AUSTRALIAN EARTH SCIENCE EDUCATION

Transition to land

Challenges and solutions for animals and plants

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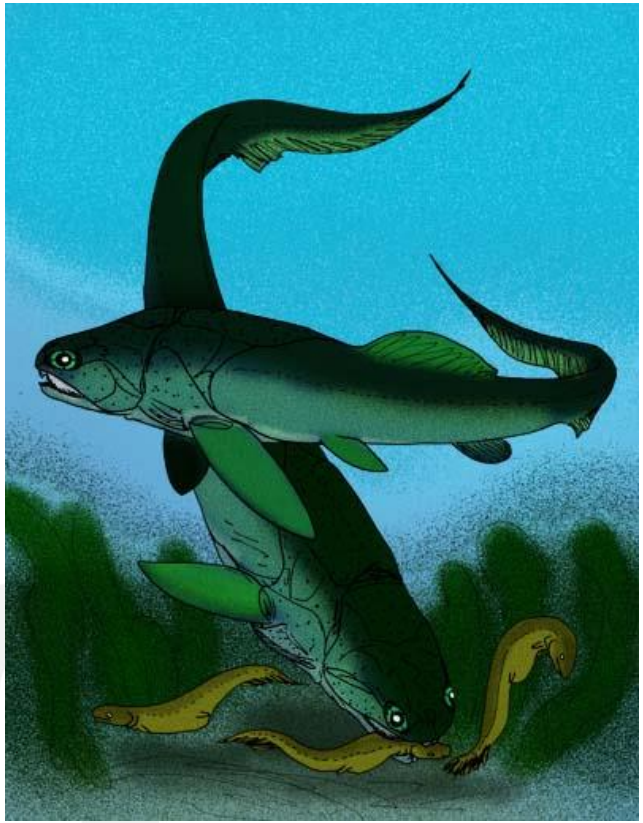
Why leave the water?

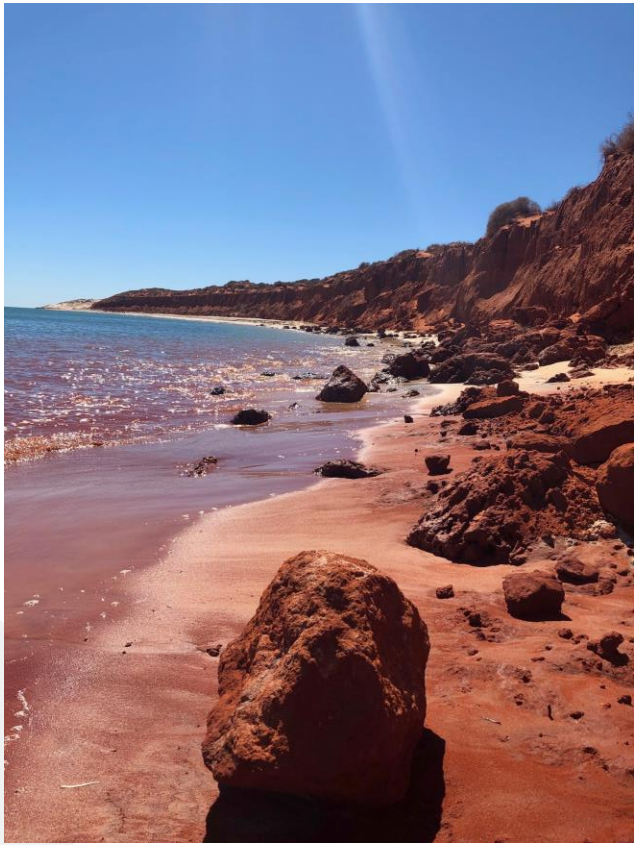
- Escape predators
- Less competition
- More space
- More oxygen
- More light



Placoderm fish (SF Fink 2007, Creative Commons)

Challenges of life on land

- Support
- Desiccation
- Gas exchange
- Reproduction



Challenges of life on land: Support

Water supports animal and plant bodies

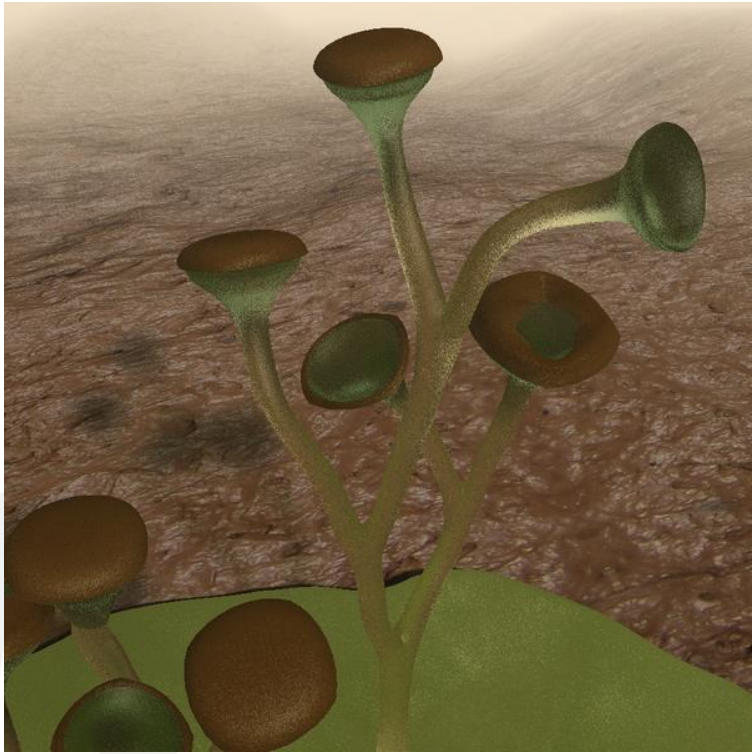
Kelp (S Maruch 2007, Creative Commons)

Support in transitional plants: mosses

- Mosses and liverworts were the first land plants
- Have a central thickening for support
- Have rhizomes to attach to rock/soil

Support in transitional plants: vascular plants

- Transport system (xylem) that is reinforced by lignin provides support



Cooksonia reconstruction
(Smith609 2008, Creative Commons)

Support in transitional animals: arthropods

- Exoskeleton with jointed limbs

Support in transitional animals: vertebrates

- Rhipidistian fish lineage
- ‘Fishibians’ were able to haul out onto land

Tiktaalik rosae (N Tamura, Creative Commons)

Challenges of life on land: Desiccation

Retaining water is vital for survival

Seaweed washed up in the Erme estuary (M Bodman 2007, Creative Commons)

Preventing desiccation: plants

- Mosses absorb water directly into their tissue and grow in damp areas
- Early vascular plants had a waxy cuticle and xylem

Water droplets on waxy cuticle of flower bud (B Inaglory 2011, Creative Commons)

Preventing desiccation: Arthropods

- Most have developed a waxy epicuticle on the outside of the exoskeleton
- May also stay in moist environments

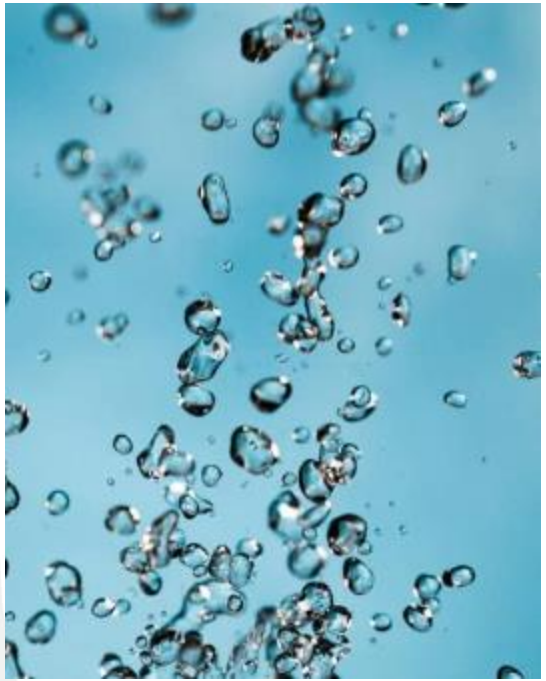
Preventing desiccation: Vertebrates

- Early amphibians were confined to moist environments
- Reptiles developed keratin for waterproofing

Amphibians like this salamander must live in moist environments, but reptiles have waterproof skin with keratin.

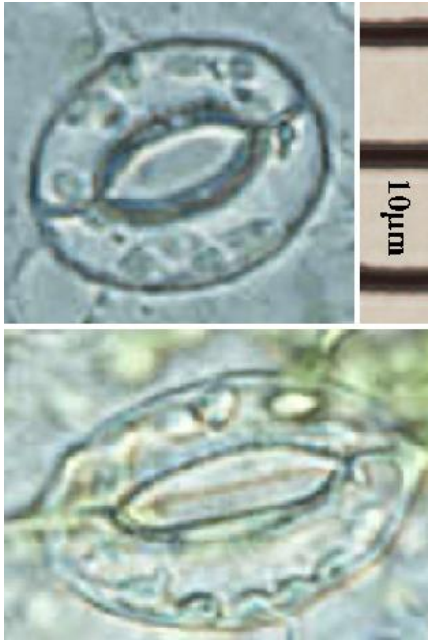
Challenges of life on land: Gas exchange

- Oxygen and carbon dioxide must be dissolved in water to move in and out of cells
- Organisms in water can absorb gases through their body tissues (plants) or gills



Gas exchange: Plants

- Moss absorb gases directly through moist surface
- Vascular plants have stomata allowing gas entry through waxy cuticle



Stomata open (top) and closed
(Kuripop 2008, Creative Commons)

Gas exchange: Arthropods

- Book gills → book lungs (stacks of folded tissue)
- Tracheal system (tubes extending inside body)

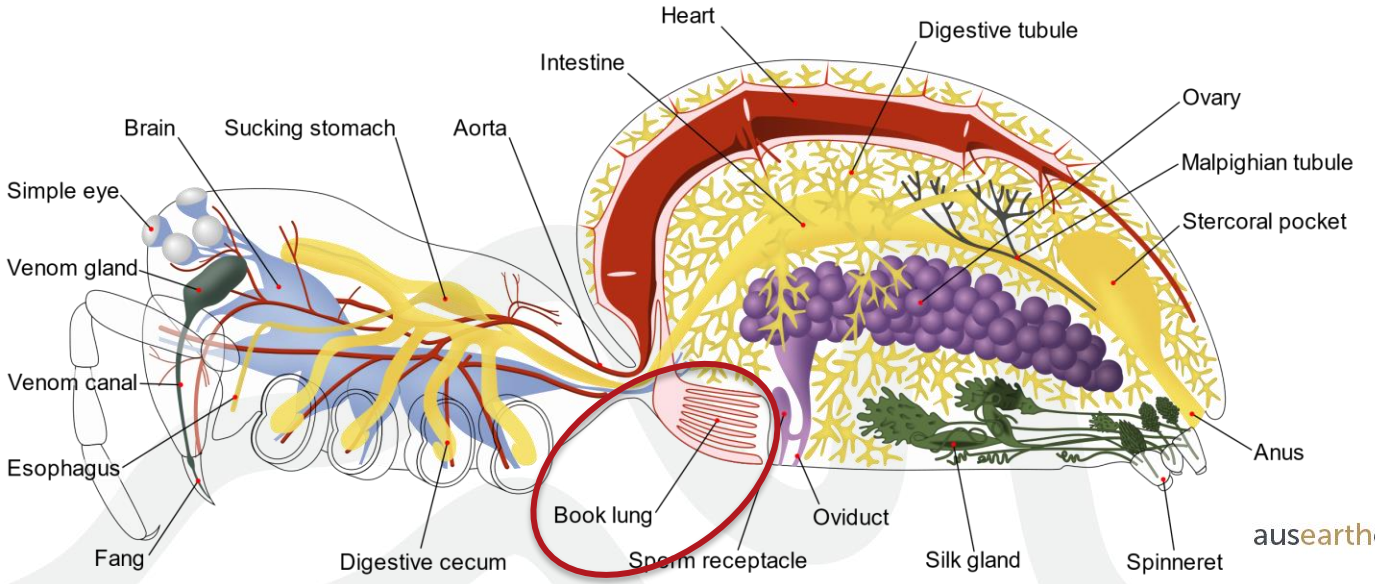


Diagram of the internal anatomy of a female spider (J H Comstock 2009, Creative Commons)

Gas exchange: Vertebrates

- Simple sac-like lungs are used by fish for gas exchange in low-oxygen environments
- Amphibians have gills when young and lungs when adult
- Lungs increase in complexity and surface area with increased air breathing

Axolotl (2014, Creative Commons)

Challenges of life on land: Reproduction

Gametes and embryos are vulnerable to drying out. Water also provides a means of dispersal for both gametes and young.

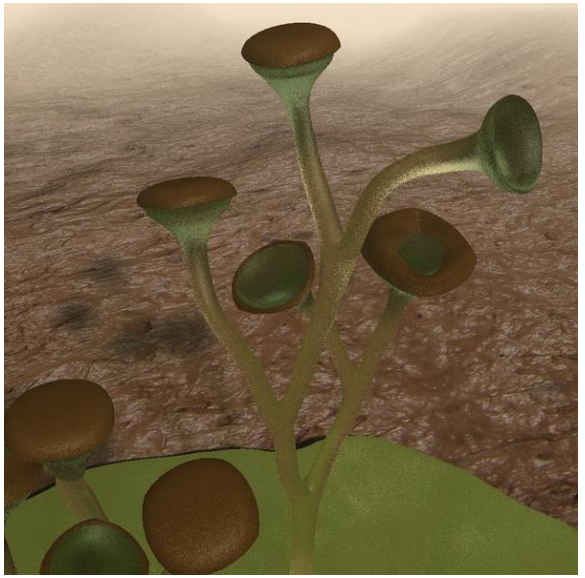
Coral spawning
(NOAA, public domain)

Reproduction: Mosses

- Moss have gametophyte and sporophyte generations
- Gametes must swim in water
- Spores can be carried by wind, but germinate in wet areas

Reproduction: Vascular plants

- Early vascular plants also had a two-part lifecycle with spores
- Spores in *Cooksonia* are in waterproof sporangia on the end of branches
- Later plants evolved seeds and do not need water for reproduction



Cooksonia reconstruction (Smith609 2008, Creative Commons) ausearthed.com.au

Reproduction: Arthropods

- Aquatic arthropods release gametes into the water
- As species evolved to a fully terrestrial life, internal fertilisation evolved
- Many arthropods place sperm in a spermatophore that is retrieved by the female

Female cricket with a spermatophore (G San Martin 2014, Creative Commons)

Reproduction: Vertebrates

- Amphibians return to water for external fertilisation
- The amniotic egg and internal fertilisation allowed vertebrates to become fully terrestrial

Mating pond frogs (K von Berg 2015, Creative Commons)

Albino Darwin carpet python laying eggs

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