UNIVERSITAS INDONESIA
Veritas, Probitas, Iustitia
FMIPA
BIOLOGI

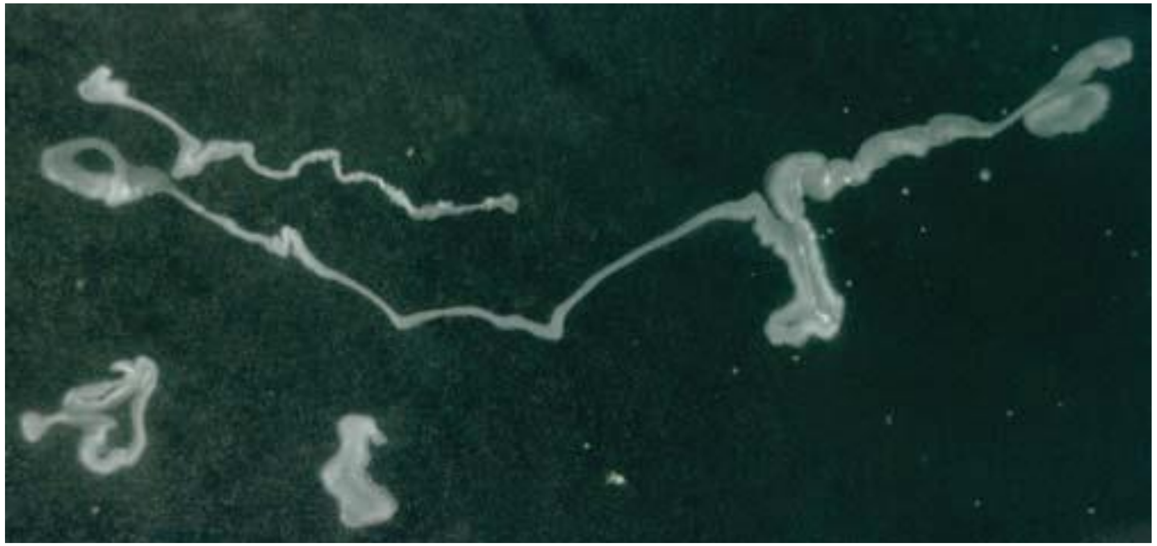
# Evolutionary and historical biogeography of animal diversity

# Learning objectives

- The students can explain the common ancestor of animal kingdom.
- The students can explain the historical biogeography of animal.
- The students can explain the invasion of animal from aquatic to terrestrial habitat.
- The students can explain the basic mechanism of speciation, allopatric and non-allopatric.

# The Common Ancestor of Animal Kingdom

# Characteristics of Animals

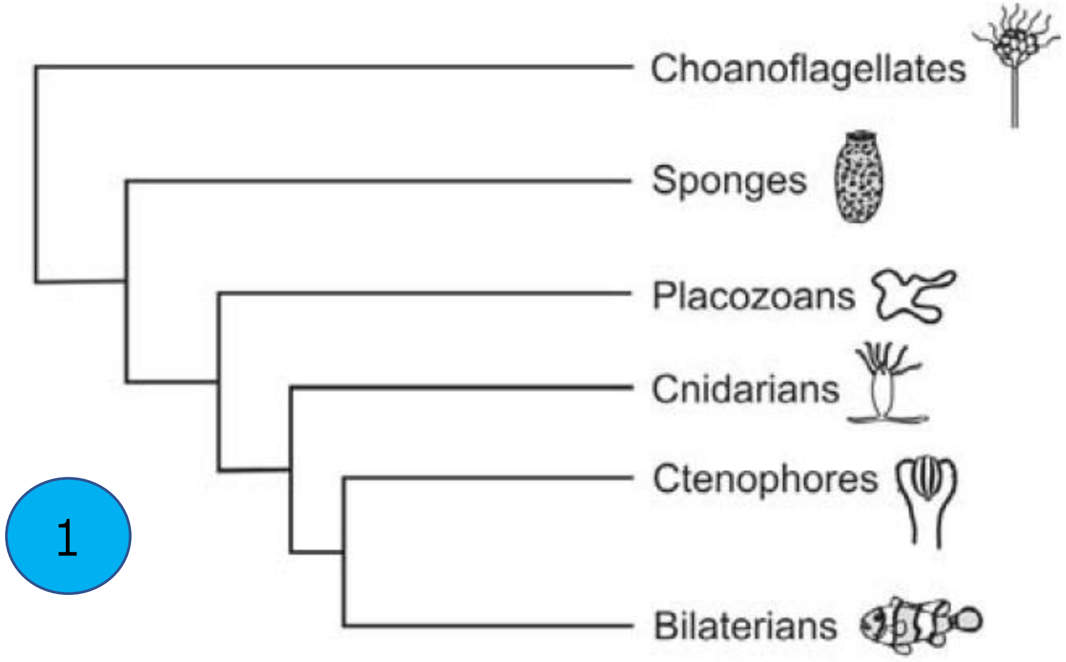


*Trichoplax adhaerens*

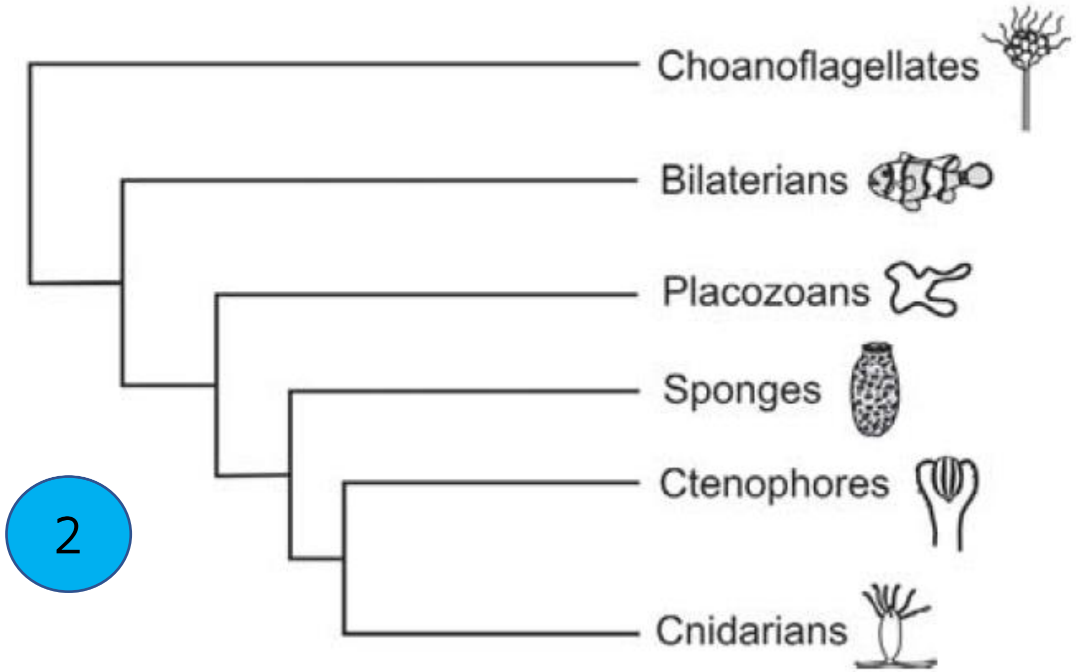
- **Animals** or "**metazoans**" are typically **heterotrophic**, **multicellular** organisms with **diploid**, **eukaryotic** cells.
- *Trichoplax adhaerens* is defined as an animal by **the presence of different somatic** (i.e., non-reproductive) cell types and by **impermeable cell–cell connections**.

Blackstone, 2009

# Two Hypotheses for the Branching Order of Groups at the Root of the Metazoan Tree



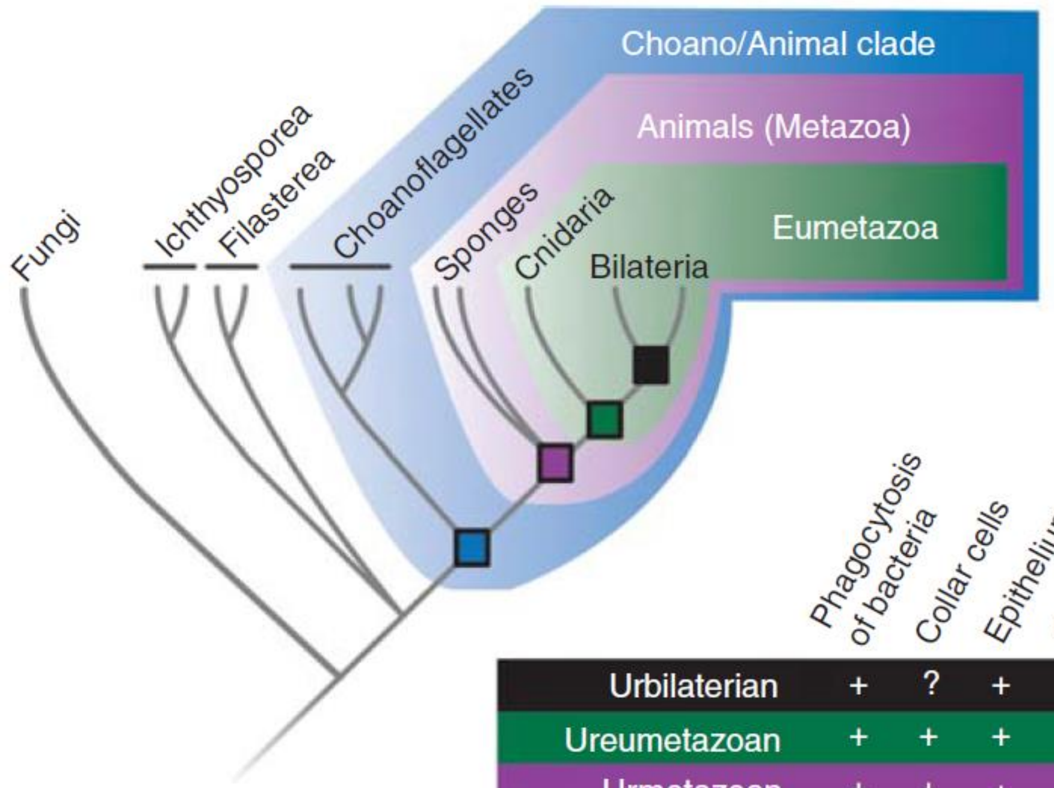

The choanoflagellates serve as an outgroup in the analysis, and sponges are the sister group to the placozoan + cnidarian + ctenophore + bilaterian clade.




Bilaterians are the sister group to the placozoan + sponge + ctenophore + cnidarian clade, while placozoans are the sister group to the sponge + ctenophore + cnidarian clade.

Blackstone, 2009

# Ancestry and evolution of animal–bacterial interactions

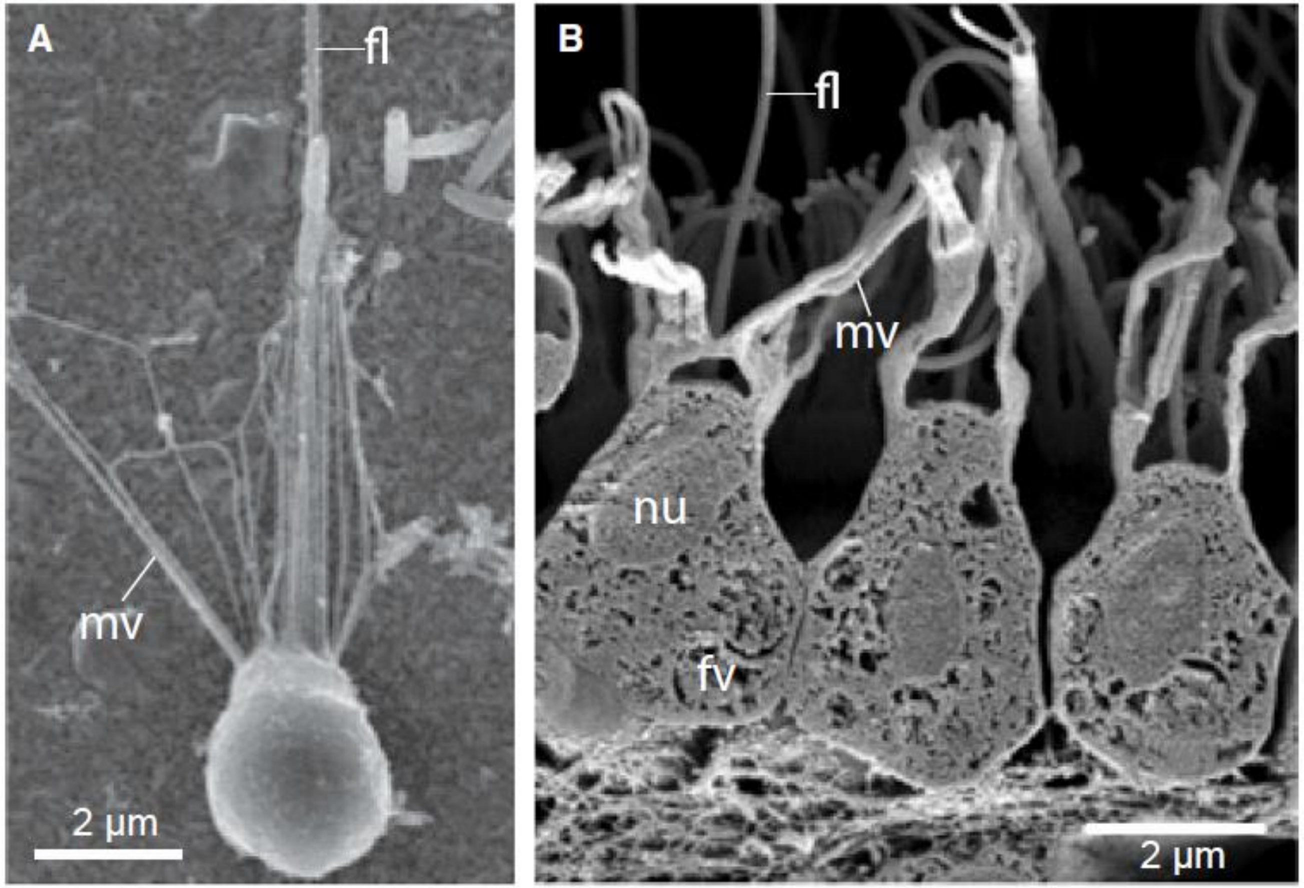



| | Phagocytosis of bacteria | Collar cells | Epithelium | Gut cavity | Innate immunity | TIR/Ig domains | C-type lectins |
|---|---|---|---|---|---|---|---|
| Urbilaterian | + | ? | + | + | + | + | + |
| Ureumetazoan | + | + | + | + | + | + | + |
| Urmetazoan | + | + | + | | ? | + | + |
| Choano/Animal LCA | + | + | | | | ? | + |

- Choanoflagellates as the last common ancestor of animal kingdom.
- Urmetazoan is the group of animal with multicellular and produce differentiated cell types (ex. Egg & sperm)

R.A. Alegado & N. King, 2014

# Conserved morphology and ultrastructure of Choanoflagellates and Sponge choanocytes




Brunet & King, 2017

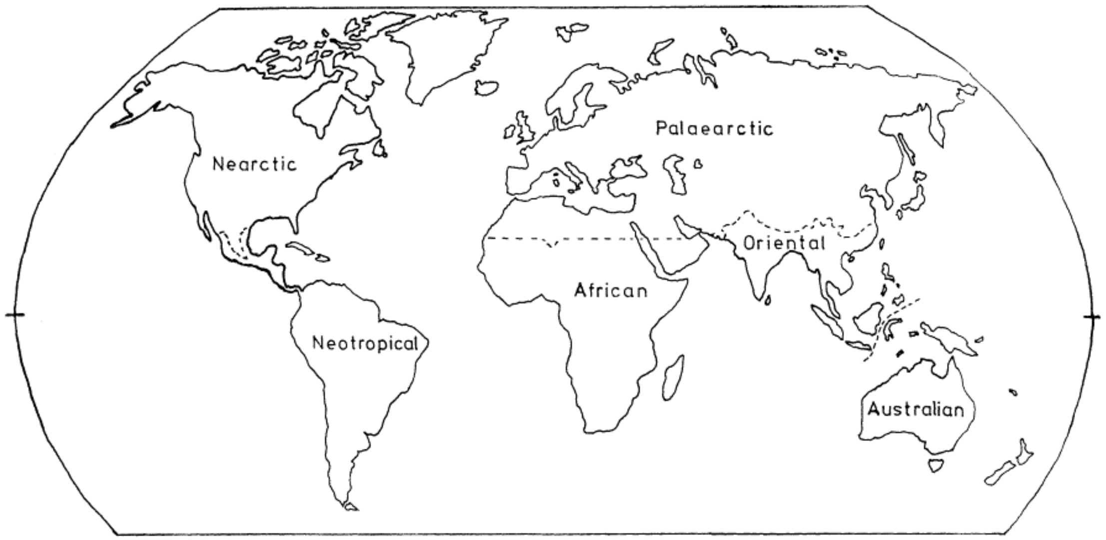
The collar complex is conserved in choanoflagellates (A. *S. rosetta*) and sponge collar cells (B. *Sycon coactum*)

flagellum (fL), microvilli (mv), a nucleus (nu), and a food vacuole (fv)

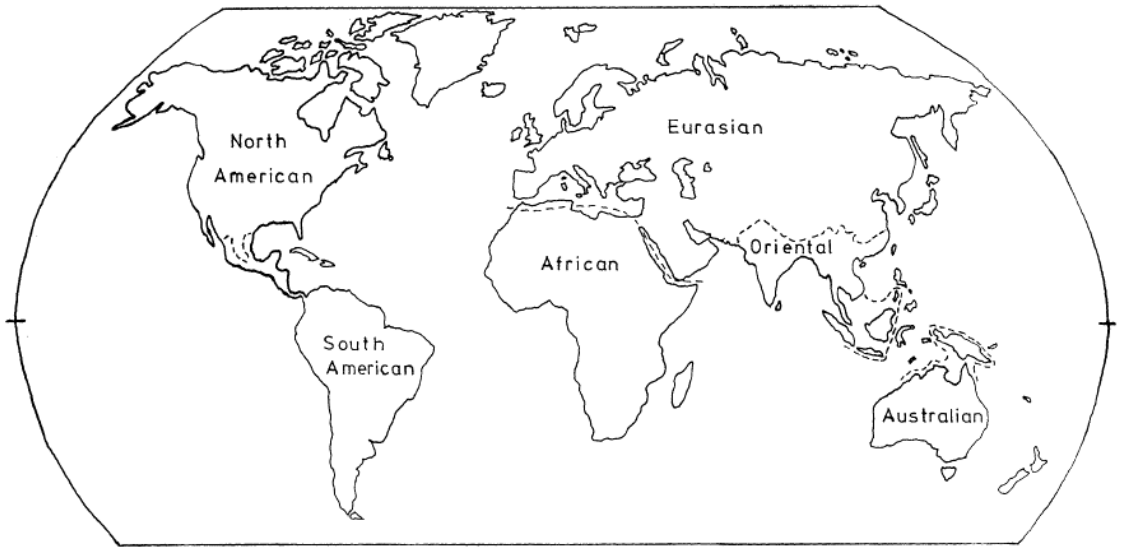
# The Historical Biogeography of Animal

# Zoogeographic regions

Old

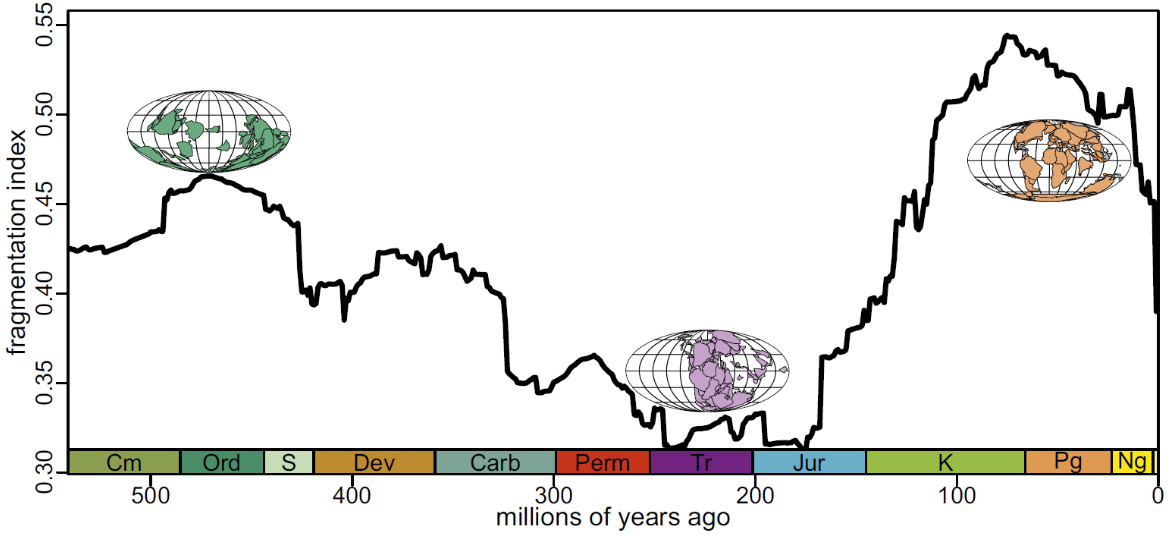



New

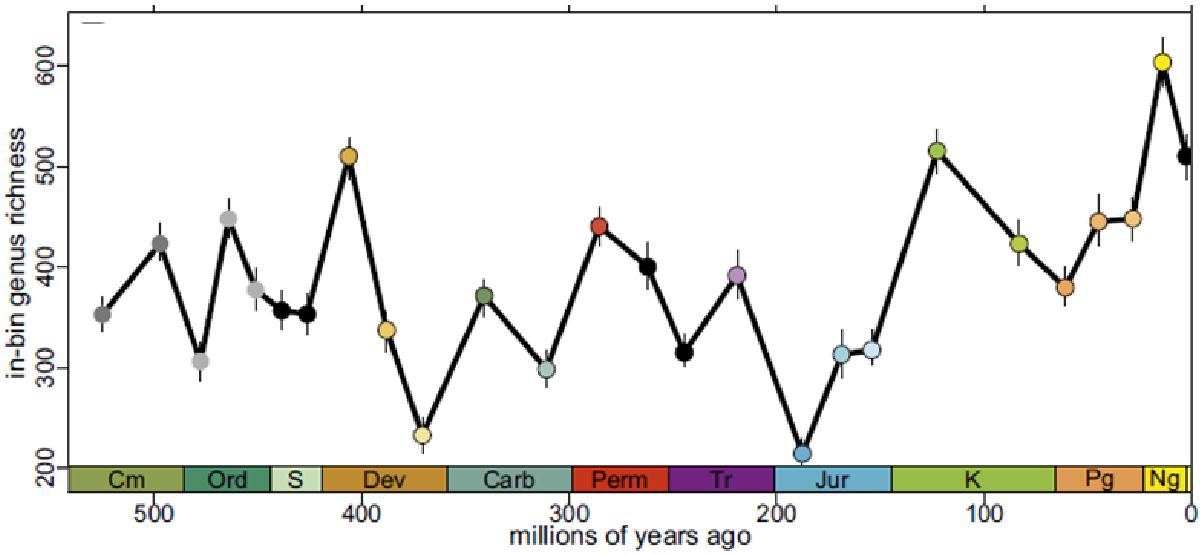



Cox, 2001

# Plate tectonic regulation of global marine animal diversity




A. An index of continental block fragmentation

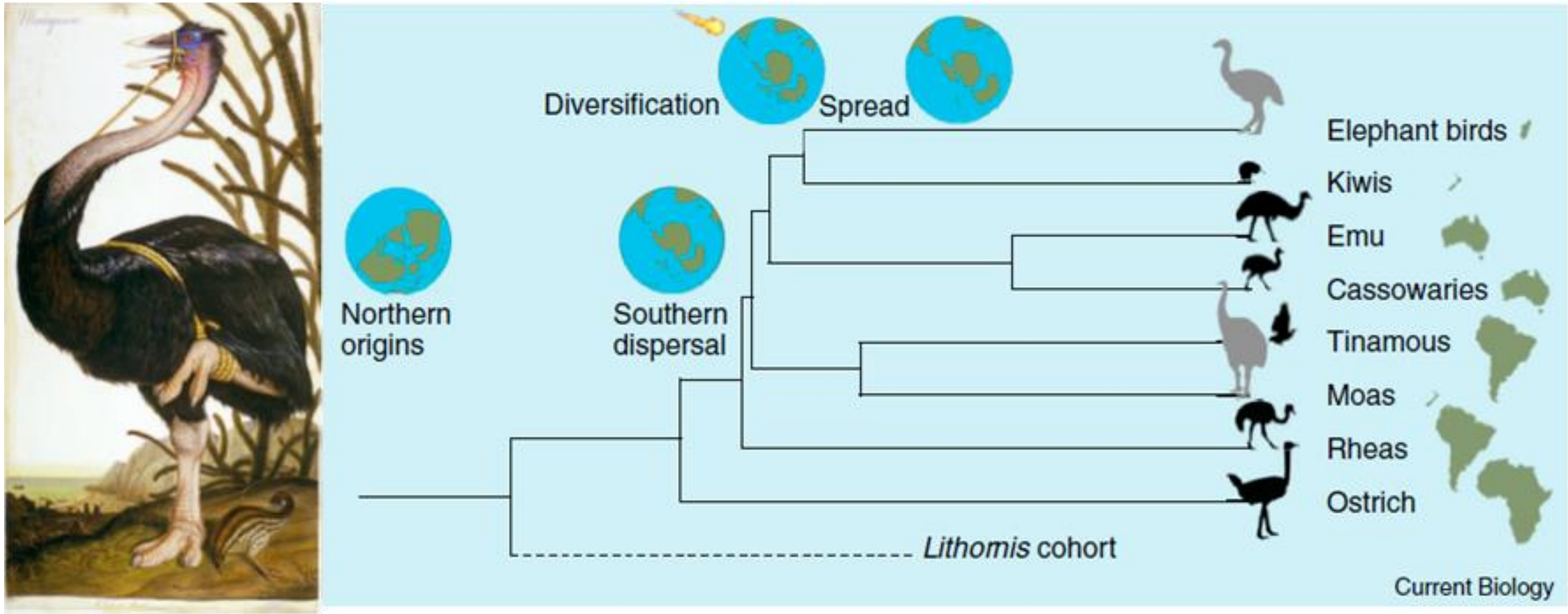



B. Genus richness

Carb, Carboniferous; Cm, Cambrian; Dev, Devonian; Jur, Jurassic; K, Cretaceous; Ng, Neogene; Ord,Ordovician; Perm, Permian; Pg, Paleogene; S, Silurian; Tr, Triassic.

Zaffos, et.al., 2017

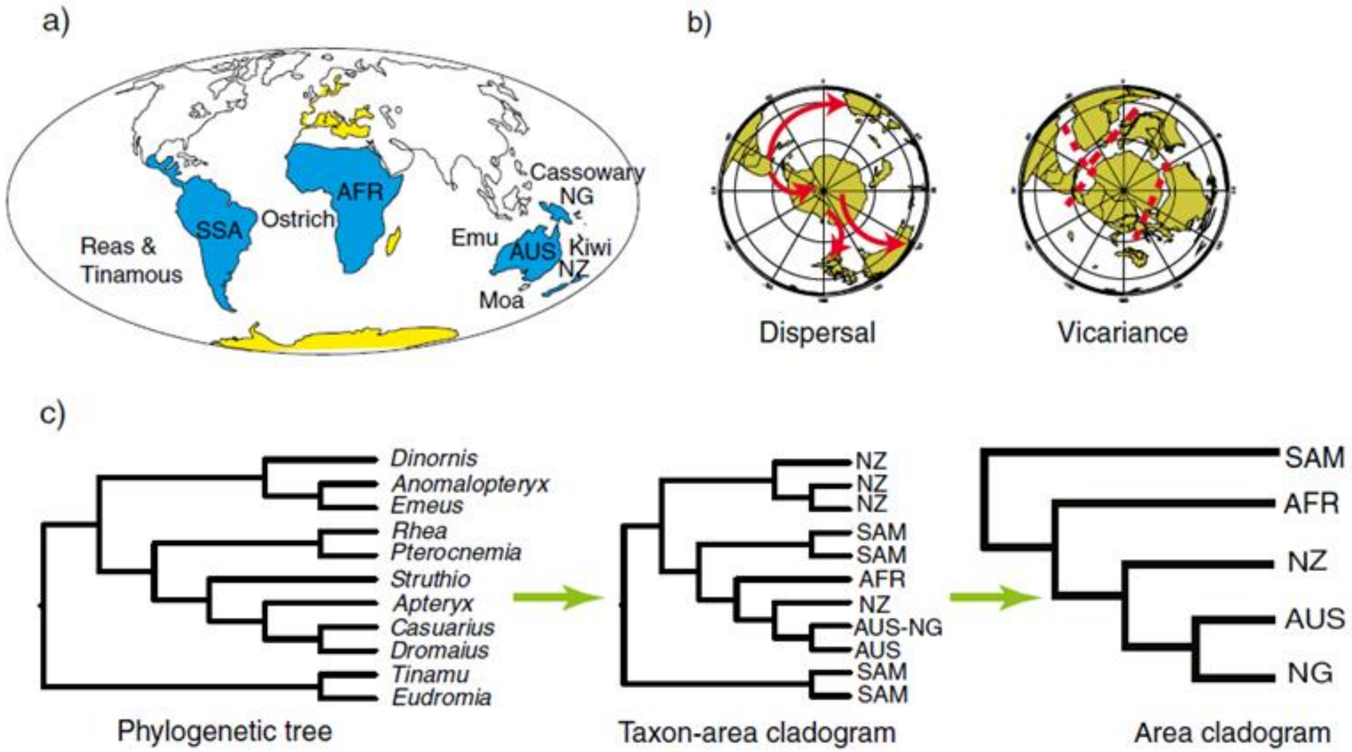
# Evolution: Flight of the Ratites




The Malagasy giant elephant bird or vorompatra

Maderspacher, 2017

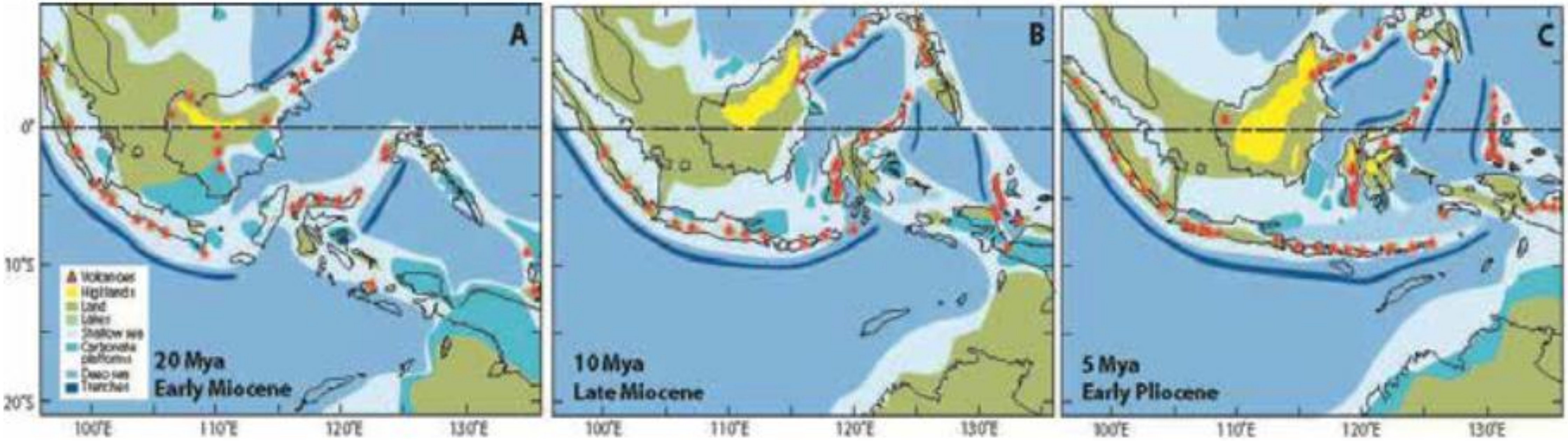
# Historical Biogeography of Ratites




Biogeographic history of the ratite birds

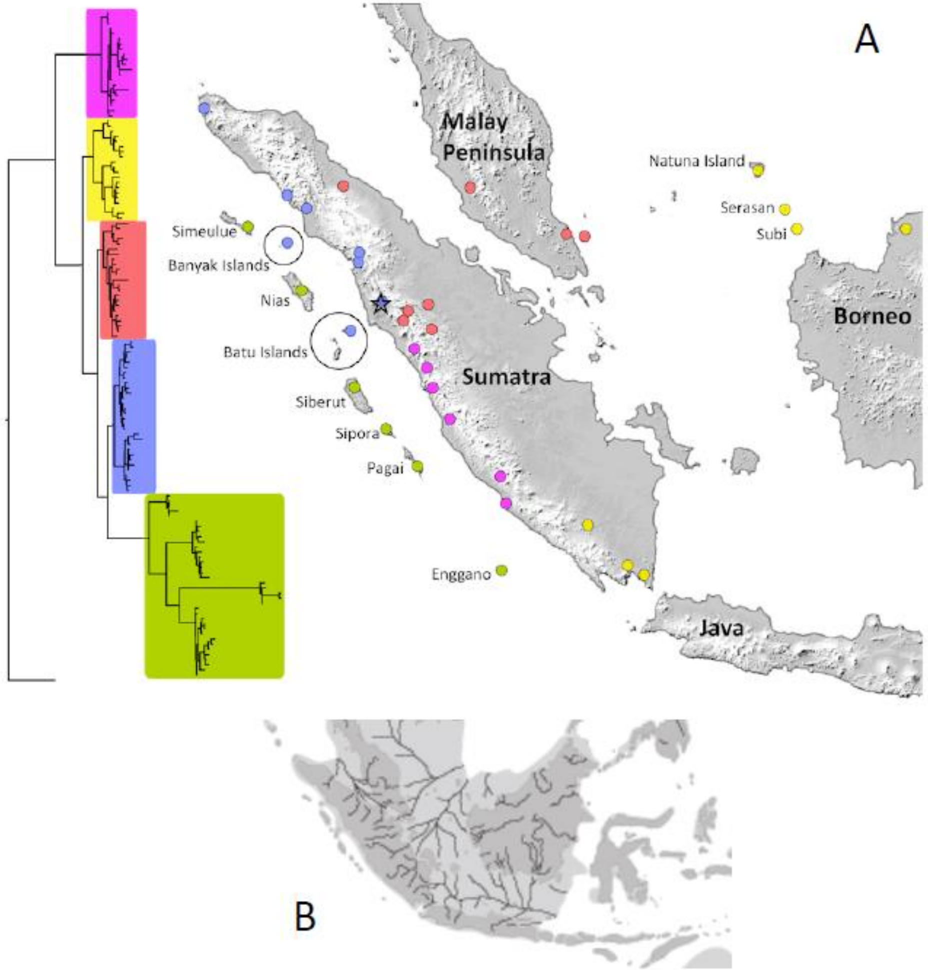
Sanmartín, 2012

# Reconstructions of Land and Sea in the Indo-Australian Archipelago



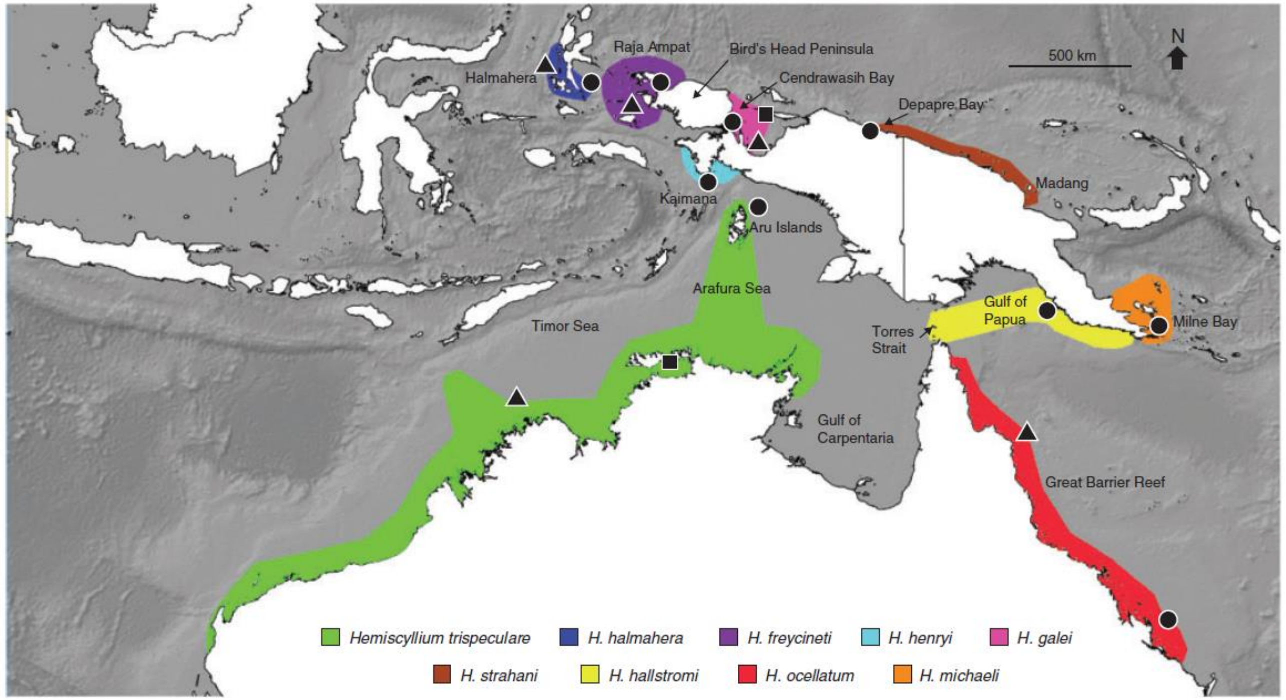

Lohmann et al. 2011

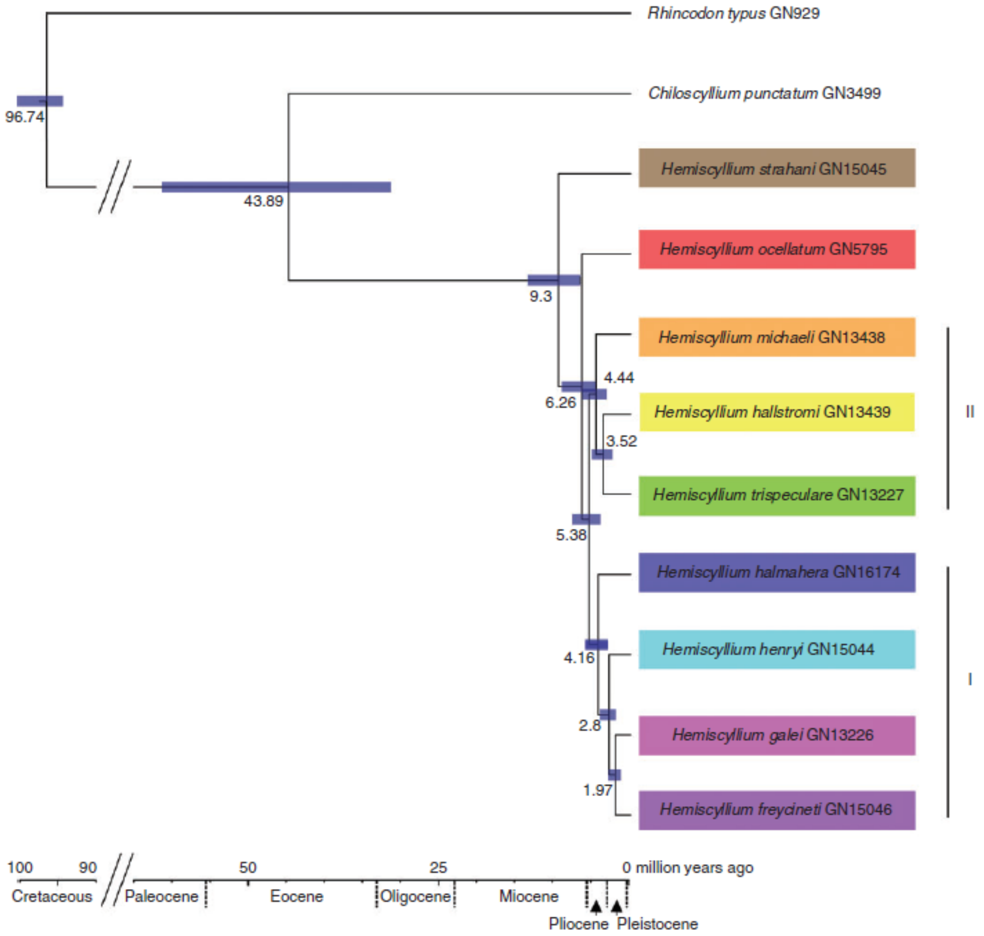
# The Geographical Distribution of *Draco sumatranus* Clades


Lawalata, 2011

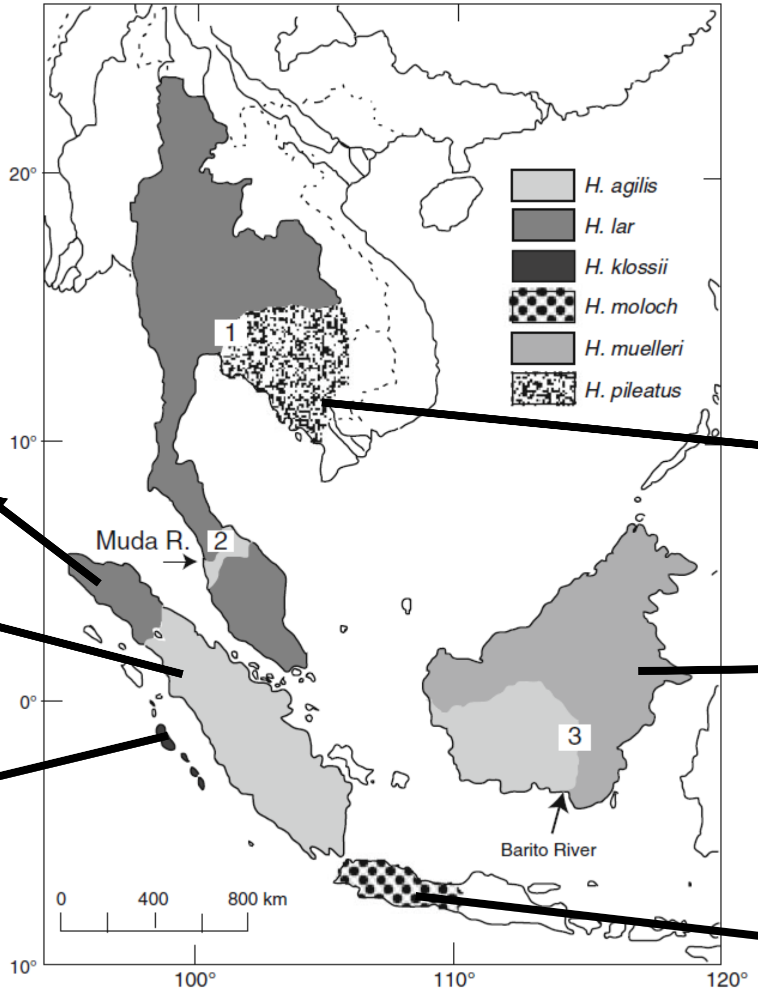
# Phylogenetics and Biogeography of The Walking Shark Genus *Hemiscyllium*

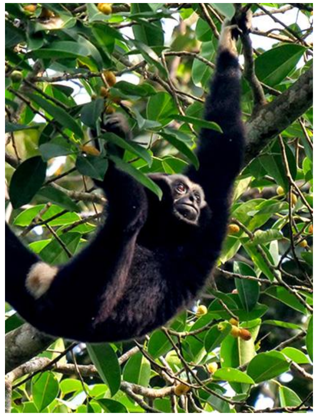



Dudgeon, 2020

# Distribution of Species in The Genus *Hylobates*

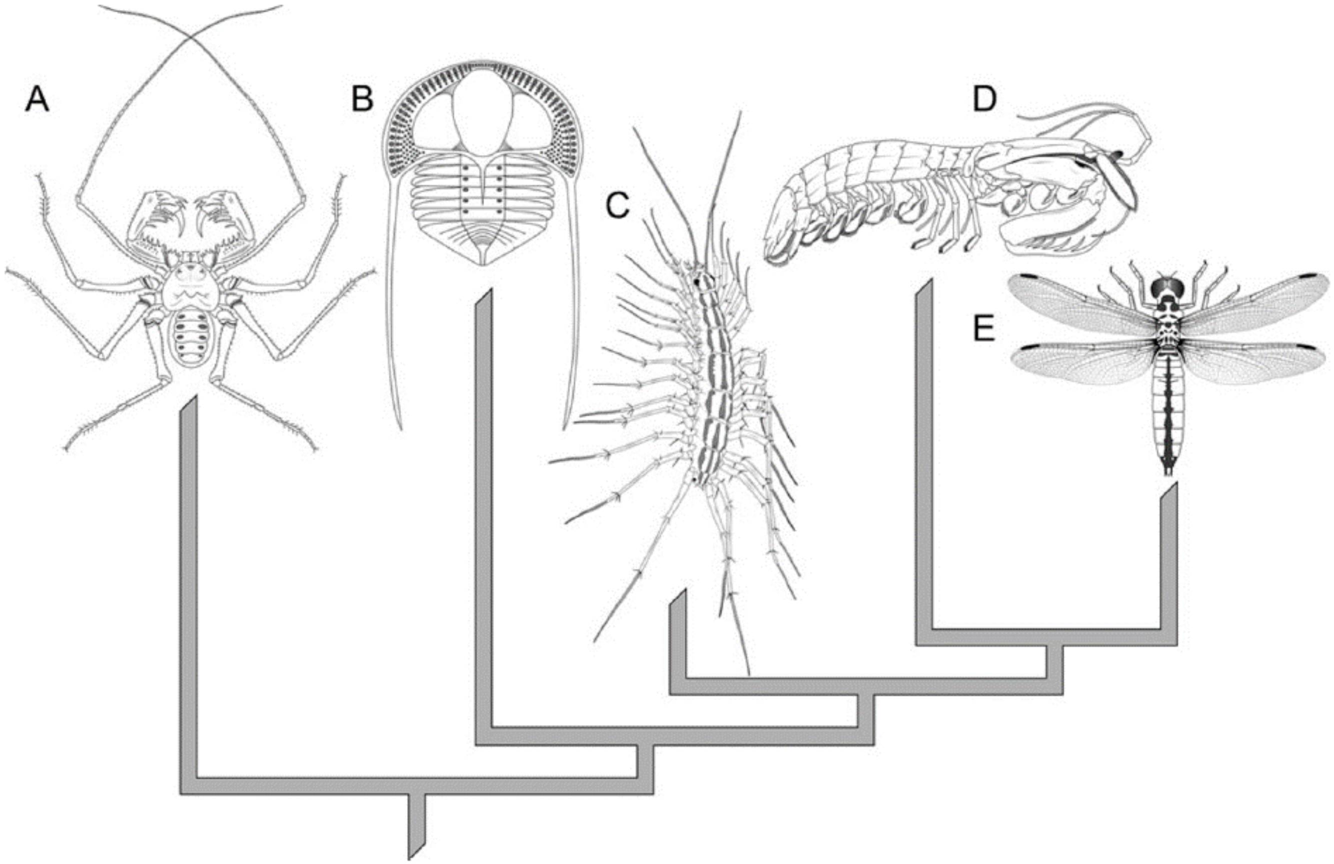


Geissmann, 1995

# The Invasion of Animal From Aquatic to Terrestrial Habitat

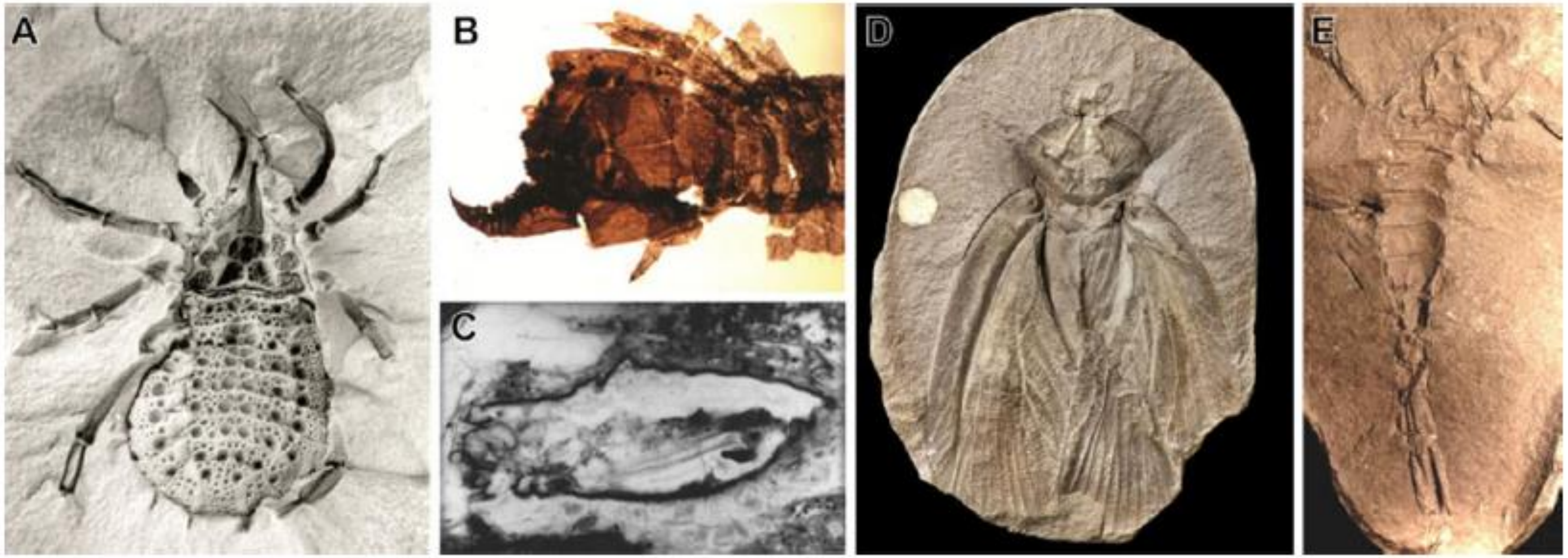
# Timeline of the colonization of land in the early Paleozoic




A. Chelicerates → amblypygid arachnid
B. Trilobites → Trinucleidae
C. Myriapods → scutigeromorph centipede, *Scutigera coleoptrata*
D. Crustaceans → stomatopod or mantis shrimp
E. Insects → dragonfly

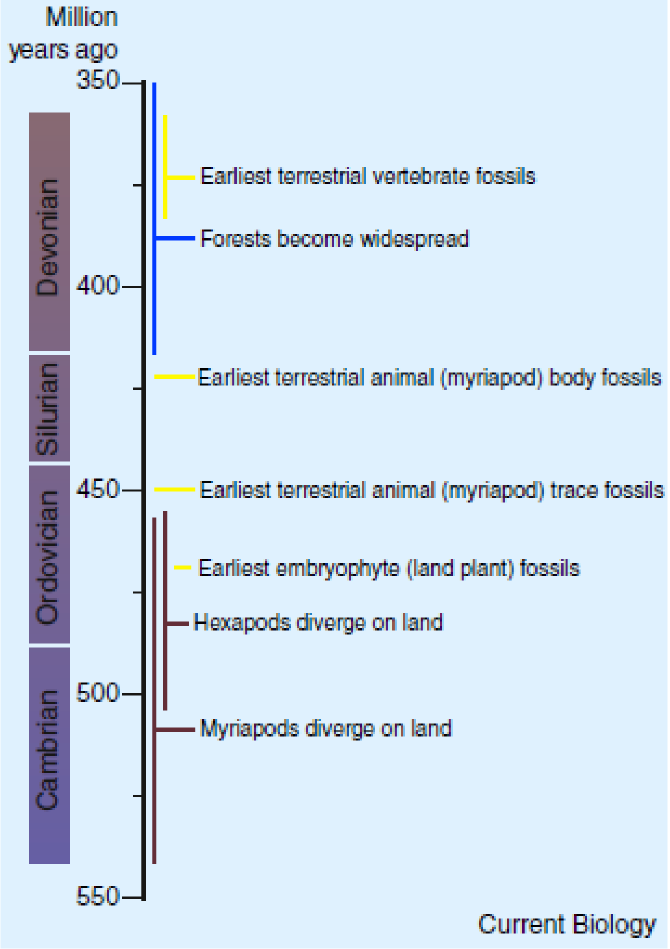
Garwood & Edgecombe, 2011

# Fossils Record a Number of Arthropod Groups



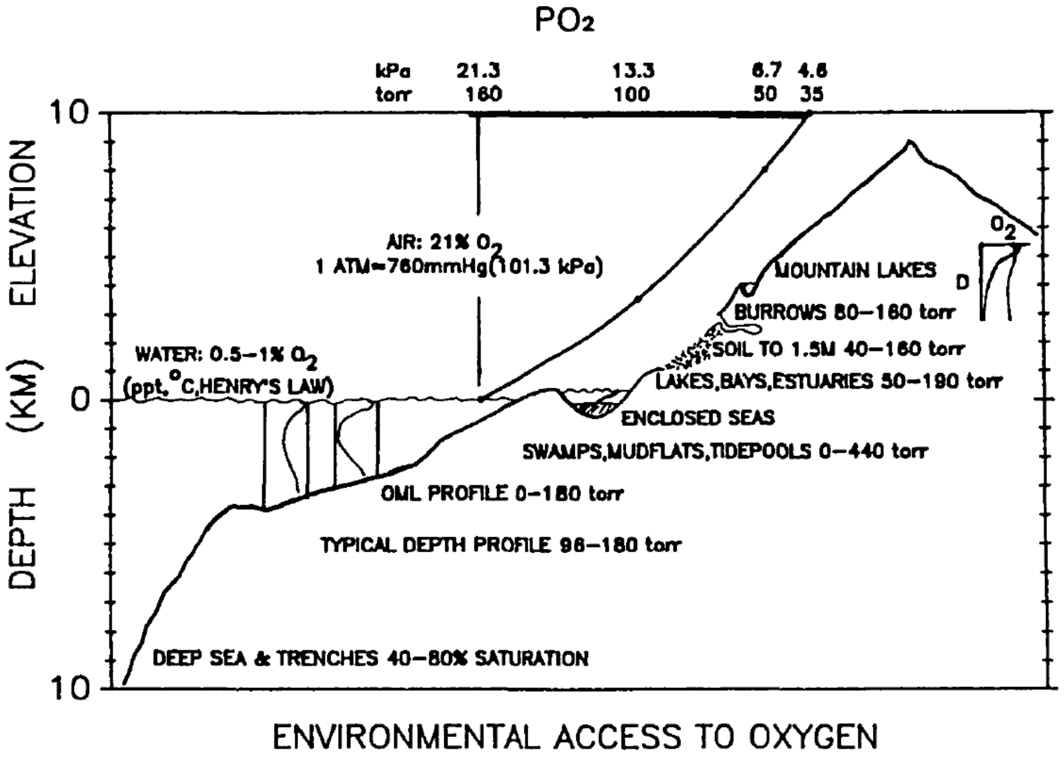

A. Trigonotarbid arachnid (*Eophrynus prestvicii*)
B. Centipede (*Devonobius delta*)
C. The Devonian harvestman arachnid (*Eophalangium sheari*)
D. Roachoid insect (*Archimylacris eggintoni*)
E. Carboniferous scorpion (*Compsoscorpius buthiformis*)

# Animals Arrived on Land Much Earlier than The Fossil Evidence

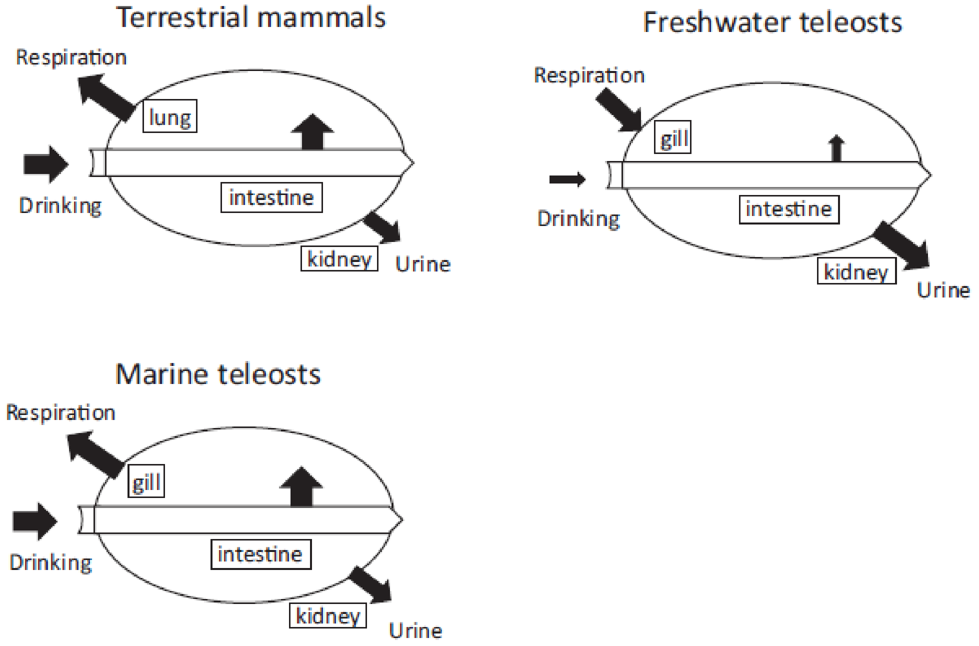



Dunn, 2013

# Evolution of The Mechanisms for Water Acquisition



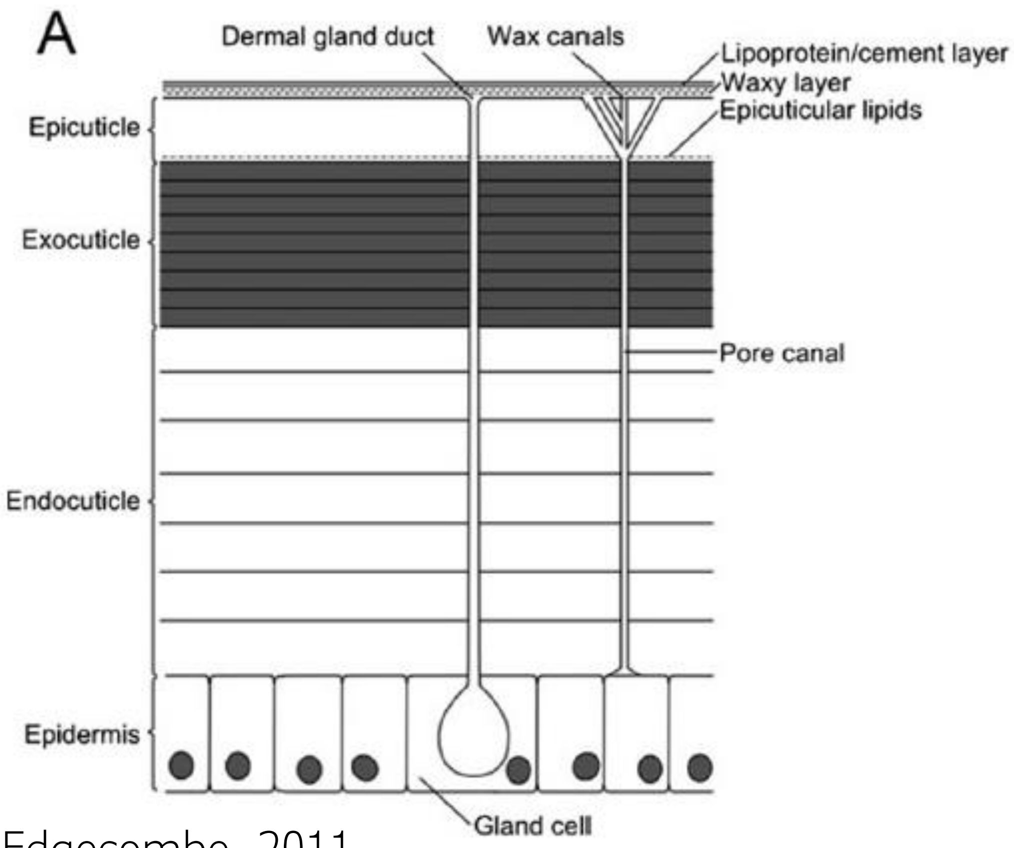

adaptation

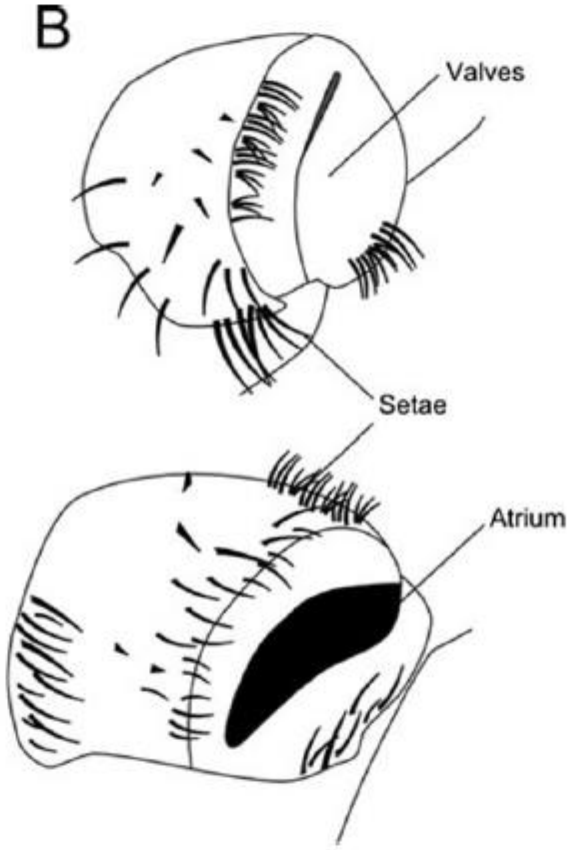



Graham, 1990

Takei, 2015

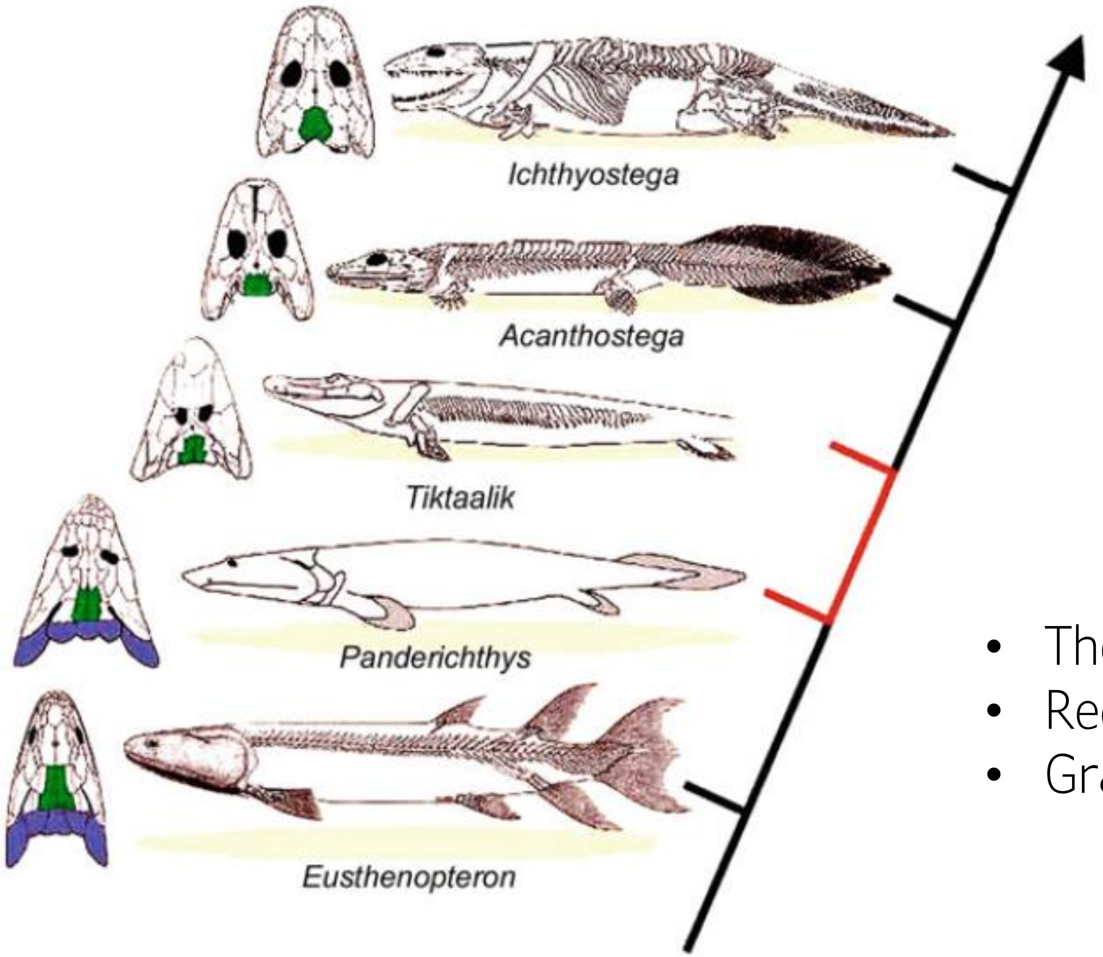
# Cutice and Spiracles as An Adaptation of Arthropod in Terrestrial




Garwood & Edgecombe, 2011

# The Lineage Leading to Modern Tetrapods

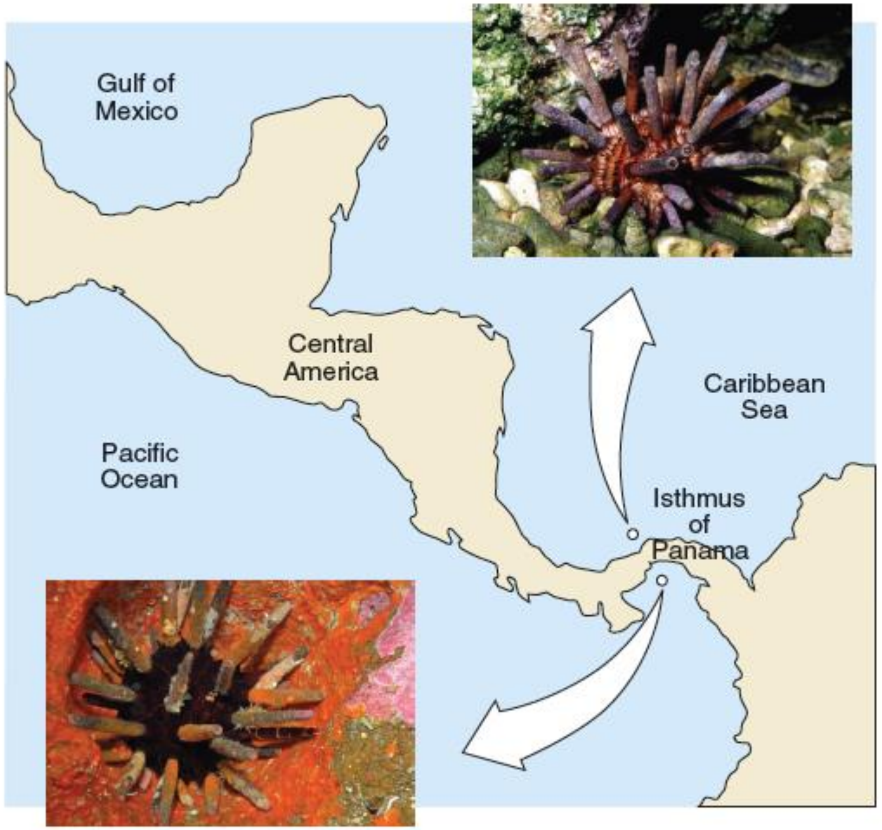



- The loss of the gill cover
- Reduction in size of the postparietal bones
- Gradual reshaping of the skull

# The Basic Mechanism of Speciation

# Evolutionary Divergence of Separated  Sea Urchin Population

## Allopatric speciation (geographical speciation)




Formation of the Isthmus of Panama separated an ancestral population, leading to evolution of separate Caribbean (*Eucidaris tribuloides*) and Pacific (*Eucidaris thouarsi* ) species.

# Habitat as A Barrier of Gene Flow

## Non-Allopatric speciation (simpatric speciation)

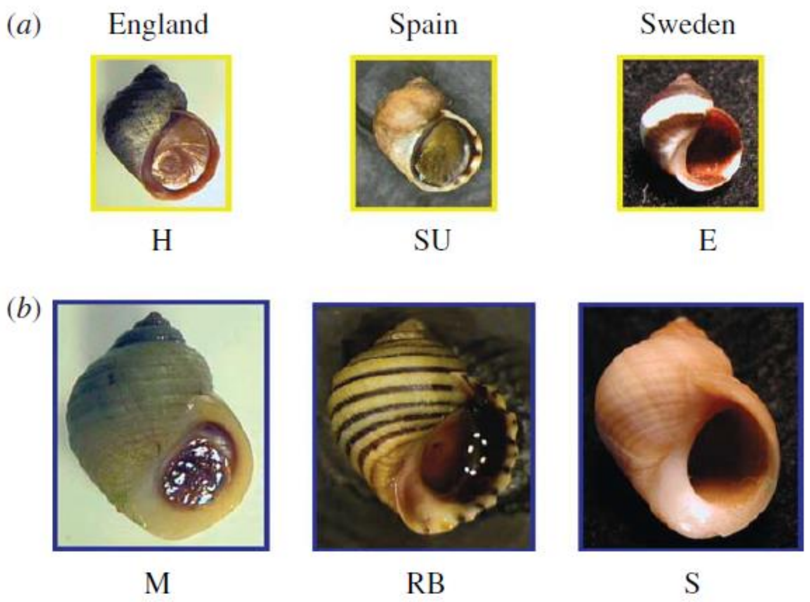



Table 2. Key features of the three *L. saxatilis* morph pairs.

| location | morphs | size | shell form | habitat | adaptation |
|---|---|---|---|---|---|
| UK | H | small | thin, wide aperture | high shore | resistant to wave action |
| Spain | M | large | thick, narrow aperture | mid shore | resistant to crab predation |
| | RB | large | thick, ridged, narrow aperture | high shore (barnacles) | resistant to crab predation |
| Sweden | SU | small | thin, wide aperture | lower shore (mussels) | resistant to wave action |
| | E | small | thin, wide aperture | exposed | resistant to wave action |
| | S | large | thick, narrow aperture | sheltered | resistant to crab predation |

[a] $I$ is an index of assortative mating: $I=0$, random mating; $I=1$, complete assortment.

The three morph pairs in *Littorina s saxatilis*. Shell height is typically (a) approximately 5–10 mm for H/SU/E (wave resistant) and (b) 10–15 mm for M/RB/S (predation resistant).

Butlin, et. al. 2008

# Distribution, Genomic Diversity, and Population Structure of the Genus *Pongo*