

Biological Interactions

Stenophagy: common in plant-eating insects

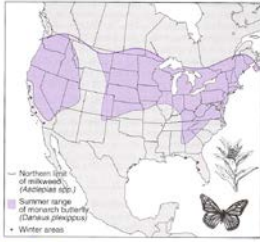


FIGURE 4.1 The correspondence between the northern range limits of the monarch butterfly (*Danaus plexippus*) and the northern range limits of its food plant, milkweed (*Asclepias* spp.) (after Brower and Malcolm, 1991).

Biogeography

1

Prof. J. Hicke

Biological Interactions



Edith's checkerspot butterfly is restricted to eating a plantain whose range is itself restricted to serpentine soils

so, the plant's distribution is controlled by abiotic (soil or edaphic) factors, but the butterfly's distribution is controlled by a biotic factor (where the plant grows)



Biogeography

2

Slide courtesy C. Still

Prof. J. Hicke

Biological Interactions

Stenophagy: examples in mammals

Giant panda (*Ailuropoda melanoleuca*)



www.tekearth.com/gallery/Asia/China/photo1084.htm

Koala (*Phascolarctus cinereus*)



www.appleblossomart.net/FreeKoala-Wallpapers.htm

Abert's squirrel (*Sciurus aberti*)



www.enature.com/fieldguides/enlarged.asp?imageID=18865

Biogeography

3

Prof. J. Hicke

Biological Interactions

Lotka-Volterra model

Classic study of Canada lynx (*Lynx canadensis*), snowshoe hare (*Lepus americanus*)

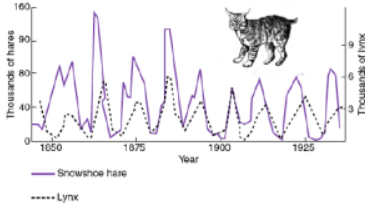


FIGURE 4.3 Historical cyclic variations in the population sizes of the snowshoe (*Lepus americanus*) and Canada lynx (*Lynx canadensis*) (after MacLulich, 1937; Begon et al., 1999).

Note: more recent studies show the influence of plant-hare cycles w/o lynx

Biogeography

4

Prof. J. Hicke

Biological Interactions

Evidence of predator controls on prey distribution

Artificial exclusion experiments:



Figure 4.4 (a) The rocky intertidal zone of the Pacific Northwest coast is dominated by a variety of species including sea urchins, barnacles, limpets, chitons, and mussels. (b) A local web of the community shows that the starfish preys on a variety of invertebrate species. The experimental removal of starfish from the community resulted in the survival of prey species as a result of increased energy flow (see section for more info).



Prey species before: 15
Prey species after: 8

Smith and Smith, 2006

Biogeography

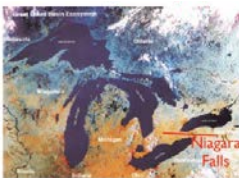
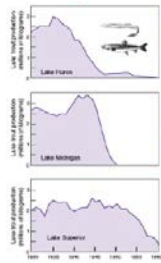
5

Prof. J. Hicke

Biological Interactions

Predator controls on prey distribution

invasive generalist predator (euryphagous)



this and other examples of such 'top-down' range controls from predation are usually limited to invasive or non-native species introductions

Figure 4.2, MacDonald

Biogeography

6

Slide courtesy C. Still

Prof. J. Hicke

Biological Interactions

Competition

Allelopathy: chemical warfare



Casuarina equisetifolia litter completely suppresses germination of understory plants as shown here despite the relative openness of the canopy and ample rainfall (>120 cm/y) at the location

en.wikipedia.org/wiki/Allelopathy

Toxins inhibit seed germination

Biogeography

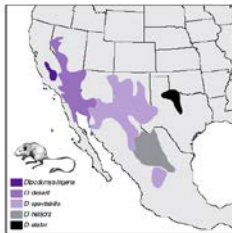
7

Prof. J. Hicke

Biological Interactions

Competition

Interspecific competition controlling species distributions



- similar, closely related species
- similar ecological niches
- no range overlap

Suggestion: interspecific competition controlling species distributions

FIGURE 4.4 The strict border of geographic ranges for the rodent species of the United States and Mexico shows strong range boundaries that suggest the influence of competition with other species in defining the geographic ranges of each species (after Brown and Brown, 1982 and Brown and Lomolino, 1998).

Biogeography

8

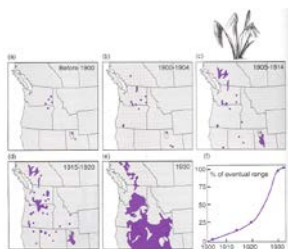
Slide courtesy C. Still

Prof. J. Hicke

Biological Interactions

Competition

Invasive species are, by definition, superior competitors



Cheatgrass
(*Bromus tectorum*)

FIGURE 8.9 The rapid expansion of invading species spreading by either diffusion or jump dispersal is illustrated by cheatgrass (*Bromus tectorum*) expansion in western North America (after Mack, 1991; Silim-Salavik and Kauseli, 1997).

Biogeography

9

Prof. J. Hicke

Biological Interactions

Introduction to the -isms

Type of -ism	Effect on species 1	Effect on species 2
mutualism	+	+
commensalism	+	neutral
parasitism	+	-

Biogeography

10

Slide courtesy C. Still

Prof. J. Hicke

Biological Interactions

Symbiotic mutualism example

Clark's nutcracker (*Nucifraga columbiana*)



www.birds.com/edu/AllAbout/Birds/BirdGuide/Clarks_Nutcracker_dtl.html

Biogeography

11

Prof. J. Hicke

Biological Interactions

Five-needle pines

- large (nutritious), wingless (not dispersed by wind) seeds
- high fat, high-energy food source

Whitebark pine (*Pinus albicaulis*)



Limber pine (*Pinus flexilis*)



esp.cr.usgs.gov/data/atlas/tittle/

Biogeography

12

Prof. J. Hicke

Biological Interactions



Photo by Michael G. Shepherd



en.wikipedia.org/wiki/Clark%27s_Nutcracker
Biogeography

Caches thousands of pine seeds each year

Has a tremendous memory:

- can remember where to find most of the seeds it hides
- 6 months later, under 3' of snow

13

Prof. J. Hicke

Biological Interactions



www.cudenver.edu/Academics/Colleges/CLAS/Biology/Biology+Faculty/Dr.+Diana+Tomback.htm



Caches by nutcracker (and squirrels) result in multiple stems in close proximity ("cache-mates")

Biogeography

14

Prof. J. Hicke

Biological Interactions

Whitebark pine is a keystone species

Reliance on whitebark pine by animal species

Key is the mutualistic relationship with the nutcracker



Biogeography

15

Prof. J. Hicke

Biological Interactions

Symbiosis: 2. Commensalism

- Clownfish are impervious to anemone's poison => protection for clownfish
- Some clownfish are anemone-specific
- Clownfish may attract predators, which serve as prey for anemone => mutualism



Biogeography

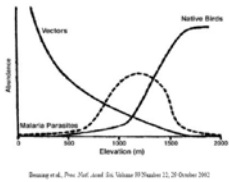
www.sherrysknowledgequest.com/clownfish.htm
16

Prof. J. Hicke

Biological Interactions

Example of controls of parasites on host geographic distribution: invasive species

- 30 species of Hawaiian honeycreepers (*Drepanididae*)
 - endemic to Hawaiian islands
- on Oahu, 6 species extinct by 1900
 - declines in lower elevation species but not higher elevation
- tied to introduction of *Culex* mosquitoes in 1820s by Europeans
 - carriers of avian malaria
 - lack of evolution in presence of mosquitoes => lack of defense in honeycreepers
 - limited in elevation extent by temperature



Beaugrand, Proc. Zool. Acad. Sci. Victoria 19 (1906)

Biogeography

17

Prof. J. Hicke

Biological Interactions

Example of combined physical, biological controls

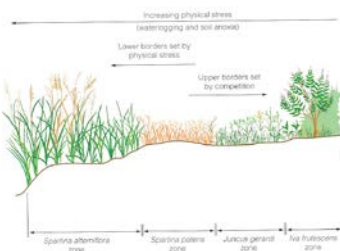


Figure 13.10 | Zonation of the dominant perennial plant species in a New England salt-marsh community. The upper boundaries of species distribution are a function of competition, whereas the lower boundaries are a function of the ability of the species to tolerate the physical stress associated with salinity, waterlogging, and low oxygen concentrations in the sediments. (adapted from Ehlers et al., 2001.)

Smith and Smith, 2006

18

Prof. J. Hicke

Biological Interactions

Biological interactions and gradients

Method of determining impact of competition: examine abundance of different species along environmental gradient

Danger: inferred, not determined

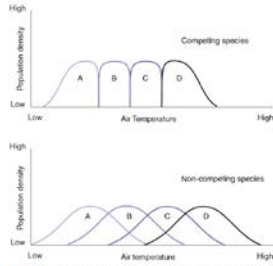


FIGURE 4.8 Hypothetical gradient distributions of four competing species and four noncompeting species.

Biogeography

19

Prof. J. Hicke

Biological Interactions

Biological interactions and niches

Concepts of niches in presence of competition

fundament niches = circles

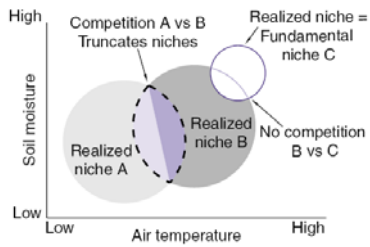


FIGURE 4.9 The realized and potential niches of three hypothetical plant species.

Biogeography

20

Prof. J. Hicke
