

1st GYPSUM ECOSYSTEM RESEARCH CONFERENCE

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Different roles of shrubs in spatially structuring the soil seed bank in semi-arid gypsum plant communities of NE Spain.

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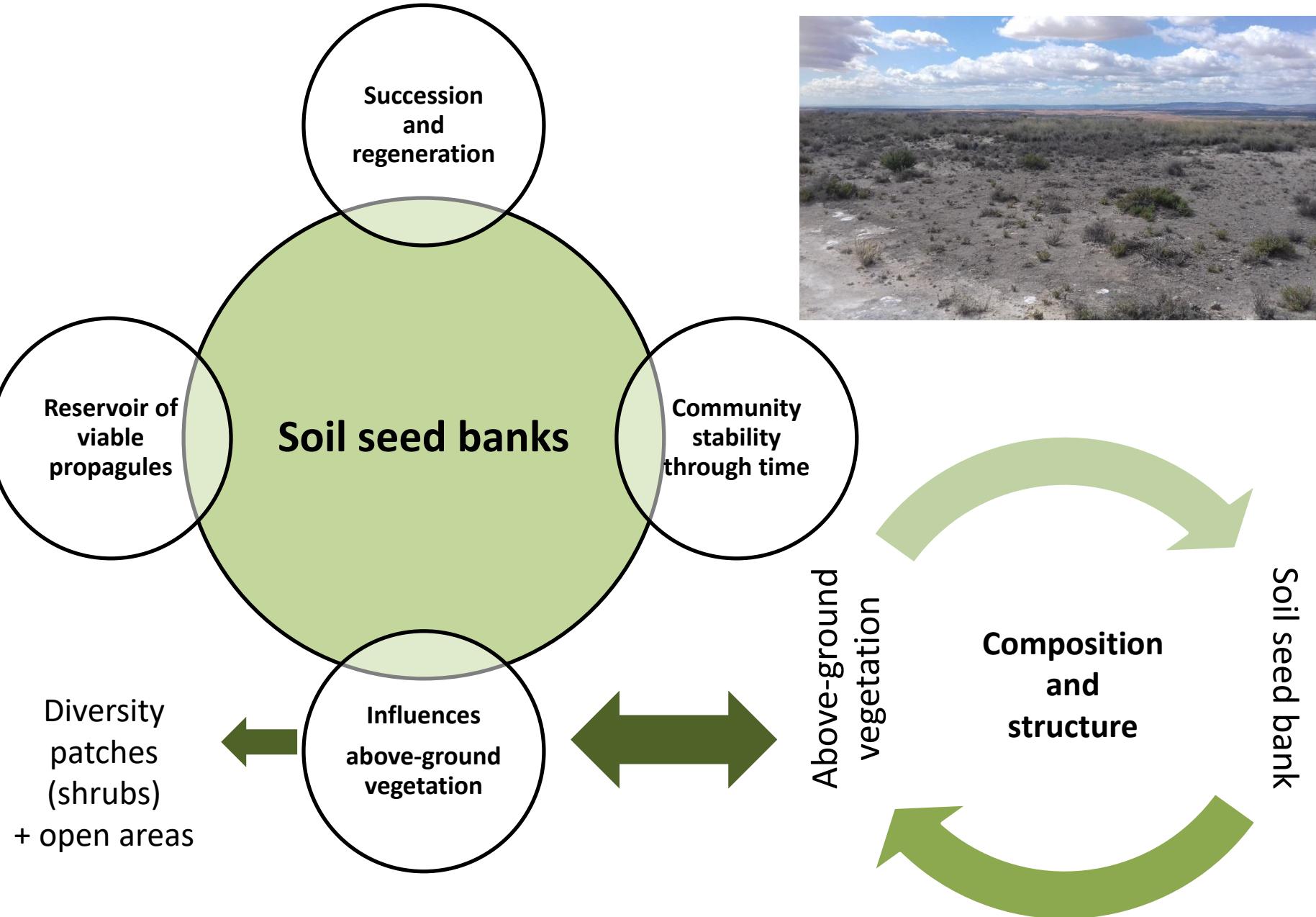
<http://www.ipe.csic.es/foronda>



INTRODUCTION



Background

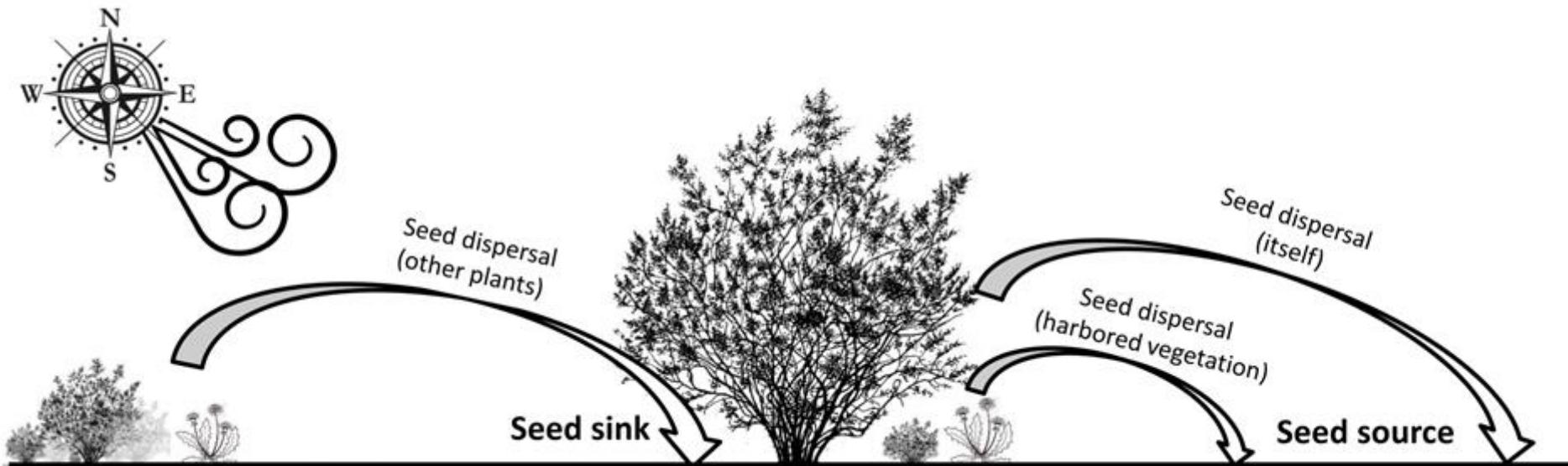


Objective and hypotheses

Objective

To study the role that defined shrub species play on the spatial structure of the soil seed bank in gypsum plant communities, acting as either seed sinks or seed sources.

Hypotheses

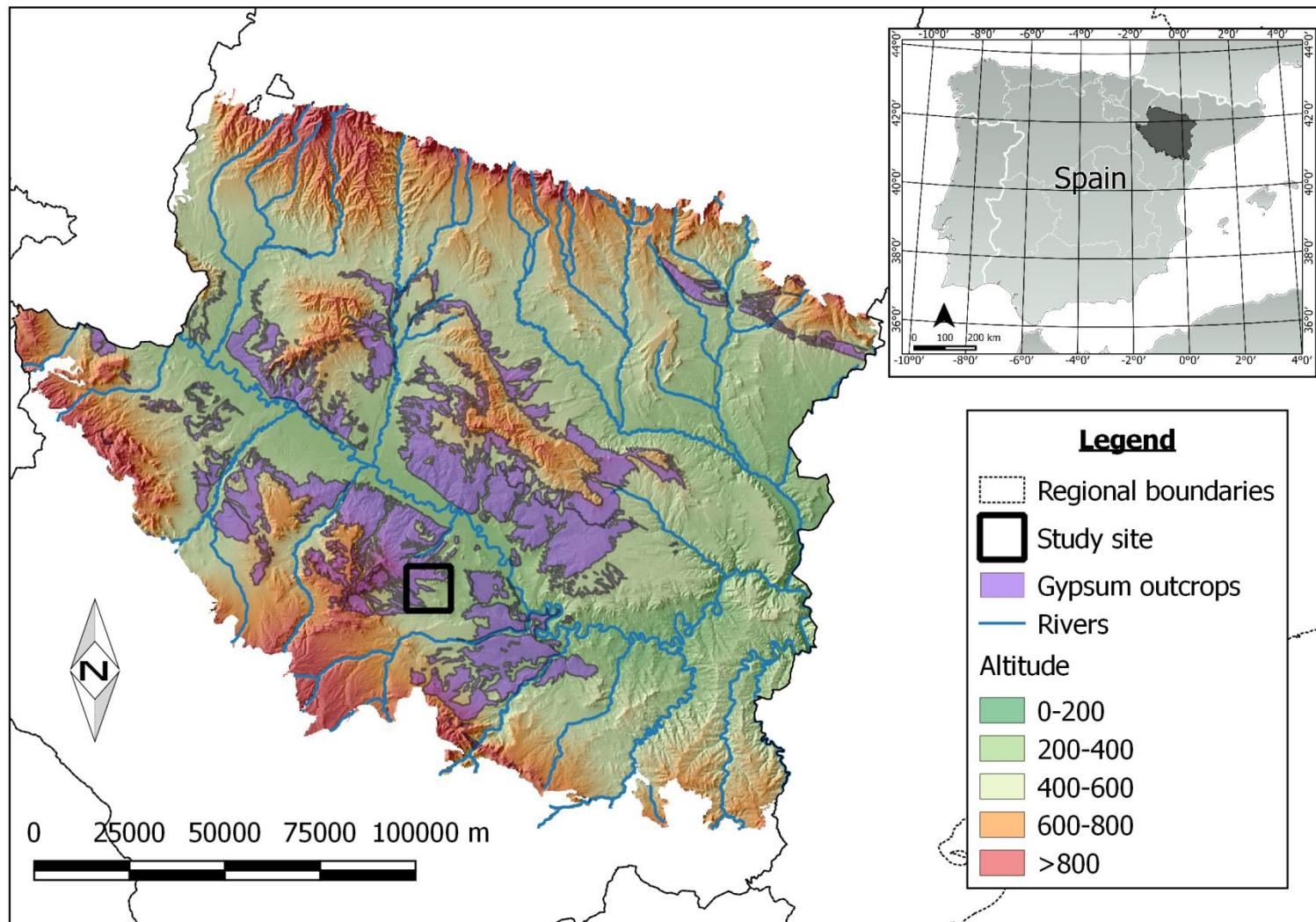


METHODS



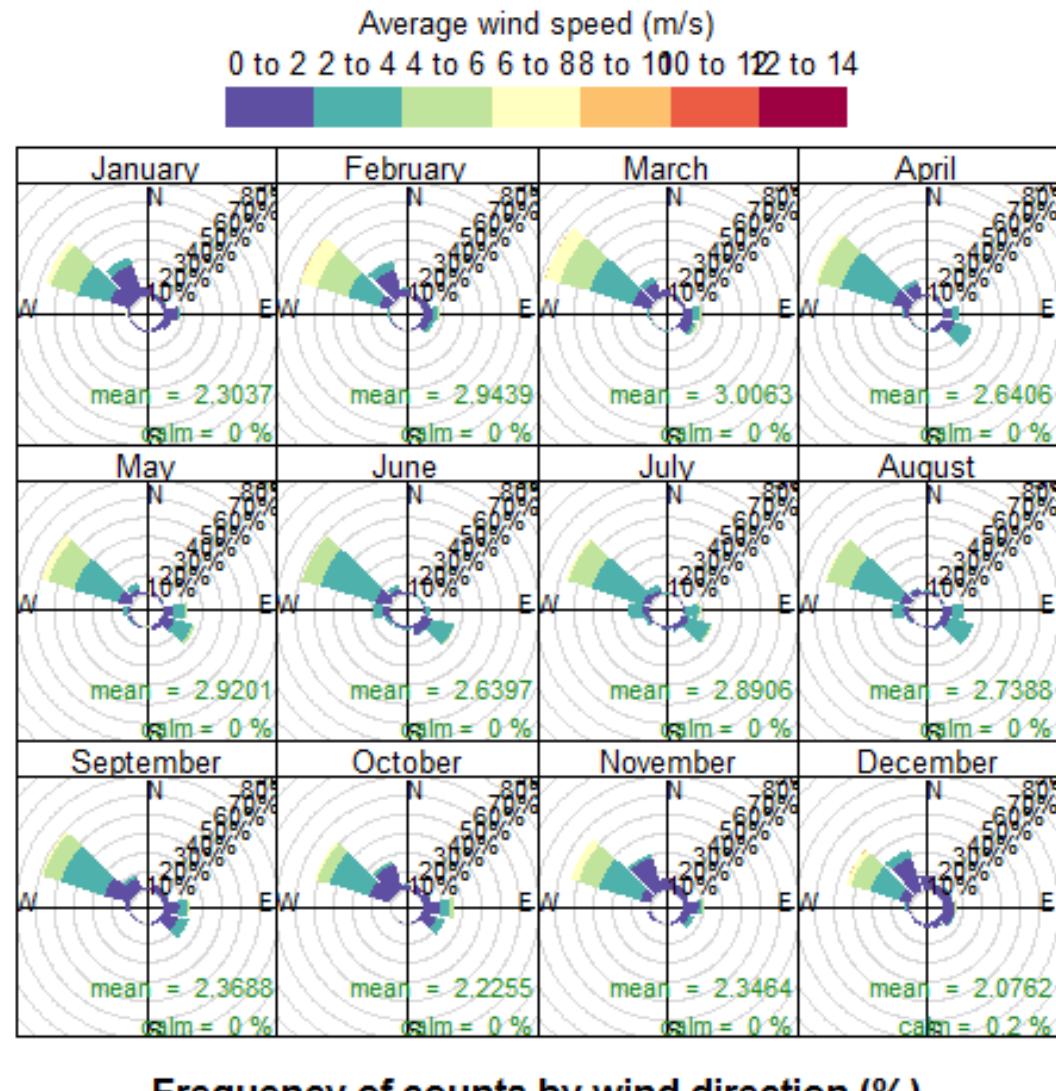
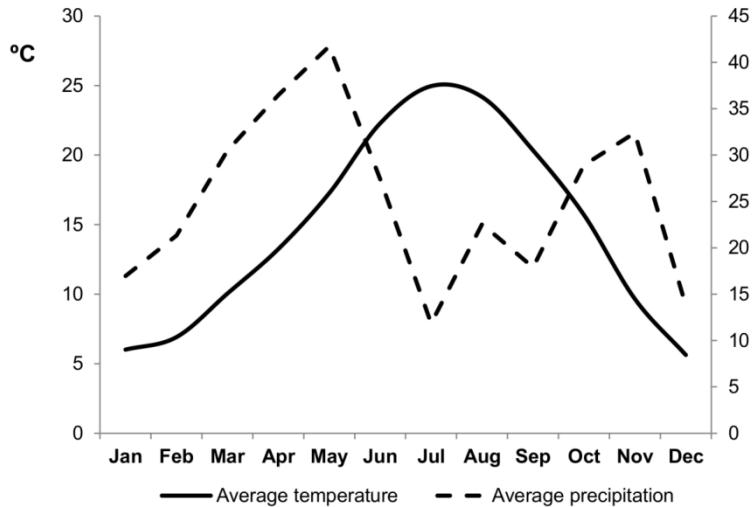
Study site

Gypsum outcrops of the Middle Ebro Valley (NE Spain)
Wildlife Reserve “La Lomaza de Belchite”



Study site

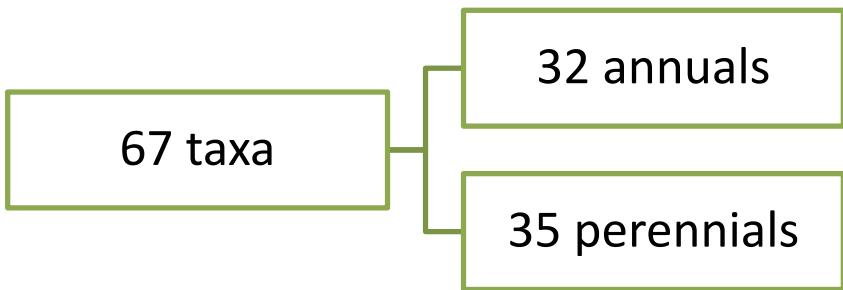
Z02 Belchite
30S / 690604 / 4580150 / 328 m a.s.l.
Zaragoza
[2004 - 2017] + 14.7 °C 302 mm



Frequency of counts by wind direction (%)

Target plant community

Species pool



| Family | N species |
|-------------------------|-----------|
| <i>Asteraceae</i> | 10 |
| <i>Boraginaceae</i> | 2 |
| <i>Brassicaceae</i> | 4 |
| <i>Campanulaceae</i> | 1 |
| <i>Caryophyllaceae</i> | 3 |
| <i>Chenopodiaceae</i> | 1 |
| <i>Cistaceae</i> | 4 |
| <i>Crassulaceae</i> | 1 |
| <i>Cruciferae</i> | 1 |
| <i>Ephedraceae</i> | 1 |
| <i>Fabaceae</i> | 7 |
| <i>Geraniaceae</i> | 1 |
| <i>Labiatae</i> | 4 |
| <i>Liliaceae</i> | 2 |
| <i>Linaceae</i> | 2 |
| <i>Plantaginaceae</i> | 1 |
| <i>Poaceae</i> | 12 |
| <i>Polygalaceae</i> | 2 |
| <i>Primulaceae</i> | 2 |
| <i>Resedaceae</i> | 1 |
| <i>Rubiaceae</i> | 1 |
| <i>Scrophulariaceae</i> | 2 |
| <i>Umbelliferae</i> | 2 |

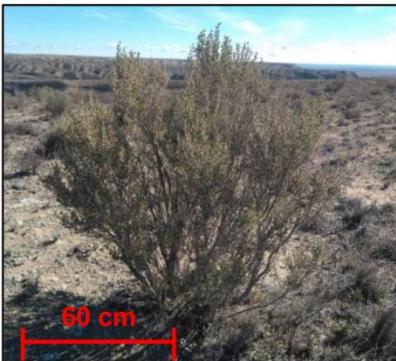
Target species

The most abundant shrubs and subshrubs in the community

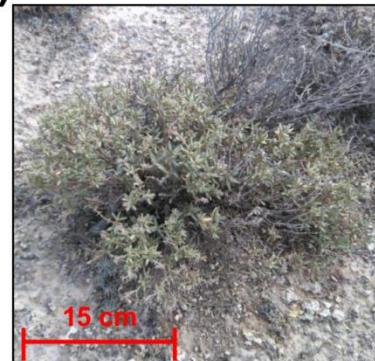
A)



B)



C)



D)



| | Species | Family | Gypsophily | Life form | Architecture | Height (cm) |
|----|--|------------------------|------------|------------------|--------------|-------------|
| A) | <i>Gypsophila struthium</i> Loefl. subsp. <i>hispanica</i> (Willk.) G. López | <i>Caryophyllaceae</i> | Gypsophile | Nanophanerophyte | Cushion-like | 47 |
| B) | <i>Ononis tridentata</i> L. | <i>Fabaceae</i> | Gypsophile | Nanophanerophyte | Erect | 53 |
| C) | <i>Helianthemum squatum</i> L. | <i>Cistaceae</i> | Gypsophile | Chamaephyte | Cushion-like | 21 |
| D) | <i>Thymus vulgaris</i> L. | <i>Labiatae</i> | Gypsovag | Chamaephyte | Erect | 25 |

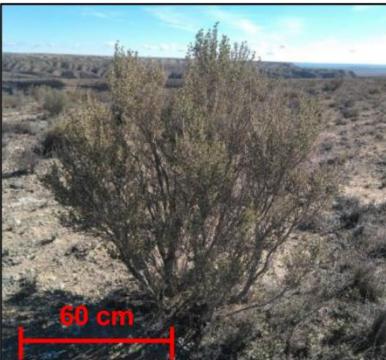
Target species

The most abundant shrubs and subshrubs in the community

A)



B)



C)

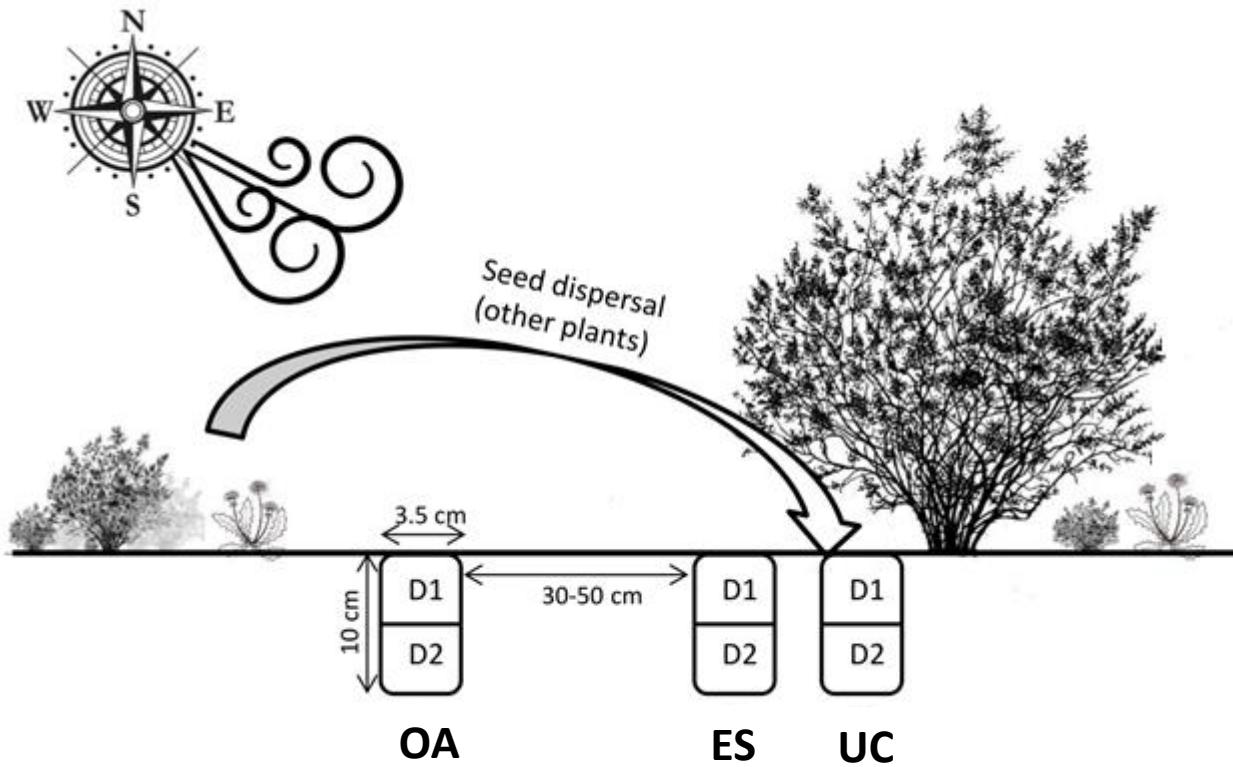


D)



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Soil seed bank sampling



- Performed in September 2015, after seeds shedding
- In the direction of the main winds
- 3 microsites associated to shrubs (OA, ES, UC)
- 25 individuals / target species
- Plant height was measured



Seedling emergence method

600 samples

- 4 target species (*G. struthium*, *O. tridentata*, *H. squamatum* and *T. vulgaris*)
- 25 individuals / target species
- 3 microsites (UC, ES, OA)
- 2 depths (D1, D2)



Seed-rich samples

- Washing
- Sieving



Trays

- Commercial substrate
- Nylon cloth

Greenhouse



Irrigation



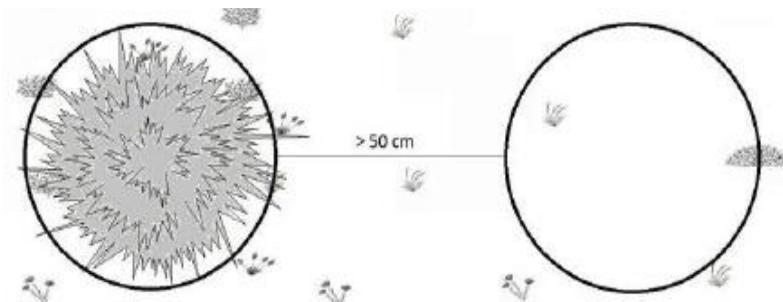
Monitoring



- 3 times a week
- After 12 weeks: GA3

- Germination / survival
- Once a week
- 20 weeks

Vegetation survey



- Performed in the growing season → Spring
 - All individuals of annuals and perennials occurring inside the ring were recorded
 - 25 individuals / target species
 - Microsites
 - Canopy = UC + ES
 - Open = OA
- A large orange arrow points from the 'Microsites' section to the right side of the slide.
- Paired rings
 - Adjustable to the plant area

Data analyses

GLMs with Poisson error distribution

- Microsite
- Target species
- Plant height

Effect on


- Richness of annuals
- Richness of perennials
- Abundance of annuals
- Abundance of perennials

Sørensen's index of similarity

$$SSI = \frac{2w}{a+b}$$

w = total shared sp.
a = total sp. seed bank
b = total sp. vegetation

SSI = 1; share all sp.
SSI = 0; no sp. shared

Presence-absence data

Calculated for each target species – open area replicate

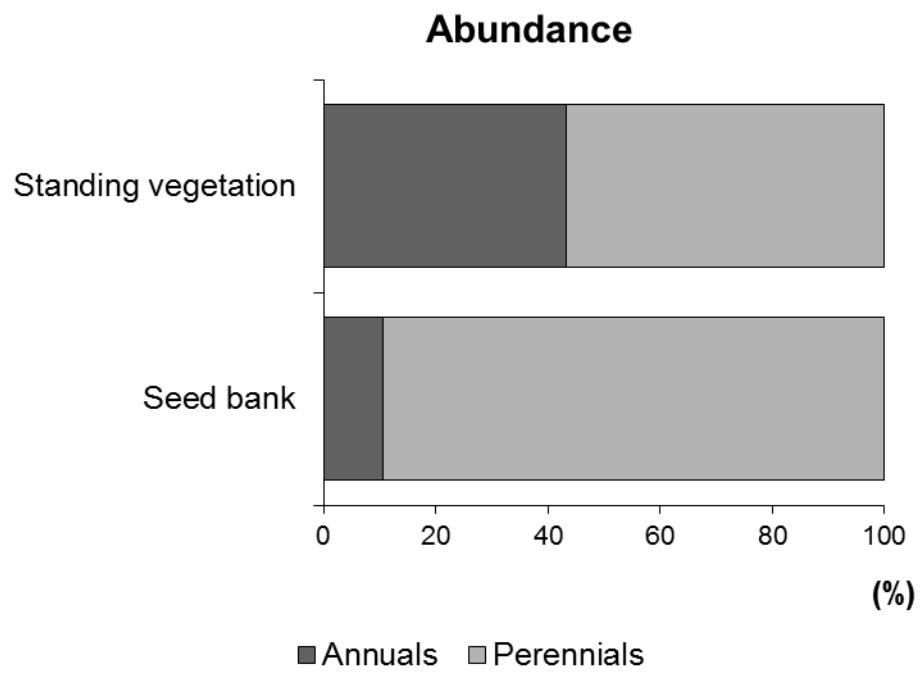
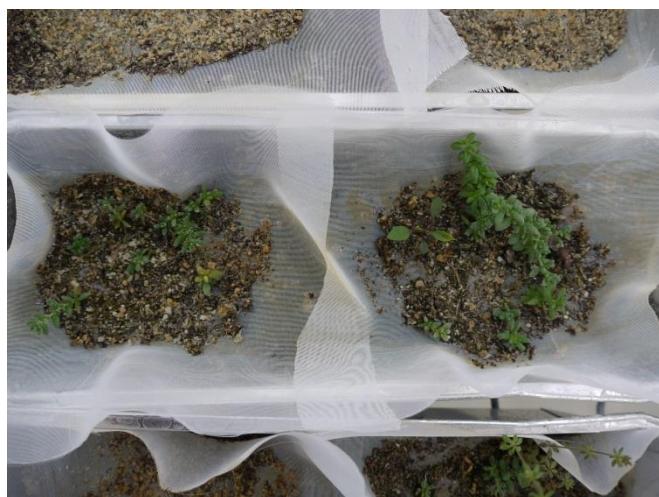
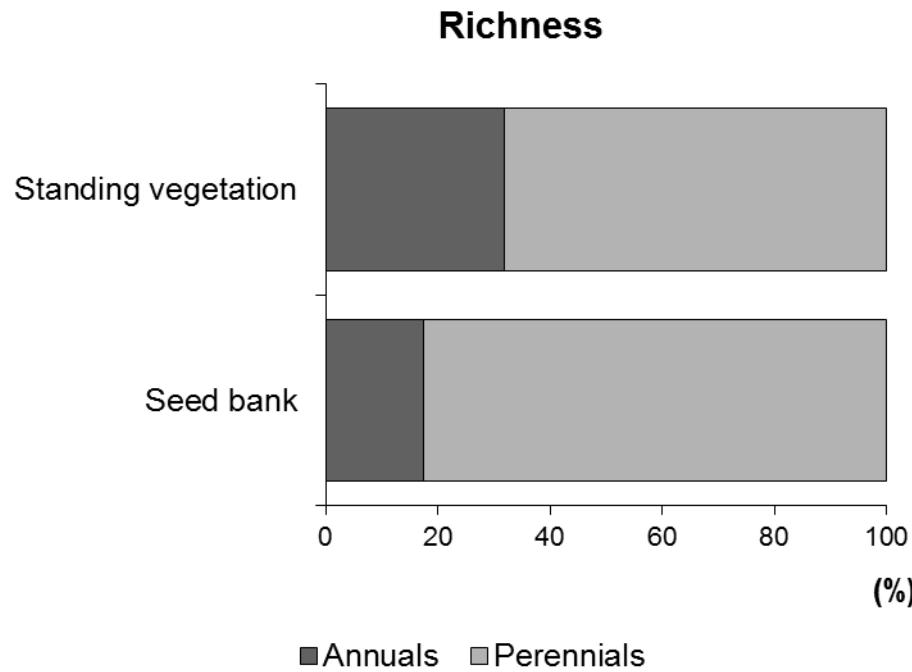
Kruskal-Wallis

Differences in SSI among target species

RESULTS



Composition of the soil seed bank and the standing vegetation



Seed density (individuals/m²)

| Annual species | | Seed bank Vegetation | |
|----------------|---|----------------------|-------|
| 1 | <i>Chaenorrhinum rubrifolium</i> (Robill. & Castagne ex DC.) Fourr. | 202702.7 | 8.27 |
| 2 | <i>Filago pyramidalis</i> L. | 24948.02 | 6.64 |
| 3 | <i>Asterolinon linum-stellatum</i> (L.) Duby | 6237.01 | 18.75 |
| 4 | <i>Linum strictum</i> L. | 6237.01 | 0.51 |
| 5 | <i>Galium verrucosum</i> Huds. | 4158 | 0.05 |
| 6 | <i>Reseda stricta</i> Pers. | 3118.5 | 0 |
| 7 | <i>Bromus rubens</i> L. | 1039.5 | 1.93 |
| 8 | <i>Cerastium pumilum</i> Curtis | 1039.5 | 0.11 |
| 9 | <i>Campanula fastigiata</i> Dufour ex A. DC | 1039.5 | 0 |
| 10 | <i>Clypeola jonthlaspi</i> L. | 1039.5 | 0 |
| 11 | Unknown annual | 1039.5 | 0 |
| 12 | <i>Desmazeria rigida</i> (L.) Tutin | 0 | 1.8 |
| 13 | <i>Narduroides salzmannii</i> (Boiss.) Rouy | 0 | 1.2 |
| 14 | <i>Brachypodium distachyon</i> (L.) P. Beauv. | 0 | 0.99 |
| 15 | <i>Trisetum loeflinngianum</i> (L.) C. Presl. | 0 | 0.95 |
| 16 | <i>Linaria arvensis</i> (L.) Desf. | 0 | 0.94 |
| 17 | <i>Neatostema apulum</i> (L.) I.M.Johnst. | 0 | 0.21 |
| 18 | <i>Hippocrepis ciliata</i> Willd. | 0 | 0.16 |
| 19 | <i>Bupleurum semicompositum</i> L. | 0 | 0.11 |
| 20 | <i>Aegilops geniculata</i> Roth. | 0 | 0.05 |
| 21 | <i>Diplotaxis ilorcitana</i> (Sennen) Aedo. Mart.-Laborde & Muñoz Garm. | 0 | 0.05 |
| 22 | <i>Helianthemum salicifolium</i> (L.) Mill. | 0 | 0.05 |
| 23 | <i>Trigonella monspeliaca</i> L. | 0 | 0.04 |
| 24 | <i>Alyssum alyssoides</i> (L.) L. | 0 | 0.02 |
| 25 | <i>Anagallis arvensis</i> L. | 0 | 0.02 |

Seed density (individuals/m²)

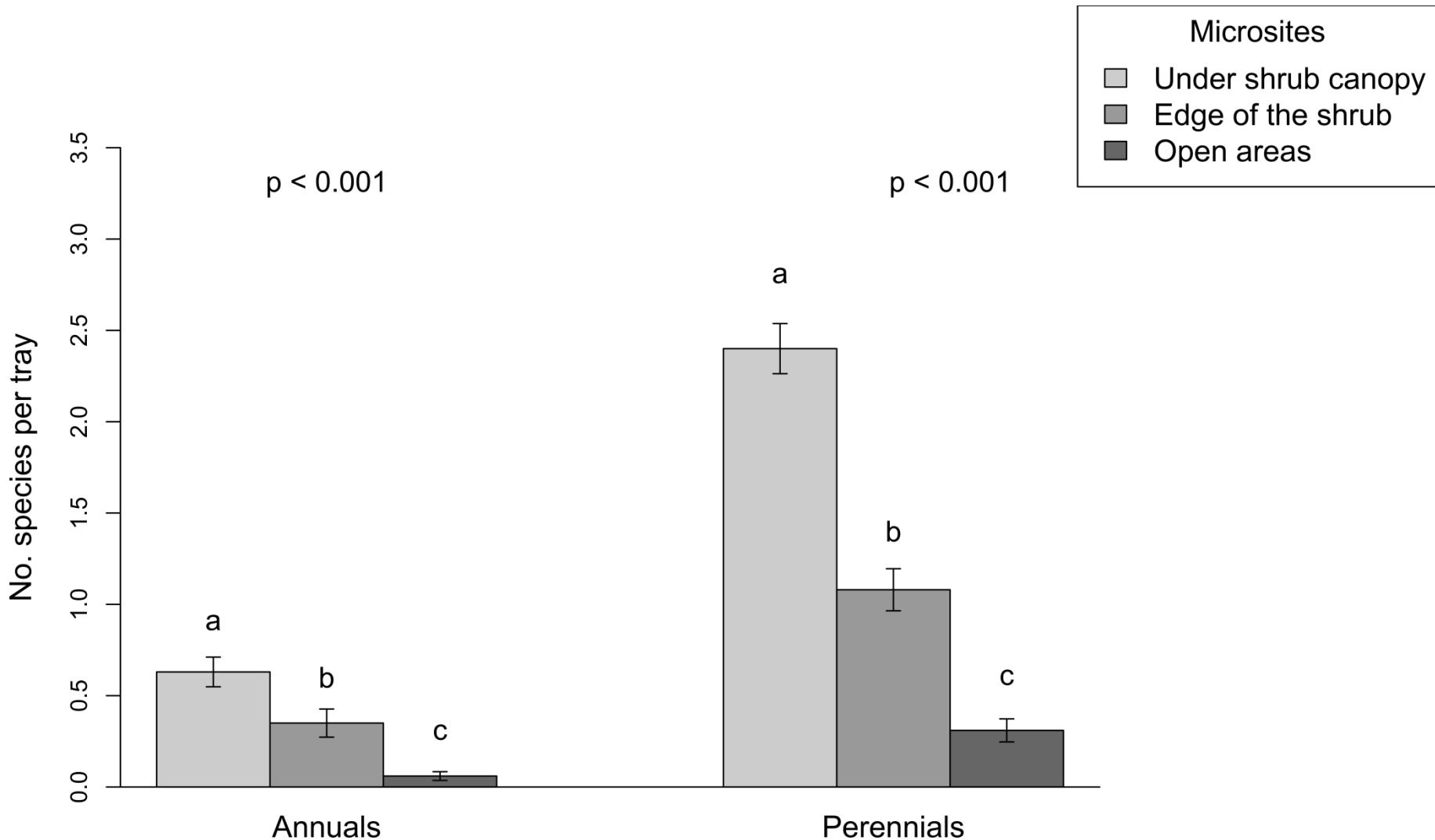
| Perennial species | | Seed bank | Vegetation |
|-------------------|---|-----------|------------|
| 1 | <i>Herniaria fruticosa</i> L. | 1150727.7 | 1.59 |
| 2 | <i>Helianthemum squatum</i> (L.) Pers. | 116424.12 | 7.63 |
| 3 | <i>Helichrysum stoechas</i> (L.) Moench | 113305.61 | 2.6 |
| 4 | <i>Thymus</i> sp. | 92515.59 | 0.97 |
| 5 | <i>Stipa</i> sp. | 23908.52 | 3.55 |
| 6 | <i>Helianthemum syriacum</i> (Jacq.) Dum. Cours | 21829.52 | 2 |
| 7 | <i>Plantago albicans</i> L. | 20790.02 | 26.38 |
| 8 | <i>Gypsophila struthium</i> Loefl. subsp. <i>hispanica</i> (Willk.) G.López | 12474.01 | 0.02 |
| 9 | <i>Sonchus tenerrimus</i> L. | 10395.01 | 0 |
| 10 | <i>Linum suffruticosum</i> L. | 8316.01 | 0.23 |
| 11 | <i>Launaea lanifera</i> Pau | 7276.51 | 0.3 |
| 12 | <i>Brachypodium retusum</i> (Pers.) P. Beauv. | 7276.51 | 0.02 |
| 13 | <i>Koeleria vallesiana</i> (Honck.) Gaudin | 5197.51 | 2 |
| 14 | <i>Teucrium capitatum</i> L. | 5197.51 | 0.18 |
| 15 | <i>Sedum sediforme</i> (Jacq.) Pau | 3118.5 | 0.12 |
| 16 | <i>Sideritis hirsuta</i> L. | 2079 | 0.12 |
| 17 | <i>Moricandia arvensis</i> (L.) DC. | 1039.5 | 0 |
| 18 | <i>Polygala rupestris</i> Pourr. | 0 | 0.42 |
| 19 | <i>Ephedra fragilis</i> Desf. | 0 | 0.34 |
| 20 | <i>Helianthemum violaceum</i> (Cav.) Pers. | 0 | 0.18 |
| 21 | <i>Hedysarum boveanum</i> Bunge ex Basiner | 0 | 0.12 |
| 22 | <i>Lygeum spartum</i> L | 0 | 0.11 |
| 23 | <i>Carduus</i> sp. | 0 | 0.02 |
| 24 | <i>Ononis tridentata</i> L. | 0 | 0.02 |

Effect of shrubs on soil seed bank richness

| | Explanatory variables | DF | Deviance | p-value |
|-------------------|--|----|----------|------------------|
| Annuals | Microsite | 2 | 54.89 | <0.001 |
| | Target species | 3 | 9.14 | <0.05 |
| | Target plant height | 1 | 5.60 | <0.05 |
| | Microsite : Target species | 6 | 2.62 | 0.854 |
| | Microsite : Target plant height | 2 | 0.65 | 0.722 |
| | Target species : Target plant height | 3 | 7.09 | 0.069 |
| | Microsite : Target species : Target plant height | 6 | 1.67 | 0.948 |
| Perennials | Microsite | 2 | 187.05 | <0.001 |
| | Target species | 3 | 0.52 | 0.916 |
| | Target plant height | 1 | 8.75 | <0.01 |
| | Microsite : Target species | 6 | 8.86 | 0.181 |
| | Microsite : Target plant height | 2 | 0.60 | 0.742 |
| | Target species : Target plant height | 3 | 0.28 | 0.964 |
| | Microsite : Target species : Target plant height | 6 | 2.61 | 0.856 |

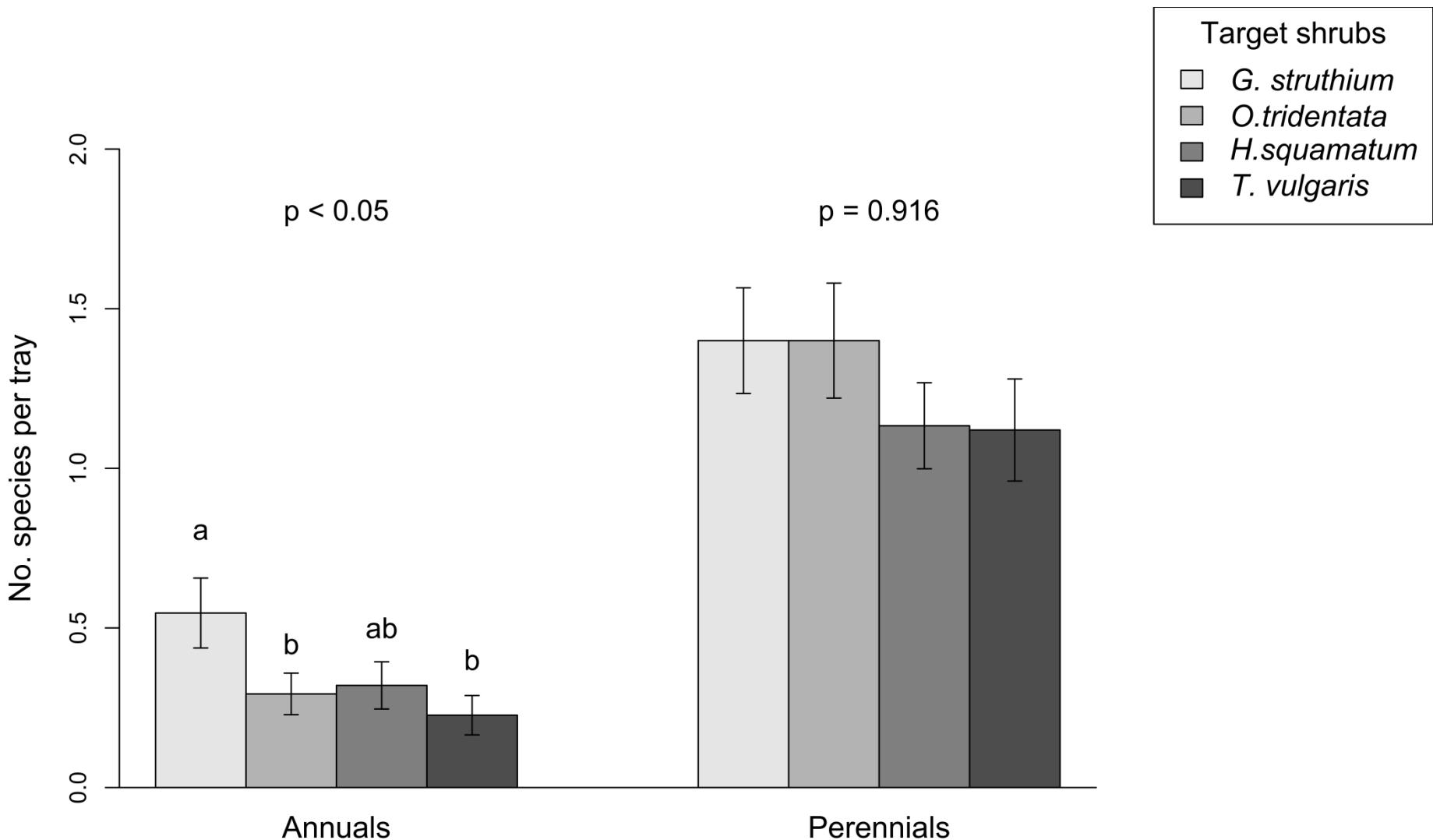
Effect of shrubs on soil seed bank richness

Effect of the microsite



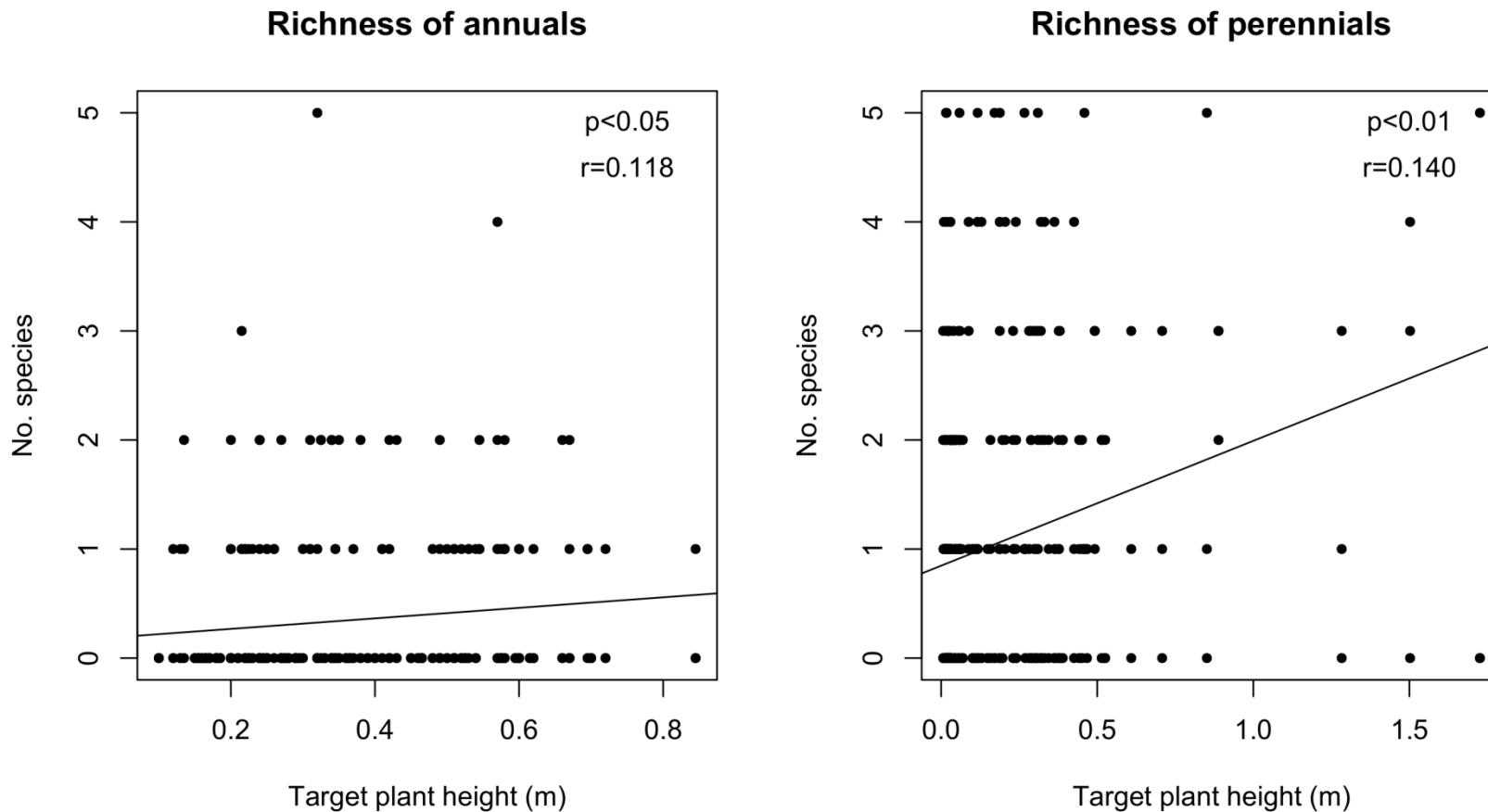
Effect of shrubs on soil seed bank richness

Effect of the target species



Effect of shrubs on soil seed bank richness

Effect of the target species height

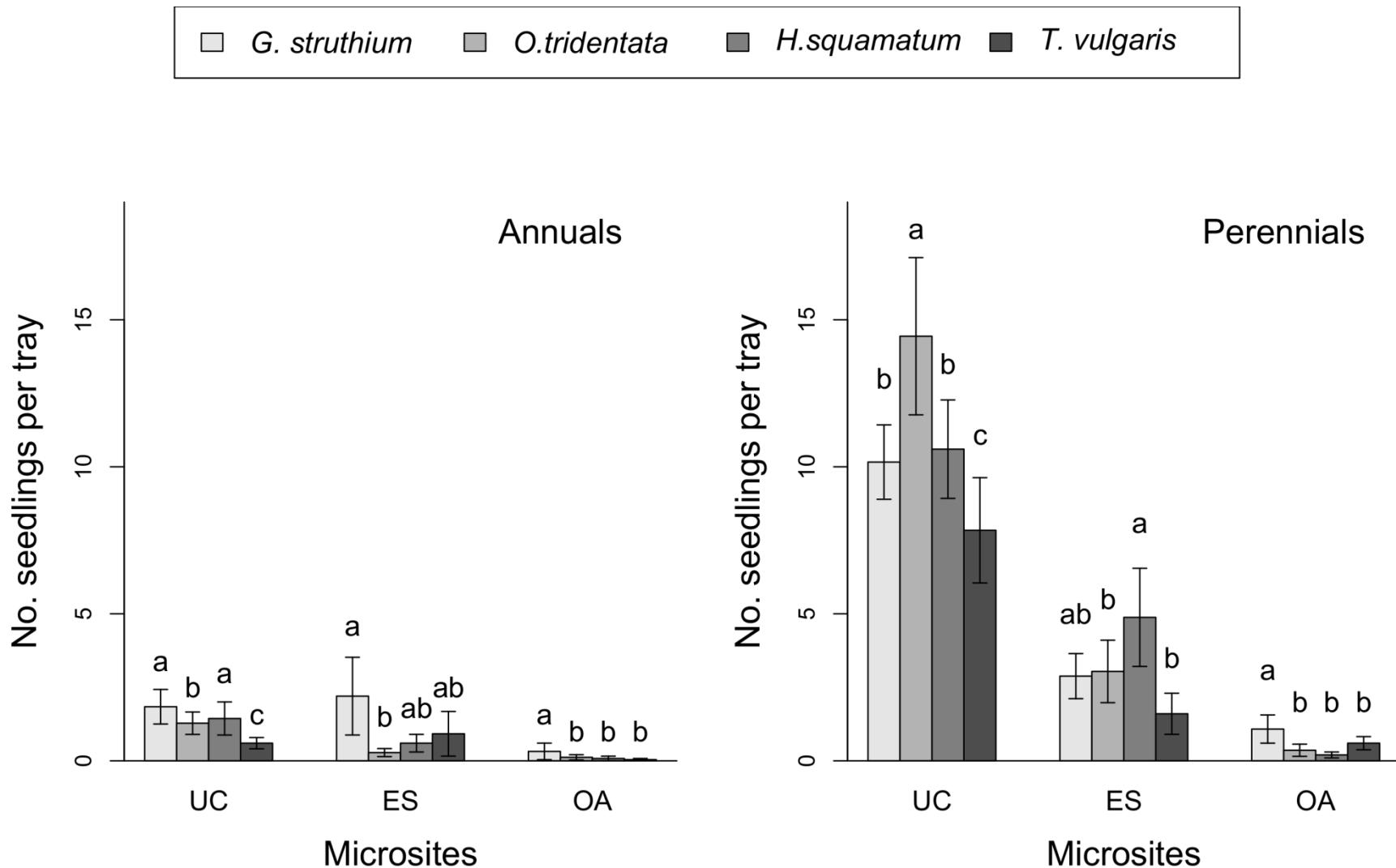


Effect of shrubs on soil seed bank abundance

| | Explanatory variables | DF | Deviance | p-value |
|-------------------|--|----|----------|------------------|
| Annuals | Microsite | 2 | 113.06 | <0.001 |
| | Target species | 3 | 40.01 | <0.001 |
| | Target plant height | 1 | 14.11 | <0.001 |
| | Microsite : Target species | 6 | 25.94 | <0.001 |
| | Microsite : Target plant height | 2 | 4.993 | 0.082 |
| | Target species : Target plant height | 3 | 42.74 | <0.001 |
| | Microsite : Target species : Target plant height | 6 | 8.62 | 0.196 |
| Perennials | Microsite | 2 | 1221.44 | <0.001 |
| | Target species | 3 | 46.28 | <0.001 |
| | Target plant height | 1 | 37.42 | <0.001 |
| | Microsite : Target species | 6 | 53.01 | <0.001 |
| | Microsite : Target plant height | 2 | 6.37 | <0.05 |
| | Target species : Target plant height | 3 | 5.20 | 0.158 |
| | Microsite : Target species : Target plant height | 6 | 6.33 | 0.388 |

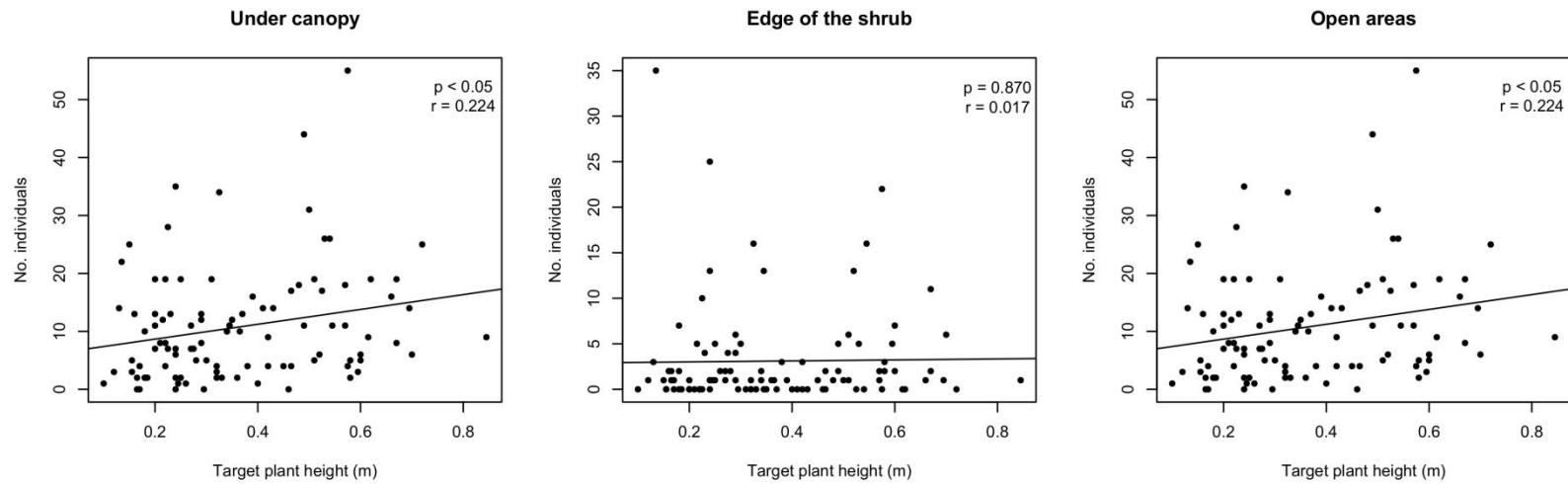
Effect of shrubs on soil seed bank abundance

Effect of the target species per microsite

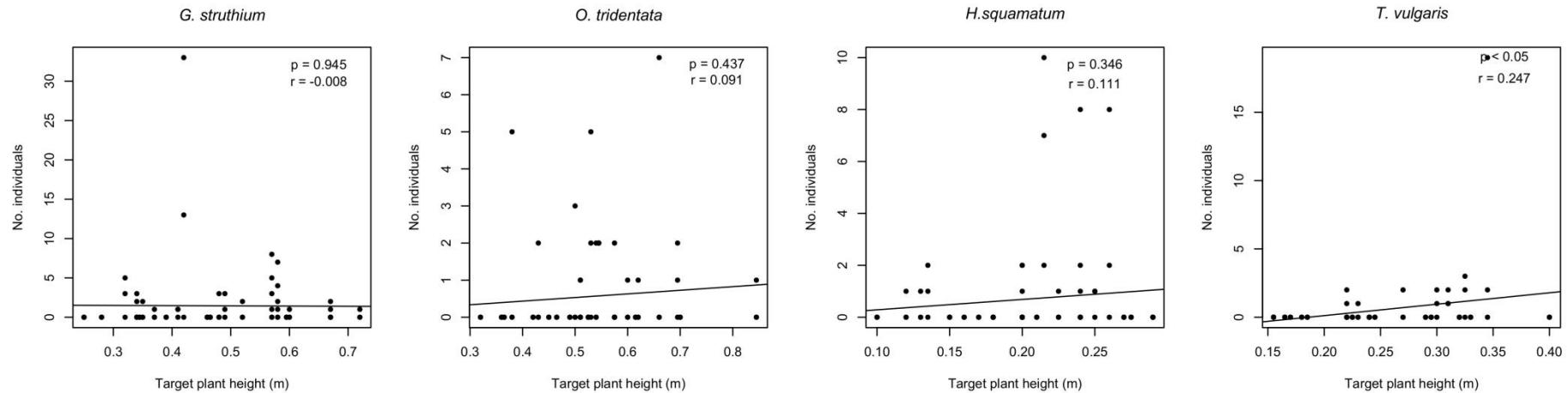


Effect of shrubs on soil seed bank abundance

Effect of the target species height per microsite

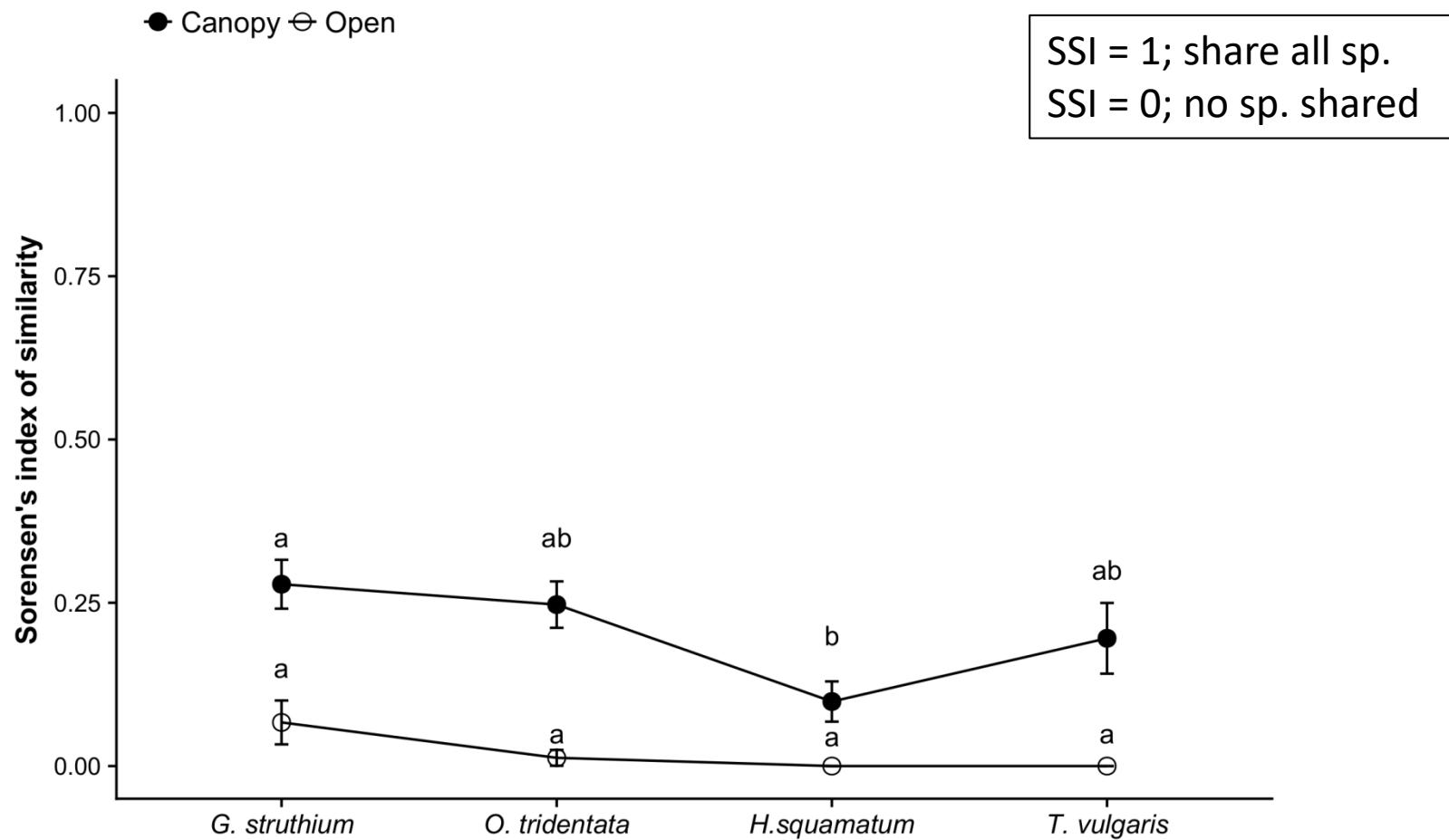


Effect of the height per target species



Shrubs as seed sinks or seed sources?

Similarity in species composition between the soil seed bank and above-ground vegetation



DISCUSSION



What did we find?

- More richness and abundance of seeds under and at the edge of shrubs than in open areas → shrubs accumulate seeds.
- Larger richness and abundance as the taller are shrubs → effect of plant size.
- More richness and abundance of seeds associated to cushion-like shrubs than erect shrubs → effect of plant architecture.
- In general, low similarity between the soil seed bank and above-ground vegetation → shrubs act more as seed traps than seed sources.
- The highest similarity between the soil seed bank and above-ground vegetation under the canopy of shrubs with supposed facilitative role → shrubs with a more significant seed source effect than non facilitative shrubs.
- *Gypsophila struthium* subsp. *hispanica* → the species with the the most significant structuring role, likely due to its seed source effect.

Conclusions

- Shrubs have an important role in structuring the soil seed bank in gypsum plant communities.
- The ability to accumulate seeds depends on shrub architecture.
- The facilitative effect of certain shrubs influence positively their role in structuring the soil seed bank.



Acknowledgements

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- Ramón Reiné



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- Ayuntamiento de Belchite



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MINISTERIO
DE ECONOMÍA, INDUSTRIA
Y COMPETITIVIDAD



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I ❤️ GYPSUM OUTCROPS

THANK YOU
VERY MUCH
FOR YOUR
ATTENTION