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Ecological Organisation

05 February 2015 12:11

Ecological studies

- Important to select the correct level at which to investigate a particular problem
- Selecting the wrong level will make it difficult to find the answer

Biosphere
Ecosystem
Community
Species
Population
Individual
Organ
Cell
Organelle

Important to look at the lower levels of organisation when trying to understand causal mechanisms for change. E.g. Pollutants.

- Individuals can be easy to recognise
- But
  - Plants propagated via underground rhizomes
    - Treat as population level
- Species often occur in predictable assemblages
- Species often occur in predictable assemblages
- **Community** - particular grouping of species in predictable manner in specific location
  - e.g. cliff communities

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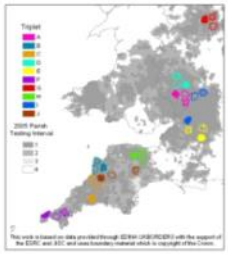
Dyfi Estuary

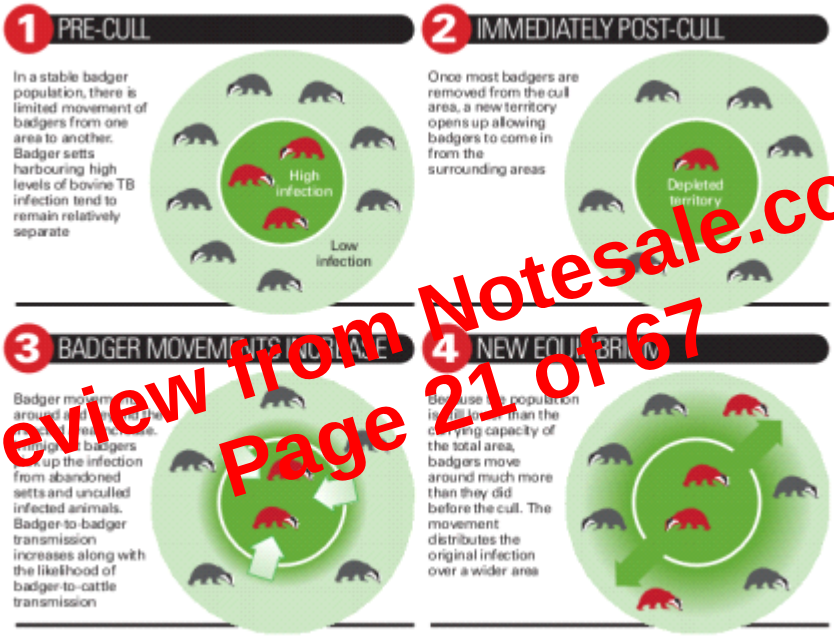
- Grassland
- Ynyslas 'foredunes'
  - Standline community of annual plants at high-tide mark
  - Lots of human traffic - poorly developed community
- Yellow dunes at Ynyslas
  - Marram grass on foredunes
  - Sand accumulates - can be encouraged, e.g. Island of Barra
- Grey dunes
  - Marran outcompeted in stabilised community
- Progress up to woodland community

- Biomes on large scale
  - Coastal chapparal scrub
  - Coniferous forest
  - Desert
  - Prairie grassland
  - Deciduous forest

1986 - Trap in cage and shoot <u>on</u> affected farms only
1994 - Live test in badgers not successful
1998 - Badger culling halted

<u>bTB in British Cattle</u>

- Exponential increase
- Increased geographical extent
- Krebs & Bourne reports
  - "The control of TB in cattle is a complex problem and there is no single solution" Krebs *et al.* (1997)
  - 
  - Badger culling trial (Bourne *et al.*, 2007)
- 'No cull' verdict of 2007 trial
  - "While badgers are clearly a source of cattle TB ... badger culling can make no meaningful contribution to cattle TB control in Britain" Prof. John Bourne *et al.* (2007)
  - 

- Contradicts epidemiological theory
  - Decreased badger density should mean fewer infectious badgers
- <u>Negative effects of spatial perturbation</u>
  - 

  - Culling badgers meant more spread into emptied territories
  - Woodchester Park
    - Clean groups bordering bTB groups for years with no infection

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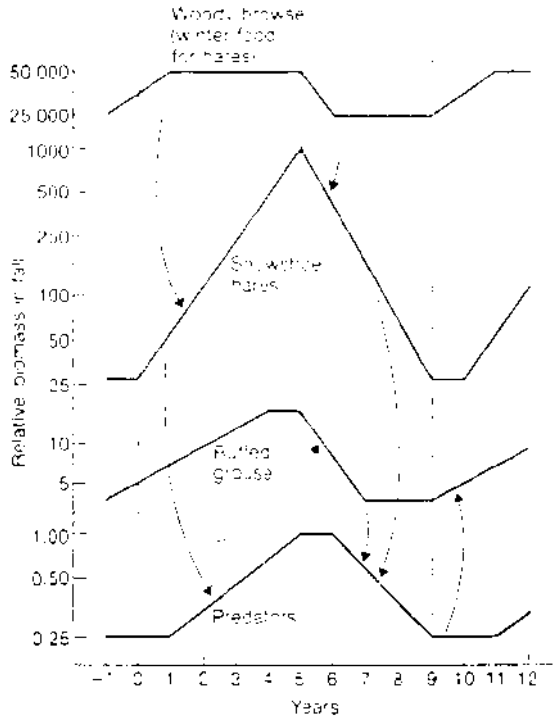
<u>Future?</u>

- Vaccination?
- Return to culling?

- 

Avoiding Predation

- Camouflage
  - Twig caterpillar
- Chemical defence
  - Skunk
- Warning colouration
  - Butterflies
- Batesian mimicry
  - Evolved to look like noxious prey
- Müllerian mimicry
  - Evolved to look like other noxious prey
- Behaviour
  - Social groups
  - Interactions and social structures reduce impacts

Increasing predation

- Predator behaviour
  - Cooperation and social groups
- Lures
  - Anglerfish

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The Niche

19 February 2015 12:29

Fundamental Niche

Total range of environmental conditions under which and organism can survive

One dimensional niche

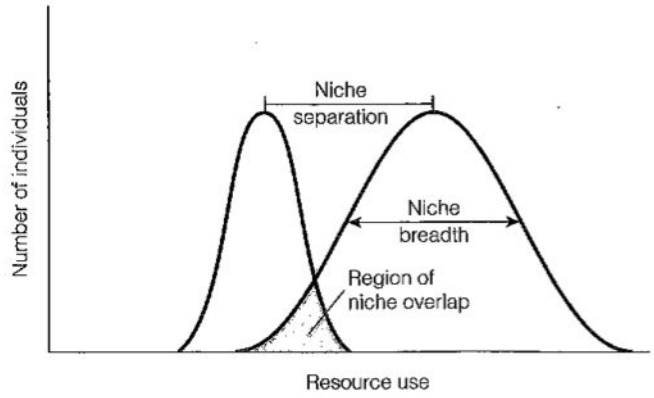
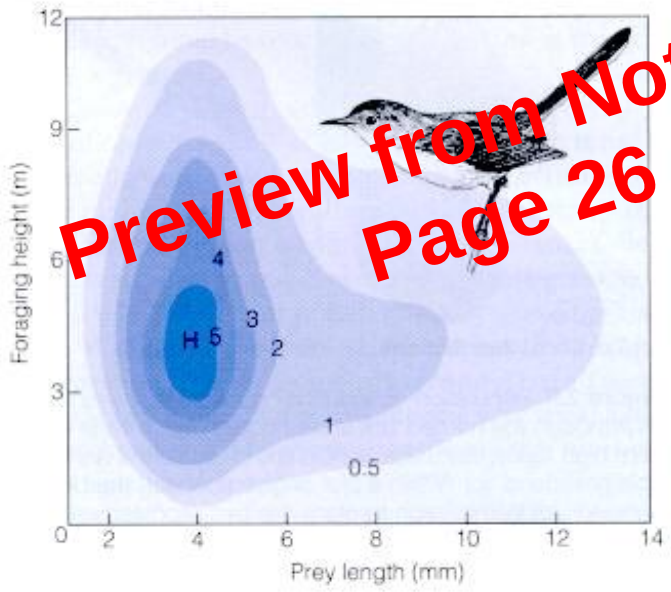


FIGURE 9.4 Important parameters of a niche. Each curve represents the niche in one dimension for one species.

Two dimensional niche



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Realised niche

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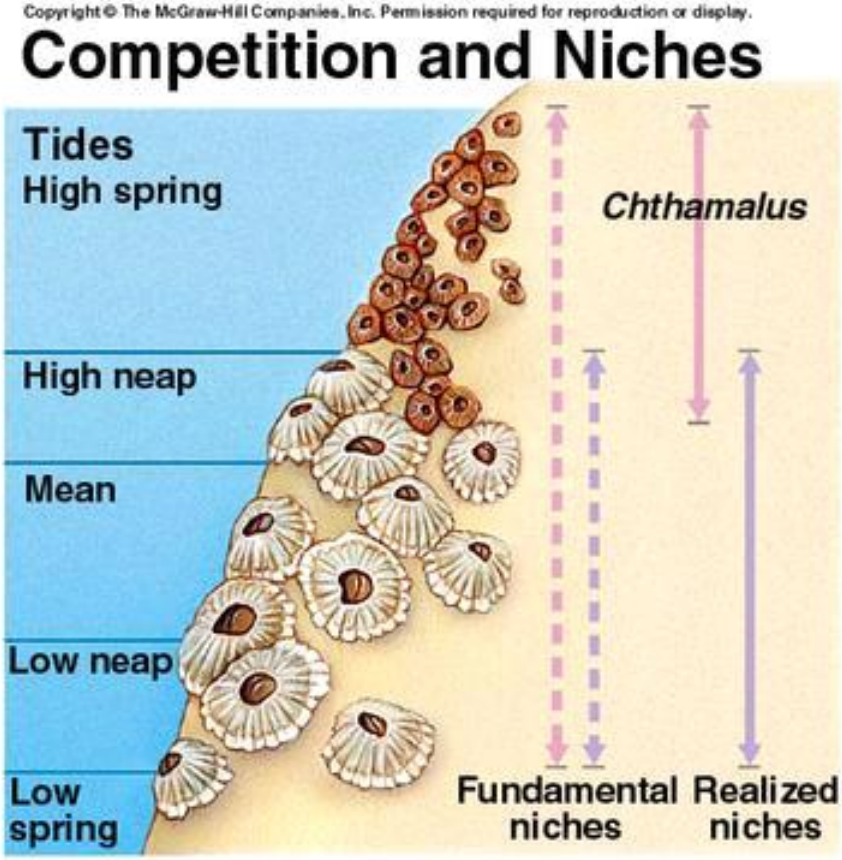
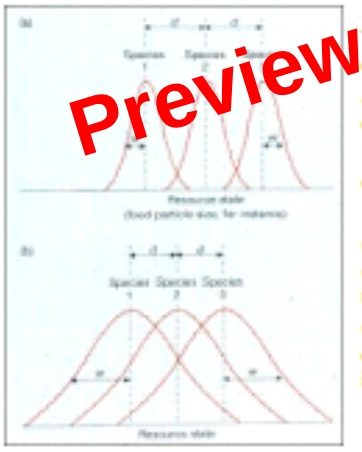


- Competition occurs
- Different to fundamental niche
- Areas often optimal for multiple species

Resource utilisation curve



Three species coexisting along a one-dimensional resource spectrum.
d is the distance between adjacent curve peaks.
w is the standard deviation of the curves.

(a) Narrow niches with little overlap ($d > w$), i.e. relatively little interspecific competition.
(b) Broader niches with greater overlap ($d < w$), i.e. relatively intense interspecific competition.

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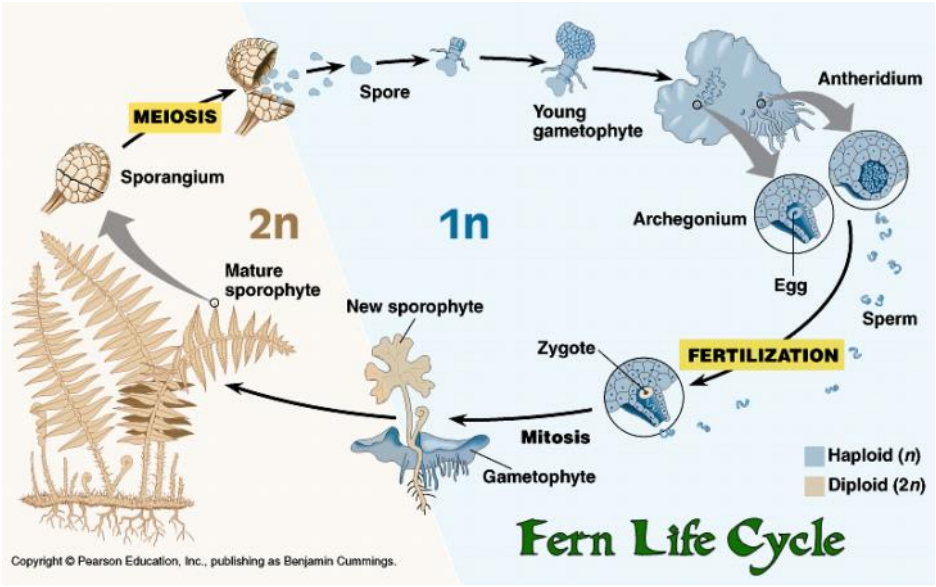
Resource allocation

- 

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Flowers and Pollinators

11 March 2015 12:46

Cycad Pollinators

- Cycads do not have flowers
- Male or female
- Weevils are pollinators
    - Most abundant arthropods

Angiosperm Radiation

- Mid-cretaceous
- ~80mya
- >75% of plants

Evolution of Pollinator Insects

- Cretaceous radiations
- Co-evolution with flowers

Angiosperm Innovations

- Bisexual flowers
    - More efficient with animals
- Enclosure of ovules in carpels
    - Reduced self-pollination

Rewards for Pollinators

- Pollen - 40% each of sugars and protein
- Nectar - sugars specifically for pollinators
- Nectaries at base - pollinators brush anthers and stigma

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Angiosperm Life Cycle

- Alternation of sporophyte and gametophyte generations
- Microscopic gametophytes in ovule and pollen
- Double fertilisation
    - One sperm and 2 haploid nuclei
        - Triploid endosperm
    - 1 sperm fertilises egg --> diploid zygote

Animal Pollinators

- Insects
    - 2/3 of angiosperms
    - Bees most common
    - Floral attractors for bees
        - Scented
        - Tubular
        - Landing platform
        - Zygomorphic
        - Not red
    - Beetles and lepidoptera prefer actinomorphic flowers
    - Butterflies
        - Yellow, pink, purple
        - Tubular
        - Clustered
        - Scented
- Birds

Marine and Freshwater Vegetation

16 April 2015 12:48

- Plants originated in the sea
  - Some have returned
- 98% of water saline
- 1% brackish
- 1% fresh

Seagrasses

- Angiosperms
- Saline "meadows"
- Light - photosynthetic O_2 passed along aerenchyma
- Dark - anaerobic respiration
- Diet for dugongs and sea turtles
- Habitat for seahorses, fish larvae and juveniles
- Rapid loss
  - Rivalling rainforests and reefs

Mangroves

- Salt tolerant trees
- Tropical-subtropical tidal mud zones
- 16 families - convergent evolution
- Red mangrove
  - Central America
  - Aerial roots with lenticels and aerenchyma for O_2 exchange
- Black and grey mangroves
  - Upward roots with lenticels and aerenchyma
  - Low tide exposure
- Ecosystems
  - Invertebrates colonise submerged roots
  - Crab, fish, and prawn nurseries
- Salt tolerance
  - Salt exclusion
  - Salt excretion
  - Slat glands in leaf epidermis

Halophytes

- Strandline
  - Terrestrial plants at top of beach
    - Tolerate salt spray and transient seawater
  - E.g. Sea rocket, sea sandwort, sea holly
- Saltmarsh
  - Intertidal land - brackish water
  - Salt-tolerant terrestrial vegetation
  - Pioneer species
  - E.g. Cordgrass, glassroot, sea aster
- Crops
  - Evaporating irrigation water can salinise soils
  - Affects up to half of irrigation schemes
  - Irrigated land provide 1/3 of world food
  - Halophyte mechanisms of agricultural interest

Freshwater Hydrophytes

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- Sap
  - Sugars - non-reducing
  - Amino acids
  - Organic acids
  - Protein
  - Potassium
  - Chloride
  - Phosphate
  - Magnesium
- Pressure-Flow Model
  - Loading
    - Sucrose accumulated against concentration gradient
    - Protein pumps actively generate H^+ gradient
    - Sucrose driven across plasma membranes cotransported with H^+ ions
    - Phloem translocates sugars etc. from sources to sinks
    - Loading at sources
    - Water follows by osmosis from source cells and xylem
  - Unloading
    - At sink
    - Water follows by osmosis
    - Phloem sap flows from high to low pressure
    - Faster than diffusion
- Signal molecules
  - In phloem
  - Day length sensor in leaves - FT protein (Florigen)
    - FT protein moves in phloem to buds, causing flowering
  - Future virus induced flowering biotech?
    - Virus expressing FT

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Soil Nutrient Cycling

29 April 2015 11:01

Soil Nitrogen Cycle

- Largest uptake by plants
- Increased dry mattter
- Soil contains 0.1-0.3% N
- Vast majority in organic form
- Virtually none in primary minerals
- Microbes responsible for cycling
- Nitrification
  - *Nitrosomonas*
  - *Nitrobacter*
  - *Nitrobacter* takes faster pathway
  - Nitroficication slower than ammonification at lower temperatures
- Denitrification
  - Warm, anaerobic conditions
  - NO_3 -> NO_2 -> NO -> N_2O -> N_2
  - 10kg/ha/year
  - N_2O is a greenhouse gas
- Nitrate leaching
  - NO_3^- leaches
  - Risk to human health
  - Salad vegetables, water, processed meat

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Soil Phosphorous

- Function
  - Nucleic acids
  - Energy storage
  - Phospholipids
- Cannot be replaced by another element
- 0.2-0.4% P in plants
- Taken up from soil mostly as dihydrogen phosphate
- In soils
  - Naturally occurring in crust, water, and organisms
  - Low concentration in minerals
  - Main source is sedimentary rock phosphates - phosphorite
    - Diminishing resource - 72 years left
  - Most UK soils have P added
    - Otherwise deficient
    - Crops limited in Australia, S. America, S. Africa
- Fertilisers
  - 1842, Lawes patent for superphosphate manufacture
    - From bones and mined rock phosphates
- Absorbed phosphate
  - Chemical precipitation
    - Ca precipitates at high pH
    - Al/Fe precipitates at low pH
  - Adsorption to soil surfaces
  - Added phosphate rapidly becomes unusable
- Movement in soil
  - Slow compared to nitrate
  - 5mm/week
  - Importance of mycorrhizal fungi