ORIGINS AND EVOLUTION OF BIRDS

GEOLOGICAL TIME - MESOZOIC ERA

- Mesozoic Era began 245 million years ago and lasted 180 million yrs
- This was the AGE of REPTILES
- Includes the Triassic, Jurassic and Cretaceous periods
- The Jurassic Period is divided into Early, Middle, and Late
- The Cretaceous Period is divided into Early and Late

GEOLOGIC TIME - CENOZOIC ERA

- The CENOZOIC ERA is the current Era and began 65 million years
- Divided into two periods; The TERTIARY PERIOD and the QUATERNARY PERIOD
- The TERTIARY PERIOD is further divided into 5 EPOCHS:
  - PALEOCENE, EOCENE, OLIGOCENE, MIOCENE, PLIOCENE

Avian Evolution

Reptilian Features of Birds

1) The skulls of both reptiles and birds articulate with the first neck vertebra – the OCCIPITAL CONDYLE
2) Reptiles and birds have a simple inner ear with only one ear bone – the STAPES
3) The lower jaw of reptiles and birds is composed of 5-6 bones on either side
4) The ankles of both birds and reptiles are sited in the tarsal bones
5) The scales on the legs of birds are similar to reptile scales
6) Both birds and reptiles lay yolked eggs
7) Female birds and many female reptiles are the heterogametic sex
8) Birds and reptiles have nucleated blood cells
1) The skulls of both reptiles and birds articulate with the first neck vertebra – the OCCIPITAL CONDYLE.

2) Reptiles and birds have a simple inner ear with only one ear bone – the STAPES.

3) The lower jaw of reptiles and birds are composed of 5-6 bones on either side.

6) Both birds and reptiles lay yolked eggs.

7) Birds and reptiles have nucleated blood cells.

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**REPTILIAN ANCESTRY of BIRDS**

- Paleontologists do not debate that reptiles are the ancestors of birds
- Thomas Huxley (1867) called them “merely glorified reptiles”
- The debate is centered around which reptiles gave rise to birds and how did the transformation from reptiles to birds proceed?
- This debate has recently seen substantial resolution
Archaeopteryx lithographica

• First evidence was a single feather found in a Bavarian quarry, 1861. A few months later a complete skeleton was found.

• Another, remarkable skeleton was found in 1877 and named Archaeopteryx lithographica.

ARCHAEOPTERYX

• ARCHIO = ANCIENT; PTERYX = WING
• These fossils were dated to the Jurassic Period ~ 150 million years ago.

• Crow-sized, bipedal "reptile" about 200 grams
• Reptilian teeth
• Hallux (hind toe) present
• Skull resembled small dinosaurs of that period with the single condyle at base
• Had 11 pairs of ribs but unlike modern birds they were unjointed — no uncinate process
• Evidence of hollow bones

ARCHAEOPTERYX

• Feathers, remarkably similar to modern birds, covered most of the body
• Probably a strong-running terrestrial species capable of gliding or short, flapping flight but not sustained flight
• Flight capabilities supported by presence of a large furcula and asymmetrical feather vanes of the primaries. Feather vanes are symmetrical in flightless birds
• Endothermy debatable

ARCHAEOPTERYX

• The second specimen was remarkable for its clarity and is considered one of the most important natural history specimens ever found
• Archaeopteryx was an intermediate link between two major vertebrate groups and therefore, a stunning transitional species
• Archaeopteryx quickly moved to the center of debate between creationists and evolutionists.
ARCHAEOPTERYX

• **Thus, ARCHAEOPTERYX** is considered one of the best examples of organic evolution and became a major contributor to the acceptance of Darwinian evolution.

• When was the “ORIGIN OF SPECIES” published?
  • 1859

Avian Origins - REPTILES

• **ARCHAEOPTERYX** has left little doubt that birds evolved from some line of Mesozoic reptiles, but which line?

• There are two general theories:
  • 1) Birds evolved from Thecodont Reptiles (reptiles with teeth in sockets)
  • 2) Birds evolved from Theropod dinosaurs

Avian Evolution – Thecodont Ancestor

Avian Evolution – Theropod Ancestor

Evidence against the 'thecodont hypothesis'

• Thecodont hypothesis basically says birds split very early in mid-Triassic from main stem of Crocodile evolution

• But — Why 90 million year fossil gap to Acrhaeopteryx?

• Currently there is no supporting fossil evidence for this hypothesis (no feathered thecodont has been found)
**THEROPOD DINOSAURS**

- Theropods evolved from Thecodonts and were a group of bi-pedal, carnivorous dinosaurs
- Theropods lived between 230 and 66 million years ago
- The Theropod hypothesis of the origin of birds is appealing because Theropods are contemporary with *Archaeopteryx* in the fossil record

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**ERA Period Epoch Million years before present**

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**Theropod Hypothesis**

- Birds arose within a group of meat-eating Cooperousaurian Theropods called the Maniraptorans
  - Includes the Dromaeosaurus or “Raptors”
  - Represented by *Deinonychus*, *Velociraptor* and *Troodon*
- The Dromaeosaurans were ground dwelling raptors that were fast and efficient hunters
THEROPOD DINOSAURS

- Theropods were small species and may have been endothermic
- Theropods had small, sharp teeth
- Some Theropods share 23 of 42 specialized skeletal features with Archaeopteryx

Recent Fossil Evidence

- In the mid to late 1990’s, a series of bird and dinosaur fossils were discovered from lake bed deposits in Liaoning Province, China
- The lake bed formation dates to the early Cretaceous (124-128 million yrs ago…Archaeopteryx was 150 mya)
- These fossils provide very strong evidence that birds arose from Theropod Dinosaurs, not Thecodonts

SINOSAUROPTERYX “DOWNY DINOS”

- Sinosauropteryx, considered the first feathered dinosaur, was discovered in China in 1997
- Sinosauropteryx was a small, chicken-sized Coelurosaur dated to the late Jurassic or early Cretaceous and was non-flying
- Small tubular and perhaps branched structures emerged from its skin and were likely very early feathers with hollow cylinders

CAUDIPTERYX

- Also discovered in China in 1997, these are the “Feathered Dinos” of the popular press
- Caudipteryx was a turkey-sized and beautifully preserved with modern pennaceous feathers on the tip of the tail and forelimbs, but still non-flying
- Some argue Caudipteryx was an early flightless bird but phylogenetic analyses place it as an Oviraptorian Theropod
In all, investigators have now found more than a dozen non-avian but feathered Theropod dinosaurs including Confuciusornis.

**CONFUCIUSORNIS**

- Dated 25 million years after Archaeopteryx
- Nearly modern flight apparatus
- No teeth in bill
- Colonial species that occurred around lakes

**FEATHERED DINOSAURS**

- **MICRORAPTOR GUI**
  - From 2001-2003, Chinese paleontologists discovered 6 specimens of a 4-winged, gliding dinosaur that might provide one of the last links of how dinosaurs evolved into birds
  - Gui, dated to the early Cretaceous (124-128 mya)
    - measured 77 centimeters long
    - Had asymmetrical feathers on both forelimbs and hind limbs
    - Had a feather-fringed tail
  - Gui could glide from tree to tree, similar to flying squirrels

Gui is of major significance because the fossil represents an intermediate form between a feathered but non-flying Theropod dinosaur and a flying bird.
End