Three plants of each species (Iris pseudacorus, Kalachoë daigremontiana, and Vicia faba) were selected from the control group, which had been watered daily, and three plants of each species were selected from the group which had been exposed to drought conditions. This amounted to 18 plants in total.

10mm diameter cork borers were used to punch 5 discs from each leaf. These discs were then weighed to give the “fresh weight” (Wf). Weighing was carried out as soon as possible to avoid drying out of the leaves.

Once weighed, the discs were placed in water in closed petri dishes, and left to stand for 45 minutes. Care was taken that all the discs were in full contact with the water.

After 45 minutes had elapsed, the discs were gently blotted and reweighed. This gave the turgid weight (Wt).
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
- Communities - particular grouping of species in predictable manner in specific location
- E.g. cliff communities

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
  - Marram 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 on affected farms only
1994 - Live test in badgers not successful
1998 - Badger culling halted

**bTB in British Cattle**
- Exponential increase
- Increased geographical extent

- Contradicts epidemiological theory
  - Decreased badger density should mean fewer infectious badgers
- **Negative effects of spatial perturbation**
  - Culling badgers meant more spread into emptied territories
  - Woodchester Park
    - Clean groups bordering bTB groups for years with no infection

**Future?**
- 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
**Fundamental Niche**
Total range of environmental conditions under which an organism can survive

**One dimensional niche**

![One dimensional niche diagram](image)

**Figure 3.4** Important parameters of a niche. Each curve represents the niche in one dimension for one species.

**Two dimensional niche**

![Two dimensional niche diagram](image)

**Realised niche**
• Competition occurs
• Different to fundamental niche
• Areas often optimal for multiple species

**Resource utilisation curve**

The species coexist along a one-dimensional resource spectrum. The distance between adjacent curves is the overlap, w, and the standard deviation of the resource. The curves represent the niches of different species:

(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.

**Resource allocation**
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 anther and stigma

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 O₂ 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 O₂ 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, grassroot, 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
• **Pressure-Flow Model**
  
  o **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
  
  o **Unloading**
    - At sink
    - Water follows by osmosis
    - Phloem sap flows from high to low pressure
    - Faster than diffusion

• **Signal molecules**
  
  o In phloem
    - Day length sensor in leaves - FT protein (Florigen)
      - FT protein moves in phloem to buds, causing flowering
  
  o Future virus induced flowering biotech?
    - Virus expressing FT
Soil Nitrogen Cycle
- Largest uptake by plants
- Increased dry matter
- 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
    - Nitrofication slower than ammonification at lower temperatures
  - Denitrification
    - Warm, anaerobic conditions
    - NO₃⁻ → NO₂⁻ → NO → N₂O → N₂
    - 10kg/ha/year
    - N₂O is a greenhouse gas
  - Nitrate leaching
    - NO₃⁻ leaches
    - Risk to human health
    - Salad vegetables, water, processed meat

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