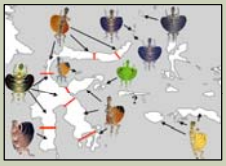
BIOGEOGRAPHY AND THE DISTRIBUTION OF AMPHIBIANS

WFS 433/533
1/29/2013

BIOGEOGRAPHY

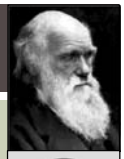
- What is it?
- Why is it important?
- What can it tell us about species distributions?



BASIC PRINCIPLES

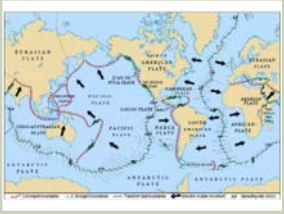
- Can be used to gain a broad perspective on species distributions
- Operates at many different scales; governs types of questions
- Not a science from one source
  - Geography
  - Paleontology
  - Phylogenetics
  - Ecology

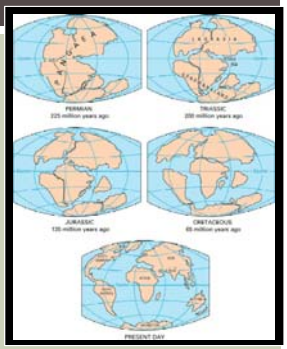
EARLY OBSERVATIONS



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

PLATE TECHTONICS AND CONTINENTAL DRIFT

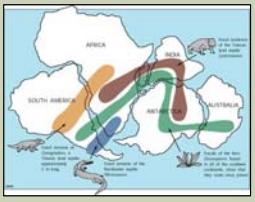




http://www.jochemnet.de/fiu/OCB3043_30.html

EARLY OBSERVATIONS

What can the fossil record tell us???



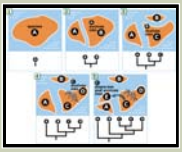
Mesosaurus

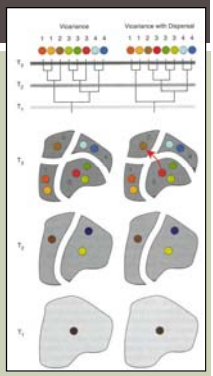
Glossopteris

Lystrosaurus

HISTORICAL SPECIES DISTRIBUTIONS

- Dispersal
  - Center of origin
  - Disperse from center across barrier
- Vicariance
  - Geological events create barriers
  - Biota diverge subsequent to isolation





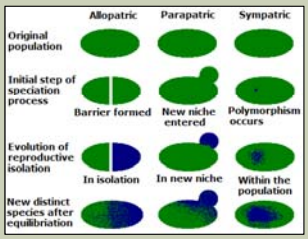
SPECIES DISTRIBUTIONS

- 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

Hyla cinerea

Plethodon nettingi

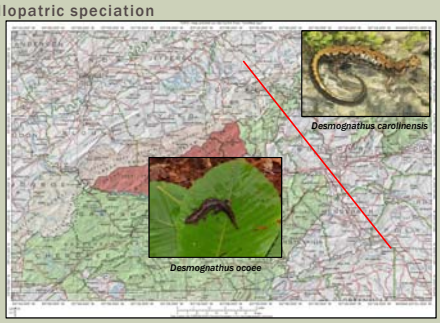
SPECIATION PROCESSES



- Multiple processes
- Allopatric best known
- Parapatric and sympatric rare

SPECIATION PROCESSES

- Allopatric speciation



SPECIATION PROCESSES

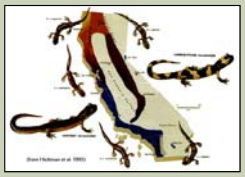
- Sympatric speciation (polyploidy)

Hyla chrysoscelis

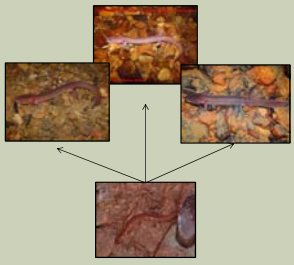
Hyla versicolor

SPECIATION PROCESSES

- Parapatric speciation



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

Bufo americanus

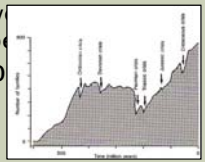
Plethodon teyahalee

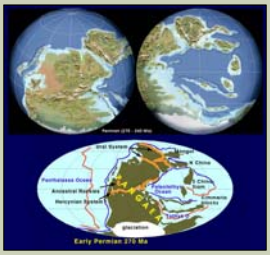
AMPHIBIAN DISTRIBUTIONS

- 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
- Ov
  sp
- 70





FIRST FROG

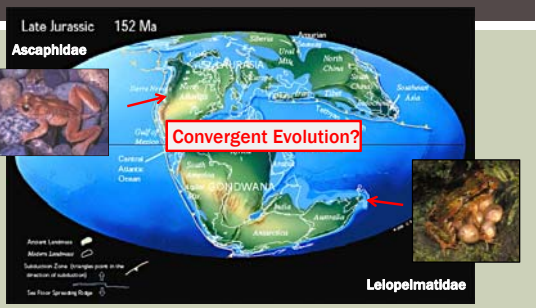
- Triassic (Triadobathrachus)
- Madagascar
- Jurassic (Vieraella)
- Argentina

JURASSIC

- Diverse anuran fossils in Europe and South America
- Frogs became wide spread

Labyrinthodont

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

Jurassic
Paleocene

PIPIDS

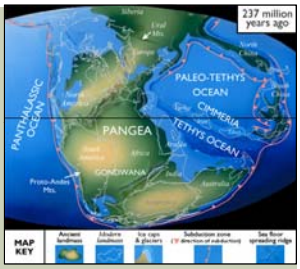
- Discoglossidae
- Mid temperate Laurasia
- Pipoids
  - Paleobatrachus
  - Rhynophrynids
  - Pipids

Current

LAURASIA

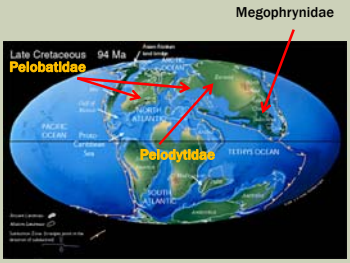
- Discoglossidae
- Mid temperate Laurasia
- Pipoids
  - Paleobatrachus
  - Rhynophrynids
  - Pipids
- Paleobatrachus and pipids divided
- Americas still together

- Pipids divided with Africa



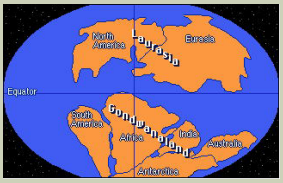
LAURASIA

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



LAURASIA

- Discoglossidae
- Paleobatrachus
- Rhynophrynids
- Pipids
- Pelodytidae
- Megophrynidae
- Pelobatidae



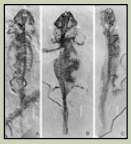
LAURASIA

- Salamanders
- First fossils from middle Jurassic (Europe)
  - Sirenoidea
  - Salamandroidea

Late Cretaceous

  - Cryptobranchoidea

Paleocene



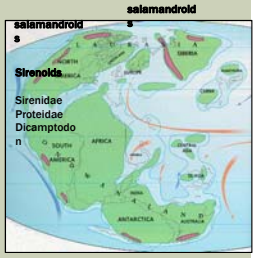
Albanerpeton

SALAMANDERS

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

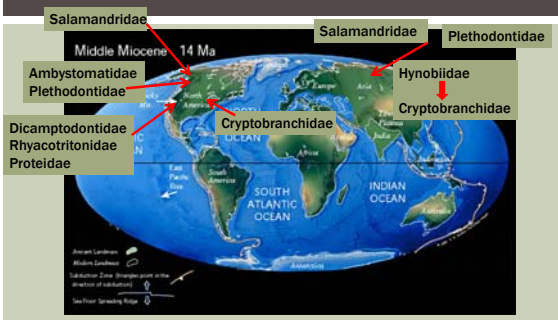
SALAMANDERS

Euroamerica drifts apart



Euroamerica divided

MIOCENE

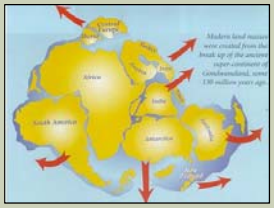


PLETHODONTIDAE

- 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

Leiopelmatidae

Hylidae

Myobatrachidae

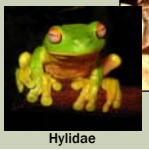
ANTARCTICA-AUSTRALIA

- Continent had temperate and tropical climates
- Late Cretaceous New Zealand fragmented from temperate part
- Only Leiopelmatids survive in NZ
- All amphibians in Antarctica extinct

Temperate

Leiopelmatids

Tropical



Myobatrachidae

Hylidae

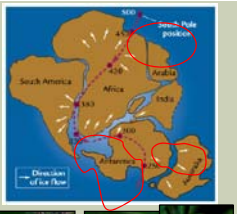
ANTARCTICA-AUSTRALIA

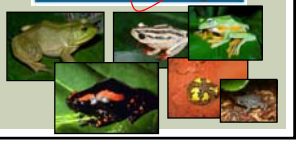
- Australia continue drifting and creates New Guinea
- Interchange of biotas separated for 120 my
- Hylids and Myobatrachids associate with Microhylids from Asia

Nyctimystes

MADAGASCAR-SEYCHELLES-INDIA

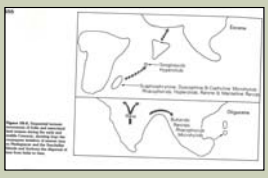
- Madagascar-Seychelles-India drifted 140 mya
- Only tropical groups
  - Ranids
  - Hyperoliids
  - Rhacophoridae
  - Microhylids
  - Myobatrachids
  - Bufonids ?





MADAGASCAR-SEYCHELLES

- 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

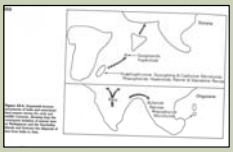
- Sooglossidae
- Hiperoliidae
- Microhylids
- Ranids
- Rhacophorids

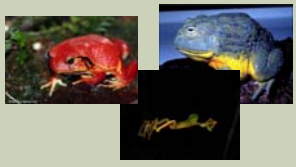
? Extinct

INDIA

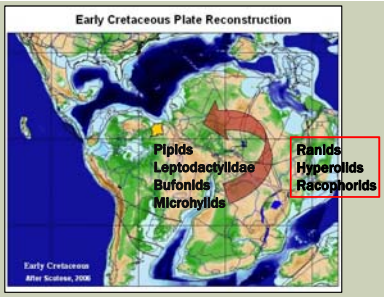
- When India collided with Asia
- Ranids disperse east and west
  - Bufonids
  - Racophorids
  - Microhylids
- Moved east

Microhylids got to Australia by New Guinea





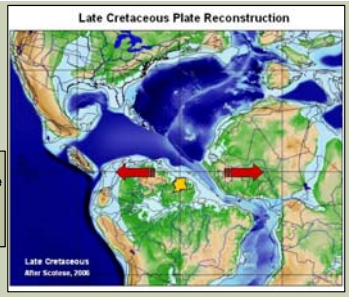
EARLY CRETACEOUS



AFRICA-SOUTH AMERICA

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

LATE CRETACEOUS



Pipids
Leptodactylidae
Bufonids
Hylids
Microhylids

Pipids
Heleophrynes
Bufonids
Ranids
Hyperoliids
Racophorids
Brevicipitines

AFRICA

- Pipids
- Heleophrynes
- Bufonids
- Ranids
- Hyperolids
- Racophorids
- Brevicipitines

SOUTH AMERICA

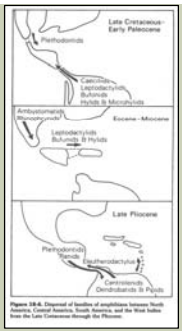
- Pipids
- Bufonids
- Leptodactylidae
- Hylids
- Microhylids

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 ?