Cave Biology for Biology Teachers

By Stephen Bunton

The Cave Environment

Caves can be divided in four distinct regions:

- The **Daylight Zone**
- The **Twilight Zone**
- The **Dark Zone**
- The **Deep Cave Zone**

Herberts Pot. Photo: Stephen Bunton

Characteristics of the Dark Zone

- Lack of Sunlight

  Caves are **aphotic**.
- Constant Temperature

  Approximately the mean annual temperature.
- High Humidity

Genghis Khan. Photo: Stephen Bunton

The Cave Ecosystem

The most significant difference between caves and almost all other ecosystem is the lack of light for photosynthesis.

There a **no producer organisms**.

All food chains must therefore begin with material which is transported into the cave.

The Daylight Zone

- This is where daylight penetrates into the cave for some period of time each day.

  This is enough for cyanobacteria, algae and some plants to survive e.g. ferns, mosses and other bryophytes.

The Twilight Zone

- No direct sunlight but there is sufficient light for some photosynthesis.

Kubla Khan Lower Entrance.
Photo: Stephen Bunton

The Transition Zone

- Is a region where the conditions vary between those on the surface and those in the Deep Cave Zone.

Midnight Hole. Photo: Stephen Bunton

The Dark Zone

Consists of:

- **High** (Kinetic) **Energy** areas where there is airflow, waterflow and potential flooding.

- **Low** (Kinetic) **Energy** areas where the conditions remain constant.

  This is where cave decorations form.

Types of Cave Organisms

- Accidentals.
- Trogloxenes and Stygoxenes.
- Troglophiles and Stygophiles.
- Troglobites and Stygobites.

Troglobites etc are Terrestrial and
Stygobites etc are aquatic
(after the River Styx which flows into Hell!).

Accidentals

Those which wander in, are washed in or fall into the cave.

Examples include:

Frogs, wallabies, the megafauna at Naracoorte and Moas in New Zealand.

Accidentals

- Are not cave adapted and will not survive in the cave environment.

Trogloxenes

- Commute in and out of the cave.
- Examples include:

  Bats and cave crickets.

  Neanderthals could have been considered trogloxenes!

Miniopterus schreibersii Photo:Garry K Smith

Troglophiles

- Prefer to live in caves but are not really cave adapted. They can also be found on the surface.

Example include:

Glow-worms and the Tasmanian Cave Spider.

Hickmania troglodytes Photo: Arthur Clarke

Troglobites

- Are fully cave adapted and cannot survive on the surface.

They are **obligate** cave fauna.

Examples include:

Harvestmen, carabid beetles and pseudoscorpions.

Pseudotyrannochthonius typhylus Photo: Arthur Clarke

Stygoxenes

- Commute in and out of the cave in streams.

Examples include:

A platypus at Croesus Cave, Mole Creek
and the Tasmanian Freshwater Crayfish.

Stygophiles

- Aquatic cave dwellers which also occur on the surface.

Examples include:

Hydrobiid Snails and the Tasmanian Mountain Shrimp, *Anaspides*.

Stygobites

- Fully cave adapted aquatic fauna.

Examples include:

Unpigmented and eyeless *Anaspides*.

Fully cave adapted *Anaspides*
Photo: Arthur Clarke

Tasmanian Cave Fauna

- Is the richest in Australia
  with 130 families represented
  including 34 troglobitic species
  and some caves with over 70 species.

  Ida Bay has 100 species including
  15 troglobites.

Sources of Food

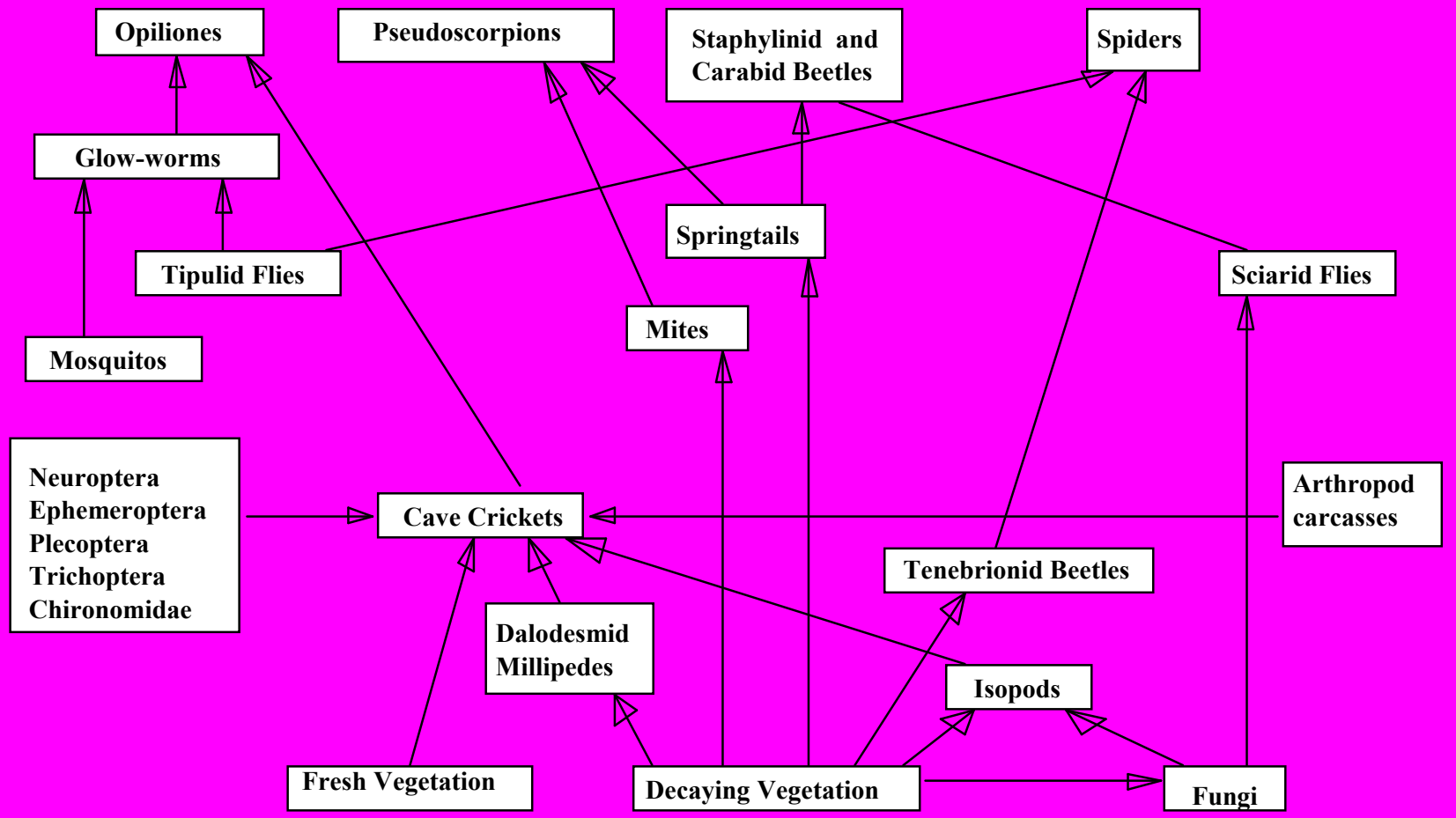
- Accidentals provide food for cave adapted species.
- Detritus.
- Guano. There are no bat caves in Tasmania.

Food Chains

- Because the amount of energy entering the cave is limited food chains have traditionally thought to have been quite short in cave environments.

  Recent studies have shown this not to be the case.

A TASMANIAN CAVE FOOD WEB



Adapted from Figure 11 in Clarke 1997 which in turn was adapted from Richards and Ollier 1976

Cave Adaptations

Are generally of two types;

- Those which result in structures of reduced size and function.
- Those which result in enhanced size and sensitivity.

Evolutionary Advantages

- Those which result in structures of reduced size and function.

  Increase the chance of survival because energy is saved when these aren't needed and don't develop.

  Examples include loss of pigmentation and eyes.

Evolutionary Advantages

- Those which result in enhanced size and sensitivity.

With the lack of light those organisms with enhanced sensory structures are at and advantage finding food or avoiding predators.

Examples include antennae, cerci, palps, spines or body hairs, longer limbs for locomotion and the ability to echo-locate.

Evolution and Island Biogeography

- Cave organisms are often highly adapted relatives of leaf litter organisms but because they can't survive on the surface they can't move from cave to cave.
- Like the different species inhabiting different islands, there are different species in different caves or caving areas…

  if the caves are joined by a **karst biospace**.

Evolution and Island Biogeography

- The organisms are geographically isolated and hence the great degree of speciation in cave fauna.
- The level of cave speciation can be used as an indicator of the separation time.

Taxa Represented in Caves

- Viruses
- Monera
- Protista
- Fungi
- Plants
- Animals

Viruses

- Whilst they are strictly considered to be **non-living** they are significant because they cause diseases such as rabies and

  Lyme's Disease.

Monera

- Cyanobacteria (Blue-Green Algae) grow in the Twilight Zone often causing formations in these areas to take on a more knobbly less attractive appearance.

Protista

- Algae grow on rocks. They are a significant problem in tourist caves where they occur as **Lampenflora** near artificial lighting.
- Other protists may be present as parasites on higher organisms.

Fungi

- Fungal spores enter the cave and thrive where there is a suitable substrate.

  They are decomposers of organic detritus and we see their fruiting bodies as mushrooms.

  Histoplasmosis is common in caves where bats roost and causes a disease like Tuberculosis.

Plants

- Mosses and ferns in the cave entrance.

Mini Martin Entrance Hole.
Photo: Stephen Bunton

Animals

- Sea caves contain many intertidal marine taxa.
- Platyhelminthes - flatworms.
- Mollusca - gastropods including Hydrobiid snails.
- Arthropoda - insects, arachnids such as spiders, guano mites, opiliones (harvestmen). Scorpions, pseudoscorpions, centipedes, millipedes and crustaceans.
- Chordates.

Chordates

- Fish
- Amphibians
- Reptiles
- Birds
- Mammals

Fish

- There are many examples of blind unpigmented fish from various parts of the world including one from Western Australia.

Amphibians

- Blind unpigmented salamanders are famous throughout the world including the

  Proteus from Slovenia (thought by the ancients to be baby dragons!).
- None are known in Australia.

Reptiles

- Many tropical caves contain snakes in the twilight or transition zones.

  These feed on bats or birds migrating in or out of the cave or mammals scavenging in the guano deposits.

  Snakes may snap at random but fine-tune their strike using their temperature sensory organs as the prey approaches.

Birds

- May roost in the entrances of caves.
- Birds Nest Soup is the harvested saliva of swallows.
- Some birds can echo-locate and therefore roost in the dark zone.
- Guano deposits below owl roosts may provide clues to the mammalian prey species present in the surrounding area.

Mammals

- Bats are insectivores.
- Flying foxes are fruitivores.
- Rats are common scavengers in caves.
- Humans.

Bats

- Bats only roost in certain caves where their loss of body heat causes the cave temperature to rise usually in chambers with a domed roof.
- The breeding season is December to March and often bat caves are closed at this time.
- There are no bat caves in Tasmania. Tasmanian bats roost in tree-hollows.

Biospeleology

- The study of cave biology.
- Cave biologists have a good knowledge of taxonomy as a result of the huge diversity of species they encounter.
- Many are ecologists or evolutionary biologists investigating the taxanomic relationship between species. These days DNA profiling provides a valuable tool for this endeavour.

Palaeontology

- Caves are formed in a number of rock types which are the result of the actions of living organisms.
- These may be as coral reefs or shell deposits.
- It is often possible to see fossils exposed in the cave walls.
- Sub-fossils of accidentals are often found in caves e.g. Thylacines (Tasmanian tigers).

Human Impact on Cave Systems

- Trampling
- Moving sediments around.
- Harvesting food.
- Over-collecting specimens.
- Rubbish disposal.
- Gating of caves.
- Modifying the cave for tourism.

Harwoods Hole, NZ. Photo: Stephen Bunton

On the Surface

- Pollution of streams.
- Diverting streams.
- Increased runoff and sedimentation from forestry or agriculture.
- Mining and quarrying of limestone for metal refining, carbide production, agricultural lime and road gravel.

Ghaping Ghyll, UK, was first descended when the stream was diverted. Photo: Stephen Bunton

The End