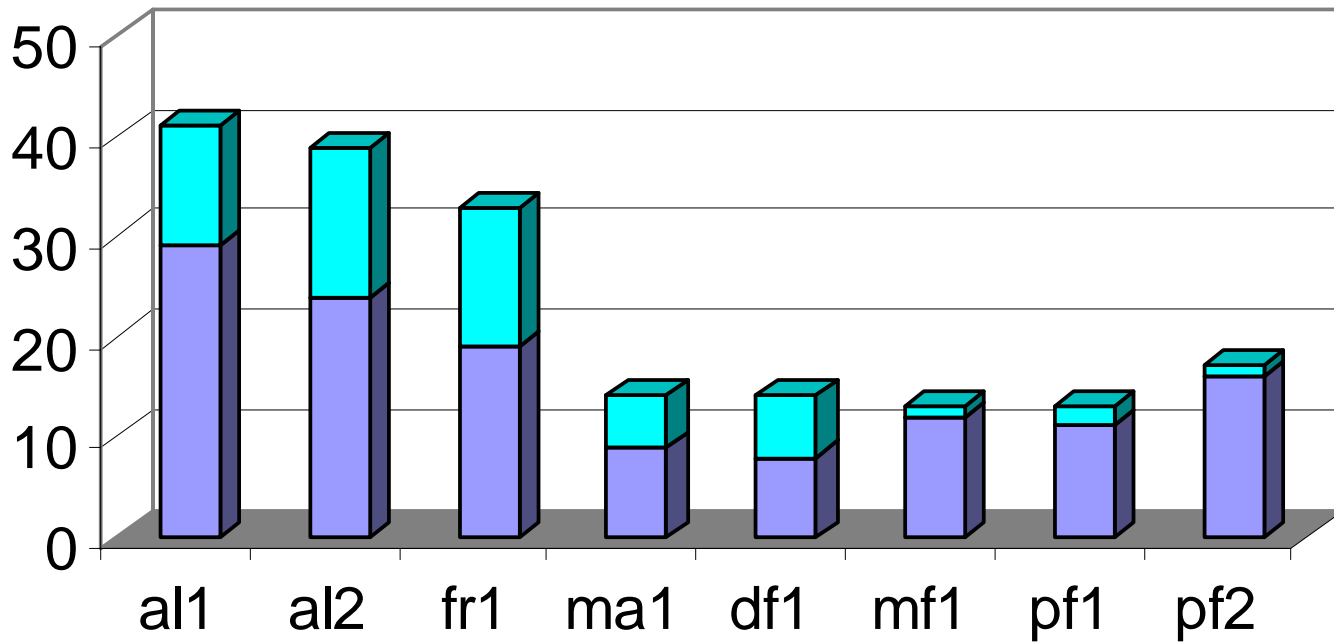


- **Altitudinal Range:** $\cong 800$ m.
- **Coverage:** Bushes, Shrubs, Soil, Rocks.
- **Vegetation:** *Quercus coccifera*, *Brachypodium* sp., *Phillyrea latifolia*, *Cistus creticus*, *Dorycnium hirsutum*, *Hypericum empetrifolium*, *Cotinus coggygria*, *Arbutus adrachne*, *A. unedo*, *Teucrium* sp.

Results

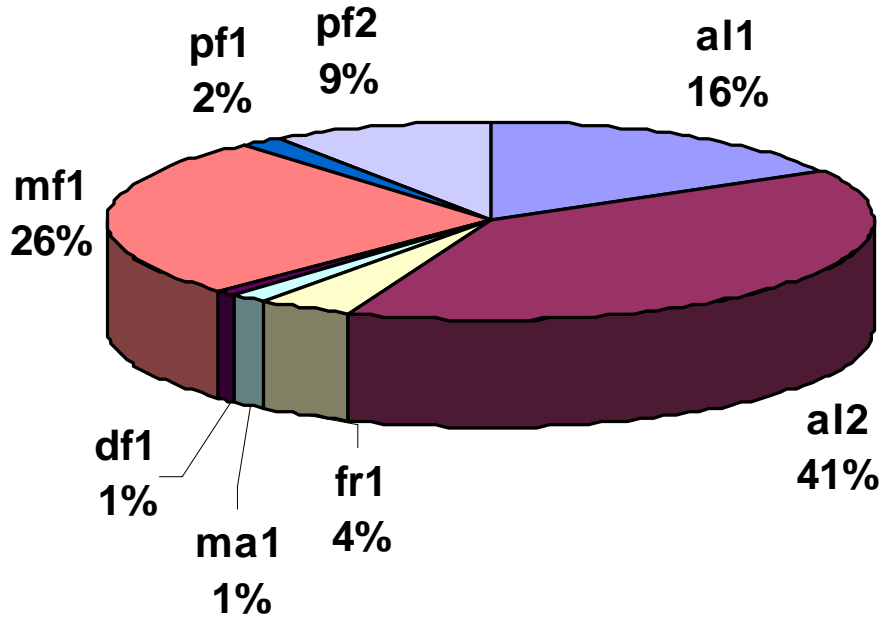
Number of Species

carabidae tenebrionidae

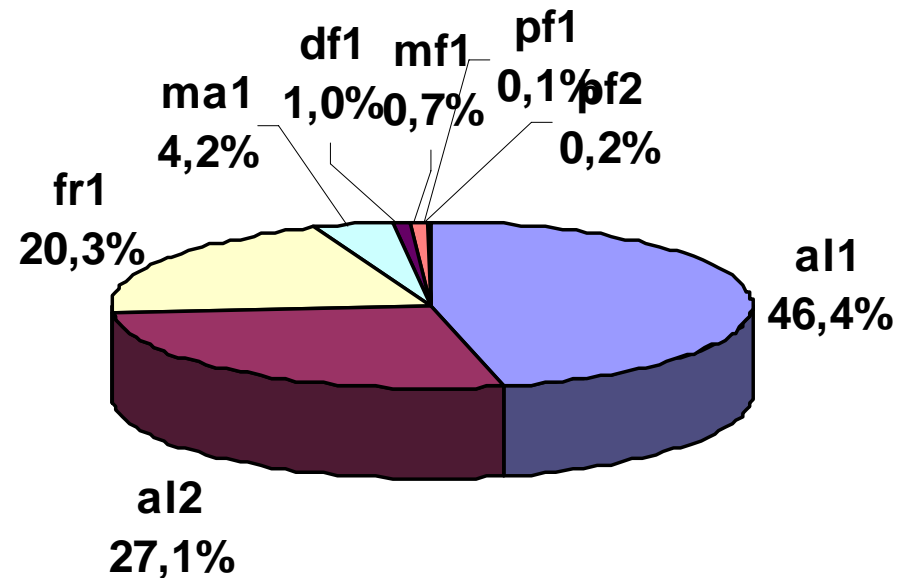


Abundance

Carabidae: Number of Individuals

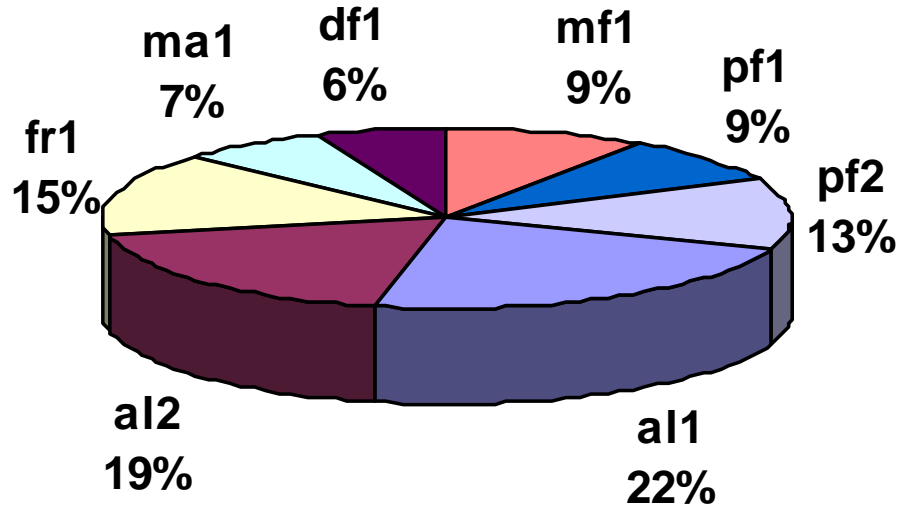


Tenebrionidae: Number of Individuals

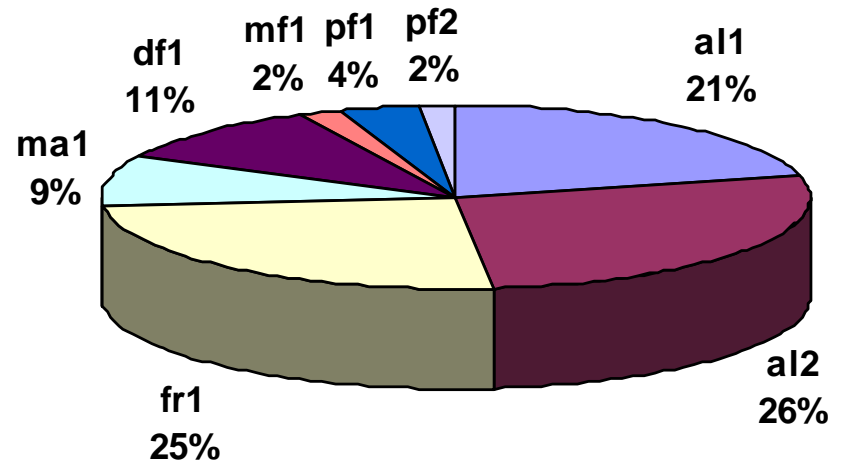


Distribution of Species

Carabidae: Number of Species



Tenebrionidae: Number of Species



Presence of Species per Biotope

	al1	al2	fr1	ma1	df1	mf1	pf1	pf2
<i>Calathus corax</i>	Widely Distributed	Widely Distributed	Widely Distributed		Widely Distributed	Widely Distributed	Widely Distributed	Widely Distributed
<i>Platyderus graecus</i>	Widely Distributed	Widely Distributed	Widely Distributed		Widely Distributed	Widely Distributed	Widely Distributed	Widely Distributed
<i>Molops spartanus</i>	Widely Distributed	Widely Distributed			Widely Distributed	Widely Distributed	Widely Distributed	Widely Distributed
<i>Carabus preslii</i>	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes
<i>Microlestes luctuosus</i>	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes
<i>Cymindis lineata</i>	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes
<i>Cymindis sinuata</i>	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes
<i>Carabus convexus</i>	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes
<i>Zabrus validus</i>	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes
<i>Tapinopterus rebellis</i>	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes
<i>Leistus parvicollis</i>	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes
<i>Harpalus sulphuripes</i>	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes
<i>Leistus spinibarbis</i>	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes
<i>Laemostenus peloponnesiacus</i>	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes	Mainly in Open Biotopes
<i>Nebria brevicollis</i>	Sub-Alpine							
<i>Amara eurynota</i>	Sub-Alpine							
<i>Ophonus (Metophonus) sp.</i>	Sub-Alpine							
<i>Harpalus rufipalpis</i>	Sub-Alpine							
<i>Licinus oertzeni</i>	Sub-Alpine							
<i>Cymindis miliaris</i>	Sub-Alpine							
<i>Philorhizus crucifer</i>	Sub-Alpine							
<i>Zabrus robustus</i>	Sub-Alpine	Sub-Alpine						
<i>Lebia trimaculata</i>	Sub-Alpine	Sub-Alpine						
<i>Cymindis axillaris</i>	Sub-Alpine	Sub-Alpine						
<i>Notiophilus interstitialis</i>	Sub-Alpine	Sub-Alpine						
<i>Zabrus aetolus hellenicus</i>	Sub-Alpine	Sub-Alpine						
<i>Acinopus baudii</i>		Open Biotopes	Open Biotopes					
<i>Ophonus cribricollis</i>		Open Biotopes	Open Biotopes					
<i>Masoreus wetterhallii</i>		Open Biotopes	Open Biotopes					
<i>Trechus austriacus</i>		Open Biotopes	Open Biotopes					
<i>Dixus obscurus</i>			Phrygana					
<i>Ophonus subquadratus</i>			Phrygana					
<i>Harpalus attenuatus</i>			Phrygana					
<i>Leistus magnicollis</i>	Mainly in Forests					Mainly in Forests	Mainly in Forests	Mainly in Forests
<i>Aptinus lugubris</i>	Mainly in Forests					Mainly in Forests	Mainly in Forests	Mainly in Forests
<i>Leistus rufomarginatus</i>				Mainly in Forests		Mainly in Forests	Mainly in Forests	Mainly in Forests
<i>Calosoma sycophanta</i>				Mainly in Forests		Mainly in Forests	Mainly in Forests	Mainly in Forests
<i>Carabus merlini</i>		Mainly in Forests				Mainly in Forests	Mainly in Forests	Mainly in Forests
<i>Notiophilus rufipes</i>					Mainly in Forests	Mainly in Forests	Mainly in Forests	Mainly in Forests
<i>Zabrus graecus</i>								Pinus Forest
<i>Calosoma inquisitor</i>								Pinus Forest
<i>Syntomus obscuroguttatus</i>								Pinus Forest
<i>Ophonus taygetanus</i>								Pinus Forest
<i>Ophonus krueperi</i>						Mixed Coniferous Forest		
<i>Tapinopterus duponcheli</i>	Various					Mixed Coniferous Forest		
<i>Laemostenus cimmerius</i>			Various		Various			
<i>Pachycarus cyaneus</i>			Various	Various	Various			
<i>Calathus cinctus</i>			Various	Various	Various			
<i>Myas chalybaeus</i>	Various			Various	Various		Various	
<i>Carabus coriaceus</i>			Various	Various	Various			Various
<i>Harpalus rufipes</i>	Various							Various

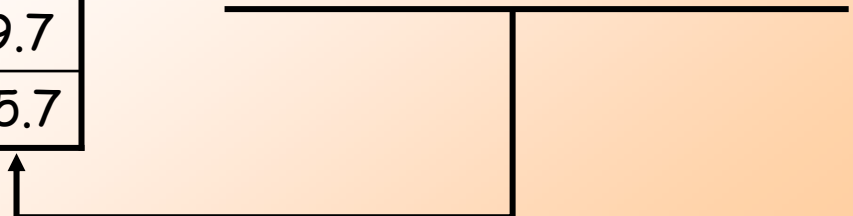
Legend

- Widely Distributed
- Mainly in Open Biotopes
- Sub-Alpine
- Open Biotopes
- Phrygana
- Mainly in Forests
- Pinus* Forest
- Mixed Coniferous Forest
- Various

Characteristic Carabidae Species

al	<i>Calathus corax</i>	34.1
	<i>Cymindis sinnuata</i>	26.4
al2	<i>Calathus corax</i>	84.8
df	<i>Myas chalybaeus</i>	45.5
	<i>Notiophilus rufipes</i>	31.7
fr	<i>Calathus cinctus</i>	24.6
	<i>Acinopus baudii hellenicus</i>	21.1
	<i>Cymindis sinnuata</i>	18.0
ma	<i>Carabus preslii</i>	78.6
pf	<i>Leistus magnicollis</i>	45.9
	<i>Calathus corax</i>	38.2
pf2	<i>Calathus corax</i>	24.3
	<i>Platyderus graecus</i>	20.4
	<i>Aptinus lugubris</i>	19.7
mf	<i>Aptinus lugubris</i>	75.7

Average contribution of each species to the overall similarity of the sample



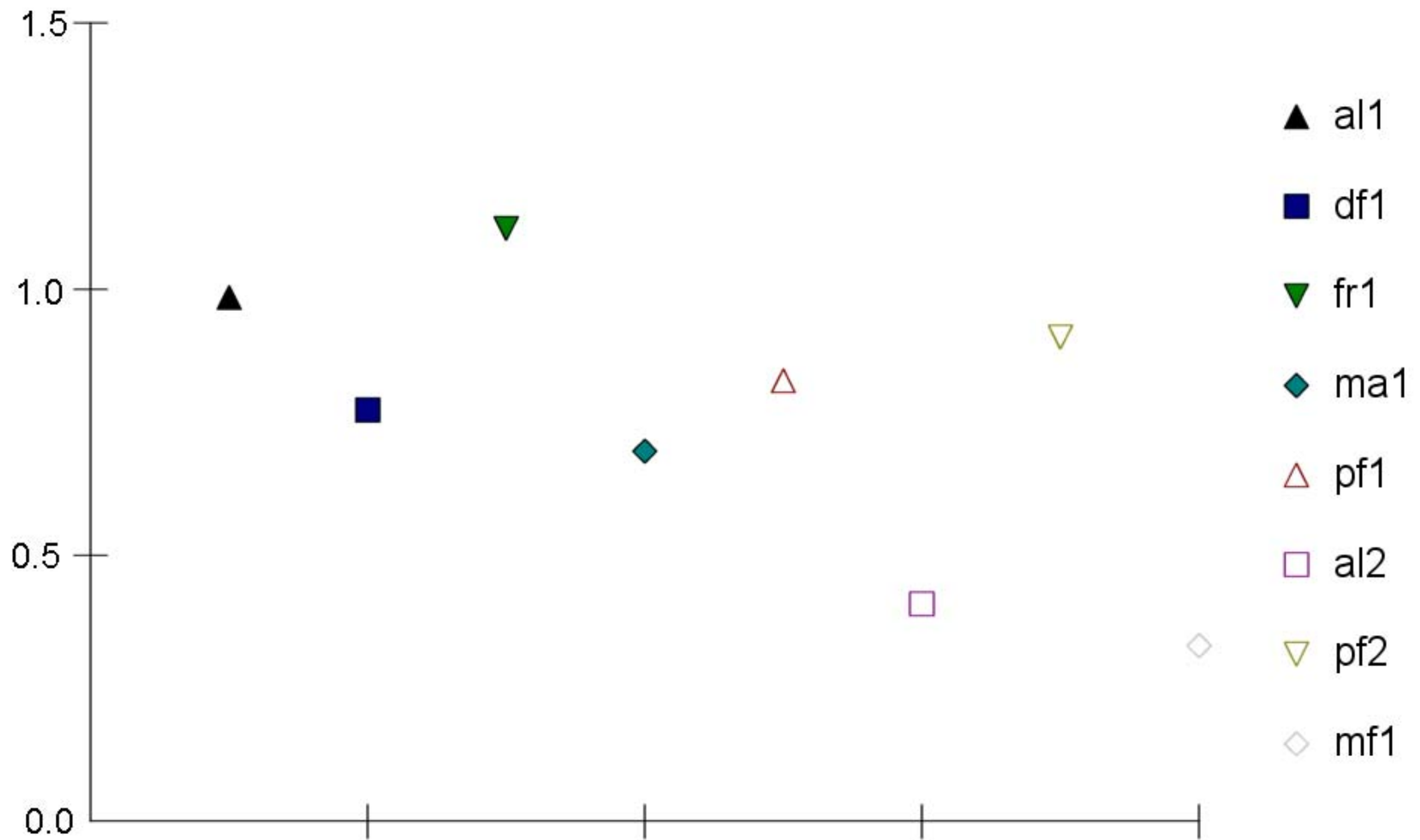
Characteristic Tenebrionidae Species

al	<i>Idastraniella taygetanus</i>	49.1
al2	<i>Calyptopsis caraboides</i>	38.4
	<i>Idastraniella taygetanus</i>	20.3
df	<i>Pedinus helopioides</i>	100
fr	<i>Dailognatha quadricollis</i>	30.7
	<i>Graecopachys quadricollis</i>	26.9
ma	<i>Dendarus plicatulus</i>	71.8
pf	-	
pf2	<i>Laena</i> sp. B	100
mf	<i>Laena</i> sp. B	100

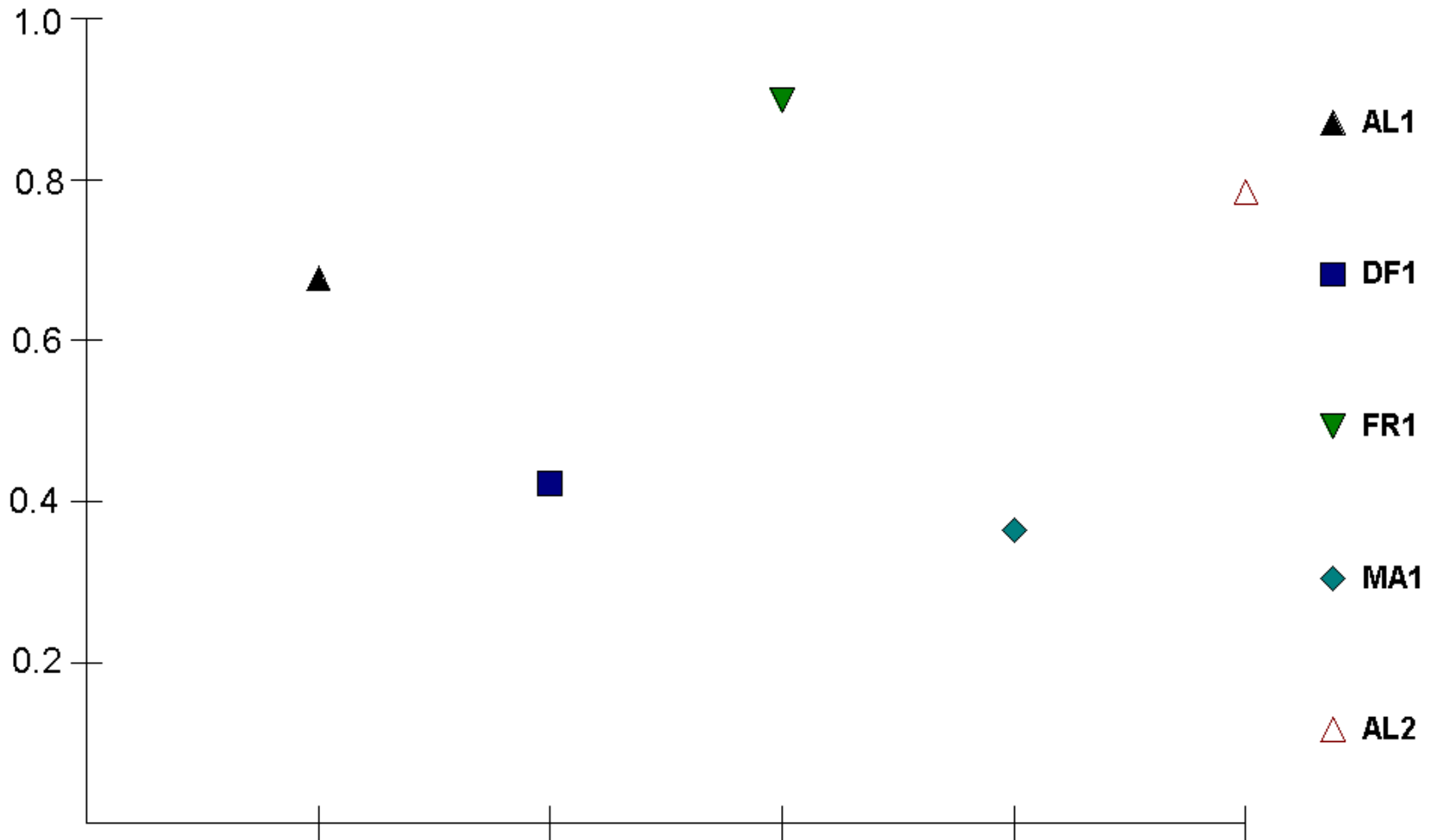
Average contribution of each species to the overall similarity of the sample



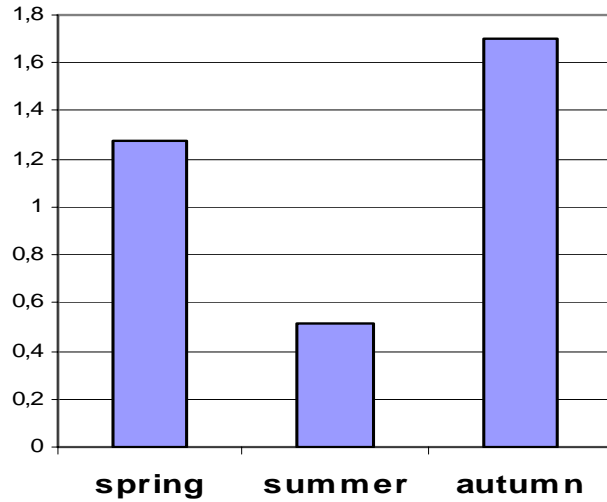
Carabidae diversity (pooled samples)



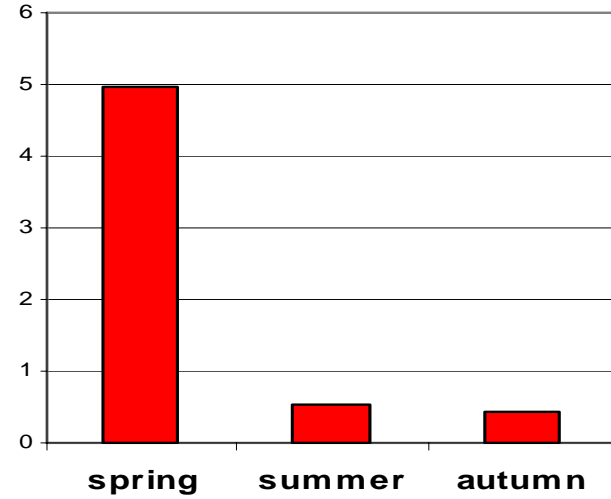
Tenebrionidae diversity (pooled samples)



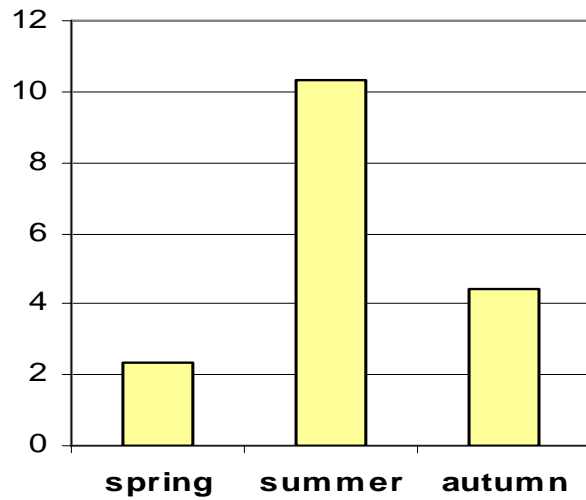
spring-autumn pattern
Carabus preslii (a11)



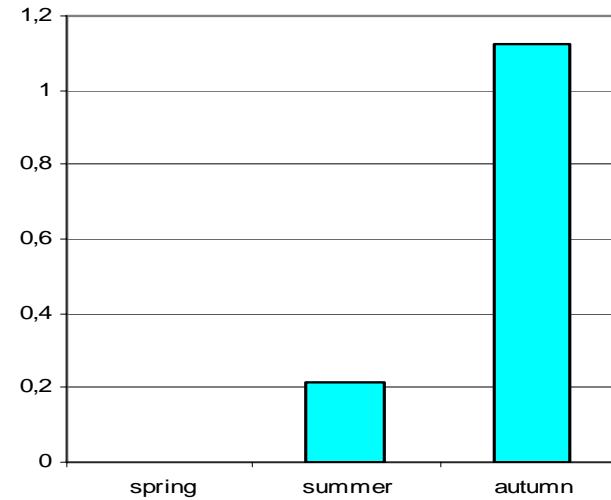
spring pattern
Platyderus graecus (pf1)



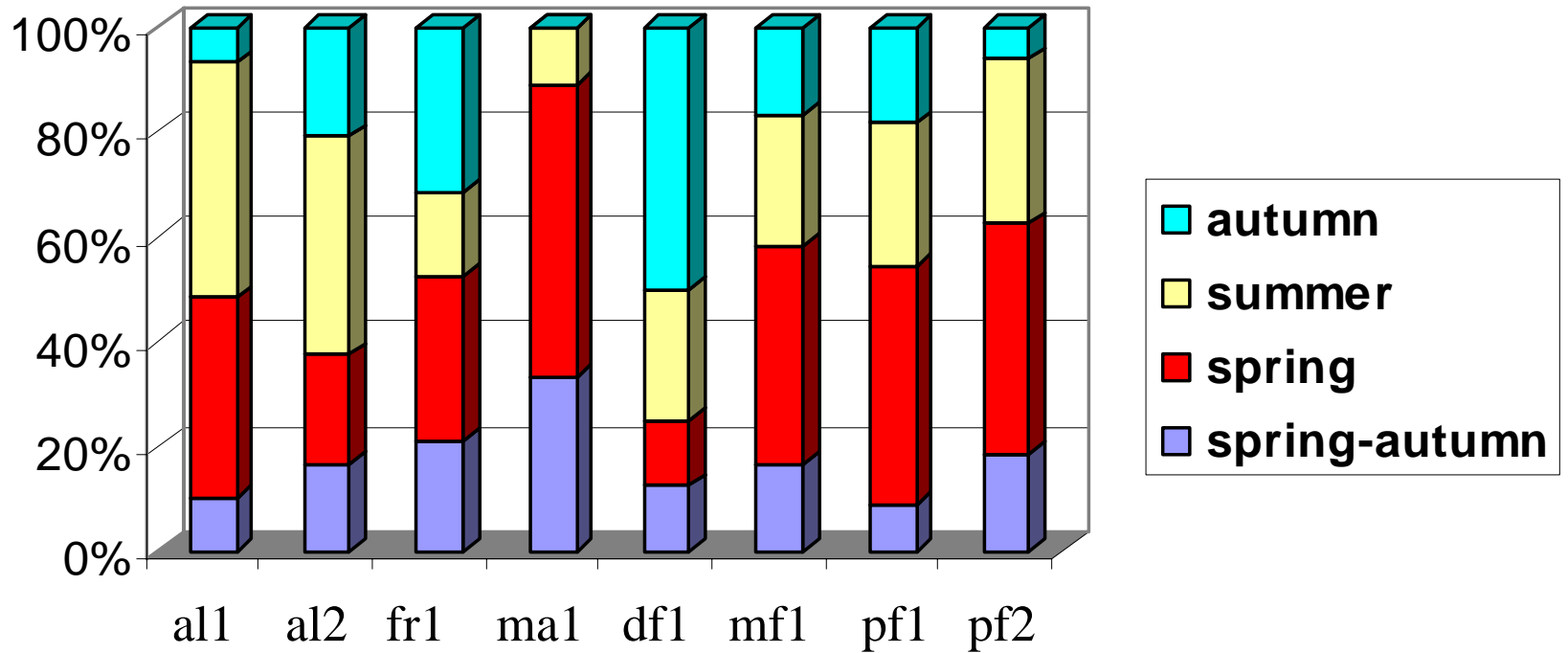
summer pattern
Calathus corax (a11)



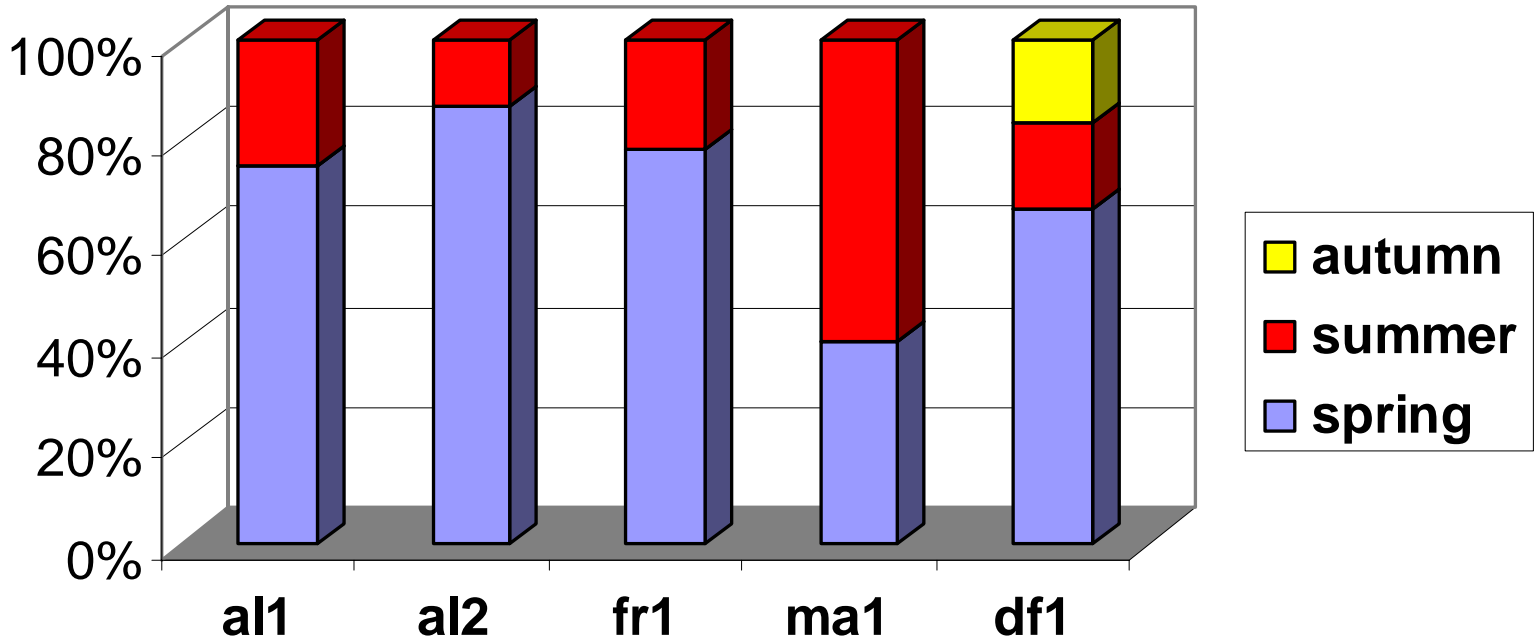
autumn pattern
Myas chalybaeus (df1)



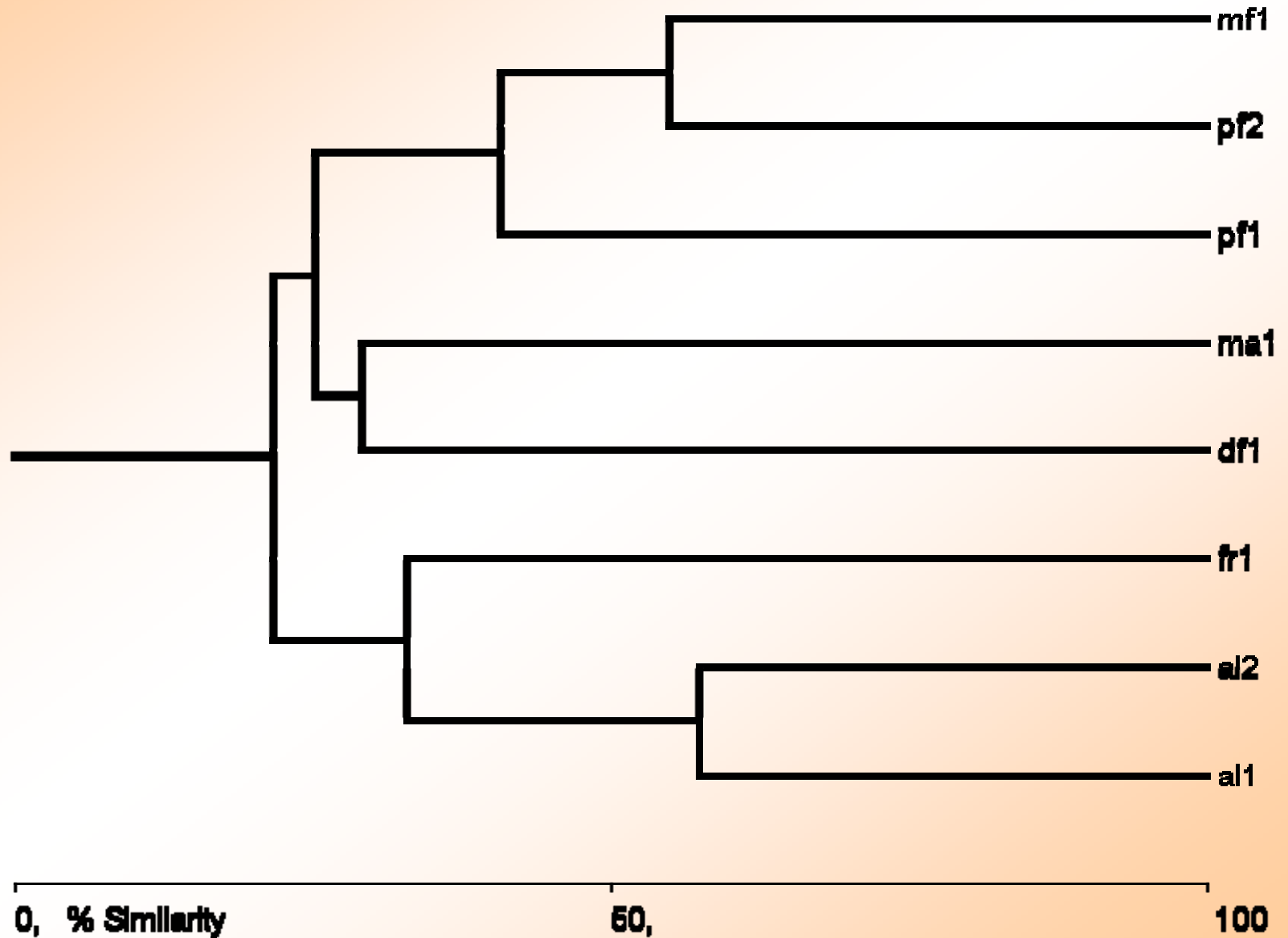
patterns of phenology fam. Carabidae



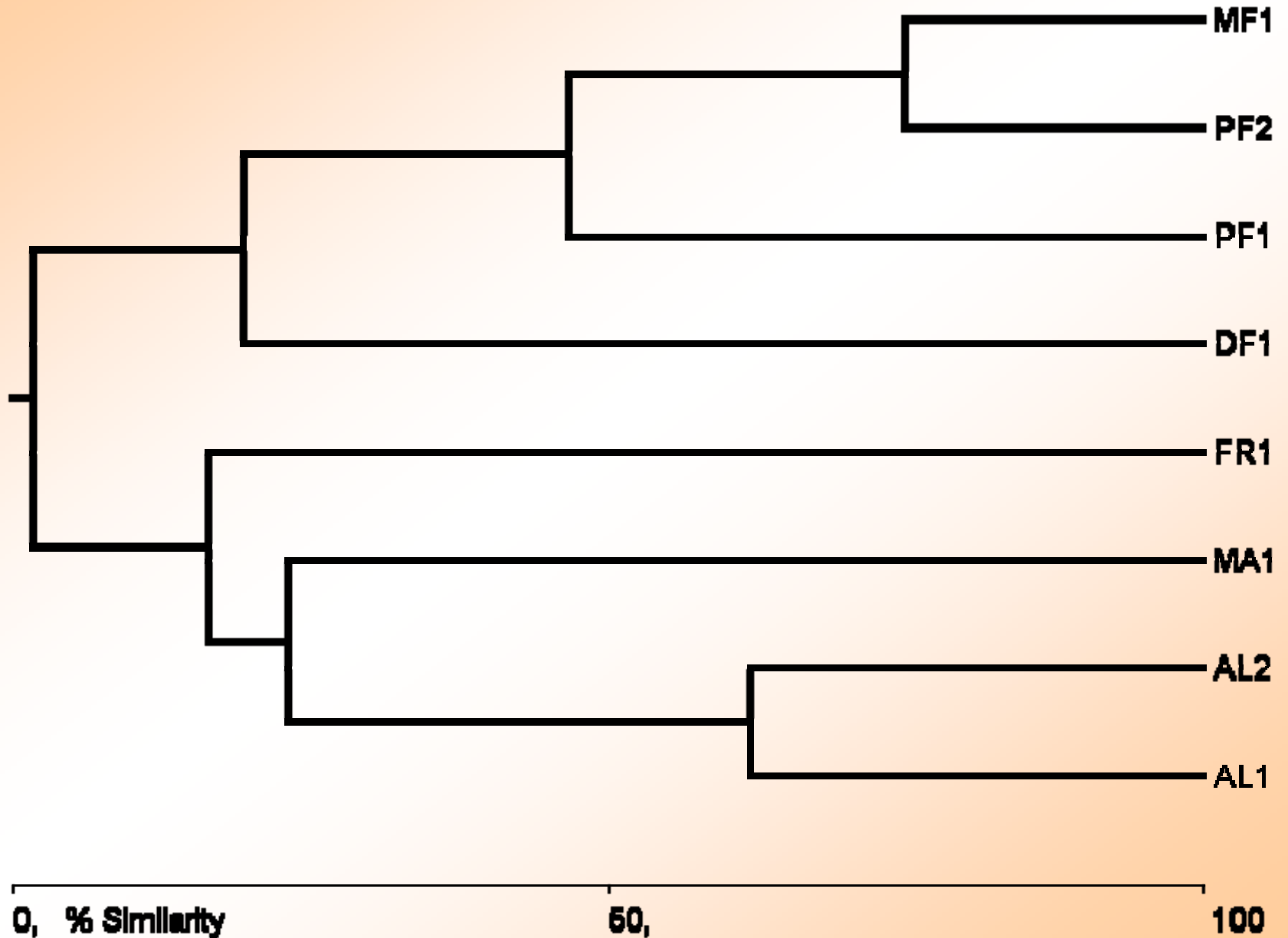
**patterns of phenology
fam. Tenebrionidae**

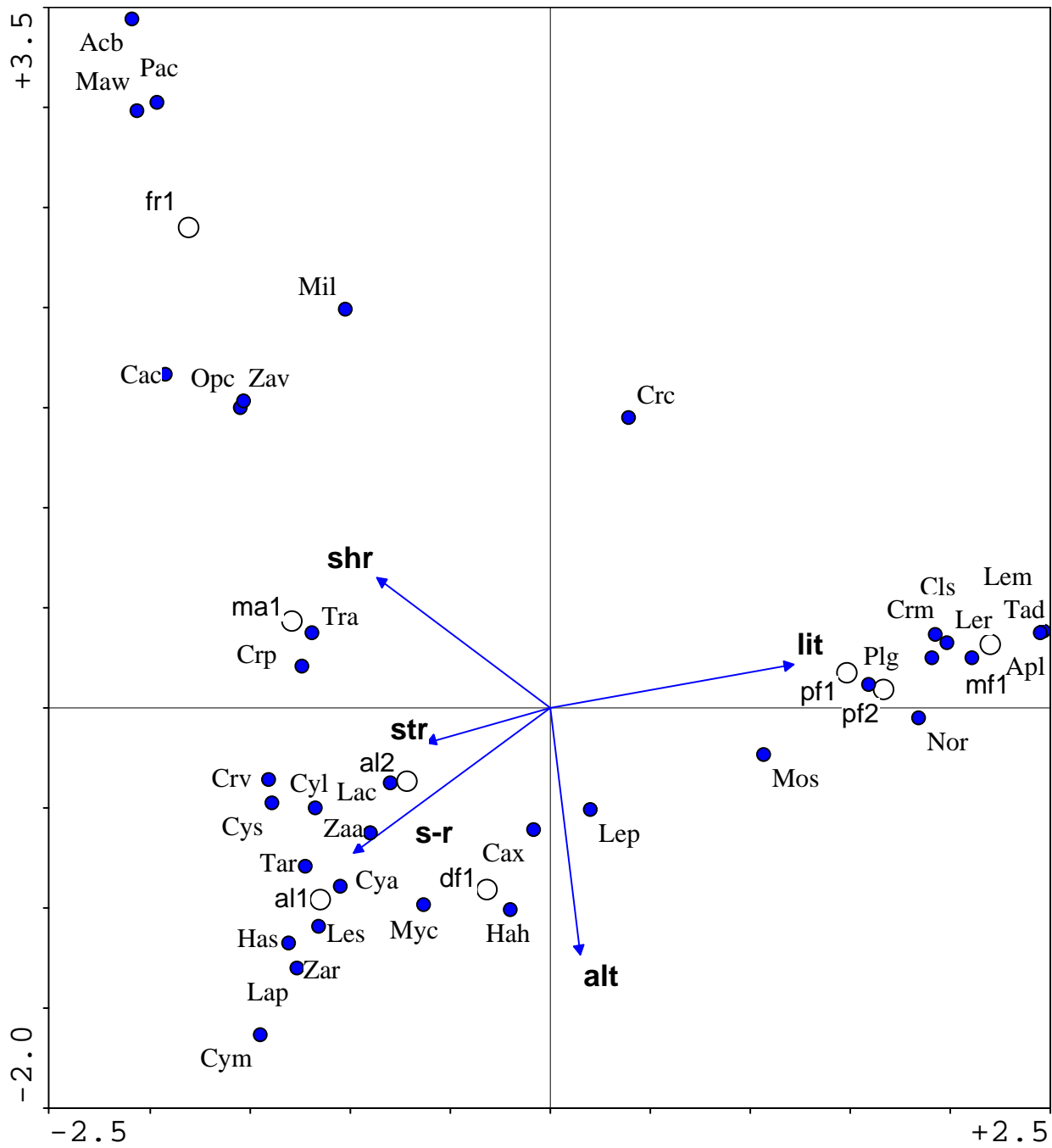


Carabidae (pooled samples per biotope)



Tenebrionidae (pooled samples per biotope)





Axes	1	2	3	4	Total inertia
Eigenvalues:	.627	.341	.302	.144	1.800
Species-environment correlations:	.997	.991	.996	.996	
Cumulative percentage variance					
of species data:	34.8	53.8	70.6	78.6	
of species-environment relation:	40.7	62.9	82.5	91.9	
Sum of all unconstrained eigenvalues					1.800
Sum of all canonical eigenvalues					1.540

Summary of Monte Carlo test

Test of significance of first canonical axis: eigenvalue = .627
F-ratio = 1.070
P-value = .0110

Test of significance of all canonical axes : Trace = 1.540
F-ratio = 2.368
P-value = .0005

Conclusions

- Carabidae have a higher number of species than Tenebrionidae
- Tenebrionidae are especially low in number of species in coniferous forests
- Open habitats have more species of Carabidae and Tenebrionidae than the other biotopes
- Highest abundance of Carabidae was recorded in sub-alpine and mixed forest. The latter had a lower number of species
- Highest number of Tenebrionidae was recorded in sub-alpine and phrygana

- In Tenebrionidae diversity was higher in open habitats; a pattern that was not obvious in Carabidae
- Each habitat type seems to have a different composition of phenology patterns
- Clustering of Carabidae samples indicates a major division between open and closed habitats
- Clustering of Tenebrionidae indicates a major division between forest and non-forest habitats
- The most important parameters that affect the Carabidae communities seem to be coverage of soil by pine litter, altitude and coverage of soil by other types of litter

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