the ecological importance of intraspecific variation

Simone Des Roches | UC Santa Cruz

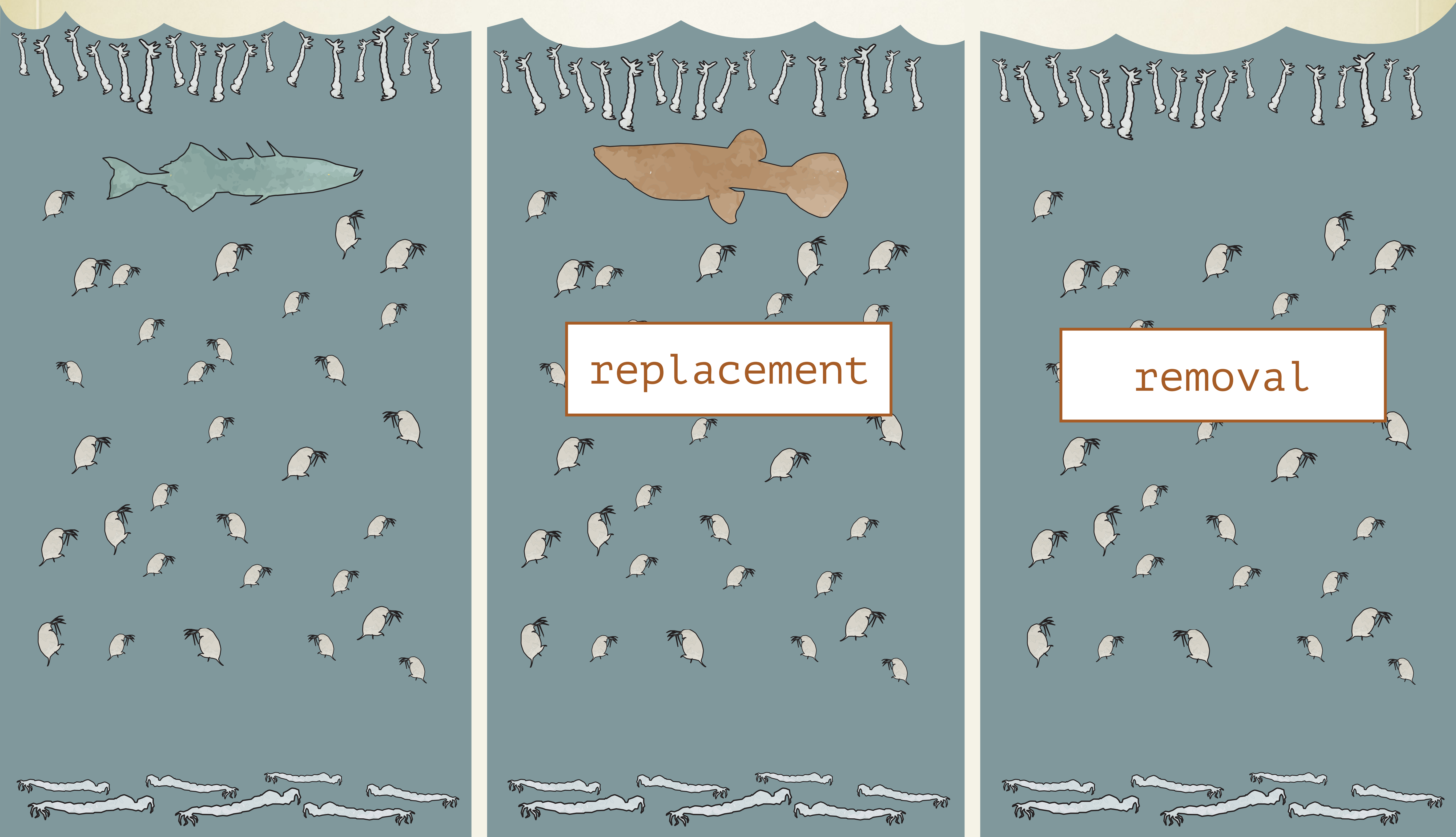
with

DM Post NE Turley JK Bailey AP Hendry MT Kinnison JA Schweitzer

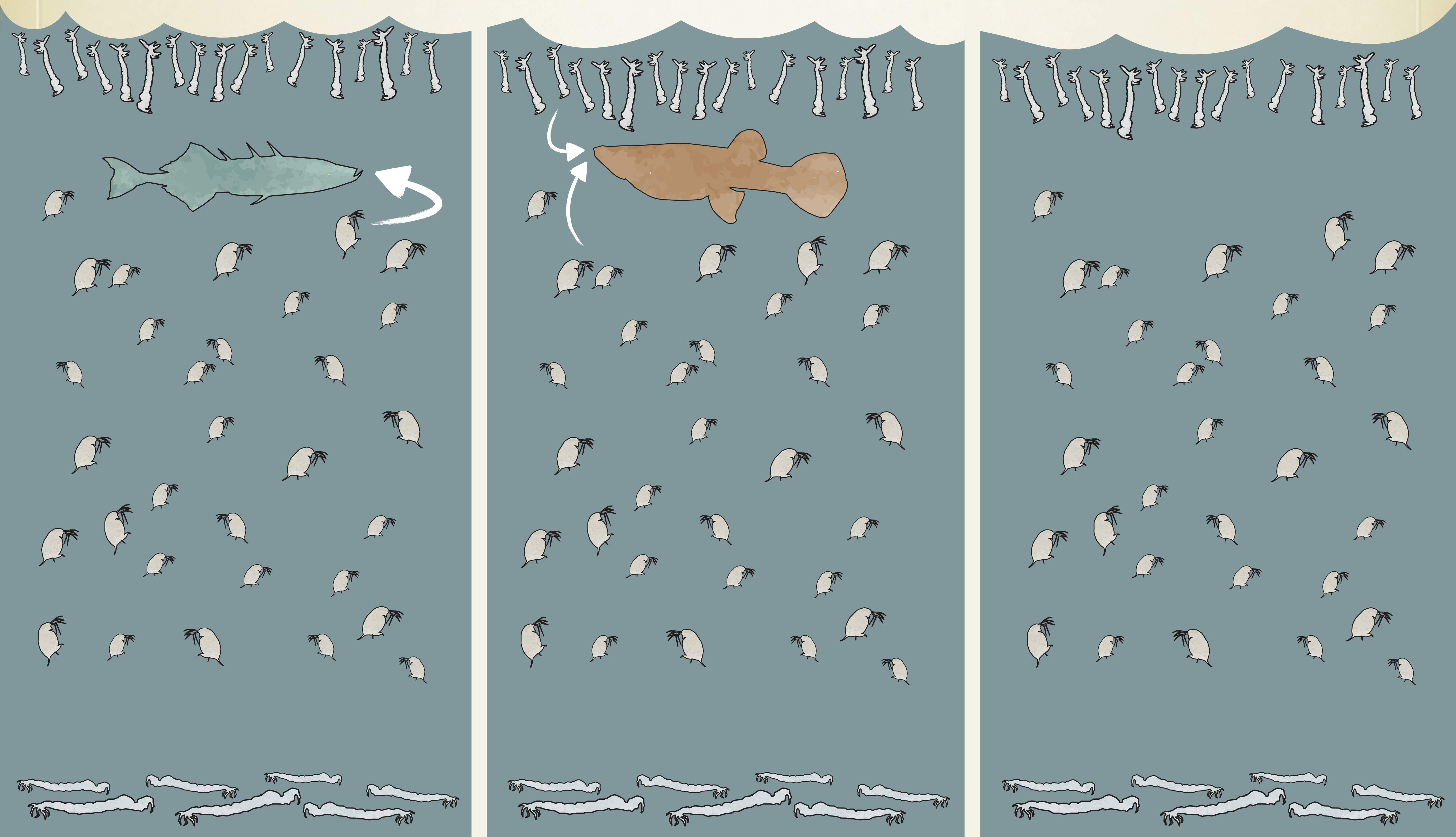
& EP Palkovacs

different species have different ecological effects

“species ecological effects”

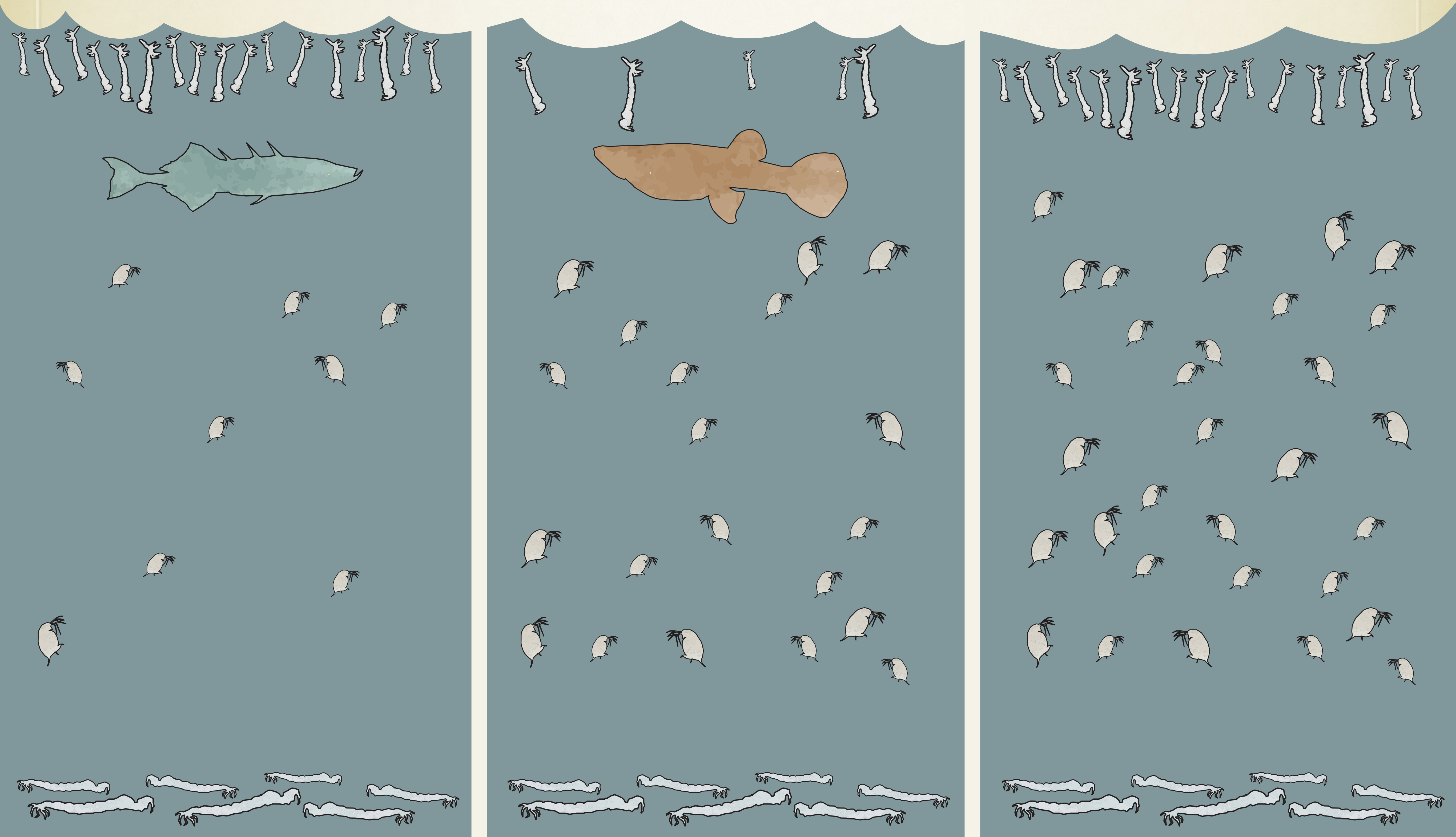


“species ecological effects”



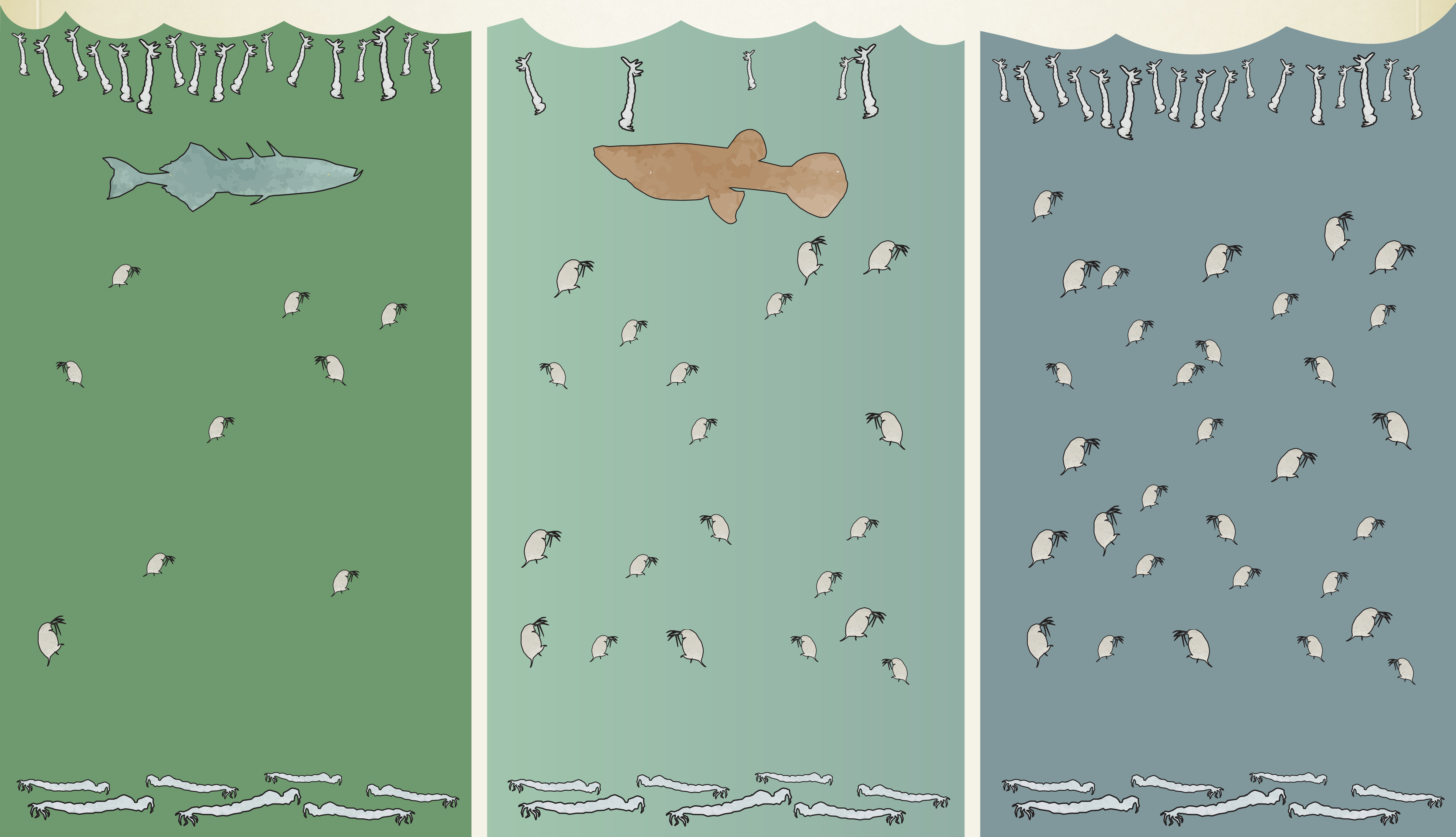
“species ecological effects”

direct ecological effects



“species ecological effects”

indirect ecological effects



substantial

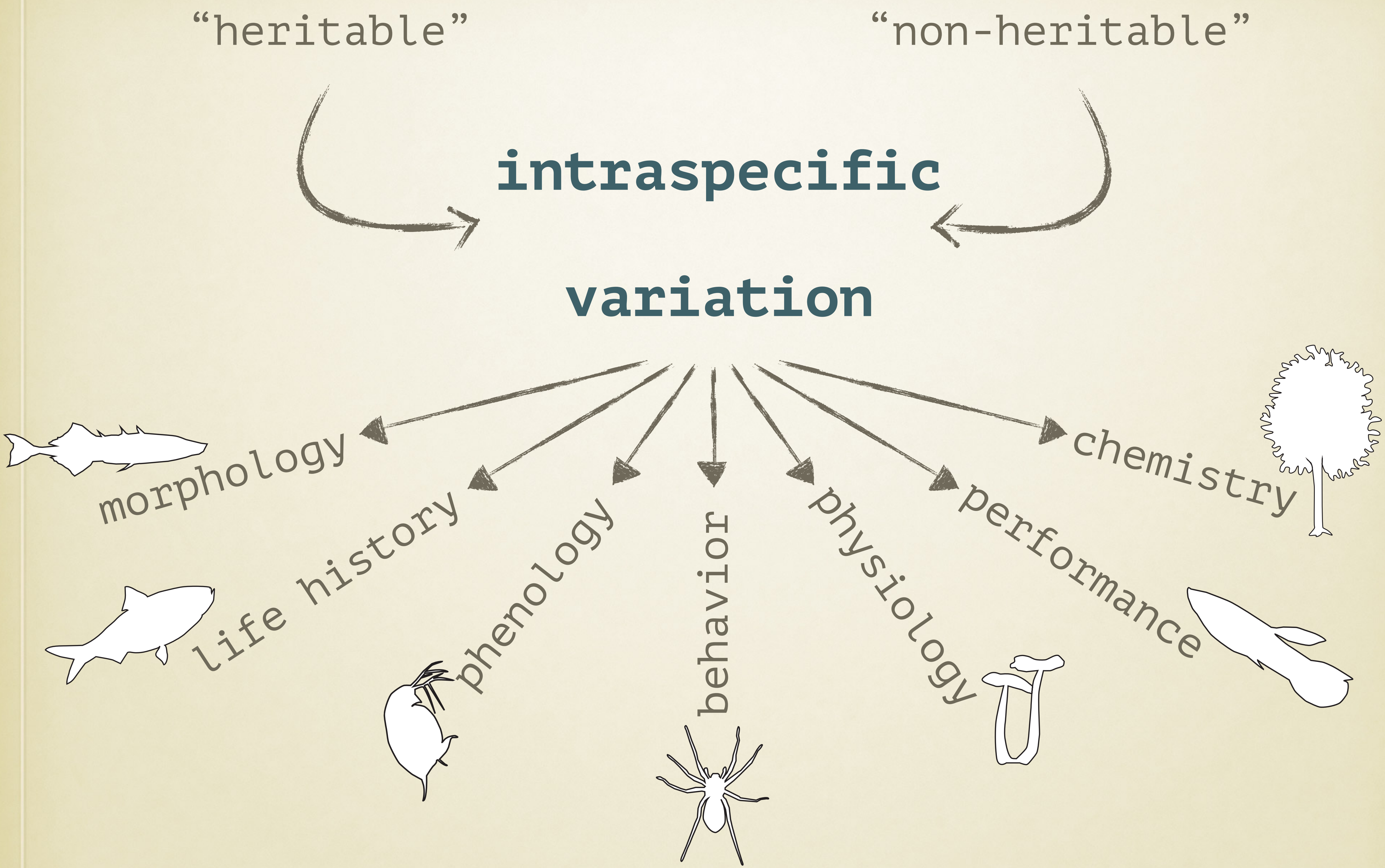
within-species

phenotypic diversity

substantial

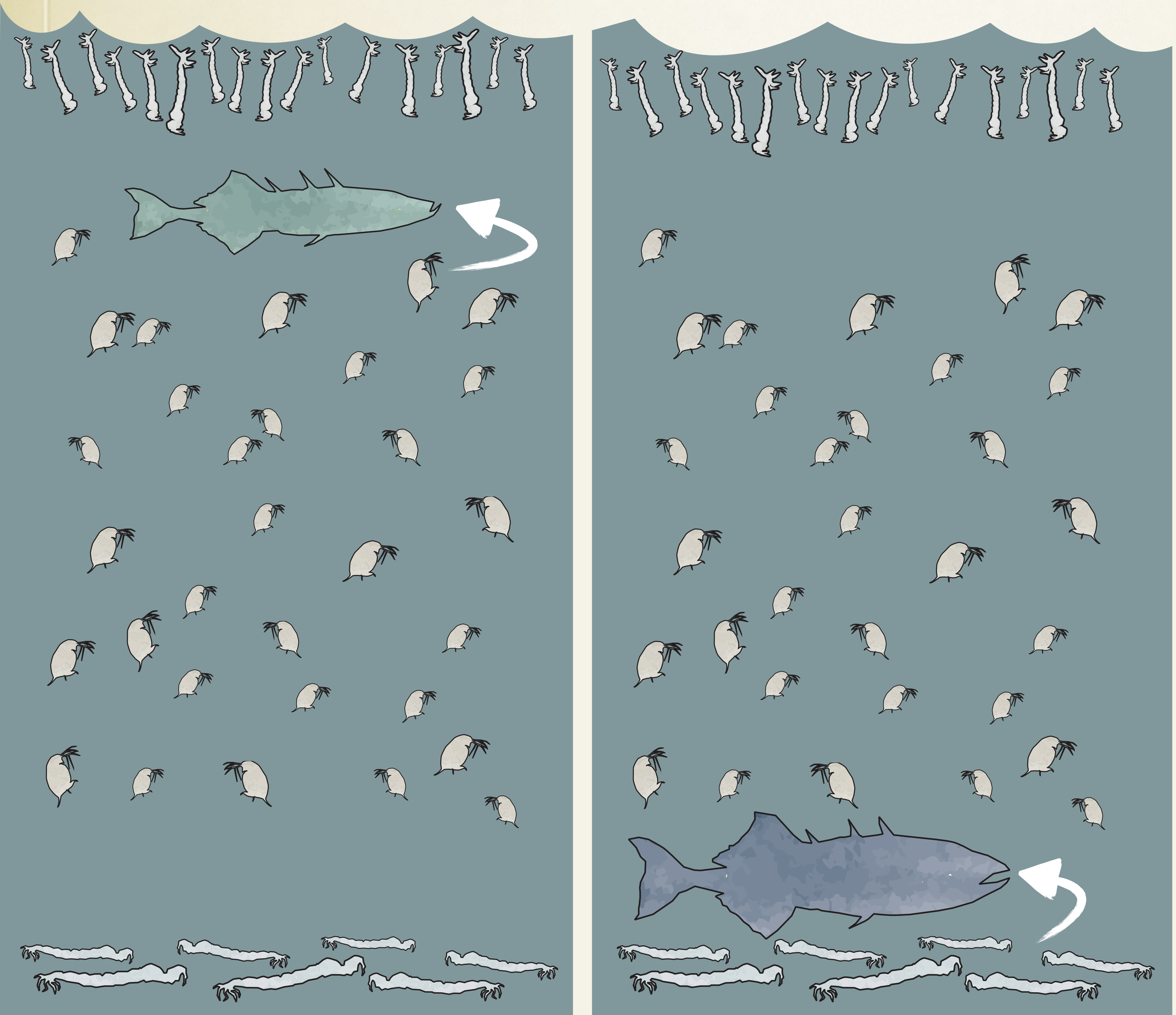
intraspecific

variation


"heritable"
"non-heritable"
intraspecific
variation
morphology
life history
phenology
behavior
physiology
performance
chemistry

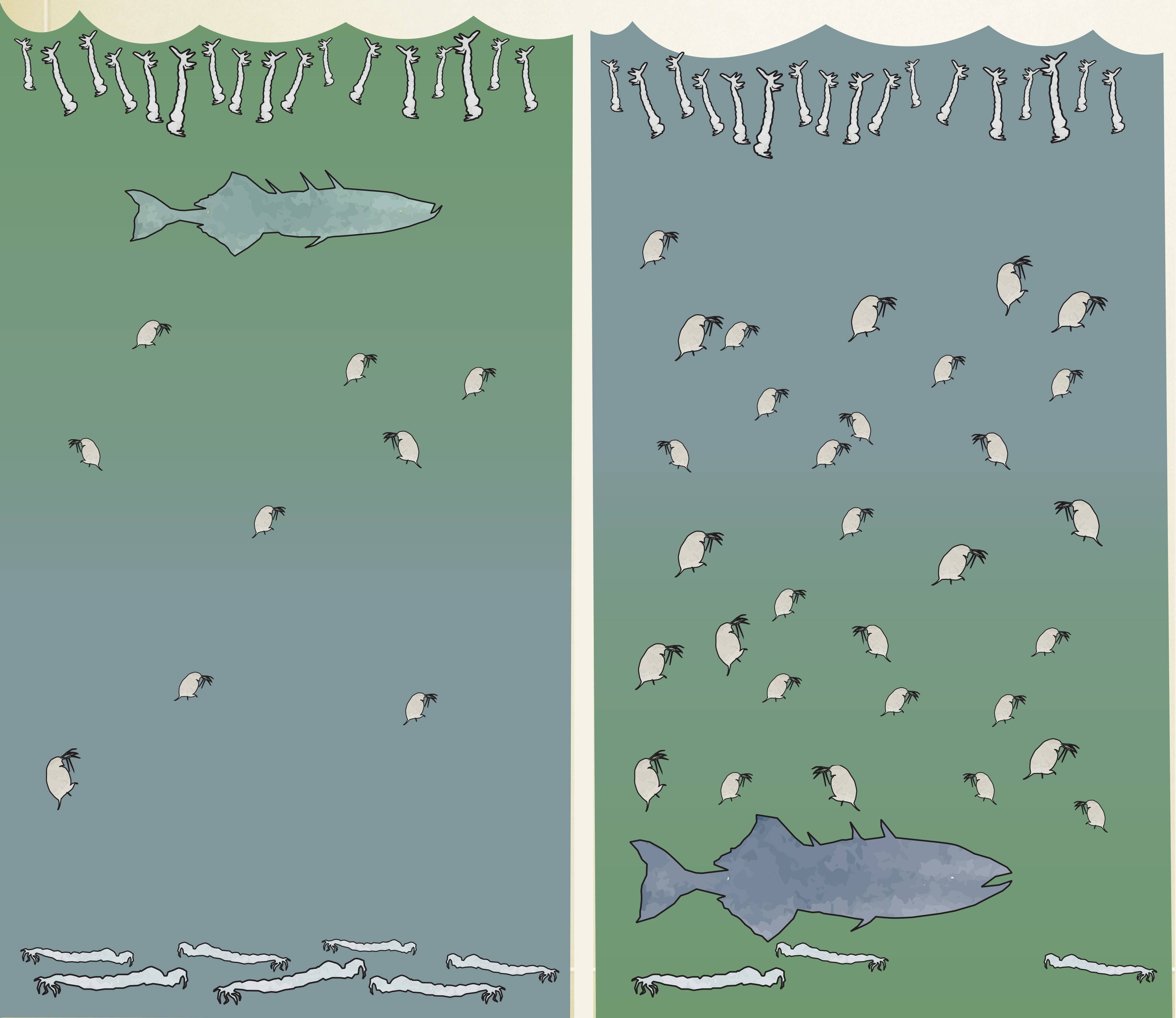
“intraspecific ecological effects”

direct ecological effects



“intraspecific ecological effects”

indirect ecological effects



how do

intraspecific effects compare to **species effects**?

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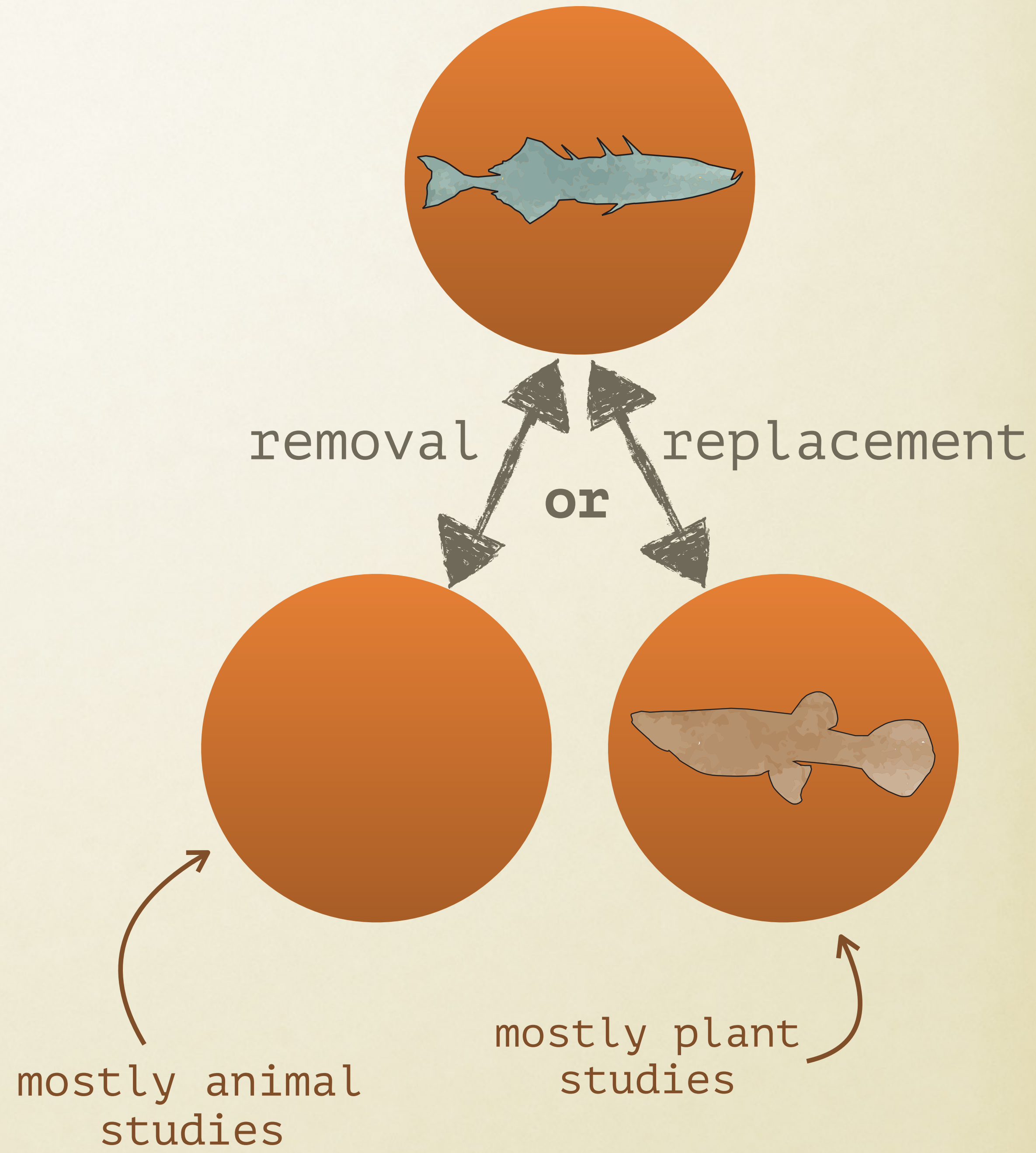
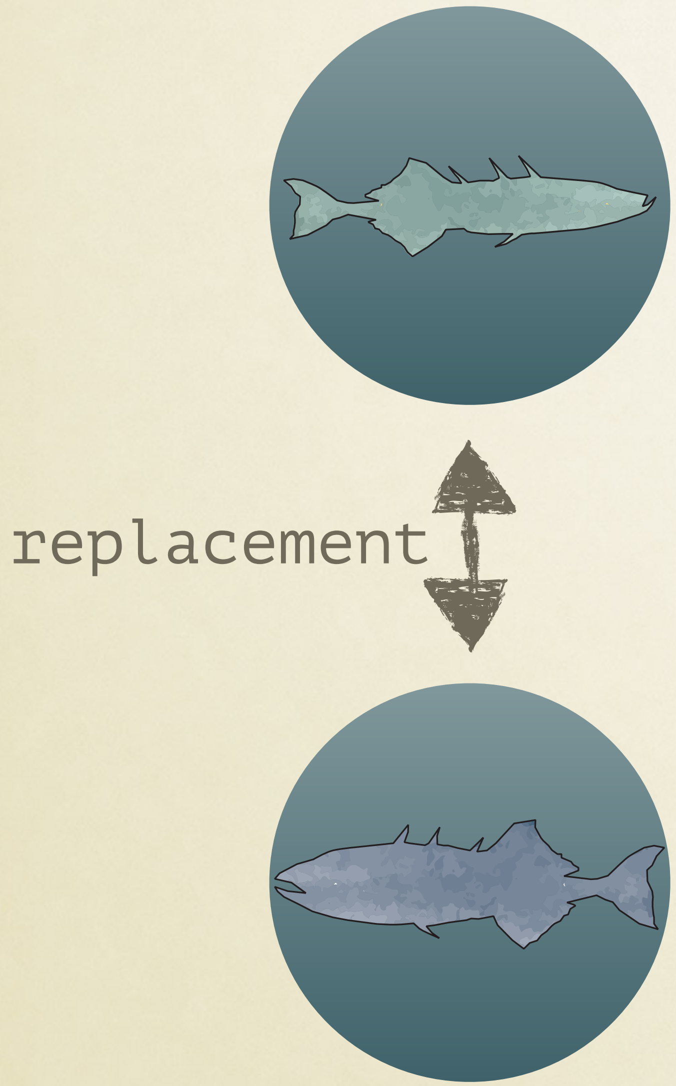
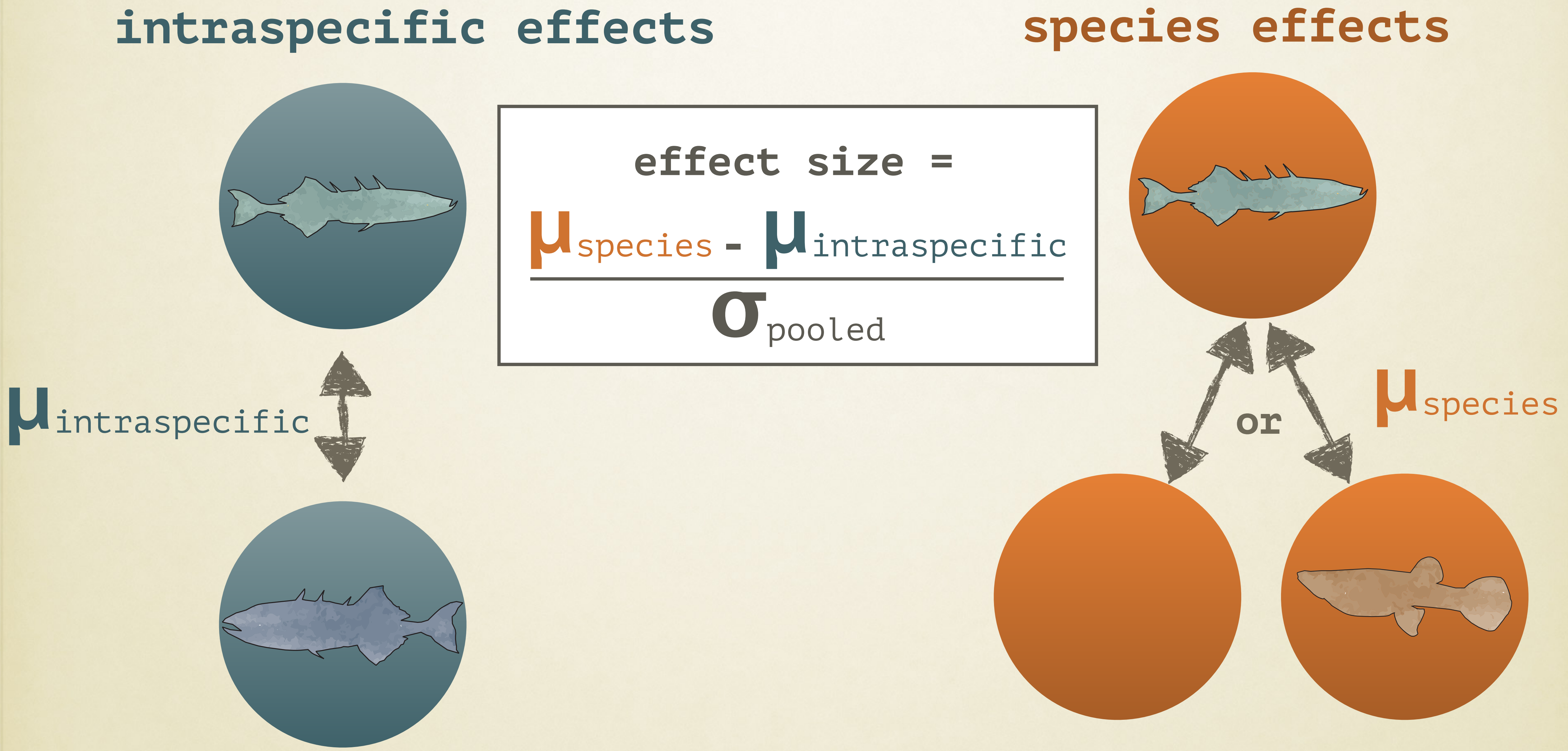
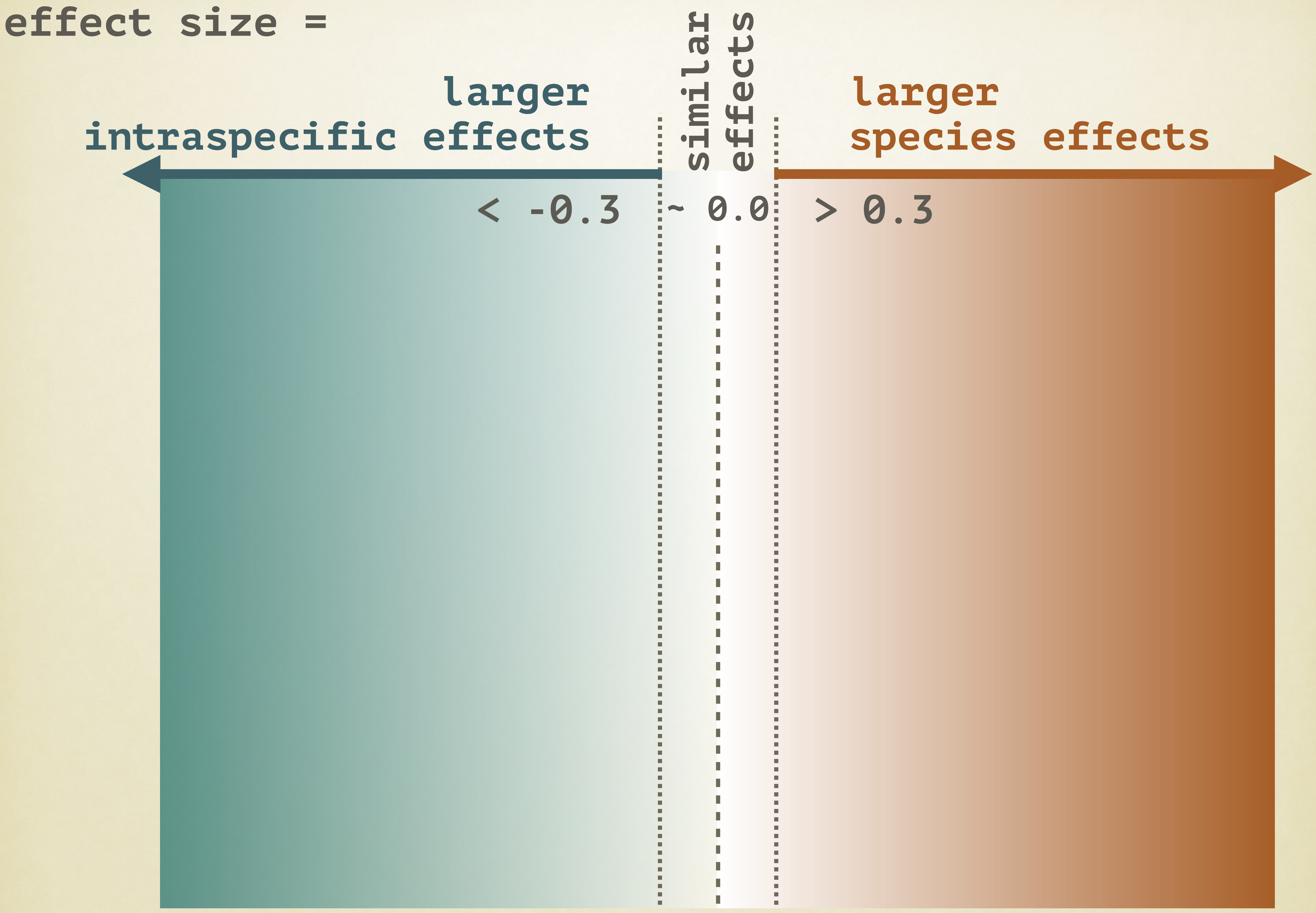


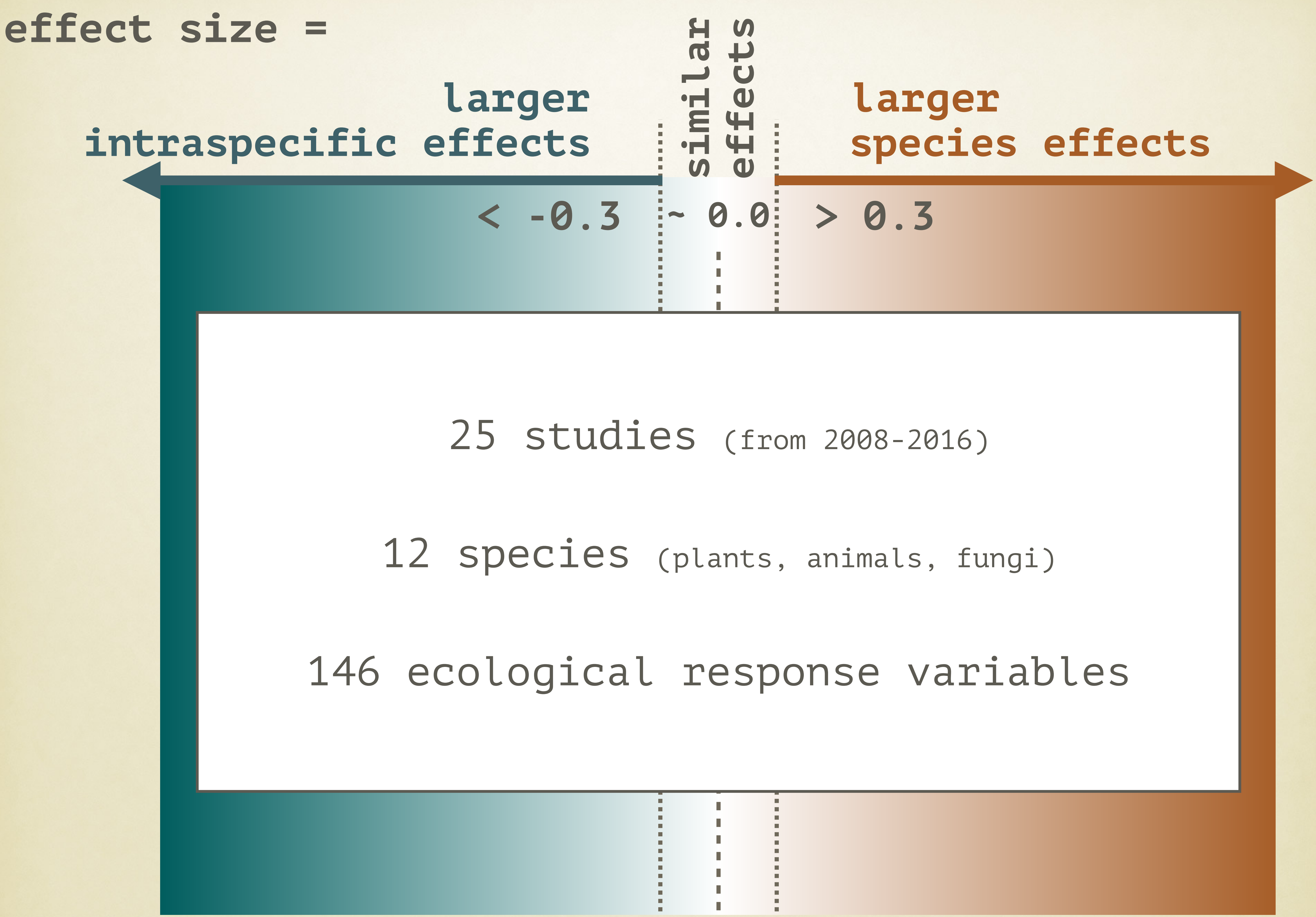
how do

intraspecific effects compare to species effects?

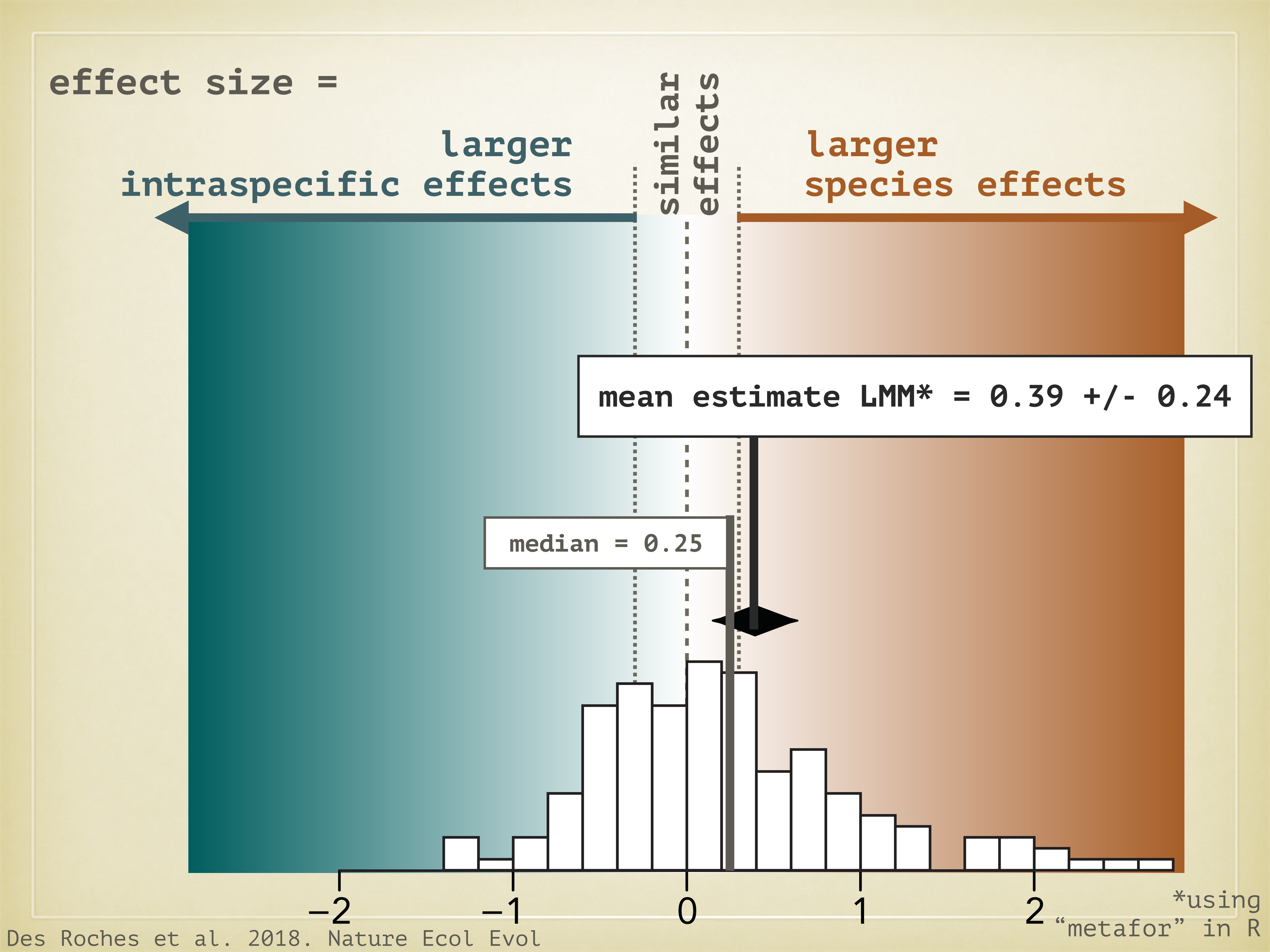


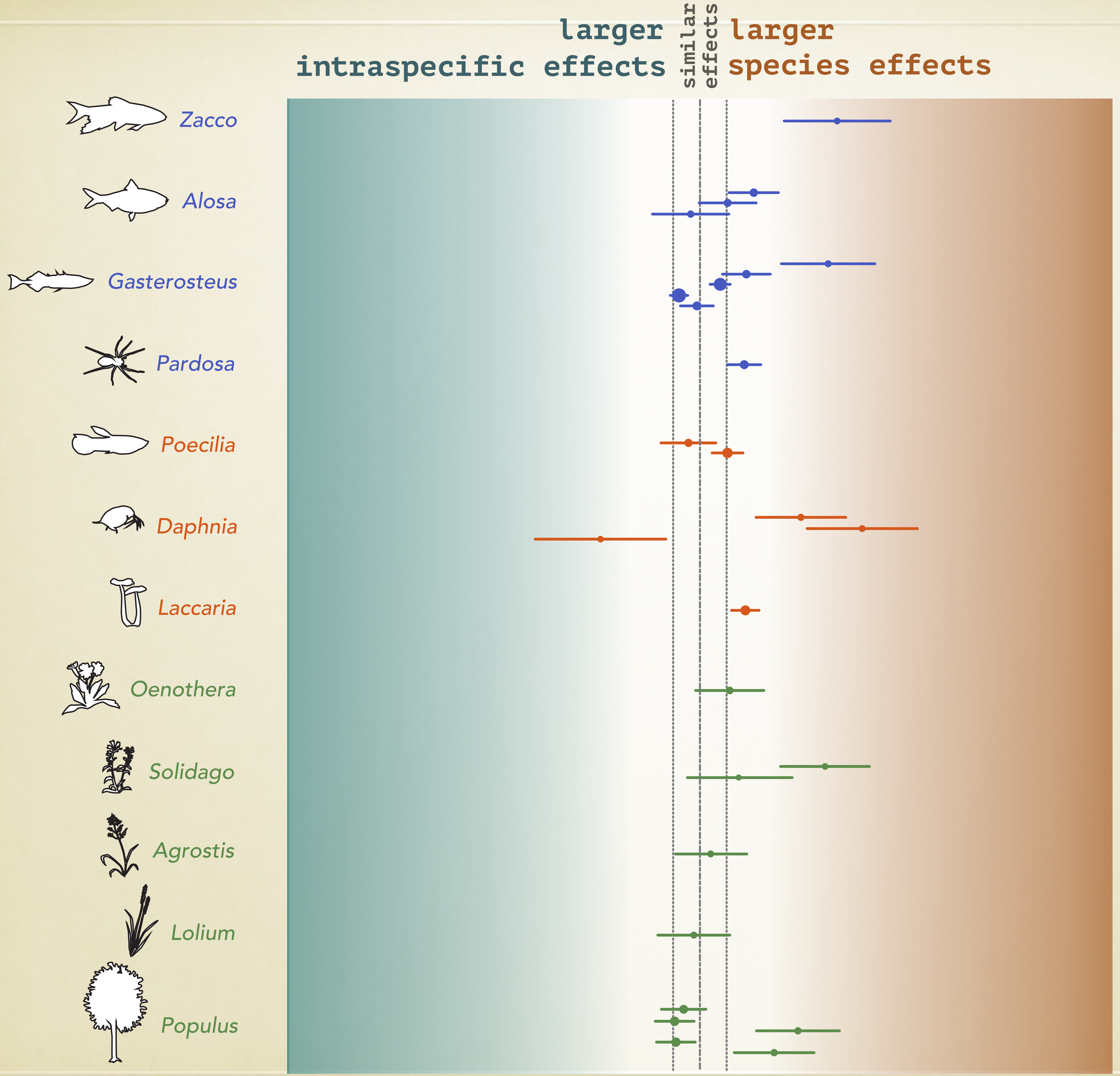

intraspecific effects
species effects
effect size =
$$\frac{\mu_{species} - \mu_{intraspecific}}{\sigma_{pooled}}$$
$\mu_{intraspecific}$
or
$\mu_{species}$


effect size =
larger
intraspecific effects
similar
effects
larger
species effects
< -0.3
~ 0.0
> 0.3



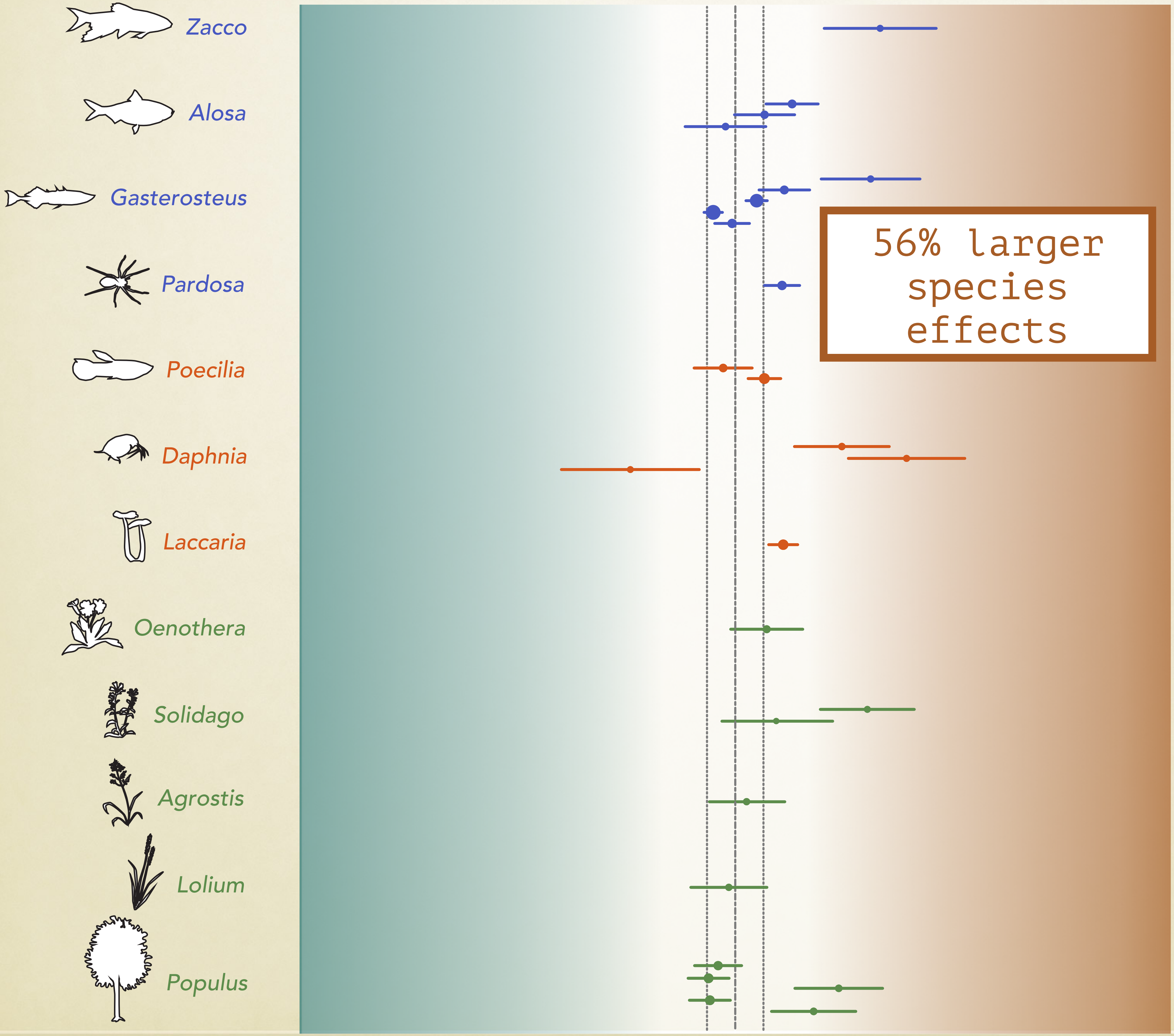
effect size =
larger intraspecific effects
similar effects
larger species effects
< -0.3
~ 0.0
> 0.3
25 studies (from 2008-2016)
12 species (plants, animals, fungi)
146 ecological response variables


effect size =
larger
intraspecific effects
similar
effects
larger
species effects
mean estimate LMM* = 0.39 +/- 0.24
median = 0.25
−2
−1
0
1
2
*using
"metafor" in R
Des Roches et al. 2018. Nature Ecol Evol



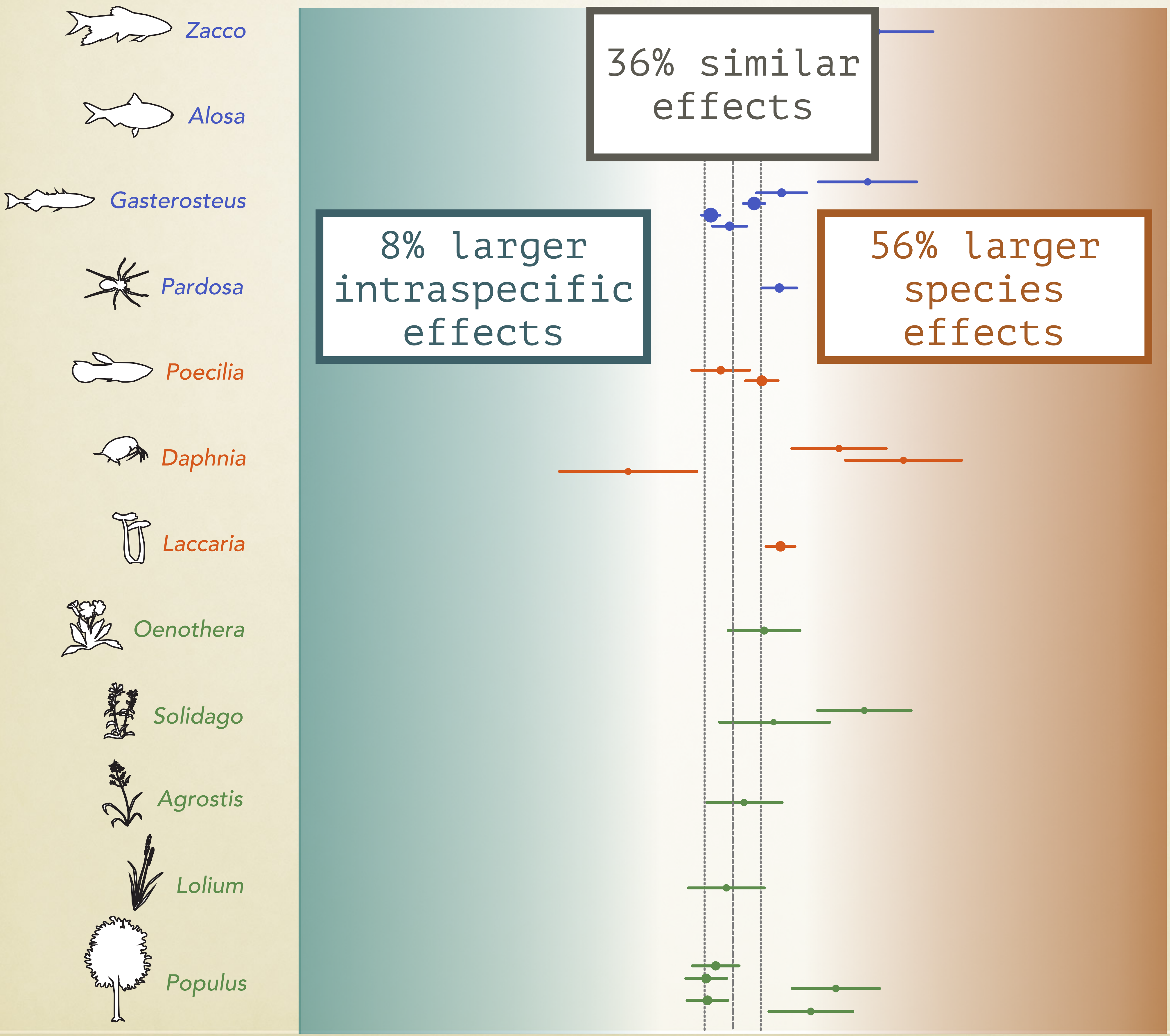
Des Roches et al. 2018. Nature Ecol Evol

of 25 different studies:



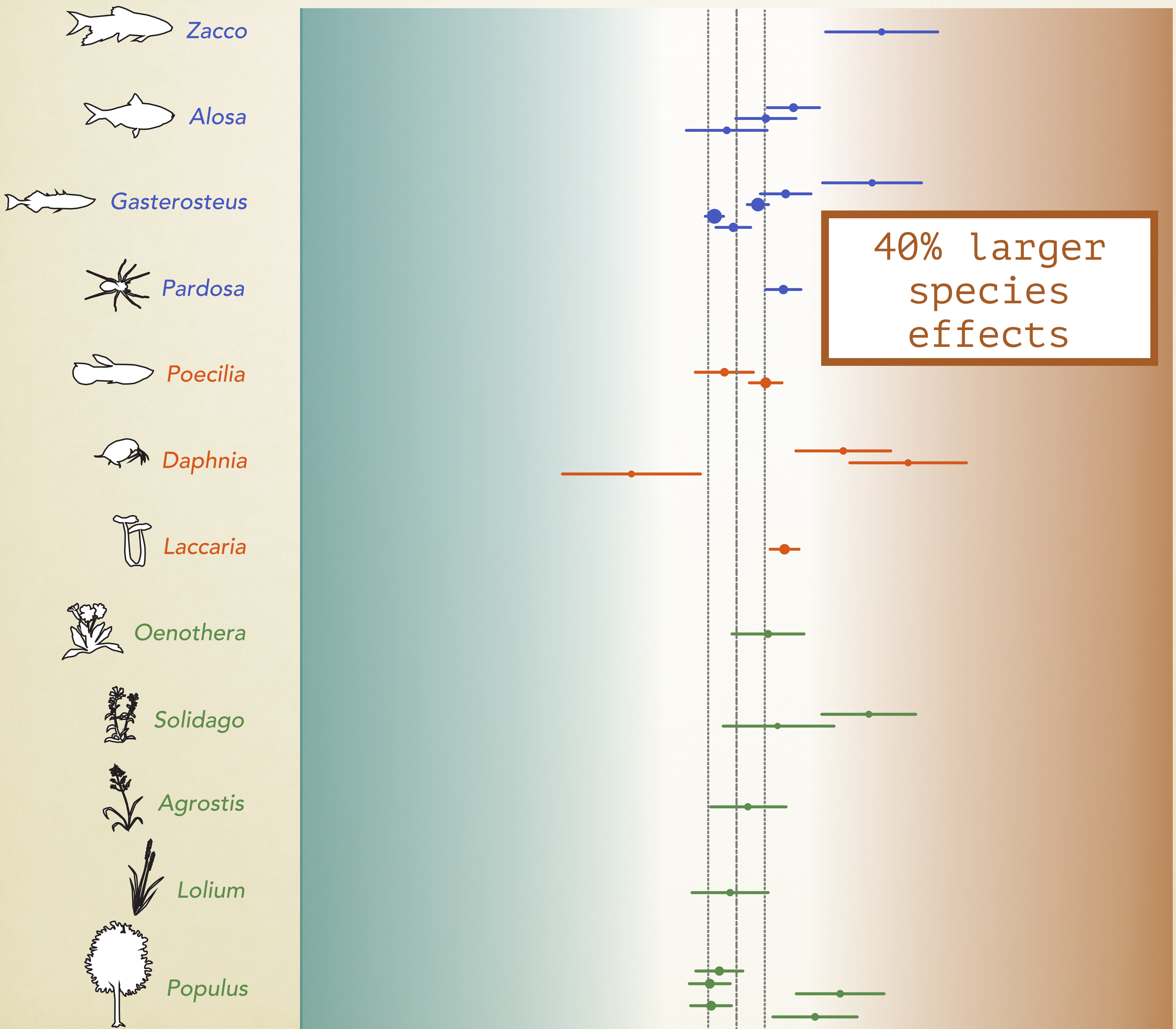
Des Roches et al. 2018. Nature Ecol Evol

of 25 different studies:



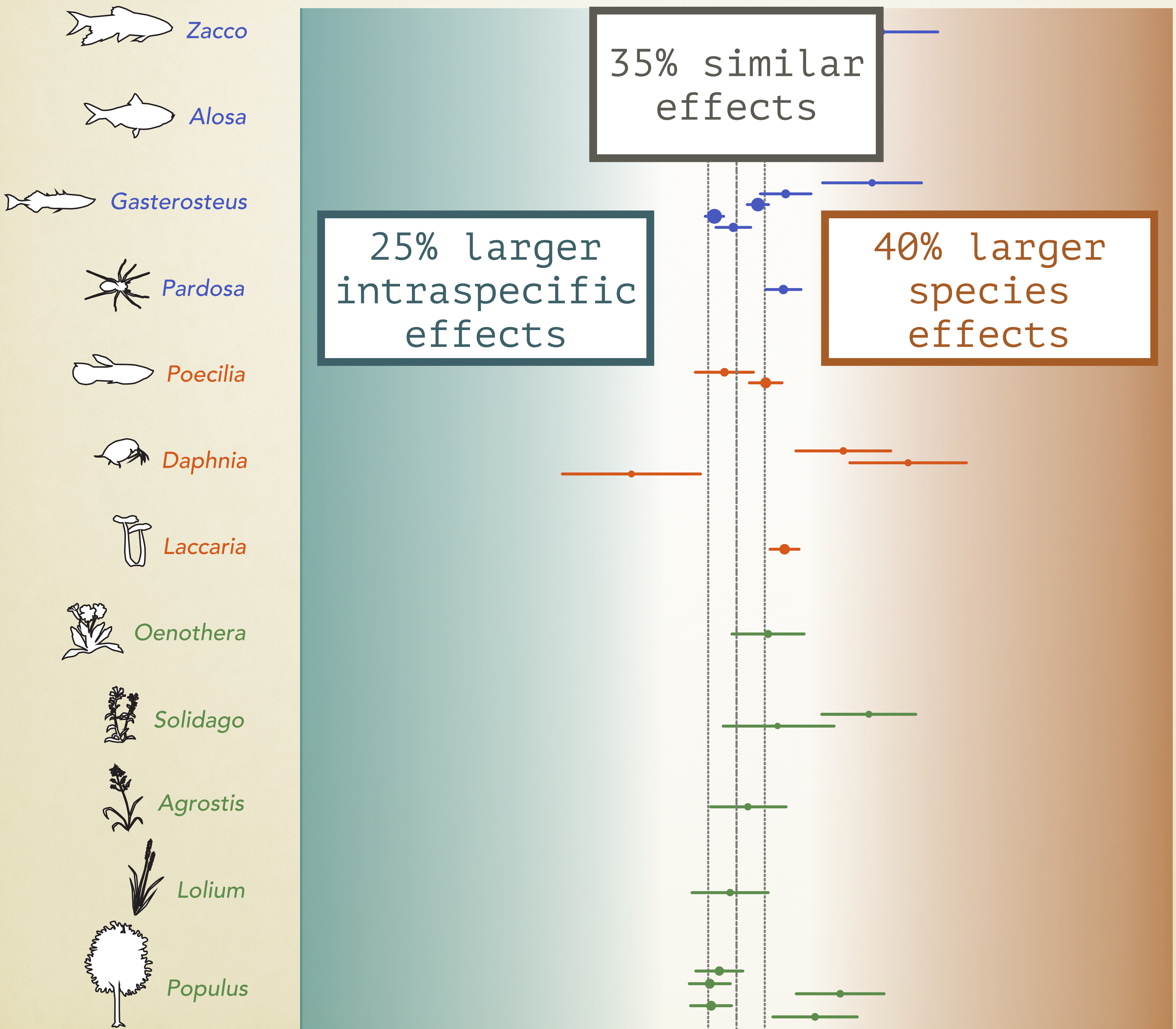
Des Roches et al. 2018. Nature Ecol Evol

of 146 ecological response variables:

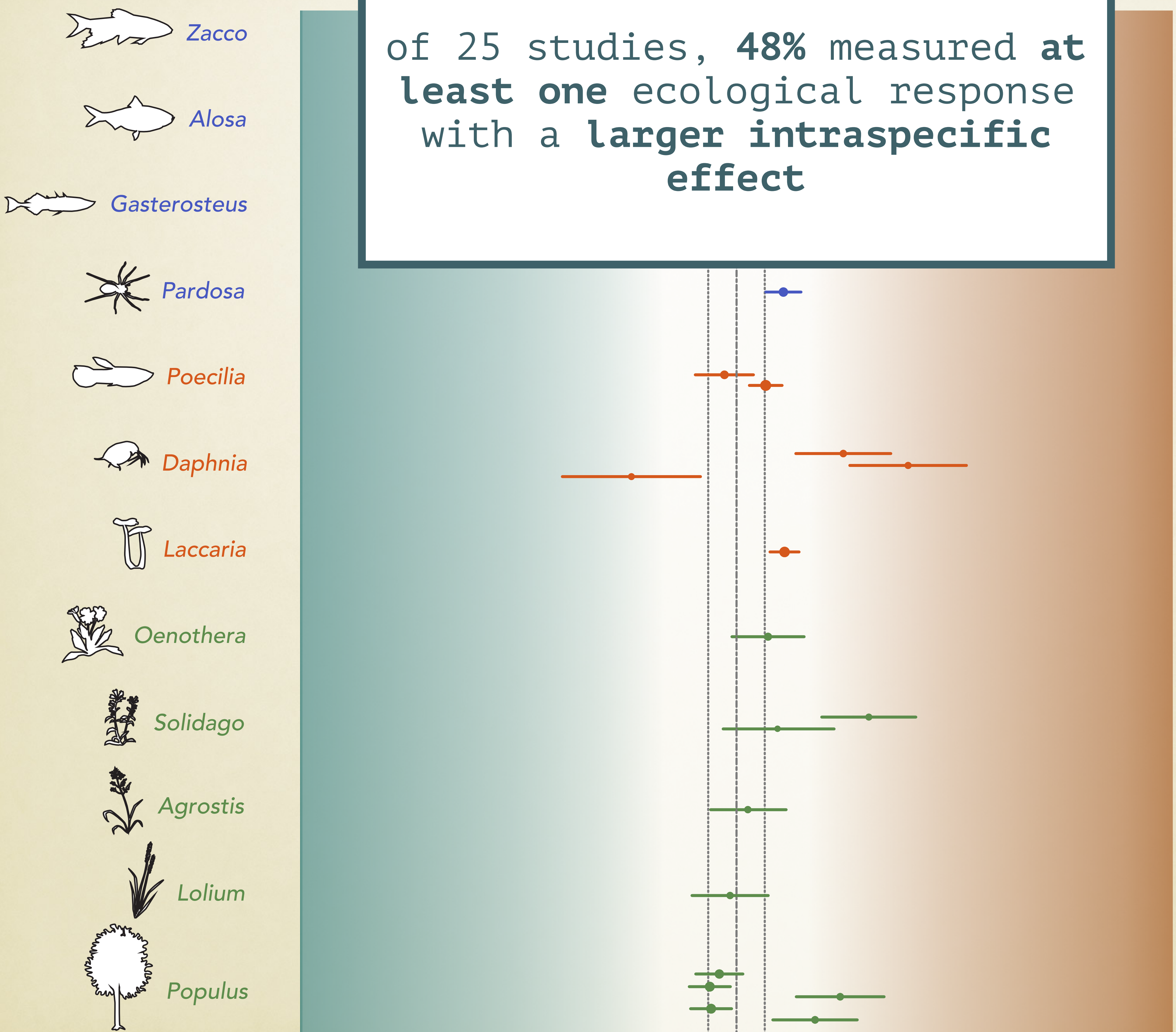


Des Roches et al. 2018. Nature Ecol Evol

of 146 ecological response variables:



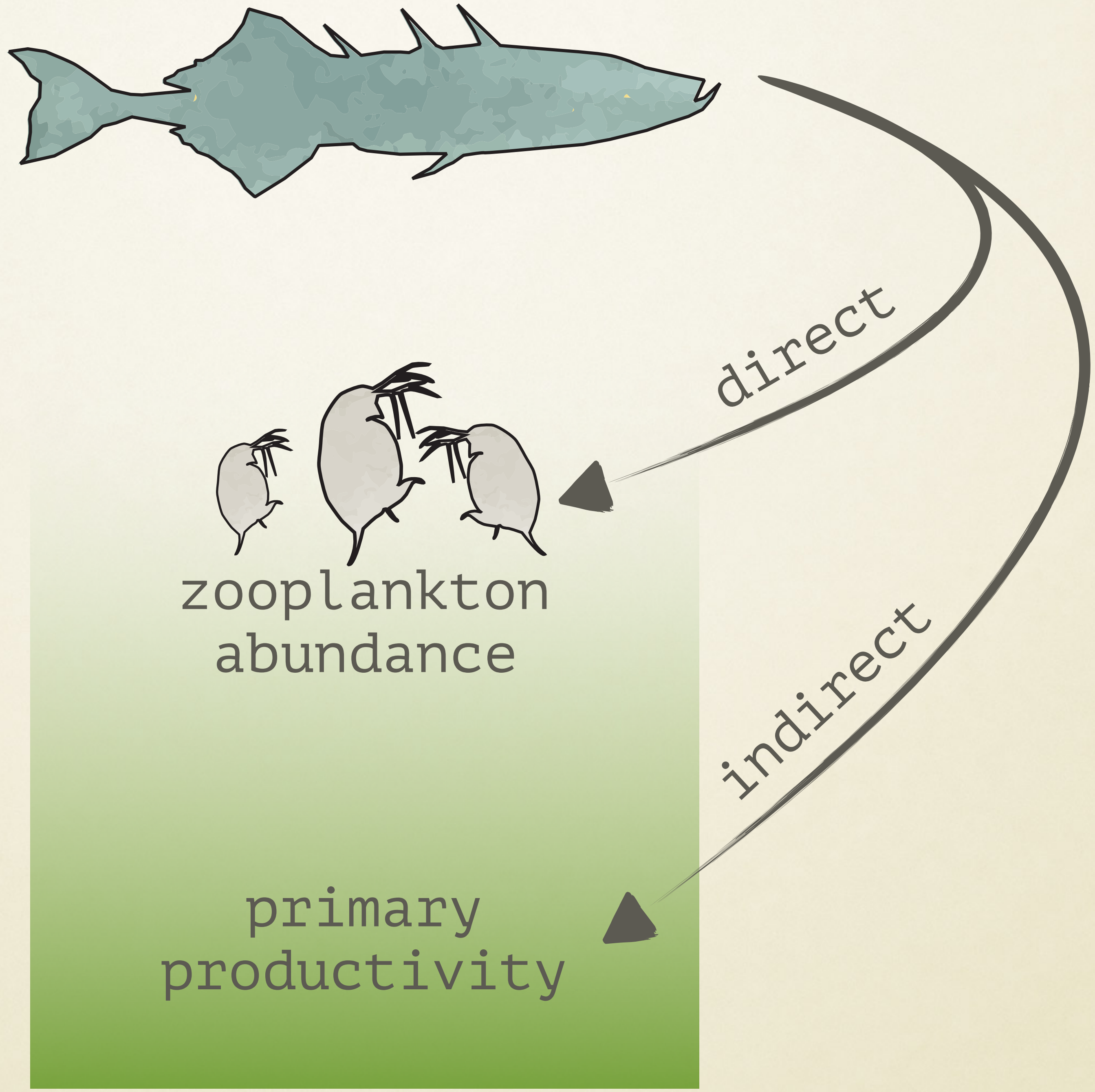
Des Roches et al. 2018. Nature Ecol Evol



of 25 studies, **48%** measured **at least one** ecological response with a **larger intraspecific effect**

Des Roches et al. 2018. Nature Ecol Evol

effect size depends on **type** of ecological response



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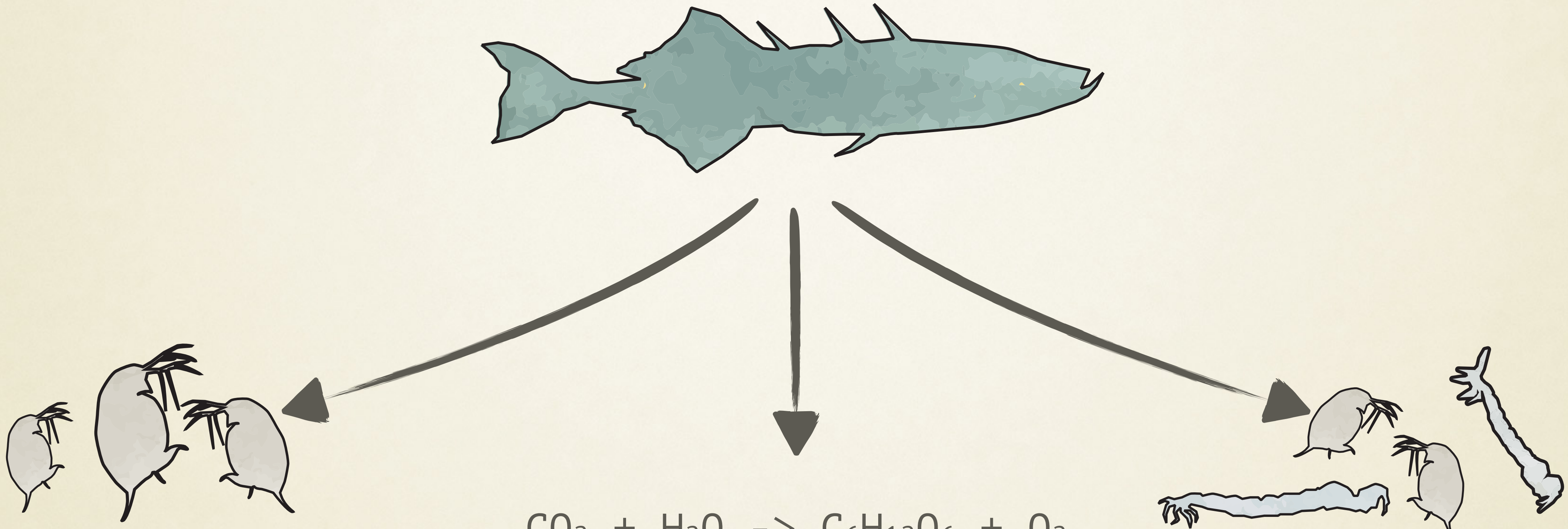


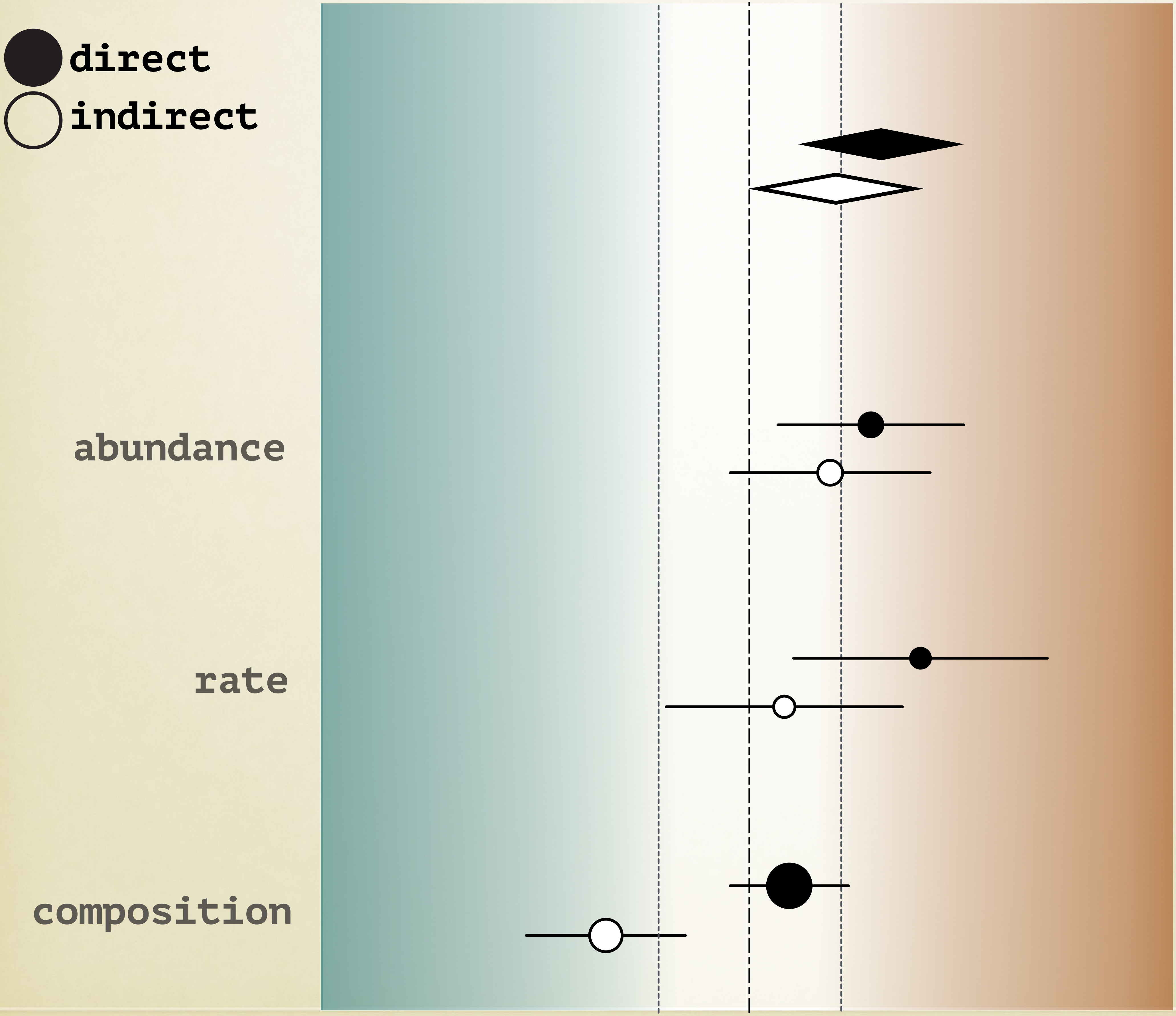
abundance

$CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$

rate

composition

effect size depends on **type** of ecological response



Des Roches et al. 2018. Nature Ecol Evol

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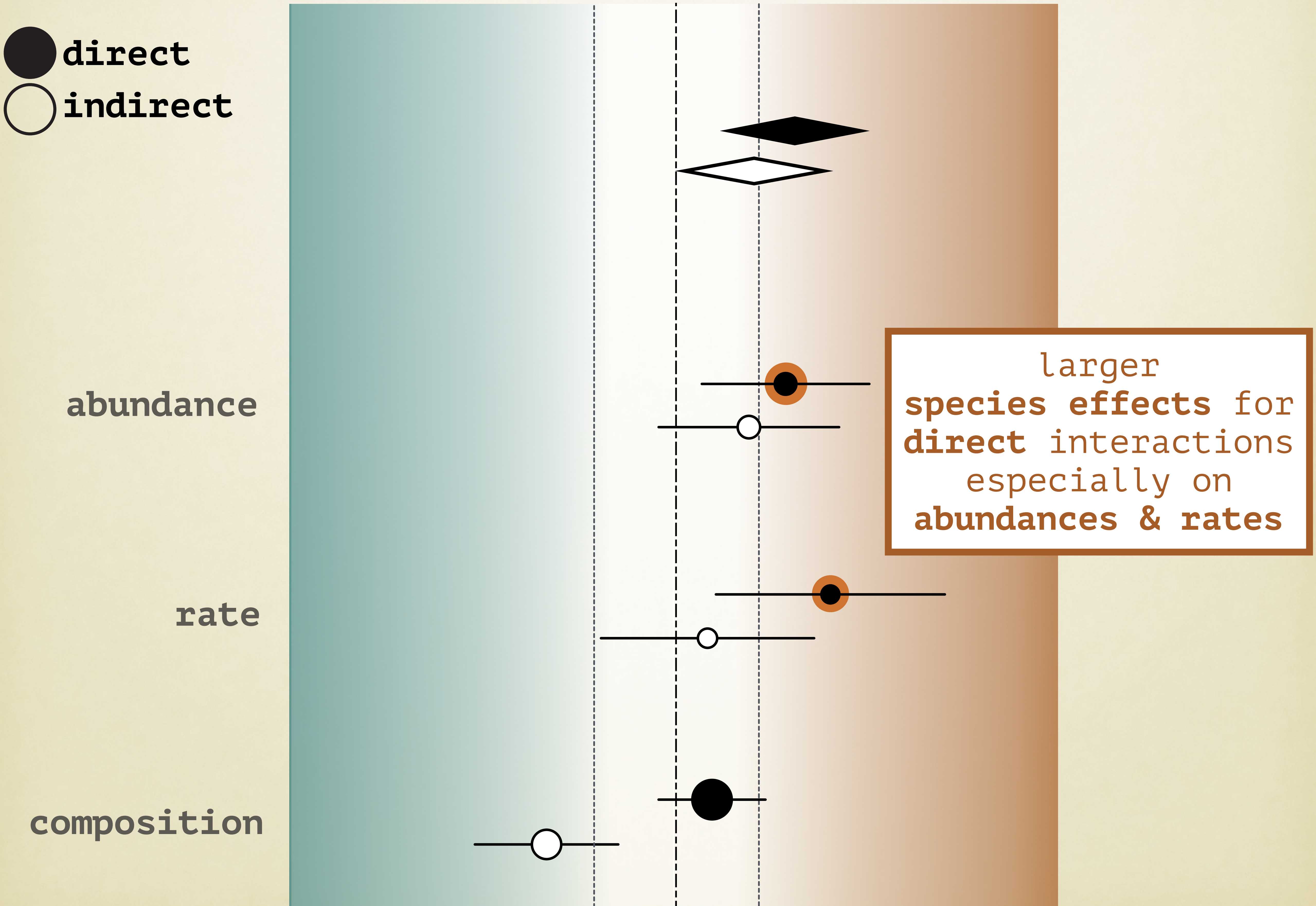
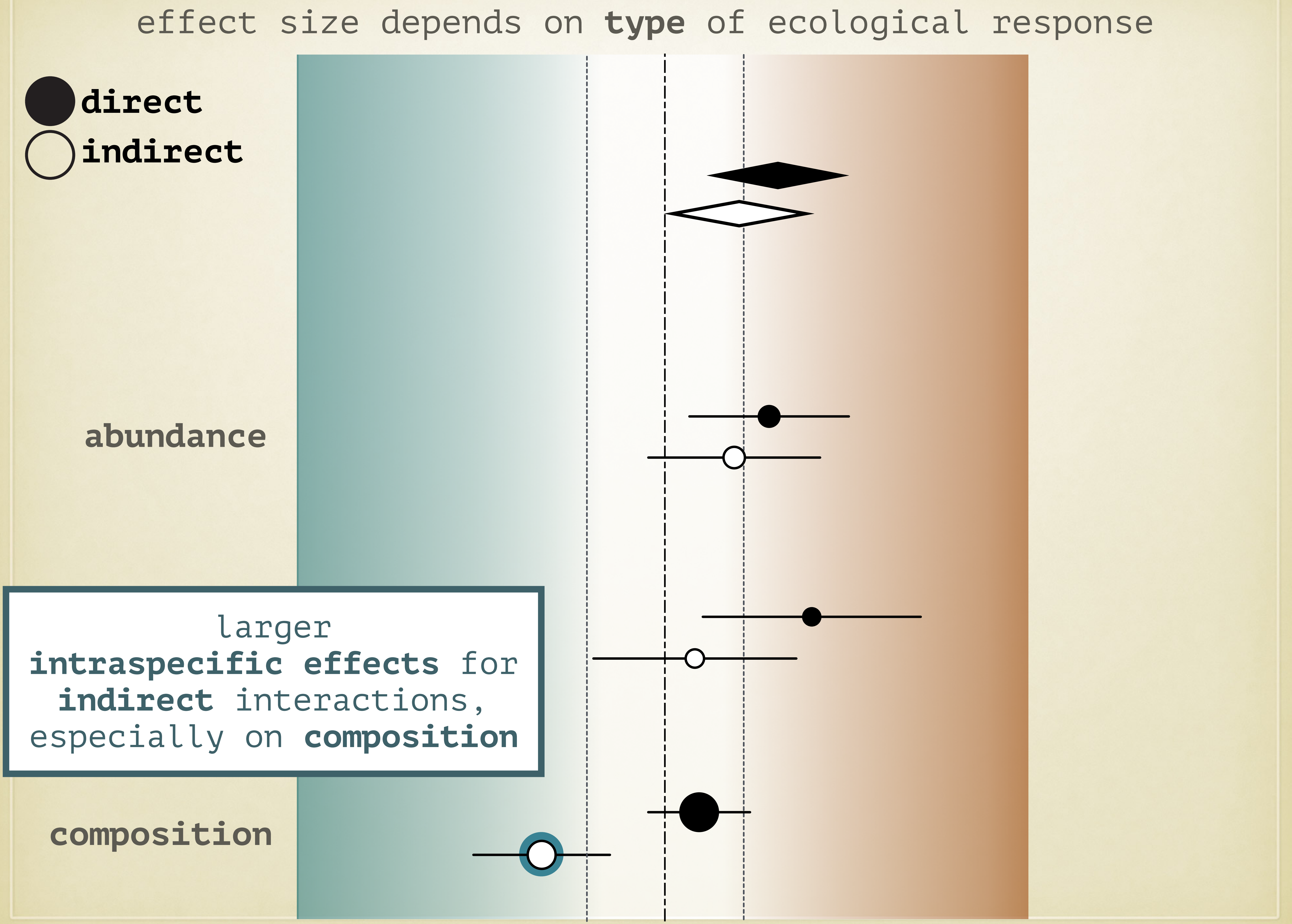


Des Roches et al. 2018. Nature Ecol Evol



Des Roches et al. 2018. Nature Ecol Evol

why does it matter?

why does it matter?

changes in intraspecific variation can occur on ecological timescales ("**rapid evolution**")

THE AMERICAN NATURALIST

Vol. LXXVI *January–February, 1942* No. 762

ECOLOGICAL ASPECTS OF EVOLUTION*

RELATIONS BETWEEN CLIMATE AND INTRA-SPECIFIC VARIATION IN PLANTS[1]

DR. WILLIAM M. HIESEY, DR. JENS CLAUSEN AND DR. DAVID D. KECK

THE AMERICAN NATURALIST

Vol. XCV July–August, 1961 No. 883

EFFECTS OF IMMIGRATION ON THE EVOLUTION OF POPULATIONS

FREDERICK A. STREAMS AND DAVID PIMENTEL

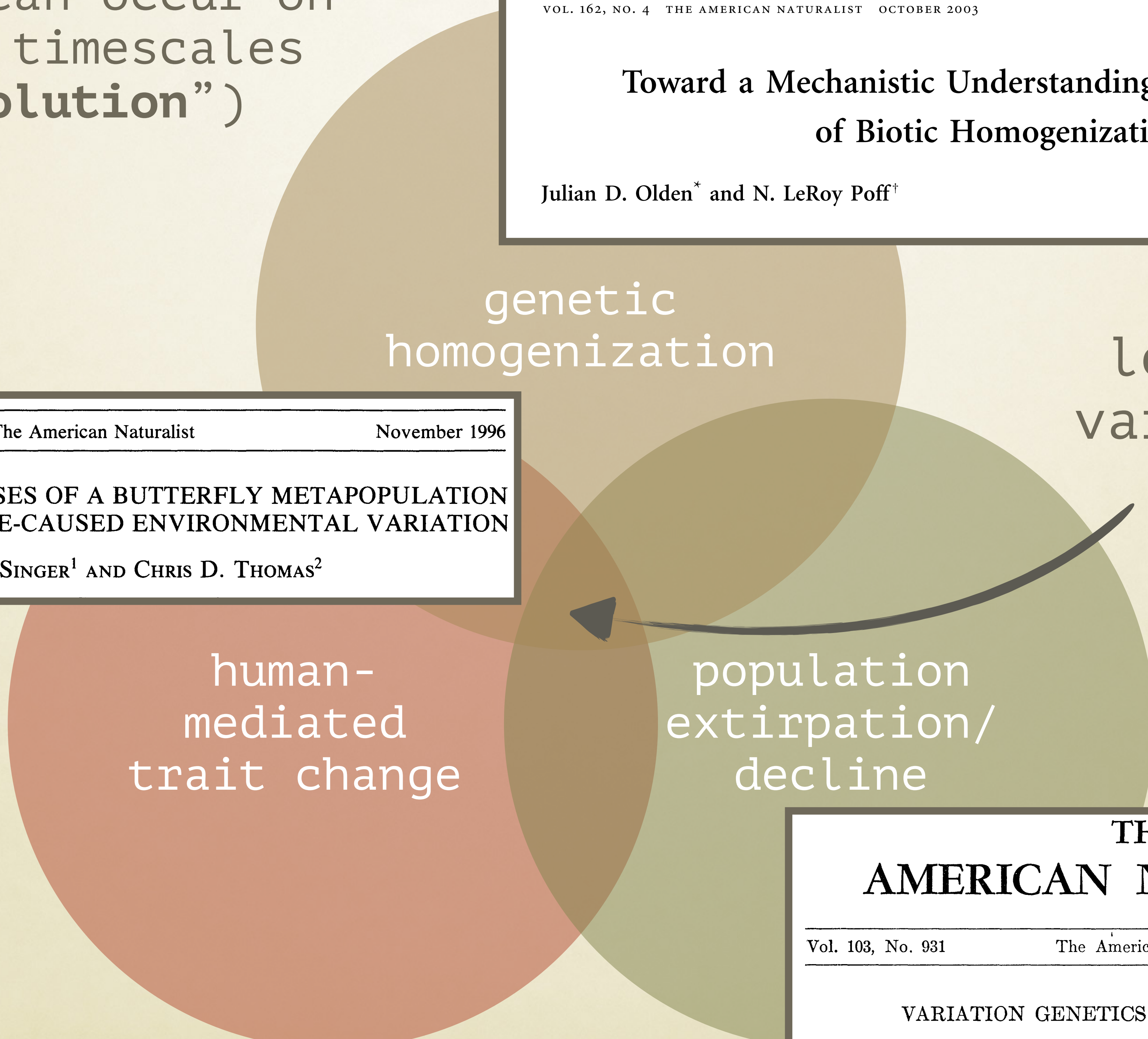
The American Naturalist October 1980

GENETIC VARIATION AND PHENOTYPIC EVOLUTION DURING ALLOPATRIC SPECIATION

RUSSELL LANDE*

why does it matter?

changes in intraspecific variation can occur on ecological timescales ("**rapid evolution**")



VOL. 162, NO. 4 THE AMERICAN NATURALIST OCTOBER 2003

Toward a Mechanistic Understanding and Prediction of Biotic Homogenization

Julian D. Olden* and N. LeRoy Poff†

Vol. 148, Supplement The American Naturalist November 1996

EVOLUTIONARY RESPONSES OF A BUTTERFLY METAPOPULATION TO HUMAN- AND CLIMATE-CAUSED ENVIRONMENTAL VARIATION

Michael C. Singer[1] and Chris D. Thomas[2]

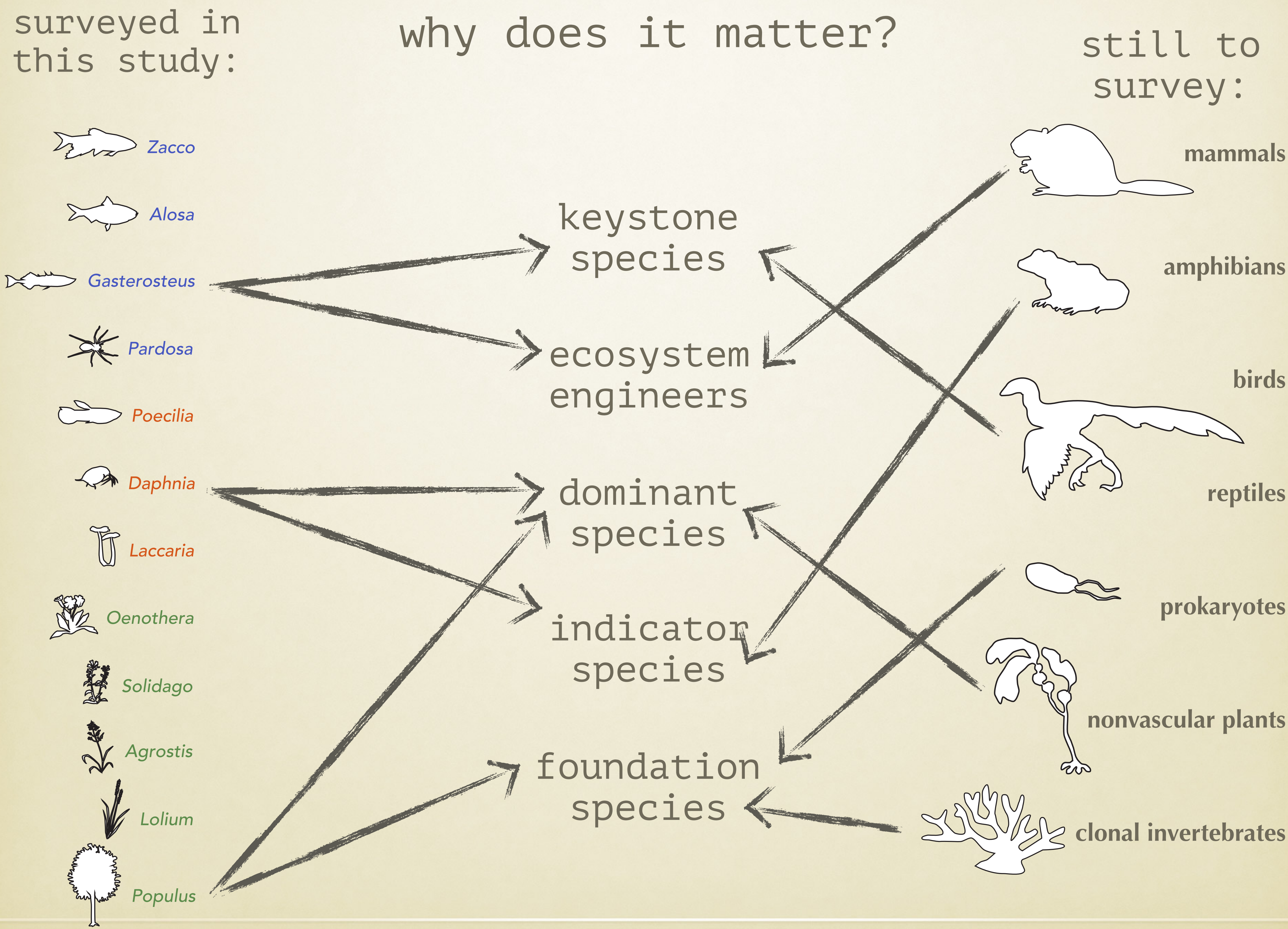
THE AMERICAN NATURALIST

Vol. 103, No. 931 The American Naturalist May-June, 1969

VARIATION GENETICS OF EXTINCT ANIMALS

Leigh Van Valen

why does it matter?



thank you!

luke harmon

All Mail - Google September 25, 2009 at 09:28 AM

Fwd: effect sizes

To: Simone DesRoches

Hi Simone,

See below from David Post. I don't care about coauthorship for me but I think you should be a coauthor if we give them all of our data. Are you interested? I see this as a win-win for you. It would add a little urgency to getting your paper published. But if you're an author on both I guess it's not that big of a deal, you can't scoop yourself!

lh

Begin forwarded message:

From: "David M. Post" <david.post@yale.edu>
Date: September 24, 2009 2:44:28 PM PDT
To: Luke Harmon <lukeh@uidaho.edu>
Subject: Re: effect sizes

Hey Luke,

Likewise. It was really great talking with you at ESA.

I am just starting the effect size paper (worked on an outline last week and started
There is a second guppy paper working its way through the review process and I wa
weeks). It has a no fish treatment also, which the Palkovacs et al. paper did not, so

I would love to include the stickleback data. I am also happy to include you (or your student - your call) as a co-author if you feel that is needed/wanted/fair (your call). It is already Post et al. and I like to give credit to all that helped.

Especially to **Luke Harmon**, who suggested I co-author this paper 8 years ago…

OPEN ACCESS Freely available online PLOS | ONE

Ecological and Evolutionary Effects of Stickleback on Community Structure

2013

Simone Des Roches[1]*, Jonathan B. Shurin[2], Dolph Schluter[3], Luke J. Harmon[1]

nature ecology & evolution ARTICLES

https://doi.org/10.1038/s41559-017-0402-5

The ecological importance of intraspecific variation

2018

Simone Des Roches[1]*, David M. Post[2], Nash E. Turley[3], Joseph K. Bailey[4], Andrew P. Hendry[5], Michael T. Kinnison[6], Jennifer A. Schweitzer[4] and Eric P. Palkovacs[1]

… and to the authors of the papers included in our meta-analysis who provided their raw data

ISEECI
INSTITUTE FOR THE STUDY OF ECOLOGICAL & EVOLUTIONARY CLIMATE IMPACTS

CENTRE DE LA SCIENCE DE LA BIODIVERSITÉ DU QUÉBEC
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the David & Lucile Packard FOUNDATION

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UC SANTA CRUZ BANANA SLUGS

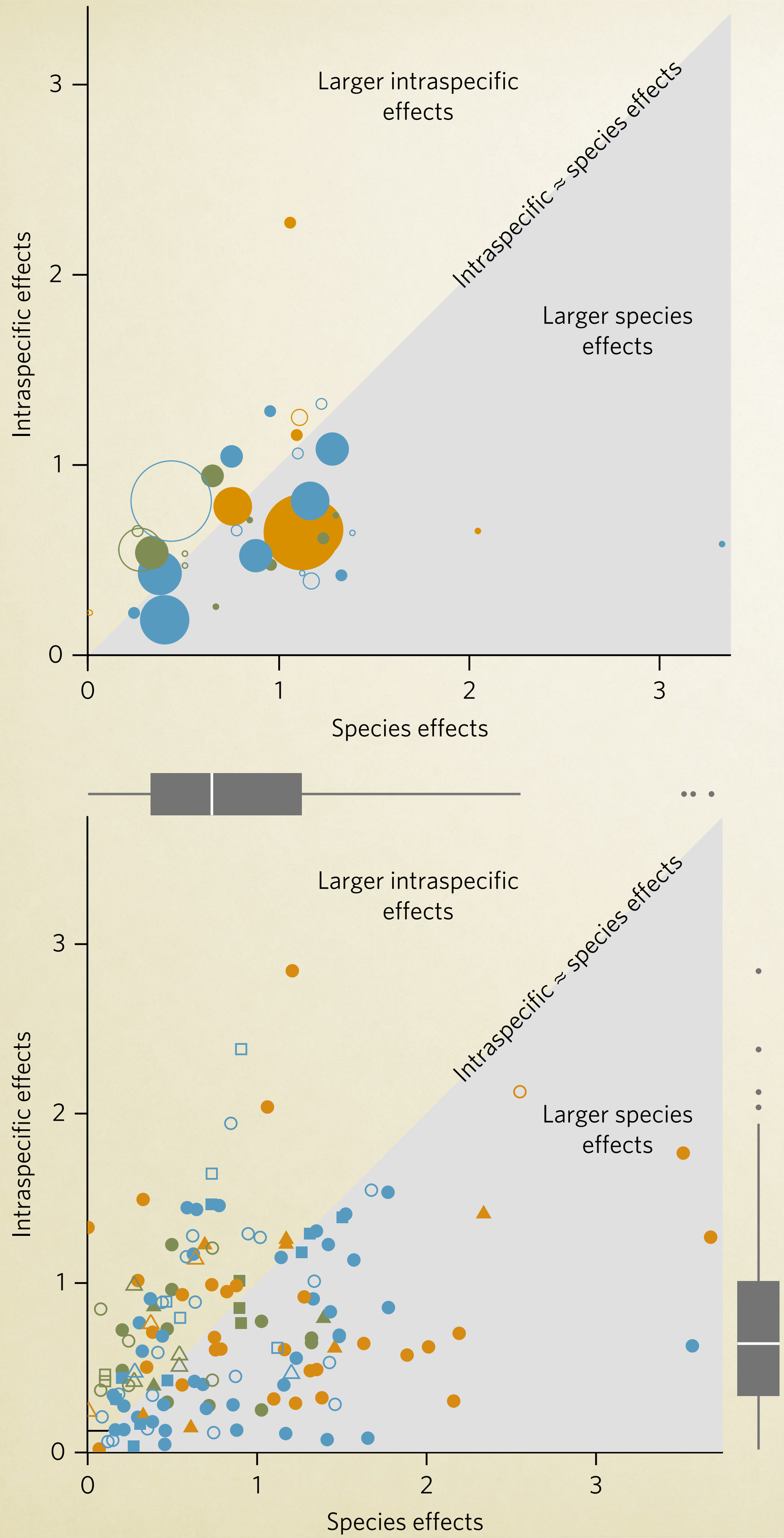

Table 1 | Characteristics of studies (by author) included in our meta-analysis, including focal species, species ('replacement' versus 'removal') and intraspecific treatments, and categorization of all response variables measured as 'direct' or 'indirect' and as 'abundance', 'rate' or 'composition'

Study	Treatments			Response		
	Focal species	Species	Intraspecific	Direct	Indirect	Type
Ingram et al.[67]; Des Roches et al.[29]; Rudman et al.[68]; Rudman and Schluter[69]; Matthews et al.[70]	*Gasterosteus aculeatus* (threespine stickleback)	Removal	Ecotypes or populations	N, PO_4, NH_4, DOC, DO concentration; benthic invertebrate, zooplankton biomass and number	NO_3, phytoplankton and periphyton chlorophyll concentration; rotifer, bacteria number and biomass; light, macrophyte percentage	Abundance
					Decomposition rate	Rate
				Benthic invertebrate, zooplankton richness	Rotifer, phytoplankton, bacteria richness	Composition
Post et al.[71]; Palkovacs and Post[12]; Howeth et al.[72]	*Alosa pseudoharengus* (alewife)	Removal	Life history	Zooplankton length and biomass	Filtered, edible chlorophyll concentration	Abundance
				Zooplankton richness and diversity	Phytoplankton richness and diversity	Composition
Royauté and Pruitt[31]	*Pardosa milvina* (wolf spider)	Removal	Personality	Arthropod prey number		Abundance
Katano[73]	*Zacco platypus* (pale chub)	Removal	Ecotypes	Benthic invertebrate number	Total chlorophyll concentration	Abundance
Palkovacs et al.[74]; Bassar et al.[75]	*Poecillia reticulata* (trinidadian guppy)	Removal	Populations	DO concentration; benthic invertebrates, zooplankton, algae biomass and number	Biomass specific productivity	Abundance
				Algae accrual, PO_4 excretion; N, PO_4, NH_4 flux	Decomposition rate, NO_3 flux	Rate
Hargrave et al.[55]; Walsh et al.[56]; Chislock et al.[30]	*Daphnia* species (water flea)	Removal or replacement (congener)	Clones or strains	DO concentration; chlorophyll biomass		Abundance
					Clearance rate	Rate
Hazard et al.[43]	*Laccaria bicolor* (bicolour deceiver mushroom)	Replacement (distant relative)	Genotypes	N, PO_4, NH_4, DOC, NO_3 concentration in soil, shoots and roots; root and shoot productivity		Abundance
McArt et al.[76]	*Oenothera biennis* (primrose)	Replacement (monoculture means)	Genotypes	Arthropod richness		Composition
Crutsinger et al.[14]; Genung et al.[18]	*Solidago altissima* (goldenrod)	Replacement (congener)	Genotypes	Pollinator number		Abundance
					Mass decay	Rate
Bowatte et al.[32]	*Lolium perenne* (ryegrass)	Replacement (distant relative)	Parental conditions		Nitrification	Rate
	Agrostis capillaris (browntop)				Nitrification	Rate
Shuster et al.[77]; Schweitzer et al.[78]; Lojewski et al.[79]; Schweitzer et al.[17]; Lojewski et al.[80]	*Populus* species (cottonwood)	Replacement (congener)	Genotypes	N, C soil percentage; arthropod abundance, biomass production, belowground C allocation	Microbe biomass; C, N, phospholipid fatty acid concentration in microbes	Abundance
				Annual N flux	Annual nitrification	Rate
				Arthropod community composition (NMDS)	Microbe phospholipid fatty acid composition (NMDS)	Composition

DOC, dissolved organic carbon; DO, dissolved oxygen; NMDS, non-metric multidimensional scaling, a measure of community composition.