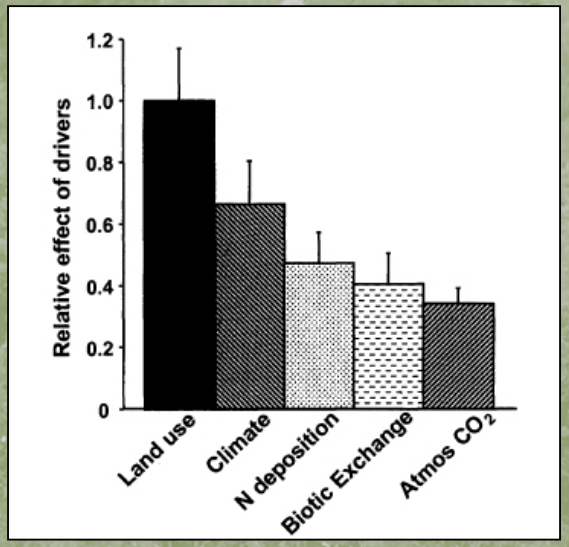
Simulated N deposition effects on soil fauna from a semiarid Mediterranean ecosystem in central Spain

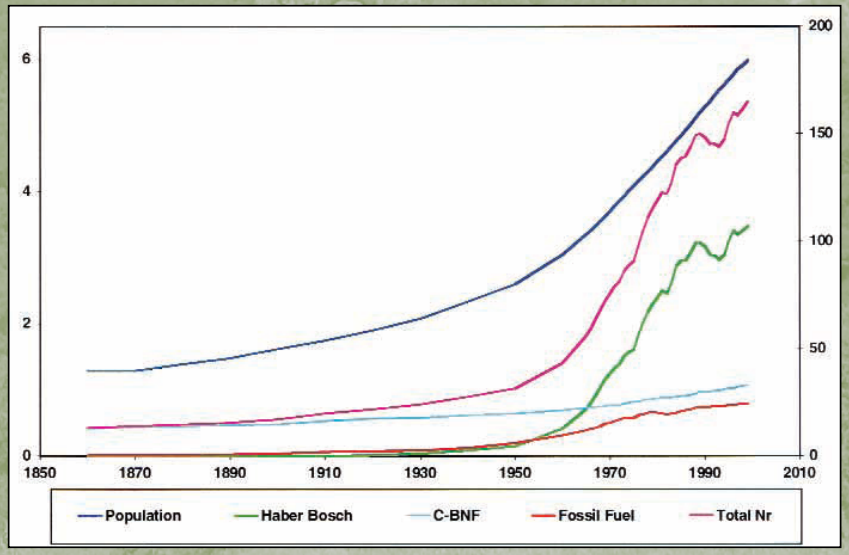
Raúl Ochoa-Hueso (URJC)
Iluminada Rocha (UAM)
Esteban Manrique (MNCN-CSIC)
Mª José Luciañez (UAM)

Nitrogen deposition

- Three main global change drivers affecting the global biodiversity loss
  - Land use changes
  - Climate change
  - **Nitrogen (N) deposition**
- Nitrogen deposition is related to human activities (food production and energy use) and it will increase in future scenarios



Sala et al., 2000; Science 287:1770-1774

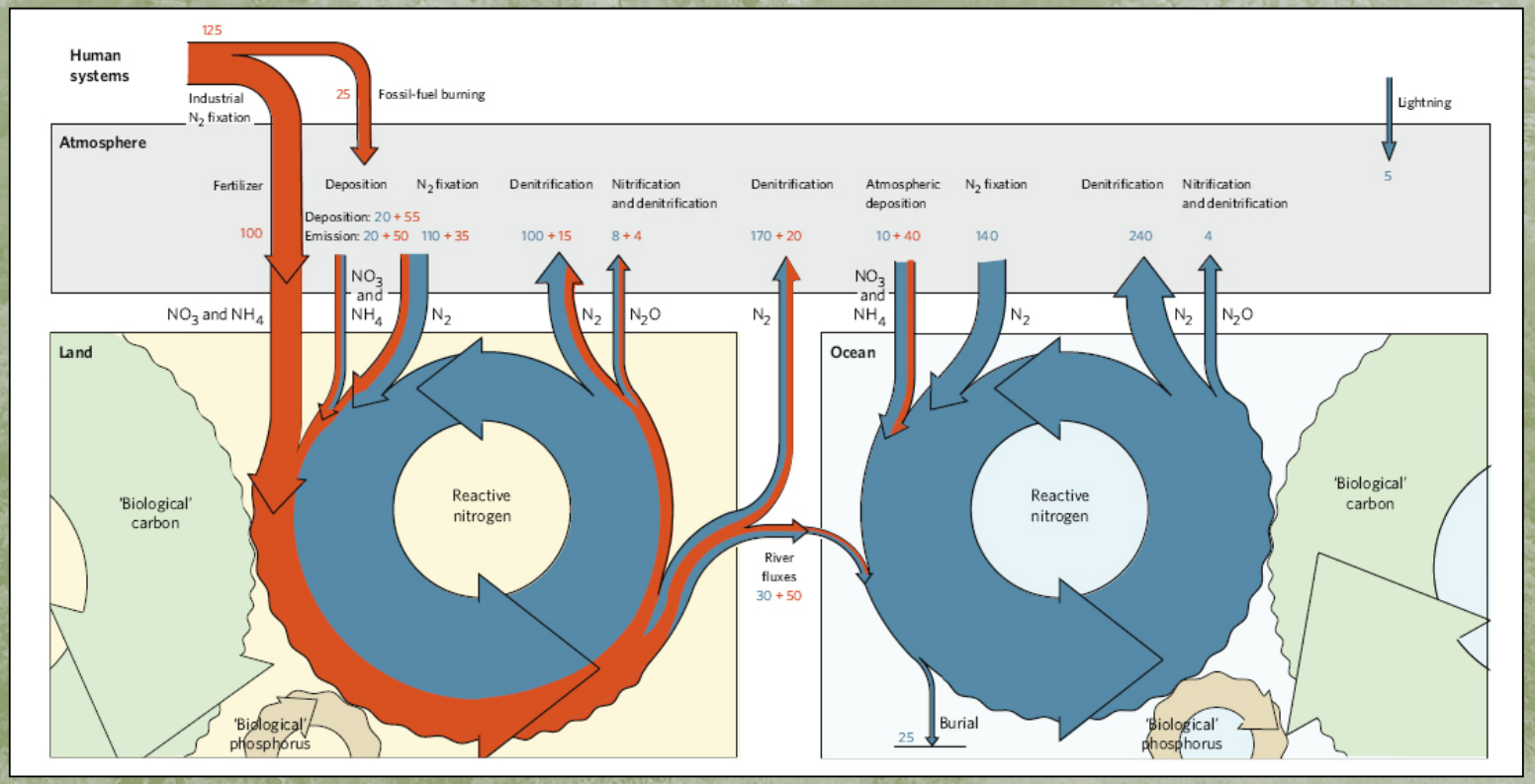


Galloway et al., 2003; BioScience 53: 341-356

Nitrogen deposition (cont.)

- Nitrogen is a limiting nutrient of productivity in terrestrial ecosystems

- Nowadays, the amount of N that is fixed naturally (120 Tg N) has been doubled by human activities (mainly Haber-Bosch reaction, 125 Tg N)



Gruber and Galloway, 2008; Nature 451: 293-296

Nitrogen deposition in Spain

- There is not a proper monitoring network to sistematically evaluate N deposition loads (reduced vs. oxidized and dry vs. wet) in Spain

- Existing atmospheric deposition models (EMEP) do not allow to accurately predict N deposition loads and forms and have not been validated with on site measurements

EL PAÍS

PORTADA | INTERNACIONAL | POL

MADRID

ESTÁ PASANDO | Horario comercial | Metro | Desempleo | Interinos | Gobierno de Ma

El aire de Madrid empeora en 2011

- Primer repunte del dióxido de nitrógeno en seis años
- "La contaminación ha mejorado hasta niveles que parecían inalcanzables", dijo Botella hace dos semanas
- Gallardón reducirá 'la boina' cobrando un 10% más por aparcar
- GRÁFICO: Los medidores de contaminación de Madrid

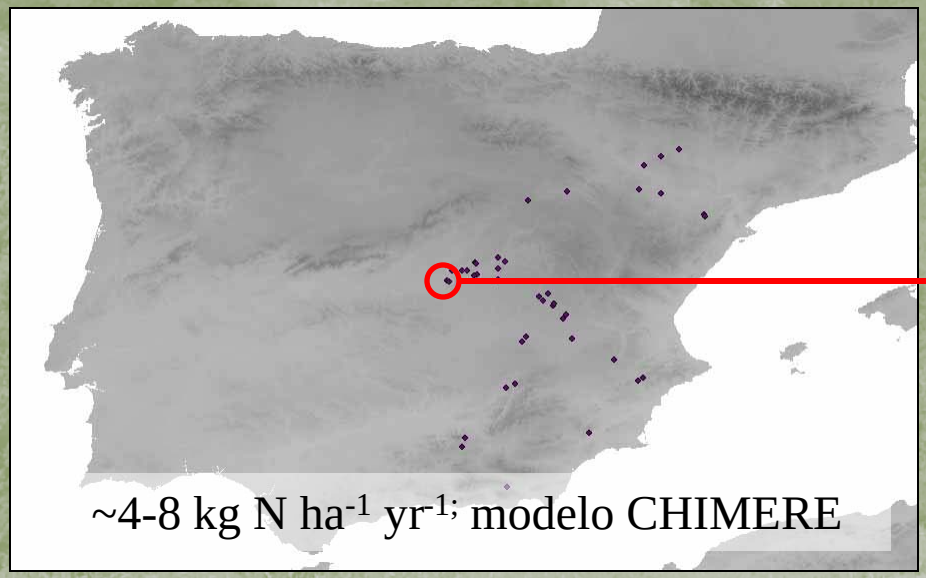
ELENA G. SEVILLANO | 3 ENE 2012 - 21:40 CET | 5

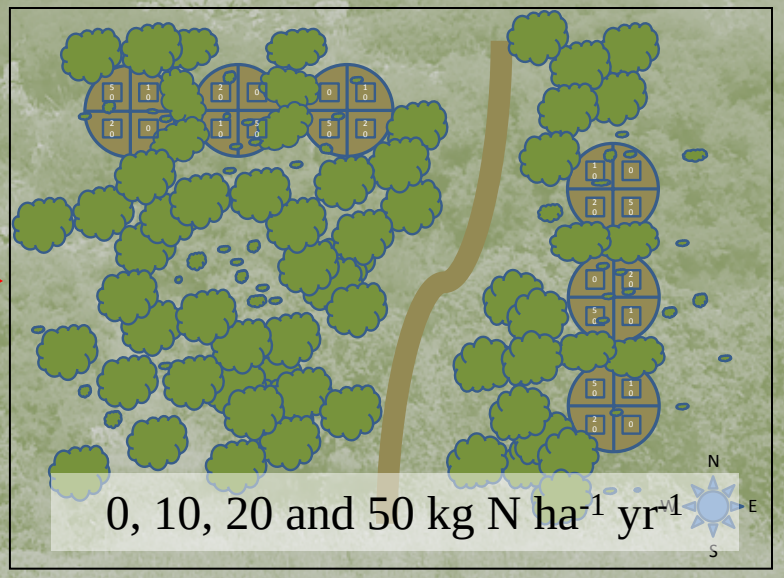
Nitrogen deposition in semiarid Mediterranean ecosystems

- Nitrogen deposition effects on semiarid Mediterranean regions are understudied
- Previous results have shown negative effects of increased N deposition on annual plant communities (Ochoa-Hueso et al., 2013; Ecosystems) and reduced carbon storage in soil (Ochoa-Hueso et al., 2013; Environmental Pollution)
- Soil organisms, including soil fauna, play numerous roles in terrestrial ecosystems, favouring plant litter decomposition and thus contributing to nutrient cycling
- Nitrogen deposition effects on soil fauna could operate:
    - Directly: via increased eutrophication and negative effects of increased ammonium availability
    - Indirectly: via acidification; alterations in soil and litter C and N content; changes in plant communities; altered competitive intractions

How do we (and many others) study the impacts of N deposition in the semiarid Mediterranean Spain?

- (1) Nitrogen fertilization experiments under controlled conditions (green-house, growth chambers, etc.)
- (2) Nitrogen fertilization experiments under field conditions simulating (more or less realistic) N deposition scenarios
- (3) Observational studies along previously identified atmospheric N deposition gradients

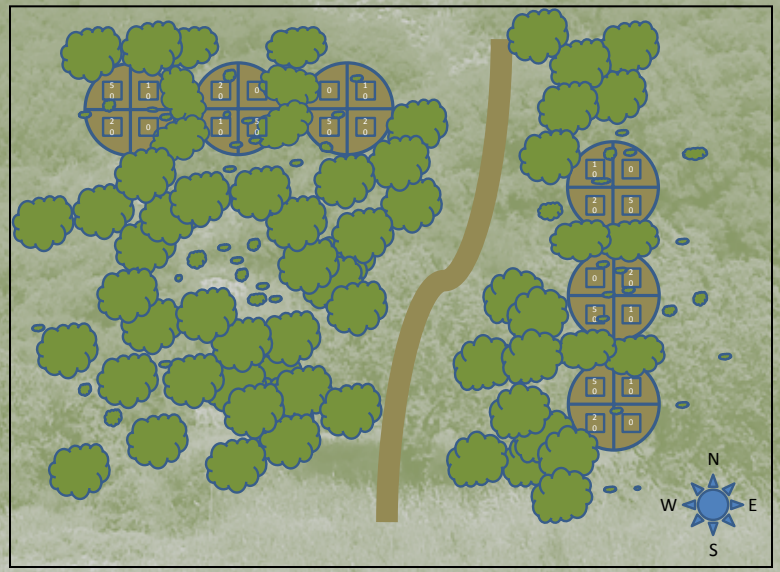


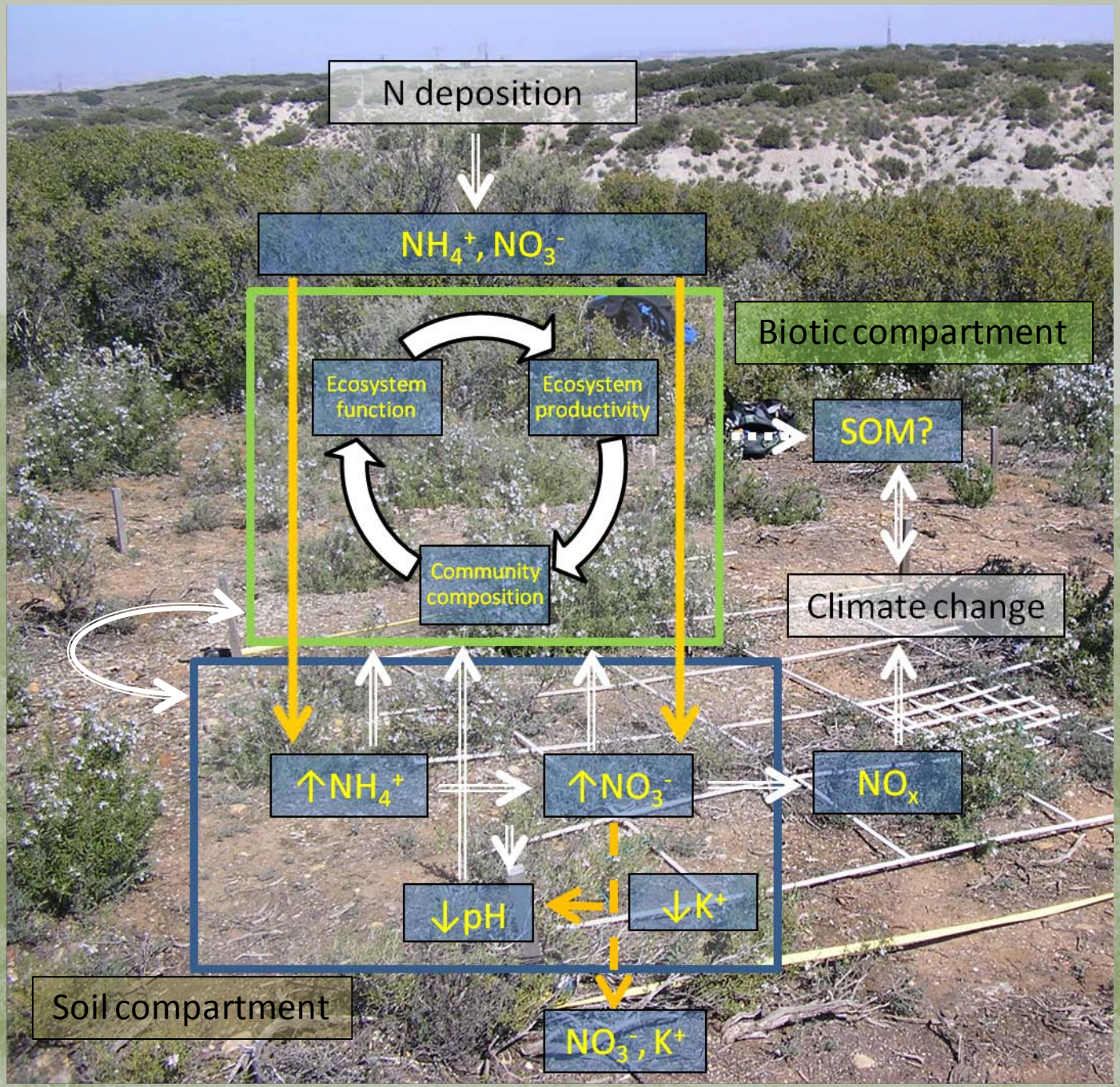


Semiarid Mediterranean shrublands

Study site in central Spain

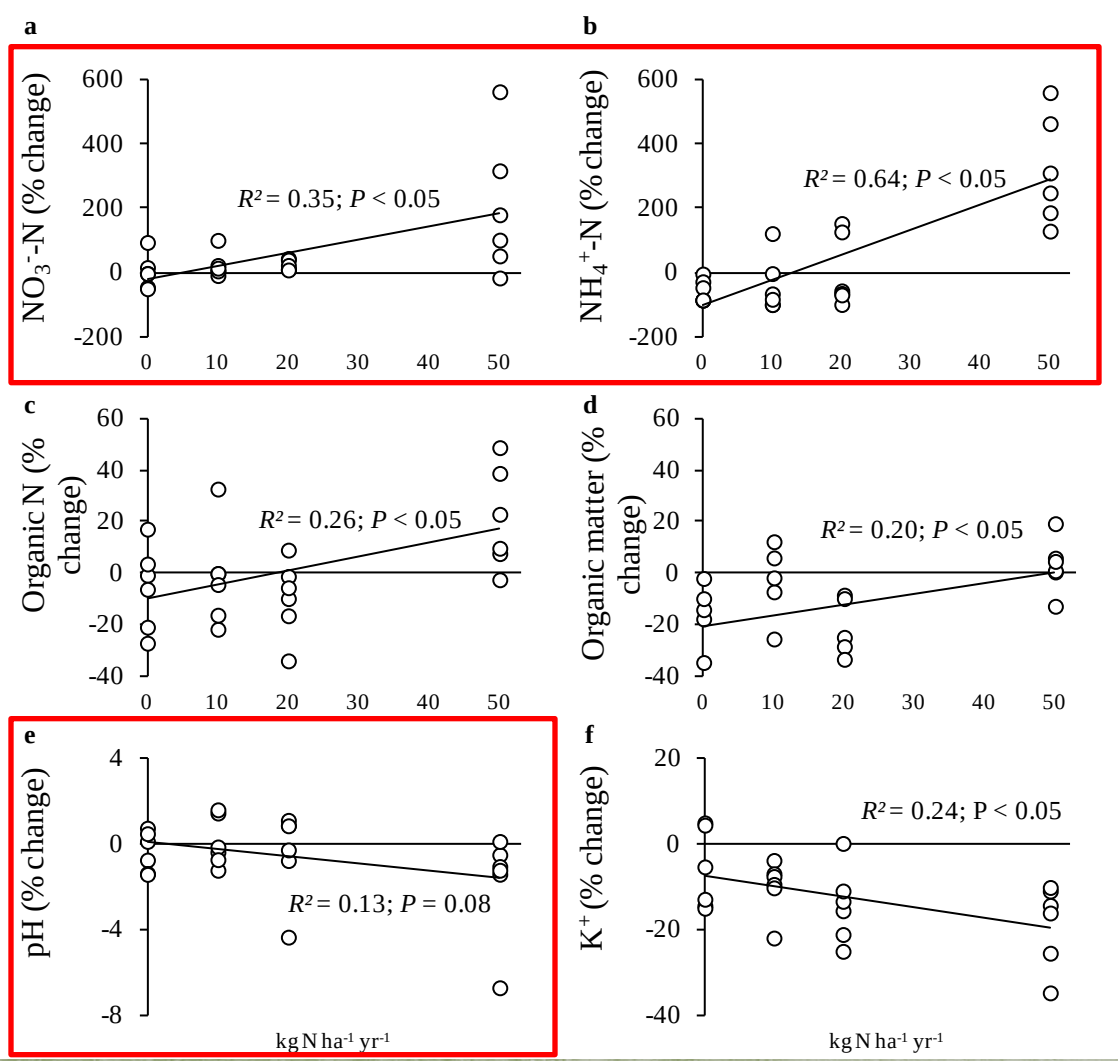
- Semiarid Mediterranean shrubland (Aranjuez, Madrid, ~ 500-600 m a.s.l.)
- Mean annual rainfall ~425 mm (October-May)
- Calcareous soils (pH ~8); low phosphorus availability (< 1 ppm)
- Experiment started in October 2007
- 4 replicated treatments: 0, 10, 20 and 50 kg N ha^{-1} yr^{-1} over the ambient N deposition (6.1 kg N ha^{-1} yr^{-1})




N deposition
NH_4^+, NO_3^-
Biotic compartment
Ecosystem function
Ecosystem productivity
Community composition
SOM?
Climate change
↑NH_4^+
↑NO_3^-
NO_x
↓pH
↓K^+
Soil compartment
NO_3^-, K^+

Relevant results for this study: soil chemistry

eutrophication



acidification

Ochoa-Hueso et al., 2013; Science of the Total Environment 287:1770-1774

Methods (soil fauna)

- Soil sampling in autumn 2011 (after four years of experiment)
- Extraction with Berlesse funnels
- Identification of individuals to the order level
- Statistical comparisons between N treatments (ANOVA; N as fixed factor and block as random factor)
- Stepwise multiple linear regression between abundance of soil groups and soil chemistry and N fertilization loads
- Regression analyses between soil fauna density and diversity and annual plant diversity

Results (soil fauna)

Collembolans (44.0%)

Insect larvae (0.4%)

Oligochaeta (3.0%)

Nematods (2.0%)

Coleoptera (0.9%)

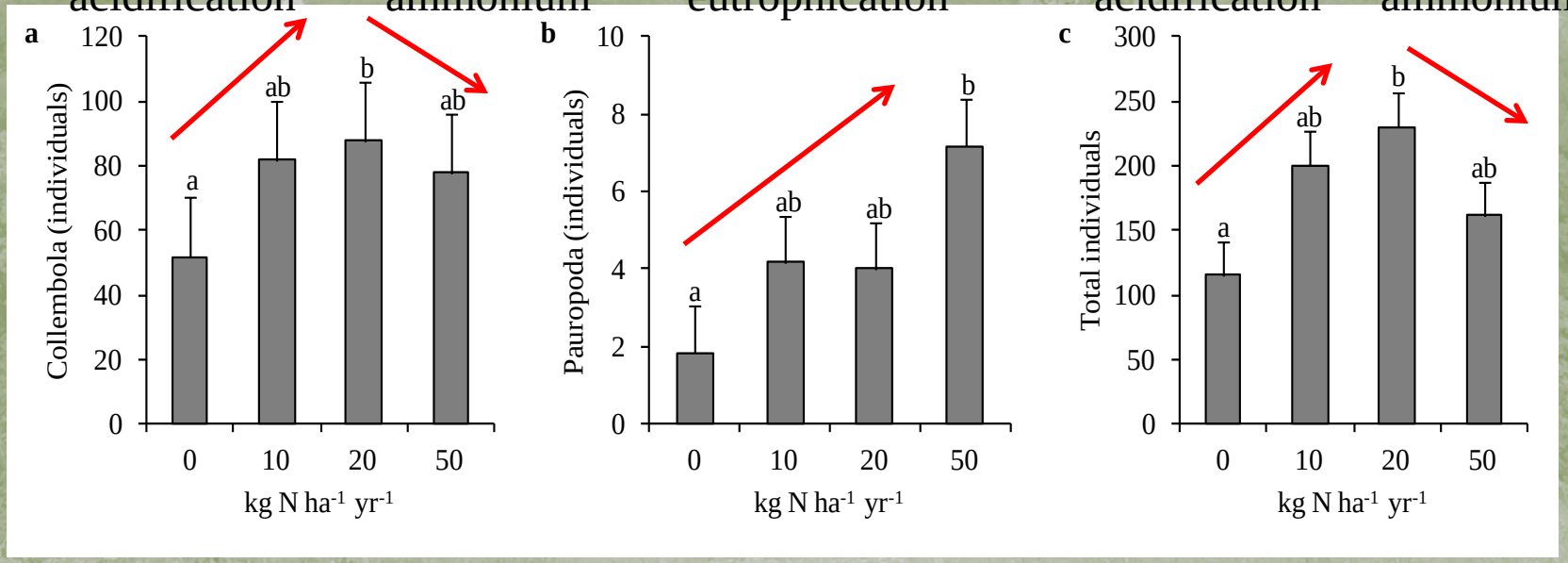
Pauropoda (3.3%)

Mites (45.5%)

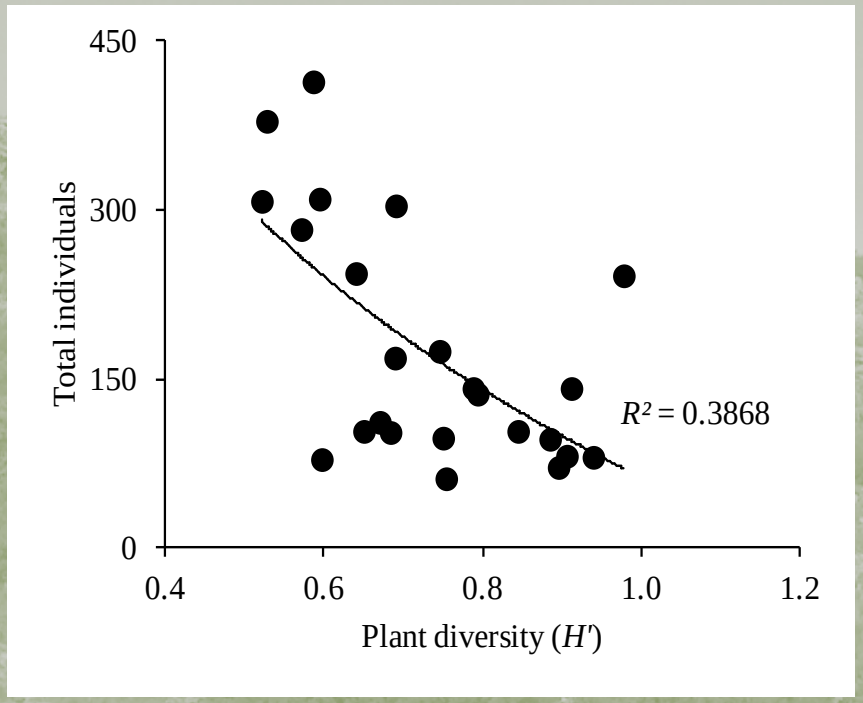
Results (soil fauna)

	ANOVAs		Stepwise linear regressions								
	Nitrogen	Block	Variable	R^2	P	Variable	R^2	P	Variable	R^2	P
Collembola	**4.02****	8.72***	pH (-)	0.49	<0.01	NH_4-N (-)	0.62	<0.01	**N deposition (+)**	0.79	<0.01
Acari	1.54	2.64*	pH (-)	0.32	<0.01	-			-		
Pauropoda	**3.23***	1.31	**N deposition (+)**	0.29	0.01	-			-		
Nematoda	0.89	1.32	-			-			-		
Oligochaeta	0.36	2.07	Cu (-)	0.19	0.03	-			-		
Coleoptera	0.55	1.03	-			-			-		
Insect larvae	1.76	1.45	P_2O_5 (+)	0.18	0.04	C:N (-)	0.39	0.01	-		
Collembola:Acari	1.17	3.04**	Ca (-)	0.32	<0.01	-			-		
Total individuals	**3.44****	6.87***	pH (-)	0.50	<0.01	NH_4-N (-)	0.59	<0.01	**N deposition (+)**	0.82	<0.01
Richness	0.22	1.55	C:N (-)	0.19	0.04	-			-		
H'	1.49	5.61***	pH (+)	0.39	<0.01	-			-		

acidification ammonium eutrophication acidification ammonium



Results (soil fauna and plant diversity)



Conclusions

- Soil fauna communities are greatly influenced by soil chemistry (mainly pH) but are also susceptible to be altered by increased N deposition

- The main drivers of change under increased N deposition are soil acidification and increased ammonium in soils where nitrate is usually the dominant mineral N form

- Changes in annual plant communities due to increased N deposition could also indirectly impact on soil fauna communities

- Pauropoda and Collembola could be used as biological indicators of increased N deposition at the national scale. This should be further evaluated.

Journal of Arid Environments 88 (2013) 78–81

Contents lists available at SciVerse ScienceDirect

Journal of Arid Environments

journal homepage: www.elsevier.com/locate/jaridenv

Short communication

Nitrogen deposition effects on tissue chemistry and phosphatase activity in *Cladonia foliacea* (Huds.) Willd., a common terricolous lichen of semi-arid Mediterranean shrublands

R. Ochoa-Hueso [a,*], V. Mejías-Sanz [a], M.E. Pérez-Corona [b], E. Manrique [a]

[a] Museo Nacional de Ciencias Naturales, MNCN-CSIC, C/ Serrano 115 bis, 28006 Madrid, Spain
[b] Department of Ecology, Faculty of Biology, Universidad Complutense de Madrid, C/ José Antonio Novais 2, 28040 Madrid, Spain

JrnlID 11270_ArtID 1492_Proof# 1 - 20/02/2013

Water Air Soil Pollut (2013) 224:1492
DOI 10.1007/s11270-013-1492-6

Effects of Nitrogen Deposition on Growth and Physiology of *Pleurochaete squarrosa* (Brid.) Lindb., a Terricolous Moss from Mediterranean Ecosystems

Raúl Ochoa-Hueso · Esteban Manrique

Received: 28 September 2012 / Accepted: 12 February 2013

Ecosystems
DOI: 10.1007/s10021-013-9659-2

ECOSYSTEMS

Impacts of Simulated N Deposition on Plants and Microbes from Spanish Semi-Arid Mediterranean Shrublands

Raúl Ochoa-Hueso,[1,2]* M. Esther Pérez-Corona,[3] and Esteban Manrique[1]

[1]Museo Nacional de Ciencias Naturales, Consejo Superior de Investigaciones Científicas, C/Serrano 115 bis, 28006 Madrid, Spain; [2]Área de Biodiversidad y Conservación, Departamento de Biología y Geología, Universidad Rey Juan Carlos, C/Tulipán s/n., 28933 Móstoles, Spain; [3]Department of Ecology, Faculty of Biology, Universidad Complutense de Madrid, C/José Antonio Novais 2, 28040 Madrid, Spain

Environmental Pollution 159 (2011) 2265–2279

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

Nitrogen deposition effects on Mediterranean-type ecosystems: An ecological assessment

Raúl Ochoa-Hueso [a,*], Edith B. Allen [b], Cristina Branquinho [c], Cristina Cruz [c], Teresa Dias [c], Mark E. Fenn [d], Esteban Manrique [a], M. Esther Pérez-Corona [a], Lucy J. Sheppard [f], William D. Stock [g]

[a] Department of Plant Physiology and Ecology, Centro de Ciencias Medioambientales, Consejo Superior de Investigaciones Científicas, C/Serrano 115 Dpdo., 28006 Madrid, Spain
[b] Department of Plant Sciences and Center for Conservation Biology, University of California, Riverside, CA 92521, USA
[c] Centro de Biologia Ambiental, Campo Grande, Bloco C4, 1749-016 Lisboa, Portugal
[d] Pacific Southwest Research Station, 4955 Canyon Crest Drive, Riverside, CA 92507, USA
[e] Ecology and Hydrology, Centre for Ecology and Hydrology, Bush Estate, Penicuik EH26 0QB, UK
[f] Department of Natural Sciences, Edith Cowan University, 100 Joondalup Drive, Joondalup, Perth, WA 6027, Australia

Environmental Pollution 159 (2011) 449–457

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

Effects of nitrogen deposition and soil fertility on cover and physiology of *Cladonia foliacea* (Huds.) Willd., a lichen of biological soil crusts from Mediterranean Spain

Raúl Ochoa-Hueso*, Esteban Manrique

Instituto de Recursos Naturales, Centro de Ciencias Medioambientales, Consejo Superior de Investigaciones Científicas, C/Serrano 115 bis, 28006 Madrid, Spain

Nitrogen deposition and soil variables affect the physiology of terrestrial Mediterranean lichens.

Plant Ecol (2010) 210:263–273
DOI 10.1007/s11258-010-9755-4

Nitrogen fertilization and water supply affect germination and plant establishment of the soil seed bank present in a semi-arid Mediterranean scrubland

Raúl Ochoa-Hueso · Esteban Manrique

Received: 17 July 2009 / Accepted: 4 March 2010 / Published online: 19 March 2010

Thank you for your attention!!