

# Biological diversity in Iceland

Skúli Skúlason\*, Hilmar J. Malmquist\*\*, Stefán Óli Steingrímsson\*  
and Bjarni K. Kristjánsson\*

\*Hólar University College and \*\* Icelandic Museum of Natural History

Ráðstefna Vistfræðifélags Íslands  
Hótel Stykkishólmi 23.-24. mars 2015

# Objectives

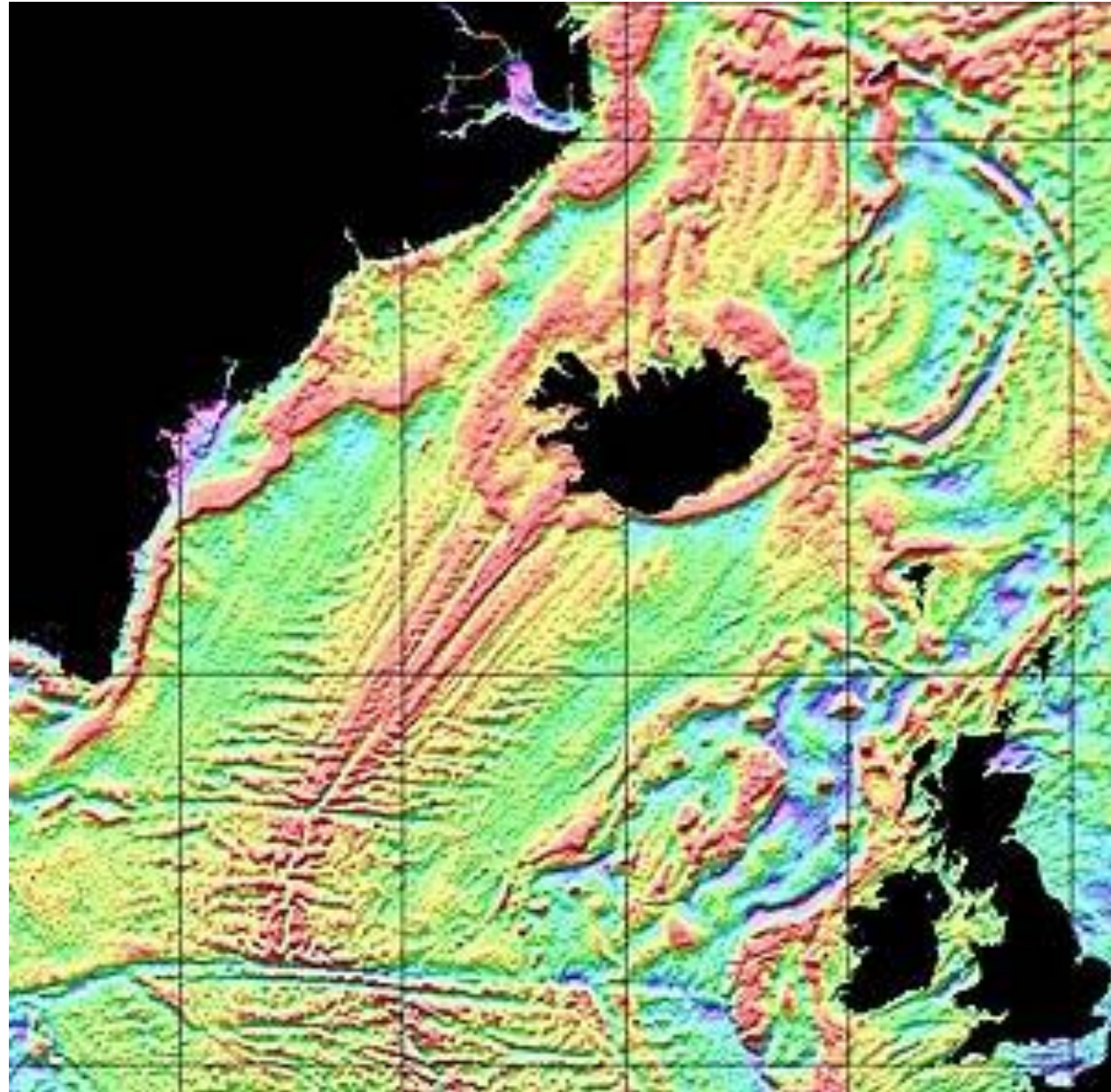
- To overview the characteristics and nature of biological diversity in Iceland\*
- Identify relevant topics, theories and hypothesis in this respect \*
- To consider and compare selected studies in Iceland which relate to these hypotheses and theories
- To propose and discuss relevant future studies
- The project is recent and ongoing and I want to engage people in a dialog about it

# Biological diversity

“Biological diversity refers to diversity among organisms from diverse origins, including ecosystems and their combinations: this applies to diversity within species, among species and ecosystems.” (Rio 1992)

The concept is often considered only in terms of species numbers, but in ecological and evolutionary studies involving biodiversity a more comprehensive and/or dynamic approach is often applied

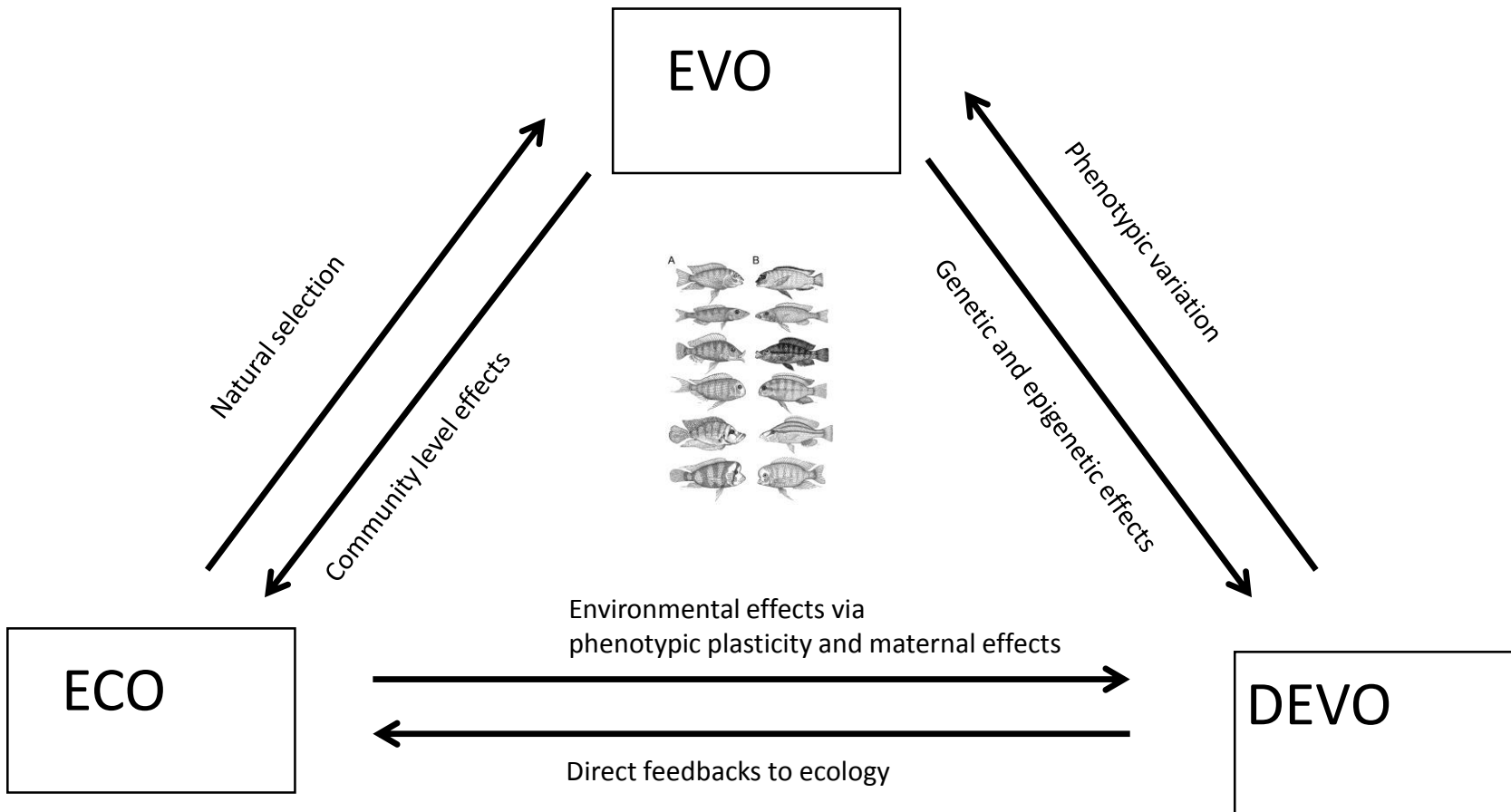
The species focus and a very static view of biodiversity characterizes the general public, management, conservation and policy - a question of communication and education



# Biodiversity in Iceland

- Species are generally few; related to geographic isolation, northern location and young age of systems
- Intraspecific diversity in terms of populations and morphs is – at least in some taxa – is relatively high and has evolved rapidly
- Habitat diversity is considerable and influenced from volcanism and tectonism
- Ecosystems are diverse but relatively simple, e.g. in terms of communities and food-webs
- Populations are often large
- Habitats are importance for migratory birds
- We have evidence for some of the above but a lot remains hypothetical
- Ample grounds for diverse research on the nature and significance of biodiversity, for example on:

- Patterns and processes of rapid evolution of novel phenotypic diversity; population formation and speciation\*
- The nature, and significance of phenotypic traits (performance traits)
- Patterns and processes of colonization and community assembly
- Biodiversity vs. ecosystem and food web stability\*
- Niche/ecosystem construction and the feedback of evolutionary changes on ecosystems\*
- Environmental threats including anthropogenic affects on ecosystems
- Interaction of all of the above .... **and more**



# Species of Icelandic vascular plants

- Approximate numbers
- Relatively few species



Group	Species in Iceland	Global numbers
Jafnar	7	1150
Elftingar	7	15
Burknar	23	12000
Berfrævingar	4	<1.000
Dulfrævingar	450	250.000

**0.2% of total number**



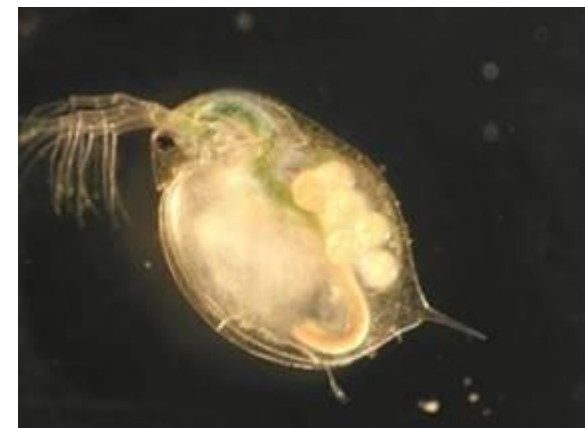
# Bird species in Iceland

- About 75 breeding species
- 370 species spotted
- There are about 10.000 species of birds
  - 0.75% breed here
  - 3.7% have been seen



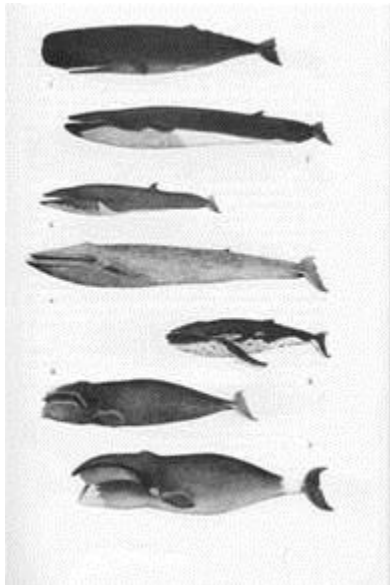
# Species in freshwaters

- Very few species compared with the same latitude in neighboring countries
  - Only 12-25% of Norwegian species
  - Only 2.5-5% of European freshwater fauna
  - Only 6 species of fish compared with 40-45 in Norway and UK



# Mammal species

- Arctic fox is the only species that has colonized without the aid of man
  - Other wild species are
    - American mink, mice and reindeer

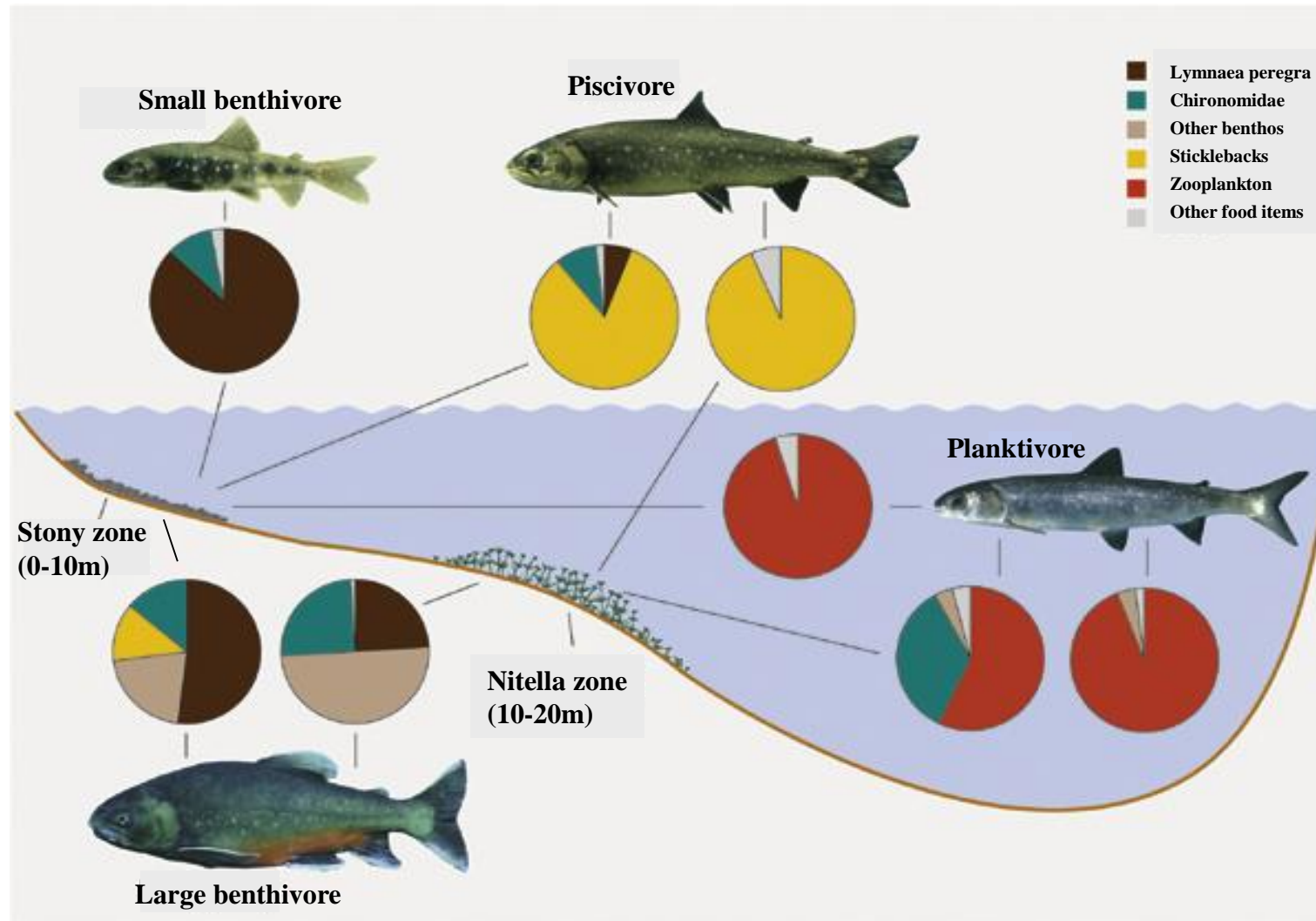


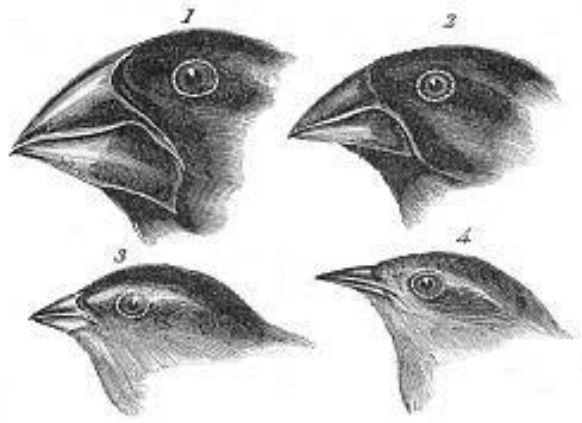
- 30 species of marine mammals

# Rapid evolution of intraspecific diversity

- Facilitated by low interspecific competition and high resource diversity
- Can result in dynamic resource polymorphism and even speciation
- Provides opportunities to study the interactive ecological, evolutionary, genetic- and developmental factors involved in such processes
- For example, it is likely that phenotypic plasticity promotes early divergence followed by ecological specialization and in some cases reproductive isolation and speciation
- Is well demonstrated in freshwater fishes, but is evident in many invertebrate and vertebrate species

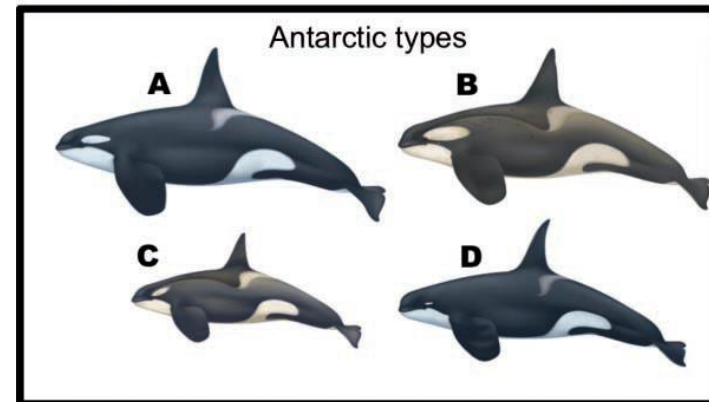
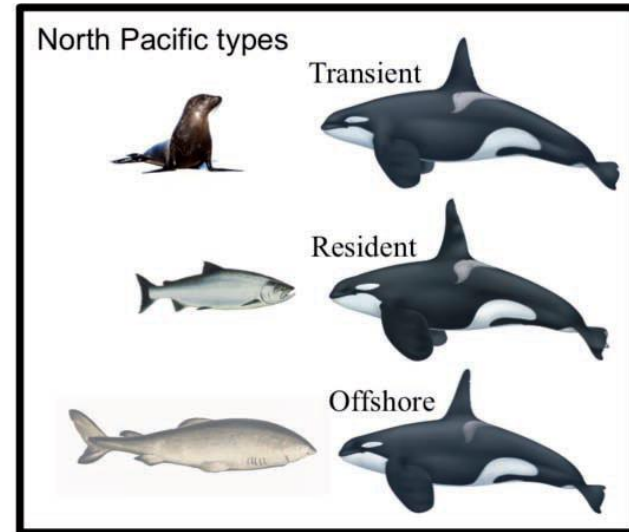
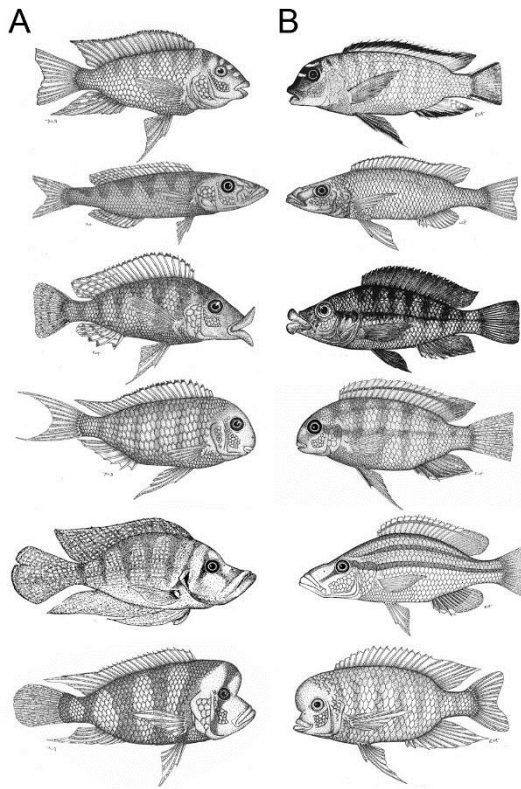
# Arctic charr in Þingvallavatn





1. *Geospiza magnirostris*  
 2. *Geospiza fortis*  
 3. *Geospiza parvula*  
 4. *Certhidea olivacea*

Finches from Galapagos Archipelago



# Biodiversity and ecosystem stability

- There is a positive relationship between biodiversity and ecosystem stability, but the processes involved are poorly understood
- Stability is defined in relation to biomass, resilience or resistance to environmental changes and/or stability of selective forces
- Recent studies suggest that ecosystem stability relates to:
  - variation in exactly how organisms respond to environmental fluctuations and how rapidly they respond
  - weak interspecific competition
  - food-web architecture; fast and slow energy channels, and if organisms are strongly or weakly connected - e.g. in slow channels

# Biodiversity and ecosystem stability

- Conditions to study this in Iceland are very good; ecosystems are relatively simple and their history is often well known
- Colonization and ecosystem evolution provide opportunities; food-webs tend to increase in complexity and diversity with time and should then become more resistant



**IDEA AND  
PERSPECTIVE**

## Biodiversity and ecosystem stability: a synthesis of underlying mechanisms

**Abstract**

There is mounting evidence that biodiversity increases the stability of ecosystem processes in changing environments, but the mechanisms that underlie this effect are still controversial and poorly understood. Here

Michel Loreau<sup>1\*</sup> and Claire de Mazancourt

**Review**



## Integrating food web diversity, structure and stability

Neil Rooney<sup>1,2</sup> and Kevin S. McCann<sup>3</sup>

*Trends in Ecology and Evolution* January 2012, Vol. 27, No. 1

**Review**



## Food webs: reconciling the structure and function of biodiversity

Ross M. Thompson<sup>1</sup>, Ulrich Brose<sup>2</sup>, Jennifer A. Dunne<sup>3,6</sup>, Robert O. Hall Jr.<sup>4</sup>, Sally Hladyz<sup>1</sup>, Roger L. Kitching<sup>5</sup>, Neo D. Martinez<sup>6</sup>, Heidi Rantala<sup>7</sup>, Tamara N. Romanuk<sup>8</sup>, Daniel B. Stouffer<sup>9,10</sup>, and Jason M. Tylianakis<sup>10</sup>

*Trends in Ecology and Evolution* December 2012, Vol. 27, No. 12

# Evolution of ecosystems and evo-eco feedbacks

- A special case is the actual evolution of new morphs, populations and species that ultimately form communities and structure ecosystems, e.g. many freshwater systems in Iceland and in the north
- Feedback of evolutionary phenotypic changes in organisms on ecosystem properties, communities and food webs
- Niche construction by organisms that influences ecosystem function – stabilization?
- Icelandic ecosystems provide good opportunities for studies on this, e.g. tracking the ecological and evolutionary processes of ecosystem formation – are there common features?

# Eco-evolutionary feedbacks in community and ecosystem ecology: interactions between the ecological theatre and the evolutionary play

David M. Post and Eric P. Palkovacs

*Phil. Trans. R. Soc. B* 2009 **364**, doi: 10.1098/rstb.2009.0012

ARCH 2013

## THE QUARTERLY REVIEW *of* BIOLOGY



NICHE CONSTRUCTION THEORY: A PRACTICAL GUIDE  
FOR ECOLOGISTS

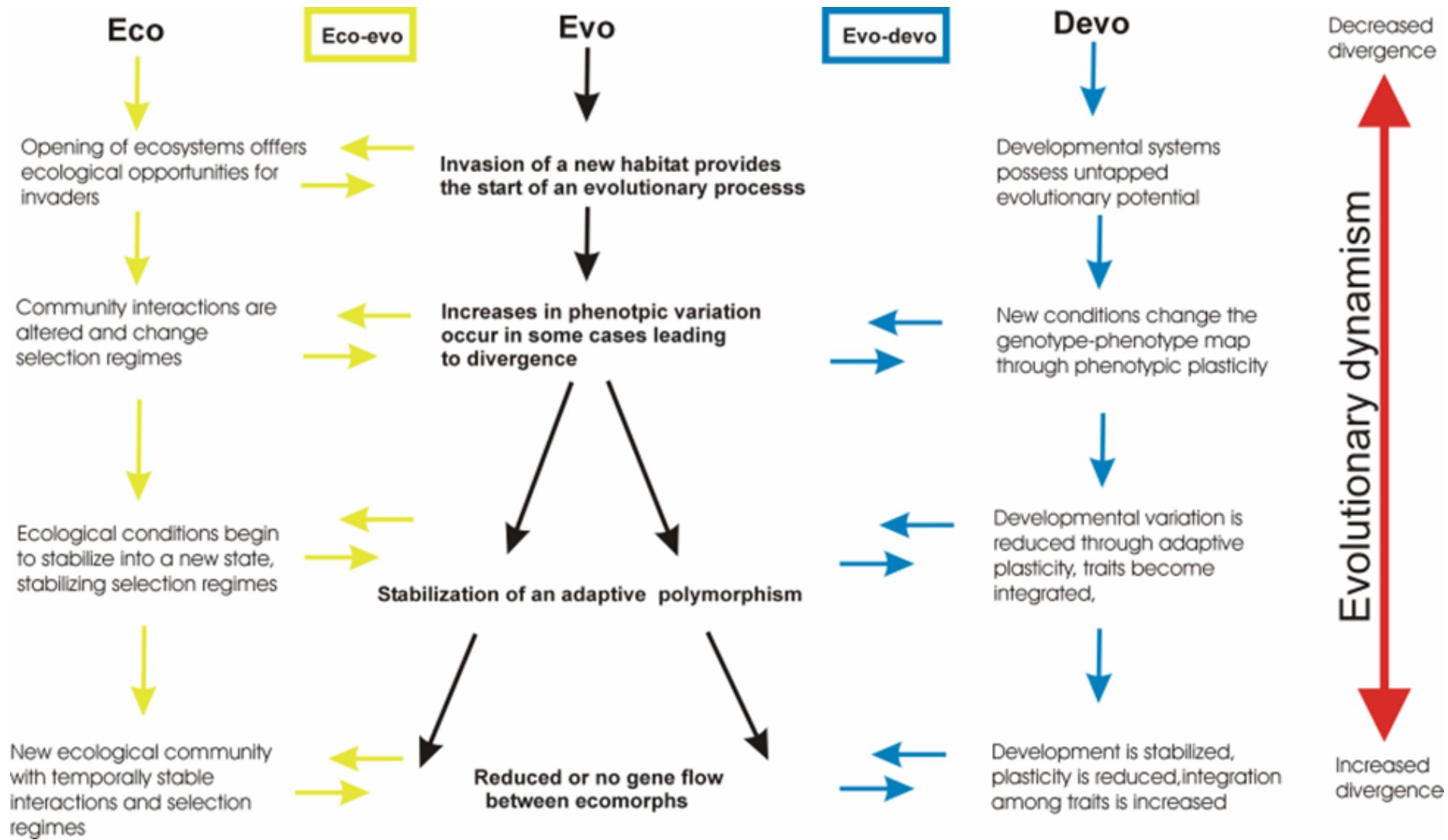
JOHN ODLING-SMEE

*Mansfield College, University of Oxford  
Oxford OX1 3TF United Kingdom*

*Ecological Monographs*, 84(2), 2014, pp. 245–263  
© 2014 by the Ecological Society of America

### Under niche construction: an operational bridge between ecology, evolution, and ecosystem science

BLAKE MATTHEWS,<sup>1,8</sup> LUC DE MEESTER,<sup>2</sup> CLIVE G. JONES,<sup>3</sup> BAS W. IBELINGS,<sup>4</sup> TJEERD J. BOUMA,<sup>5</sup> VISA NUUTINEN,<sup>6</sup>  
JOHAN VAN DE KOPPEL,<sup>5</sup> AND JOHN ODLING-SMEE<sup>7</sup>



# Existing and future research

- How common is intraspecific divergence, including eco-evo dynamics?
- Colonization and community formation – including evolutionary processes
- Biodiversity – ecosystem and food web stability studies
- Disturbance studies, model systems, climate change, grazing etc.
- Generalism, specialism, flexibility of traits etc.
- Application of biodiversity in conservation, management and policy
- Many knowledge holes regarding biodiversity in Iceland
- Overview of biological diversity is needed



Diverse environments differing spatially and temporally in numerous abiotic and biotic properties