

Phenological mismatches increase the rate of forbidden links in a Mediterranean scrubland



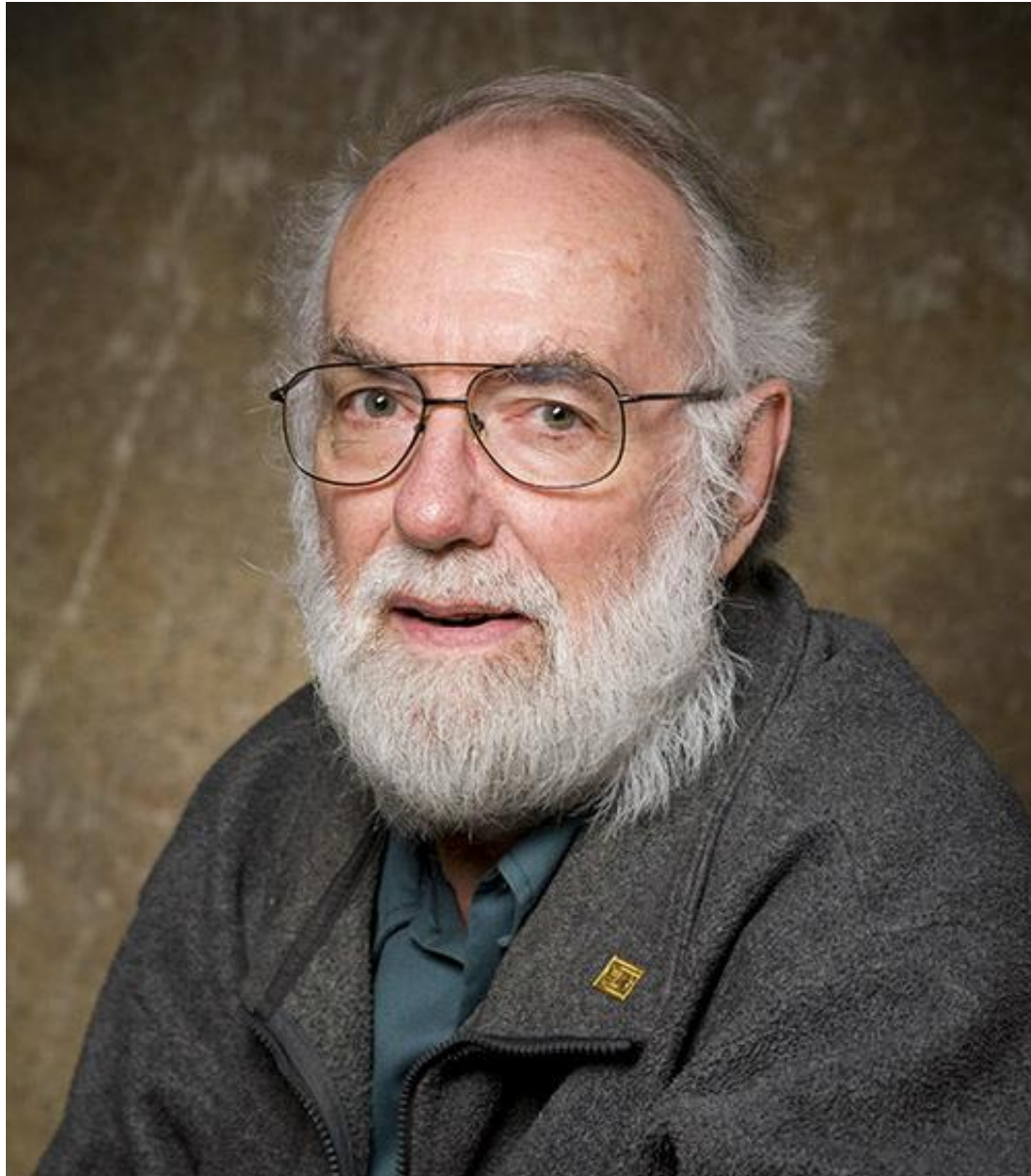
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Integrative Ecology Group

Doñana Biological Station (CSIC)





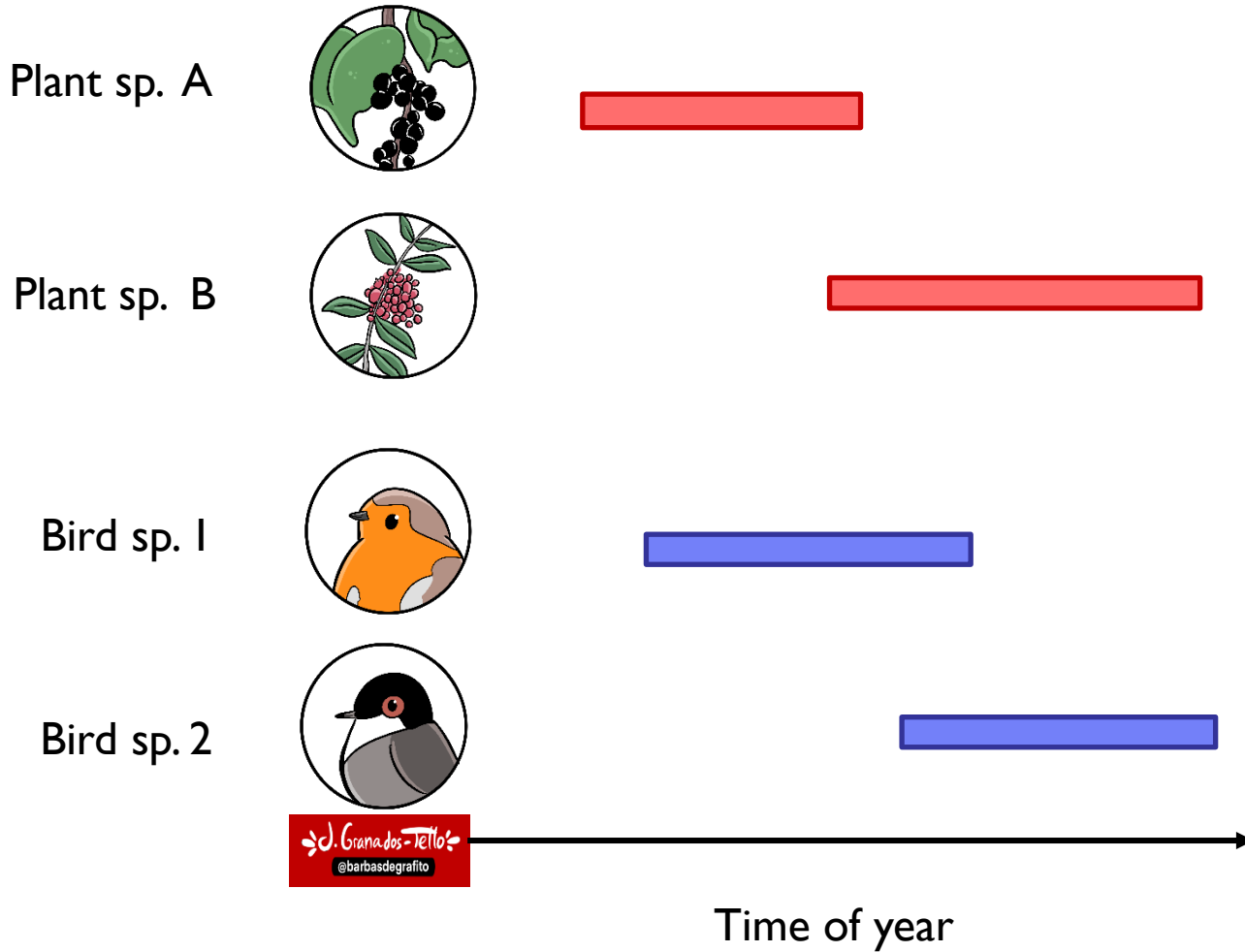
‘What escapes the eye,
however, is a much
more insidious kind of
extinction: the
extinction of ecological
interactions’

Daniel Janzen, 1974.

Janzen, D.H. 1974. The deflowering of Central America.
Natural History, 83, 48–53.

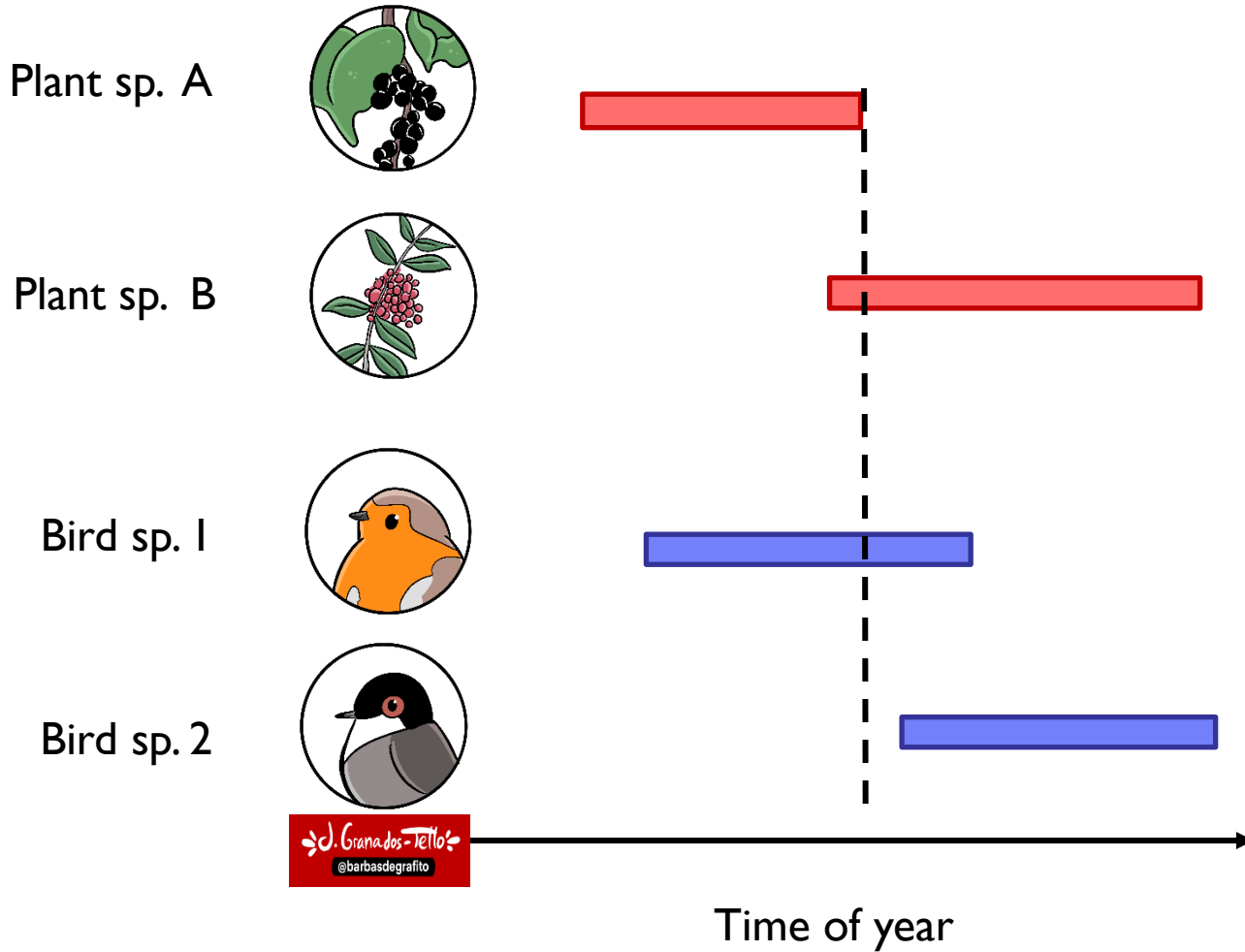
Seed dispersal takes place when phenologies of plants and frugivores match

DENSITY OF FRUIT  / BIRDS 



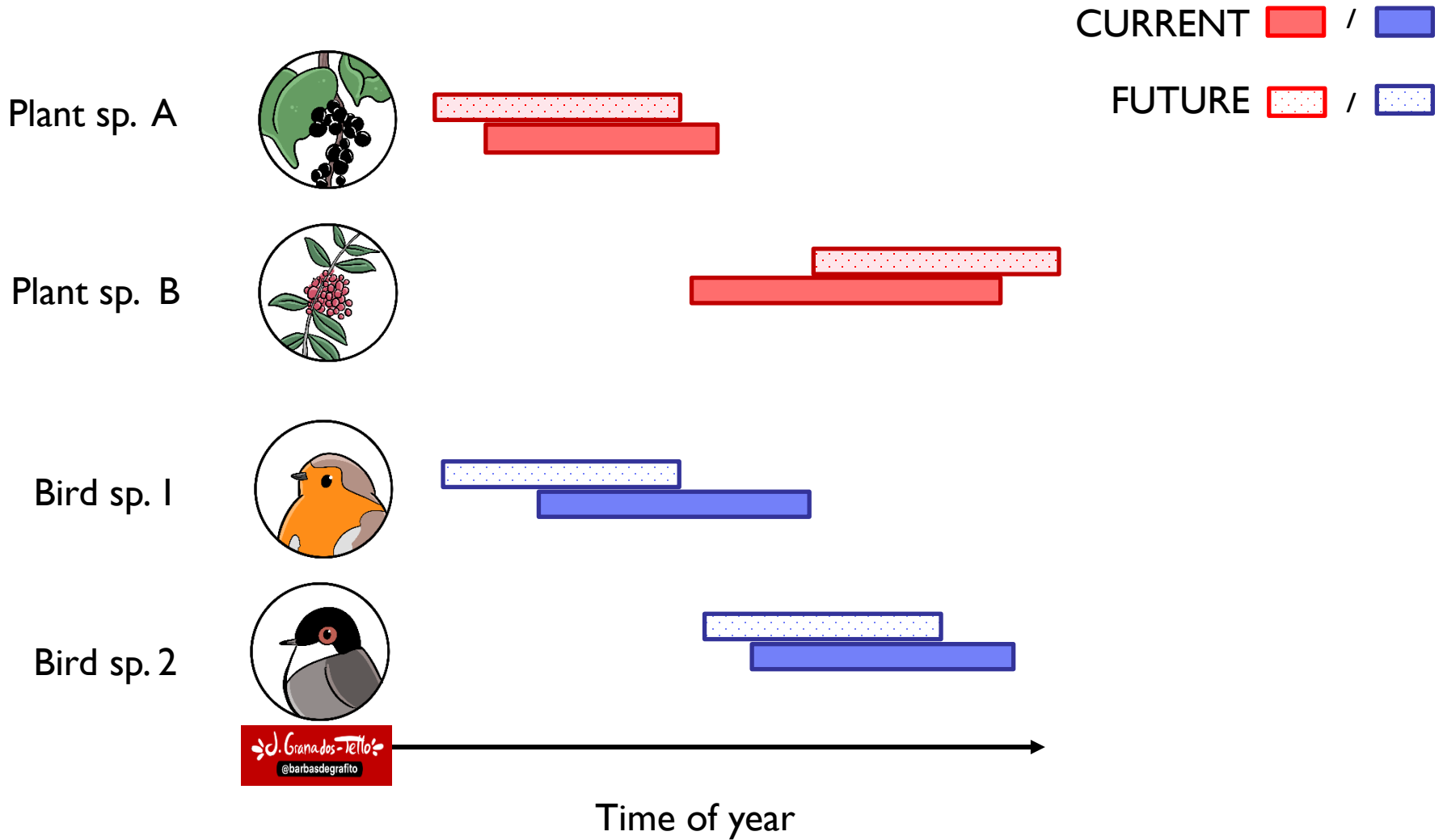
Seed dispersal takes place when phenologies of plants and frugivores match

DENSITY OF FRUIT  / BIRD 

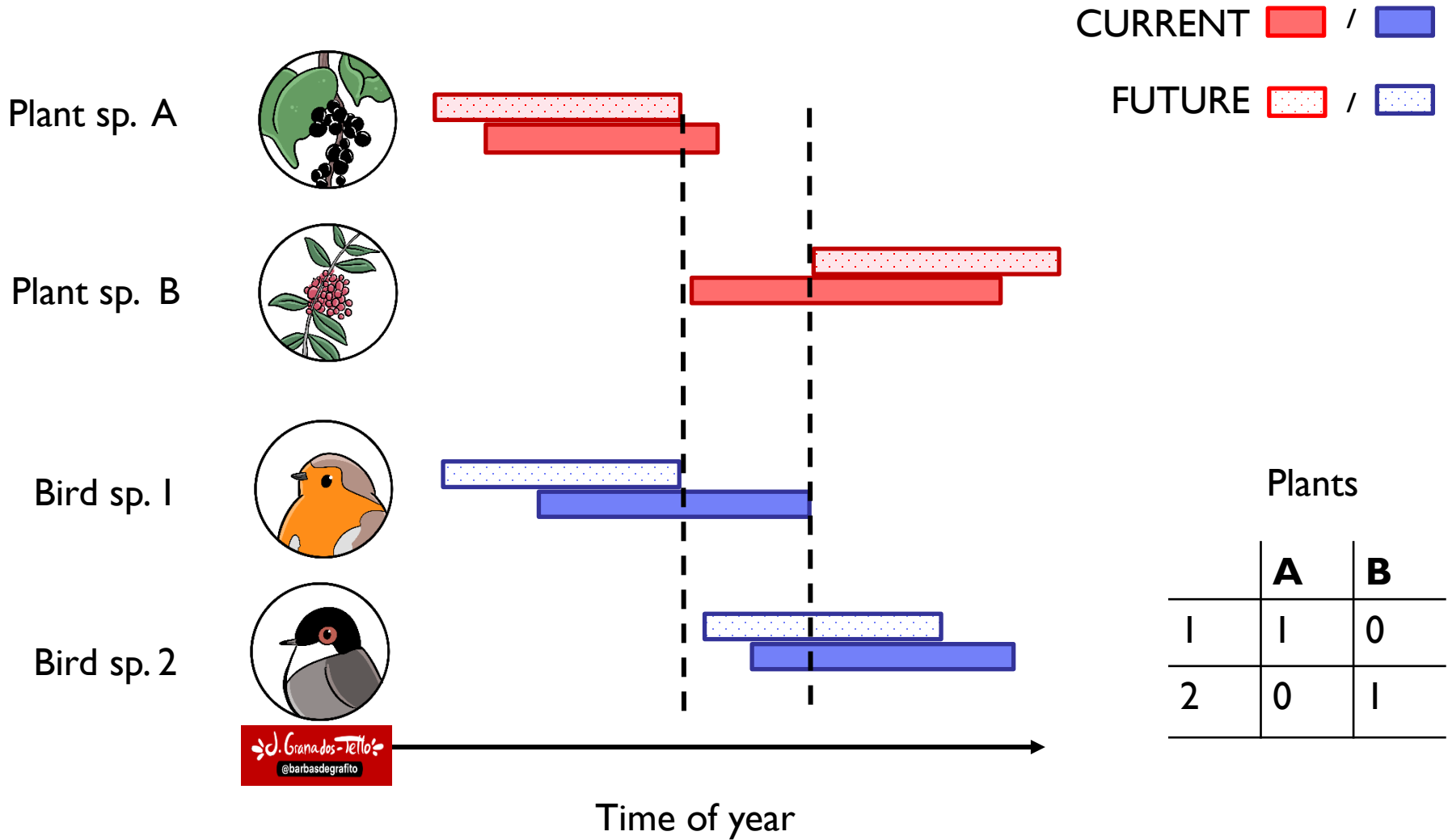


		Plants	
		A	B
Birds	1	1	1
	2	0	1

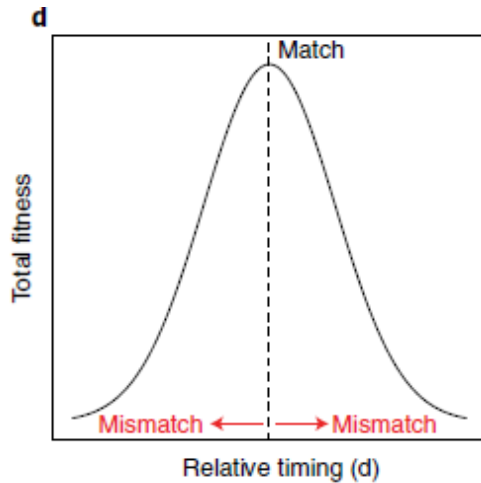
Seed dispersal takes place when phenologies of plants and frugivores match



Seed dispersal takes place when phenologies of plants and frugivores match



What do we not know yet about phenological mismatches?



Kharouba & Wolkovich 2020 *Nature Climate Change*

1. Community approaches lacking
2. Long-term data series difficult to obtain
3. Forecasting under climatic scenarios is the last challenge

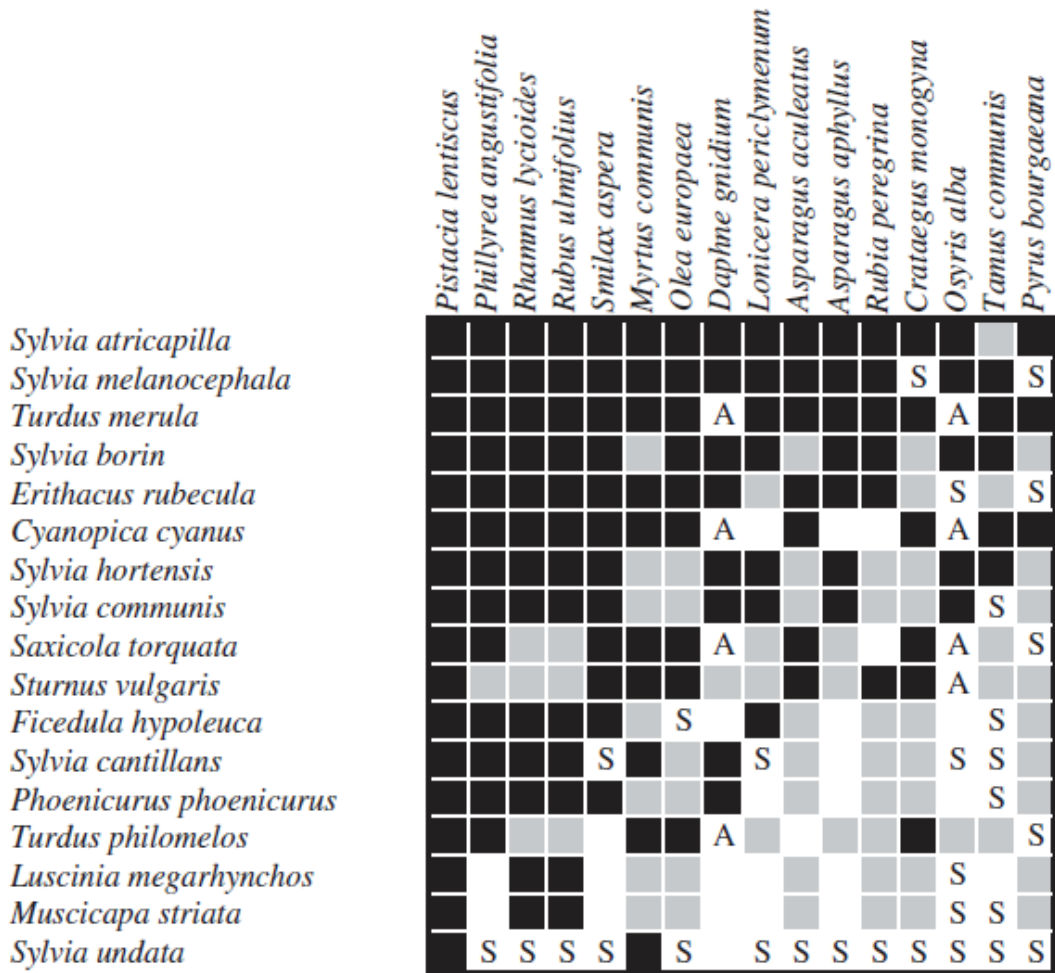
**ANNUAL
REVIEWS**

Annual Review of Ecology, Evolution, and Systematics

Climate Change and Phenological Mismatch in Trophic Interactions Among Plants, Insects, and Vertebrates

Susanne S. Renner¹ and Constantin M. Zohner²

Forbidden links



no. links and cell colour code

141



observed links *I*

131

forbidden links *F*

68



— owing to phenological uncoupling

63



— owing to other constraints = (a) + (b) + (c)

8



(a) accessibility constraints

30



(b) size constraints

25



(c) unknown

272

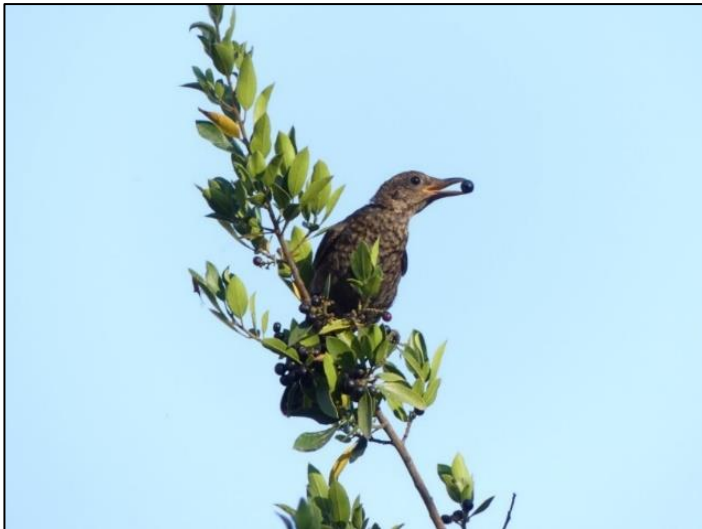
total potential links *AP*

Research aims:



#MISMATCH

1. This study aims to analyse the prevalence of phenological mismatches in bird-fruit interactions over long temporal scales.
2. Evaluating its ultimate consequences for biodiversity conservation.

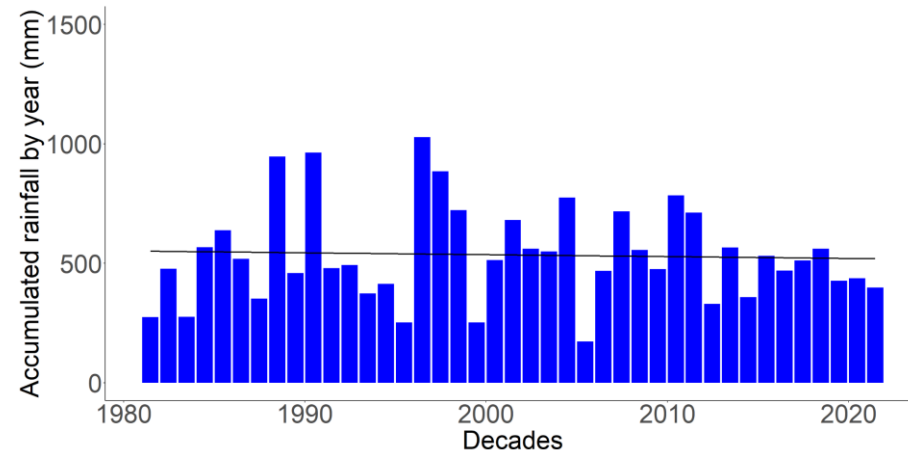
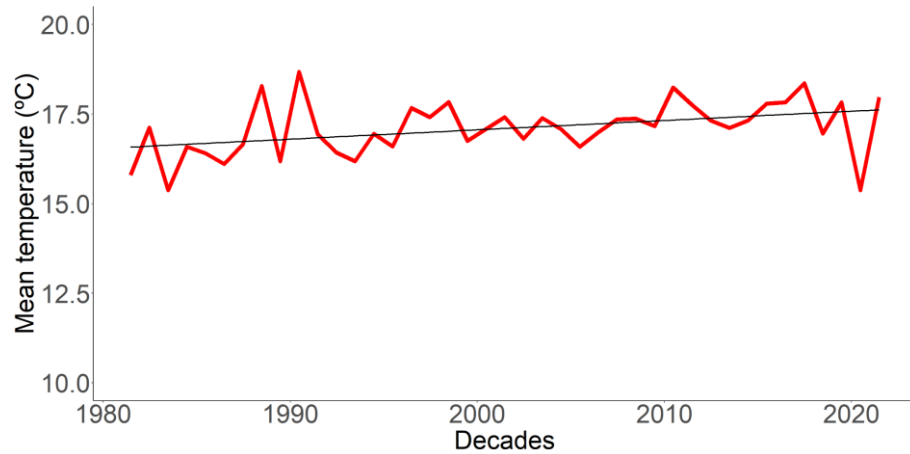


J.P. Gonzalez-Varo



Irene Mendoza

Hato Ratón (Doñana Nature Area, Spain)



Hato Ratón (Doñana Nature Area, Spain)

1981



2019



Instituto Geográfico, http://www.ign.es/web/comparador_pnoa/index.html

#TEMPNET: long-term temporal dynamics of mutualistic ecological networks

1981-1983:

- Mist nets
- Weekly censuses of plant phenology
- Transects of fruit counts

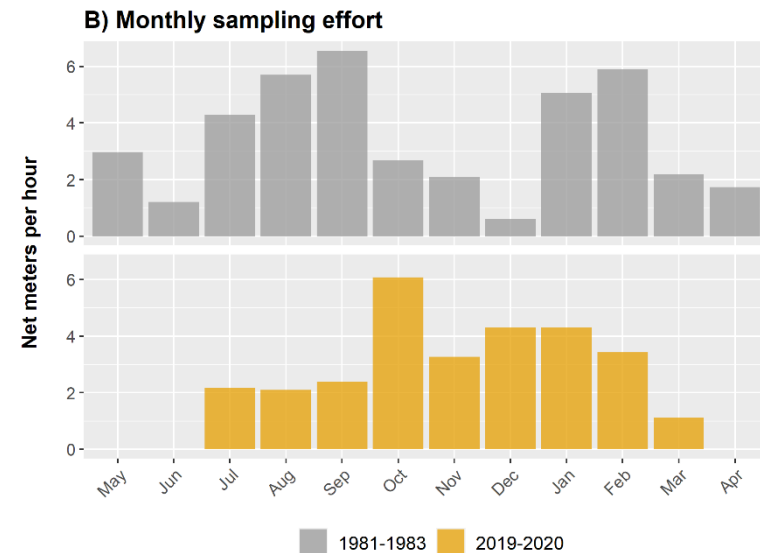
2019-2021:

- Mist nets
- Biweekly censuses of plant phenology
- Transects of fruit counts



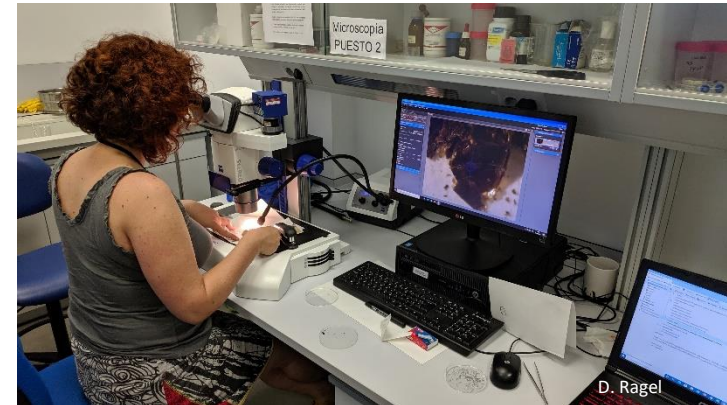
Bird sampling

- ~3000 indiv. sampled using mist nets
- 32 bird species
- 68 1-km linear transects (k.a.i.)



Sampling interactions

- 100 unique pairwise interactions
- ~ 5200 seeds analyzed



Bird phenology



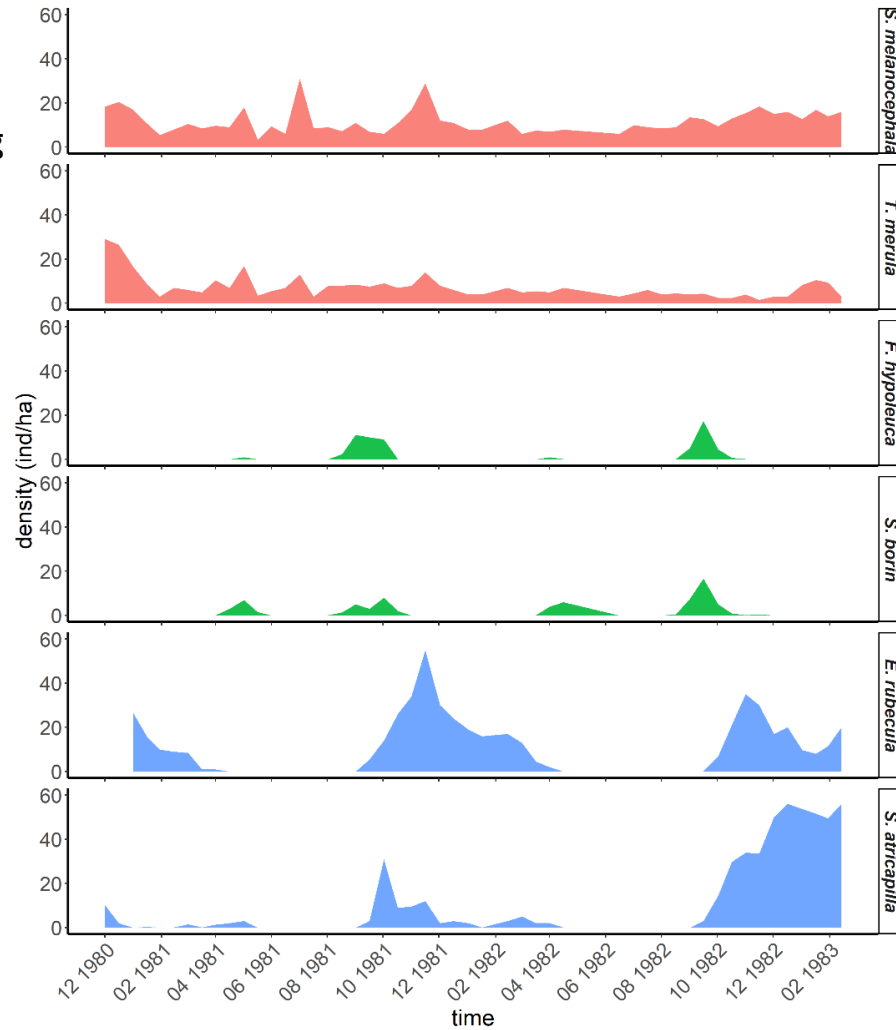
Resident



Wintering



Transient



Curruca melanocephala



Turdus merula



Ficedula hypoleuca



Sylvia borin



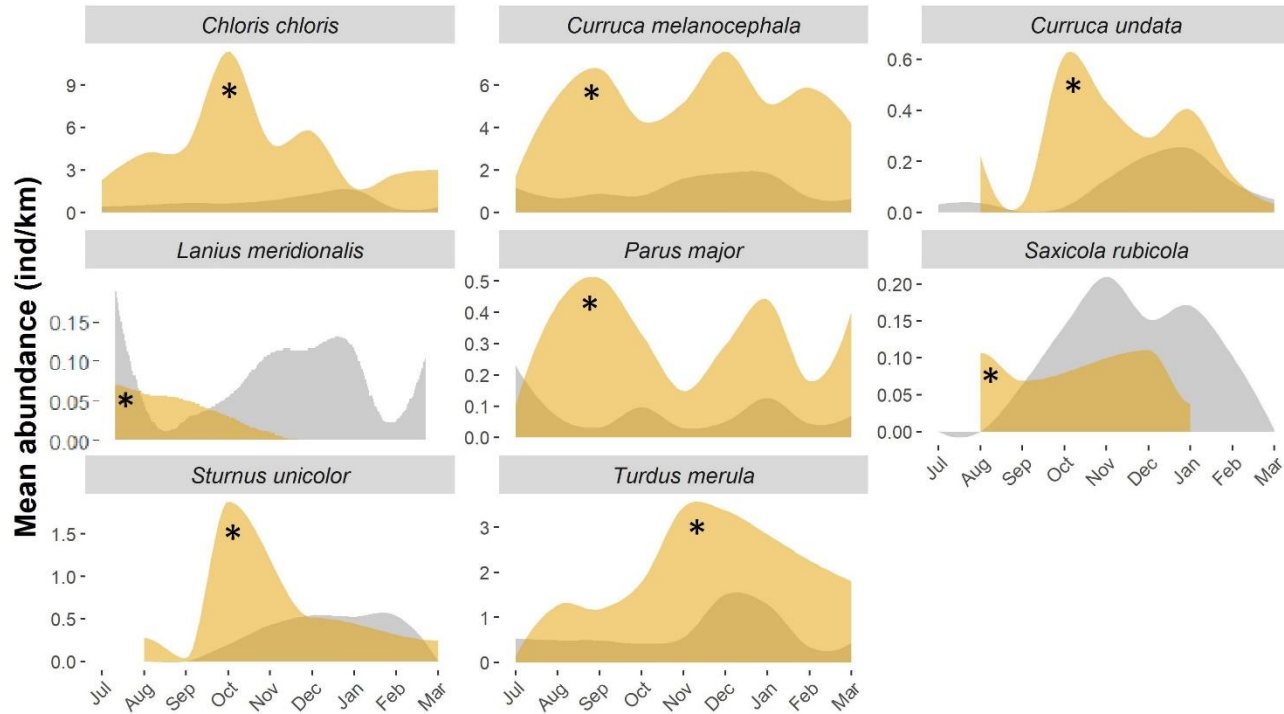
Erithacus rubecula



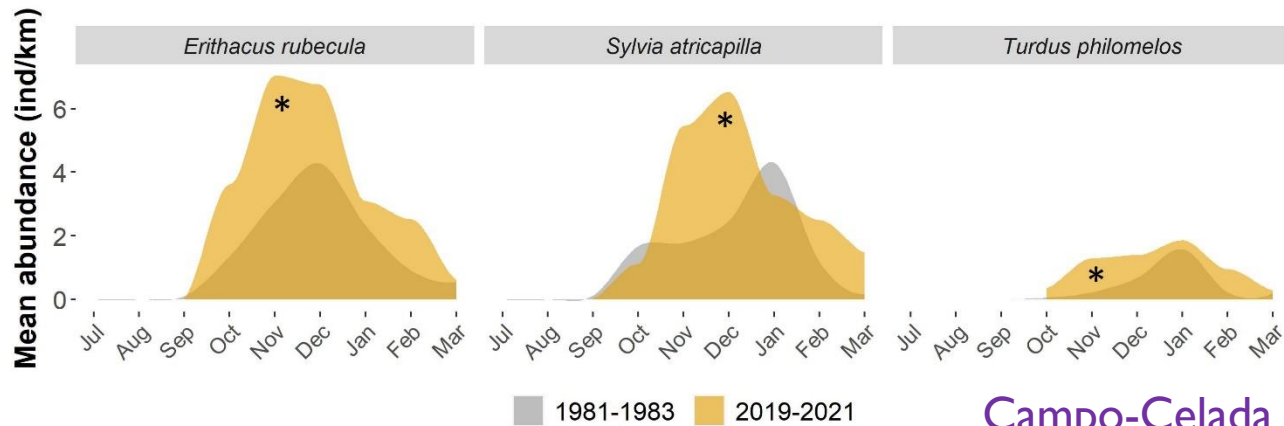
Sylvia atricapilla

Changes in bird phenology

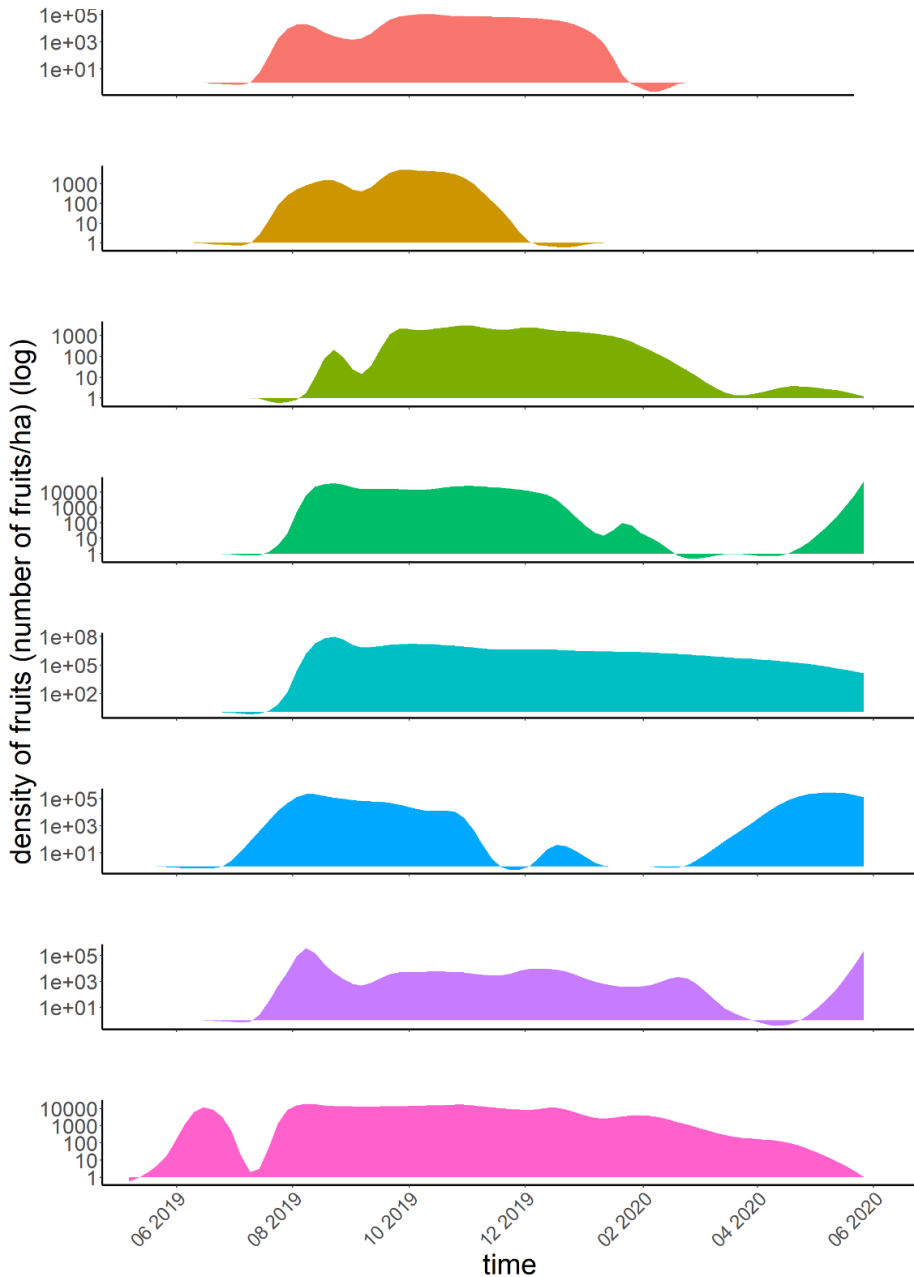
A) Resident species' monthly abundances



B) Wintering species' monthly abundances



Plant phenology



Asparagus aphyllus

Daphne gnidium

Myrtus communis

Olea europaea

Pistacia lentiscus

Rhamnus lycioides

Rubia peregrina

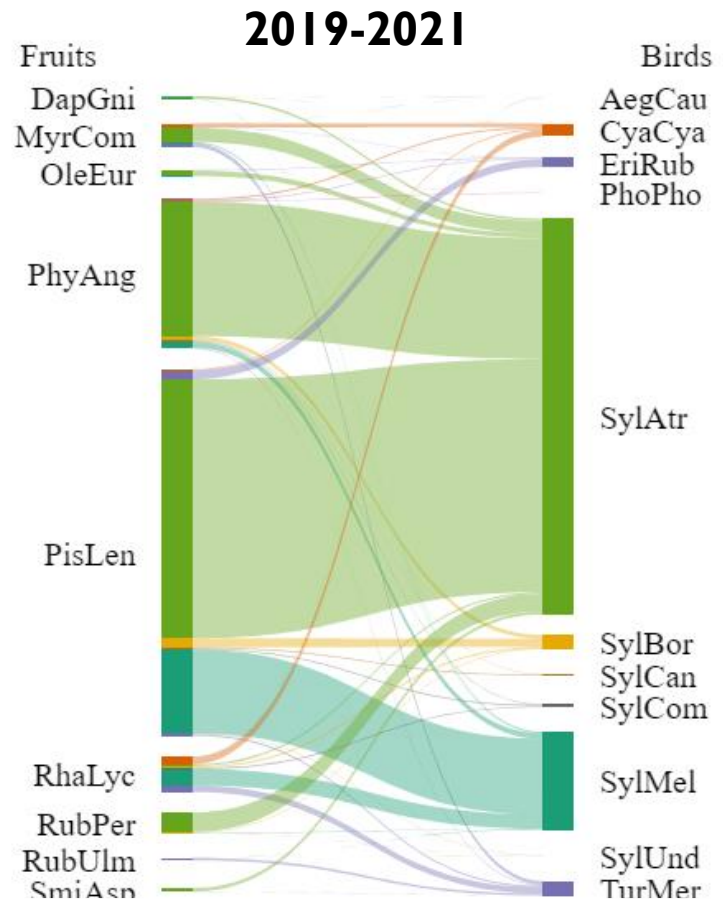
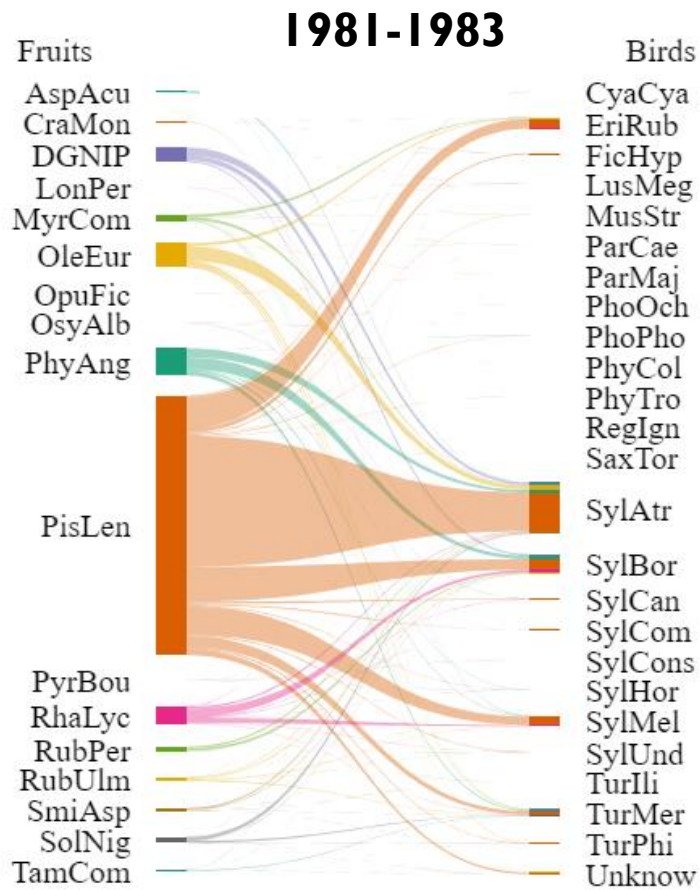
Smilax aspera

Fruit counts:

1981-1983: 7.6×10^6 fr/ha

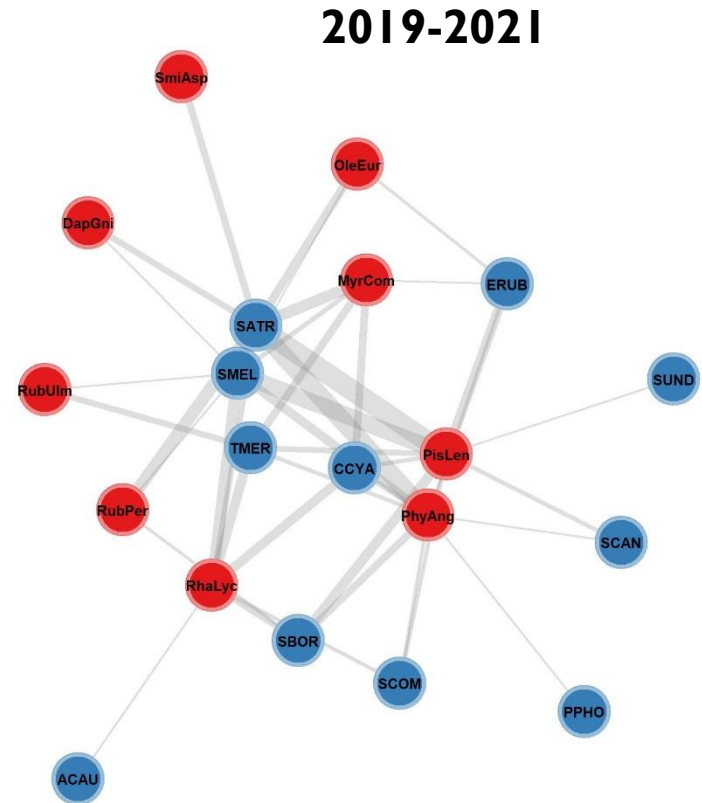
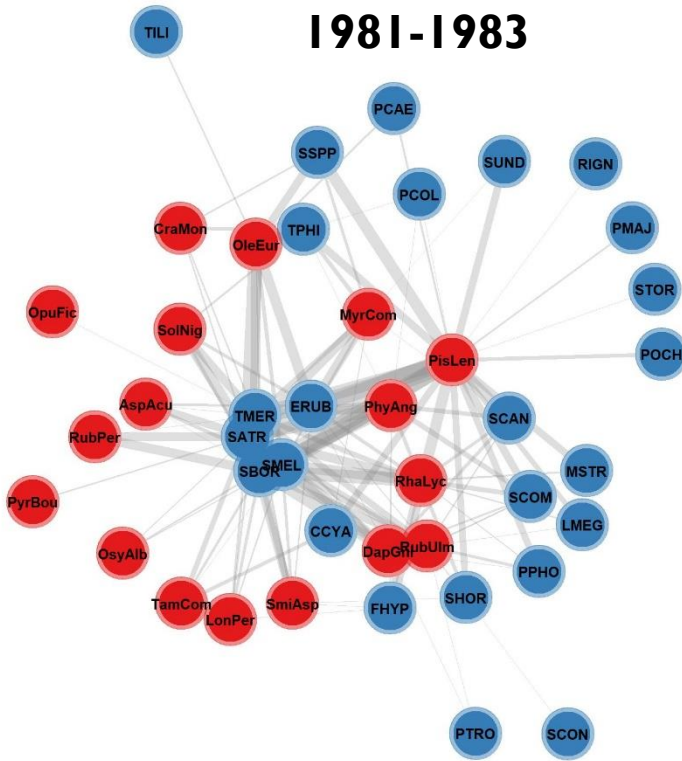
2019-2021: 4.97×10^4 fr/ha

Network comparison between 1981-1983 and 2019-2021



Preliminary!


Network comparison between 1981-1983 and 2019-2021



Forbidden links

 Interaction

 Phenological Uncoupling

 S = Size constrains
A = Accessibility constrains
UN = unknown

1981-1983

	PisL	Phy	Rha	Rub	Smi	Myr	OleE	Dap	Lon	Rub
SATR	■	■	■	■	■	■	■	■	■	■
SMEL	■	■	■	■	■	■	■	■	■	■
TMER	■	■	■	■	■	■	■	A	■	■
SBOR	■	■	■	■	■	PU	■	■	■	■
ERUB	■	■	■	■	■	■	■	■	PU	■
CCYA	■	■	■	■	■	■	■	A	UNK	UNK
SHOR	■	■	■	■	■	PU	PU	■	■	PU
SCOM	■	■	■	■	■	PU	PU	■	■	PU
FHYP	■	■	■	■	■	PU	S	UNK	■	PU
SCAN	■	■	■	■	S	■	PU	■	S	PU
PPHO	■	■	■	■	■	PU	PU	■	UNK	PU
TPHI	■	■	PU	PU	UNK	■	■	A	PU	PU
LMEG	■	■	■	■	UNK	PU	PU	UNK	UNK	PU
MSTR	■	■	■	■	UNK	PU	PU	UNK	UNK	PU
SUND	■	S	S	S	S	■	S	UNK	S	S

Connectance: 67 %
PU ~ 25 %

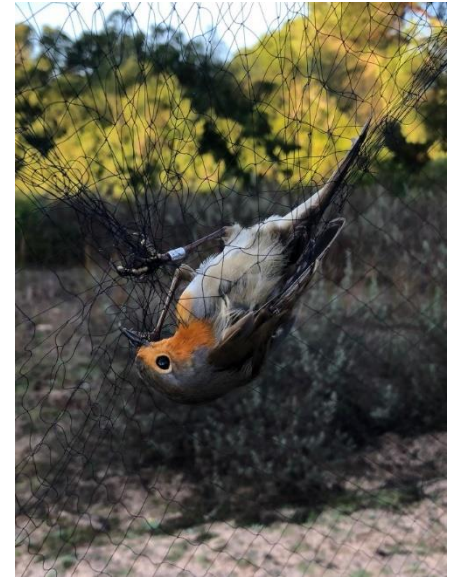
2019-2021

	PisLe	PhyAl	RhaL	MyrC	RubP	OleEt	SmiAs	DapG	RubU
SATR	■	■	■	■	■	■	■	■	PU
SMEL	■	■	■	■	■	■	■	■	■
TMER	■	■	■	■	PU	PU	PU	A	■
CCYA	■	■	■	■	UN	PU	PU	A	PU
SBOR	■	■	■	PU	■	PU	PU	PU	PU
ERUB	■	■	PU	■	PU	■	PU	PU	PU
SCAN	■	■	PU	PU	PU	PU	PU	PU	PU
SCOM	■	■	■	PU	PU	PU	PU	PU	PU
PPHO	PU	■	PU	PU	PU	PU	PU	PU	PU
SUND	■	S	S	PU	S	S	S	S	S

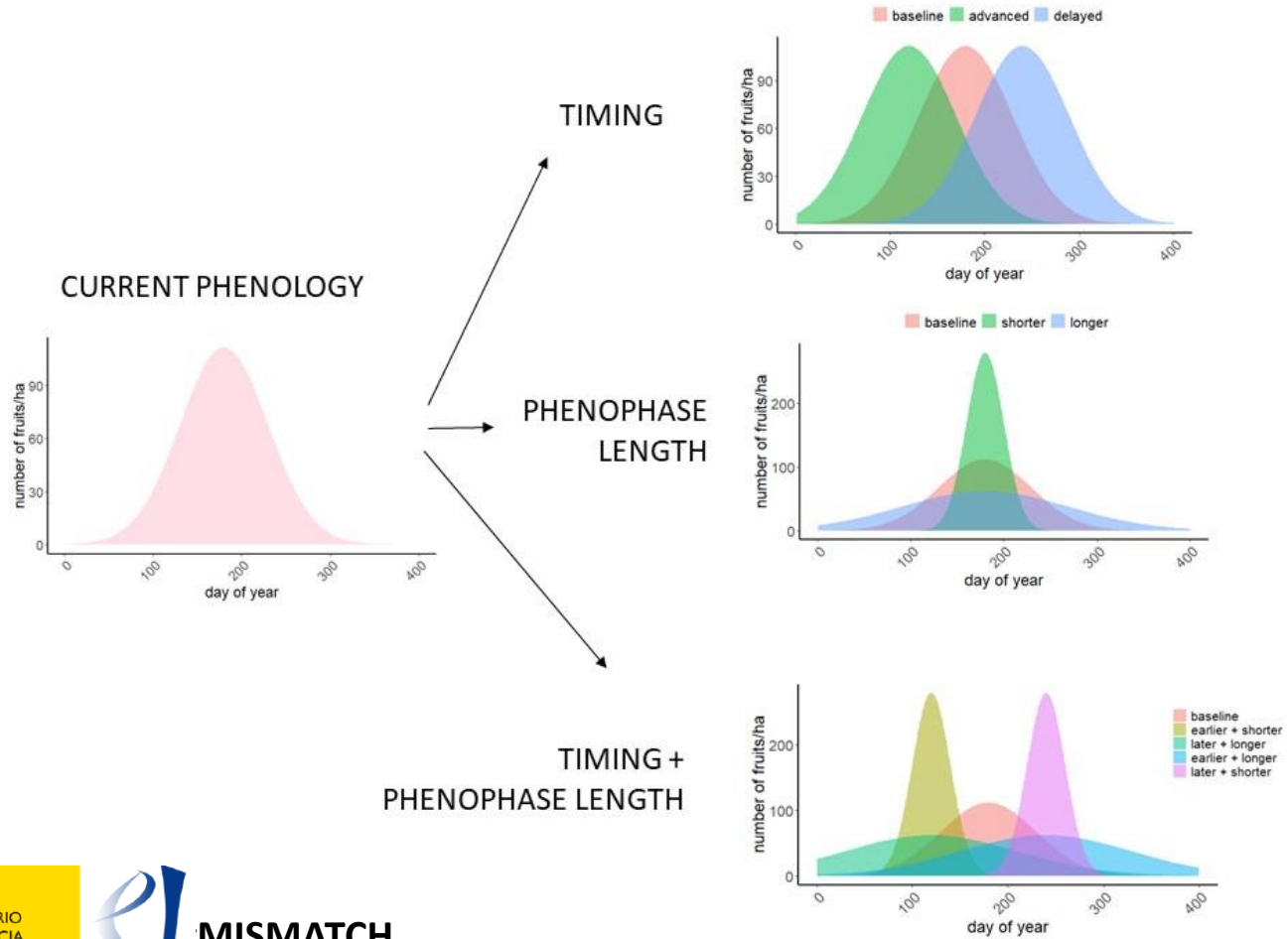
Connectance: 44 %
PU ~ 80 %

Take-home messages

- Temporal dynamics of ecological interactions remains challenging and we still do not understand how future global change scenarios will affect interactions.
- There is a higher frequency of forbidden links occurring when shifts were maintained over long temporal spans



Forthcoming: Simulation models



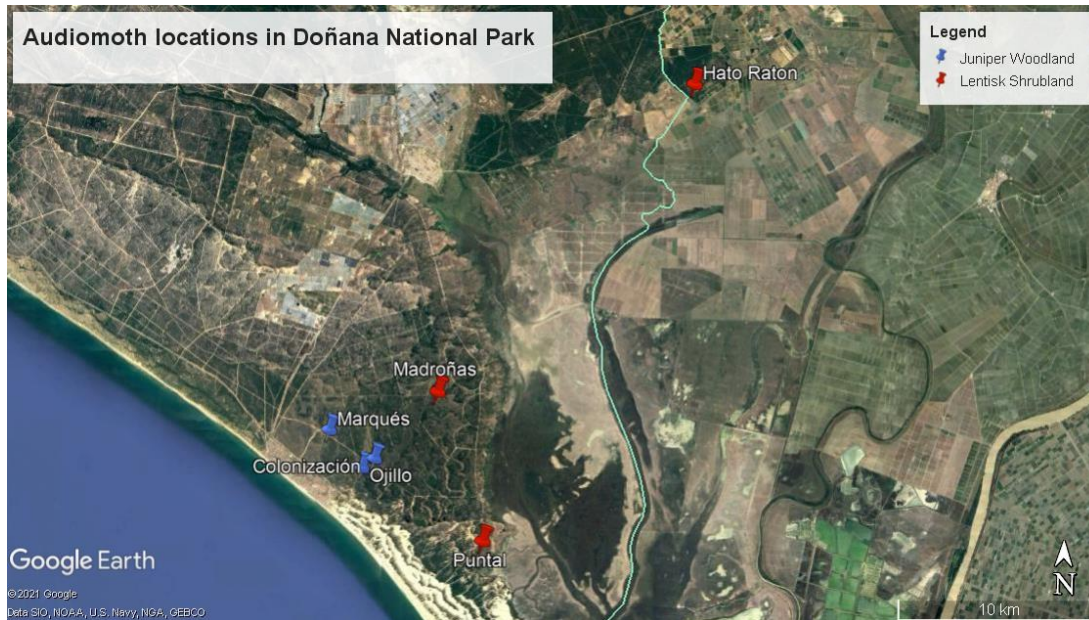
Forthcoming: Fruit estimation using drone flights and Deep learning techniques



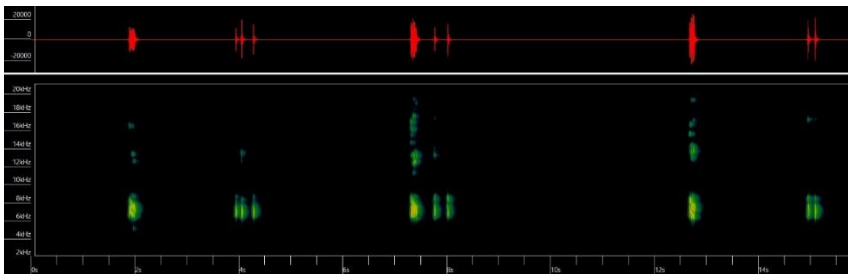
Apolo-Apolo et al. 2022. In prep.



Forthcoming: Monitoring of bird phenology using acoustic data and CNN



AudioMoth recorders



Granados-Tello et al. 2022. In prep.



MINISTERIO DE CIENCIA E INNOVACIÓN



AGENCIA ESTADAL DE INVESTIGACIÓN

#MISMATCH

Acknowledgements



Integrative Ecology Group



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Lidia López

Bird ringers



Julio Rabadán



Carlines Gutiérrez



Fernando Ibáñez

Merci !

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