



Modern Bird Diversity

Dr. Ethan Linck
Office: 305 Lewis Hall

<https://join.iclicker.com/SSVI>

Ornithology

Go to

join.iClicker.com
SSVI

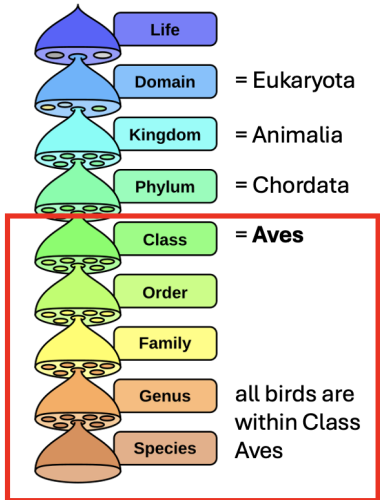


An “ology”: What is a bird?



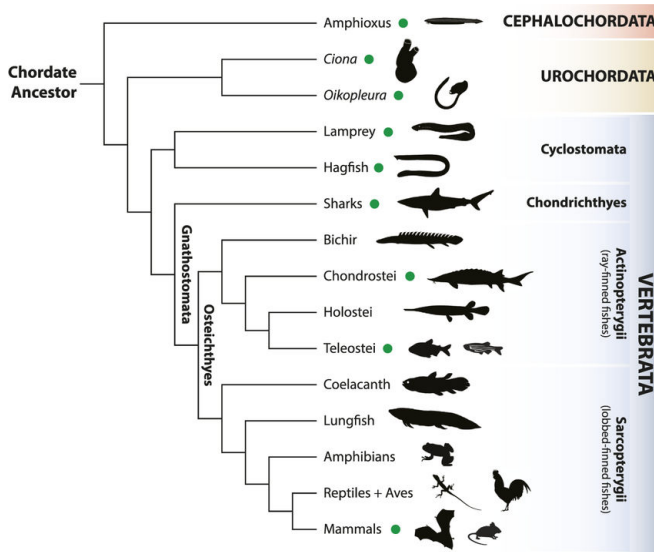
(*Rhynchotus jubatus*)

Taxonomy



(Taxonomic rank figure from Wikipedia)

Phylogenetic Position

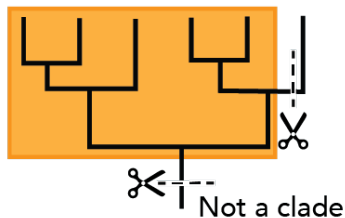
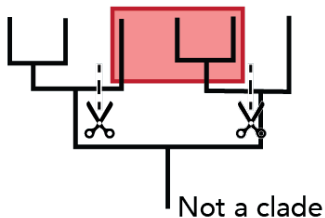
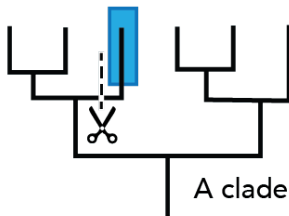
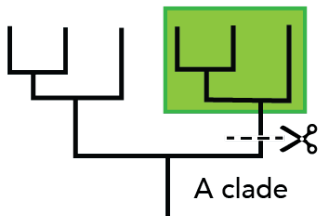


(Pascual-Anaya et al. 2022)

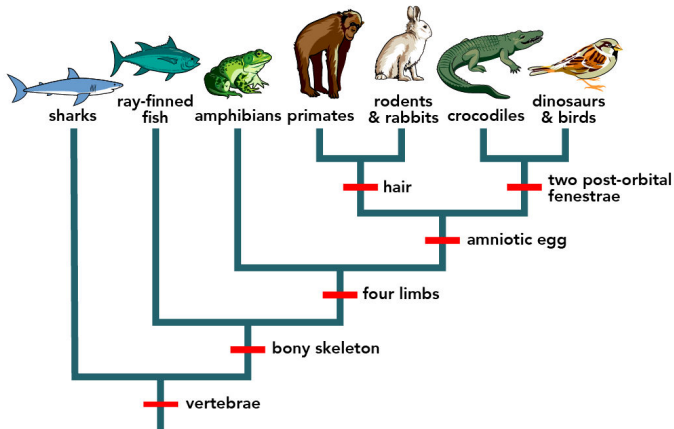
Phylogenetic Terminology

- ▶ **Taxonomy**: the study of naming and classifying things
- ▶ **Taxon**: A taxonomic unit (e.g., a species, genus, family, order, class)
- ▶ **Sister Taxa**: each other's closest relatives
- ▶ **Systematics**: the study of the evolutionary relationships of organisms
- ▶ **Phylogeny**: a hypothetical reconstruction of relationships
- ▶ [Monophyletic] **Clade**: A group of taxa that are each others' closest relatives / share a common ancestor more recently than they do with any other taxa
- ▶ **Apomorphy**: A trait that defines a clade

Phylogenetic Terminology: Clade

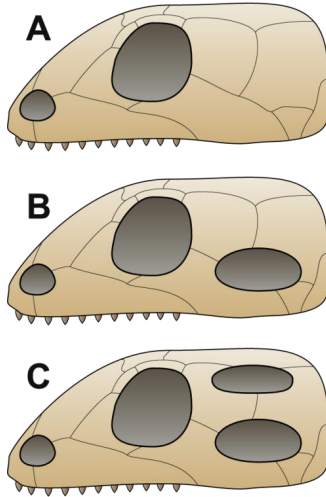


Phylogenetic Terminology: Apomorphies



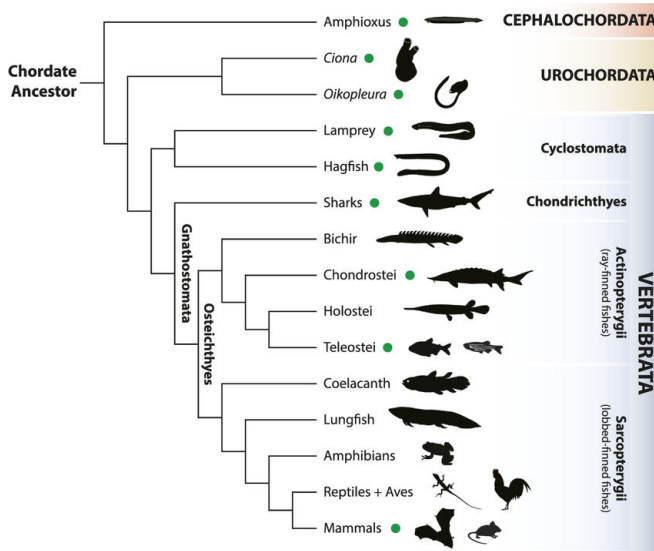
(Berkeley: Understanding Evolution)

Two post-orbital fenestrae define diapsids



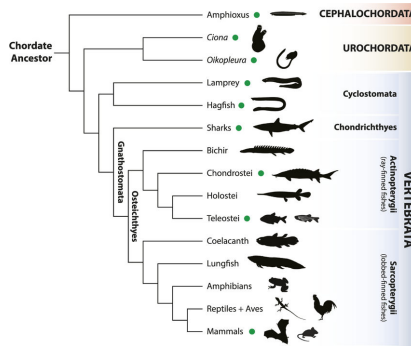
(Wikipedia)

What is the sister taxon to reptiles and birds?



(Pascual-Anaya et al. 2022)

What is the sister taxon to reptiles and birds?

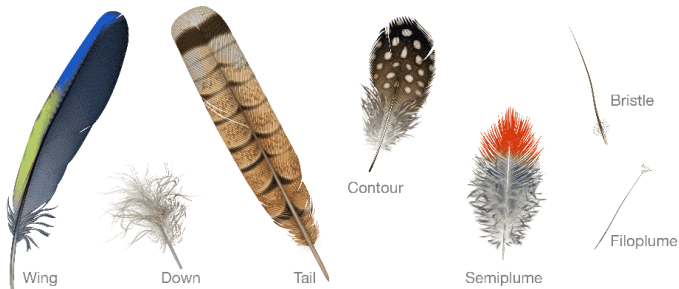


(Pascual-Anaya et al. 2022)

- a) Amphibians
- b) Mammals
- c) Lungfish
- d) Impossible to say

Avian Apomorphies: Feathers

- ▶ All birds (and some non-avian dinosaurs) have feathers
- ▶ Feathers are dead structures and are constantly replaced (through *molt*)
- ▶ Filamentous, soft, flexible, lightweight
- ▶ Diverse structure and function



(Cornell Lab of Ornithology)

Avian Apomorphies: Beak

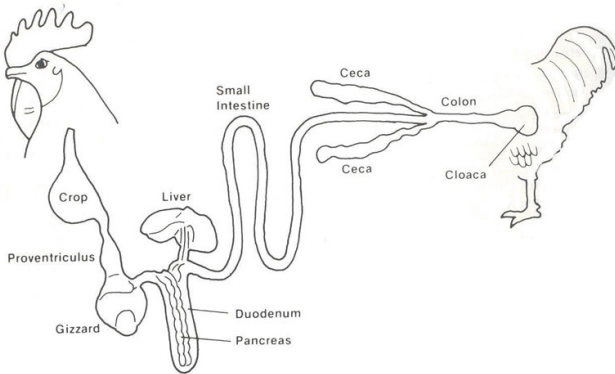
- ▶ All birds have beaks (= bills)
- ▶ Diverse in form and function, but always toothless and covered in a horny sheath
- ▶ No other bills / beaks in animal kingdom (though the platypus bill comes close)



(*Ramphastos toco*)

Avian Apomorphies: Gizzard

- ▶ Posterior portion of stomach
- ▶ Bird “chewing” organ
- ▶ Thickness, musculature, and quantity of grit / stones determined by diet.



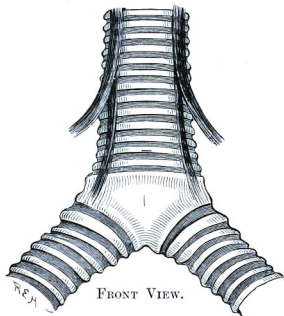
Avian Apomorphies: External Eggs

- ▶ Most complex reproductive cells of any animal
- ▶ Protected and provisioned with food
- ▶ Only vertebrate clade where no species have live young

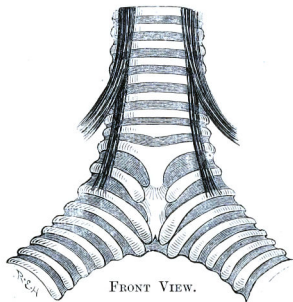


Avian Apomorphies*: Syrinx

- ▶ Vocal organ at the base of trachea
 - ▶ C.f. mammalian *larynx*: no folds
 - ▶ Sounds from vibrating membranes and cartilage
 - ▶ Can be used to mimic speech (parrots, crows, and mynas)
- * absent in New World Vultures



FRONT VIEW.
SYRINX OF *Aceros nipalensis*.



FRONT VIEW.
SYRINX OF *Bucorvus abyssinicus*.

(AFTER BEDDARD.)

Avian Apomorphies*: Lightweight Bones

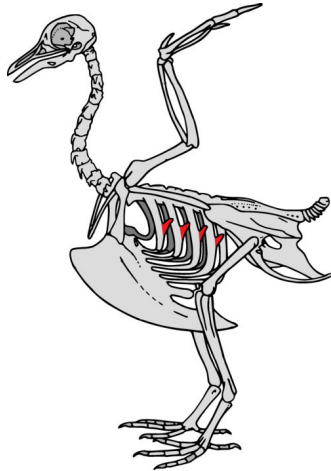
- ▶ Lightweight, strong, bones
- ▶ Mostly hollow (air-filled spaces = “pneumatized”)
 - * divers like loons in particular have denser bones



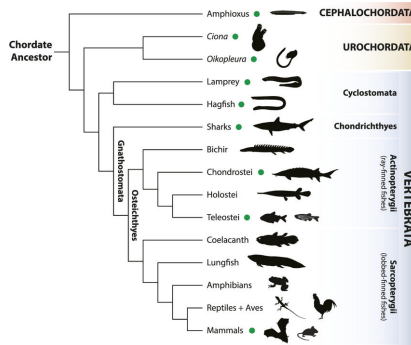
National Audubon Society Bird Guide Training Curriculum

Skeletal Structures: Uncinate Processes

- ▶ Horizontal, backwards bone projections from ribs
- ▶ Reinforce rib cage and provide attachment point for muscles



Which of the following is an apomorphy shared by birds, mammals, reptiles, and amphibians?

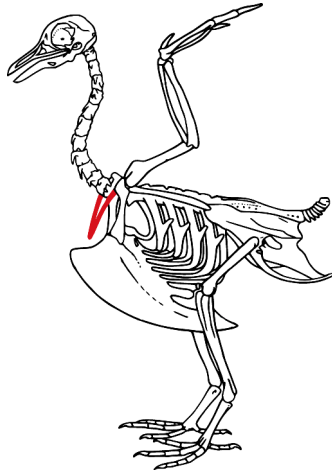


(Pascual-Anaya et al. 2022)

- a) Endothermy
- b) Four limbs with digits
- c) Feathers
- d) Hair
- e) Eggs with hard calcium-carbonate shells

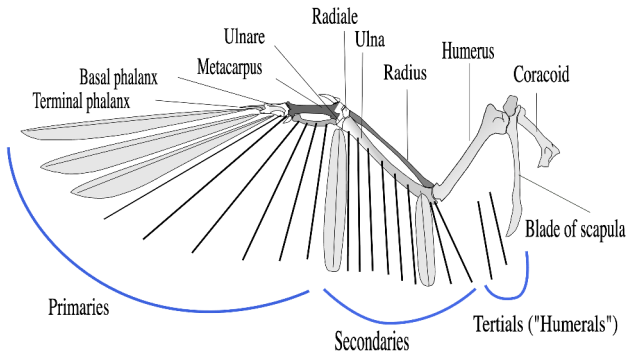
Skeletal Structures: Furcula

- ▶ a.k.a. Wishbone
- ▶ Compresses and rebounds like a spring in flight



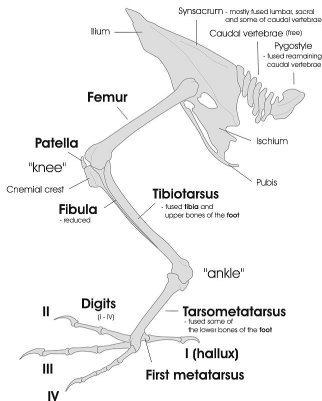
Skeletal Structures: Wings

- ▶ Modified forelimbs
- ▶ Carpometacarpus / metacarpus is a set of fused hand bones that support the primary flight feathers



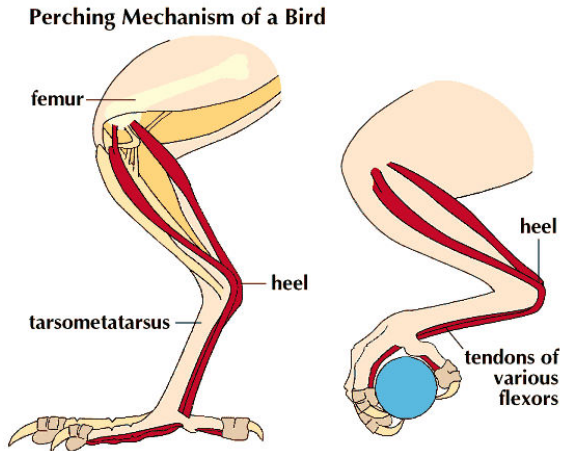
Skeletal Structures: Specialized Legs

- ▶ Birds are mostly digigrade (toe-walkers)
- ▶ Fused leg bones: tibiotarsus (below femur) and tarsometatarsus; equal length in long-legged birds for balance
- ▶ Opposable rear toe called hallux unique in vertebrates



Skeletal Structures: Perching Mechanism

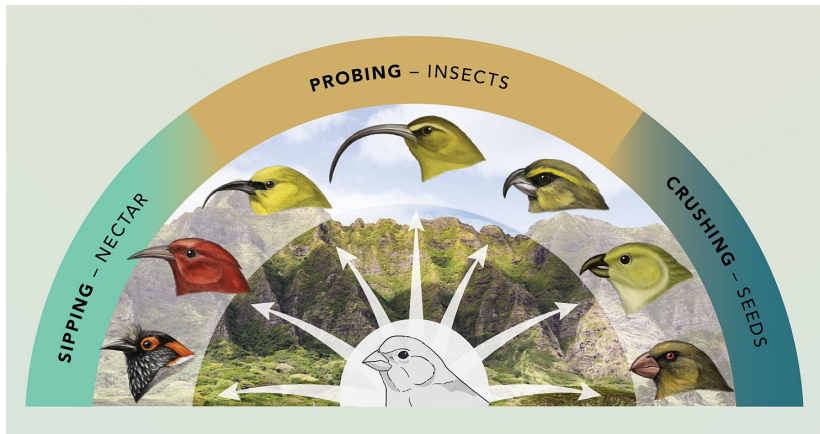
- Tendons lock toes around perch



[*Encyclopedia Britannica*]

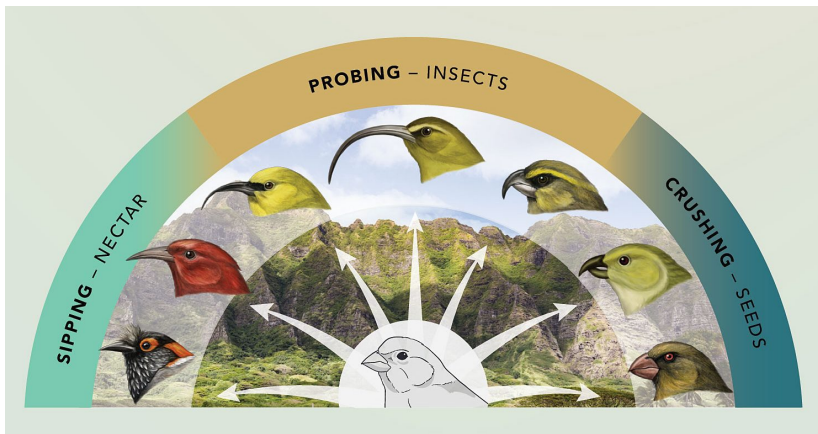
Adaptation

- ▶ An adaptation is a phenotypic trait that increases fitness (survival and reproduction) in a specific environment
- ▶ Adaptation is also a process of evolutionary change in a population that results in increased fitness



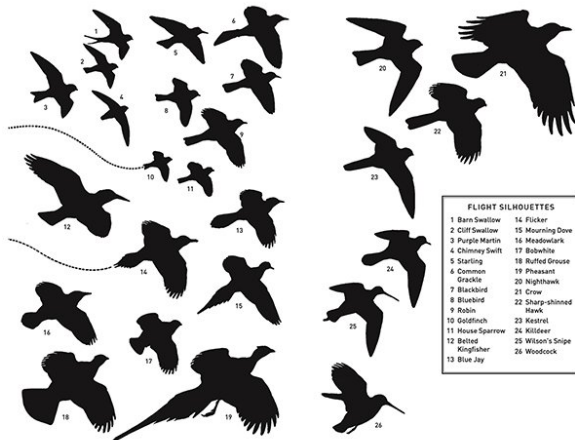
Birds can be considered an adaptive radiation

- ▶ Adaptive Radiation: An evolutionary process where an ancestral species rapidly diversifies into multiple new species specializing on diverse resources; also refers to the taxa resulting from this process



Adaptive Radiation: Body Types

- ▶ Diverse body types evolved in response to selection
- ▶ Important identification clue



(Peterson Field Guide to Birds)

Adaptive Radiation: Diet



Ensifera ensifera, *Sarcoramphus papa*, *Psittirichas fulgidus*, *Harpia harpyja*, *Rynchops minor*, *Myiagra cyanoleuca*

Adaptive Radiation: Diet



nectar



carrion



fruit



meat



fish



insects

Ensifera ensifera, *Sarcoramphus papa*, *Psittirichas fulgidus*, *Harpia harpyja*, *Rynchops minor*, *Myiagra cyanoleuca*

Why are there so few herbivorous birds?



Opisthocomus hoazin; Moa

Adaptive Radiation: Environment



Pterocles alchata, *Lagopus leucura*, *Otidiphaps nobilis*, *Jacana jacana*, *Diomedea sanfordi*, *Rhea americana*

Adaptive Radiation: Bills



Generalist



Insect catching



Chiseling



Dip netting



Aerial fishing



Pursuit fishing



Grain eating



Coniferous-seed eating



Surface skimming



Scything



Scavenging



Raptorial



Nectar feeding



Fruit eating



Probing



Filter feeding

Adaptive Radiation: Feet



(A) Duck



(B) Blue-footed Booby



(C) Coot



(D) Ostrich



(E) Pheasant



(F) Ptarmigan



(G) Heron



(H) Woodpecker



(I) Eagle



(J) Warbler

References

- ▶ Title Slide Species: *Melanodera xanthogramma*, *Emberiza aureola*, *Pterodroma feae*, *Cursorius rufus*
- ▶ Gill, F. B., Prum, R. O., & Robinson, S. K. (2019). Ornithology (4th ed.). W. H. Freeman.
- ▶ Pascual-Anaya, J., D'Aniello, S., & Bertrand, S. (2022). new approaches in chordate and vertebrate evolution and development. *Frontiers in Cell and Developmental Biology*, 10, 917101.