

National & Kapodistrian University of Athens



**ENVIRONMENTAL PARAMETERS AND GROUND BEETLE
(COLEOPTERA, CARABIDAE) DIVERSITY
ON MT. TAYGETOS (PELOPONNESE, GREECE)**



Ioannis ANASTASIOU, Anna PAPADOPOULOU & Anastasios LEGAKIS

Zoological Museum, Dept. of Biology, Univ. of Athens, GR-15784 Athens, Greece

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 it's invertebrate fauna has not been studied sufficiently.

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

Methods

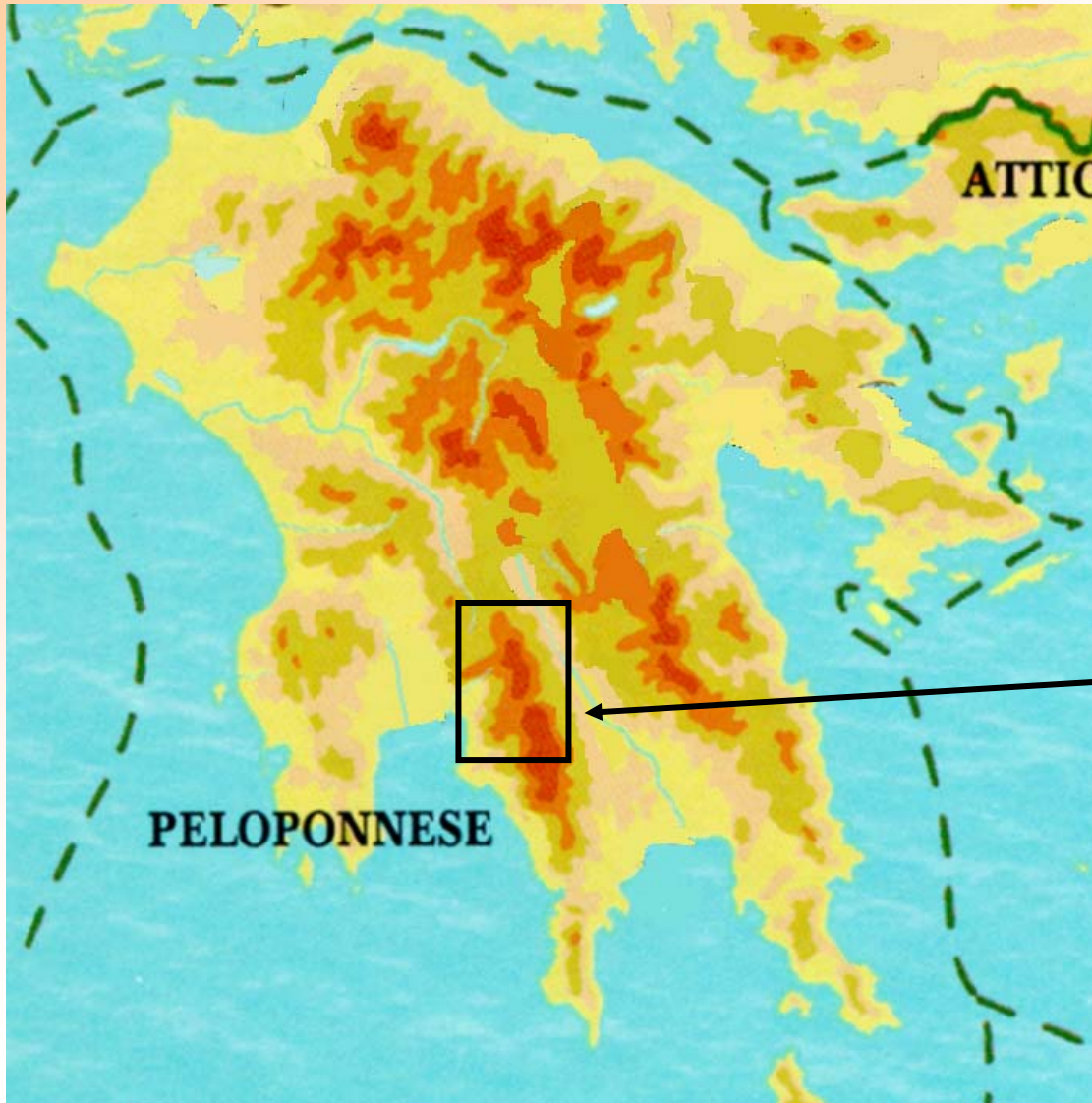
Sampling Period March - November 1997

Sampling Frequency Seasonally

Sampling Method

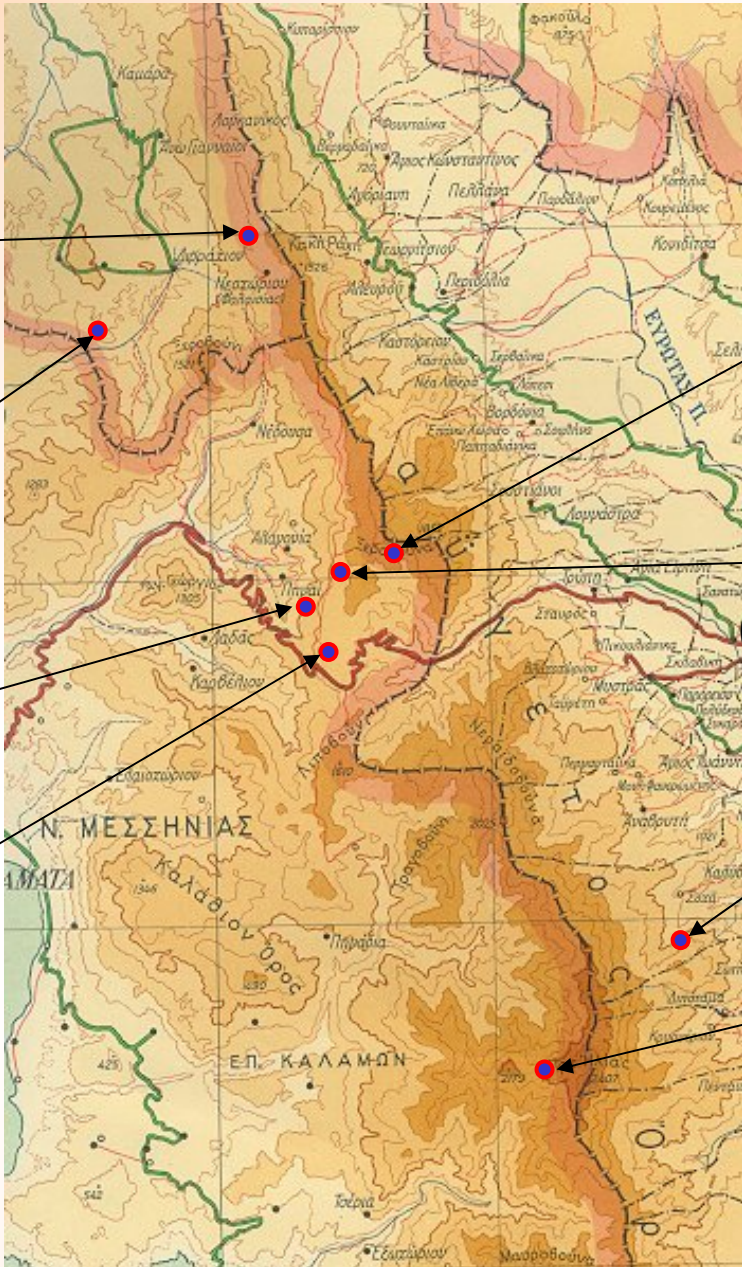
- Standard Pitfall Traps (plastic cups of 250ml containing about 50ml of ethylene glycol)
- 30 traps per biotope (distance between them → 15m) laying on two transect lines (distance between lines → 50m)

Study Area



Mt. Taygetos

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.

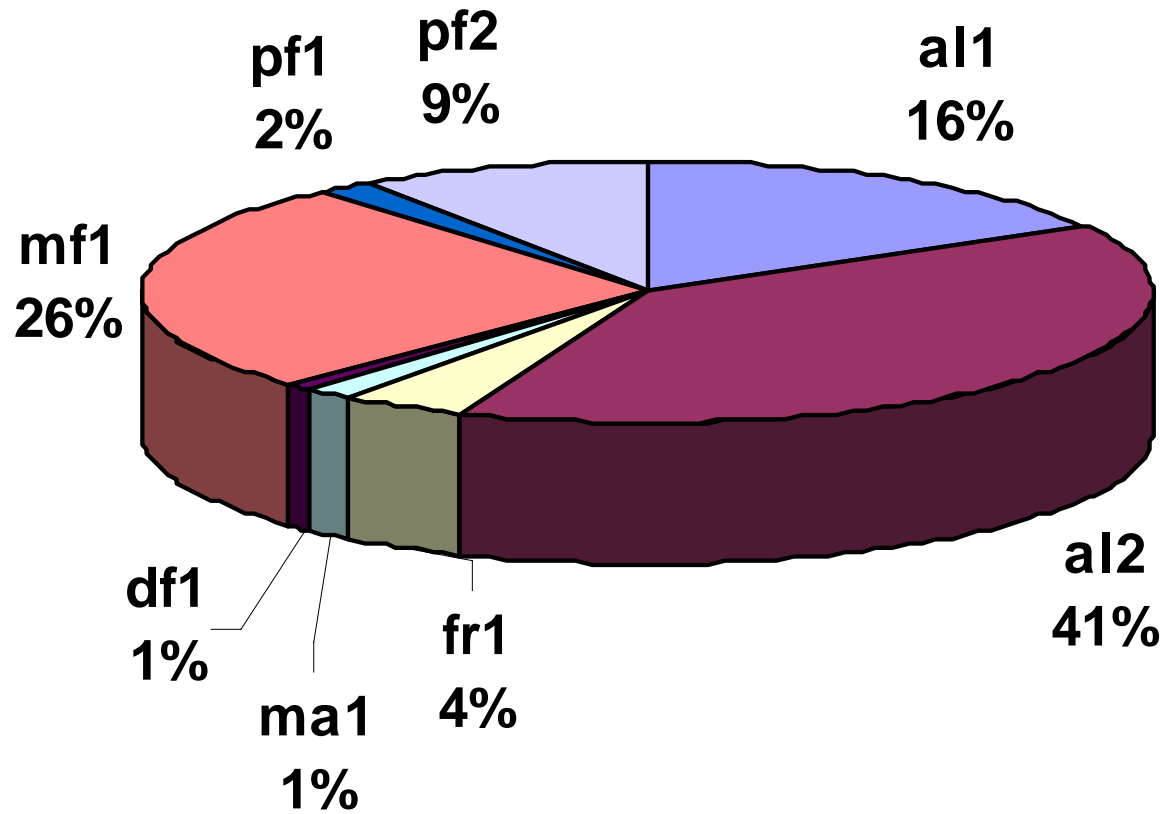
MA 1



- **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.

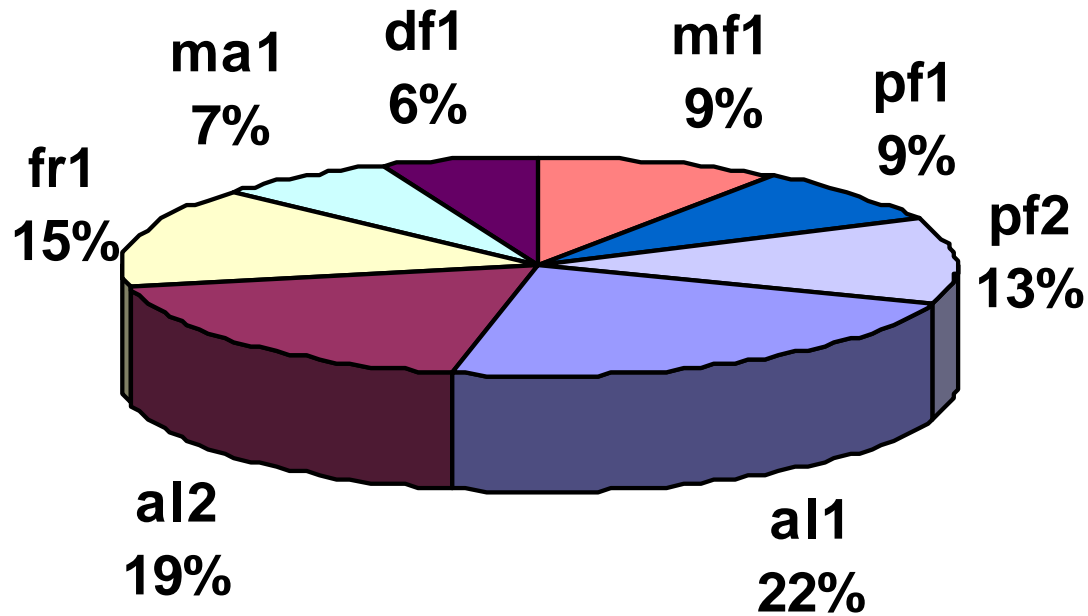
Abundance

Carabidae: Number of Individuals



Distribution of Species

Carabidae: Number of Species



Presence of Species per Biotope

	al1	al2	fr1	ma1	df1	mf1	pf1	pf2
<i>Calathus corax</i>	Red	Red	Red		Red	Red	Red	Red
<i>Platyderus graecus</i>	Red	Red	Red		Red	Red	Red	Red
<i>Molops spartanus</i>	Red	Red			Red	Red	Red	Red
<i>Carabus preslii</i>	Cyan	Cyan	Cyan	Cyan	Cyan	Cyan	Cyan	
<i>Microlestes luctuosus</i>	Cyan	Cyan	Cyan		Cyan	Cyan		
<i>Cymindis lineata</i>	Cyan	Cyan	Cyan				Cyan	Cyan
<i>Cymindis sinuata</i>	Cyan	Cyan	Cyan				Cyan	
<i>Carabus convexus</i>	Cyan	Cyan	Cyan		Cyan			
<i>Zabrus validus</i>	Cyan	Cyan	Cyan					
<i>Tapinopterus rebellis</i>	Cyan	Cyan		Cyan	Cyan		Cyan	
<i>Leistus parvicollis</i>	Cyan	Cyan	Cyan					Cyan
<i>Harpalus sulphuripes</i>	Cyan	Cyan		Cyan				
<i>Leistus spinibarbis</i>	Cyan	Cyan	Cyan					
<i>Laemostenus peloponnesiacus</i>	Cyan	Cyan	Cyan					
<i>Nebria brevicollis</i>	Blue							
<i>Amara eurynota</i>	Blue							
<i>Ophonus (Metophonus) sp.</i>	Blue							
<i>Harpalus rufipalpis</i>	Blue							
<i>Licinus oertzeni</i>	Blue							
<i>Cymindis miliaris</i>	Blue							
<i>Philorhizus crucifer</i>	Blue							
<i>Zabrus robustus</i>	Blue	Blue						
<i>Lebia trimaculata</i>	Blue	Blue						
<i>Cymindis axillaris</i>	Blue	Blue						
<i>Notiophilus interstitialis</i>	Blue	Blue						
<i>Zabrus aetolus hellenicus</i>	Blue	Blue						
<i>Acinopus baudii</i>		Dark Red	Dark Red					
<i>Ophonus cribricollis</i>		Dark Red	Dark Red					
<i>Masoreus wetterhallii</i>		Dark Red	Dark Red					
<i>Trechus austriacus</i>		Dark Red	Dark Red					
<i>Dixus obscurus</i>			Yellow					
<i>Ophonus subquadratus</i>			Yellow					
<i>Harpalus attenuatus</i>			Yellow					
<i>Leistus magnicollis</i>	Light Green					Light Green	Light Green	Light Green
<i>Aptinus lugubris</i>	Light Green					Light Green	Light Green	Light Green
<i>Leistus rufomarginatus</i>				Light Green		Light Green	Light Green	Light Green
<i>Calosoma sycophanta</i>				Light Green		Light Green	Light Green	Light Green
<i>Carabus merlini</i>		Light Green				Light Green	Light Green	Light Green
<i>Notiophilus rufipes</i>					Light Green	Light Green	Light Green	Light Green
<i>Zabrus graecus</i>								Light Green
<i>Calosoma inquisitor</i>								Light Green
<i>Syntomus obscuroguttatus</i>							Light Green	Light Green
<i>Ophonus taygetanus</i>							Light Green	Light Green
<i>Ophonus krueperi</i>						Dark Green	Dark Green	Dark Green
<i>Tapinopterus duponcheli</i>	Grey					Dark Green	Dark Green	Dark Green
<i>Laemostenus cimmerius</i>			Grey		Grey	Grey	Grey	Grey
<i>Pachycarus cyaneus</i>			Grey	Grey	Grey	Grey	Grey	Grey
<i>Calathus cinctus</i>			Grey	Grey	Grey	Grey	Grey	Grey
<i>Myas chalybaeus</i>	Grey			Grey	Grey	Grey	Grey	Grey
<i>Carabus coriaceus</i>	Grey		Grey	Grey	Grey	Grey	Grey	Grey
<i>Harpalus rufipes</i>	Grey			Grey	Grey	Grey	Grey	Grey

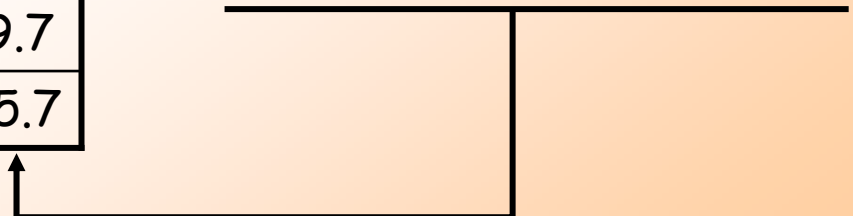
Legend

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

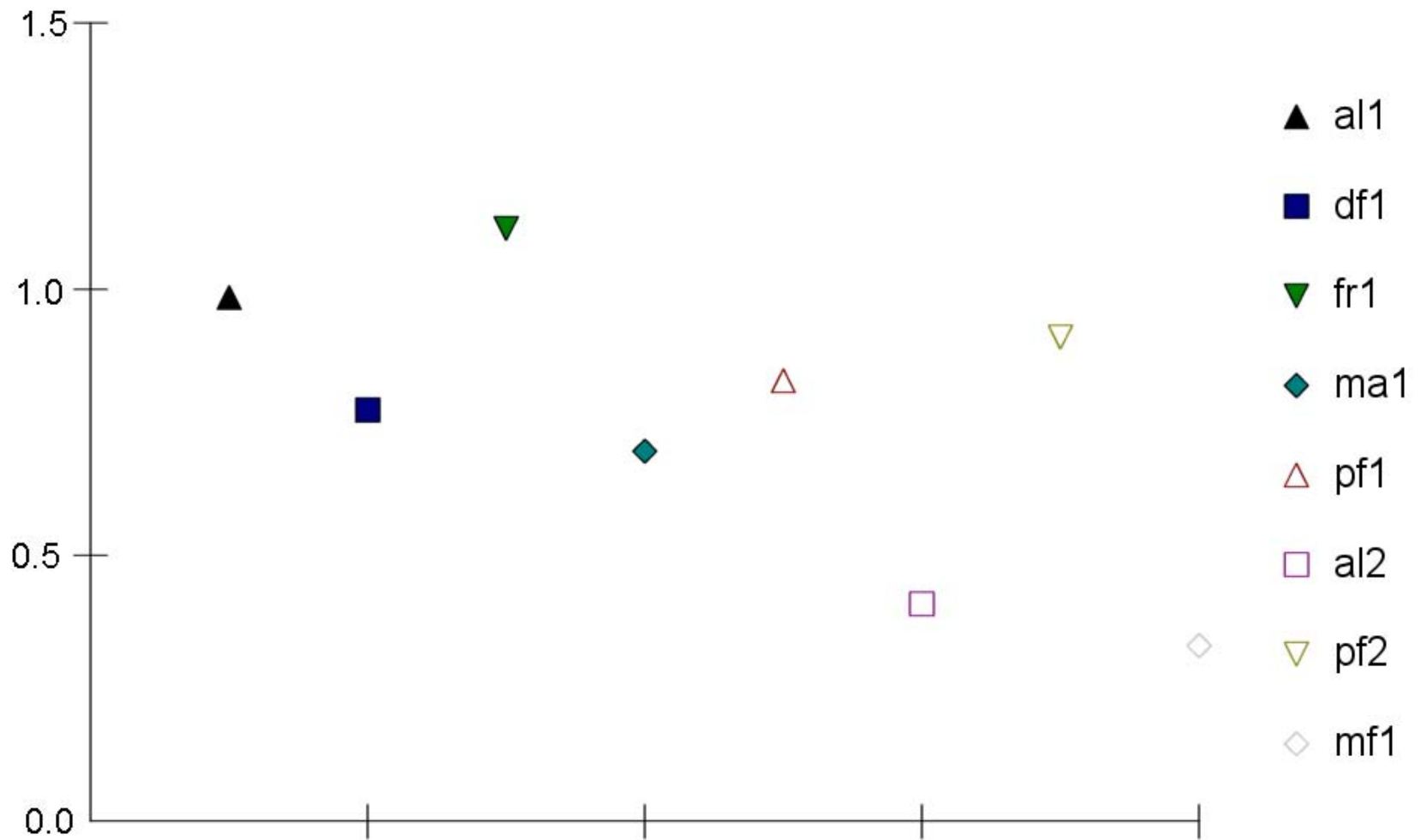
Characteristic Carabidae Species

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

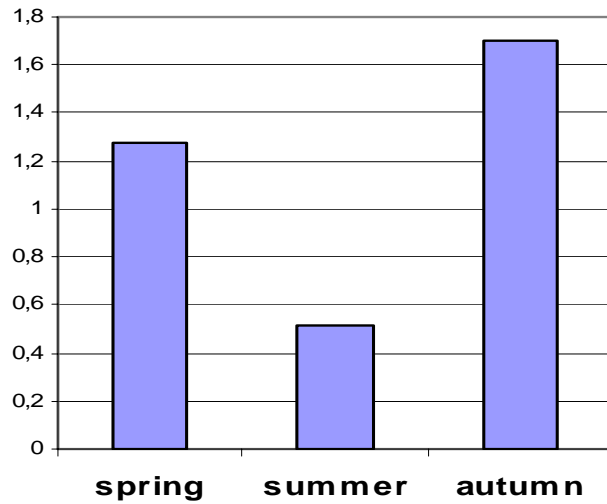
Average contribution of each species to the overall similarity of the sample



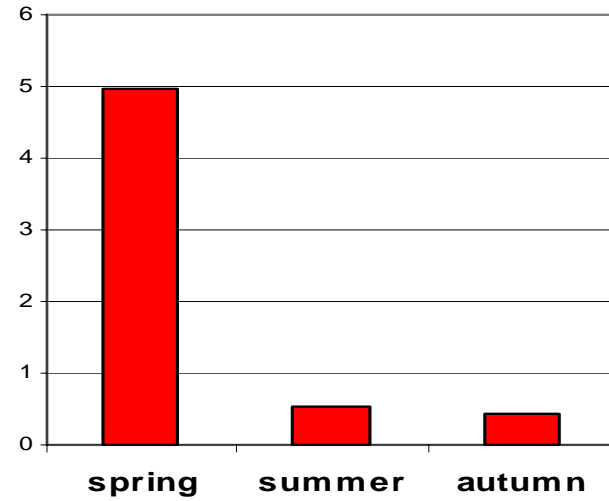
Carabidae diversity (pooled samples)



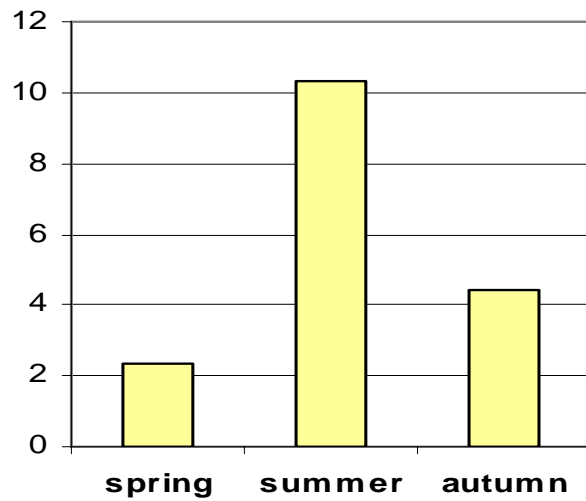
spring-autumn pattern
Carabus preslii (a11)



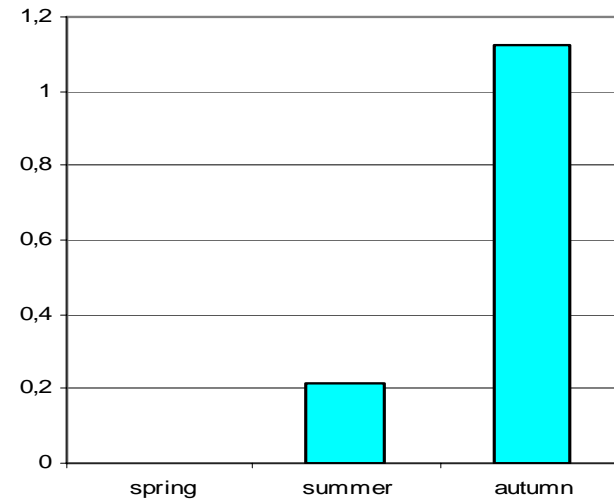
spring pattern
Platyderus graecus (pf1)



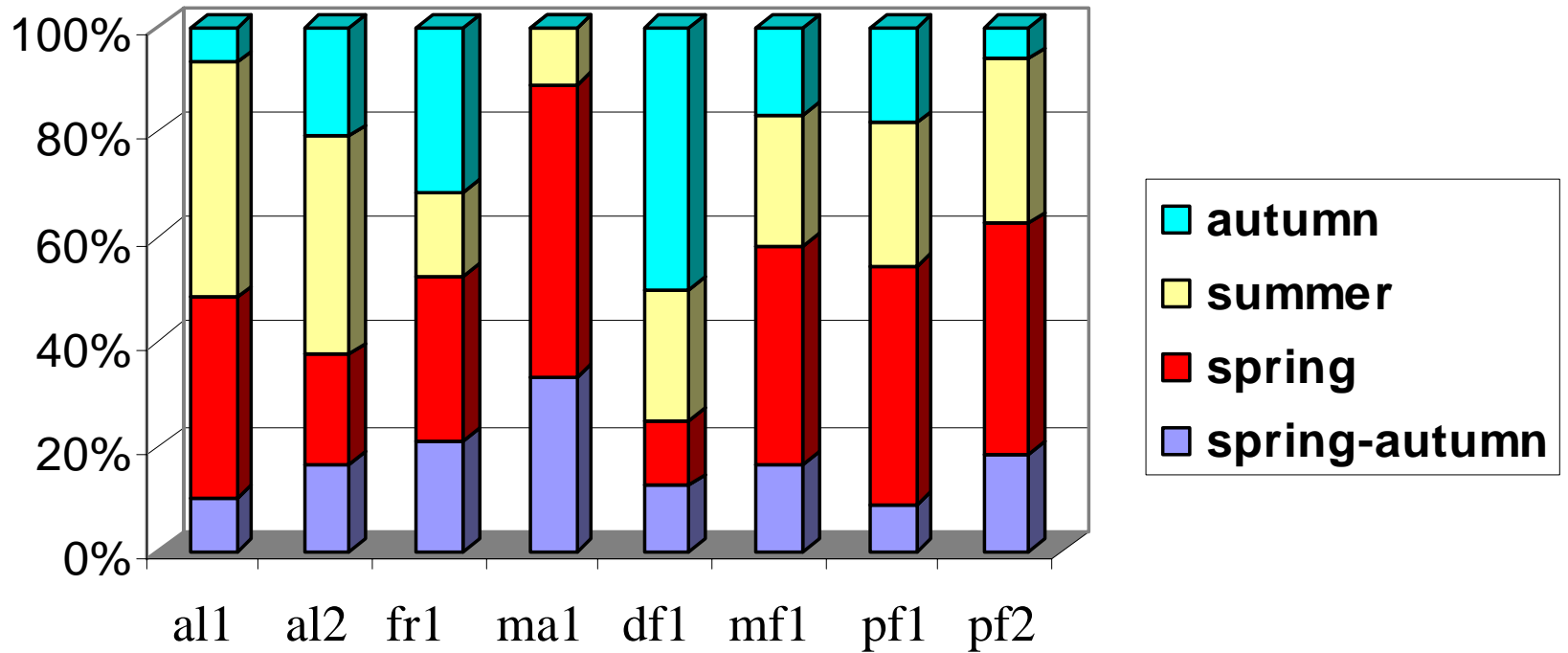
summer pattern
Calathus corax (a11)



autumn pattern
Myas chalybaeus (df1)

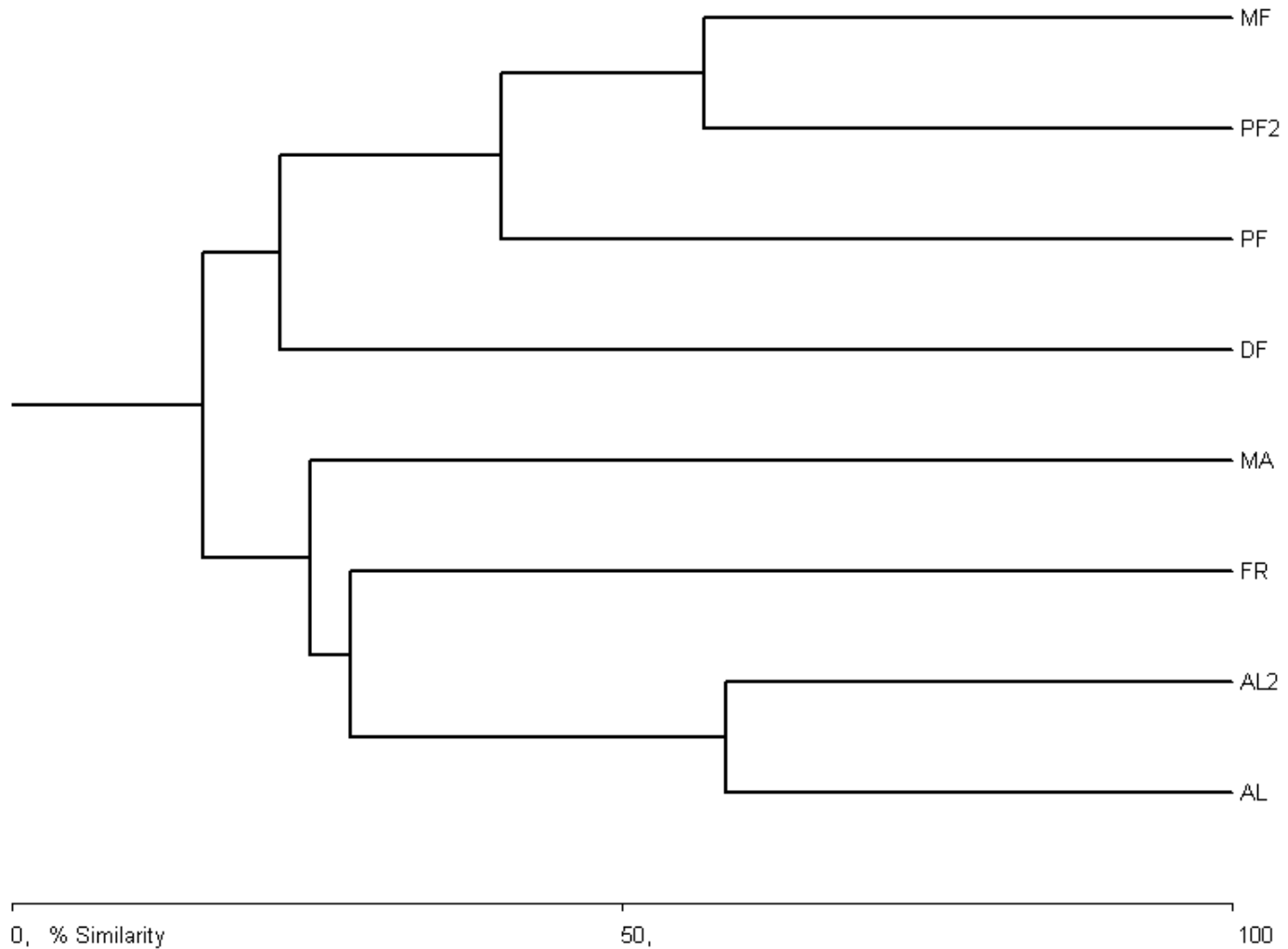


patterns of phenology fam. Carabidae

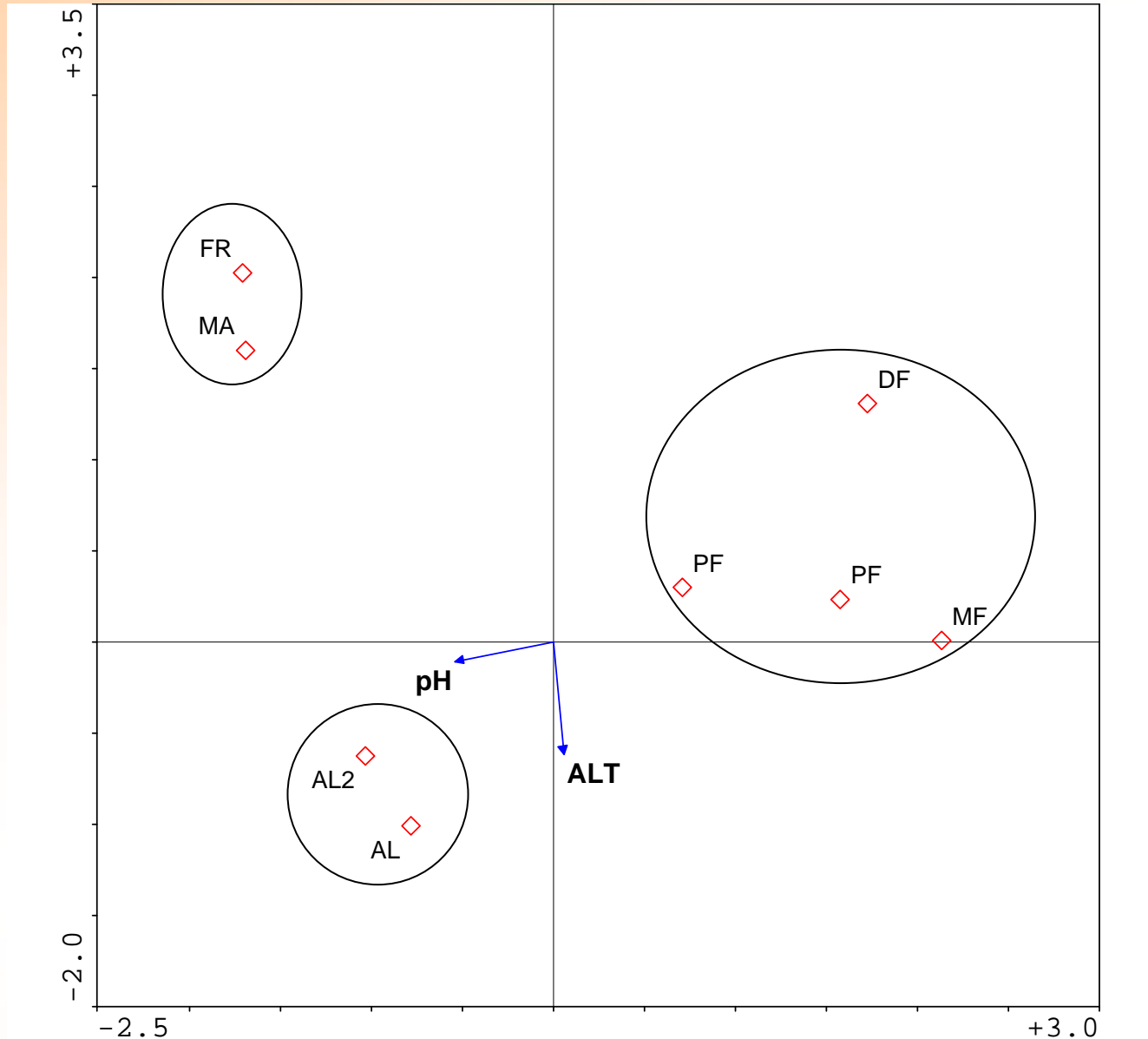


Carabidae (pooled samples per biotope)

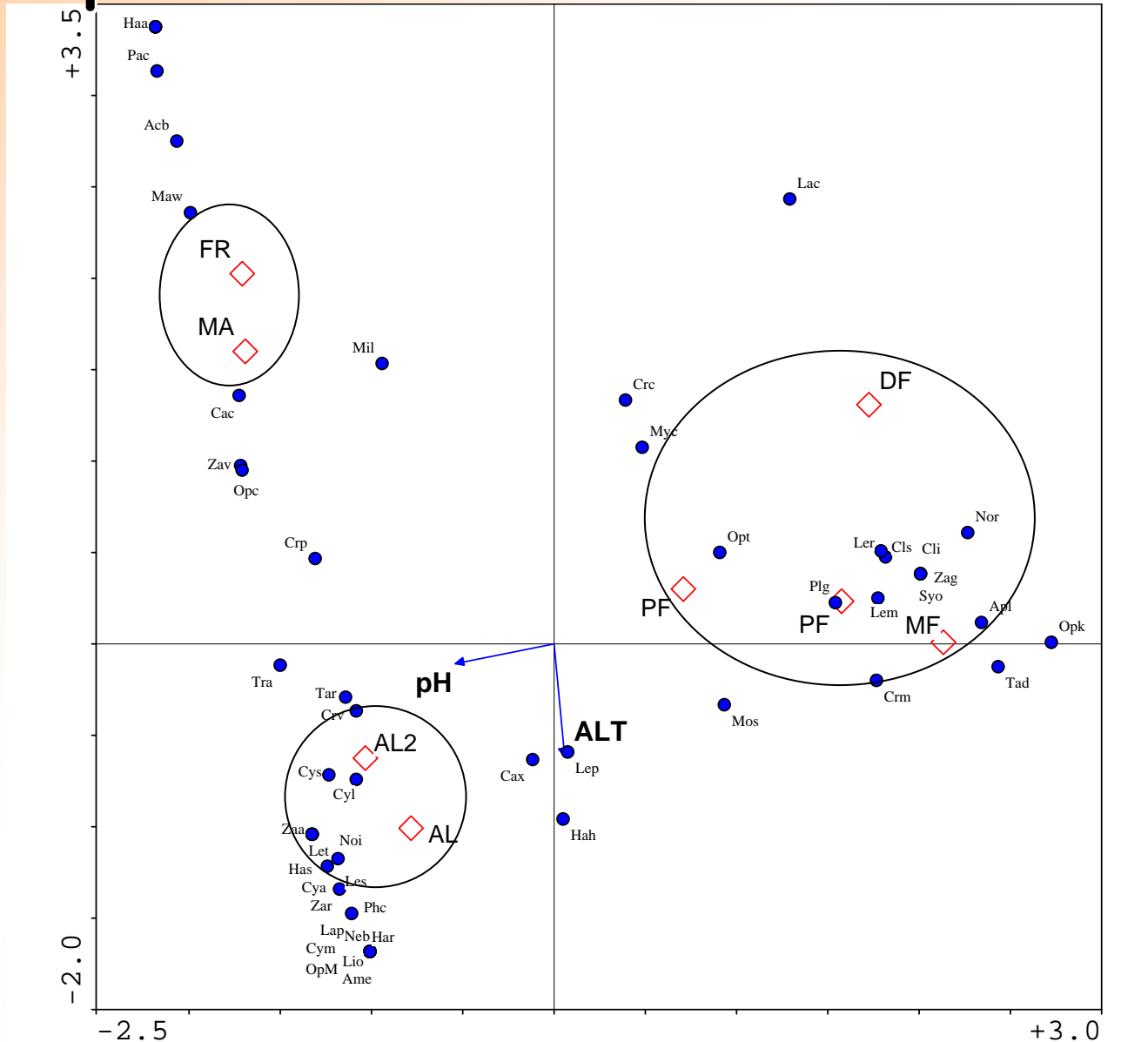
Bray-Curtis Cluster Analysis (Group Average Link)



Canonical correlation analysis of habitats vs. environmental factors



Canonical correlation analysis of habitats and species vs. environmental factors



Axes	1	2	3	4	Total inertia
Eigenvalues:	.611	.360	.336	.201	1.917
Species-environment correlations:	.983	.984	.000	.000	
Cumulative percentage variance					
of species data:	31.8	50.6	68.1	78.6	
of species-environment relation:	62.9	100.0	.0	.0	
Sum of all unconstrained eigenvalues					1.919
Sum of all canonical eigenvalues					0.971

Summary of Monte Carlo test

Test of significance of environmental variable eigenvalues

	p-value
pH	0.0005
Altitude	0.0415

Other environmental variables used were organic content, hydrocapacity, soil humidity, cover by litter, soil and rocks. However, they were not included in the analysis as their effect was not statistically significant.

Conclusions

- Open habitats have more species of Carabidae than the other biotopes
- Highest abundance of Carabidae was recorded in sub-alpine and mixed forest. The latter had a lower number of species
- Each habitat type seems to have a different composition of phenology patterns

Conclusions

- Clustering of Carabidae samples indicates a major division between open and closed habitats
- The most important parameters that affect the Carabidae communities seem to be pH and altitude

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