BIOGEOGRAPHY AND THE DISTRIBUTION OF AMPHIBIANS

BIOGEOGRAPHY

- What is it?
- Why is it important?
- What can it tell us about species distributions?

BASIC PRINCIPLES

- Can be used to gain a broad perspective on species distributions
- Operates at many different scales; governs types of questions
- Not a science from one source
  - Geography
  - Paleontology
  - Phylogenetics
  - Ecology
**EARLY OBSERVATIONS**

1. Distant oceanic islands; long-distance dispersal
2. Indigenous species are less on oceanic islands compared to mainland
3. Species on islands are clearly related to the closest mainland
4. The proportion of endemic species is high when dispersal is low
5. Island species bear the mark of continental ancestry

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**PLATE TECHTONICS AND CONTINENTAL DRIFT**

http://www.jochemnet.de/fiu/OCB3043_30.html

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**EARLY OBSERVATIONS**

What can the fossil record tell us???

- Glossopteris
- Mosasaurus
- Lystrosaurus
**HISTORICAL SPECIES DISTRIBUTIONS**

- **Dispersal**
  - Center of origin
  - Disperse from center across barrier

- **Vicariance**
  - Geological events create barriers
  - Biota diverge subsequent to isolation

**SPECIES DISTRIBUTIONS**

- **Expanding populations**
  - Populations are increasing
  - May be due to human activity

- **Relict populations**
  - Decreasing or staying constant
  - Less competitive
  - Habitat requirement

- **Island or “waif” population**
  - Lead to colonization of islands
  - Similar to mainland relatives

**SPECIATION PROCESSES**

- **Multiple processes**
- Allopatric best known
- Parapatric and sympatric rare
SPECIATION PROCESSES

- Allopatric speciation

- Sympatric speciation (polyploidy)

- Parapatic speciation

Species examples:

- Desmognathus ocoee
- Desmognathus carolinensis
- Hyla chrysoscelis
- Hyla versicolor
- Gyrinophilus sp. complex
SPECIATION PROCESSES

- Pre-zygotic isolation mechanisms
  - Differences in breeding behavior
  - Differences in breeding season
  - Morphological incompatibility
  - Recognition cues

- Post-zygotic mechanisms
  - Hybrid inviability
  - Primary sterility

- Introgression
  - Hybrid stability

AMPHIBIAN DISTRIBUTIONS

- History of the amphibian family groups is related with history of the land masses

- Distribution during Mesozoic and Cenozoic

- Mainly Gondwanaland

- As early as Pangaea (Early Jurassic 160-180 mya)

GREAT EXTINCTION OF THE PERMIAN

- The end of the Permian

- Bigger than the Cretaceous extinction

- Over 95% marine species

- 70% terrestrial species
FIRST FROG
- Triassic (Triadobatrachus)
- Madagascar
- Jurassic (Vieraella)
- Argentina

JURASSIC
- Diverse anuran fossils in Europe and South America
- Frogs became widespread

MOST PRIMITIVE FROGS
DISCOGLOSSIDAE

- Discoglossidae
- Mid temperate
  Laurasia

Current 4 genera

PALEOBATRACHUS

- Discoglossidae
- Mid temperate
  Laurasia
- Pipoids
  - Paleobatrachus

RHYNOPHRYNIDS

- Discoglossidae
- Mid temperate
  Laurasia
- Pipoids
  - Paleobatrachus
  - Rhynophrynids

Current 1 sp
**PIPIDS**
- Discoglossidae
- Mid temperate Laurasia
- Pipoids
  - Paleobatrachus
  - Rhynophrynids
  - Pipids

**LAURASIA**
- Discoglossidae
- Mid temperate Laurasia
- Pipoids
  - Paleobatrachus
  - Rhynophrynids
  - Pipids
  - Paleobatrachus and pipids divided
  - Americas still together
- Pipids divided with Africa

**LAURASIA**
- Pelobatinae
  - Pelodytidae
  - Megophrynidae
  - Pelobatidae
- All over Laurasia
- Divide on Cretaceous
LAURASIA

- Discoglossidae
- Paleobatrachus
- Rhynophrynids
- Pips
- Pelodytidae
- Megophrynidae
- Pelobatidae

LAURASIA

- Salamanders
- First fossils from middle Jurassic (Europe)
  - Sirenioidea
  - Salamandroidea
  - Cryptobranchioidea

SALAMANDERS

- Continental fragmentation
  - Division of Laurasia
  - Continental Drift
- Expansion of humid climates
- Four orders of salamanders
Salamanders

- Cryptobranchus
- Sirenoids
- Proteidae

MIOCENE

- Salamandridae
- Ambystomatidae
- Plethodontidae
- Dicamptodontidae
- Rhyacotritonidae
- Proteidae

- Associated with the Appalachians in the Paleocene
- Differentiation between east and west in Oligocene
- Genus Hydromantes in Europe via Bering
- Bolitoglossa and Odepina: 11 genera, 140 spp
GONDWANALAND
- Late Jurassic (140 mya)
- Ancestral stock differentiates
  - Bufonids
  - Ranoids
  - Microhyloids
- Break up in three continental masses

ANTARCTICA-AUSTRALIA
- Leopelmatidae
- Myobatrachidae
- Hylidae

ANTARCTICA-AUSTRALIA
- Continent had temperate and tropical climates
- Late Cretaceous New Zealand fragmented from temperate part
- Only Leopelmatids survive in NZ
- All amphibians in Antarctica extinct
ANTARCTICA-AUSTRALIA
- Australia continue drifting and creates New Guinea
- Interchange of biotas separated for 120 my
- Hylids and Myobatrachids associate with Microhylids from Asia

MADAGASCAR-SEYCHELLES-INDIA
- Madagascar-Seychelles-India drifted 140 mya
- Only tropical groups:
  - Ranids
  - Hyperoliids
  - Rhacophoridae
  - Microhylids
  - Myobatrachids
  - Bufonids
- Madagascar drifted 100 mya
- Seychelles broke off from India 64 mya
- India collided with Asia 35 mya
- Many families moved to the east
- Families became isolated
MADAGASCAR

- Scaphiophrynidae
- Dyscophine
- Microhylidae
- Rhacophoridae
- Hiperoliidae
- Mantellidae
- Ranidae

SEYCHELLES

- Sooglossidae
- Hiperoliidae
- Microhylids
- Ranids
- Rhacophorids

INDIA

- When India collided with Asia
- Ranids disperse east and west
  - Bufonids
  - Racophorids
  - Microhylids
- Moved east

Microhylids got to Australia by New Guinea
EARLY CRETACEOUS

- Pipids
- Leptodactylidae
- Bufonids
- Microhylids
- Ranids
- Hyperolids
- Racophorids

AFRICA-SOUTH AMERICA

- Separation started 100 mya
- Land connection persisted until 90 mya
- Before separation:
  - Pipids
  - Leptodactylidae
  - Bufonids
  - Microhylids

LATE CRETACEOUS

- Pipids
- Leptodactylidae
- Bufonids
- Hylids
- Microhylids
- Hylaeophrynidae
- Bufonidae
- Ranidae
- Hyperolidae
- Racophoridae
- Brevicipitinae
AFRICA
- Pipids
- Heleophrynes
- Bufonids
- Ranids
- Hyperolids
- Racophorids
- Brevicipitines

SOUTH AMERICA
- Pipids
- Bufonids
- Leptodactylidae
- Hylids
- Microhylids

INTER-AMERICA EXCHANGE
- Late cretaceous connection between N and S America
- Some groups moved north
  - Caecilians
  - Phyllomedusine
  - Microhylidae
  - Bufonidae
  - Eleutherodactylidae
INTER-AMERICA EXCHANGE
- Others moved south in Pliocene
  - Agalychnis
  - Ranidae
  - Plethodontids

OVERVIEW
- Understand the processes that influenced amphibian dispersion
- Be able to relate families in different continents (ecological equivalents), why they live where they live
- Understand basic geological events that created amphibian distributions

QUESTIONS
- Why there are no Centrolenids in North America or Ranids in the southern tip of South America?
- Why there is only one family of salamanders in the southern hemisphere?
- Why is the level of endemism so high in Madagascar?
- How you explain the presence of Hydromantes in Europe and of Cryptobranchus in North America?