

Origin of birds

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INTRODUCTION

- Birds are one of the most conspicuous groups of animals in the modern world. They are hugely diverse with more than 10,000 extant species distributed across the globe, filling a range of ecological niches and ranging in size from as tiny as a Humming bee to as huge as an Ostrich.
- Their feathered bodies are optimized for flight, their supercharged growth rates and metabolism stands out among living animals. The ability of many bird species to imitate vocalization makes them some of the most intelligent species on the planet.
- The ancestors of birds were bipedal, terrestrial, agile, cursorial and carnivorous or omnivorous. Apart from a perching foot and some skeletal fusions, a great many characters that are usually considered 'avian' (e.g. the furcula, the elongated forearm, the laterally flexing wrist and apparently feathers) evolved in non-avian theropods for reasons unrelated to birds or to flight
- During the late 19th and 20th centuries the question "Where did birds evolve from and where do they fit into the family tree of life?" were hotly debated.

BIRDS ANCESTOR

During the early 20th Century, a new hypothesis was suggested. In 1910, discovery of Euparkeria (a very primitive archosaur about the size of a cat). Its discover suggested it might have been a very near the ancestor of the Dinosaurs, Pterodactyls or simply ancestors of crocodiles.

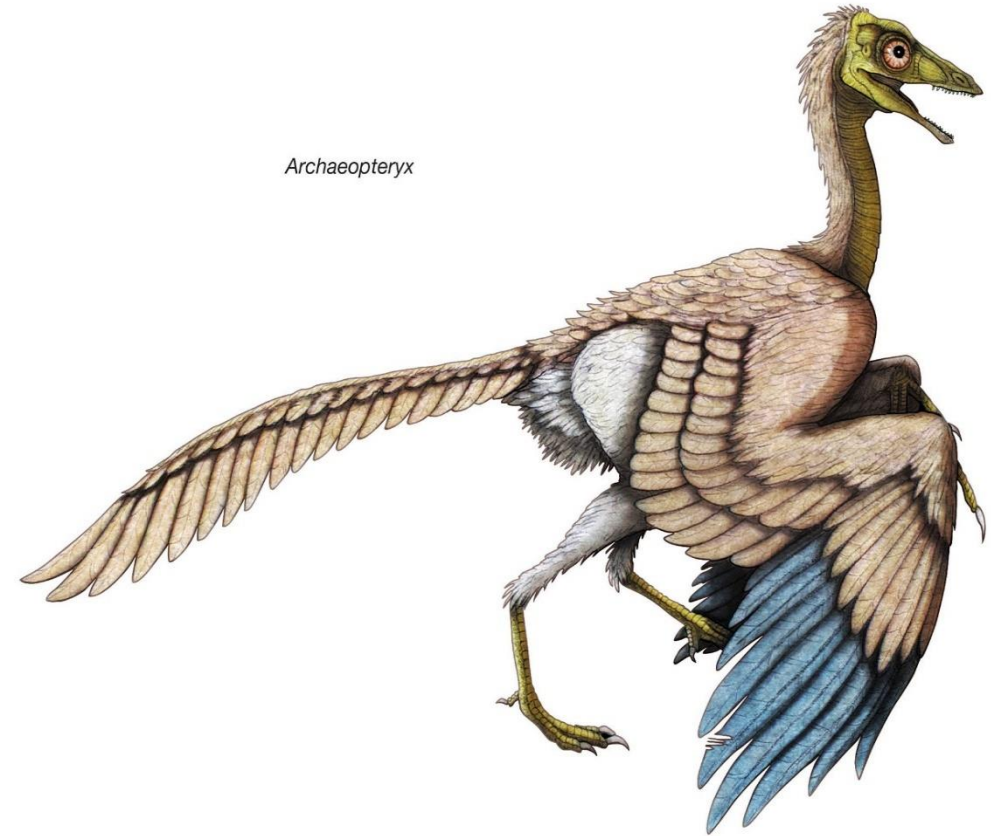
This idea was amplified by artist and natural historian Gerhard Heilmann. Heilmann examined lots of Mesozoic archosaurs. He considered coelurosaurian dinosaurs to have the most shared features with birds, but thought that they didn't have furculae or clavicles (and therefore didn't have anything that could evolve into bird clavicles).

He settled instead on Euparkeria, suggesting that it was sufficiently primitive to be a bird ancestor. His book "The Origin of Birds" published in 1927 in English (earlier Dutch version not as influential). Became the main hypothesis by far from the 1920s until the 1970s/1980s.



THE EARLIEST KNOWN BIRD

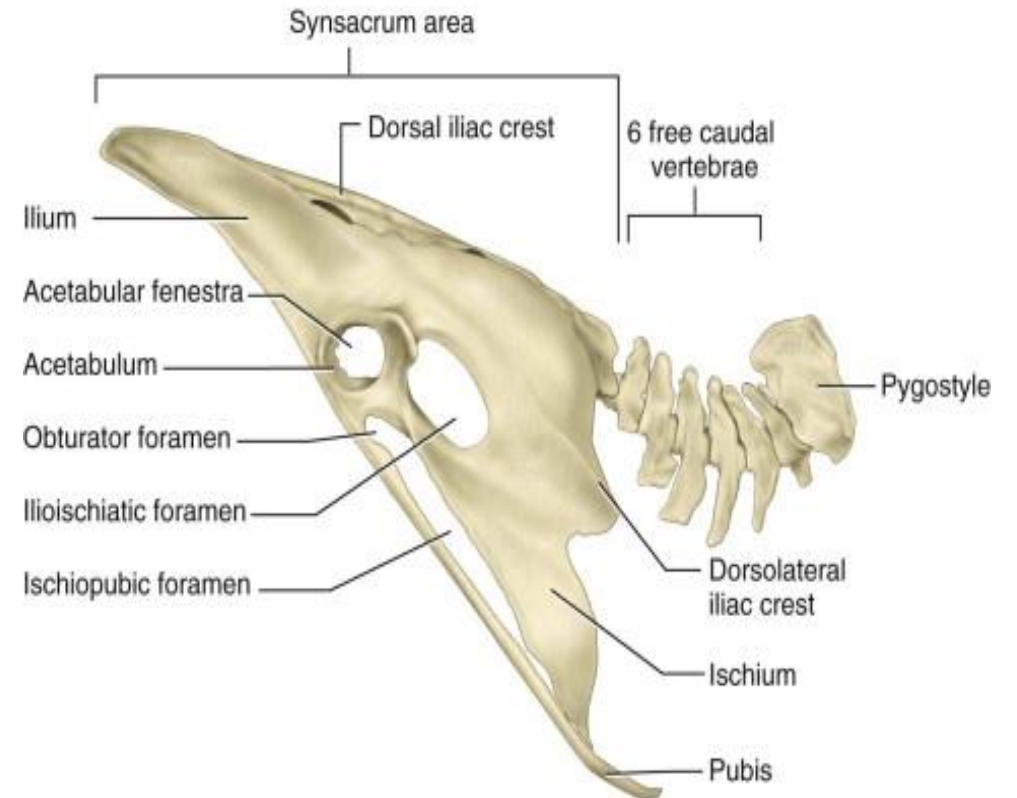
- The first hint that birds evolved from reptiles appeared in 1861 in Charles Darwin book "Origin of Species" along with the discovery of the fossil record of a bird found in the rocks of the Jurassic period in Germany. The bird had some of the most peculiar features and was named *Archaeopteryx* by Richard Owen, a British anatomist.
- *Archaeopteryx* is about the size of a crow and in certain respects was quite like a reptile.
- Like birds, it has wings with feathers, but they were small in size. It's tail quite unlike that of a modern bird was long with rows of feathers on each sides.
- Further its jaws were equipped with conical teeth and three of the digits of each forelimb persisted, armed with claws. It is probable that that the forelimbs were used for climbing as well as flying. However *Archaeopteryx* resembles more with the reptiles than the bird.
- Thus it provides a connecting link between the reptiles and birds, suggesting that birds evolved from reptiles.



Archaeopteryx

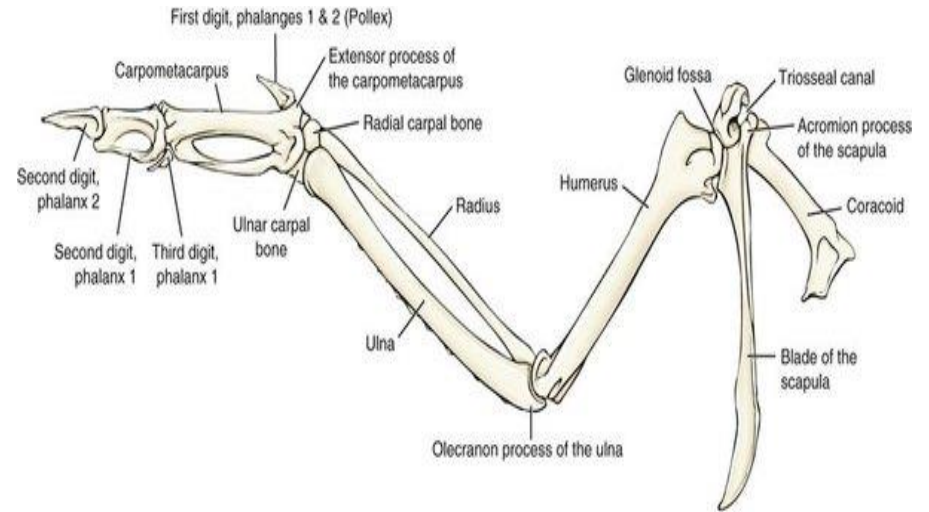
EVOLUTION OF FEATURES

- Many features that characterize modern birds evolved long after *Archaeopteryx*. These include:
- **Loss of teeth** (occurs more than once in bird history)
- **Synsacrum**: The pelvis and the synsacrum together form a rigid platform for muscles of the hindlimb and the tail and is a part of the system that helps a bird maintain a stable, streamlined posture during flight.
- **Pygostyle**: It is a flat bone created by the fusion of the final few caudal vertebrae into a single ossification. It serves as the attachment site for tail feathers as well as muscles, thus providing flight stabilization.

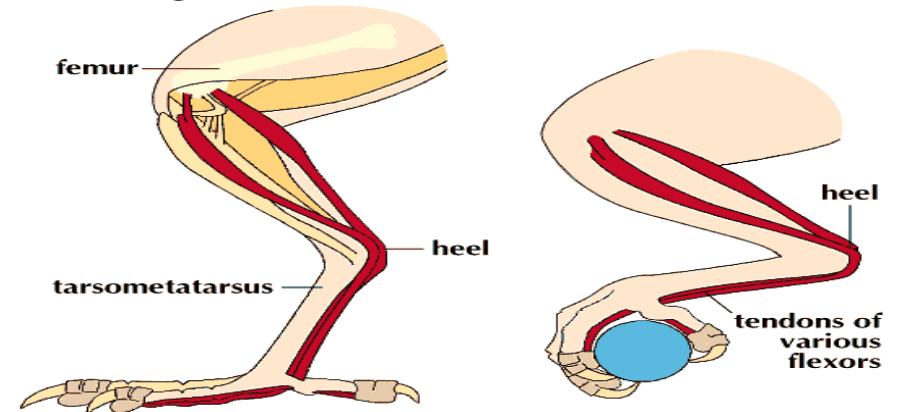


- **Carpometacarpus:** A bone of the bird wing formed by the fusion of the carpal and metacarpal bones. While gliding or maneuvering, the scapholunar interlocks with the carpometacarpus and prevents the manus from supinating.

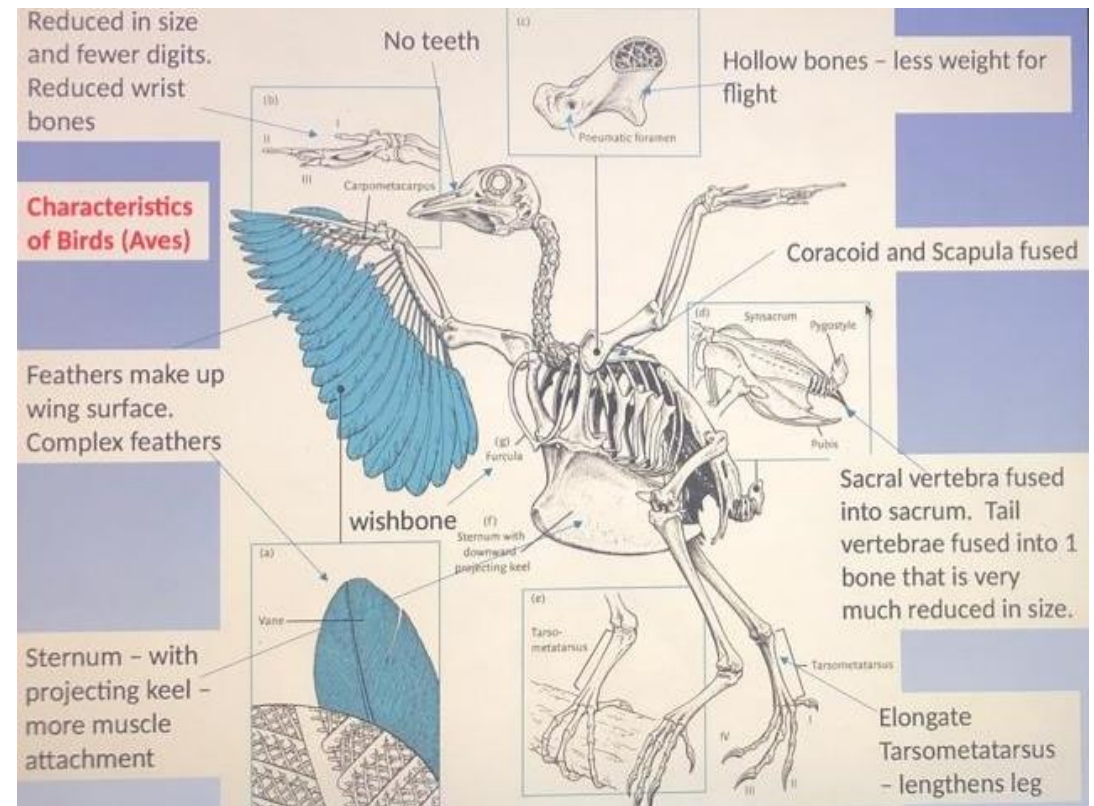
- **Tarsometatarsus:** It plays an important role in skeletal support, locomotion and hunting and even prey capture



Perching Mechanism of a Bird



- The **bipedal posture, hinge-like ankle, hollowed bones, and long S-shaped neck** of birds were inherited from deep dinosaurian ancestors.
- The **wishbone** (furcula) and three-fingered hands of birds first appeared in primitive theropods, the reversion of the pubis and associated forward movement of the center of mass occurred in maniraptoran theropods, and the ability to fold the forearm against the body evolved in paravians closely related to birds.
- Other classic avian features, such as the **keeled breastbone** to support flight muscles and highly reduced tail, evolved after the origin of birds, meaning that the earliest birds looked more like dinosaurs in lacking these features.



EVOLUTION OF BIRDS

- The evolutionary history of birds is still somewhat unclear. Due to the fragility of bird bones, they do not fossilize as well as other vertebrates. Birds are diapsids, meaning they have two fenestrations, or openings, in their skulls. Birds belong to a group of diapsids called the archosaurs, which also includes crocodiles and dinosaurs. It is commonly accepted that birds evolved from dinosaurs.
- For much of the last two centuries how birds achieve such great diversity and evolutionary success was a mystery, but over the past two decades a wealth of new fossil discoveries and molecular phylogenetic analysis of living birds, and quantitative macroevolutionary analyses have revolutionized our understanding of bird origins and evolution.
- Dinosaurs were subdivided into two groups, the **Saurischia** (“lizard like”) and the **Ornithischia** (“bird like”). Despite the names of these groups, it was not the bird-like dinosaurs that gave rise to modern birds. Rather, Saurischia diverged into two groups. One included the long-necked herbivorous dinosaurs, such as Apatosaurus. The second group, bipedal predators called theropods, includes the ancestors of modern birds. This course of evolution is suggested by similarities between theropod fossils and birds, specifically in the structure of the hip and wrist bones, as well as the presence of the wishbone, formed by the fusing of the clavicles.
- One important fossil of an animal intermediate to dinosaurs and birds is Archaeopteryx, which is from the Jurassic period and has characteristics of both dinosaurs and birds.

FLIGHT ORIGINS

- Two main theories exist: the arboreal (“tree”) hypothesis and the terrestrial or cursorial (“land”) hypothesis. The **arboreal hypothesis** posits that tree-dwelling precursors jumped from branch to branch using their feathers for gliding before becoming fully capable of flapping flight.
- In contrast to this, the **cursorial hypothesis** holds that running was the stimulus for flight, as wings could be used to improve running and then became used for flapping flight. Given a bipedal cursorial (running) ancestor of a flying lineage, flight must have proceeded from the ground into the air, assuming that the ancestor did not normally live in trees, or if there were no trees around.
- As with the question of how flight evolved, the question of how endothermy evolved in birds still is unanswered. Feathers provide insulation, but this is only beneficial if body heat is being produced internally. Similarly, internal heat production is only viable if insulation is present to retain that heat. It has been suggested that one or the other (feathers or endothermy) evolved in response to some other selective pressure.
- During the Cretaceous period, a group known as the **Enantiornithes** was the dominant bird type. Enantiornithes means “opposite birds,” which refers to the fact that certain bones of the feet are joined differently than the way the bones are joined in modern birds. These birds formed an evolutionary line separate from modern birds; they did not survive past the Cretaceous. Along with the Enantiornithes, **Ornithurae** birds (the evolutionary line that includes modern birds) were also present in the Cretaceous. After the extinction of Enantiornithes, modern birds became the dominant bird, with a large radiation occurring during the Cenozoic Era.
- Referred to as **Neornithes** (“new birds”), modern birds are now classified into two groups, the Paleognathae (“old jaw”) or ratites (a group of flightless birds including ostriches, emus, rheas, and kiwis) and the Neognathae (“new jaw”), all other birds.



- Figure: Example of an extinct bird: *Shanweiniao cooperorum* was a species of Enantiornithes, which evolved separately from modern birds. It did not survive past the Cretaceous period.

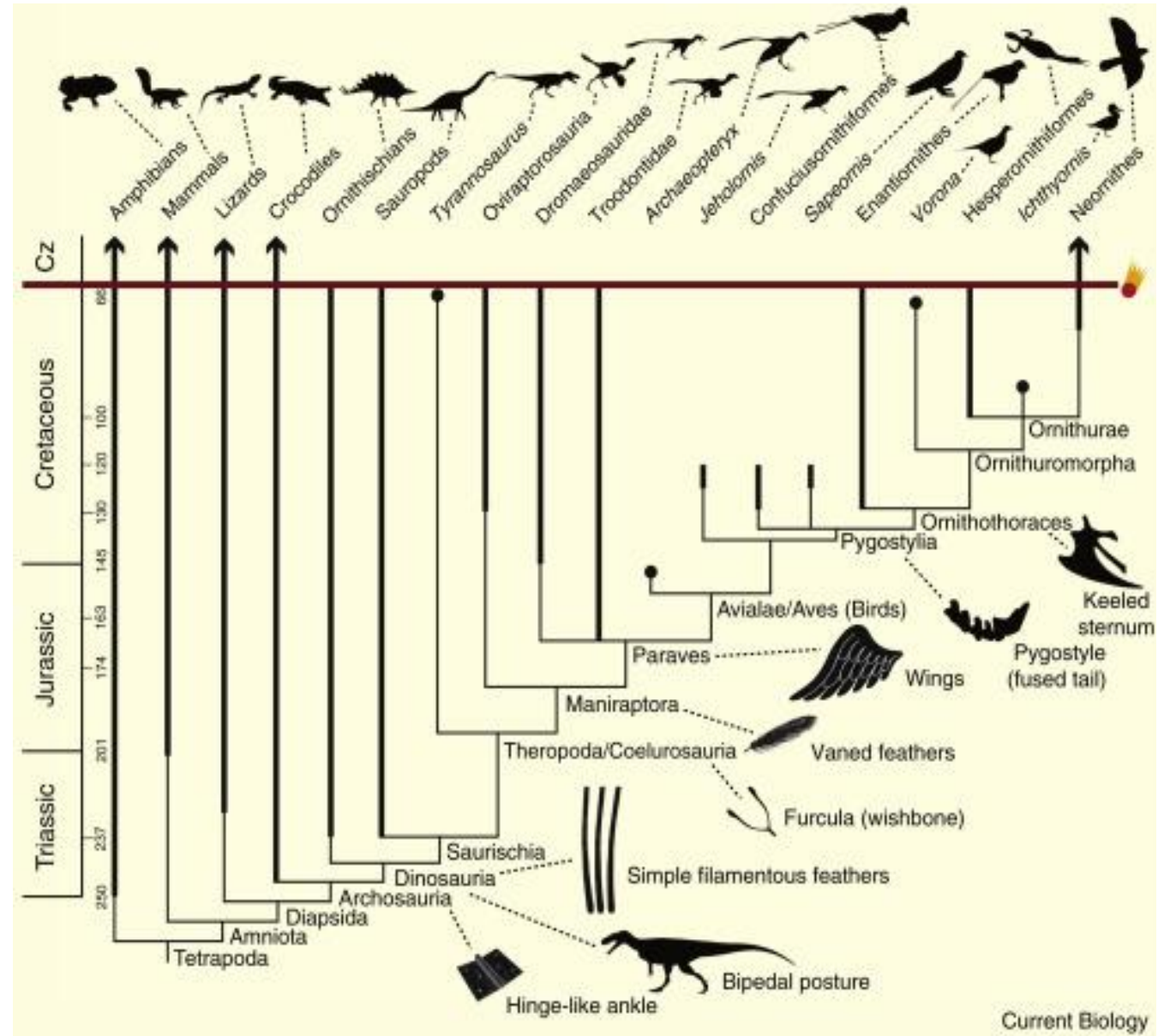
BIRDS COMMON ANCESTOR CHART

The phylogeny shows where birds fit into the larger vertebrate family tree and the relationships of the earliest birds and their closest dinosaurian relatives.

Timescale values are in millions of years; thick red line denotes the mass extinction at the Cretaceous–Paleogene boundary caused by asteroid impact (denoted by fireball on the right); arrows denote lineages that survived the extinction.

Arrows denote lineages that survived the extinction. Circles represent species known from a particular point in time.

Thick line sections of branches indicate direct fossil evidence and thin lines are temporal distributions.



WHY DID BIRDS EVOVLE

- Several Main Hypotheses:
 - (1) To help escape from predators
 - (2) To help catch flying or speedy prey
 - (3) To help move from place to place (leaping or gliding)
 - (4) To free the hindlegs for use as weapons.
 - (5) To gain access to new food sources or an unoccupied nich