



Wildlife and Agroforestry



What is a Agroforestry system?

“Agroforestry is an integrated approach of using the interactive benefits from combining trees and shrubs with crops and/or livestock. It combines agricultural and forestry technologies to create more diverse, productive, profitable, healthy and sustainable land-use systems.” (USDA - National Agroforestry Center)



Only trees, shrubs and crops? A community? An ecosystem?



Includes animals? Streams and lakes?



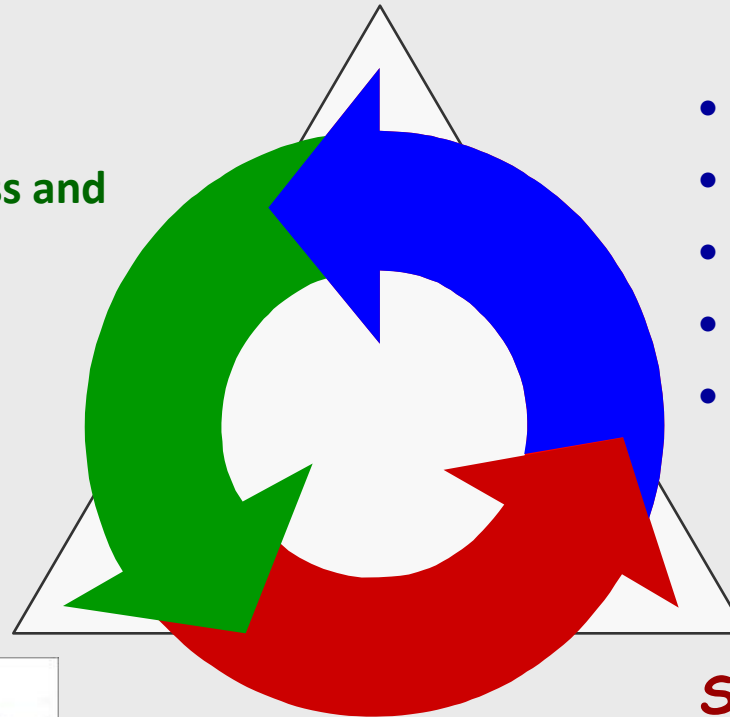
Ecological processes like nutrient and energy cycling?

COMPOSITION

- Genetic diversity
- Species abundance, richness and diversity
- Community diversity
- Habitat diversity

FUNCTION

- Energy Capture & Trophics
- Mineral and nutrient cycles
- Water movement
- Ecological succession
- Disturbance

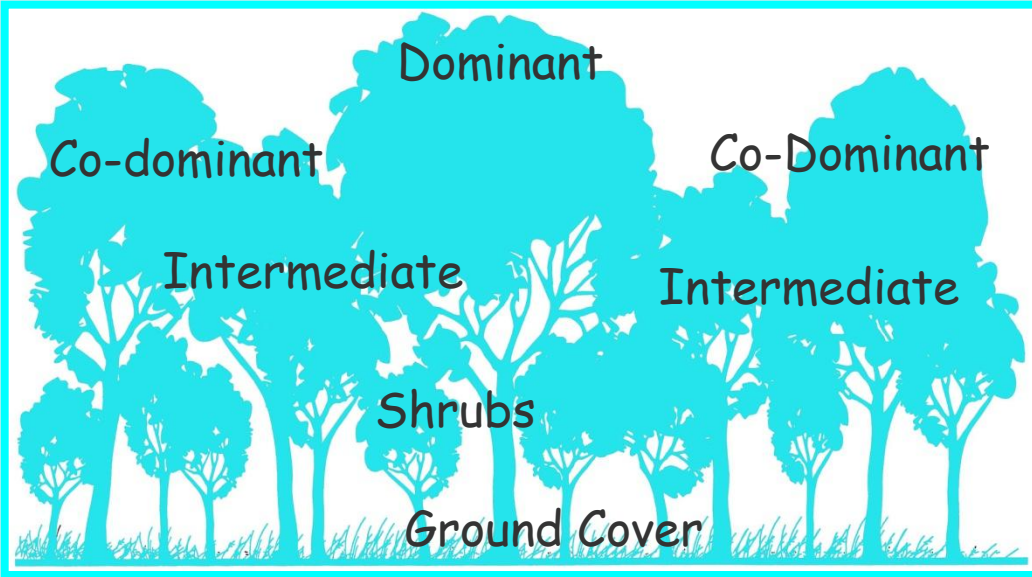


STRUCTURE

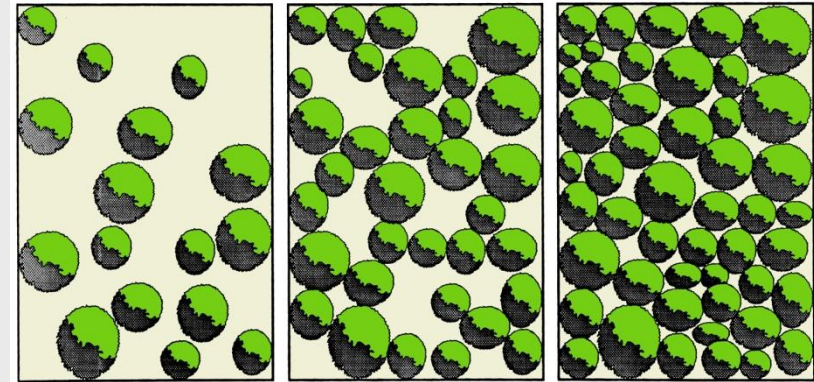
- Vertical and horizontal
- Spatial heterogeneity and density
- Edge Effect
- Island effect and Fragmentation
- Logs and dead trees



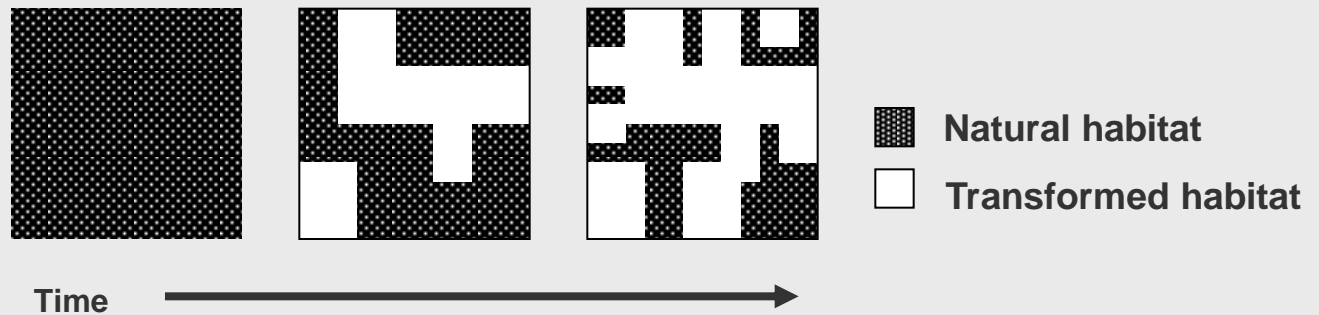
Vertical Structure



Horizontal Structure



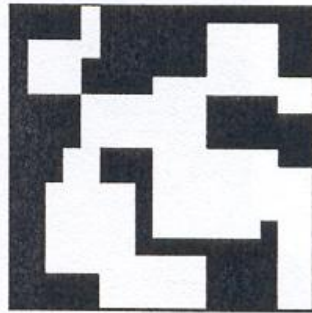
Spatial heterogeneity



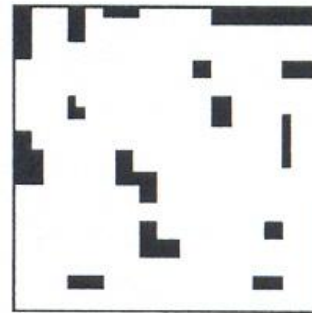
Fragmentation



1



2



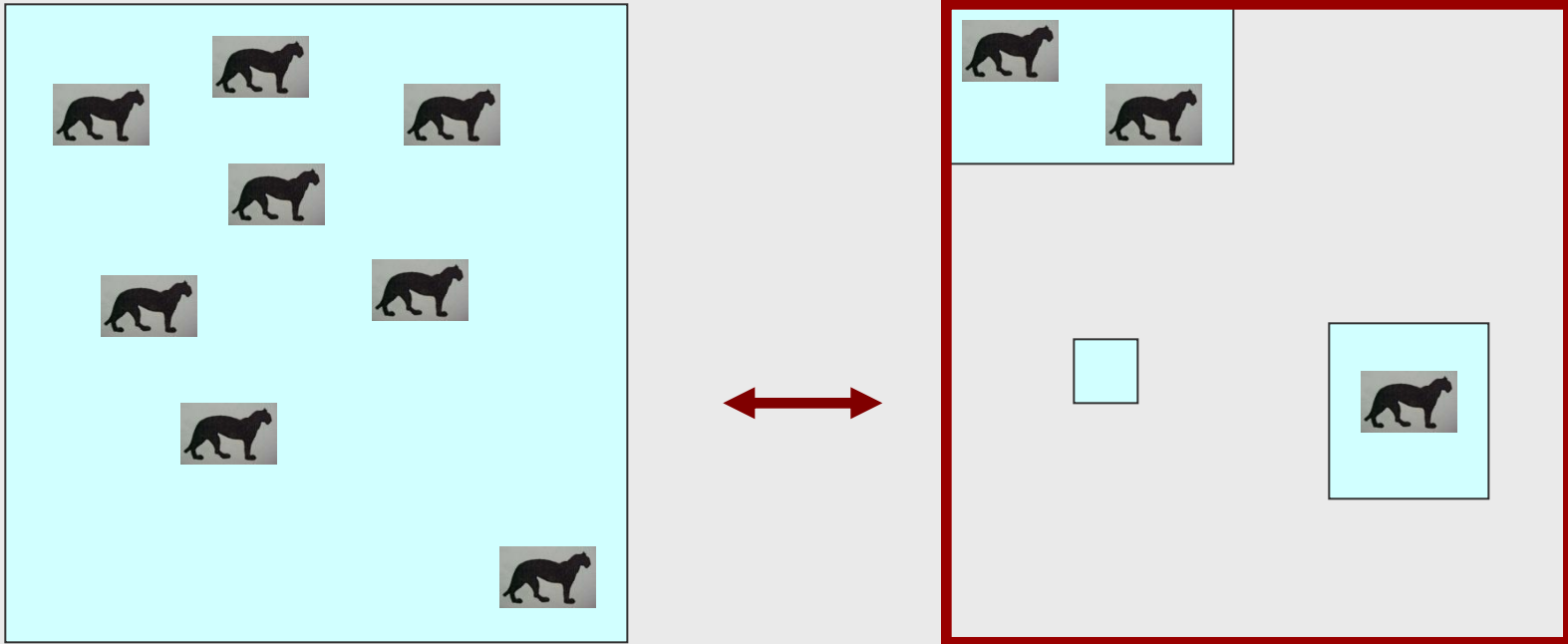
3



time

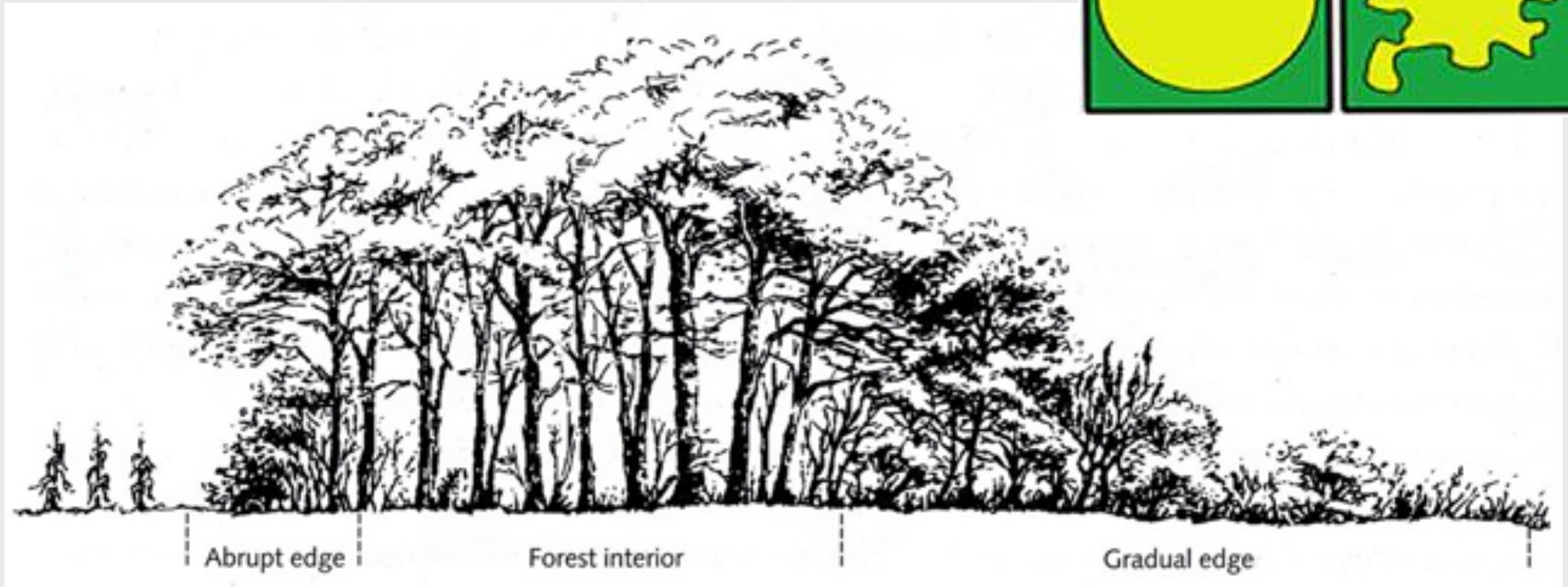


Habitat Fragmentation



Fragmentation change directly or indirectly the abundance of species and its distribution, affecting interactions between species.

Edge effect



Effect of the juxtaposition of contrasting environments on an ecosystem. Create mixed communities, containing features of both systems in contact.

Island effect

The isolation of forest fragments - Island biogeography theory (MacArthur & Wilson 1963).

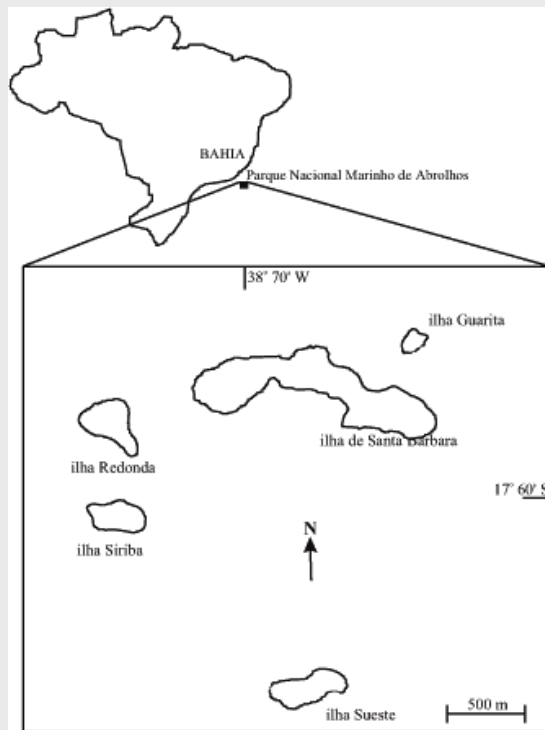


Figura 1. Localização do Parque Nacional Marinho de Abrolhos e disposição das ilhas no arquipélago.

Figure 1. Location of the Abrolhos National Marine Park showing the distribution of islands in the archipelago.

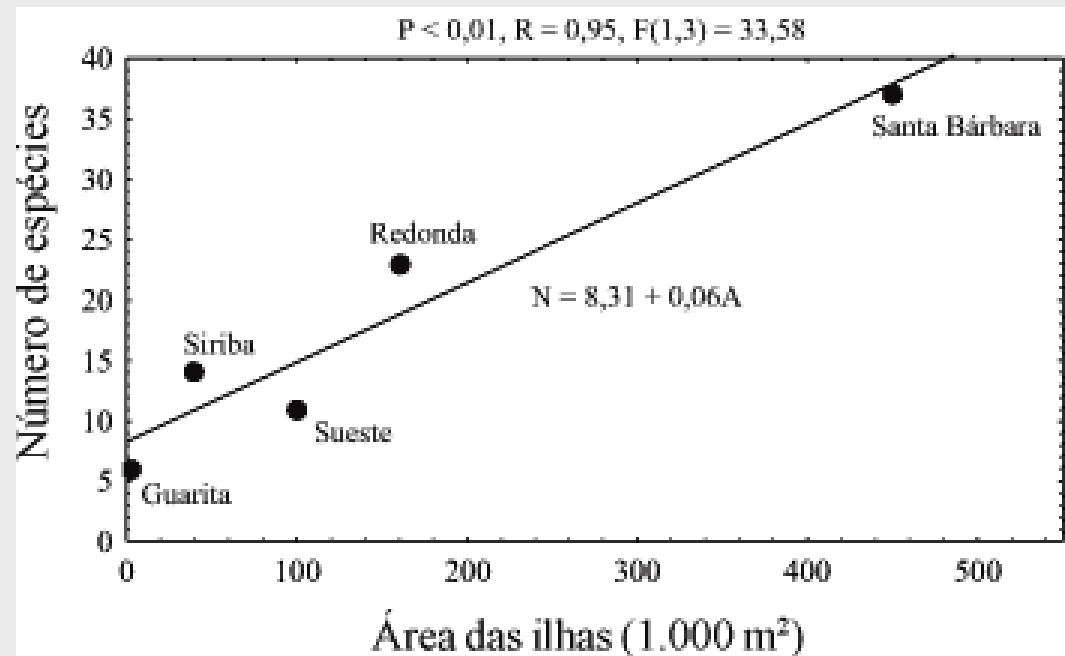


Figura 4. Relação entre o número de espécies e o tamanho das ilhas no arquipélago de Abrolhos.

Figure 4. Relationship between the number of species and the size of the islands in the Abrolhos archipelago.

Iberian Agroforestry system “montado” / “dehesa”



Characteristics:

- Perennial oak woodlands (cork oak & holm oak)
- Low tree density (less than 40% cover).
- **Economic value:** acorn for livestock feed, bark from the cork oak, wild mushrooms, charcoal, and firewood.
- **Understory:** annual grasslands for grazing / cereals (wheat, barley, oats, rye).
- Different habitats and food available for wildlife.

Iberian Agroforestry system “montado” / “dehesa”

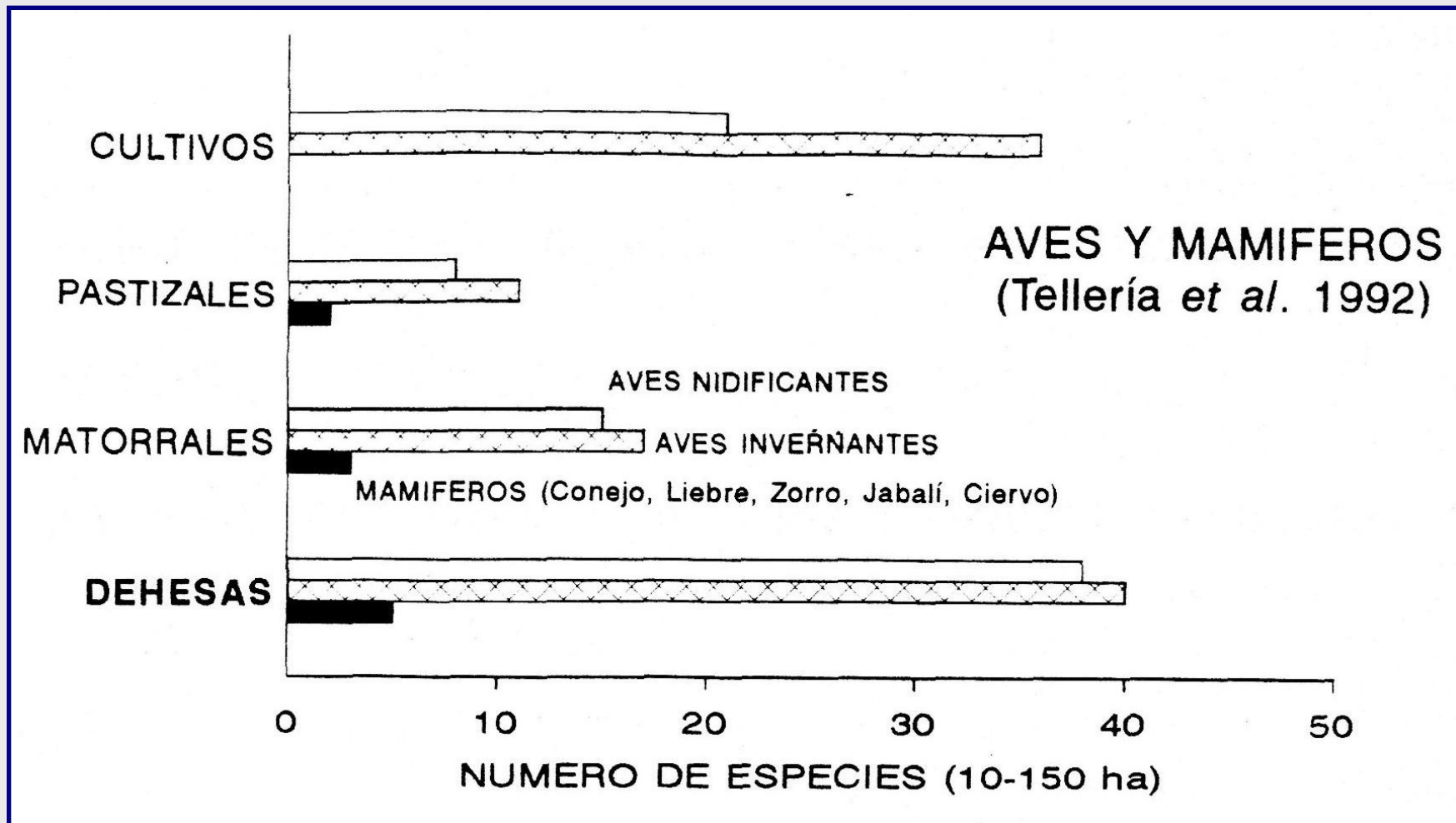


Composition

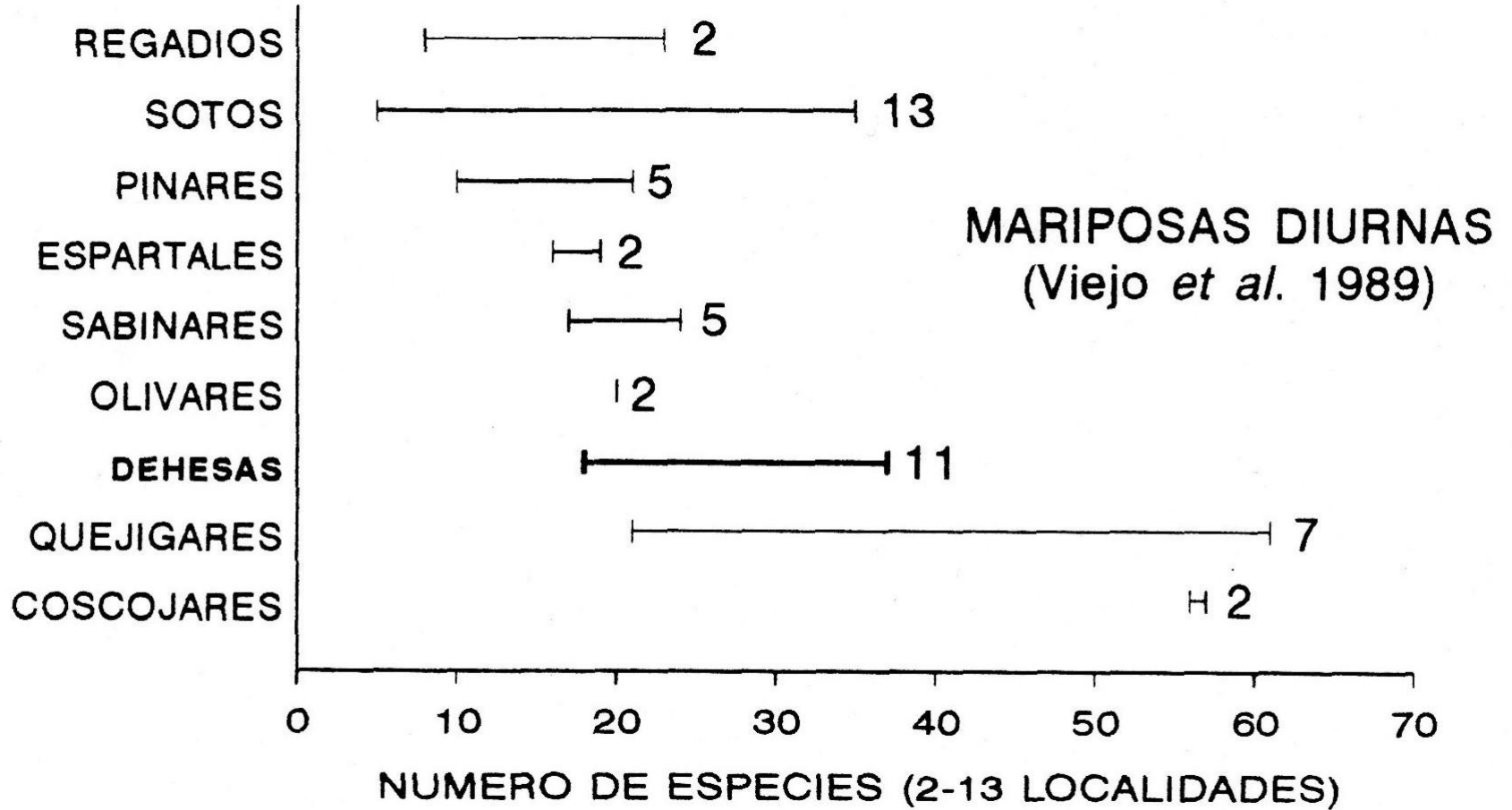


- 1 - pica-pau-verde (*Picus viridis*) e fauna associada;
- 2 - pombo-torcaz (*Columba palumbus*);
- 3 - picanço-real (*Lanius excubitor*)
e picanço-barreteiro (*Lanius senator*);
- 4 - pega-rabuda (*Pica pica*);
- 5 - águia-calçada (*Hieraaetus pennatus*);
- 6 - águia-de-asa-redonda (*Buteo buteo*);
- 7 - águia-real (*Aquila chysaetos*);
- 8 - cegonha-branca (*Ciconia ciconia*);
- 9 - milhano (*Milvus milvus*)
e milhafre-preto (*Milvus migrans*);
- 10 - mocho-galego (*Athene noctua*);
- 11 - coruja-das-torres (*Tyto alba*);
- 12 - gralha-de-nuca-cinzenta (*Corvus monedula*);
- 13 - morcegos;
- 14 - geneta (*Genetta genetta*);
- 15 - lince (*Lynx pardinus*);
- 16 - coelho-bravo (*Oryctolagus cuniculus*).

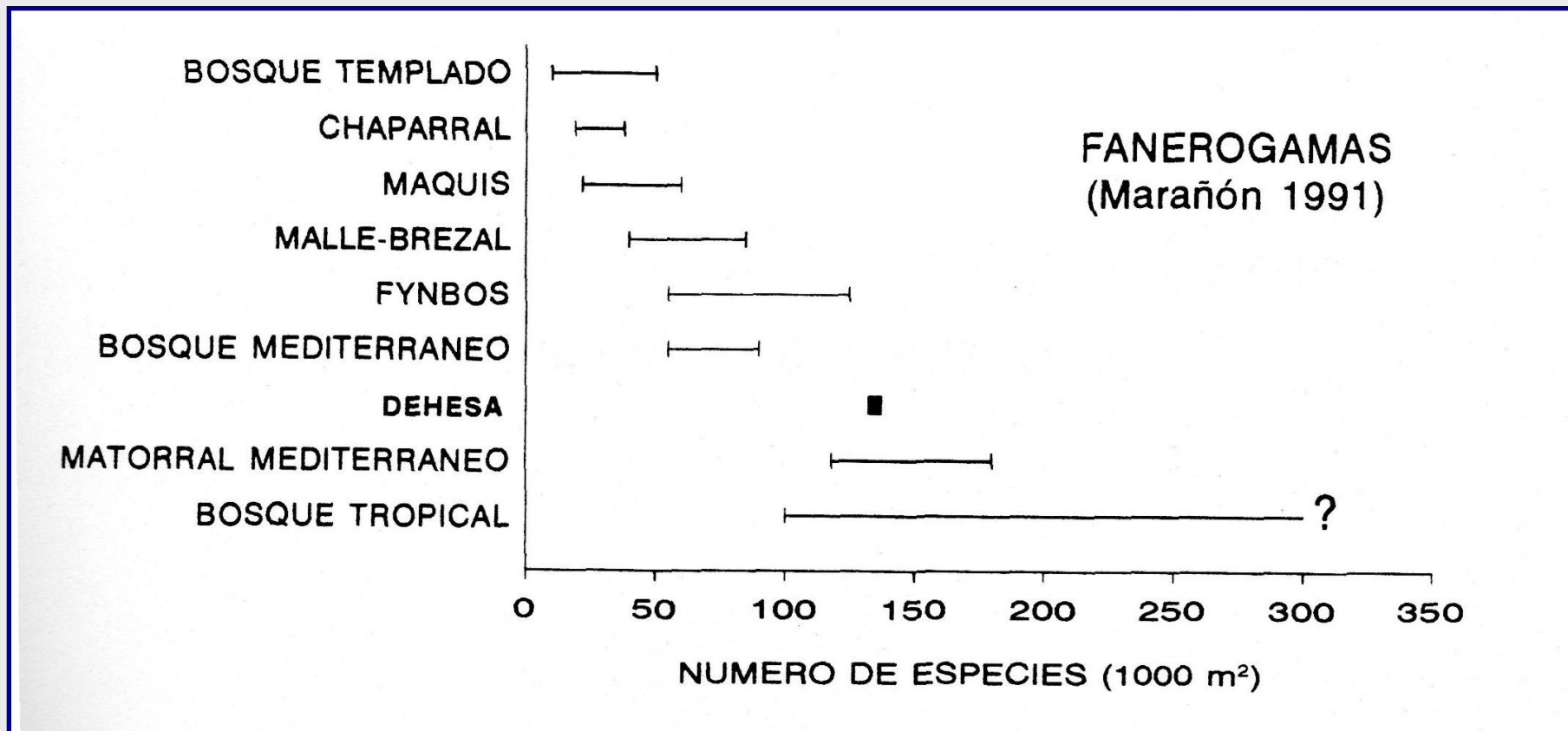
Composition



Composition

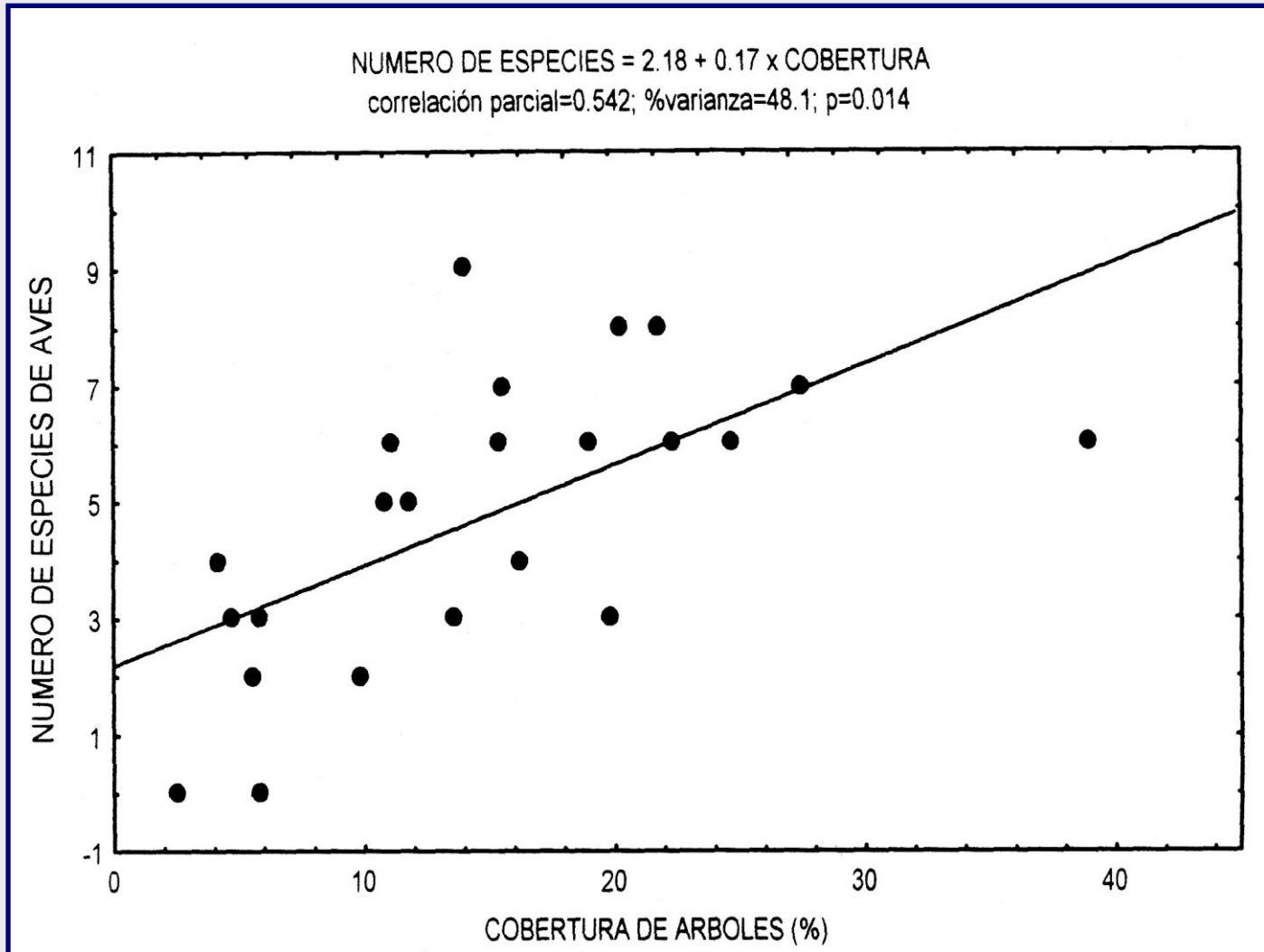


Composition



RIQUEZA DE ESPECIES DE AVES NIDIFICANTES EN DEHESAS SEGÚN LA COBERTURA DE ARBOLADO

(Pulido & Díaz, inédito)



Foliage height diversity (FHD)
vs.
Bird diversity
(Wilson, 1974)

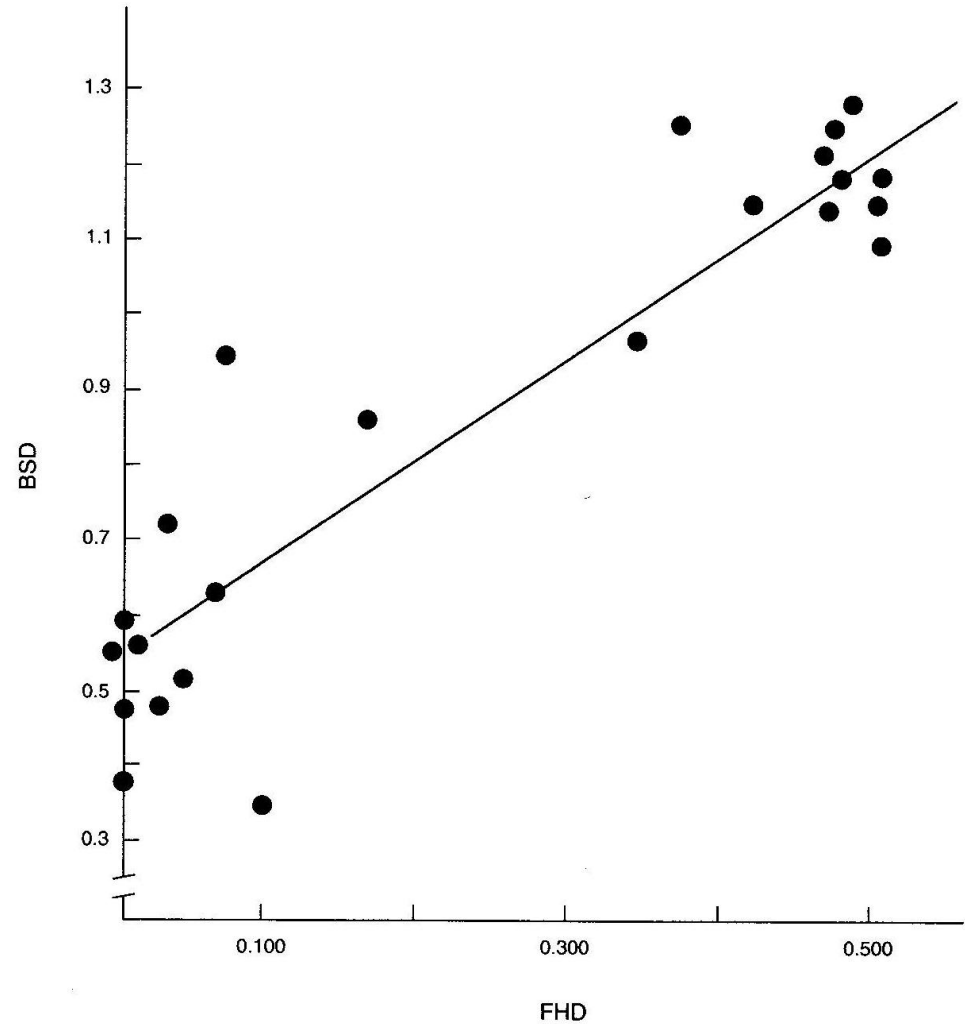


Figure 3.1. Foliage height diversity (FHD) versus bird species diversity (BSD). • represent the study sites. (Reproduced from Willson 1974 [fig. 1], by permission of the Ecological Society of America)



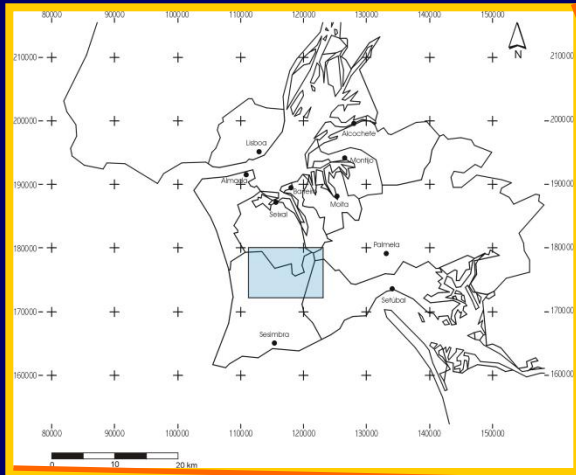
**Assessment of the vegetation structure
influence on bird communities' occurrence
in portuguese agroforestry systems**

Objectives

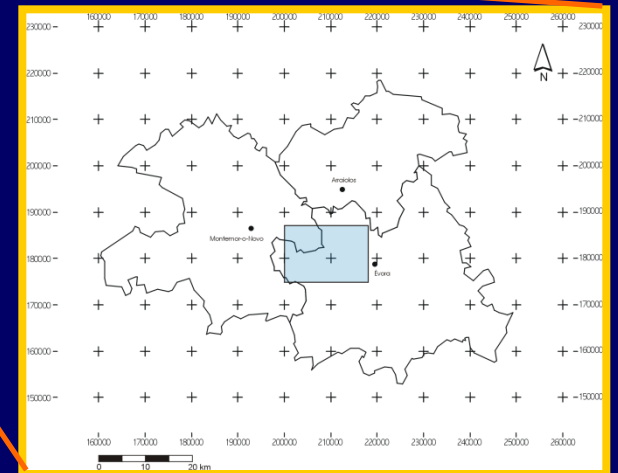
- To study of the relationships between the vegetation vertical structure and the breeding bird (passerine) community composition.
- To identify physiognomic types of vegetation with faunistic importance, based on different measures, including vegetation vertical structure, percentage of vegetation cover types, and vegetation diversity measures.
- To develop a methodology to classify vegetation in order to understand the breeding bird composition and distribution.
- This approach for classifying habitat types allows a consistent development of wildlife management strategies in agroforestry systems.

Location

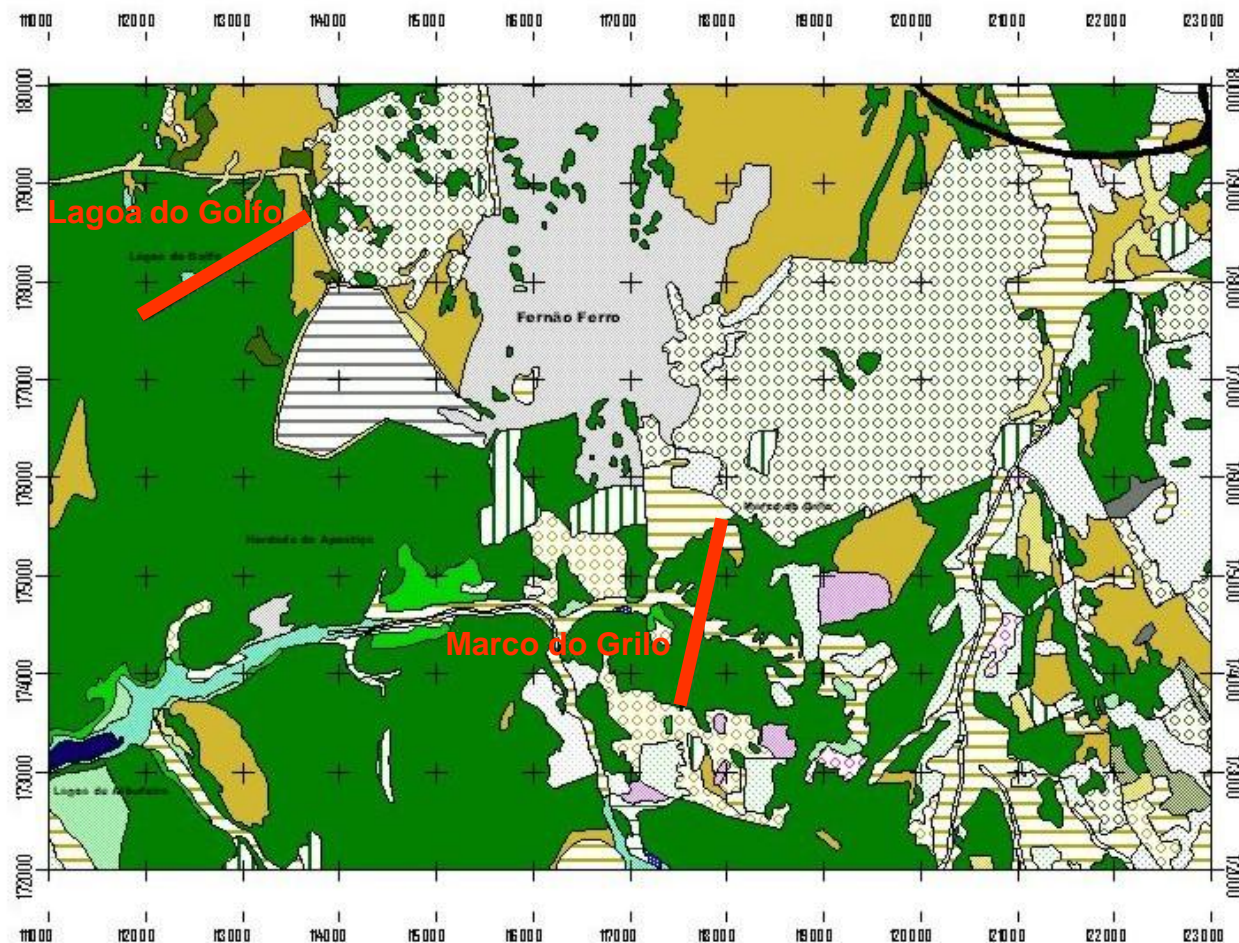
Area 1- Setúbal



Area 2 - Évora

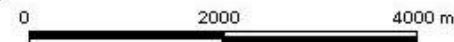


APOSTIÇA (PENÍNSULA DE SETÚBAL)

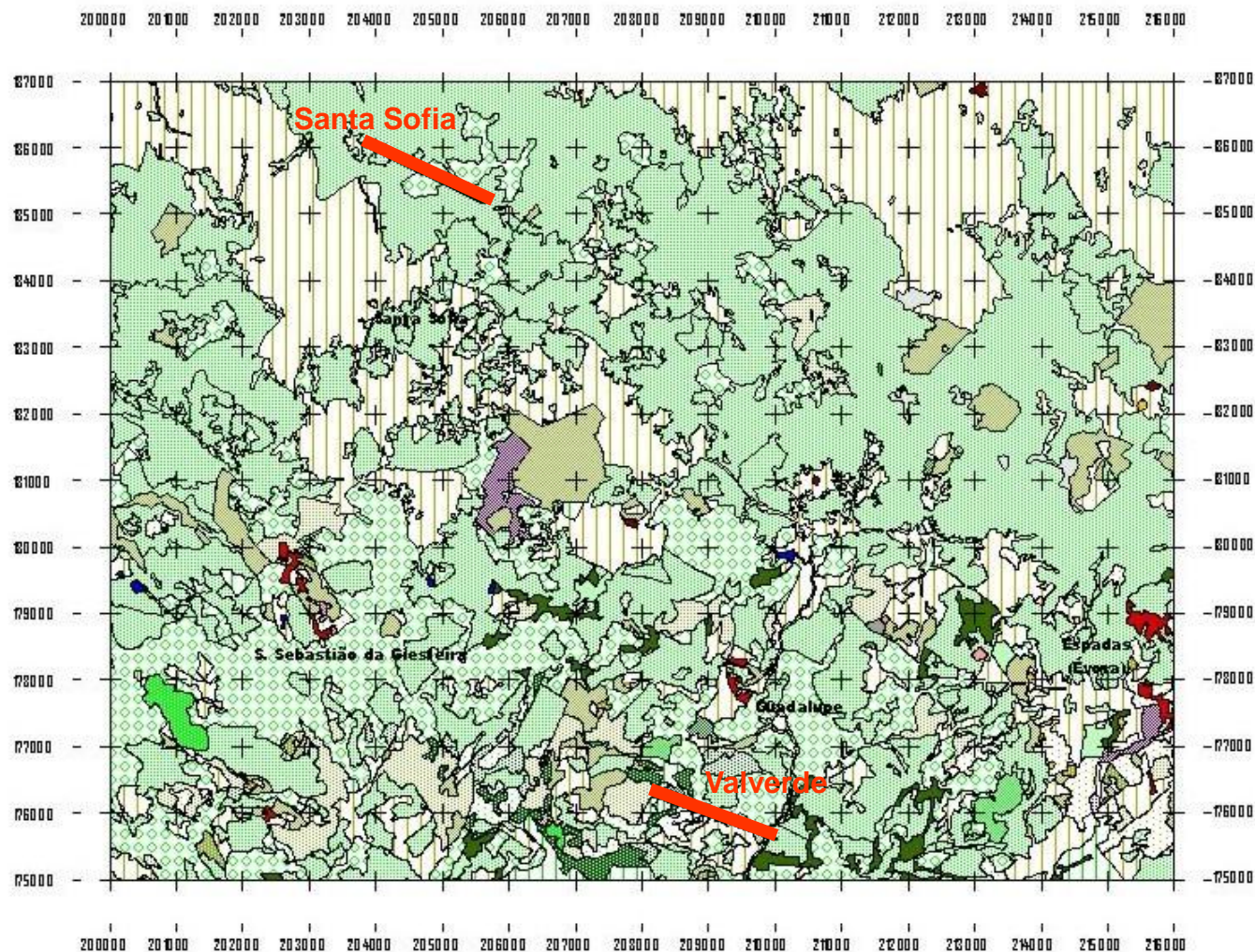


LEGENDA

-  Tecido Urbano Descontínuo
-  Aglomerados e Habitações Rurais
-  Loteamentos Urbanos
-  Espaços Industriais e Comerciais
-  Espaços Verdes Urbanos
-  Cultivos Anuais
-  Zonas Agrícolas Heterogéneas
-  Pomares
-  Vinha
-  Olivais
-  Prados
-  Formações Ruderais
-  Montado de Sobreiro
-  Povoamento de Pinheiro Bravo
-  Povoamento de Pinheiro Manso
-  Pinhal Misto (P. Bravo x P. Manso)
-  Eucaliptal
-  Matos
-  Vias de Comunicação
-  Instalações e Estruturas Militares
-  Pedreiras e Saibreiras
-  Galeria Ripícola
-  Zonas Húmidas
-  Lagoas
-  Laguna (Lagoa de Albufeira)



ÉVORA (SANTA SOFIA/GUADALUPE)



LEGENDA

- Tecido Urbano Contínuo
- Tecido Urbano Descontínuo
- Aglomerados e Habitações Rurais
- Espaços Verdes Urbanos
- Zonas Agrícolas Heterogêneas
- Cultivos Anuais
- Cultivos Anuais + Pomar
- Cultivos Anuais + Vinha
- Cultivos Anuais + Folhosas
- Cultivos Anuais + Olivais
- Vinha
- Vinha + Pomar
- Pomar
- Pomar + Olivais
- Olivais + Pomar
- Olivais
- Olivais + Montado de Azinho
- Olivais + Montado de Sobre
- Pastos
- Formações Ruderais
- Montado de Sobre + Olivais
- Montado de Azinho + Olivais
- Montado de Sobre
- Montado de Azinho
- Montado Misto
- Montado de Sobre + Pinhal
- Montado de Azinho + Pinhal
- Povoamento de Pinheiro Bravo
- Povoamento de Pinheiro Manso
- Pinhal Misto (P. Bravo x P. Manso)
- Pinhal + Montado de Sobre
- Eucaliptal + Pinhal
- Eucaliptal
- Choupal
- Folhosas
- Matos
- Pedreiras e Saibreiras
- Albufeiras



Methods

➔ Data collection

- 4 transects - 2 in Évora (Santa Sofia and Guadalupe/Valverde) and 2 in Setúbal (Marco do Grilo and Lagoa do Golfo).
- The transects have a total length of 2 km, divided in 10 sections of 200 m each.
- Avian species:
 - Census using the *Line Transects* method (BIBBY *et al.*, 1992).
 - Bird censuses were carried out between April and June. 6 visits in each transect. 24 censuses in total.
 - Experienced field workers took note of all visual and auditive contacts.

- **Vegetation:**

- *Line-intercept method* (KENT & COKER, 1992).
- All plant species were registered. A percent cover for the 3 vertical layers was assessed (tree, shrub e herbaceous layers).

➔ **Data analysis**

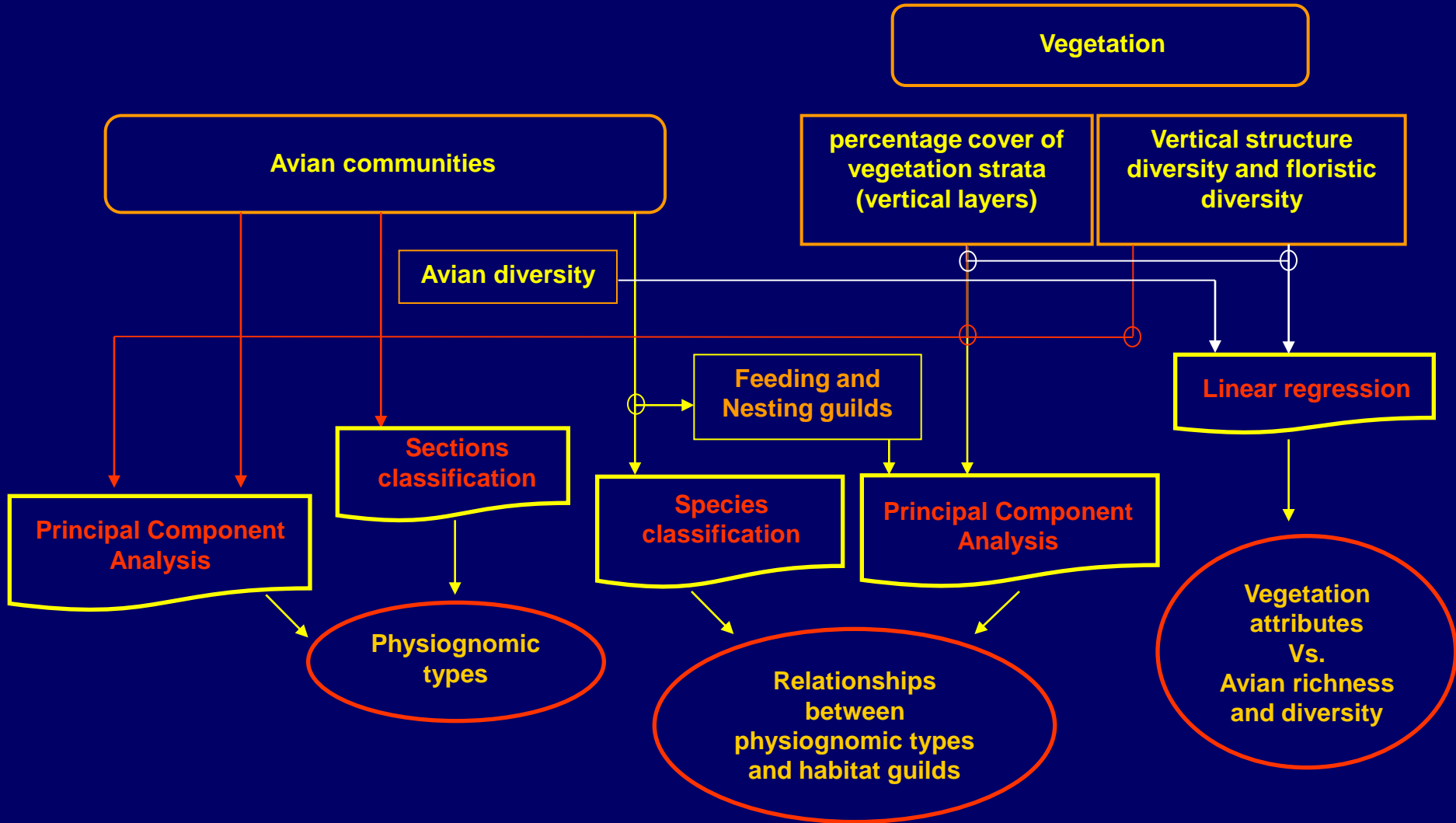
Avian diversity and plant diversity values were obtained using the *Shannon-Wiener diversity index* (MAGURRAN, 1988).

$$H' = - \sum_{i=1}^s p_i \cdot \ln p_i$$

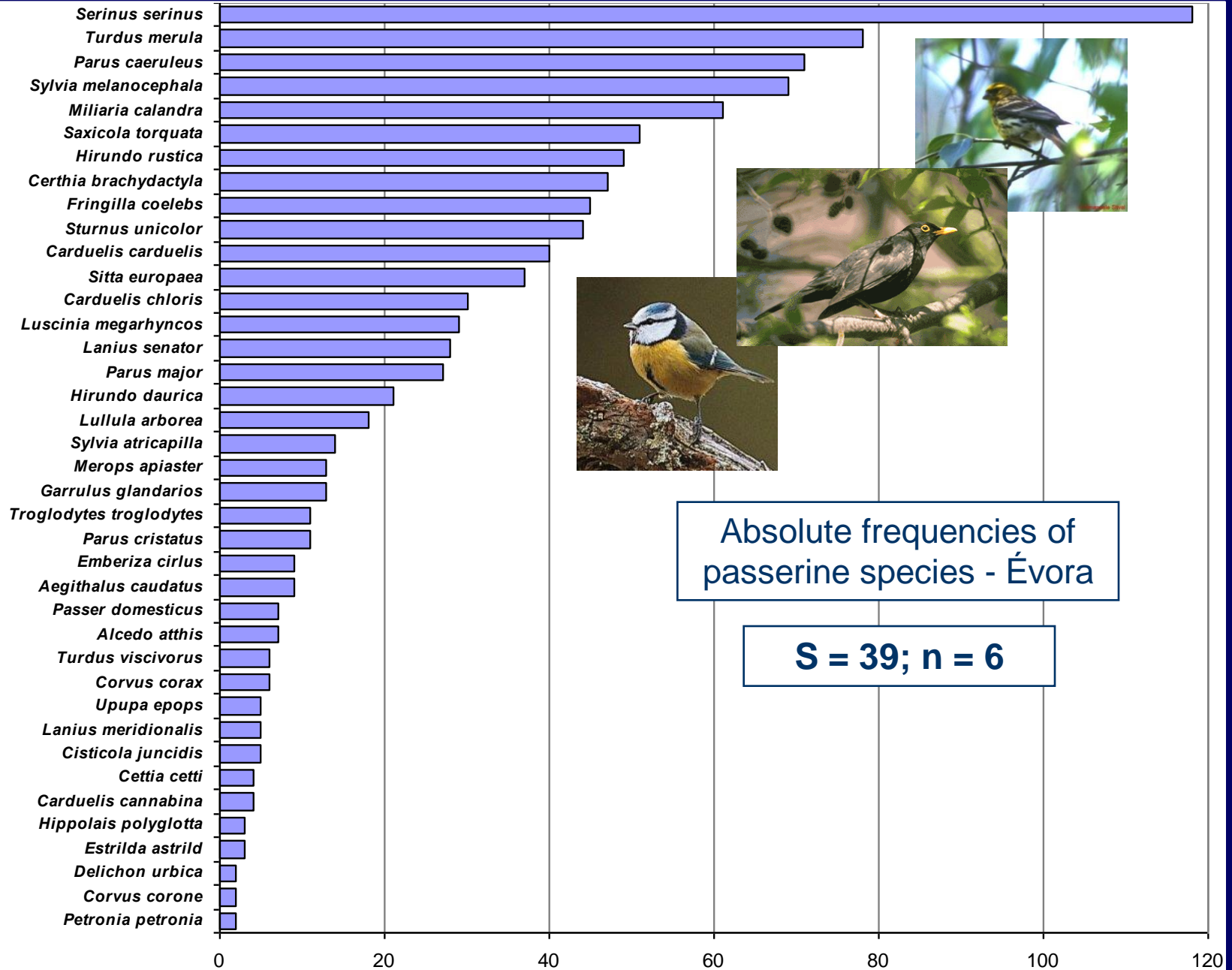
$p_i = n_i/N$ The relative abundance of each species, calculated as the proportion of individuals of a given species to the total number of individuals in the community.

s = number of species (species richness).

Vertical structure of vegetation was measured using the *Foliage Height Diversity* (ANDERSON & OHMART, 1986)

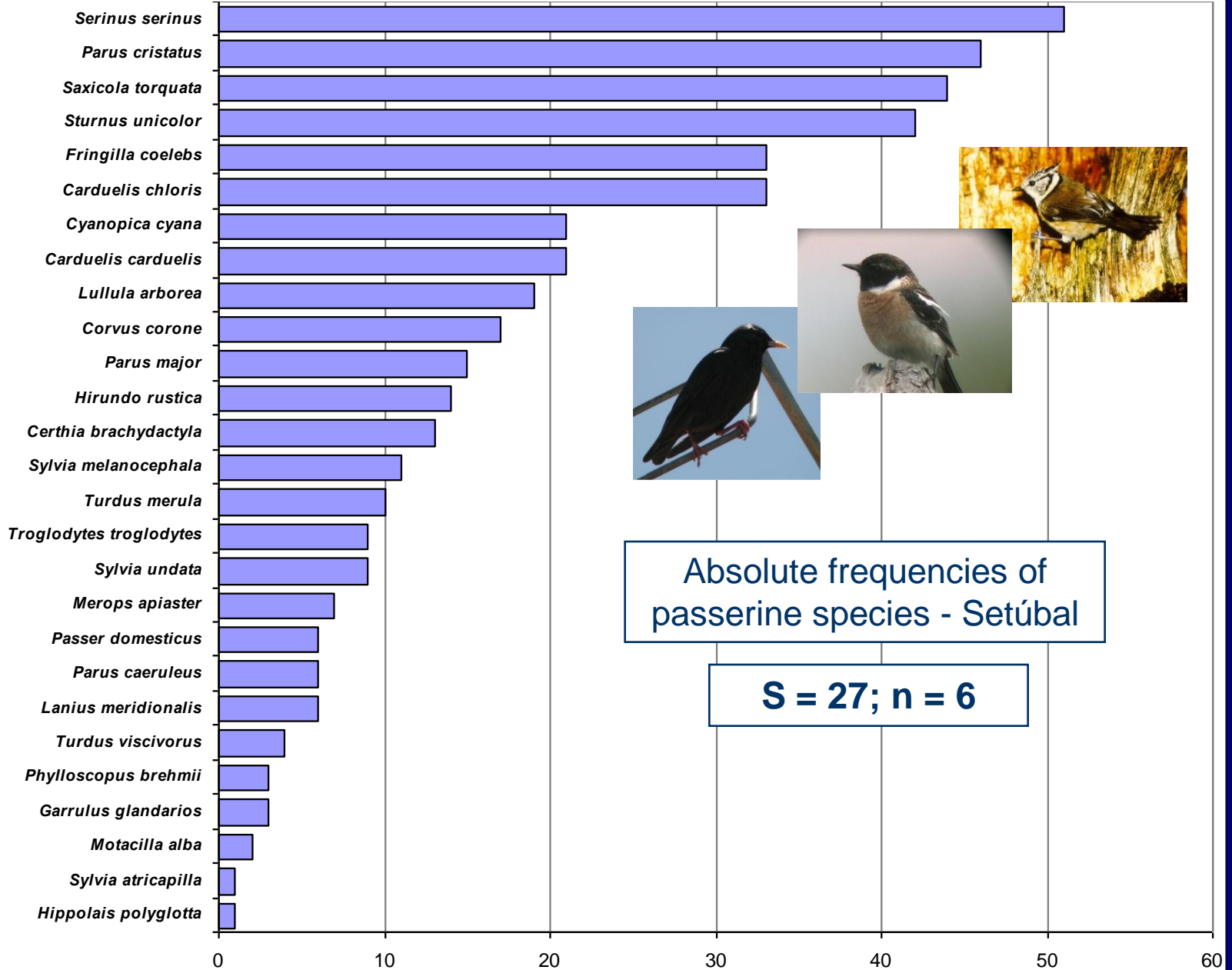


Results



Absolute frequencies of passerine species - Évora

S = 39; n = 6



Principal Component Analysis - Santa Sofia (Évora)

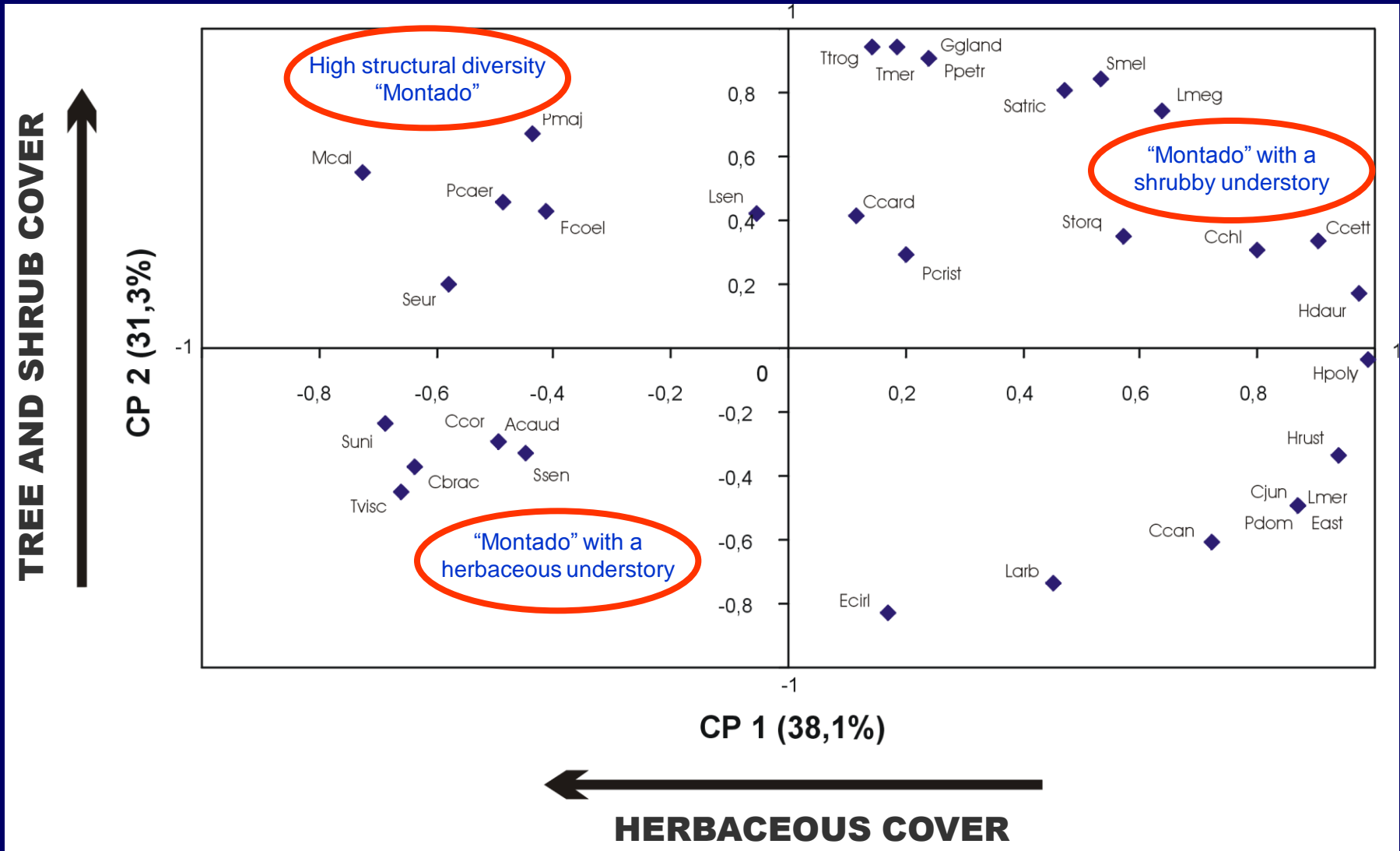
Pearson correlation coefficient - 3 first PCA axes

Variables	PC1	PC2	PC3
Foliage Height diversity	-0,2851	0,7461	0,4223
Floristic diversity	0,4490	0,7880	0,3922
Tree cover (%)	-0,2066	0,8158 *	-0,0124
Shrub cover (%)	0,1874	0,9678 **	-0,0008
Herbaceous cover (%)	-0,7929*	0,0428	0,4135
Eigenvalue	12,96	10,65	6,04
Variance explained (%)	38,1	31,3	17,8
Cumulative variance (%)	38,1	69,4	87,2

*p<0,05; **p<0,01; ***p<0,001

Principal Component Analysis - Santa Sofia (Évora)

Species ordination - PC1 and PC2



Principal Component Analysis - Marco do Grilo (Setúbal)

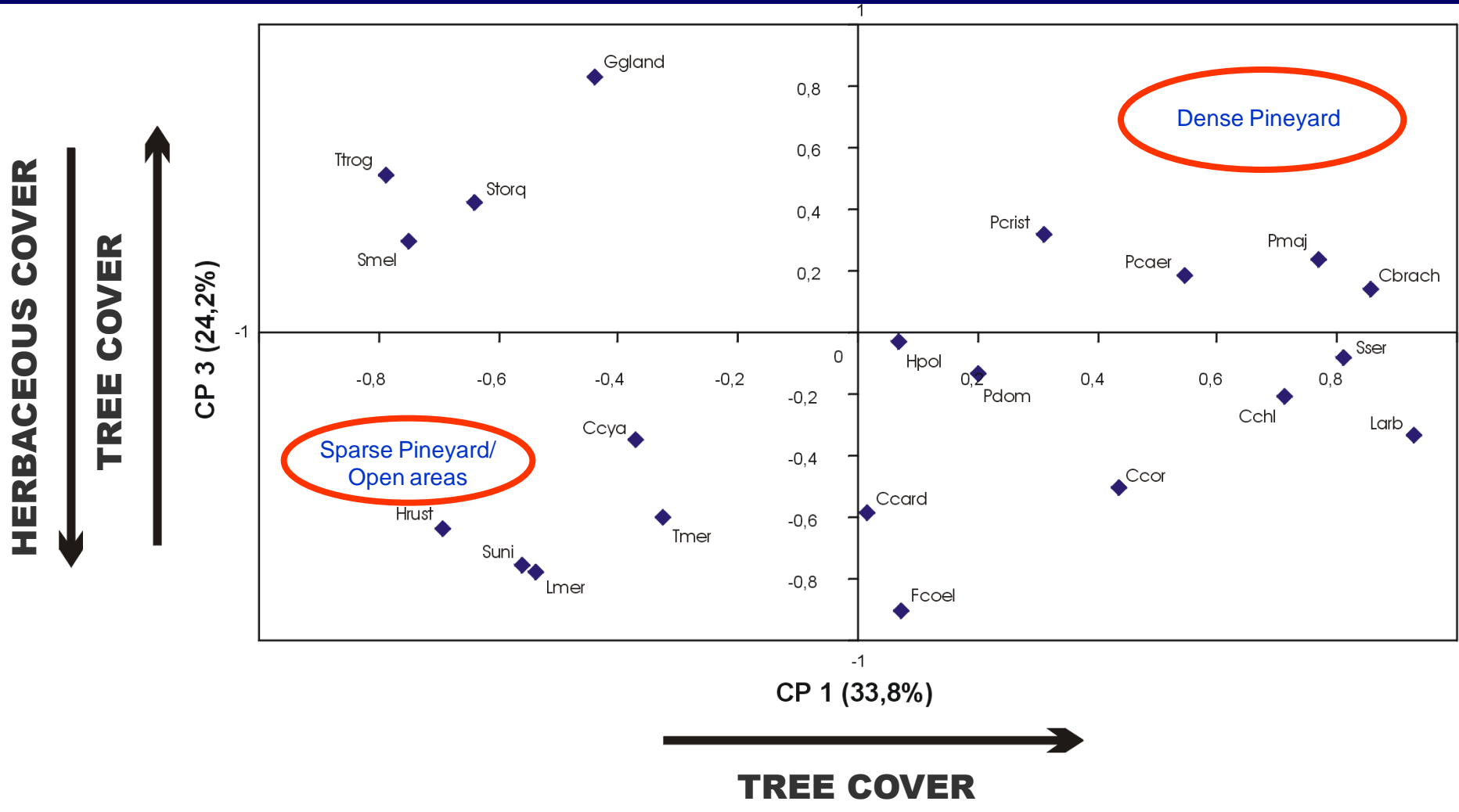
Pearson correlation coefficient - 3 first PCA axes

Variables	PC1	PC2	PC3
Foliage Height diversity	-0,4697	0,7145	-0,5260
Floristic diversity	-0,9074*	0,7265	-0,5436
Tree cover (%)	0,7875*	-0,7474	0,9456**
Shrub cover (%)	-0,7748	0,3885	-0,1133
Herbaceous cover (%)	-0,5162	0,4973	-0,9876***
Eigenvalue	7,10	6,04	5,07
Variance explained (%)	33,8	28,8	24,2
Cumulative variance (%)	33,8	62,6	86,7

*p<0,05; **p<0,01; ***p<0,001

Principal Component Analysis - Marco do Grilo (Setúbal)

Species ordination - PC1 and PC3

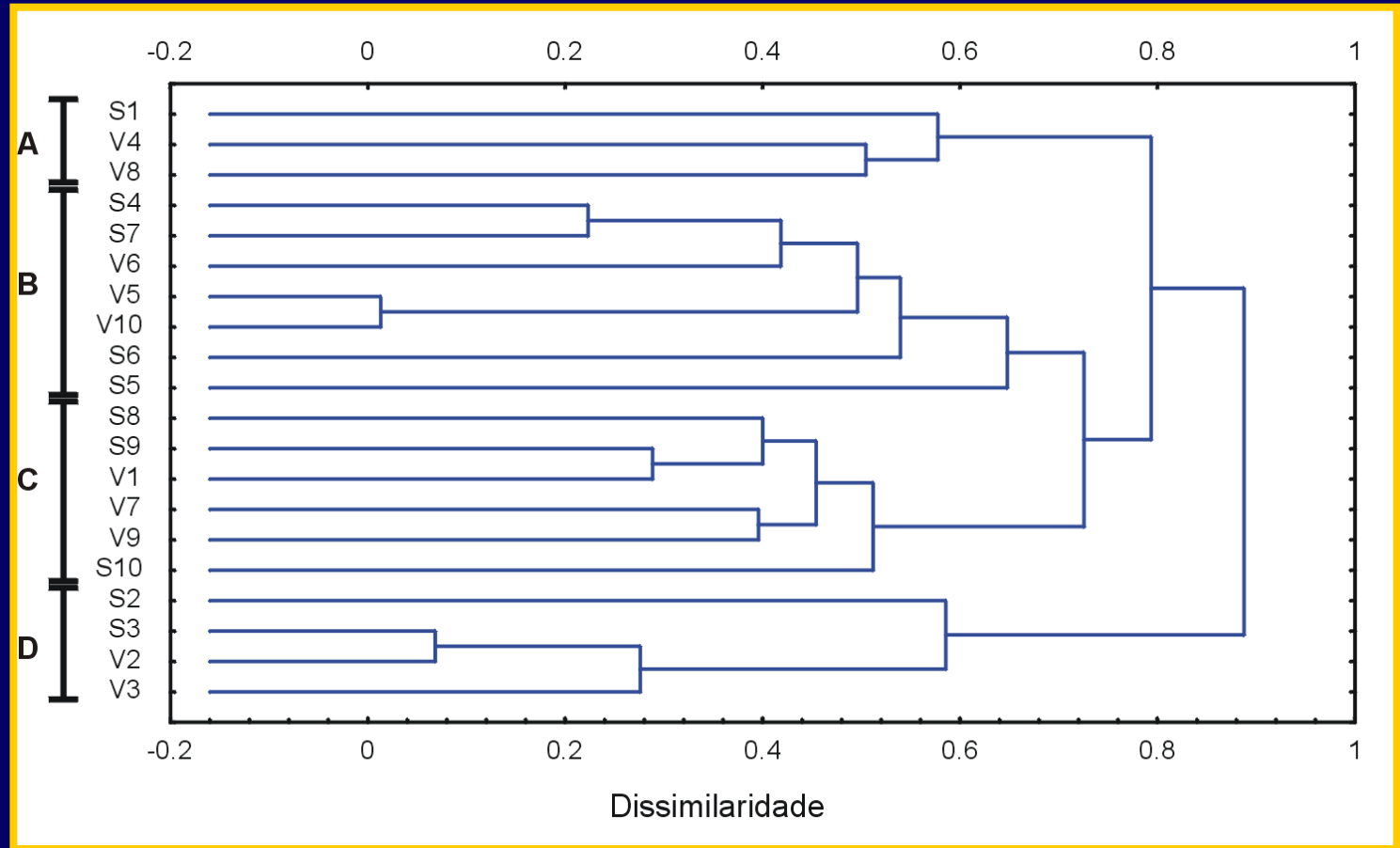


Agglomerative technique (UPGMA) of the dissimilarity values (*Pearson coefficient*) for avian communities

Évora transects

Physiognomic types

- Herbaceous communities
- Sparse “Montado” with herbaceous understory
- Sparse “Montado” with a shrub/herbaceous mosaic
- Different types of “Montado”



Legend: letters - transects, numbers - sections

Agglomerative technique (UPGMA) of the dissimilarity values (*Pearson coefficient*) for avian communities

Setúbal transects

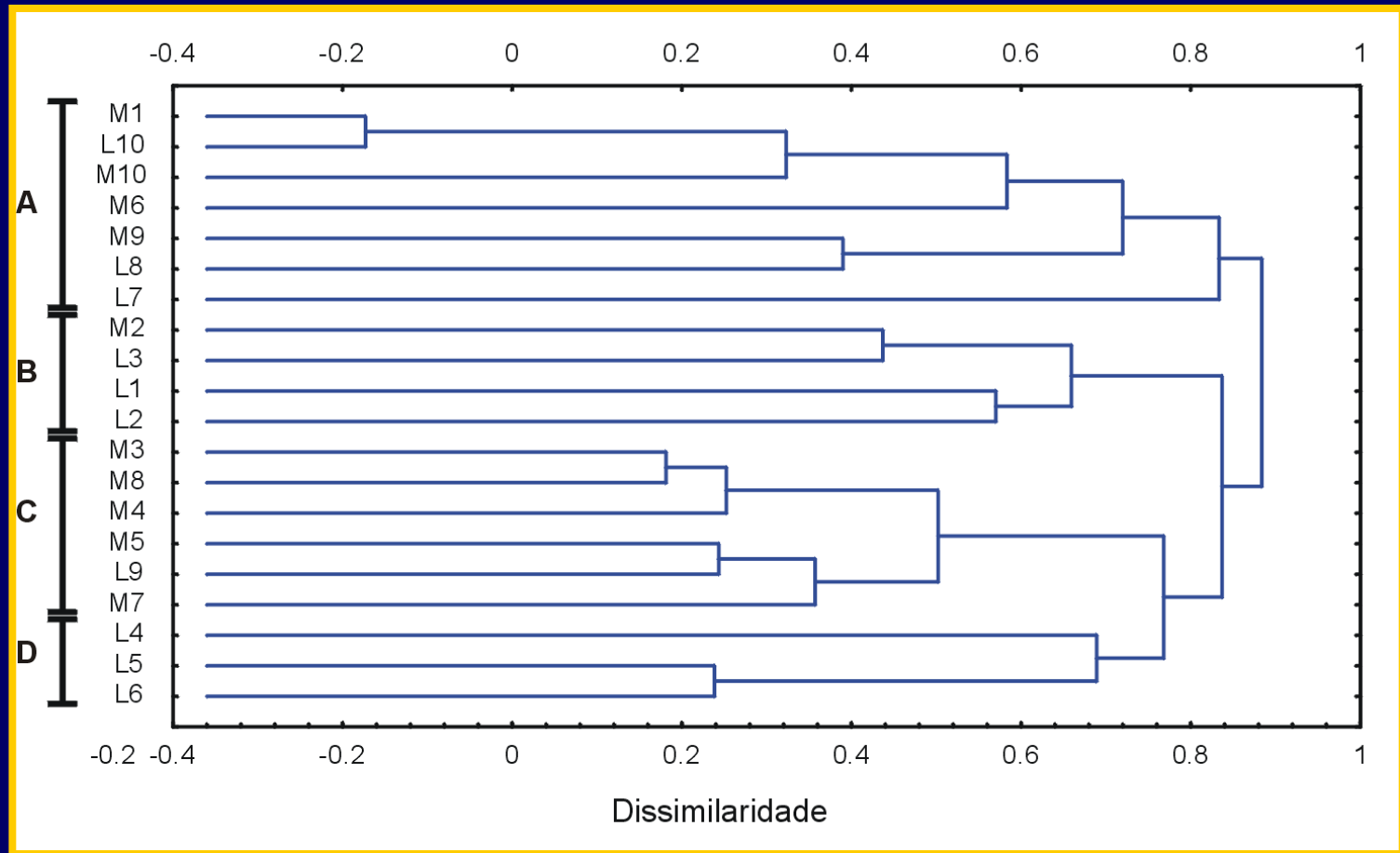
Physiognomic types

Medium density
Pineyard with a
shrubby understory

Sparse Pineyard
with a high density
shrubby understory

High density
Pineyard

Shrub communities



Legend: letters - transects, numbers - sections

Conclusions

Relationships between avian communities and vegetation measures

Évora

- ➔ The main feature that influences the passerines distribution seems to be the understory characteristics.
- ➔ The Classification Analysis confirmed the results obtained with the PCA, addressing the importance of the dominance/co-dominance of the shrub and herbaceous layers in the differentiation of the avian communities.

Setúbal

- ➔ The tree cover density is the variable that better explains the differentiation of the avian communities.

Relationships between the vegetation attributes and the avian diversity

➔ Didn't exist a relationship between the vertical diversity of vegetation and the avian diversity in the studied agroforestry systems.

Évora

➔ For the “Montado” system, a increase of the tree cover is associated to a increase in avian richness and diversity, possibly due to the existence of different habitat structures.