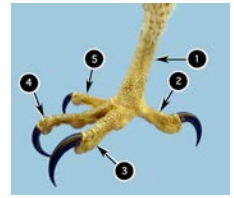
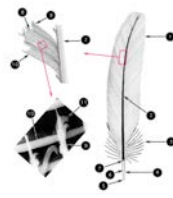
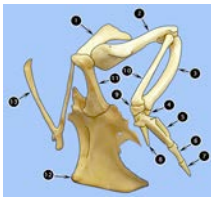
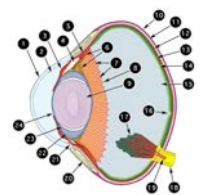
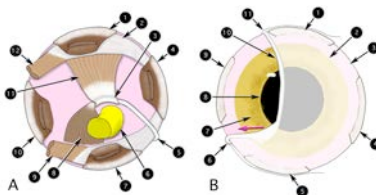
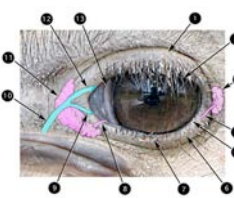
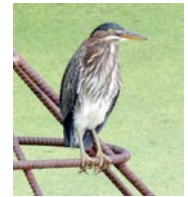
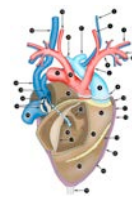
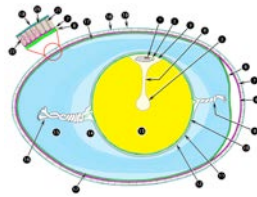
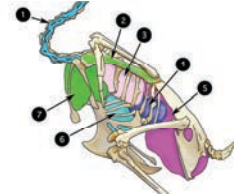
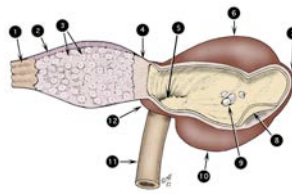


A Guided Tour of Birds and Their Anatomy



James Edgar Smallwood, DVM, MS

2021 Revision of 2015 Edition



For Some Questions Answered In This Book, See Back Cover.

A Guided Tour of Birds and Their Anatomy

2021 Revision of 2015 Edition

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Dedication

This book is dedicated to bird lovers, This book was written for *YOU*, but if others find it useful, I am delighted to be of assistance.

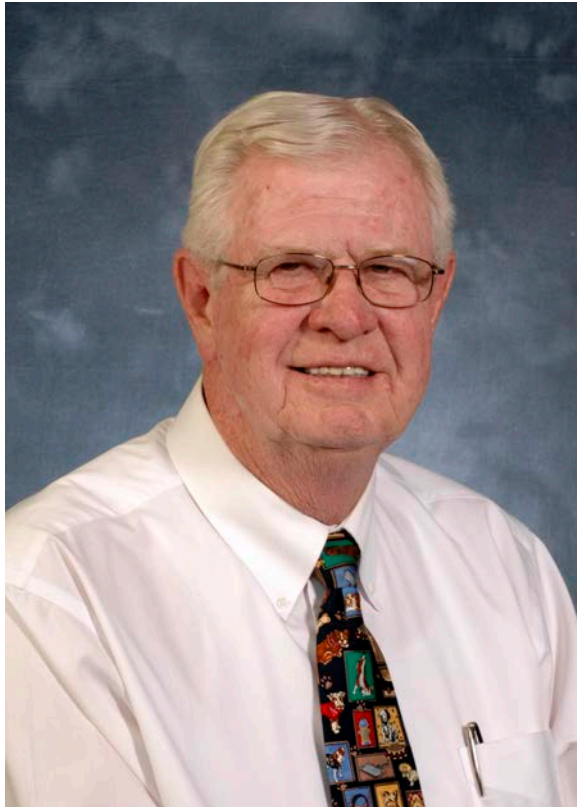
About the Author

James Edgar Smallwood was born in Dallas, Texas and grew up on a small farm near Fort Worth. He attended Burleson High School, Sam Houston State University, San Antonio College, and Texas A & M University, from which he received the DVM in 1969. Upon graduation, Dr. Smallwood was offered an instructorship in the Department of Veterinary Anatomy, which *in lieu of* finding a real job, he accepted. Thus he began teaching veterinary students in 1969. While serving as an instructor, he completed his MS degree in veterinary anatomy in 1972, at which time it became obvious he had been educated well beyond his intelligence.

In 1975, Dr. Smallwood left academia and tried working for a living as an associate in a small animal practice in San Antonio. The university was gracious enough to extend a one-year leave of absence, during which time the opportunity arose for Dr. Smallwood to return to Texas A & M University in a "split appointment" in veterinary anatomy and radiology. From 1976 to 1981, he spent approximately 50% of his time teaching anatomy and 50% doing a residency in veterinary radiology.

In 1981 Dr. Smallwood was offered the unique opportunity to become one of the initial faculty members of a new veterinary college being established at North Carolina State University. He became Professor of Anatomy and began teaching the first class of that college, which graduated in 1985. In 1989 he was named Alumni Distinguished Professor of Anatomy, and continued to

harass first-year veterinary students as their "tour guide" in learning veterinary anatomy through the spring of 2013. Dr. Smallwood retired on July 1, 2013 to pursue his "bucket list" and drive his wife crazy.



James E. Smallwood, DVM, MS
1945 - ?

Dr. Smallwood has received numerous teaching awards including the Texas Veterinary Medical Association Faculty Achievement Award for Teaching, Texas A & M University Faculty Distinguished Achievement Award for Teaching, Norden Distinguished Teacher Award, North Carolina State University Outstanding Teacher Award, NCSU Alumni Distinguished Professor Award, UNC System Board of Governors' Award for Excellence in Teaching, and Second Place Winner of the Student AVMA National Teaching Excellence Awards in Basic Sciences. He has served as President of the American Association of Veterinary Anatomists (1988-89) and the World

Association of Veterinary Anatomists (1995-99). In 2002, Dr. Smallwood received the Distinguished Veterinarian Award from the North Carolina Veterinary Medical Association. In 2014, he was honored by Texas A&M University with an Outstanding Alumnus Award from the College of Veterinary Medicine

About the Book

A Guided Tour of Birds and Their Anatomy emerged from my photographing birds in our neighborhood. As I began to do some research on each species I had photographed, I had a collection of some 38 files, which I shared with some of my friends.

But then, as I looked at more and more “bird books,” I discovered a **lack of much information on bird anatomy**, and some anatomy references I did find, turned out to be inaccurate. Although I am not (by any stretch of the imagination), an ornithologist, **I am an anatomist**. Thus, I decided to include information on the anatomy of birds, and it turned out to occupy a significant part of the book. There are hundreds of “bird books,” but one of the things that sets this book apart is its **emphasis on anatomy**.

Acknowledgements

The author is greatly appreciative of the dedicated efforts of Ms. Monica Wilson of Millennium Print Group. Without her perseverance and patience, this book would never have been completed.

My lovely and exciting wife, Kay, has helped in many ways with the production of this book. Special thanks to Dr. Martje Fentener van Vlissingen for providing many of the original line drawings that I have modified to be included in this book. Mr. William A. Wise has kindly provided me with many of the photographs of skeletal

material and bird feet that are included in the book.

I am also greatly indebted to the many photographers and authors who have contributed their works to the Wikipedia Website. I have learned so much from you, and have borrowed so much from your work to put this book together.

2015 (“First”) Edition

Prior to this book, all of my previous books had been directed to a “captive audience, namely veterinary students. **This is my first attempt to direct a book to a more “general public.”** As with any “first” edition, there are undoubtedly many, yet-to-be-discovered, errors in this edition. With your help, we shall attempt to remove these as soon as they are identified. *Comments and suggestions relative to the improvement of this book are always welcomed and appreciated.* Just send your comments to me via e-mail at:

edandkay.smallwood@gmail.com

Thank you,



Raleigh, North Carolina

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Wood Sculpture of Belted Kingfisher
James Edgar Smallwood, August 2013

Chapter 1: Introduction to the Exciting World of Birds

Birds are remarkable creatures, capable of doing things none of us could even imagine doing. First of all, most birds can fly (without assistance from an airline). Not only do they fly, they can migrate thousands of miles, with little time to stop for refueling. For an example of **extreme athleticism**, our little ruby-throated hummingbird that we enjoy watching during the summer may travel as far south as western Panama for the winter. In making the trip back to south Florida, they fly 1000 miles, most of it non-stop (**20+ hours**) **across the Gulf of Mexico**. Looks like they would at least stop in Cuba for a nap. Trust me, birds are remarkable in what they can do.

Not only are they supreme athletes, **birds are some of the most beautiful creatures on earth**. Admittedly, some are well camouflaged and blend into their surroundings, but others are spectacular in their coloration (Fig. 1-1).



Figure 1-1. Eastern Bluebirds¹ at the mealworm plate. This photo was made in Raleigh, NC on March 1, 2015.

In 1997, due to some curricular changes

¹ My personal opinion is that the Eastern Bluebird should be the State Bird of North Carolina. The Cardinal is a beautiful bird, but the Eastern Bluebird is spectacular. No one asked for my opinion.

at the NC State College of Veterinary Medicine, **I reluctantly took on the responsibility of teaching bird anatomy**—only because I couldn’t get anyone else to do it. Well, that reluctant, born-from-necessity task, has led me to fall in love with birds. Now that I am retired, I get to spend much of my time photographing and constantly learning more about birds.

Before we go any further, I want to make it clear that **I do not even pretend to be any kind of “bird expert.”** I’ve never even taken an ornithology course, and my training as a veterinarian did not include all that much about birds. But, I am a “lifelong learner,” and at age 69, I still try to learn something new and useful everyday. **I hope the day I stop learning is the same day I stop breathing.**

There must be almost as many “bird books” out there as there are cookbooks. So what sets this little book apart from most other bird books is that **it is written from the perspective of a veterinary anatomist**. And as an anatomist, I couldn’t help but to include information on the anatomy of birds. I tried to soften it as much as possible, and hopefully I didn’t over-do the anatomy part.

Living in NC, we are fortunate to have a plethora of bird species, so I just started recording all the species I come across, either from my back porch, or walking around the neighborhood with my camera. **I was surprised at the number of species, just in our neighborhood.** Therefore, I began to make little one-page files on each species. **Leaning heavily on Wikipedia** (and other references), I have tried to include some interesting facts about each bird in this book. You’ll have to be the judge

of how successful I have been in that effort.

Also, I travel twice a year to the beautiful island nation of **Grenada**, where I teach avian anatomy to veterinary students at St. George's University. I never leave my camera behind, so I have been able to include some of the birds I have photographed in Grenada ($\approx 12.4^\circ$ North of Equator).

Because of the great diversity among bird (avian) species, it should be intuitively obvious that the material contained in this little book is merely **a basic introduction to the exciting world of birds**. Birds represent such a diverse group that almost any statement about birds should be construed as a "**general rule**."² Undoubtedly, there is some bird out there somewhere that didn't get the memo when this or that "bird rule" was enacted, and thus represents an exception to any basic bird type.

Birds represent a highly diverse group of animals, with more than 10,000 recognized species as compared with less than 5000 known species of mammals. Birds can be found in almost every known habitat—from the arctic to the desert and from the tropics to the open sea. If I had to use one word to describe why birds have been so successful as a group, I would have to say **adaptability**. **They can adapt to just about any environment, and figure out a way, not only to survive, but in most cases to thrive.**

Before we get too carried away with focusing our attention on the relatively few species of birds covered in this book, let's step back a moment and take a **broader look** at how those species relate to one another and how they fit into the larger

scheme of birds on the planet. **Figure 1-2** shows how the **Class Aves** can be divided into its various subclasses and orders.

Since the eighteenth century, humans have made numerous attempts to classify birds correctly, and it is unlikely that ornithologists will ever completely agree on the taxonomy. **Figure 1-2 is just my attempt to put birds in some reasonable order.** One thing to keep in mind about the taxonomy of birds is that it is **ever changing** in a way. For hundreds of years, classification was based almost entirely on **morphology** (comparative anatomy). In more recent years, with advanced **genetic tracing methods**, it has been found that some of our earlier assumptions, based strictly on morphology, are actually **WRONG**. Can you believe that?

A quick perusal of figure 1-2 reveals that modern birds are divided into two basic groups— **paleognathae** (old jaw) and **neognathae** (new jaw). What does that mean? Well, it means that **a few birds have an older type of upper jaw structure** than most modern-day birds. The best way to demonstrate what old jaw and new jaw mean is to show you a picture of the two, together (Fig. 1-3).

Binomial Nomenclature: Throughout this book, you will see me using binomial nomenclature (*Genus & species*) to describe different birds. The reason for using this nomenclature is simple— **common names for birds** (animals & plants) **can lead to a lot of confusion**. The same bird can have multiple common names, and that same bird can be called something entirely different in another part of the world or even another region. Therefore, the use of binomial nomenclature, although a bit foreign to the novice, **is much more accurate**.

² Birds are a lot like Libertarians, they don't like too many rules.



Figure 1-2. Class Aves: There are more than 10,000 recognized species of modern-day birds. **The orders shown in bold print are the only ones considered elsewhere in this book.**

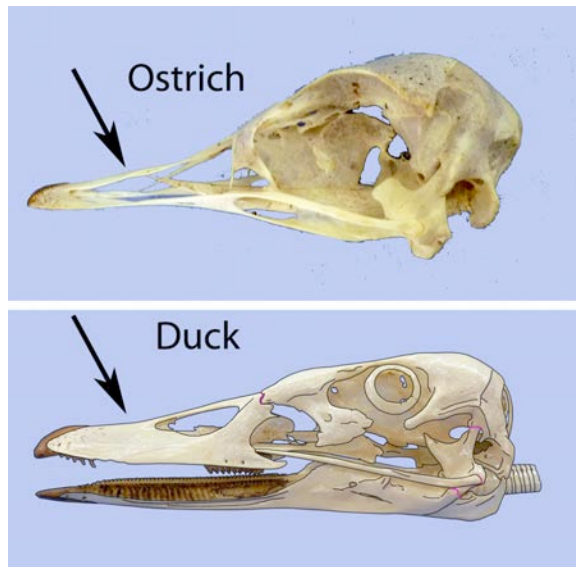


Figure 1-3. Ostrich skull (old jaw) above and duck skull (new jaw) below. Note the increased fusion (arrow) of bones in the duck vs. lack of fusion in the ostrich.

The problem with using common names was first recognized by a Swedish botanist, physician, and zoologist, named **Carl Linnaeus** (1707 – 1778), also known as Carl von Linné (Fig. 1-4). Linnaeus was the first to propose the biological naming system known as **binomial nomenclature** (two-word name).

Throughout his adult life, Carl Linnaeus published many works, mostly in Latin, including *Systema Naturae*. In 1757, at the age of 50, the Swedish king **granted Linnaeus nobility**, which was bestowed in 1761. At that time, he took the name Carl von Linné. When Linnaeus died in 1778, he was widely recognized as **one of the greatest scientist of his time**. Even today, any time you see a scientific name for an animal or plant, followed by “L.” or in older books “Linn.,” it means that the species was first named by Carl Linnaeus, **the father of modern taxonomy**.

Lastly, I want to make it clear that this little book, born from my love for birds, is anything but a comprehensive coverage of birds. It is just a **simple starting point** and was originally intended to be limited to those birds I have photographed.

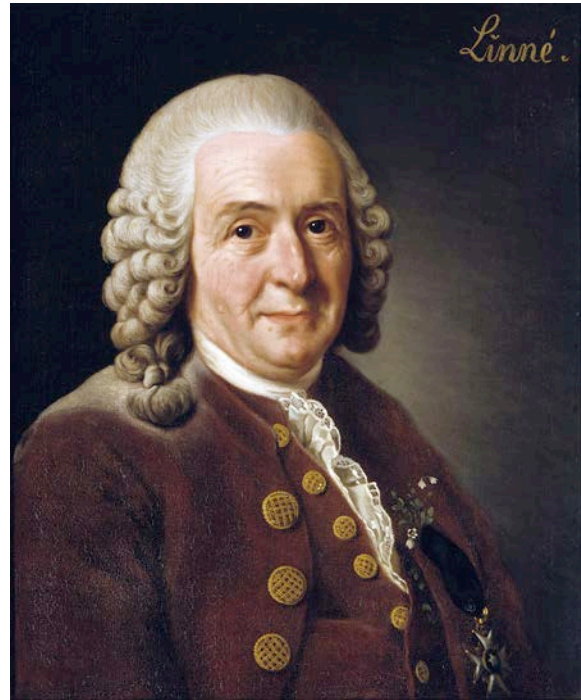


Figure 1-4. Carl von Linné. Oil painting in the portrait collection at Gripsholm Castle. (Photo courtesy of: http://upload.wikimedia.org/wikipedia/commons/6/68/Carl_von_Linn%C3%A9.jpg).

However, one thing led to another, and I ended up expanding the coverage to include more birds. If you are interested in a more comprehensive coverage, and I hope you are, I would recommend one of the references listed in the back of this book. In particular, I would refer you to: ***Complete Birds of North America***, 2nd ed., J. Alderfer, Ed., National Geographic, Washington, DC.

There are also many on-line resources, including **Wikipedia**, the free encyclopedia. I don't know what I would do without Wikipedia. You sometimes hear it said that you can't trust everything you read on Wikipedia. To which I respond—**“name me one resource that is 100% accurate.”**

Chapter 2: Terminology, Bones, Joints, and Muscles

Without getting too involved with the complex anatomy of birds, it should be useful over the next 11 chapters to give the reader some basic anatomic information because it could be helpful in understanding what we will be talking about in later chapters.¹

Directional Terms

In order to describe relationships of various parts of the bird, we should understand a few directional terms (no more difficult than north, south, east, and west). **Basic directional terms used in avian anatomy are shown in figure 2-1.**

Dorsal means toward the back or upper part of the bird; **ventral** means toward the belly or under part of the bird. **Cranial** means toward the head; **caudal** means toward the tail. On the head, **rostral** means toward the beak; **caudal** means toward the back of the head. The top of the wing is its **dorsal** surface; the bottom of the wing is its **ventral** surface. **Medial** means toward the midline of the bird; **lateral** means away from the midline. On the limbs, **proximal** means closer to the body; **distal** means further from the body. **Dorsal** also means the front side of the lower leg; **plantar** means the backside of the lower leg. Refer back to figure 2-1 if you come across a directional term later on you don't understand.

Bones & Joints (Skeletal System)

¹ If you are interested in more on the anatomy of birds, you might want to look at my book: "A Guided Tour of Avian Anatomy." This book can be ordered from: edandkay.smallwood@gmail.com

The skeletal system is divided into two major divisions. The **axial skeleton** includes the skull and vertebral column. The **appendicular skeleton** is made up of the bones of the limbs, including the pelvis.

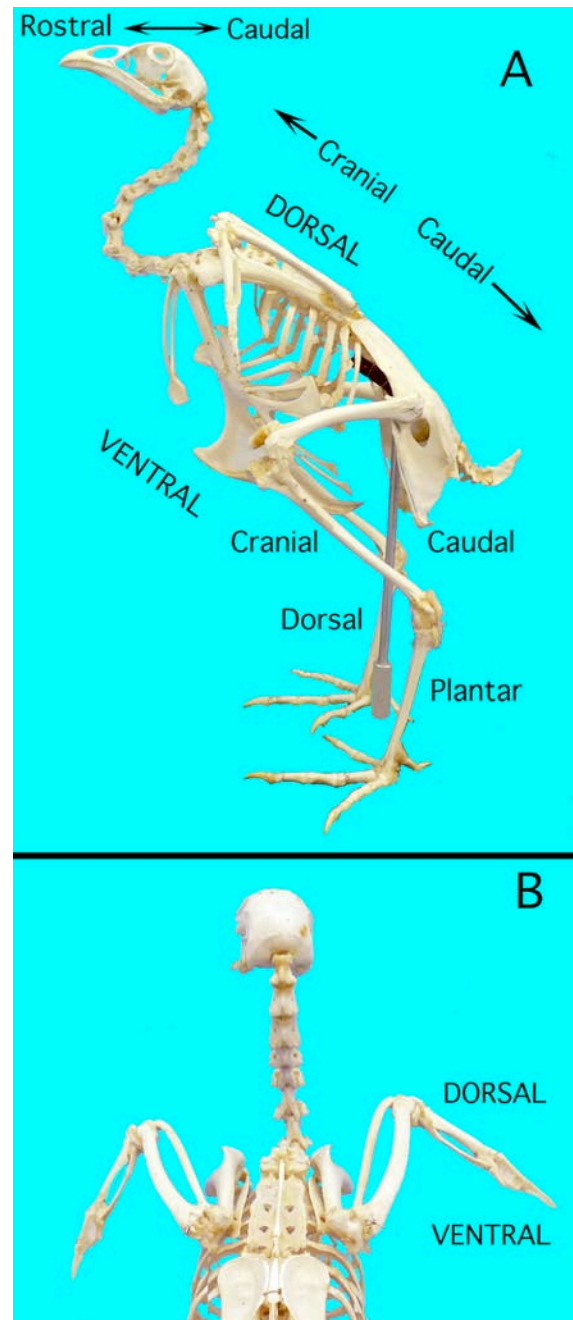


Figure 2-1. Directional terms used in avian anatomy. Chicken skeleton: (A) lateral view; (B) caudal view.

As an adaptation for flight, **the skeleton of birds has been markedly lightened, through the pneumatization² of various bones.** Mammalian bones typically contain a “wet-tissue” (fat or blood-forming cells), in the medullary (marrow) cavity of their bones. This design is fine, but it is also heavy. Most birds need to reduce their weight because, after-all, they are going to fly. When you’re trying to fly, weight is not your friend. **Pneumatization is a process where the wet bone marrow is replaced by air.** The air gets into (and out of) the bones *via* connections to what are termed **air sacs**, which in-turn are connected to the lungs. Thus, the air in the bones is air that was breathed in by the bird.

The extent of pneumatization varies with the species, and in particular with its “flightiness,” *i.e.*, greatest in marathon fliers such as the albatross, and least in the flightless ratites (ostrich, emu, kiwi, etc.). Prior to egg production, there is increased deposition of mineral in the bones of females; however, the degree of mineralization of the bones is reduced during periods of molting and egg production.

The **skull** of the bird shows remarkable variation among species, and has some unique features as well. The skull of the bird, like that of mammals consists developmentally of numerous individual bones, many of which fuse during maturation of the animal. Birds retain from their reptilian ancestry a **quadrate bone**, which rotates during opening of the mouth (Fig. 2-2).

Ever wonder how birds can open their mouth so wide? Rotation of the quadrate bone pushes forward on some other bones at

the side and base of the skull, which in-turn push up on the upper beak as the lower beak is moved downward. This mechanism obviously increases the mouth-opening ability or **gape** of the bird. The skeletal basis for the upper beak is joined to the bones of the cranium by an elastic zone known as the **craniofacial hinge** (Fig. 2-2). This movement, **craniokinesis**, is well developed in parrots (psittacines), in which the hinge has evolved to form an actual joint, the **nasofrontal joint**. Budgerigars in particular have a great deal of mobility in the movement of their mandibles and tongue, which comes in “handy” when they are shelling seeds.

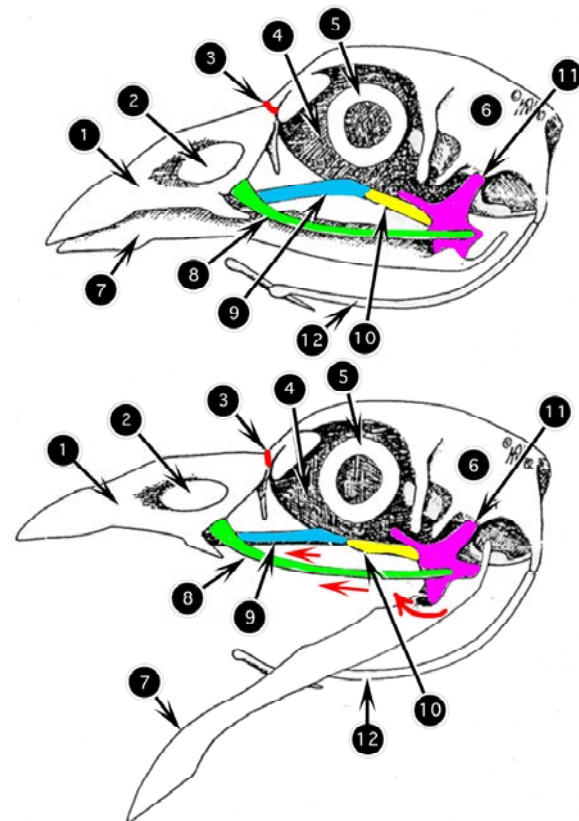


Figure 2-2. Drawing of avian skull to demonstrate craniokinesis: (1) fused premaxillae; (2) nasal aperture; (3) craniofacial hinge; (4) interorbital septum; (5) scleral ossicles forming sclerotic ring; (6) calvaria; (7) fused mandibles; (8) jugal arch; (9) palatine bone; (10) pterygoid bone; (11) quadrate bone; (12) hyobranchial apparatus.

² pneumatization- infusion of air to replace other things.

Figures 2-3 to 2-7 show some of the diversity in the skulls of different birds. Also see figure 1-3.

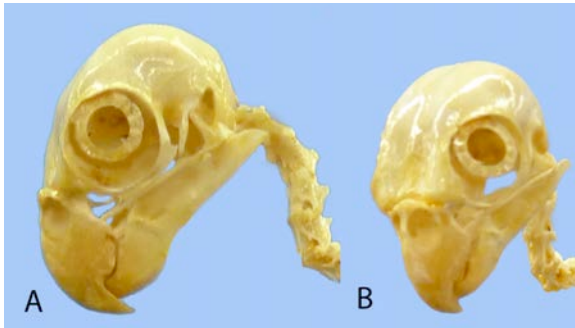


Figure 2-3. Skull of Cockatiel (*Nymphicus hollandicus*): (A) left lateral view; (B) left rostralateral view.



Figure 2-4. Skull of Red-shouldered Hawk (*Buteo lineatus*), left lateral view.



Figure 2-5. Skull of Turkey Vulture (*Cathartes aura*), left lateral view.



Figure 2-6. Skull of Barred Owl (*Strix varia*), left lateral view. Note bones around eye.



Figure 2-7. Skull of Ruby-throated Hummingbird (*Archilocus colubris*), left lateral view.

The **vertebral column** of birds is characterized by a **high degree of mobility in the cervical region** and a variable fusion in the thoracic, lumbar, and sacral regions (Fig. 2-8). **All mammals have 7 cervical (neck) vertebrae.** Birds didn't get that memo. In fact, the **number of cervical vertebrae** varies greatly with the length and mobility of the neck, ranging from about **12 to 25**. The cervical vertebrae of most birds form a distinct S-shaped curve when viewed from the side. **Selected bones of the axial skeleton of a bird are shown in figure 2-9.**

Further back many vertebrae in the thoracic, lumbar, sacral, and caudal regions are **fused for additional rigidity and support**. The amount of fusion of vertebrae varies among different species of birds. One result of fusion of some of the caudal (coccygeal) vertebrae is the formation of the

pygostyle (Fig. 2-9). The **pygostyle serves as the bony support for the very important tail feathers (rectrices)**. The sacral vertebrae, not only fuse to one another, but also fuse with the pelvis, giving additional strength to this important area of weight support.

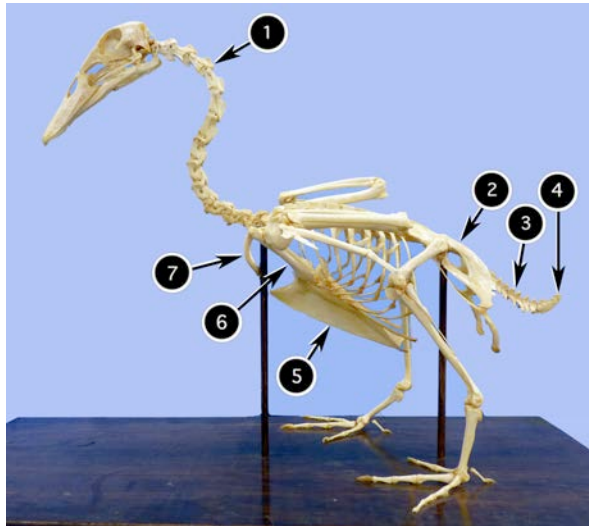


Figure 2-8. Skeleton of duck, left lateral view: (1) cervical vertebrae; (2) os coxae fused with synsacrum (3) free caudal vertebrae; (4) fused caudal vertebrae forming pygostyle; (5) keel of sternum; (6) coracoid bones; (7) furcula.

Bones and joints of the bird's wing are much like the bones and joints in the human arm. **The scapula is a relatively thin bone, laying along side the rib cage** (Fig. 2-10).

The clavicles (collar bones) of the bird are quite variable. Bird clavicles do not attach directly to the sternum, but rather in many species of birds, the two clavicles unite to form a fused unit known as the **furcula** (Fig. 2-10), but you know it better as the “**wishbone**.” In other birds (*viz.* some parrots and owls), the two clavicles do not fuse, but are united by fibrous tissue. **The furcula is greatly reduced or even absent in some species of parrots, including the budgerigar.**

The sternum of the bird articulates with the large **coracoid bones** of the thoracic girdle (Figs. 2-10 & 2-11). Coracoid bones are not present as separate bones in mammals, but **the coracoid is the largest bone of the pectoral girdle in birds**. Coracoid bones are also present in some reptiles (*viz.* turtles, crocodile).

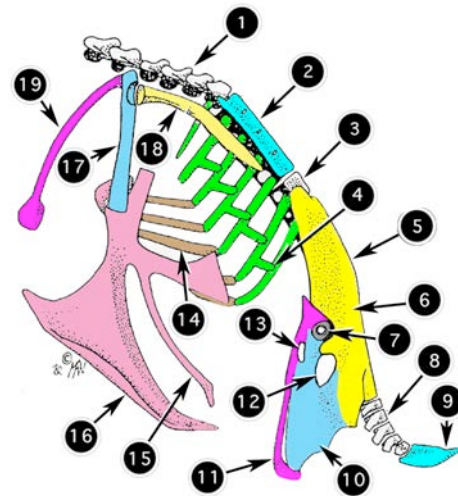


Figure 2-9. Selective components of axial skeleton, and pelvic and pectoral girdles: (1) cervical vertebrae; (2) fused thoracic vertebrae to form notarium; (3) unfused thoracic vertebra; (4) uncinate process of rib; (5) os coxae fused with synsacrum; (6) ilium; (7) acetabulum & acetabular foramen; (8) free caudal vertebrae; (9) fused caudal vertebrae to form pygostyle; (10) ischium; (11) pubis; (12) ilioischadic foramen- transmits sciatic nerve; (13) obturator foramen; (14) sternal rib; (15) caudal process of sternum; (16) carina of sternum; (17) coracoid bone; (18) scapula; (19) furcula (fused clavicles).

Together with the coracoid bone and scapula, the upper end of the clavicle forms a short **triosseal canal**, through which the tendon of the **supracoracoideus** muscle passes (Fig. 2-11). During the upstroke of the wing, the supracoracoideus muscle contracts, and its tendon, which terminates on the humerus, is pulled through the triosseal canal in a pulley-like fashion to raise the humerus and wing. This action works with gravity and requires far less effort than the down-stroke, which is

produced by the downward pull of the far more powerful **pectoral muscles**.

The coracoid bones serve an important function in the bird in that they act as **struts** to support the shoulder joint from the powerful downward forces exerted by the down stroke of the wing. **When the wings move downward, the coracoids brace the shoulder joint against the sternum** (Fig. 2-12).

The **humerus** rests alongside the scapula when the bird's wing is folded. The humerus is pneumatized by an extension of the clavicular air sac. The powerful pectoral muscle attaches to the humerus (Fig. 2-11).

Of the two bones that form the skeleton of the forearm (antebrachium), the **ulna** is larger and typically longer than the **radius** (Fig. 2-10). **The ulna forms the bony support for the powerful secondary flight feathers (remiges)**. When the wing is folded, the radius and ulna lie parallel to the humerus with the elbow joint fully flexed (Fig. 2-10).

The radius and ulna articulate distally with the **radial and ulnar carpal bones** (Fig. 2-10). Most of the carpal bones fuse with the metacarpal bones to form the **carpometacarpus**. **Birds typically have three digits in their wing: the alula (digit 1), a major digit, and a minor digit** (Fig. 2-10 & 2-13).

The large primary flight feathers attach to the skeletal components of the **carpo-metacarpus and the major and minor digits**. The alula can be pulled away (abducted) from the other digits in some birds. In a few species of birds (*viz.* ostrich), the **alula even retains a claw**- perhaps as a subtle reminder of the bird's reptilian predecessors.

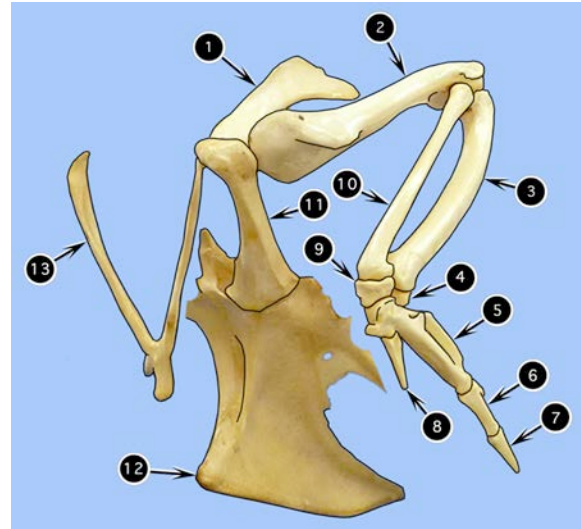


Figure 2-10. Left pectoral girdle & wing of turkey skeleton, craniolateral view: (1) scapula; (2) humerus; (3) ulna; (4) ulnar carpal bone; (5) carpometacarpal bones; (6) proximal phalanx of major digit; (7) distal phalanx of major digit; (8) alula (digit 1); (9) radial carpal bone; (10) radius; (11) coracoid bone; (12) carina of sternum; (13) furcula.

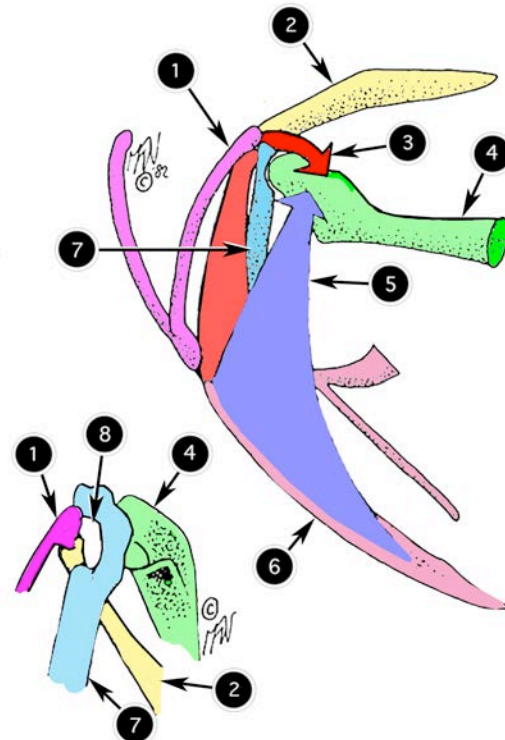


Figure 2-11. Arrangement of bones of thoracic girdle forming triosseal canal: (1) fused clavicles forming furcula; (2) scapula; (3) tendon of supracoracoideus muscle passing through triosseal canal; (4) humerus; (5) pectoral muscle; (6) sternum; (7) coracoid bone; (8) triosseal canal.

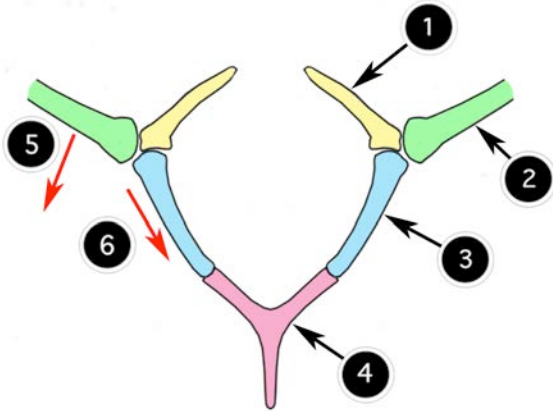


Figure 2-12. Schematic representation of how coracoid bones serve as supporting struts for the shoulder joint during down-stroke of wing: (1) scapula; (2) humerus; (3) coracoid bone; (4) sternum; (5) down-stroke of wing; (6) downward pressure on coracoid bone.

With the exception of ratites (ostrich, emu, etc.), the right and left **pelvic bones** (os coxa) do not fuse ventrally along a pelvic symphysis (Fig. 2-14). This “open pelvis” design is certainly a welcomed

anatomic feature for egg layers, and the space between the pelvic bones actually increases during the laying period.

Another interesting feature of the bird pelvis is an additional articulation associated with the hip joint (Fig. 2-14). **Ever wonder why ducks waddle?** Well, **birds do not have as free of movement at the hip joint as mammals**. Abduction (movement of the distal femur away from the midline) is quite restricted in birds due to this additional joint between the **greater trochanter** of the femur and the **antitrochanter** of the bird pelvis. This added articulation obviously **adds stability** to the hip joint, but at the expense of some flexibility. As previously mentioned, the two pelvic bones of the bird do fuse with the fused sacral vertebrae to form a single large pelvic unit or **symsacrum** (Fig. 2-15).

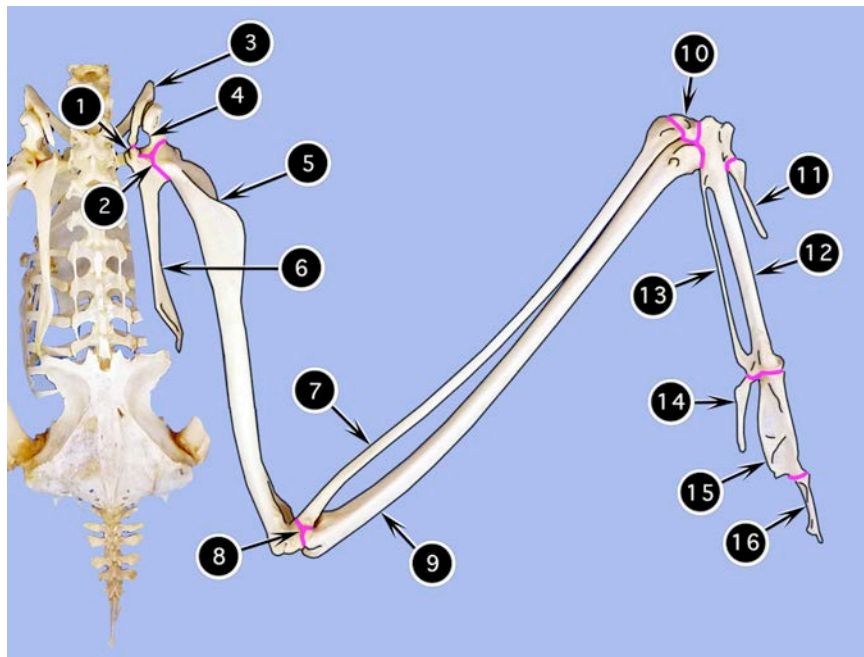


Figure 2-13. Skeleton of right wing of osprey, dorsal view: (1) acromion of scapula articulating with clavicle; (2) glenoid cavity, formed by scapula & coracoid bone; (3) clavicle; (4) triosseal canal for tendon of supracoracoideus muscle; (5) humerus; (6) scapula; (7) radius; (8) elbow (cubital) joint; (9) ulna; (10) radial carpal bone; (11) alula (digit 1); (12) carpometacarpal bone of major digit; (13) carpometacarpal bone of minor digit; (14) proximal phalanx of minor digit; (15) proximal phalanx of major digit; (16) distal phalanx of major digit.

The **femur** of the bird is similar to that of mammals, and much shorter than the tibiotarsus, which is formed by the fusion of the tibia and some tarsal bones (Fig. 2-16). The **fibula** is typically reduced to a splinter of a bone along the outside of the **tibiotarsus**. The **patella** articulates with the patellar groove of the femur.

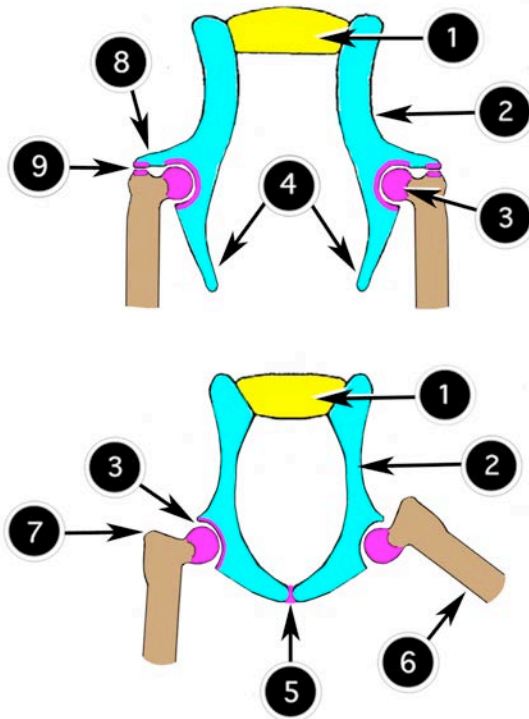


Figure 2-14. Schematic comparison of avian (top) and mammalian (bottom) coxal joints: (1) sacrum; (2) hip bones; (3) hip joints; (4) lack of fusion of pelvic bones in bird; (5) pelvic symphysis of mammal; (6) abduction of hip joint in mammal; (7) greater trochanter of femur; (8) antitrochanter of bird. Abduction of the hip joint is limited in birds by this secondary articulation (9) between the greater trochanter and the antitrochanter.

The **tibiotarsus**, which is formed by the fusion of the tibia and some tarsal bones articulates with the femur at the knee joint. Just like in people, **medial** and **lateral menisci** (fibrocartilages) are present in the knee joint (Fig. 2-16).

The distal end of the **tibiotarsus** articulates at the **intertarsal joint** with the proximal end of the **tarsometatarsus**, which is formed by fusion of the metatarsal bones with some of the tarsal bones (Fig. 2-16). Because of this fusion, **the tarsal joint of the bird is much simpler than the ankle (tarsus) of the human.**

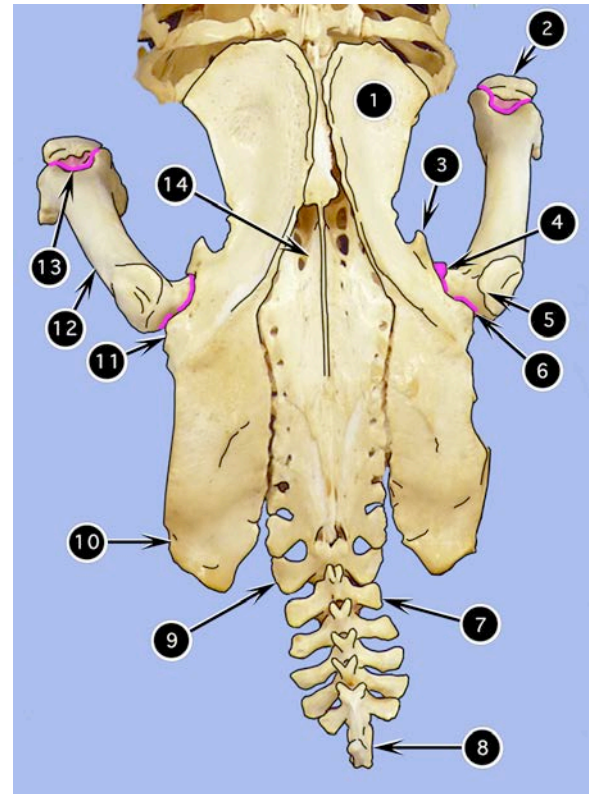


Figure 2-15. Pelvic skeleton of turkey, dorsal view: (1) ilium; (2) patella; (3) preacetabular tubercle; (4) head of femur (coxal joint); (5) greater trochanter of femur; (6) articulation of femur with antitrochanter of pelvis (part of coxal joint); (7) caudal vertebrae; (8) pygostyle; (9) caudal vertebra fused with synsacrum; (10) ischium; (11) antitrochanter of pelvis (12) body of femur; (13) femoropatellar joint; (14) fused sacral vertebrae.

Birds typically retain **pelvic digits 1-4**, but unlike mammals, the digits contain a **variable number of phalanges**. **Each digit contains one more phalanx than its number; i.e.,** digit 1 has 2 phalanges, digit 2 has 3, digit 3 has 4, and digit 4 has 5. It appears that the more time birds spend

walking (vs. flying or swimming), the fewer digits they retain. Although most birds retain four pelvic digits, there is obvious variation in the ostrich, which retains on two digits.

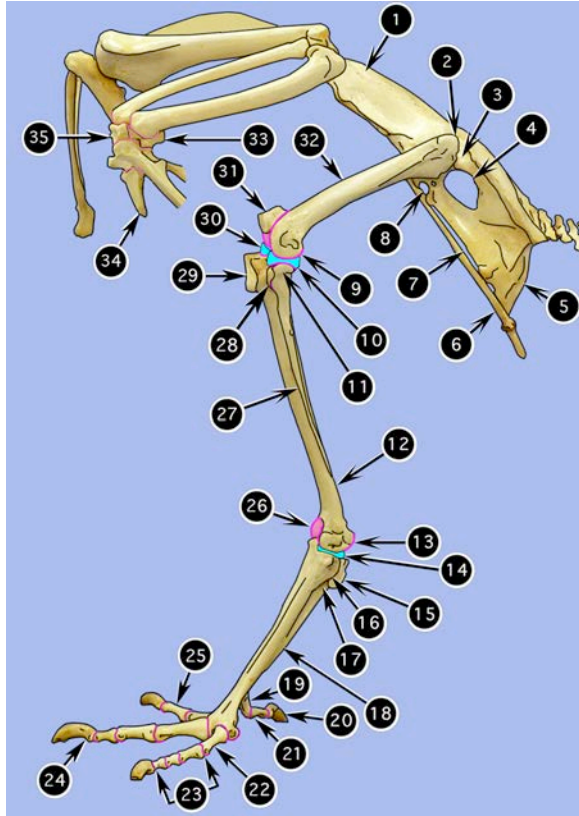


Figure 2-16. Pelvic limb skeleton of turkey, lateral view: (1) ilium; (2) greater trochanter of femur; (3) antitrochanter; (4) ilioischadic foramen; (5) ischium; (6) pubis; (7) ischiopubic fenestra; (8) obturator foramen; (9) lateral condyle of femur; (10) lateral meniscus of genu joint; (11) head of fibula; (12) body of tibiotarsus; (13) lateral condyle of tibiotarsus; (14) lateral meniscus of intertarsal joint; (15) medial hypotarsal crest; (16) lateral hypotarsal crest; (17) hypotarsal groove; (18) body of tarsometatarsus (fusion of metatarsal bones 2-4); (19) metatarsal bone 1; (20) distal phalanx of digit 1; (21) proximal phalanx of digit 1; (22) proximal phalanx of digit 4 (5 phalanges); (23) middle phalanges of digit 4; (24) distal phalanx of digit 3; (25) middle phalanx of digit 2; (26) medial condyle of tibiotarsus; (27) body of fibula; (28) lateral cnemial crest; (29) cranial cnemial crest of tibiotarsus; (30) medial meniscus of genu joint; (31) patella; (32) body of femur; (33) ulnar carpal bone; (34) alula; (35) radial carpal bone.

Muscles: Because most of us typically think of the muscles of birds in terms of “white meat” (breast) or “dark meat” (thigh & drumstick), our coverage of muscles will be rather superficial. To do a comprehensive study of the muscular system would take many pages and a great deal of time. **Figure 2-17 shows selected muscles of the head, trunk, and pelvic limb of the chicken.**

As you can see, many of the muscles have names similar to their mammalian counterparts. In addition, birds have quite a few highly modified muscles that make possible some of their unique movements of the wings, pelvic limb, and tail.

One of the most remarkable things about birds is their great stamina in being able to fly for hours at a time, in an **aerobic** state of muscle metabolism. This ability is undoubtedly related to their **efficient respiratory system**, which allows them to exert strenuous muscular activity for prolonged periods without creating an oxygen deficiency in their skeletal muscles (see Chapter 6).

Figure 2-18 shows selected muscles of the wing. Again there are many similarities to mammals, but other muscles are unique to the bird. The **patagium** is a double fold of skin, which forms the so-called “wing web.” Numerous muscles of the patagium are used to tense or otherwise manipulate this skin fold, to which feathers are embedded. The patagium contains considerable elastic tissue, which allows it to accommodate extension and folding of the wing.

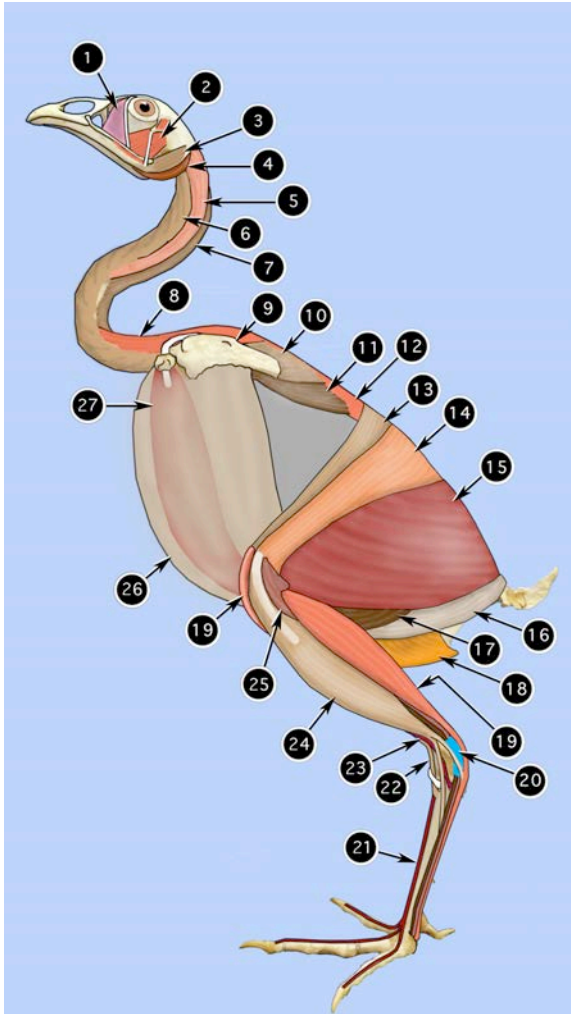


Figure 2-17. Selected muscles of trunk, & pelvic limb of the chicken, left lateral view: (1) infraorbital sinus; (2) external mandibular adductor (masseter); (3) depressor mandibulae (occipitomandibularis); (4) stylohyoideus; (5) complexus; (6) longus colli; (7) biventer cervicis; (8) longissimus cervicis; (9) humerus; (10) trapezius; (11) latissimus dorsi; (12) longissimus thoracis *et* lumborum; (13) sartorius; (14) tensor fasciae latae; (15) biceps femoris; (16) semimembranosus; (17) semitendinosus; (18) external abdominal oblique; (19) gastrocnemius; (20) deep digital flexor tendons passing through tibial cartilage; (21) long digital extensor tendon; (22) cranial tibial tendon; (23) fibularis brevis tendon; (24) fibularis longus; (25) deep digital flexor; (26) pectoral; (27) supracoracoideus with tendon passing through triosseal canal.

Figure 2-19 shows selected muscles of the abdominal wall, medial thigh, and cranial leg. **Figure 2-20** shows selected muscles of the pelvic limb. The **tibial cartilage** is a fibrocartilaginous pad that lies over the plantar aspect of the tibiotarsus just above the intertarsal joint.

The tendon of the large **gastrocnemius** passes over the tibial cartilage and continues into the tarsometatarsus. The tendons of the **superficial digital flexor** also pass over the cartilage, while the tendons of the **deep digital flexor muscle** pass through the tibial cartilage.

Figure 2-21 is a semischematic representation of the components of the “**perching mechanism**” of the bird. This unique mechanism, which is effected through the digital flexor tendons, allows the bird to grasp a perch with little or no muscular effort. By merely “squatting down” and **flexing the tarsus**, the resulting tension on the digital flexor tendons acts as a mechanical apparatus to flex the digital joints passively. This causes the opposed digits (3-1 or 2-2) to grasp or clamp around the perch.

If you ever have the unfortunate situation **where a raptor has part of you in its talons, remember, they can’t let go so long as the tarsus (limb) is flexed.** Straighten out the leg so they can let go. Or at least, you can pry their talons out of your bleeding flesh.

Another feature of many avian species (*viz.*, turkey, owl) is the **ossification of tendons**, particularly in the tibiotarsal and tarsometatarsal regions.

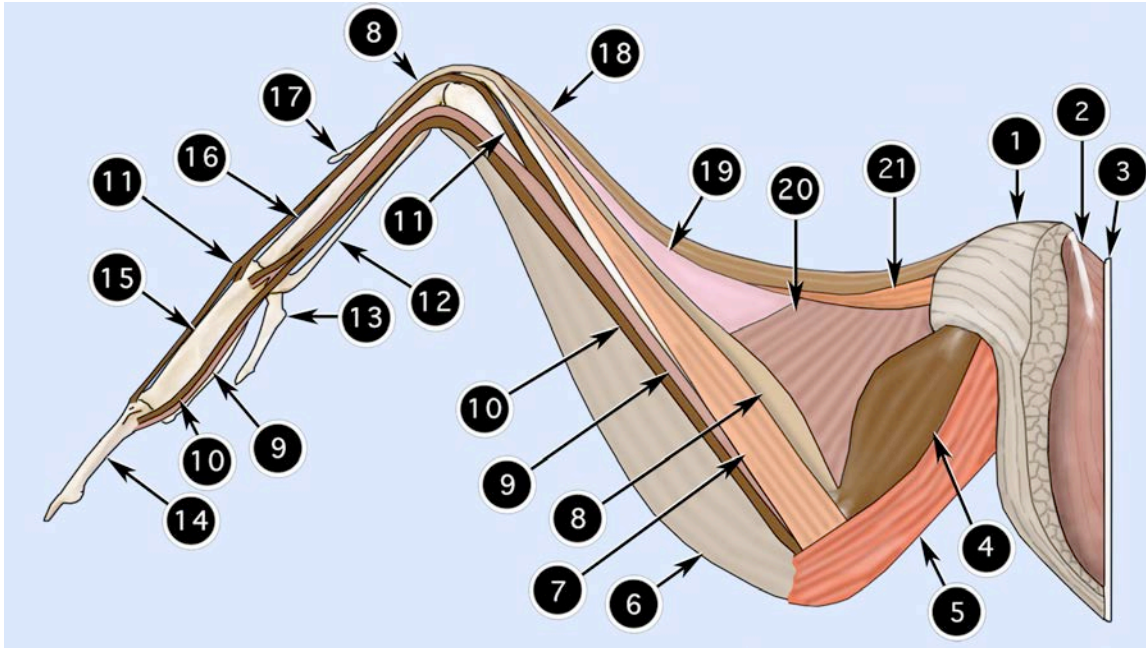


Figure 2-18. Selected muscles of wing, ventral view: (1) pectoral muscle; (2) supracoracoideus muscle; (3) carina (keel) of sternum; (4) biceps brachii muscle; (5) triceps brachii muscle; (6) flexor carpi ulnaris muscle; (7) pronator longus *et* brevis muscle; (8) extensor carpi radialis muscle; (9) deep digital flexor muscle; (10) superficial digital flexor muscle; (11) extensor indicis longus muscle; (12) carpometacarpal bone of minor digit; (13) proximal phalanx of minor digit; (14) distal phalanx of major digit; (15) proximal phalanx of major digit; (16) carpometacarpal bone of major digit; (17) alula (digit 1); (18) tensor patagii longus muscle; (19) patagium (skin fold forming wing web); (20) tensor patagii brevis muscle; (21) accessory patagii muscle.



Red-shouldered Hawk with a frog. Photo courtesy of Carlton Howard.

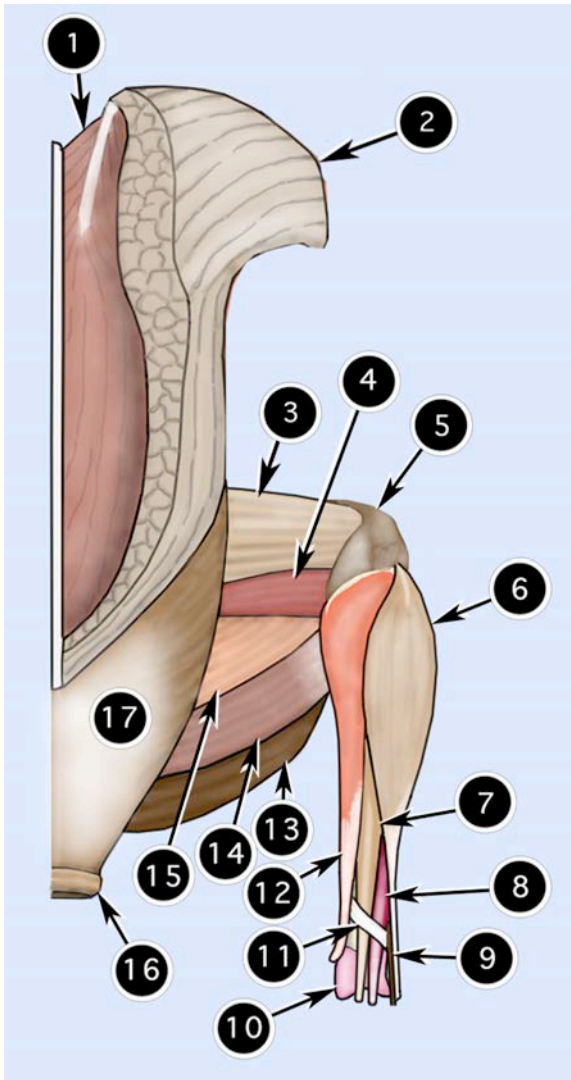


Figure 2-19. Selected muscles of pelvic limb, ventral view: (1) pectoral muscle; (2) supracoracoideus muscle; (3) sartorius muscle; (4) vastus medialis of quadriceps femoris muscle; (5) rectus femoris of quadriceps femoris muscle; (6) fibularis longus muscle; (7) long digital extensor muscle; (8) cranial tibial muscle; (9) fibularis brevis muscle; (10) trochlea of tibiotarsus; (11) proximal extensor retinaculum of tarsus; (12) gastrocnemius muscle; (13) semimembranosus muscle; (14) gracilis muscle; (15) adductor muscle; (16) sphincter cloacae muscle; (17) external abdominal oblique muscle.

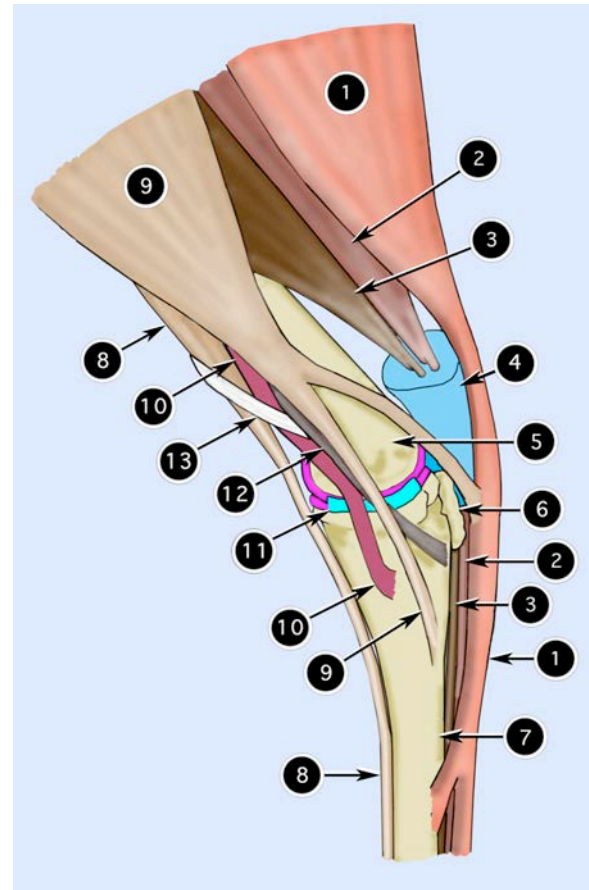


Figure 2-20. Selected muscles of pelvic limb, lateral view: (1) gastrocnemius muscle; (2) superficial digital flexor muscle; (3) deep digital flexor muscle; (4) tibial cartilage; (5) lateral epicondyle of tibiotarsus; (6) lateral crest of hypotarsus; (7) tarsometatarsus; (8) long digital extensor muscle; (9) fibularis longus muscle; (10) cranial tibial muscle; (11) lateral meniscus of intertarsal joint; (12) fibularis brevis muscle; (13) proximal extensor retinaculum of tarsus.

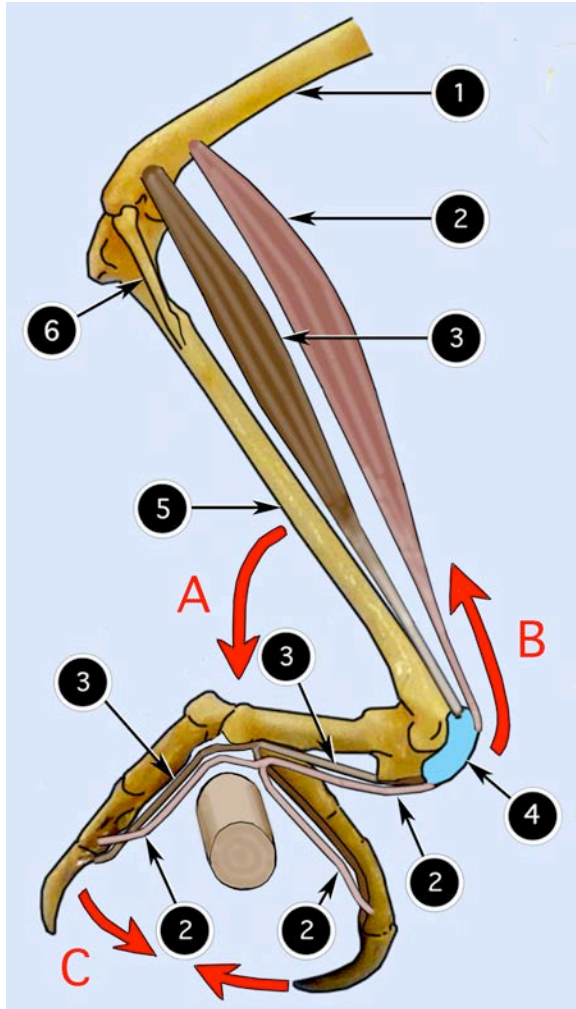
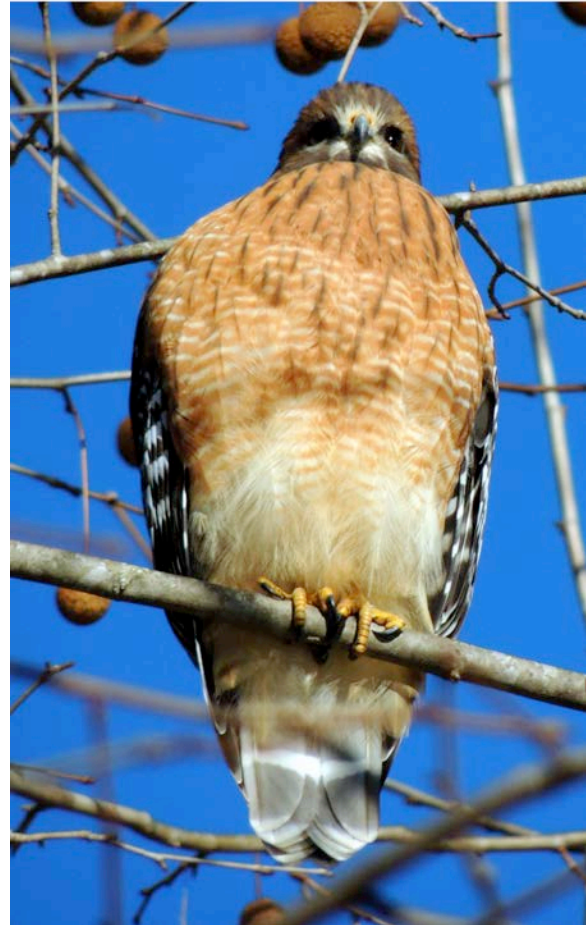


Figure 2-21. Semischematic representation of “perching mechanism” of bird: (1) femur; (2) superficial digital flexor; (3) deep digital flexor; (4) tibial cartilage; (5) tibiotarsus; (6) fibula. The red arrows indicate that when the bird “squats” and flexes its tarsus (A), the digital flexor tendons are pulled proximally around the tibial cartilage (B), and the resulting tension on the flexor tendons causes the opposing digits to clamp on to the perch (C).



This photograph doesn’t really have much to do with what we’ve been talking about, but it does show the talons of a Red-shouldered Hawk, and I had some blank space to fill. This photo was made in Raleigh, NC on December 18, 2013.

Chapter 3: Evolution of Feathers and Birds

Which came first, the feather or the bird? Well, that's an easy one; feathers have been around a lot longer than any bird. Feathers evolved prior to the origin of birds, but they are **one of the few things all birds have in common. All birds have feathers; none have fur or hair, even though some feathers may look like hair.**

Following its original discovery in Germany in 1861, the fossilized remains of *Archaeopteryx* (Fig. 3-1) enjoyed more than 100 years of being generally accepted as the predecessor of modern birds. Yet in recent years, the discoveries of some small, **feathered dinosaurs** in China have brought in to question whether *Archaeopteryx* is the ancestor of modern birds or is it just an “early bird.” With its long, wing-like forelimbs, there is no argument that *Archaeopteryx* is a bird, but is it the earliest ancestor of modern birds?

Feathers were originally believed to represent *modified scales*, and the transformation from scale to feather is thought to have evolved initially to provide insulation against cold. The theory that feathers evolved from scales has more recently been questioned, and it now appears that **feathers evolved independently as hollow tubular extensions of skin**, not from gradual modification of a scale.¹ In any case, **feathers evolved for warmth, not for flight.**

Birds are now believed to have evolved from small dinosaurs² (Fig. 3-2) that were

able to slowly evolve feathers, which were especially welcomed with the coming of an ice age. Feathers on the forelimbs also came in handy as “bug swatters” in their running pursuit of large flying insects. Well, one thing led to another, and after a million or so years those little dinosaurs were “gliding” along between strides, and well, **you know the rest of the story.**³



Figure 3-1. *Archaeopteryx lithographica*, specimen displayed at the *Museum für Naturkunde* in Berlin. (Photo courtesy: [http://en.wikipedia.org/wiki/File:Archaeopteryx_lithographica_\(Berlin_specimen\)\)](http://en.wikipedia.org/wiki/File:Archaeopteryx_lithographica_(Berlin_specimen)))).

When these “feathered dinosaurs” were originally discovered in China in the 1990s,

from dinosaurs (see *National Geographic*, July, 1998).

³ The fact that feathers just happened to enable birds to fly was an unexpected, yet not insignificant, “spin-off” of this evolutionary transformation.

¹ <https://www.youtube.com/watch?v=p8B0Ug2IXEQ>

² The discovery of two turkey-sized, feathered dinosaur fossils (dated at about 130 million years) in China strengthened the theory that birds evolved

it naturally raised questions among scientists about just how *Archaeopteryx*, the earliest known bird, fit into the evolutionary story of birds, and even what it meant to be a bird. The “*Archaeopteryx*” group argued that these newly discovered “feathered dinosaurs” weren’t old enough to be the ancestors of birds because they could not be dated back as far as their beloved icon, *Archaeopteryx*, **which could be dated to about 150 million years.**



Figure 3-2. Model of *Sinosauropteryx* created for *National Geographic* magazine in 1996, when this dinosaur was announced as the first to have feathers. The artist, Brian Cooley, worked closely with paleontologist Philip Currie to create this reconstruction.

This debate went on for more than ten years, but then in about 2008, more feathered dinosaurs, including one called *Anchiornis* (Fig. 3-3), were discovered, also in China. And, if that weren’t enough, **these fossils were dated to more than 150 million years,** and thus pre-date *Archaeopteryx*.

Old ideas die hard, especially when that’s the way it’s been taught for a hundred years, but it looks like the long-dominant theory that modern birds evolved from *Archaeopteryx* is just not true.⁴ **Figure 3-4,**

⁴ As you may know Galileo got in big trouble with the Pope for proposing the “preposterous idea” that the earth actually revolved around the sun, which was contrary to the teachings of the Church. Although

taken from the July, 1998 issue of the *National Geographic Magazine*, gives a beautiful depiction of how modern birds are thought to have evolved from dinosaurs, with *Archaeopteryx* being just one step along the way from dinosaurs to modern birds.



Figure 3-3. *Anchiornis*, a very bird-like feathered dinosaur described in 2008, has been confirmed to be older than *Archaeopteryx*. (Photo courtesy of Xu Xing/IVPP).

In addition to serving as insulation and in flight, feathers are used in nest building, and in displays of aggression and courtship behaviors. The **basal part** of the feather is the attached end, whereas the tip of a feather is termed its **apex**.

There are **three main types of feathers**: (1) *contour feathers*; (2) *plumules* or down feathers; and (3) *filoplumes*. Of these, the **contour feathers** are the most conspicuous in that they cover the adult bird’s body, wings, and tail and basically account for the shape of the bird. The large flight feathers of the wing (remiges) and the

not executed for his beliefs, Galileo was ordered to quit saying that, and was sentenced to “house arrest” for much of his adult life.

tail (rectrices) are the most conspicuous of the contour feathers.

In most water birds, the contour feathers trap air, which not only insulates the bird, but also gives it **buoyancy**. The exposed part of a typical contour feather is flat and is supported by a central **rachis**, flanked on two sides by the **vane** (Fig. 3-5). The more proximal part of the feather, which is embedded in a follicle, is termed the **calamus** or quill, and the combined calamus and rachis make up the hollow **shaft** of the feather.

The calamus is hollow and is divided internally into smaller compartments called “pulp caps.” At the junction of the calamus and rachis is an opening into its cavity known as the **distal** (superior) **umbilicus** (Fig. 3-5). The **proximal** (inferior) **umbilicus** is the opening at the tip of the calamus into which the dermal papilla of the follicle projects. On some feathers, a secondary feather may branch from the underside of the main feather at the level of the distal umbilicus (Fig. 3-5). These “afterfeathers” are typically much smaller than the main feather; however, in the emu, they are as large as the primary feather.

The **vane** is the part of the feather extending out to either side of the rachis (Fig. 3-6). The main branches from the rachis are the **barbs**, and from the barbs are smaller branches known as **barbules** (Figs. 3-5 & 3-6). Those barbules directed back toward the calamus are termed **proximal barbules**, while those directed toward the tip of the feather are termed **distal barbules**. The distal barbules of contour feathers have numerous **hooklets** that lock over small flanges located on the proximal barbules from the adjacent barb. It is this **complex interlocking of the barbules** that maintains the smooth shape of the contour feathers.

The most proximal group of barbs on a contour feather, typically lack interlocking barbules and as a group forms a “**downy barb**” arrangement (Fig. 3-6).⁵ **Healthy birds want to be well groomed** and give immediate attention to “frazzled feathers.” They restore the interlocked arrangement of the barbules by passing the feathers through their beak in the grooming ritual known as “**preening**.”

Stealth Technology? As you know, aeronautical engineers have developed a “stealth technology” so that aircraft can slip through radar detection. This technology involves the implementation of “soft edges” on the wings and fuselage so that they do not reflect radar waves. This is pretty high-tech stuff, but **the owl was way ahead of those engineers**. When most birds fly, the movement of their wings disturbs the air along the crisp leading edge of the flight feathers, thus producing the “swoosh-swoosh” sound or the “hum” of the humming bird as the **wings disrupt the air**.

Most owls are nocturnal predators, and their prey are very “tuned-in” to “sounds in the night.” To avoid detection by the keen hearing of their prey, owls have developed (evolved) a “stealth technology” of their own. To “soften” the leading edge of their flight feathers, the distal barbules along the leading wing edge do not contain functional hooklets, creating a **soft, flexible edge** (Fig. 3-8). **Owls fly virtually soundlessly**, and by the time their prey detects an “incoming” owl, it is too late.

⁵ Having no need for flight feathers, the contour feathers of the ostrich have poorly developed barbule hooklets.

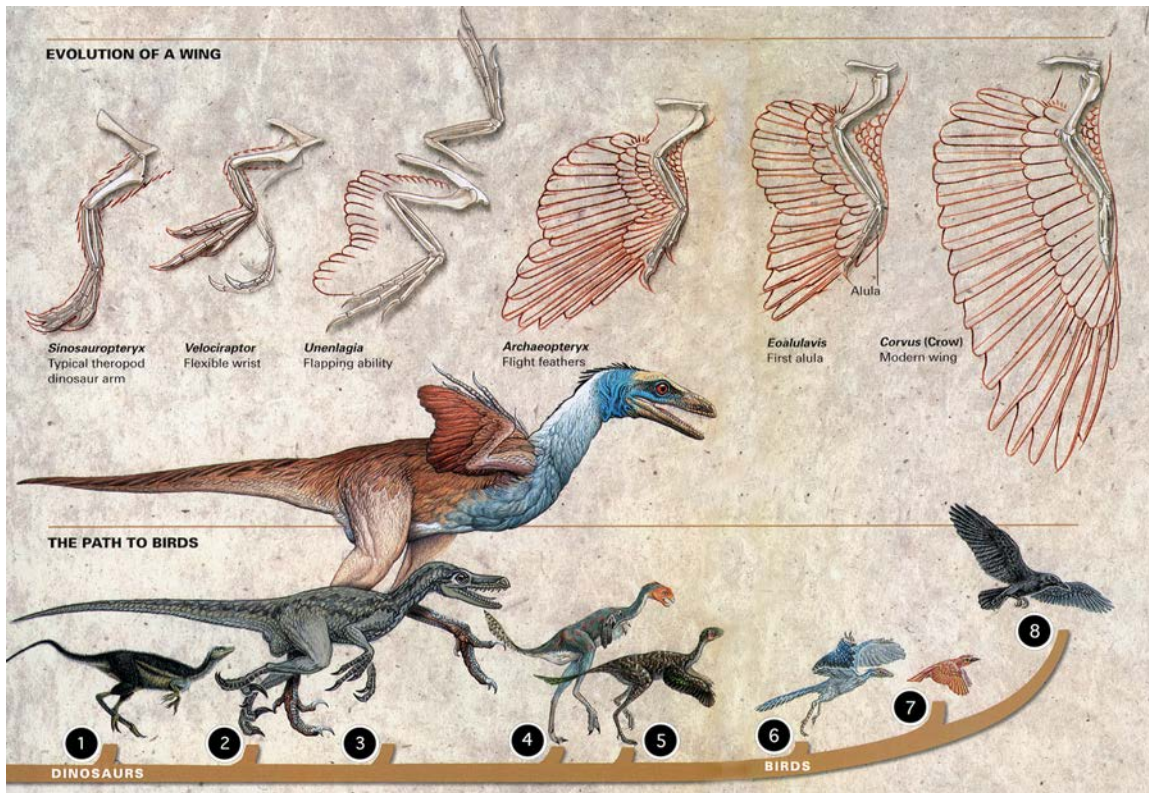


Figure 3-4. “Evolution of a Wing” and “The Path to Flight” from *National Geographic Magazine*, July 1998 issue. *Sinosauropteryx* by Michael Skrepnick; *Unenlagia* by Aldo Chiappe; based on fossil interpretation by Fernando Novas: (1) *Sinosauropteryx* (China) was a runner that was covered with filaments and had short forelimbs with 3 thoracic digits; (2) *Velociraptor* (Mongolia) had a carpus capable of rotation, a motion necessary for flight; (3) *Unenlagia* (Patagonia) was about 8 feet long and could move its forelimbs up and down, which is necessary for flight; (4) *Caudipteryx* (China) was a fast runner, which was covered with primitive feathers; (5) *Protarchaeopteryx* (China) resembles *Archaeopteryx*, but had more primitive feathers, and was probably not capable of achieving powered flight; (6) *Archaeopteryx* (Germany) had a more advanced feather design in that the leading edge was narrower and more streamlined than the trailing edge, and it was very likely capable of some elementary flying; (7) *Eoalulavis* (Spain) is the oldest bird with an *alula*, the movement of which is necessary for more advanced flying; (8) *Corvus* (crow) and other modern birds have developed many more adaptations for controlled flight and maneuverability.

Filoplume feathers are **hair-like** (but not hairs) and typically consist of a flexible shaft that may have a tuft of barbs near its apex. Owing to this design, these feathers are sometimes referred to as “tufted bristles,” and are commonly found on the head and neck.

The most impressive and functionally significant contour feathers of flight birds are those of the wings and tail (Fig. 3-9). The feathers of the wing are divided into

remiges, which are the longer flight feathers, and **coverts**, which are the smaller feathers that cover and contour the leading edge of the wing. Remiges are further divided into **primary flight feathers**, which are the longer more distal group that attach to the carpometacarpus and phalanges, and **secondary flight feathers**, which are the shorter feathers that attach to the ulna (antebrachium). For any species of bird, there is a constant number and arrangement of remiges.

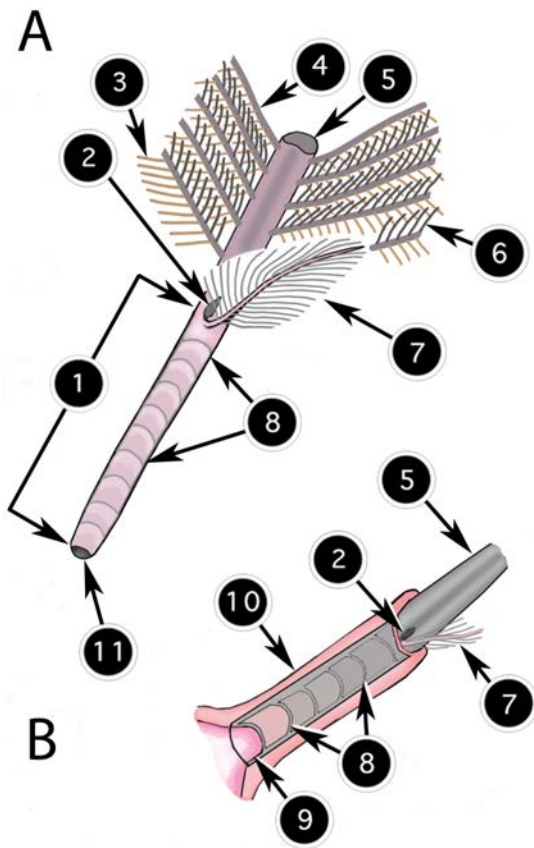


Figure 3-5. Drawings of (A) calamus and proximal vane of contour feather; (B) growing feather in feather sheath: (1) calamus exposed; (2) distal umbilicus; (3) proximal barbules; (4) barb; (5) rachis (cut); (6) distal barbule; (7) hypopenna (after-feather); (8) epidermal septae forming pulp caps; (9) dermal papilla projecting into proximal umbilicus; (10) feather sheath surrounding calamus; (11) inferior umbilicus.

The large feathers of the tail, known as **rectrices**, are symmetrical, and again, the number, size, and arrangement of these feathers is species specific. Smaller covert feathers cover the more proximal (basal) part of the tail. As a note of interest, the large **fan of the peafowl** is not formed by the tail feathers (rectrices), but rather from elongated covert feathers just above the tail feathers. Other than display, the fan is thought to focus sound waves to their ears.

Birds routinely replace their feathers by a process called **molting**. In wild birds, molting **typically takes place once a year**, at the end of their natural breeding season; however, there are some birds that molt twice a year. The onset of molting is hormonally induced and the timing is usually determined by changes in the **photoperiod** and **temperature**.

Molting represents a **stressful time** in the life of birds, and during the molt, they require added nutrients to support the rapid production of the new feathers. In most species, the primary flight feathers are lost sequentially as new ones come in to replace them. **Ducks and geese**, however, replace many of their flight feathers in a relatively short period of time so that they are unable to fly very well during this period. **This molting period of ducks and geese typically coincides with the time when they have young that are also incapable of flight.**

New feathers are produced within the **feather follicle**, which is a sheath or inverted tube of skin (Fig. 3-5). At the base of the follicle is a **dermal papilla**, which projects a short distance into the feather through the proximal umbilicus. Feathers are produced by the replication and keratinization⁶ of epidermal cells surrounding the dermal papilla. Feathers **continue to grow out from the follicle only until the definitive length of that feather is achieved**, at which time growth ceases. Like hair, the oldest (first-formed) part of a feather is at its apex, and the youngest (most recently formed) part is represented by the basal region. However, unlike hair, **feathers do not continue to grow indefinitely.**

⁶ keratinization- a process by which epithelial cells lose their moisture and are replaced by tough (horny) tissue like in the formation of a finger nail.

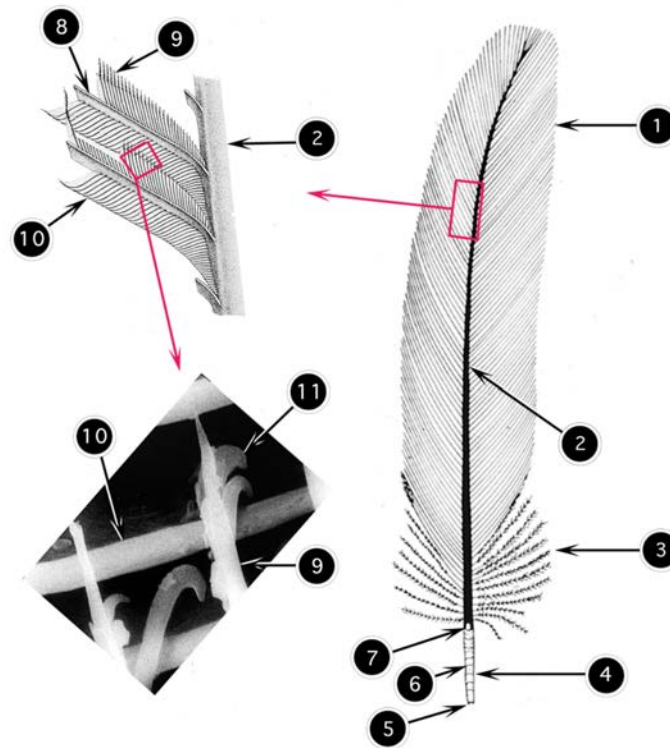


Figure 3-6. Anatomy of a contour feather: (1) vane; (2) rachis; (3); (4) calamus; (5) proximal umbilicus; (6) pulp caps; (7) distal umbilicus; (8) barb (9) distal barbules; (10) proximal barbules; (11) hooklets on distal barbules. (Modified after King & McLelland, 1975 & Nickel, Schummer, Sieferle, 1977.)

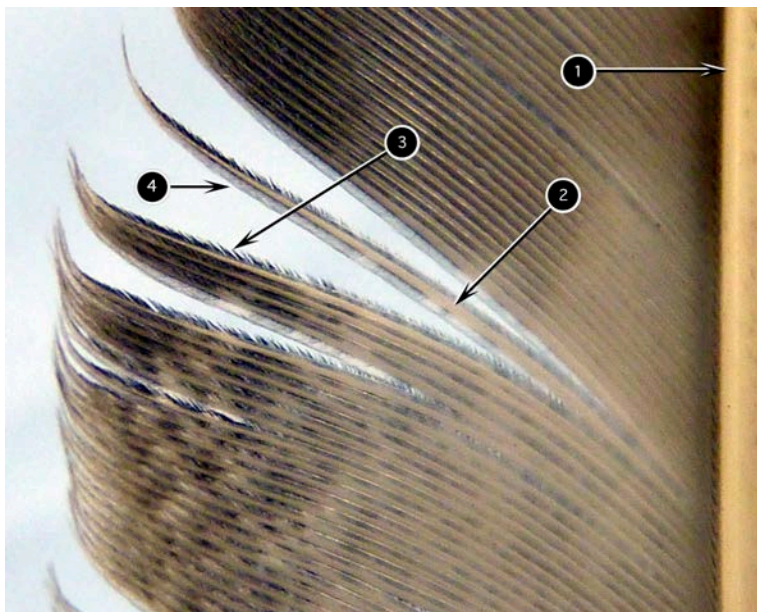


Figure 3-7. Close-up photograph of vane of contour feather: (1) rachis; (2) barb with proximal & distal barbules; (3) distal barbules with hooklets; (4) proximal barbules without hooklets.

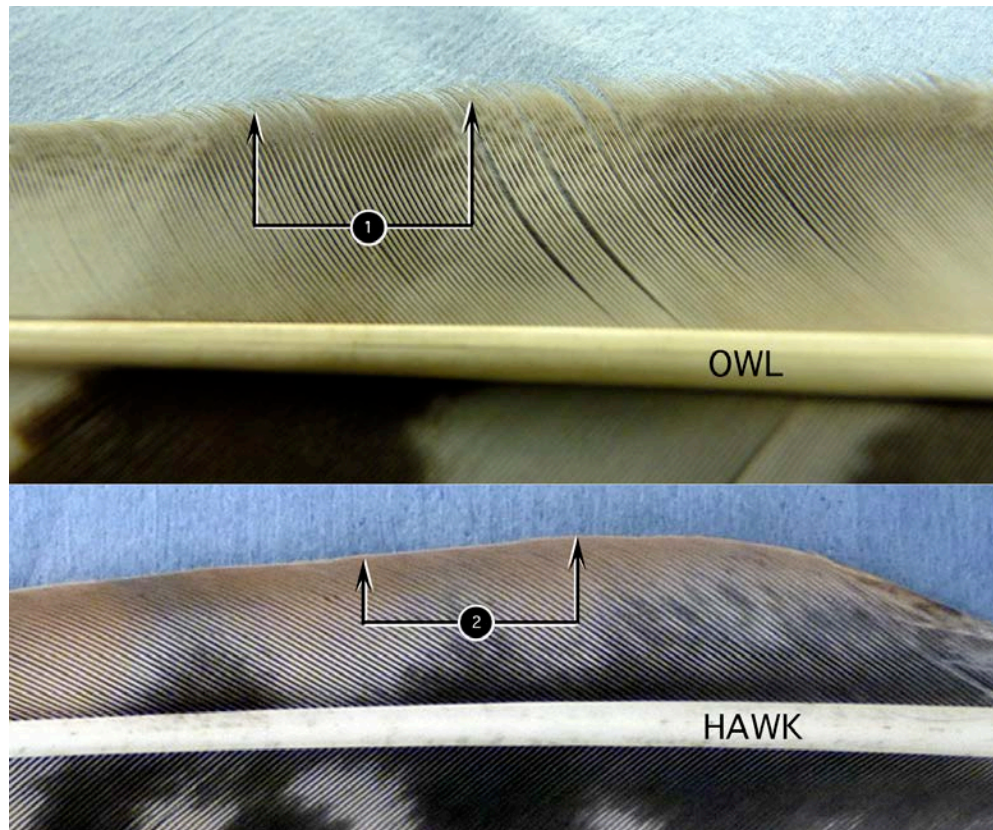


Figure 3-8. Flight feathers (remiges) of owl and hawk: (1) soft (unlocked) leading edge of owl feather; (2) sharp (locked) leading edge of hawk feather. The soft, flexible leading edge of owl feather allows for virtually silent flight.

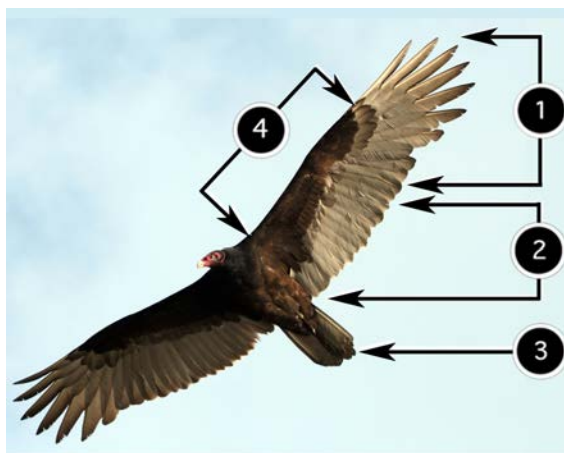


Figure 3-9. Contour feathers of turkey vulture: (1) primary remiges associated with manus; (2) secondary remiges associated with ulna (antebrachium); (3) rectrices (primary tail feathers); (4) covert feathers giving smooth contour to cranial edge of wing as well as body and tail. (Photo courtesy:

[http://en.wikipedia.org/wiki/File:Cathartes_aura_-Florida_-USA_-flying-8-4c](http://en.wikipedia.org/wiki/File:Cathartes_aura_-_Florida_-USA_-flying-8-4c)).

During early development of a feather, a vascular **dermal core** extends outward into the epidermal cylinder that will become the feather. **When a new feather first emerges from the follicle, it is encapsulated by a thin epidermal sheath that ruptures to release the unfolding barbs and barbules of the feather.** Successive generations of feathers are produced over the same dermal papillae throughout life, with **a new feather developing to replace its predecessor.** This replacement occurs regardless of whether the old feather was lost during the natural molting process or was unceremoniously plucked from its follicle by man, beast or turbulent weather.

As keratinized epidermal structures (like your fingernail), feathers are primarily proteinaceous appendages into which various substances can be incorporated. Among these are **both dietary and synthesized pigments** (carotenoids, lipochromes, etc.), which account, in part, for the variety of coloration among feathers.

Selective incorporation of specific pigments into certain feathers is both genetically prescribed and hormonally influenced. The plethora of coloration patterns varies, not only from feather to feather, but also among specific barbs and barbules of a single feather. **The diversity in coloration patterns is virtually endless.**

In mostly female birds, an area of feathers on the under surface of the body may be shed or plucked during the nesting season. This temporarily featherless region is the so-called “**brooding patch**,” which allows the eggs to come in more direct contact with a highly vascular area of skin for incubation purposes. Actually, some male birds (*viz.*, *pigeon*) develop brood patches. Because **commercial layers** get paid to lay, not sit on their eggs, **broodiness has pretty much been eliminated** in these birds through selective breeding.

Once you get below the feathers of the bird, the skin is rather thin and relatively inelastic. In most areas of the body, the skin is rather loosely attached to the deeper tissues. **Birds tend to store quite a bit of fat just under their skin**, which explains its yellowish color and why removing the skin from a piece of fried chicken before one ingests same can greatly reduce the calorie and fat content of the meal. **A complex system of dermal muscles interconnects and acts upon groups of feather follicles.** Acting much like the arrector pili muscles of mammals, these dermal muscles can elevate

the feathers of a body region in unison to “ruffle” them or say to raise the crest in a cockatoo.

Many bird books have specific terminology for feathers on various parts of the body, particularly those around the head. **Figures 3-10 & 3-11** show some of the terminology used to describe certain feather groups and markings.

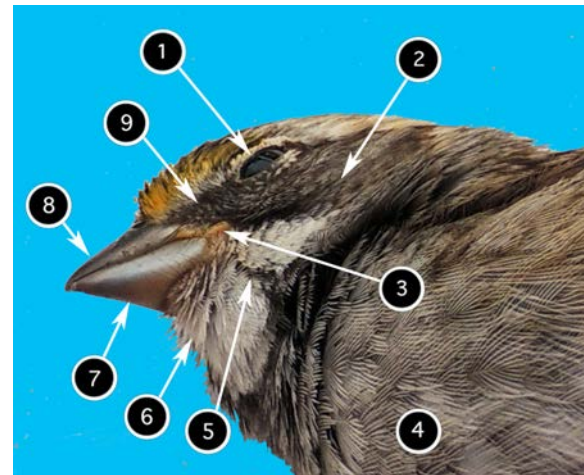


Figure 3-10. Head of dead White-throated Sparrow: (1) eye ring; (2) auriculars; (3) rictus; (4) breast; (5) malar stripe; (6) throat; (7) lower beak; (8) upper beak; (9) lores. Note: This bird died by flying into a glass door.

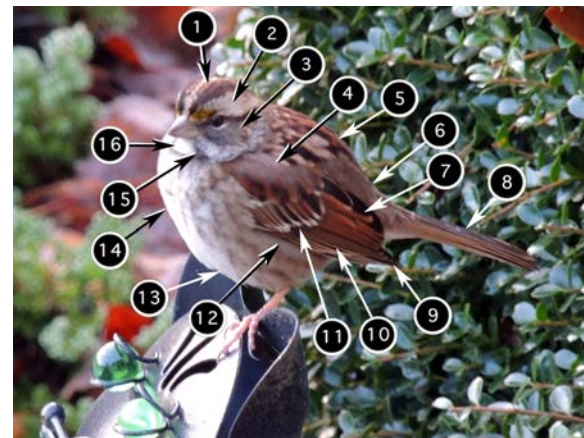


Figure 3-11. Regions, feathers and markings as demonstrated on a white-throated sparrow: (1) crown or cap; (2) supercilium; (3) auriculars; (4) scapulars; (5) back; (6) rump; (7) tertials; (8) tail; (9) primary flight feathers; (10) secondary flight feathers; (11) coverts of wing; (12) flank; (13) coverts of belly; (14) breast; (15) malar stripe; (16) throat.

Chapter 4: Non-Feathered Structures and Heat Loss

What about those parts of the bird that are not covered by feathers?

In most birds, digit 1 is directed plantarly (backward), while digits 2-4 radiate in a more dorsal (forward) direction (Fig. 4-1). A common variation is present in parrots and woodpeckers, in which digit 4 is rotated to join digit 1 in a plantar orientation (Fig. 4-2). The 3-1 orientation appears to work best for walking, while the 2-2 modification gives an advantage for climbing and clinging to vertical surfaces. **The osprey is unique in being able to switch from a 3-1 for perching and a 2-2 for grasping fish.**

Of course, many aquatic birds have webbing between their toes to aid in swimming (Fig. 4-3). Most aquatic birds only have webbing between digits 2-4; however, the pelican and some of its relatives have webbing between all 4 digits.

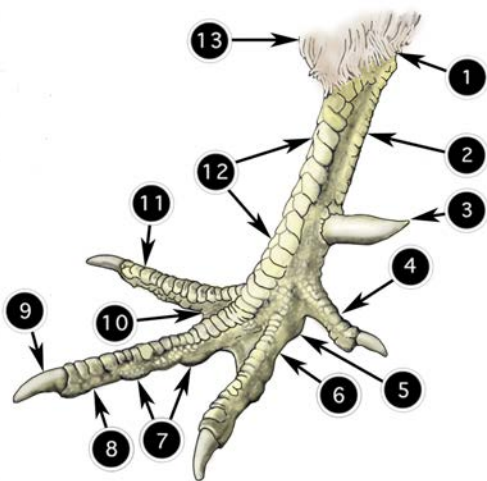


Figure 4-1. Right foot of chicken, medial view: (1) tarsus; (2) tarsometatarsus; (3) calcar (epidermal sheath over calcaris process); (4) digit 1; (5) metatarsal pad; (6) digit 2; (7) digital pads; (8) digit 3; (9) nail or claw; (10) interdigital web; (11) digit 4; (12) scales on tarsometatarsus; (13) feathers on tibiotarsus. (Modified after Nickel, Schummer, Sieferle, 1977.)

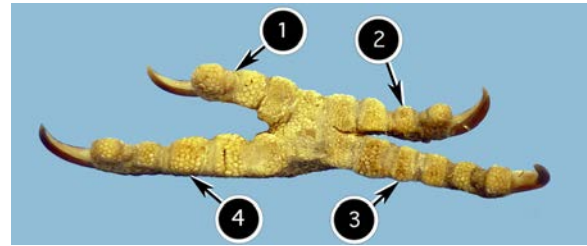


Figure 4-2. Left foot of African grey parrot (*Psittacus erithacus*), plantar view: (1) digit 1; (2) digit 2; (3) digit 3; (4) digit 4 rotated to join digit 1 in 2-2 alignment.

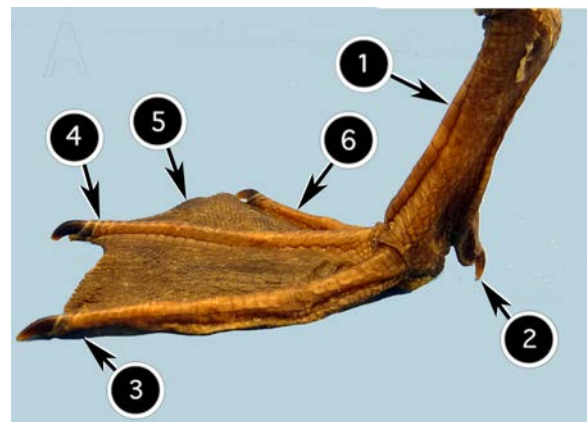


Figure 4-3. Left foot of duck, lateral view: (1) tarsometatarsus; (2) digit 1; (3) digit 2; (4) digit 3; (5) interdigital web; (6) digit 4.

The head and neck of birds may be adorned with one or more skin modifications. The chicken typically exhibits the comb, wattles, and earlobes (Fig. 3-15). The **comb**, which is often better developed in the male bird, can serve as a general index of health in the chicken, with a bright red comb being indicative of the onset of egg production. Among commercial and exotic breeds of chicken, there are **many variations in the size and shape of the comb**.

The comb represents a fleshy crest and is a highly vascular structure, which will bleed readily when traumatized. **Plumed crests** are present in many species of domestic and

wild birds (*viz.* cockatoo, crowned pigeon, and some chicken breeds).

The **wattles** are the two skin appendages associated with the mandibles (Fig. 4-4). Because the **earlobes** exhibit considerable variation in color among different breeds of chickens, its color is **sometimes used to distinguish a particular breed**. Chicken breeds with white earlobes typically lay white eggs, while those with colored earlobes typically lay colored eggs.

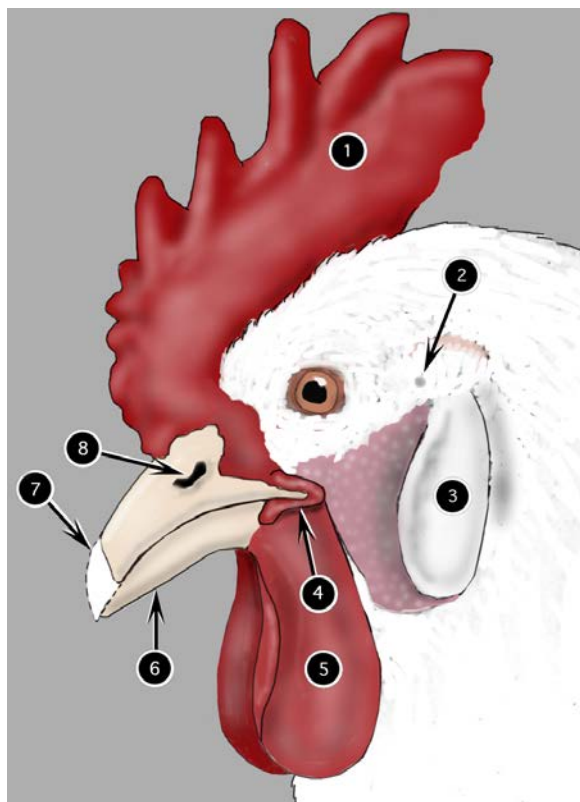


Figure 4-4. Head of chicken: (1) comb; (2) external acoustic meatus (covered by feathers); (3) earlobe; (4) rectus; (5) wattles (palea); (6) lower beak; (7) upper beak, properly “debeaked”; (8) operculum, overhanging nostril.

Decorative adornments associated with the head and neck of the turkey consist of the snood, dewlap, and caruncles (Fig. 4-5). Like the comb of the chicken, the extensible **snood** is better developed in the male. The **dewlap** is a simple skin fold in the throat

region, while the entire head and neck of the turkey is characterized by **caruncles** and a sparse covering of bristle feathers. In addition to the above ornaments, a filamentous **beard** develops from a papilla near the base of the neck of the tom (sometimes present in hen) (Fig. 4-6).

The **beak** or **bill** consists of a heavily keratinized sheath, which covers the upper and lower jaws. In most birds the beak grows continuously throughout life, and in some captive species (*viz.*, parrots) may require periodic trimming to prevent overgrowth. In commercial poultry operations, the upper beak is routinely trimmed (debeaking) to prevent cannibalism during confined housing situations (Fig 4-4). **Debeaking** is typically performed in day-old birds (*viz.*, turkeys and chickens), and when done, should include no more than 1/3 of the upper beak as measured from the tip of the beak to the nostrils (Fig. 4-4).

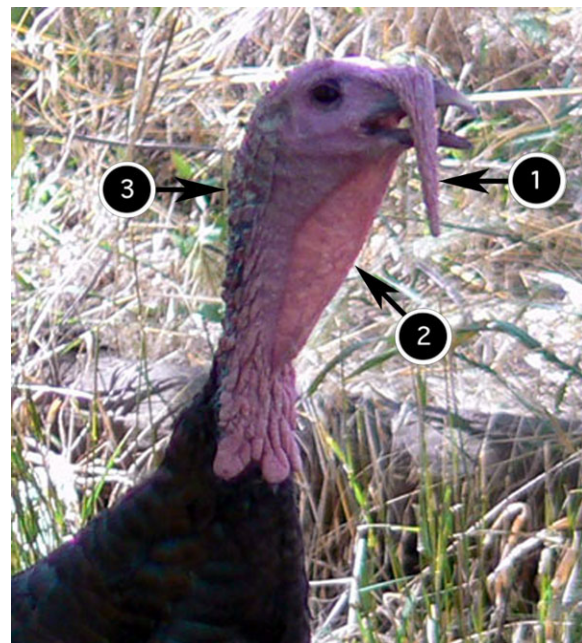


Figure 4-5. Head and neck of wild turkey tom (gobbler): (1) snood; (2) dewlap; (3) caruncles. (Photo courtesy: http://en.wikipedia.org/wiki/File:Meleagris_gallopavo_Wild_Turkey).



Figure 4-6. Wild Turkey Gobbler. The beard (arrow) of the gobbler is the trophy of the turkey hunter. (Photo courtesy: <http://en.wikipedia.org/wiki/File:Gall-dindi>).

In pigeons, psittacines, and some other birds (*viz.*, eagles, falcons, hawks) there is a soft saddle of thickened skin over the base of the upper beak termed the **cere** (Fig. 4-7). The **cere**, which may be feathered or bare, typically surrounds the nostrils, and is often colored. In the **budgerigar**, its color can be used to determine the sex of the bird. In the male bird the cere is typically blue, while in the female it is pink or light brown. Note: this is not a 100% accurate method of “sexing budgies.”



Figure 4-7. Cere (arrows) of pigeon and male budgerigar.

Newly hatched birds have a so-called “**egg tooth**” (which is not a tooth at all) that functions in cracking open or “**pipping**” the egg shell (Fig. 4-8). The egg tooth typically drops off within a day after hatching.

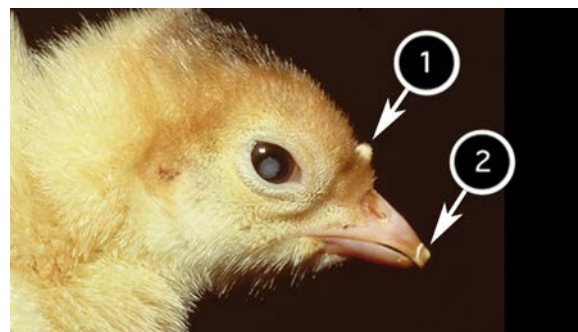


Figure 4-8. Head of newly hatched turkey poult: (1) snood; (2) “egg tooth” used in pipping the eggshell.

Birds like to look their very best. And to do so they take good care of their feathers through the process known as **preening** (Fig. 4-9).



Figure 4-9. Canada Goose preening its feathers. This process not only straightens the feathers, but also serves to waterproof them with secretion of the uropygial (preen) gland. This photo was made in Raleigh, NC on March 2, 2015.

On the top of their tail base is the **uropygial papilla**, upon which open the paired ducts of the bilobed **uropygial (preen) gland** (Figs. 4-10 & 4-11). In the absence of sweat glands and generally distributed sebaceous glands, **this is the major skin gland in birds.** The uropygial

gland serves as the source of a sebaceous secretion or *sebum*.

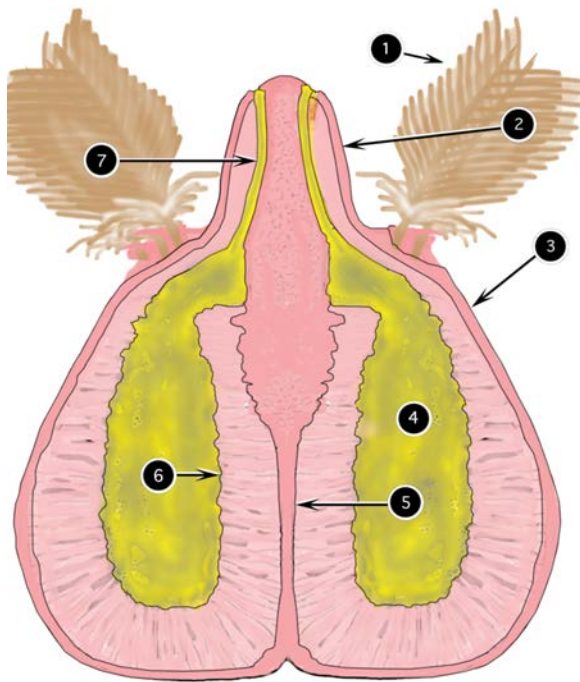


Figure 4-10. Semischematic of uropygial gland: (1) circle of down feathers present in some species; (2) uropygial papilla; (3) fibrous capsule; (4) lumen of gland filled with sebum; (5) septum between two lobes of gland; (6) holocrine tubular glands; (7) paired ducts opening on apex of uropygial papilla.

During preening, the bird uses its beak (bill) to obtain the fatty secretion from this large gland, and by pulling its feathers through its beak, coats them with this material. The gland is particularly important in most aquatic birds in that the **oily coating serves to waterproof the feathers** as well as to reduce the incidence of skin infections.

Although present in the budgerigar, the **uropygial gland is absent in some other parrots** (*viz.*, Amazon parrot) and in some pigeons. **There are also some marine birds that do not oil their feathers.** Among these are the **cormorant** and the **anhinga**. Both are diving fisher-birds, and the added buoyancy created by

waterproofing their feathers would impede their underwater agility.

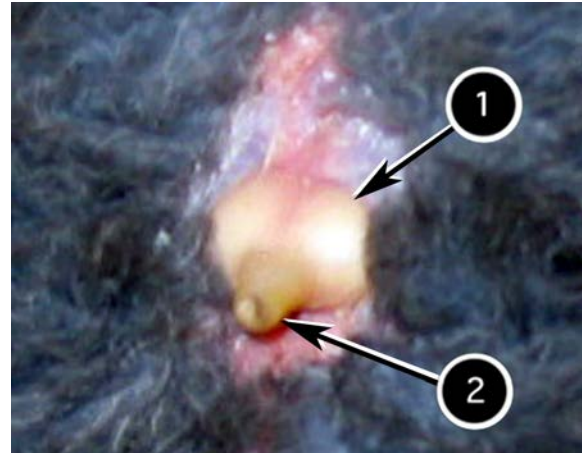


Figure 4-11. Uropygial or “preen” gland of barred owl (*Strix varia*): (1) bilobed gland; (2) uropygial papilla.

In most bird species feathers do not cover their lower legs and feet (Fig. 4-12). However, like almost anything else we could say about birds, there are exceptions. Among these are some, but not all, species of owls (Fig. 4-13).

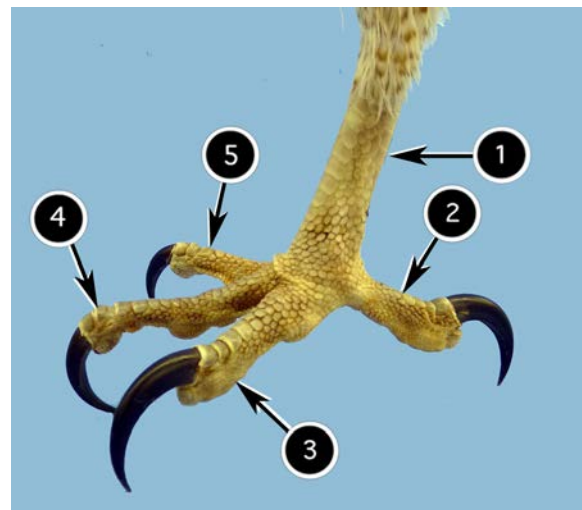


Figure 4-12. Right foot of red-shouldered hawk. medial view: (1) tarsometatarsus; (2) digit 1; (3) digit 2; (4) digit 3; (5) digit 4. Note there are no feathers on lower leg or foot.

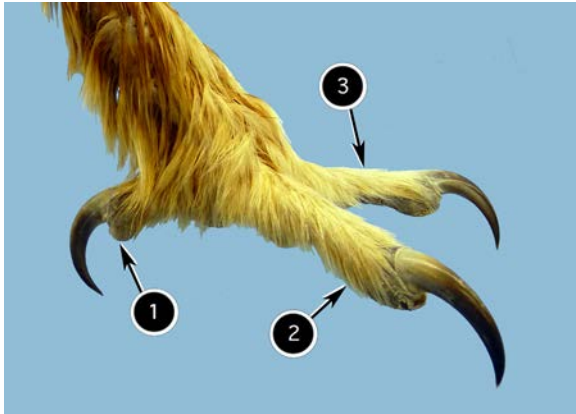


Figure 4-13. Left foot of great horned owl, medial view: (1) digit 1; (2) digit 2; (3) digit. Note feathers extending onto toes.

As mentioned previously, **feathers trap air and the combined feathers and trapped air serve as an excellent insulator against cold.** Birds don't lose much body heat in their feathered areas, but **what about those areas not covered by feathers.** Well, that can be a problem, or maybe not.

Birds native to tropical regions, where ambient temperature is high, actually **need to dissipate body heat.** They may have long, non-feathered legs, like the flamingo, or a large bill like the toucan (Fig. 4-14). **The toucan dissipates a lot of body heat through its bill, which acts like a "radiator" of heat.**

During periods of cold weather, birds try to conserve body heat. To do this, they ruffle their feathers to increase the warm-air insulation thickness, and they reduce exposure of non-feathered parts. If its not too cold, they may use the simple technique of just pulling one leg and foot up into their feathers (Fig. 4-15).

But as temperatures continue to drop, **birds use different strategies to cover those "exposed" areas of their body-** the feet, legs, and bill (Fig. 4-16). Birds that are native to temperate and subarctic regions would not benefit from a large bill, long featherless legs, and any head adornments

such as a comb, wattles, snood, etc. Penguins wouldn't do well with a comb or wattles.

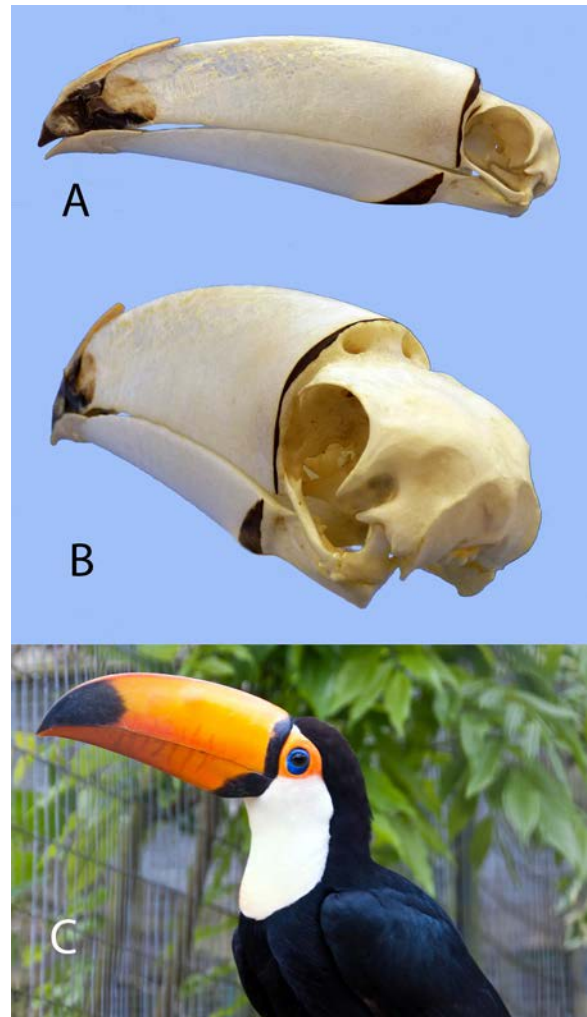


Figure 4-14. Skull of common toucan (*Ramphastos toco*): (A) left lateral view; (B) left caudolateral view; (C) photo of common toucan courtesy of: [http://en.wikipedia.org/wiki/File: Ramphastos_toco_Birdworld,_Farnham,_Surrey,_England-8a.jpg](http://en.wikipedia.org/wiki/File:Ramphastos_toco_Birdworld,_Farnham,_Surrey,_England-8a.jpg).

So what happens when none of the above techniques is works? Is there any thing else a bird can do? Well, there is old saying- **"If you can't beat'em, join them."** And when birds, especially small birds, with a large surface area relative to body mass, can't stay warm enough, **they can resort to another technique known as going into a state of "torpor."**



Figure 4-15. Canada Goose conserving some body heat by pulling one leg into its feathers. This photo was made in Raleigh, NC on March 4, 2015.



Figure 4-16. Canada Goose on a cold frosty morning with ambient temperature about 12° F. To conserve body heat, the feathers are ruffled, it is sitting on its feet and legs, and it has tucked its bill under a wing. The photo was made in Raleigh, NC on February 20, 2015.

Do birds hibernate? The idea that some birds hibernate dates back to at least Aristotle, who believed some birds spent the winter hiding in holes. Even Carl Linnaeus wrote about swallows spending the winter beneath lakes. Meriwether Lewis recorded hibernating common poorwills in 1804. The Hopi Indians were apparently aware of the hibernation of the poorwill, giving it the name *Hölchoko*, meaning “the sleeping one.” To date the **common poorwill (Fig. 4-17) is the only bird known to hibernate for an extended period (weeks or months).** However other small birds are known to go into a state of “minihibernation” or **torpor**.



Figure 4-17. Common Poorwill (*Phalaenoptilus nuttallii*). Watercolor by Louis Agassiz Fuertes (1925). (Photo courtesy: https://en.wikipedia.org/wiki/Common_poorwill#/media/File:Phalaenoptilus_nuttalliiDF28N04B).

During this torpor period (usually at night), there is reduced physiologic activity, **allowing the metabolic rate and body temperature to drop.** In this state of “**physiologic hypothermia,**” which may last 12-15 hours, the bird is non-responsive, as if it were in a coma. This technique is employed by several species of small birds, including the Carolina Chickadee and the Ruby-throated Hummingbird. These birds find a protected cavity or other space, and go into a temporary state of minihibernation.

So why do so many birds migrate if they can tolerate cold weather? Well, the reason many birds migrate to a warmer climate during the winter months is only indirectly related to temperature. When heavy snows come, it makes food harder to find. When lakes freeze over, fish are no longer available to diving birds. **The primary reason birds migrate to a warmer climate is so they can find adequate food.**

I’ve said it before, and I’ll say it again. **One of the primary reasons that birds have been so successful as a group of animals is their remarkable ability to adapt to different environments, even the harsh cold of Antarctica.**

Chapter 5: The Adaptable Digestive System

The digestive system of birds varies widely with the great diversity of foods consumed by different avian species. We have already looked at the beak and its keratinized sheath, the **rhamphotheca** (Fig. 4-4). **Teeth are replaced by the cutting edge of the rhamphotheca, referred to as the tomia.**

Did you know that birds have a cleft palate? This would be a deformity in mammals, but is perfectly normal in birds. The cleft or opening between the nasal cavity and oral cavity (oropharynx) is called the **choana** (Fig. 5-1). There is also a second opening, a little further back called the **infundibular cleft**, which is where the auditory tubes from the middle ears open into the oropharynx. **During swallowing, the choana and infundibular clefts are closed-off to prevent food from entering these openings.** The **palate** is characterized by numerous ridges, which are used in some species to remove the outer shell of seeds.

The avian **tongue** is as variable as the many types of food eaten by birds. Those variations can be considered as **adaptations for the collection, manipulation, and swallowing of food.** For example, the tongue of woodpeckers can be protruded to collect insect larvae and tree sap, while the tongue of hummingbirds (nectar feeder) can be extended into flowers.

The tongue of some birds is adapted for manipulating food and may be **fleshy** as it is in many parrots (Fig. 5-2). Other modifications are seen in fish-eating species that use their **spiny tongues** to help grasp slippery prey (Fig. 5-3), or in **filter-feeding** and **grass-eating** geese and duck.

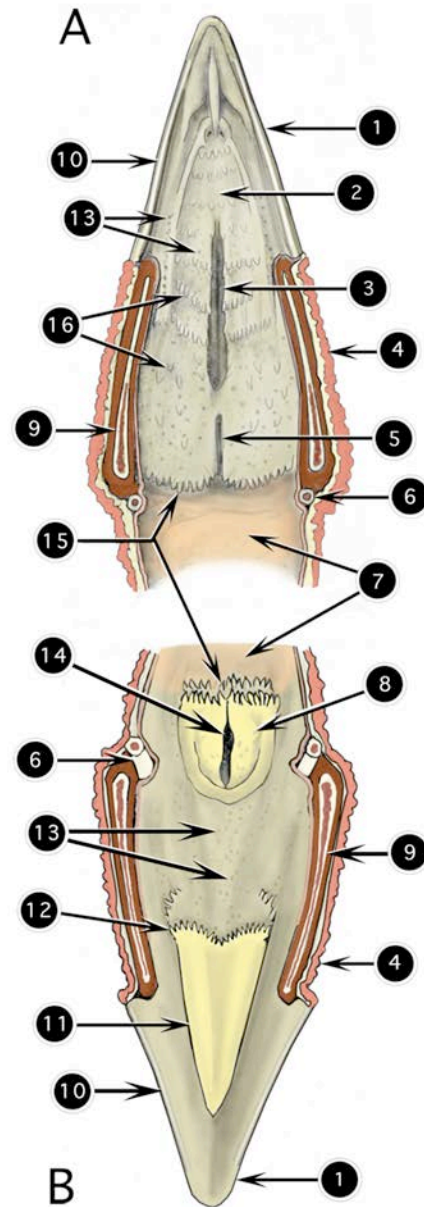


Figure 5-1. Opened oropharynx of chicken, roof A, floor B: (1) rhamphotheca (beak); (2) palate; (3) choana (palatine cleft); (4) rictus; (5) infundibular cleft (common opening of auditory tubes); (6) hyobranchial apparatus; (7) esophagus; (8) laryngeal mound; (9) mandible; (10) tomia, cutting edge of 1; (11) tongue; (12) lingual papillae; (13) openings of salivary glands; (14) glottic cleft; (15) pharyngeal papillae; (16) palatine papillae. (Modified after *Anatomy of the Domestic Birds*, R. Nickel, A. Schummer, E. Seiferle, Springer-Verlag, New York, 1977, page 43.)

For example, in the **dabbling ducks**, there are numerous stiff bristles along the lateral margins of the tongue, which interdigitate with the **lamellae** of the bill (Fig. 5-4). Water containing the small particles upon which they feed is drawn into the oropharynx, the tongue is pressed against the palate, and the **food material is filtered from the water** as it is forced out laterally between the lamellae of the bill. This is similar to the way baleen works in some species of whales. Likewise, in grass-eating ducks and geese, similar stiff bristles assist in cutting the blades of grass with the bill.



Figure 5-2. Photograph of Blue & Gold Macaw showing fleshy tongue used to manipulate food. (Photo courtesy of: shutterstock_29064781-1).



Figure 5-3. Photograph of penguin tongue showing stiff dorsal papillae or spines that help in grasping fish. (Photo courtesy of: 5399202917_ebebb9fcab).

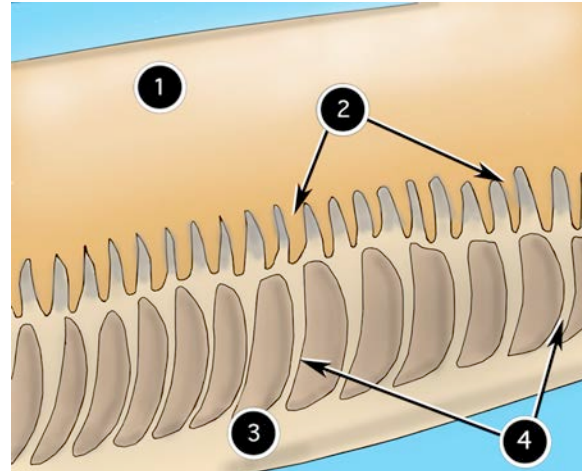


Figure 5-4. Drawing of tongue of dabbling duck, lateral view: (1) fleshy tongue; (2) bristles on lateral margin of tongue; (3) lower bill; (4) lamellae of bill.

There is considerable variation in how birds drink- chickens, and many other birds, raise their head and use the help of "gravity flow," while other species (*viz.*, pigeons, doves) keep their head down while drinking. The **laryngeal mound** (larynx) is located on the floor of the oropharynx, just behind the root of the tongue (Fig. 5-1).

Figure 5-5 is my attempt at showing what I call a "**generic bird gut**" (alimentary canal). There really isn't such a thing, because birds have options. The "**Y/N**" notations indicate that some birds have a crop, others don't; some birds have a gallbladder, others don't; and some birds have paired ceca, others don't have ceca at all.

In contrast to the typical left-sided path in mammals, the **esophagus** of the bird courses in a subcutaneous position along the **right side of the trachea** in the cervical region (Fig. 5-6). In many species (*viz.*, chicken, turkey, pigeon, canary, parrots), the esophagus forms a dilatation near the thoracic inlet technically known as the **ingluvies**, but more commonly called the **crop**.

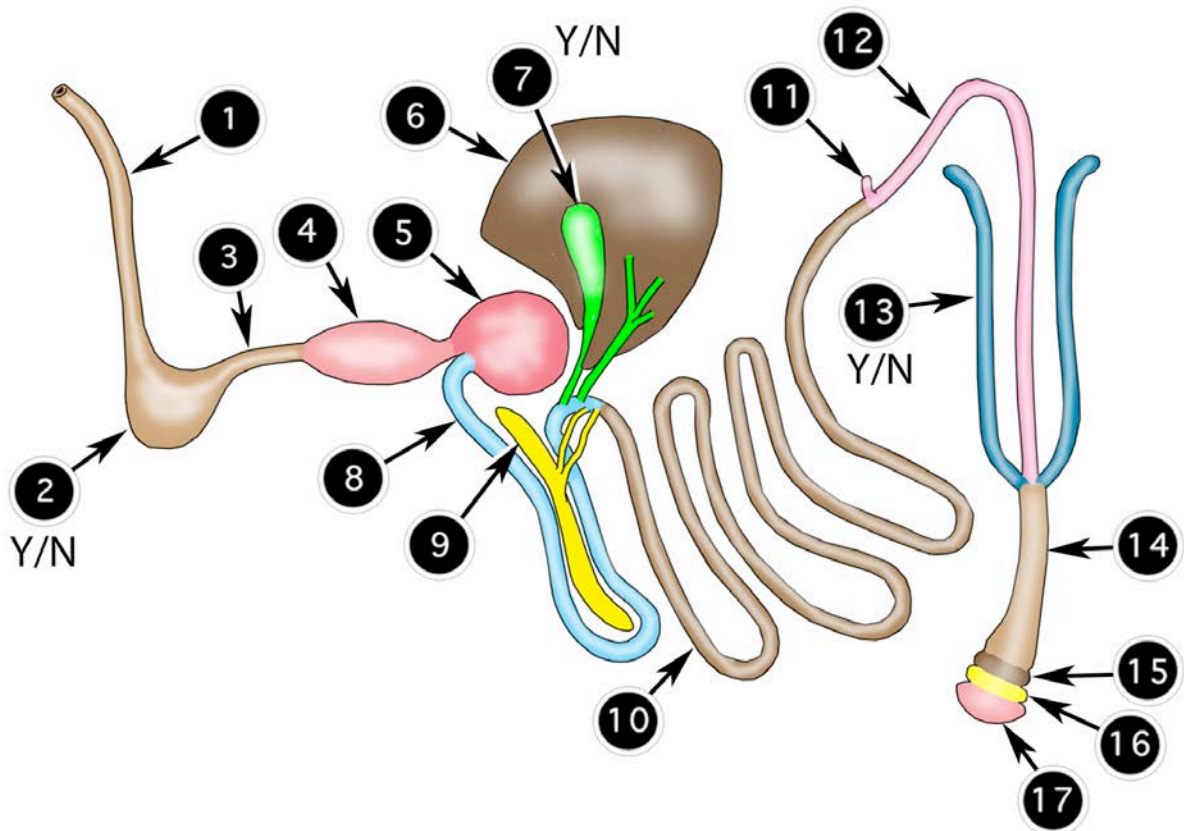


Figure 5-5. My version of a “generic bird gut (alimentary canal): (1) cervical esophagus; (2) crop or ingluvies; (3) thoracic esophagus; (4) proventriculus or glandular part of stomach; (5) ventriculus or muscular part of stomach; (6) liver; (7) gallbladder; (8) duodenum; (9) pancreas; (10) jejunum; (11) vitelline (Meckel’s) diverticulum; (12) ileum; (13) paired ceca; (14) rectum; (15) coprodeum; (16) urodeum; (17) proctodeum. 15-17 are divisions of the cloaca; Y/N = optional structure.

The **crop**, which like the esophagus proper has prominent mucous glands associated with it, represents a **temporary storage compartment** for food waiting to move into the stomach. **The crop allows for an “eat-now, digest-later” advantage so that birds can feed quickly and gain possession of potentially scarce food before some competitor gets to it. Many species of birds, including many fish-eating groups (viz., penguins and gulls) do not have a crop.** When present, the shape and size of the crop show considerable variation.

The **crop of pigeons and doves is especially well developed**, consisting of two large lateral sacs. Pigeons produce what is commonly called “**crop milk**,” which consists of fat-laden epithelial cells, mixed with food. This nutritious material is regurgitated by the adults (both sexes) and fed to the young (**squabs**) for some days after hatching. Other birds such as the male emperor penguin and the greater flamingo also produce a nutritive fluid in their esophagus, which is regurgitated to feed their chicks.

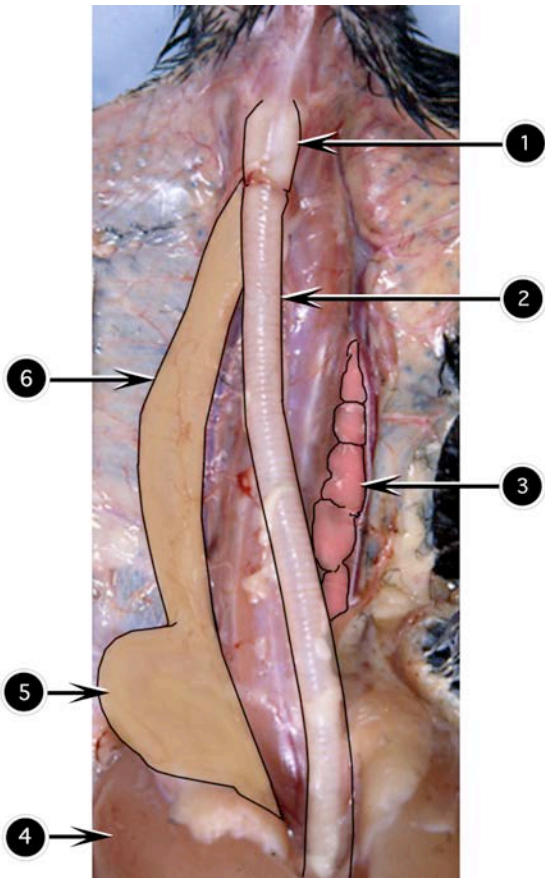


Figure 5-6. Dissection of neck of chicken, ventral view: (1) larynx; (2) trachea; (3) thymus; (4) pectoral muscle; (5) crop (ingluvies); (6) esophagus.

The bird with the greatest development of the crop is the hoatzin (Fig. 5-7). This native of the Amazon region eats leaves, fruits, and flowers. Its crop is divided into 3 large compartments. **Much like a cow, the hoatzin uses its complex crop for fermentative digestion.** As a result of this fermentation, the hoatzin releases a rather unpleasant aroma, which contributes to one of its common names—**“stink bird.”** Actually, being a stinky bird is not such a bad thing for a clumsy bird that doesn’t fly very well. **Potential predators, including humans, tend to leave this bird alone because of its unpleasant odor.**¹

¹ Sometimes being a “stinky bird” is not such a bad thing.



Figure 5-7. South American Hoatzin (*Opisthocomus hoazin*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Opisthocomus_hoazin.jpg)

The stomachs of birds vary considerably with their diet, and are divided into two basic types: type 1 (carnivorous) & type 2 (non-carnivorous). **A type 1 stomach is relatively large and is designed more for storage and chemical breakdown than for physical digestion.** Thus, this type is typically thin-walled and more sac-like (Fig. 5-8). The gastric glands of the avian stomach are associated with the first compartment of the stomach, termed the **proventriculus**.

Large glands within the wall of the **proventriculus produce both enzymes and hydrochloric acid.** The second compartment of the stomach is termed the **ventriculus**, which in the carnivorous stomach is typically large and relatively thin-walled as compared with that of the seedeaters.

The **type 2 stomach** of non-carnivorous birds (chicken, turkey, pigeon, etc.) consists of the same two compartments, the **proventriculus** or glandular part, and the **ventriculus** or muscular part, which are connected by a constriction or **gastric isthmus** (Fig. 5-9).

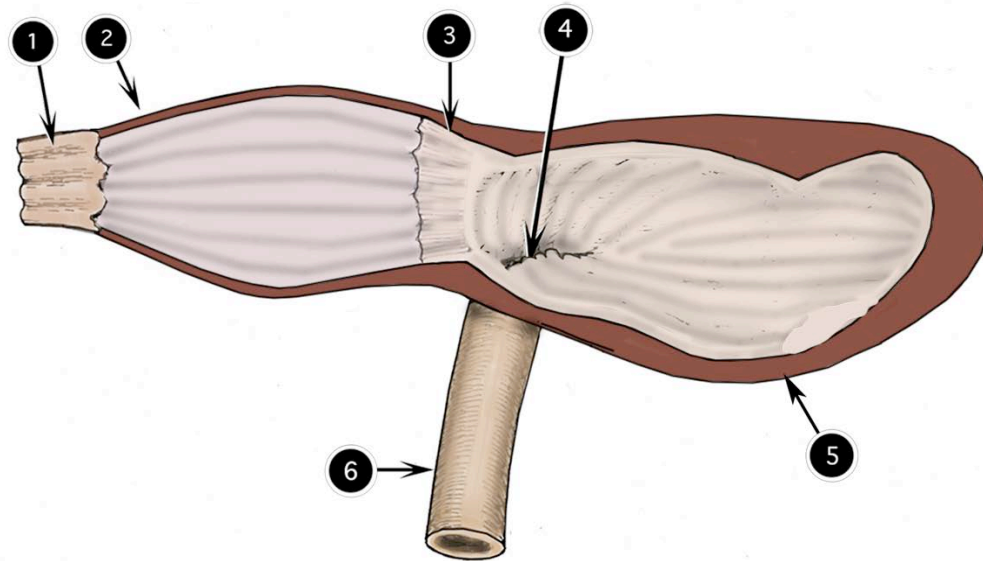


Figure 5-8. Type 1 stomach of carnivorous birds: (1) esophagus; (2) proventriculus; (3) intermediate zone; (4) pyloric part of ventriculus leading to duodenum; (5) thin-walled ventriculus; (6) duodenum.

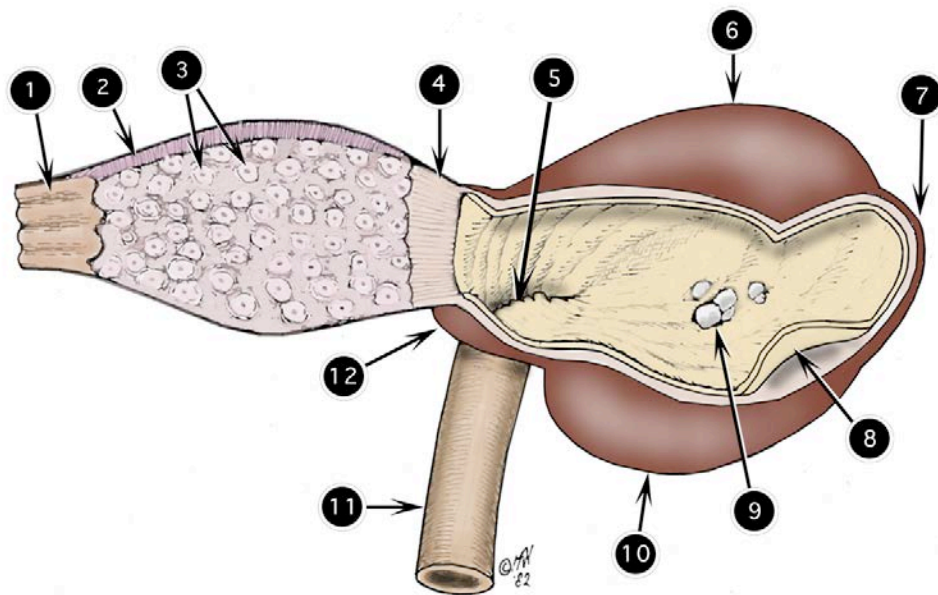


Figure 5-9. Stomach of chicken (opened), left lateral view: (1) esophagus; (2) compound gastric glands forming thick layer in wall of proventriculus; (3) gastric gland opening on papillae; (4) gastric isthmus; (5) pyloric part of ventriculus leading to duodenum; (6) caudodorsal thick muscle of ventriculus; (7) caudal sac of ventriculus; (8) gastric cuticle (koilin layer), partly reflected; (9) grit used to help grind seeds; (10) cranioventral thick muscle of ventriculus; (11) duodenum; (12) cranial sac of ventriculus.

The ventriculus of seed-eating (non-carnivorous) birds is also called the “**gizzard**.” It is **much more muscular than the ventriculus of carnivorous birds**, and typically takes the form of a flattened oval of muscle (Fig. 5-9). The lining of the ventriculus is thin, but is protected by a **cuticle or koilin layer**, which is produced by glands within the stomach wall. Koilin is a carbohydrate-protein complex that solidifies on the mucosal surface, forming a protective inner-liner for the ventriculus (Fig. 5-8). **It is removed in processing the gizzard for food.**

In seed-eating birds (*viz.*, chicken, turkey, budgerigar), the ventriculus typically contains small stones or **grit**, which owing to the lack of teeth, **functions in the "gastric mastication" of the food material** (Fig. 5-8).

As mentioned above, various species of birds regurgitate material from their crop or stomach to feed their young. Another function of **gastric regurgitation** in raptors is to **purge the stomach of indigestible remnants of their prey**. Not only is it normal for hawks and owls to regurgitate this digestive residue, it is essential for the health of the bird.

The term **pellet** is used to describe these regurgitated **clumps of fur, feathers, bones, teeth, etc.** (Fig. 5-10). In falconry the pellets are called **castings**. Regurgitating the pellet, which typically occurs some 6-10 hours after the meal, **helps to scour or clean the esophagus**.

Falconers, routinely give their birds roughage so that it will be regurgitated to cleanse the crop of bacteria, a process known as “casting.” **Captive birds of prey need to be given roughage in addition to meat.** Although typically associated with

hawks and owls, pellets are also regurgitated by herons, kingfishers, cormorants, gulls, terns, grebes, crows, and many shorebirds.

Although the avian stomach is divided into the two main categories of type 1 and type 2, **this is an over simplification of the great diversity of stomach designs among avian species.** Like the esophagus, the stomach of many carnivorous birds must be large and distensible to accommodate the large prey that is often swallowed whole.

For example, great blue herons, in addition to large fish, will swallow an adult rat or even a duckling. Also, **birds can be very indiscriminant in what they ingest**, often including **foreign bodies**, which can lead to serious illness and even death (Fig. 5-11).



Figure 5-10. Regurgitated bird pellet. Black bars are 1 cm long. (Photo courtesy: http://en.wikipedia.org/wiki/File:Bird_pellet.jpg)



Figure 5-11. Foreign bodies removed from stomach of crane at necropsy. Anyone lose a bungee cord?

As in mammals, the intestines of the bird can be divided into the **small intestine**, made up of the duodenum, jejunum, and ileum (Fig. 5-5), and the **large intestine**, consisting of the paired ceca, and a rectum (Fig. 5-5).

The **duodenum** is the first part of the small intestine and typically forms a distinct loop with descending and ascending limbs. The duodenum lies close to the ventral body wall and **encloses the pancreas within its loop** (Figs. 5-12 & 5-13).

In most birds, the **jejunum** forms numerous loosely arranged loops (Fig. 5-13). Its junction with the **ileum** is defined in the bird by the presence of the **vitelline** (Meckel's) **diverticulum**, a small remnant of where the yolk sac was attached to the gut.

The **large intestine** consists of paired **ceca** and a short **rectum**.² In the chicken, turkey, duck, goose and owl, two long ceca are present alongside the ileum. In the base of the ceca, their walls contain areas of lymphatic tissue, which are often referred to as the "cecal tonsils." The **ceca provide an area of fermentative digestion, and serve an important role in water resorption.**

Ceca are short and poorly developed in the pigeon, and are not present at all in psittacine birds (parrots). The term **rectum** is used to describe the short, terminal part of the large intestine, which enters the **cloaca** in an expanded area termed the **coprodeum**.

The **cloaca** is common to both the digestive and urogenital systems, and consists of three areas, the **coprodeum**, **urodeum**, and **proctodeum**, which are

partly partitioned by two annular folds (Fig. 5-14). **The external opening of the cloaca is properly termed the vent.**

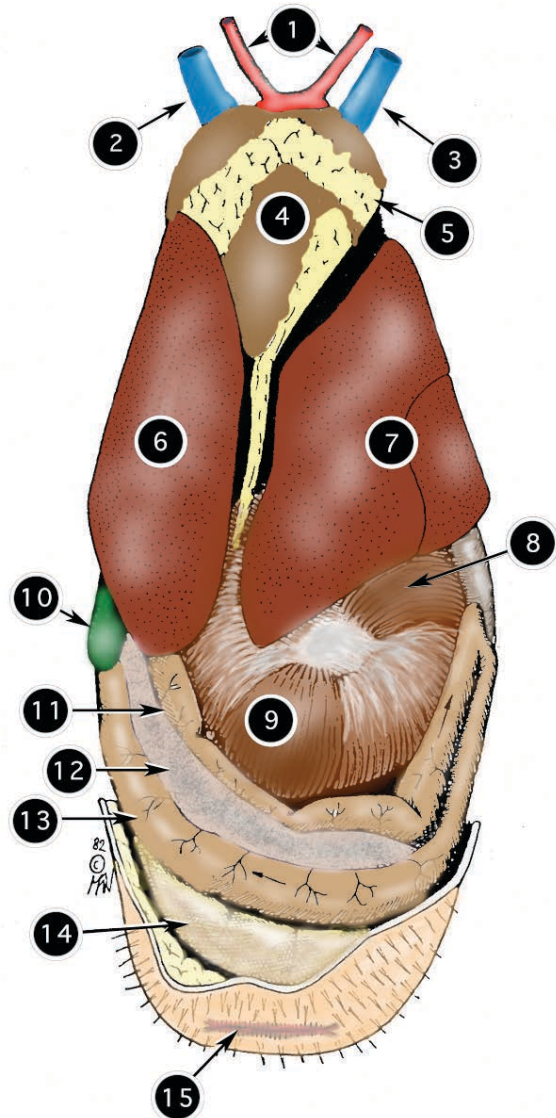


Figure 5-12. Viscera of chicken, ventral view: (1) right & left brachiocephalic trunks; (2) right cranial vena cava; (3) left cranial vena cava; (4) heart; (5) fat in coronary groove; (6) right lobe of liver; (7) left lobe of liver; (8) cranial sac of ventriculus; (9) caudal sac of ventriculus; (10) gallbladder; (11) descending limb of duodenum; (12) pancreas; (13) ascending limb of duodenum; (14) one of paired ceca; (15) opening of cloaca (vent).

² Some references will refer to the rectum as the colon, but *Nomina Anatomica Avium*, the official book of avian nomenclature uses rectum, not colon.

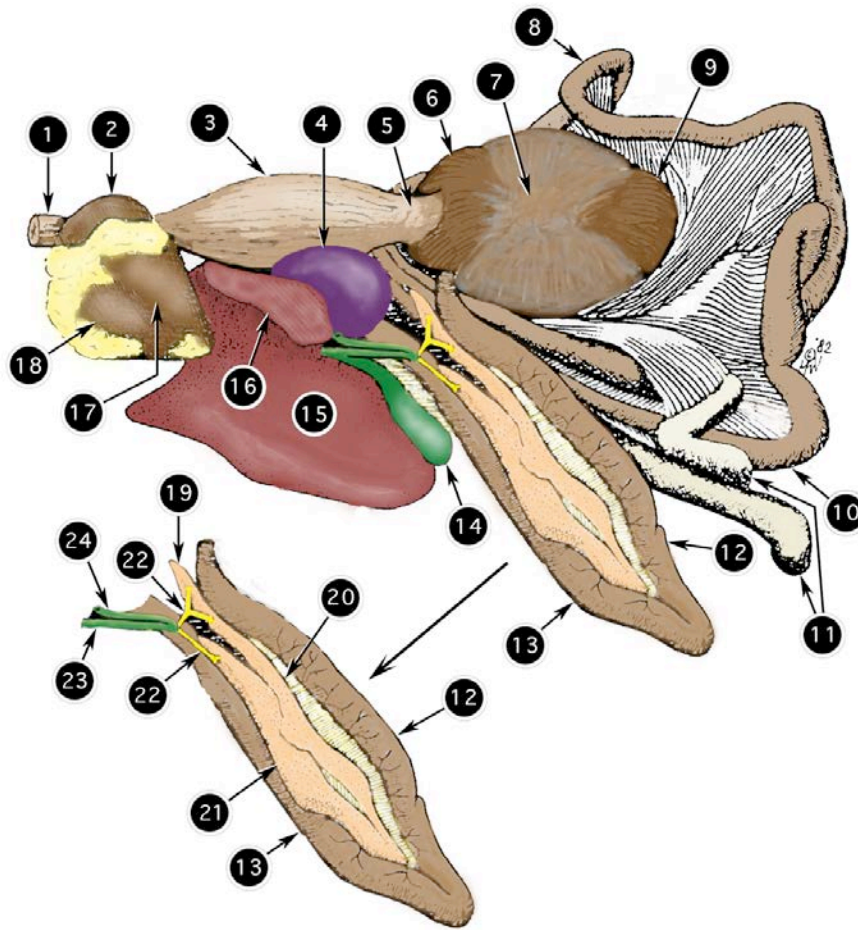


Figure 5-13. Viscera of chicken in situ, left lateral view: (1) esophagus; (2) left atrium of heart; (3) proventriculus; (4) spleen; (5) gastric isthmus; (6) thin muscle covering cranial sac of ventriculus; (7) central tendinous part of ventriculus; (8) jejunum; (9) thin muscle covering caudal sac of ventriculus; (10) ileum; (11) apices of paired ceca; (12) descending limb of duodenum; (13) ascending limb of duodenum; (14) gallbladder; (15) right lobe of liver; (16) cut surface of liver where left lobe of liver was removed; (17) left ventricle of heart; (18) right ventricle of heart; (19) splenic lobe of pancreas; (20) dorsal lobe of pancreas; (21) ventral lobe of pancreas; (22) pancreatic ducts; (23) cystoenteric duct from gallbladder and right lobe of liver; (24) hepatoenteric duct from left lobe of liver.

The **coprodeum** receives the fecal matter from the rectum and is separated from the urodeum by the **coprourodeal fold**. As the name implies, the **urodeum** receives the ureters and either the ducti deferentes (*vas deferens*) of the male or the left oviduct in the female. The **proctodeum** is the terminal part of the cloaca, between the uroproctodeal fold and the vent.

In young birds, there is a duct in the dorsal wall of the proctodeum leading to the large **cloacal bursa** (Fig. 5-14). This “bursa,” popularly known as the “bursa of Fabricius,” is in reality a **lymphoid diverticulum that is immunologically important**. The lymphatic tissue surrounding the lumen of the diverticulum is the **site of differentiation of the bursal (B)-lymphocytes**, which are thought to be originally derived from yolk sac stem cells.

mammals, containing amylase, lipase and proteinases.

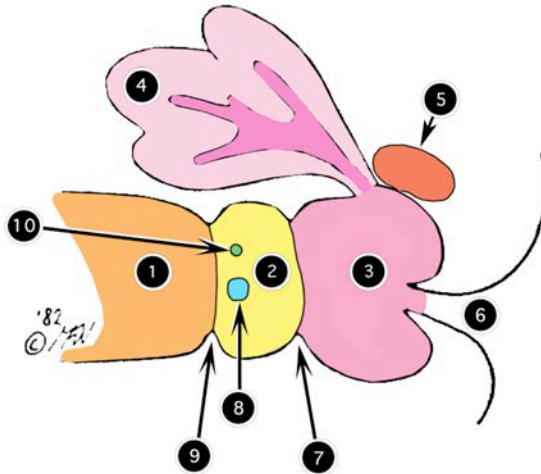


Figure 5-14. Schematic representation of cloaca of young chicken, median section, left lateral view: (1) coprodeum; (2) urodeum; (3) proctodeum; (4) cloacal bursa; (5) dorsal proctodeal gland; (6) vent; (7) uroproctodeal fold; (8) location of papilla of ductus deferens in male or left oviduct in female; (9) coprourodeal fold; (10) opening of ureter.

Liver: The liver occupies much of the cranial part of the thoracoabdominal cavity. **In young hatchlings, the liver has a more yellow color**, which is due to the presence of pigments absorbed from the **yolk sac**. The liver consists of **right** and **left lobes**, which are connected dorsal to the heart (Figs. 5-12 & 5-13). The **gallbladder**, when present, is associated with the surface of the right lobe of the liver. **There is no gallbladder in the ostrich, pigeon or budgerigar**; however, some other species of parrots do have a gallbladder.

Pancreas: As previously noted, the pancreas is located within the duodenal loop (Figs. 5-12 & 5-13). The exocrine secretion of the pancreas is similar to that of



This wood sculpture of the Great Blue Heron has nothing to do with what we've been talking about, but I had some space to fill here. I did this sculpture in August, 2013.

Chapter 6: The Efficient Respiratory System

One of the most remarkable anatomic features of birds is their highly efficient respiratory system. **They are able to breathe very effectively, even without a diaphragm.**

The **nostril** (naris) is partly protected in the some bird species by an over-hanging shelf of beak known as the **operculum** (Fig. 4-4). In some species the nostrils are surrounded by the **cere** (Fig. 4-7). **Albatrosses and petrels have tubular nostrils** (Fig. 6-1). In some species (herons & cormorants), the nostrils are non-functional, and **Anhingas don't have any nostrils at all.**

As in mammals, the **nasal cavity** is divided by a **nasal septum** into right and left halves. As previously noted, the nasal cavity communicates with the oropharynx *via* the **choana** (Fig. 5-1). Each side of the nasal cavity of the chicken has three scroll-like structures known as **conchae**, designated as rostral, middle, and caudal (Fig. 6-2). The latter concha is air-filled, and its cavity communicates with the infraorbital sinus, which is an extension from the nasal cavity. **Even though birds have conchae in their nasal cavity, very few birds can smell.**

The **infraorbital sinus** (Fig. 6-3), which lies ventral to the eye, **is subject to infections of various types in the bird.** In psittacine birds (parrots), right and left infraorbital sinuses communicate, not only with one another, but also with extensive pneumatized areas of the skull and neck. **This is why respiratory diseases in birds, especially psittacines, can be difficult to treat.** The infection can easily become widespread throughout the body.



Figure 6-1. Head of Southern Royal Albatross showing **tubular nostril**. (Photo courtesy: http://en.wikipedia.org/wiki/File:070226_southern_royal_albatross_off_Kaikoura_2.jpg).

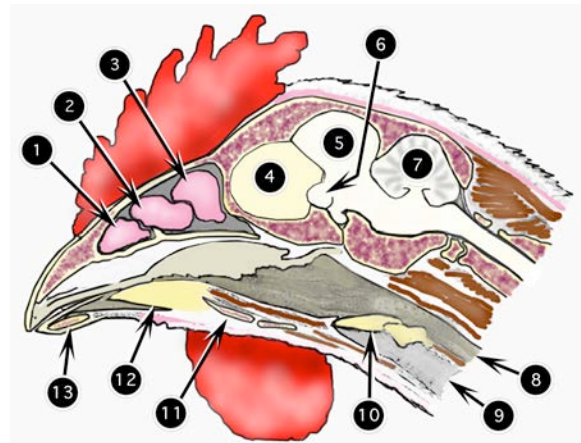


Figure 6-2. Head of Chicken, sagittal section: (1) rostral nasal concha; (2) middle nasal concha; (3) caudal nasal concha; (4) interorbital septum; (5) cerebrum; (6) optic chiasm; (7) cerebellum; (8) esophagus; (9) trachea; (10) arytenoid cartilage of larynx; (11) hyobranchial apparatus; (12) tongue; (13) mandible. (Modified after *Anatomy of the Domestic Birds*, R. Nickel, A. Schummer, E. Seiferle, Springer-Verlag, New York, 1977, page 45.)

One duct that opens into each side of the nasal cavity of birds is that of the **nasal gland** (Fig. 6-4), which is not located within the nasal cavity, but lies dorsal to (above) the orbit. This is the so-called "**salt gland**," so named because in some marine birds, the gland has an osmoregulatory function that **allows them to drink seawater ($\approx 3\%$ salt) and excrete the salt via this gland**. The salt is excreted as a hypertonic ($\approx 5\%$) saline solution from the nostril.

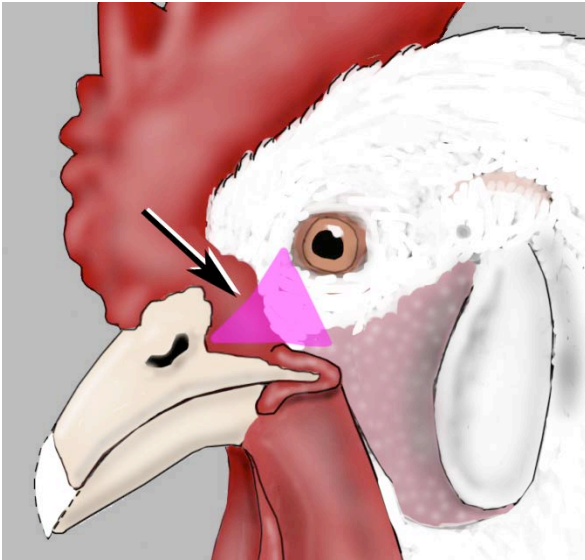


Figure 6-3. Location of left infraorbital sinus of chicken. These paired sinuses are subject to serious infections, which can be difficult to treat, especially in psittacine birds.

Although the gland has a similar osmoregulatory function in some raptors and desert birds that feed on salty prey, it is present in many other species (*viz.*, chicken), where it has no known salt-excreting function.

The **laryngeal mound (larynx)**, which projects into the floor of the oropharynx, is supported by several cartilages (Fig. 5-1). Unlike the situation in mammals, the **larynx is not the site of sound production in birds**. **Birds don't even have any vocal cords.**

Vocalization occurs in the syrinx, which is located at the other end of the trachea, where it divides into the principal bronchi going to the lungs. Although the larynx is not the site of sound origination, the **larynx can serve to modulate the sounds** produced in the syrinx.

The **glottis** is not homologous to the mammalian glottis in that there are no vocal cords in birds; however, paired cartilages surround and protect the slit-like opening of the glottis (Fig. 5-1). **Closure of the glottis during swallowing protects the lower respiratory tract against aspiration of water or food material.**

Unlike the C-shaped **tracheal cartilages** of mammals, those of birds consist of tightly overlapping and **complete rings** (Fig. 6-5). The trachea accompanies the esophagus through the cervical region and can typically be palpated (Fig. 5-6). Some portions of the trachea of the ostrich are not supported by cartilage. Other species (*viz.*, penguins) have a so-called "double trachea" in which a median septum divides the trachea for a variable length into right and left halves.

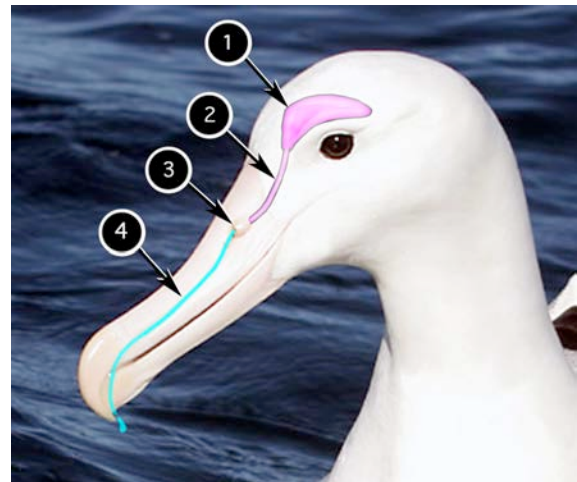


Figure 6-4. Nasal gland of Southern Royal Albatross: (1) nasal gland in supraorbital location; (2) duct of gland leading to nasal cavity near naris; (3) tubular naris; (4) hypertonic saline solution being conducted rostrally *via* groove in upper beak.

The avian trachea shows a great deal of species-specific variation. For example, the trachea of the emu and ruddy duck has an inflatable compartment, the **tracheal sac**. Some species (*viz.*, swans, cranes, etc.) have **rather complicated tracheal loops or coils**, which may be partially housed within the sternum (Fig. 6-6). Having such a long trachea would appear to increase airflow resistance; however, **the avian trachea has a diameter almost 1.5 times that of a comparably sized mammal**.

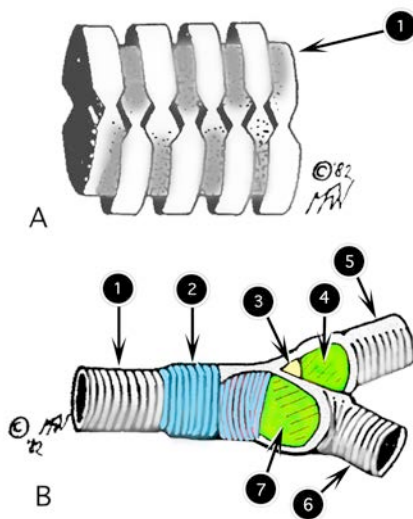


Figure 6-5. Schematic representation of trachea (A) and syrinx (B) of chicken, left lateral view: (1) interlocking tracheal cartilages; (2) tympanum; (3) pessulus; (4) medial tympaniform membrane; (5) right principal bronchus; (6) left principal bronchus; (7) lateral tympaniform membrane.

It is thought that these species-specific arrangements of loops and coils serve as **sound resonating chambers**, allowing the unique call of a particular species to be produced with rather low pressure. When one considers the wide variation in tracheal looping among different species, it is certainly suggestive of the **variations found in musical instruments** such as the trumpet, coronet, trombone, and French horn.

The **syrinx, which is the source of sound production in birds**, is typically located in the vicinity of the tracheal bifurcation (division) into bronchi (Fig. 6-5). There is considerable species variation, and even differences between the male and female.

In its basic design, the syrinx consists of partially ossified cartilages for support, paired **tympaniform membranes** that **vibrate to produce sound**, and various muscles that can alter the tension on the syrinx and its tympaniform membranes. **All "vocalization" in birds is thought to be produced on expiration**, when a rise in pressure forces the tympaniform membranes into the lumen (cavity) of the syrinx. **Sound is produced either by vibration of the tympaniform membranes and/or other mechanisms that produce columns of turbulent airflow through the syrinx.**

The syrinx of the **male duck** should receive special attention because of its peculiar feature, the **syringeal bulla**. This egg-shell-like, osseous bulla is asymmetric, being primarily associated with the left bronchial part of the syrinx (Fig. 6-7). **Such a bulla is present in most species of duck.** Apparently, this bulla serves as an additional resonance chamber to modulate the sound of the male "quack." **It may even serve to soften the sound of the drake as compared with the more boisterous sound of the hen.**

Lungs: Avian lungs are relatively small for body size, are confined to the craniodorsal (upper front) part of the thoracoabdominal cavity, and are more or less embedded against the ribs and thoracic vertebral column. Unlike in mammals, there is **no diaphragm** separating the body cavity into thoracic and abdominal cavities. However, the lungs do not extend down

around the heart, because they are held in their dorsal compartment by a **horizontal septum**. The lungs are loosely attached to their surroundings, there are **no pleural**

cavities, as in mammals, and most remarkable, there is **very little change in lung volume between inspiration and expiration**.

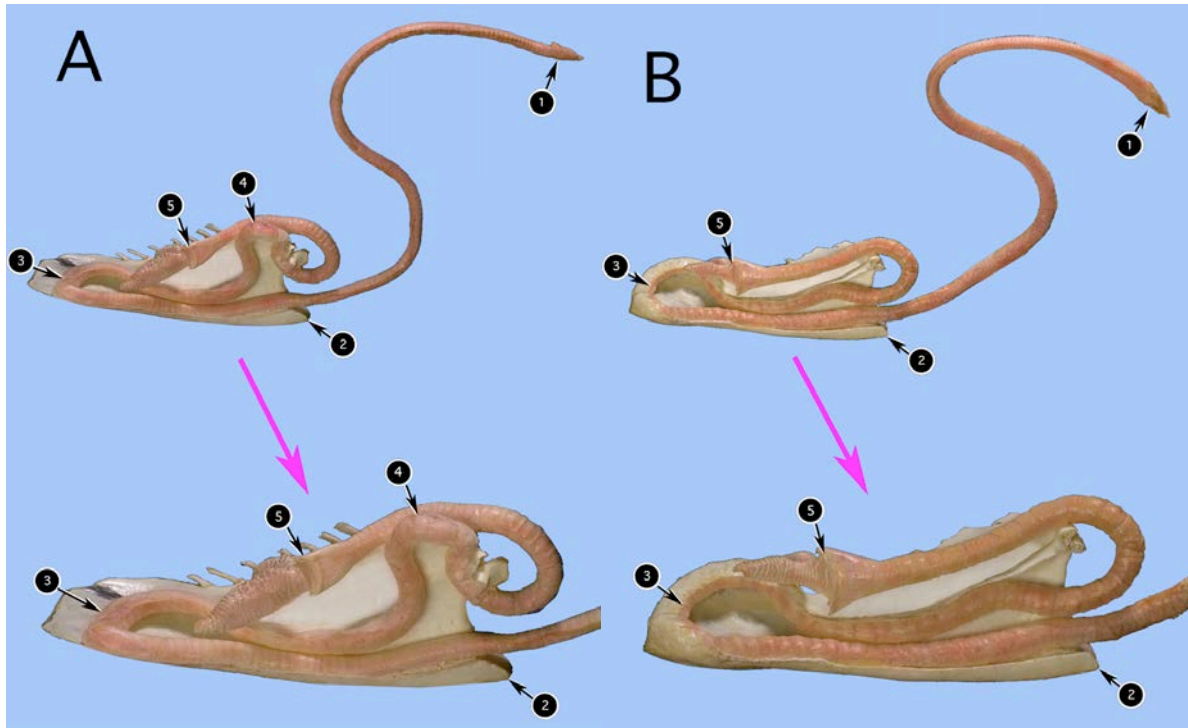


Figure 6-6. Photographs comparing trachea and sternum of trumpeter swan, *Olor buccinator* (A) with that of tundra (whistling) swan, *Cygnus columbianus* (B): (1) larynx; (2) keel of sternum; (3) caudal transverse loop of trachea; (4) dorsal loop of trachea in osseous bulla (A only); (5) syrinx. (Specimens kindly provided by Dr. Laurel Degernes, NC State University College of Veterinary Medicine.)

The lungs of birds are bright red in color, are not divided into lobes, and have a quadrilateral to triangular shape (Fig. 6-8). Similar to mammals, the principal bronchus and pulmonary vessels enter the lung at its **hilus**.

Before we go any further, we have to tell you something pretty basic about bird lungs. The lung of the bird has been "added onto" over time. There is the basic "old lung" (paleopulmo), which is present in all birds, and the so-called "new lung" (neopulmo), which is the more recent (phylogenetically speaking) addition.

The **paleopulmo** consists of the medioventral and mediadorsal secondary bronchi and their parabronchi; the large lateroventral bronchus, which passes through to the caudal thoracic air sac; and two or three other lateroventral bronchi and their parabronchi. The **parabronchi of the paleopulmo** are generally arranged in a pattern of parallel, **arch-like connecting loops** between two secondary bronchi (Fig. 6-8), and **airflow is unidirectional** through these parabronchi. In some species of birds (*i.e.*, penguins), the entire lung is formed by the paleopulmo.

In most avian species, the neopulmo makes up about 10% of the lung. The

neopulmo is made up of a network of **anastomosing (interconnecting) bronchi** consisting of small laterodorsal bronchi and their parabronchi; laterally directed parabronchi of the lateroventral bronchi; and the connections of this network with the caudal air sacs. In addition to their anastomotic design, the **parabronchi of the neopulmo allow gas exchange in either direction— a major advantage.**

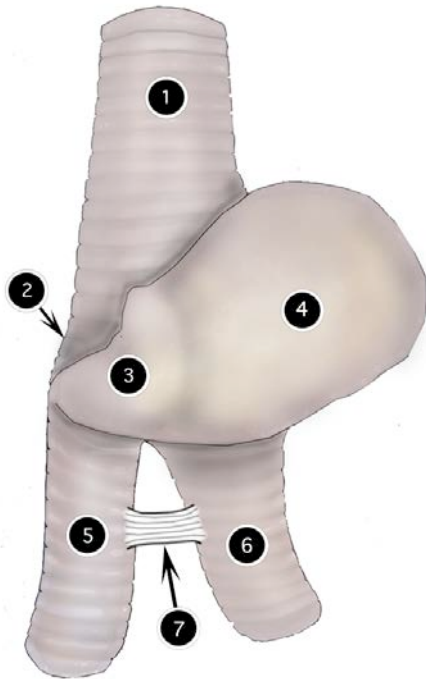


Figure 6-7. Syringeal bulla of drake, ventral view: (1) trachea; (2) syrinx; (3) minor compartment of syringeal bulla; (4) major compartment of syringeal bulla; (5) right principal bronchus; (6) left principal bronchus; (7) interbronchial ligament. (Modified after McLelland, *A Color Atlas of Avian Anatomy*, WB Saunders Co., 1991: p. 103.)

The term **parabronchi**, which was originally introduced to bird terminology about 1882, has hung-on supposedly because of its "simplicity." What this term actually describes are the **tertiary bronchi**, which includes all bronchi of the 3rd order or smaller. Although more logical, attempts to use the term tertiary bronchi for these structures have been largely unsuccessful.

Parabronchi are of uniform diameter ranging in size from about 0.5 mm in the hummingbird to about 2.0 mm in the chicken and other species. Thus, they are grossly visible in the chicken lung.

Parabronchi differ significantly from the tertiary bronchi of mammals, which we would expect to continue branching on down to the "terminal" alveoli. Well, **parabronchi actually have a whole network of minute air capillaries mixed with blood capillaries right in their wall** (Fig. 6-9). As mentioned above, parabronchi measure about 2 mm, while the air capillaries, which are functional homologues of the mammalian alveoli, are only about 5 μm in diameter. Obviously, the **air capillaries have a distinct functional advantage in that they are not "terminal," but rather can receive air (oxygen) coming through from either direction.**

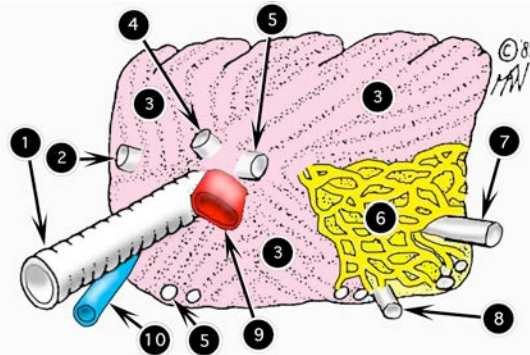


Figure 6-8. Right lung of chicken, septal surface: (1) principal bronchus; (2) connection with cervical air sac; (3) arch-like pattern of parabronchi in paleopulmo (old lung); (4) connection with clavicular air sac; (5) connection with cranial thoracic air sac; (6) net-like pattern of parabronchi of neopulmo (new lung); (7) direct continuation of principal bronchus with abdominal air sac; (8) connection with caudal thoracic air sac; (9) pulmonary vein; (10) pulmonary artery.

The air capillaries are highly tortuous tubes that branch and anastomose

(interconnect) freely with one another. With their small, but uniform diameter, there is considerable resistance to airflow, which makes the **pressure gradient for oxygen exchange in birds much higher** than in mammals. As mentioned above, the air capillaries intermesh intimately with a high-volume network of blood capillaries, which is more extensive than in mammals. Also, the **blood-gas barrier is significantly thinner in birds** than in mammals. All of these features (and others not mentioned) **give the bird a distinct respiratory advantage over the mammalian arrangement.**

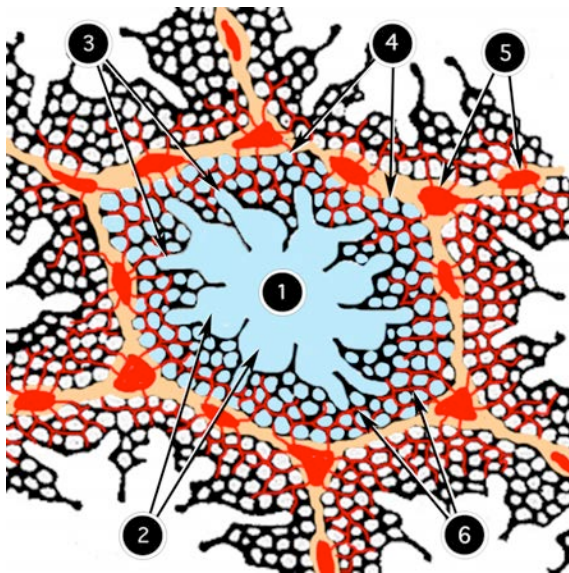


Figure 6-9. Schematic representation of adjacent parabronchi in cross-section: (1) lumen of parabronchus; (2) atria; (3) infundibula; (4) air capillaries; (5) interparabronchial blood vessels; (6) blood capillaries of lung.

Air Sacs: Air sacs are **thin-walled extensions of the respiratory system** (Figs. 6-10 & 6-11). **Diverticula from the air sacs invade just about everything in the area, including bones.** There are **eight air sacs in the chicken** as follows: unpaired clavicular and cervical air sacs (= 2); and paired cranial thoracic, caudal thoracic, and abdominal air sacs (= 6).

Although air sacs function in the overall plan of air movement for respiration, the lungs of the bird account for almost all the actual gas exchange. On the other hand **the air sacs provide "turn-around points" for the air so that it can make another run, back through the lungs.** The cervical, clavicular, and cranial thoracic together form a functional unit referred to as the **cranial air sacs.** This group has been around longer and is associated with the paleopulmo. The caudal thoracic and abdominal air sacs comprise the **caudal air sacs**, which are relative newcomers and are associated with the neopulmo.

So how does all of this work? Well here goes. **On inspiration, slight movements of the ribs and sternum pull air through the lungs and into the air sacs** (Fig. 6-12). The caudal air sacs get a first-pass hit of fresh air because some of it takes an express way *via* a direct continuation of the principal bronchus. The cranial air sacs have to settle for "semi-used" air that has already been through a set of parabronchi. **This means that we now have some reserve fresh air in the caudal air sacs that can be pushed back through the lungs on expiration.** As you can see, birds are definitely on the cutting-edge of respiratory technology. *They're not cheating are they?*

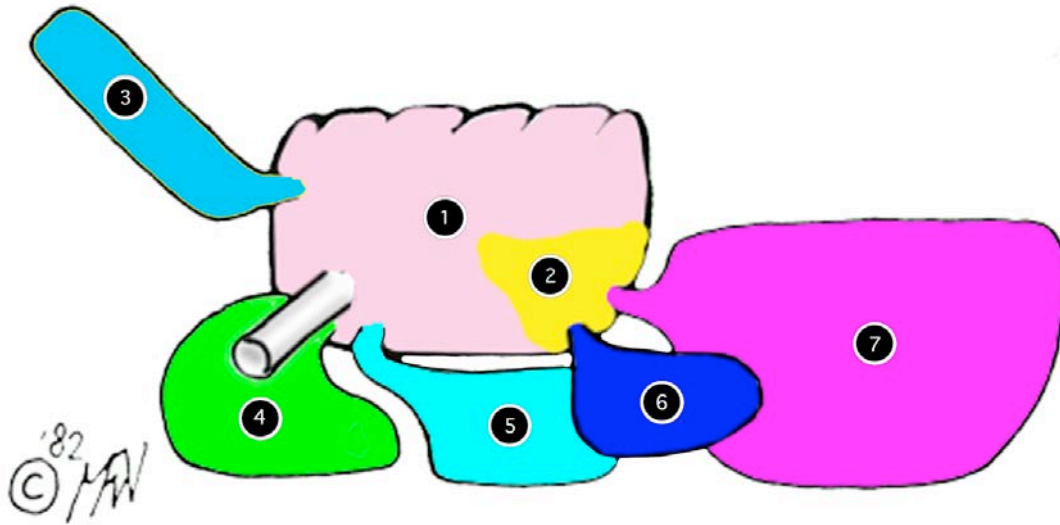


Figure 6-10. Schematic representation of right lung & air sacs of chicken: (1) right lung, paleopulmo; (2) right lung, neopulmo; (3) cervical air sac; (4) clavicular air sac; (5) cranial thoracic air sac; (6) caudal thoracic air sac; (7) abdominal air sac.

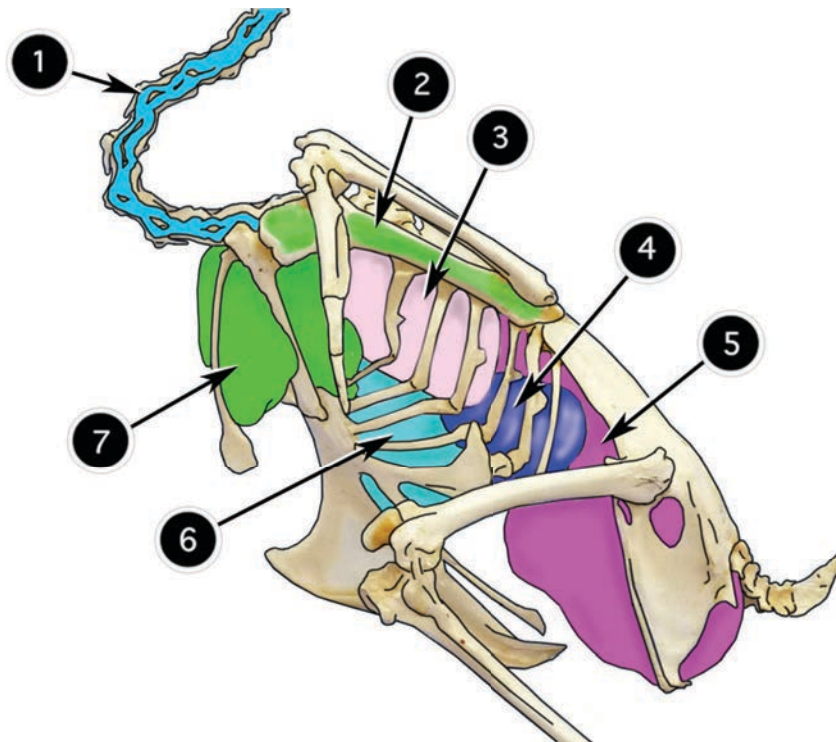


Figure 6-11. Lungs & air sacs of chicken: (1) cervical air sac; (2) extension of clavicular air sac into humerus; (3) lung; (4) left caudal thoracic air sac; (5) left abdominal air sac; (6) left cranial thoracic air sac; (7) clavicular air sac.

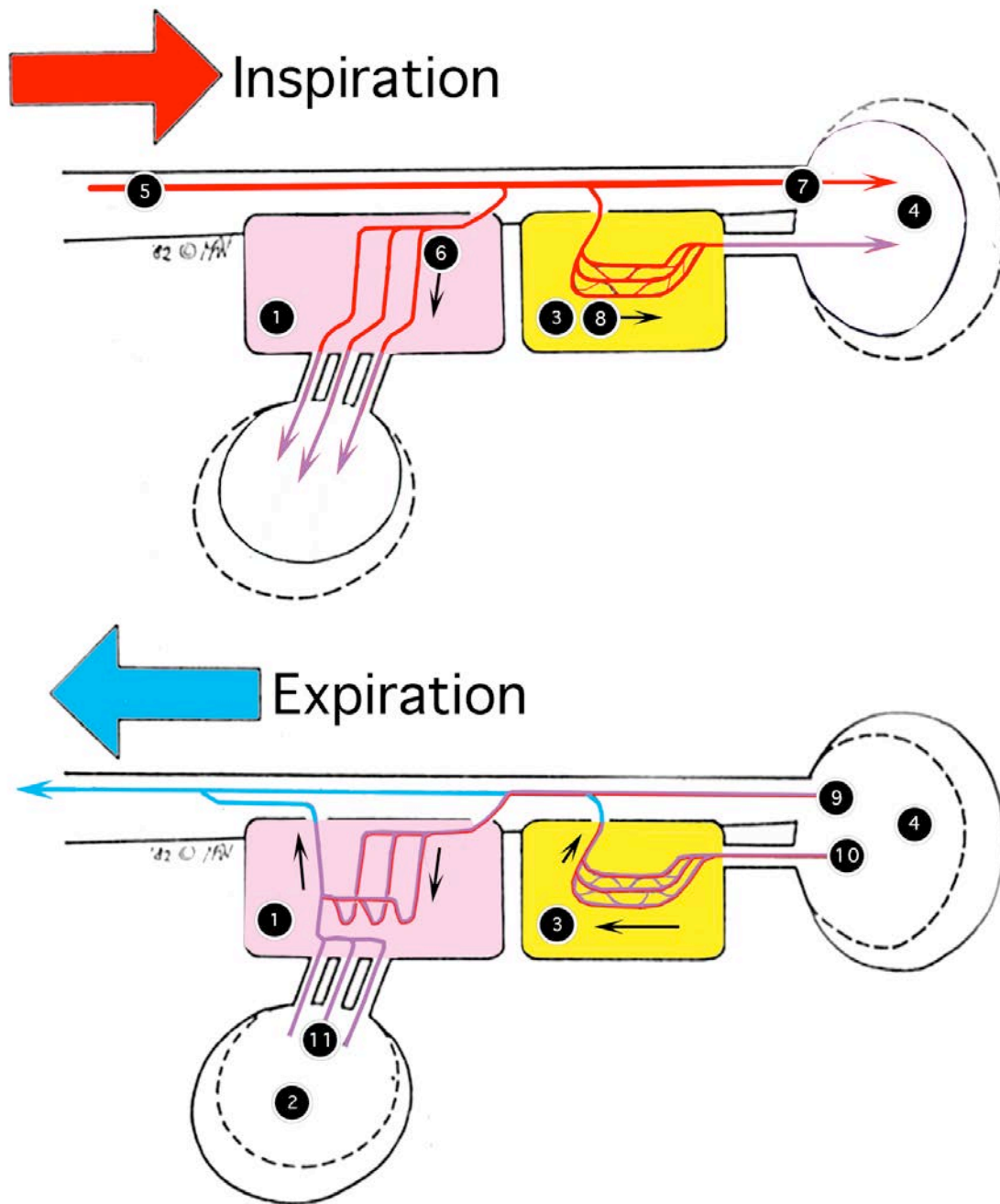


Figure 6-12. Schematic representation of air flow through lungs and air sacs of bird: (1) paleopulmo (one-way air flow in parabronchi); (2) cranial air sacs; (3) neopulmo (two-way air flow in parabronchi); (4) caudal air sacs; (5) inspired air in principal bronchus; (6) part of 5 is diverted through paleopulmo & to cranial air sacs; (7) part of 5 goes directly to caudal air sacs; (8) part of 5 goes through neopulmo to caudal air sacs; (9) part of air passes back through paleopulmo; (10) part of air is diverted back through neopulmo; (11) air in cranial air sacs is diverted back into principal bronchus.

Chapter 7: Urinary and Reproductive Systems

The **urinary** and the **reproductive** (genital) **systems** can be grouped together as the **urogenital system**.

The **kidneys** of the bird are elongated, brown structures that are embedded for the most part in excavations of the ventral surface of the pelvic bones. The kidney of the bird is typically divided by adjacent arteries into **cranial**, **middle**, and **caudal divisions** (Fig. 7-1). These divisions are not distinct in passerine birds such as the canary, and in both the canary and budgerigar, the caudal divisions appear to be fused.

As in mammals, the functional (blood filtering) unit of the kidney is the **nephron**, but in birds there are two distinct types. The **cortical nephrons** are the majority type in most birds and are similar in structure to those of reptiles in that they located entirely within the outer cortex of the kidney (Fig. 7-1). The **medullary nephrons** are more like those of mammals in that they have a loop that extends into the medulla of the kidney. The **collecting ducts** from groups of nephrons come together forming bundles, which drain one renal lobule. Several bundles of these collecting ducts then unite to form **secondary branches** of the ureter, which drain one **renal lobe**. Likewise, several secondary branches come together to form a **primary branch** of the ureter (Figs 7-1 & 7-2).

The **ureter** (Fig. 7-1), which originates in the cranial division of the kidney by union of several primary branches, courses caudally along the ventromedial aspect of the kidney, receiving additional primary branches along the way. **Once all of these branches have been collected, the ureter continues directly to the cloaca**, where it

empties its thick, white semisolid urates in the dorsal part of the **urodeum**.

These urates can then be moved by retrograde peristalsis back into the rectum and ceca, where additional water can be reclaimed. Following this little detour, the urates and feces are typically expelled together. The dark-colored fecal matter is mixed with the white urates. **Conspicuously absent in the bird are a urinary bladder and a urethra.**

The major difference between blood flow through the avian kidney *vs.* that of the mammal is the presence in the bird of a **renal portal system, which is capable of filtering in-coming venous blood** on its way back from a capillary bed in other body tissues. Blood returning from the pelvic limbs *via* the **ischiodic veins** or from the pelvic area *via* the **internal iliac veins** can be partially diverted through renal portal veins (Fig. 7-1). Here it is filtered through the kidney just as if it were arterial blood. The amount of venous blood diverted through the kidney is controlled by a **renal portal valve** located in the **common iliac vein** (Fig. 7-2). Closure of this valve increases resistance to direct venous return and the blood follows the path of least resistance, which is through the kidney.

Although the percentage of blood from the pelvic limbs and pelvis that is filtered by the kidney varies with the closure-status of the renal portal valve, there are always "escape routes" around the kidney if renal portal pressure increases so that it is no longer the path of least resistance. For this reason, **injection of medications into the pelvic limbs is not a good idea in birds.**

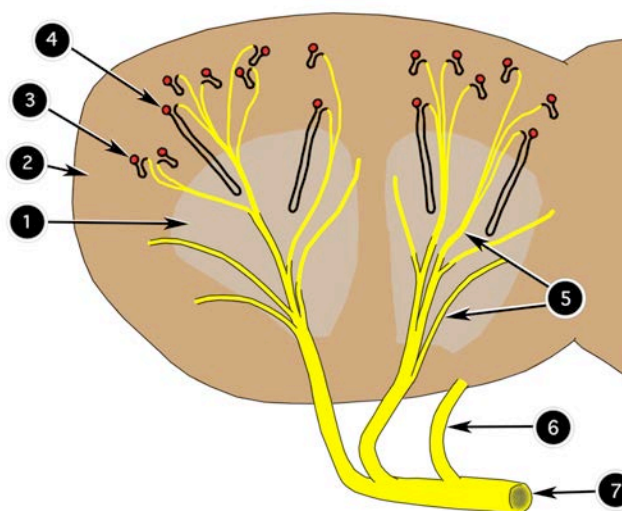


Figure 7-1. Schematic representation of bird kidney showing two adjacent lobes: (1) medulla of one lobe; (2) cortex of kidney; (3) cortical nephron (majority type); (4) medullary nephron with loop extending into medulla; (5) bundles of collecting ducts from groups of nephrons; (6) secondary branch of ureter draining one lobe; (7) primary branch of ureter.

Male Genital Organs: The male genital organs consist of paired testes, epididymes, ducti deferentes (*vas deferens*), and the phallus or copulatory organ (Fig. 7-3). The absence of a urethra pretty much eliminates the home base for any accessory genital glands (prostate, etc.).

The size of the testes varies greatly with the reproductive activity level of the bird. During the breeding season (nuptial phase), they more than double in size compared with the non-breeding period. The testes are typically located near the cranial extremities of the kidneys, where they are attached to the dorsal body wall.

Sex determination, which is not possible from external examination in some birds, used to be done *via* laparoscopy, with direct visualization of the gonads using a fiber optic scope. Knowing the sex of a large pet bird can increase significantly its monetary value. **DNA testing is now the method of**

choice for use in sexing birds so that laparoscopy is no longer necessary.

The testes of common domestic species appear yellow or whitish yellow in color, however, the presence of some dark pigmentation is not uncommon. The **epididymis**, is formed primarily by the highly convoluted ductus epididymis. The latter is continuous with the tightly looped **ductus deferens** (*vas deferens*) near the caudal extremity of the testis. The ductus deferens, which owing to its full load of spermatozoa appears white during the breeding season, courses caudally with the ureter to the urodeum. The terminal part of the ductus straightens out and is slightly enlarged in this segment (Fig. 7-3). In some species (canaries), the more caudal part of the ductus becomes highly convoluted forming an enlarged mass.

During the breeding season (nuptial phase) of these birds, this part of the

ductus becomes so enlarged with spermatozoa that it produces a protrusion externally, which can be used to sex male canaries. The ductus deferens opens on a

papilla in the dorsal wall of the urodeum (Fig. 7-3).

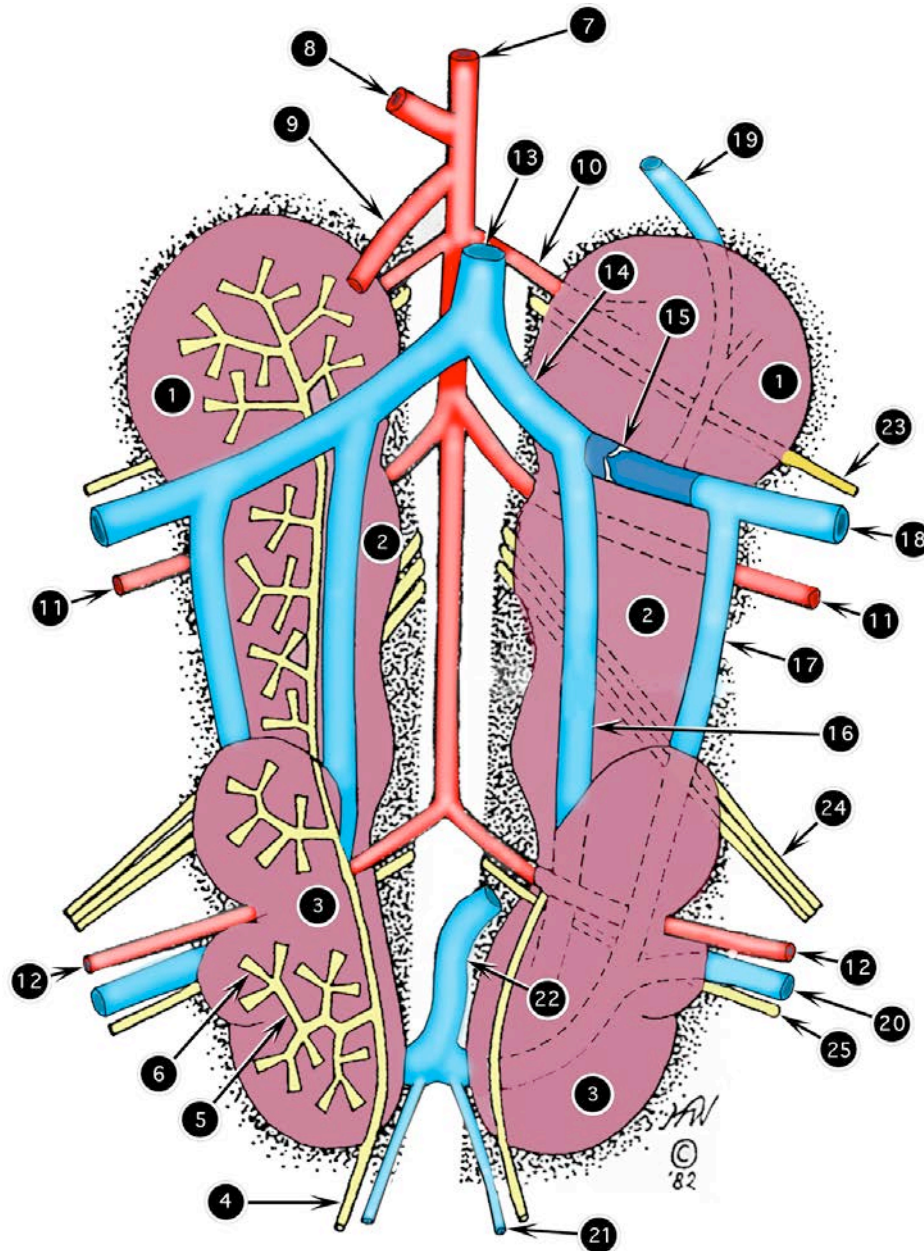


Figure 7-2. Schematic representation of kidneys of chicken, ventral view: (1) cranial division of kidney; (2) middle division of kidney; (3) caudal division of kidney; (4) ureter; (5) primary branch of ureter; (6) secondary branch of ureter; (7) aorta; (8) celiac artery; (9) cranial mesenteric artery; (10) cranial renal artery; (11) external iliac artery; (12) ischiadic artery; (13) caudal vena cava; (14) common iliac vein; (15) renal portal valve; (16) caudal renal vein; (17) caudal renal portal vein; (18) external iliac vein; (19) anastomosis of cranial renal portal vein with vertebral venous sinus; (20) ischiadic vein; (21) internal iliac vein; (22) caudal mesenteric vein; (23) femoral nerve; (24) sciatic nerve; (25) nerve to pudendal plexus.

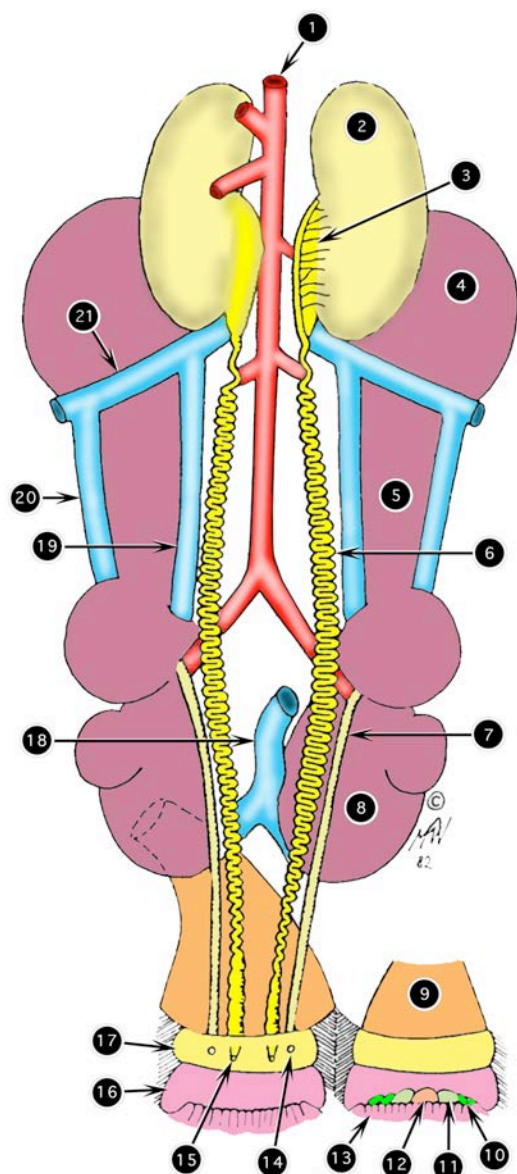


Figure 7-3. Genital organs of rooster, ventral view: (1) aorta; (2) testes; (3) epididymis; (4) cranial division of kidney; (5) middle division of kidney; (6) ductus deferens; (7) ureter; (8) caudal division of kidney; (9) coprodeum; (10) lymphatic folds; (11) lateral phallic body; (12) median phallic body; (13) vent; (14) ureteral orifice; (15) opening of ductus deferens on papilla; (16) proctodeum; (17) urodeum; (18) caudal mesenteric vein; (19) caudal renal vein; (20) caudal renal portal vein; (21) external iliac vein.

Along the ventral lip of the vent are located several structures that together form the **non-protrusible phallus** of many bird

species, including the chicken and turkey. These consist of a **median tubercle**, which is flanked on either side by the **lateral phallic bodies**. These are supplemented with lymphatic folds that become involved with intumescence¹ of the phallus (Fig. 7-3).

When engorged during the tumescent state, the **phallus protrudes slightly from the cloaca** and the grooves formed between the median tubercle and lateral phallic bodies serve as "gutters" to direct the semen to the cloaca of the female. During copulation, the phallus is pressed against the cloacal mucosa of the female, an act commonly referred to as the "cloacal kiss." It's typically not a long, lingering kiss, but does last long enough for the semen to be transferred to the cloaca of the female.

Ducks, geese, ratites (ostrich, emu, etc.) and some other species are different. These birds have a **protrusible phallus**, which functions much like a penis (although it is not a penis) for cloacal intromission (Fig. 7-4). The phallus of the duck is an elongated, spiral structure several centimeters in length. The semen is conducted along the phallus *via* a **phallic groove**, which spirals around the organ (Fig. 7-4).

Female Genital Organs: Embryologically birds have paired **ovaries** and oviducts; however, during development **the right ovary and oviduct typically degenerate** so that only the left develops to a functional state (Fig. 7-5). The oviduct, which consists of several distinct segments, is a very large structure when fully developed, measuring about twice the length of the bird when straightened out. Degeneration of the right ovary and oviduct saves a lot of room in the thoracoabdominal cavity, and saves a lot of unnecessary weight. If you want to fly, weight is not your friend. The **kiwi**, one of

¹ Intumescence- engorgement with fluid.

the flightless birds, **retains both ovaries and oviducts**. I'm not really sure why they need two ovaries; they only lay one egg a year, but it's a whopper.

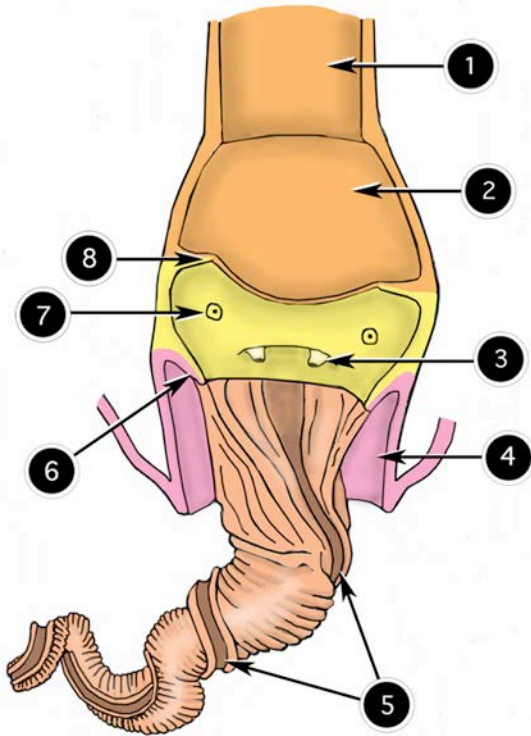


Figure 7-4. Genital organs of male duck, ventral view: (1) rectum; (2) coprodeum; (3) opening of ductus deferens on papilla; (4) proctodeum; (5) phallic groove spiraling around protrusible phallus; (6) uroproctodeal fold (7) ureteral orifice; (8) coprourodeal fold.

As the female bird matures to the state of reproductive competency, the **ovary** develops from a small infantile structure to one that is **completely covered with follicles**, which then enlarge in sequence to a phenomenal size, reaching several centimeters in diameter in the chicken. Because the ovary becomes covered with these developing follicles, the ovary of the

mature bird resembles a cluster of grapes (Fig. 7-5).

Each **follicle** contains a large yolk-filled **oocyte**, which is enveloped by the thin-walled follicle. The follicular wall is highly vascular, but as the time of ovulation approaches, a linear non-vascular zone, the **stigma**, develops (Fig. 7-5). It is along this avascular stigma that the follicle tears to release the oocyte. The **oocyte** contains the germinal disc, which lies on the surface of the large yolk component of the oocyte, which is now contained within a soft yolk membrane.

Immediately following ovulation, the oocyte is fertilized if viable spermatozoa are available for the job. These spermatozoa are brought up the **oviduct** by the female, from a storage facility located in her vagina. **One insemination can be used for the daily fertilization of ova for up to 10 days or more (a clutch).**

The oocyte is drawn immediately into the upper end of the oviduct, which is a large funnel-shaped segment known as the **infundibulum** (Fig. 7-5). During the approximately **15 minutes** the oocyte spends in the infundibulum, a stronger outer yolk membrane is added. It is then coated with a thin layer of **very dense albumin** known as the **chalaziferous layer**. This layer, which later forms a "twisted-towel" wrapper known as the **chalaza**, extends from the yolk out toward the ends of the egg (see Chapter 8). The chalaza is **important in keeping the germinal disc in the center of the egg**. It becomes twisted by the rotation of the yolk around the longitudinal axis of the egg, and **it prevents any end-to-end rotation of the yolk**.

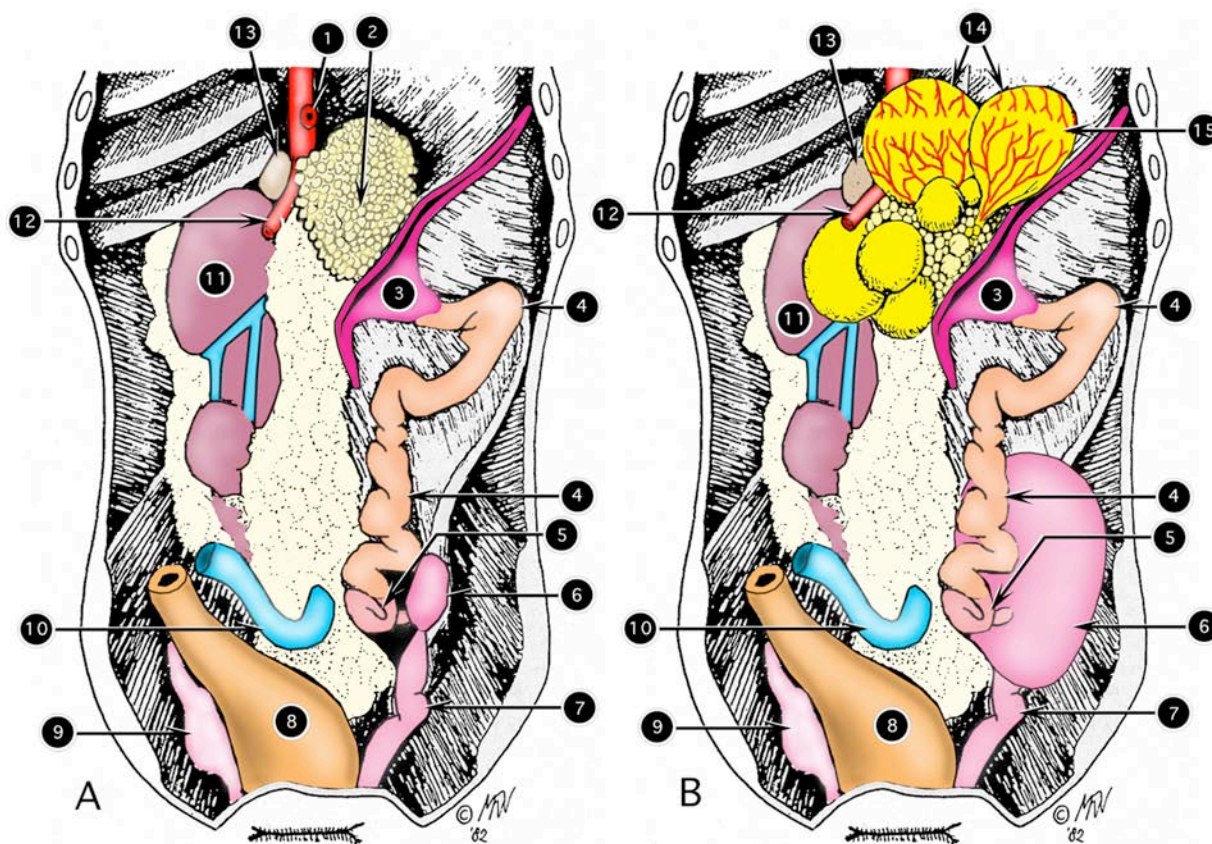


Figure 7-5. Genital organs of hen, ventral view: (A) Non-Laying hen; (B) Laying hen; (1) celiac artery; (2) ovary; (3) infundibulum; (4) magnum; (5) isthmus; (6) uterus (contains egg in B); (7) vagina; (8) coprodeum; (9) cyst in vestigial right oviduct; (10) caudal mesenteric vein; (11) right kidney; (12) cranial mesenteric artery; (13) right adrenal gland; (14) mature follicles; (15) stigma (avascular area along which follicle will rupture to release oocyte).

From the infundibulum, the oocyte now enters the **magnum, which is the longest segment of the oviduct**. During the next **3 hours** or so, large glands within in the thick wall of the magnum are busy pumping out more albumen, which is added on in layers around the slowly moving oocyte. The inner part of the albumen is thinner and more liquid than the more gel-like outer part, which is added in the lower part of the magnum and isthmus.

The **isthmus** is only about 8 cm long in the chicken, and the oocyte typically spends about **an hour** or less here. Besides adding more albumen, the inner and outer **shell**

membranes are added to the surface of the albumen layer.

Leaving the isthmus, the encapsulated albumen sac is ready for the outer hard shell, which is added to the oocyte in the **uterus**. The uterus of the chicken is only about 8 cm long, **but the egg remains in this short segment for approximately 20 hours**.²

² Some birds require longer than 20 hours to produce the calcified shell. Some birds can only lay one egg every other day, and one bird, the kiwi, only lays one egg a year. It takes the kiwi about 30 days to produce that one egg, but it is a whopper. Although the kiwi is about the size of a chicken, its egg is 5 times the size of a chicken egg. Wow! Now that's something to cackle about.

First some more thin albumen is pumped in through the shell membranes to "plump" the egg, and then **the real work begins**.

Production of the hard outer shell takes a lot of work, and a good bit of time. After the shell is finished, it is top-coated with a thin glaze-like cuticle, which helps protect the egg (ovum) and its contents.

The **vagina** is a short, S-shaped muscular tube, through which the egg is expelled into the urodeum. The ovum is propelled through the vagina rapidly, where it continues through the cloaca and vent to the outside world. **Now she can start cackling, being so proud of her accomplishment and all.** More on the anatomy of the egg itself will be covered in the next chapter.

Gynandromorphism: Some strange things can happen during embryologic development of birds. One such event is known as **bilateral gynandromorphism**. This phenomenon is also seen in insects and crustaceans, but is thought to be quite rare in birds. On February 21, 2021, a long-time birder named Jamie Hill photographed a gynandromorphic Northern Cardinal in Warren County, Pennsylvania, about 55 miles southeast of Erie (Fig. 7-6).

Hill's photograph was not the first documentation of gynandromorphism in Northern Cardinals. In fact, a similar bird was photographed by Shirley Caldwell in January 2019, also near Erie, Pennsylvania. (See (<https://www.nationalgeographic.com/animals/article/halfmale-half-female-cardinal-pennsylvania>).

So just how does this happen? Well, that's a good question, and it is believed that it happens like this. First you must understand that, unlike in mammals where the male

determines the sex of the progeny by supplying either an X or Y chromosome, it is the female bird that has both Z and W chromosomes. The male can supply only Z spermatozoa.



Figure 7-6: Gynandromorphic Northern Cardinal. (Photograph made February 20, 2021 by Jamie Hill in Warren County, Pennsylvania.) Arrows and letters added by JES.

For such a chimeric³ individual to result, the first mistake is that the female oocyte retains two nuclei, one with the Z, and one with the W chromosome. Now along come a couple of eager Z spermatozoa (the only kind), and each of the two nuclei are fertilized. Now you have both ZW and ZZ cells in the same individual resulting from this double fertilization. As the embryo develops, it tries to follow the genetic code, but receives "mixed messages." Thus one side of the chick contains female (ZW) cells and the other side contains male (ZZ) cells (Fig. 7-6). Why are just cardinals affected? Well this rare phenomenon likely occurs in other bird species, perhaps with equal frequency, but just goes unnoticed.

³ A genetic chimera is a single organism composed of cells with more than one genotype. In animals, such an individual is derived from two or more zygotes., which can include possession of both female and male sex organs = gynandromorphism.

Chapter 8: The Remarkable Egg

Now that we have followed the oocyte (now ovum) from the ovary to the vent, we should take a closer look at the ovum (egg) itself. In fact, **the anatomy of the egg is more complex than one might think** (Fig. 8-1).

We will start with the oocyte (yolk sphere), which is released from the follicle as the latter tore along the stigma. When the oocyte is released and captured by the infundibulum, the yolk sphere is already contained within a soft **yolk membrane**, which is produced by the ovary. The nucleus of the oocyte now rests on the **germinal disc**, which is a white spot on the surface of the yolk and is about 3 mm in diameter (Fig. 8-2). If fertilized, the germinal disc becomes the **blastoderm**; if not fertilized, it is known as the **blastodisc**. **Note: Almost all eggs you buy at the grocery store are infertile.** (These eggs are laid by commercial layers that have never even heard of a rooster, much less seen one.)

There are actually two types of yolk material. **White yolk** contains much more protein than fat and forms the **latebra**, which is a supporting pedestal for the germinal disc. The latebra consists of a central bulb, connected by a narrow neck to the **laterbral disc**, which lies just beneath the germinal disc (Fig. 8-1). Most of the yolk is made up of **yellow yolk**, which contains much more fat than protein.

In the **infundibulum**, a thicker **outer yolk membrane** is added to strengthen the yolk on its journey through the oviduct. The semi-permeable yolk membranes allow water from the albumen to enter the yolk and “plump” it to its definitive size. Also, within the infundibulum, the **chalaziferous**

layer of very dense albumin is added to the surface of the outer yolk membrane. This chalaziferous layer will mature within the oviduct to form the definitive **chalaza** that we see in the fully formed egg. The chalaza extends toward the ends of the egg, and becomes twisted as the yolk moves through the oviduct (Fig. 8-1). **Note: the chalaza is that “white blob” you see associated with the egg yolk; it is not the embryo** (Fig. 8-2).

The chalaza functions to keep the germinal disc centered in the egg, and because the side of the yolk away from the germinal disc is heavier, **the germinal disc consistently rotates to the top of the yolk**. The twisted part of the chalaza extending toward the blunt end of the egg is a single strand, while that toward the pointed end consists of a double-twisted strand (Fig. 8-1). The ends of the chalaza are embedded in the dense (polar) albumen.

A less viscous layer of **liquid or thin albumen** is added to the egg in the upper part of the **magnum**, which accounts for about 50% of the total albumen production. The albumen produced in the lower part of the magnum becomes more viscous or gel-like, forming the **dense or thick albumen** (Fig. 8-1).

In the **isthmus**, the **internal and external shell membranes** are added, and the remaining 50% of the albumen is produced. Part of this albumen forms the external layer of liquid albumen. In the uterus, more thin albumin is pumped through the shell membranes to “**plump**” the egg prior to production of the mineralized shell.

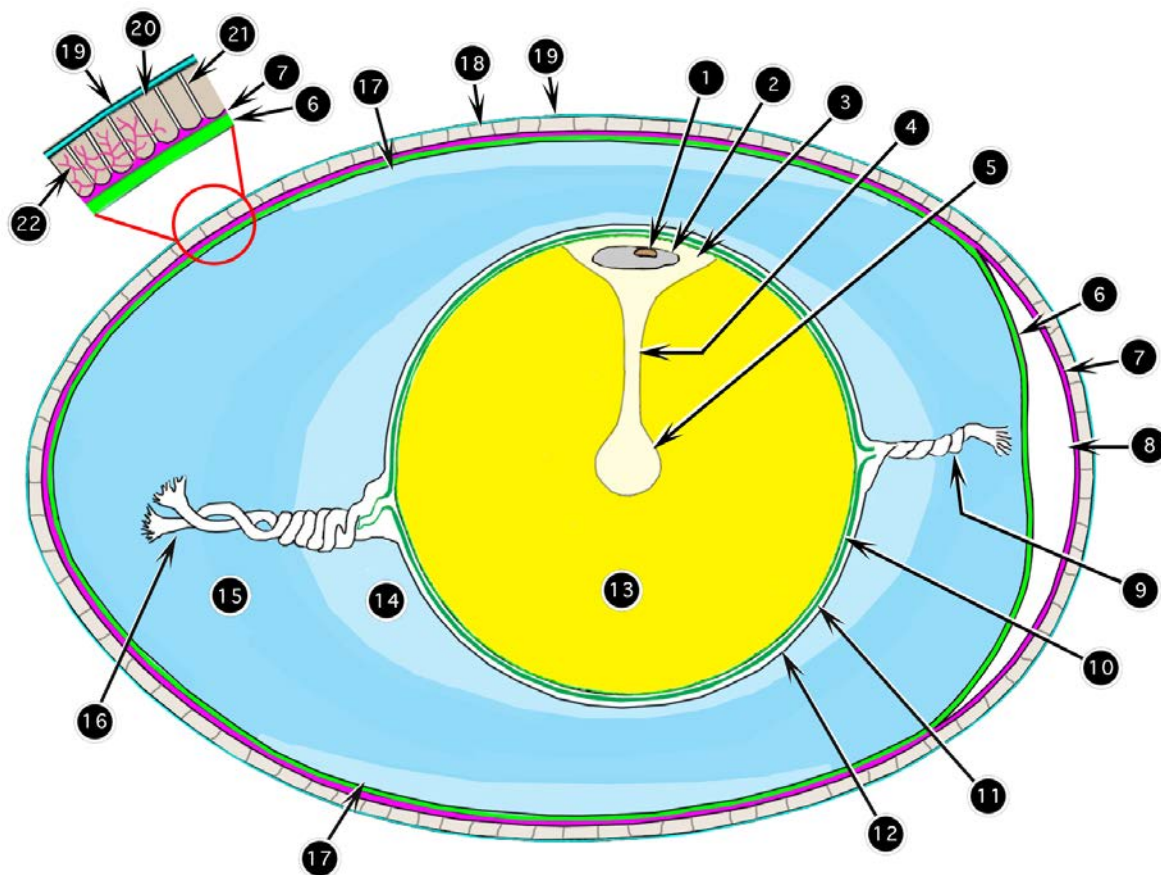


Figure 8-1. Schematic representation of an egg, longitudinal section, with magnified insert of shell: (1) nucleus of oocyte; (2) germinal disc; (3) white yolk forming latebra; (4) latebra neck; (5) centrum of latebra; (6) inner shell membrane; (7) outer shell membrane; (8) air cell; (9) single strand of chalaza toward blunt end; (10) yolk membrane; (11) outer yolk membrane; (12) chalaziferous layer of very dense albumin; (13) yellow yolk; (14) internal layer of liquid or thin albumen; (15) dense or thick albumen, extending to ends of egg; (16) ends of chalaza embedded in polar part of dense albumen; (17) external layer of liquid albumen; (18) calcified shell; (19) cuticle; (20) spherites of calcium carbonate; (21) air canaliculi through calcified shell between adjacent spherites; (22) organic matrix holding spherites together and giving strength to shell.

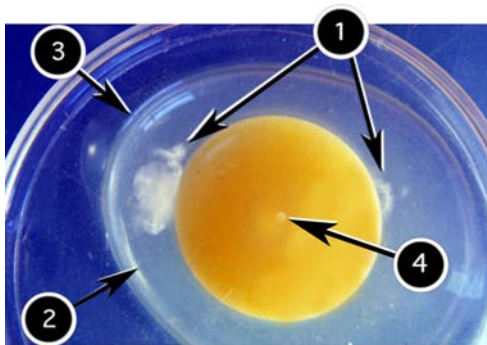


Figure 8-2. Infertile chicken egg in a dish ready for cooking. (1) chalaza; (2) thick albumen; (3) thin albumen; (4) blastodisc (germinal disc).

Ever wonder why a bird can only lay one egg a day? Well it's all about that darn shell. The calcified shell consists primarily of **calcium carbonate "spherites"** (spheres at the base, continued outwardly as cylinders), with a small amount of organic material holding these "spherocylinders" together. Without the organic matrix, the eggshell would be too brittle and subject to cracking. Between the spherites are thousands of **tiny air canals (canaliculi)**

leading to **pores** on the egg's surface (Fig. 8-1). It is *via* these "air ducts" through the calcified shell that there is **gaseous exchange with the surrounding air**. In fact, the **air cell** at the blunt end of the egg forms *via* this exchange after the egg has been laid and is surrounded by air.

Once the calcified shell is complete, the last step is the application of a thin, outer coating of organic material known as the **cuticle** or "bloom." This is typically, the final layer; however, in certain species, including some broiler breeds of chickens, there is another thin calcified layer called the "cover" added over the cuticle.

Loss of a certain amount of water during incubation is necessary for proper formation of the air cell. This is important during incubation because the air cell is penetrated by the fully developed embryo prior to hatching and provides a **source of breathing air** prior to "pipping" the shell as the first-step in hatching. The amount of natural water loss from an egg during incubation varies among species. And it seems "parent nature" has taken this evaporative loss into account. **In certain species, there must be a considerable loss of liquid** ($\approx 15\%$ in weight reduction in ostrich vs. 12% loss in chicken) from the egg or the embryo may drown prior to hatching.¹

The longer an egg is exposed to air, the more evaporation of moisture from the egg occurs, and the larger the air cell becomes. By releasing an egg gently into a saucepan of water, you can perform a simple "freshness test." Fresh eggs will sink to the bottom quickly; the older the egg, the more

slowly it will sink as it contains more air. If the egg does not sink, don't eat it.

Variation in the color of eggs is produced by the incorporation of pigments into the calcified shell. Egg color varies mostly with species and breeds of birds. In general, chicken breeds with white ear lobes lay white eggs, whereas chickens with colored ear lobes lay colored eggs.

There are differences in the number of eggs a particular species will lay. With regard to laying behavior, birds are classified as either **determinate or indeterminate layers**. As these terms imply, determinate layers have a pre-programmed number of eggs for a particular "lay." If one or more of the eggs is broken or removed, during the lay period, it will not be replaced. Thus, the total number of eggs for that lay (clutch) will be reduced if an egg is lost or removed from the nest. Many wild bird species (*viz.*, Eastern bluebirds) are determinate layers.

Indeterminate layers have no pre-determined number of eggs in a laying period. If an egg is removed, it will be replaced. The domestic chicken is obviously an indeterminate layer, and so long as the eggs are removed, a single hen can lay more than 240 eggs during a laying period. In wild birds and many domesticated species, egg laying ceases with the onset of **broodiness** (hormonal changes, which trigger incubation of the eggs). In the genetically selected, high egg-producing chicken lines, laying continues uninterrupted until the time of molting.

Molting in commercial laying flocks can be induced by changes in the diet and by adjustments in the daily light/dark periods to which the birds are exposed. **In laying**

¹ Ley DH, Morris RH, Smallwood JE, Loomis MR: Mortality of chicks and decreased fertility and hatchability of eggs from a captive breeding pair of ostriches. JAVMA 189 (1986): 1124-26.

breeds, broodiness has been almost **eliminated** by genetic selection, and the molting period has been greatly reduced so that birds come back into lay after a short molting period.

Embryogenesis in Birds: If the haploid² oocyte (female gamete) is fertilized in the infundibulum, the resulting **zygote** rests on the germinal disc, which now becomes the **blastoderm**. In contrast with mammals, where the male determines the sex of the progeny by contributing either an X or Y gamete, **it is the female bird that produces both Z and W oocytes**. All avian **spermatozoa** contain the Z chromosome. Male birds are ZZ and female birds are ZW.

Because avian oocytes (zygotes) are associated with a large amount of yolk material, this prevents complete division of the zygote, and **initial cell division is only partial** (4 or 5 cell divisions). At that stage, further cell division is temporarily interrupted (pause button) **until the egg has been laid and incubation begins**. With the initiation of incubation, cell division resumes, with the formation of the several germ layers- ectoderm, mesoderm, and endoderm.

Only part of the germinal material resulting from fertilization is used to produce the embryo itself- another portion is used to form the embryonic membranes. The **amnion** encloses a fluid-filled chamber, the **amniotic cavity**, surrounding the embryo (Fig. 8-3). The amnion is continuous with the skin of the embryo at the umbilicus. The amniotic cavity, which contains **amniotic fluid mixed with some**

albumen, serves to protect and float the embryo so that it can move freely.

The **chorion** continues to expand so that it becomes closely associated with the inner shell membrane (Fig. 8-3). The **allantois** forms a diverticulum of the embryonic gut. As the allantois expands, it fuses with the yolk sac and with the chorion.

The **allantoic sac collects the uric acid wastes as the embryo continues to grow**. With the exception of the **vitelline veins**, which are associated with the yolk sac, the allantois carries most of the blood vessels to and from the embryo.

Once the vascularized allantois fuses with the chorion, forming the **chorioallantois**, it is these vessels that allow for the gaseous exchange of oxygen and carbon dioxide through the porous calcified shell. As the embryo continues to develop and occupy more space within the egg, the yolk sac and albumen sac are drawn into the thoracoabdominal cavity. **After hatching, the yolk sac persists for some days until it is drawn completely into the gut**, leaving a remnant of its stalk as the vitelline or Meckel's diverticulum. The vitelline remnant marks the junction of the jejunum with the ileum (See figure 5-5).

Similar to the situation with newborn mammals, **not all birds have the same degree of development or parental independence at the time of hatching**. In some avian species, particularly those that nest in trees, the chicks are hatched at a state of relative helplessness (like human babies). That is to say, they remain in the nest as "nestlings" for an extended period and require intensive parental nurturing to mature to the stage of independent activity.

² Haploid = one half the total number of chromosomes; this is the number contributed by **one** sex; diploid = total number of chromosomes contributed by **both** sexes.

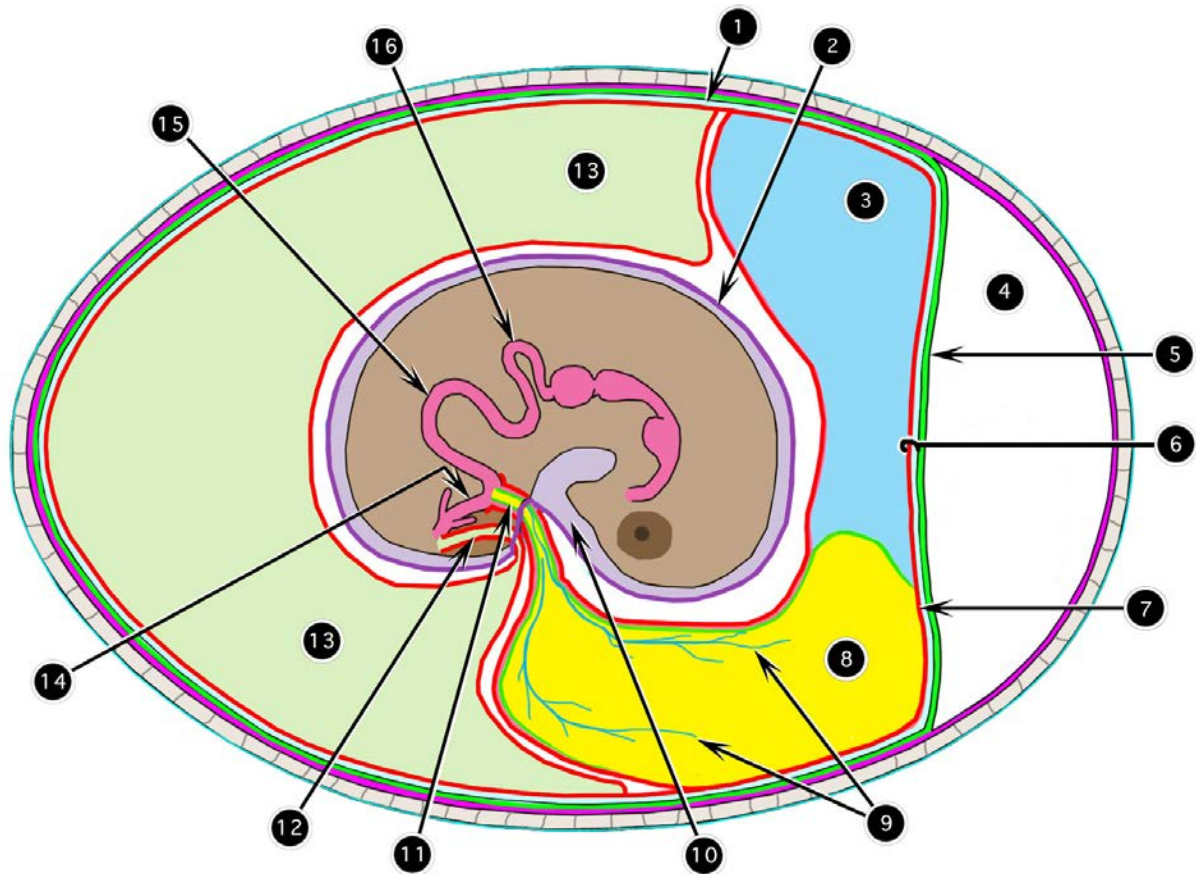


Figure 8-3. Schematic representation of egg with developing embryo and embryonic membranes, longitudinal section: (1) chorion fused with inner shell membrane; (2) amnion, continuous with ectoderm of skin at umbilicus; (3) albumen sac; (4) air cell; (5) inner shell membrane; (6) chorioallantois; (7) vascularized allantois; (8) yolk sac; (9) vitelline veins on surface of yolk sac; (10) amniotic cavity; (11) stalk of yolk sac entering gut; (12) connection of allantoic cavity with hindgut; (13) allantoic cavity containing uric acid waste; (14) ileum of small intestine; (15) jejunum; (16) duodenal loop.

In other species (*viz.* chicken, ducks), the hatchlings are more mature and capable of walking and/or swimming, independent of parental care (like calves or foals).

Incubation Periods: Not surprisingly, the state of maturity at hatching is related to the length of the incubation period. Table 8-1 gives the incubation periods of some common avian species. You might notice that the shortest incubation period on this list is that of the **brown-headed cowbird** (Fig. 8-4). Having a very short incubation period is part of the strategy of this “parasitic” species of birds. **Cowbirds lay**

their eggs in the nests of other birds and let the parent birds of the “host” species raise their young for them. Because the **female cowbird typically deposits only one egg in the nest of the host species**, she has the potential of “parasitizing” as many as 40 nests in a single breeding season.

Because of the short 10-day cowbird incubation period, their chick is typically the first to hatch in the nest of the target species such as the Eastern bluebird (11-19 days). This hungry chick takes most of the food brought to the nest by the host parents. As a result of this “parasitism,” host chicks are

often so malnourished that they die or may be crowded out of the nest altogether.

In addition to the cowbird, some species of the Old-World **cuckoos**, are brood parasites, laying their eggs in the nests of other birds. Interestingly, the **Mangrove Cuckoo** (*Coccyzus minor*), native to south Florida, Mexico, South America, and the Caribbean, is not a brood parasite. It **builds its own nest**.



Figure 8-4. Female and male brown-headed cowbirds (*Molothrus ater*). (Photos made in Raleigh, NC on June 23, 2014.

Table 8-1. Some Avian Incubation Periods

Bird Name	# Days
emu	49-50
ostrich	42
Muscovy duck	35-37
turkey	28
Guinea fowl	28
duck	28
goose (various species)	22-30
cockatoo	22-30
parrots (various species)	18-28
ring-necked pheasant	23-25
lovebird	22-25
bobwhite quail	23
chicken	21
cockatiel	18-20
Eastern bluebird	11-19
budgerigar	18
pigeon	18-19
canary	13-14
cowbird	10

Chapter 9: Anatomy of the Cardiovascular System

With reference to the cardiovascular system, **our attention will be directed toward some of the more important differences between birds and mammals.** For example, you should know that the erythrocytes (RBCs) of birds retain their nuclei, and the bird has **nucleated red blood cells.**

Birds have a four-chambered heart that is considerably larger than the mammalian heart relative to body size. In the domestic species (chicken, turkey, duck) the heart accounts for about 0.5-1.0% of their body weight, while in smaller birds, it may represent more than 1.5%. The high metabolic rate of birds demands a commensurate level of blood flow, which is reflected by their **rapid heart rate.** In domestic fowl the heart rate averages about 250 beats per minute, while it **may exceed 800 bpm in small, fast-flying birds.**

As previously noted, the heart of the bird is located in the thoracic part of the thoracoabdominal cavity, ventral to the horizontal septum, and partly surrounded by the liver. (See Figs. 5-12 & 5-13.) It is surrounded by a thin-walled pericardial sac, which is connected ventrally with the liver.

The ascending aorta gives rise to both **left and right brachiocephalic trunks** (Figs. 9-1 & 9-2). The left trunk typically arises first, followed immediately by the right trunk. Each brachiocephalic trunk gives rise to its respective common carotid and subclavian arteries to the head and wings.

There are **3 venae cavae** in the bird, the caudal vena cava, and the paired **right and left cranial venae cavae** (Figs. 9-1 & 9-2). The entrance of the caudal vena cava into

the right atrium is flanked by two muscular flaps forming the **sinoatrial valve**, which functions to prevent regurgitation of blood into the caudal vena cava (Fig. 9-1). This valve also helps prevent backflow into the adjacent openings of the two cranial venae cavae.

The left atrioventricular (AV) valve is similar in structure to that of the mammalian heart, with the notable exception that it has three *vs.* two major cusps. The avian left AV valve has chordae tendineae associated with each of three papillary muscles (Fig. 9-2).

The right atrioventricular orifice is crescent-shaped (vs. round), and the right atrioventricular (AV) valve is much different, and perhaps more primitive in structure than that of mammals. It consists of a **simple muscular flap**, derived from both atrial and ventricular musculature (Fig. 9-1). There are no papillary muscles or chordae tendineae associated with the right AV valve; however, the flap is anchored to the interventricular septum by a thick strand of tissue (Fig. 9-1).

The **right and left pulmonary veins** typically join one another prior to entering the left atrium. The confluence of the two veins protrudes into the atrium forming a sub-compartment termed the **pulmonary chamber** (*camera pulmonalis*). The left wall of this invagination extends through the right AV ostium, and during atrial systole (contraction) acts as a valve to prevent backflow from the left atrium into the pulmonary veins.

As previously noted, birds have a **renal portal system.** (See Fig. 7-2.) Blood from

the pelvic limbs may be filtered through the kidneys before reaching general circulation.

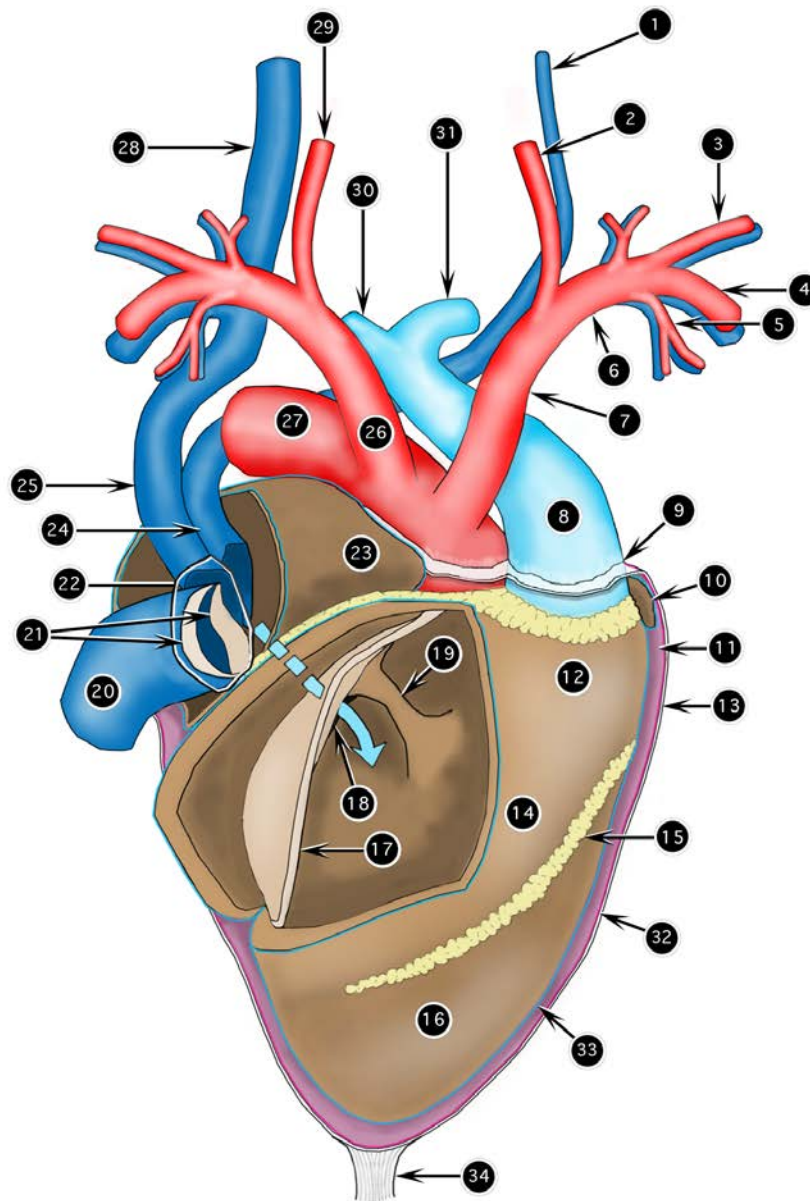


Figure 9-1. Semi-schematic drawing of avian heart & pericardium, ventral view: (1) left external jugular vein smaller than right; (2) left common carotid artery; (3) left axillary artery; (4) left pectoral trunk; (5) left internal thoracic artery; (6) left subclavian artery; (7) left brachiocephalic trunk; (8) pulmonary trunk; (9) line of pericardial reflection; (10) tip of left auricle; (11) pericardial cavity; (12) conus arteriosus; (13) fibrous pericardium; (14) right ventricle (opened); (15) paraconal interventricular groove; (16) left ventricle; (17) right AV valve; (18) right AV ostium; (19) attachment of right AV valve to interventricular septum; (20) caudal vena cava; (21) sinuatrial valve; (22) sinus venosus; (23) right auricle; (24) left cranial vena cava; (25) right cranial vena cava; (26) right brachiocephalic trunk; (27) aorta; (28) right external jugular vein; (29) right common carotid artery; (30) right pulmonary artery; (31) left pulmonary artery; (32) parietal serous pericardium; (33) visceral serous pericardium (epicardium); (34) reflection of 13 between lobes of liver forming hepatopericardiac ligament.

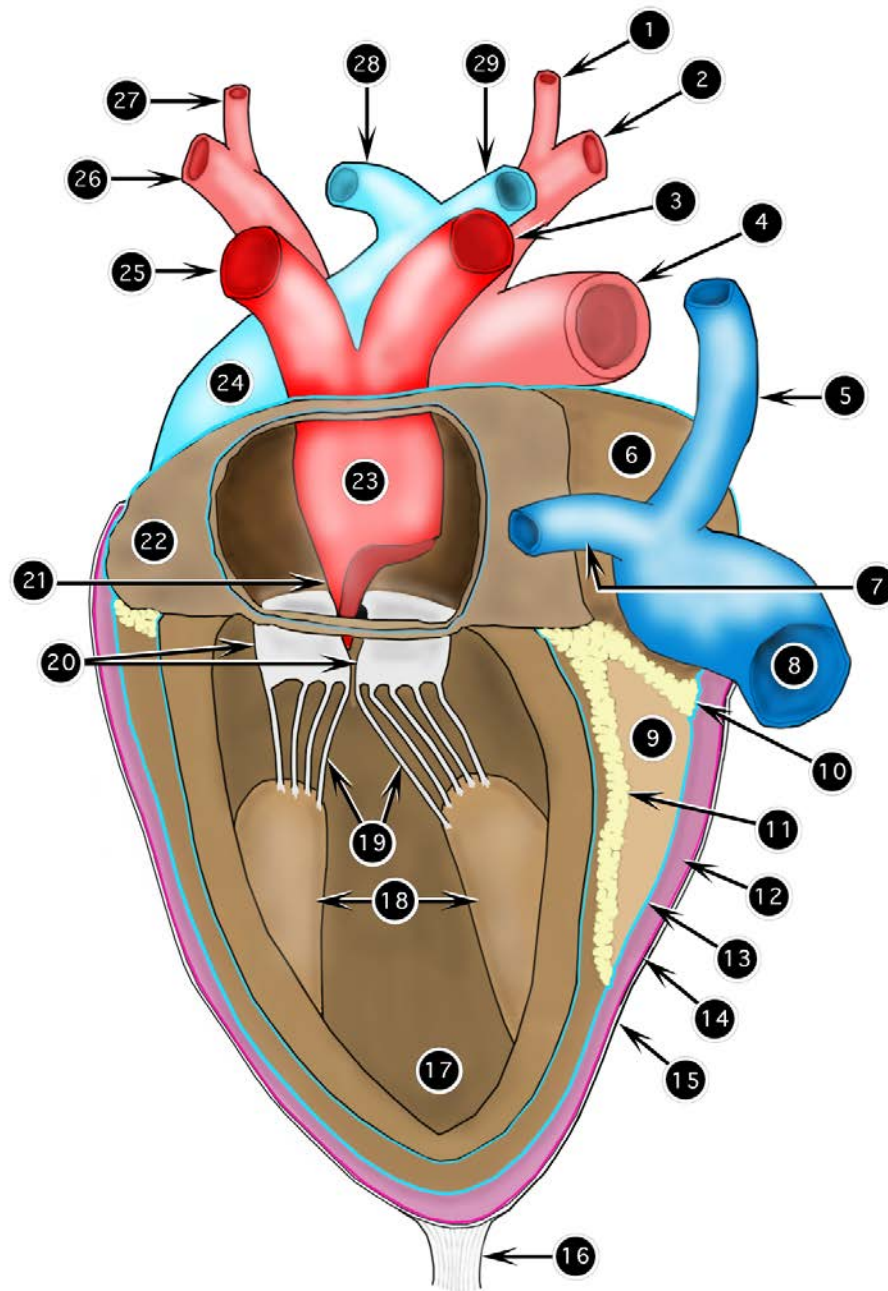


Figure 9-2. Semi-schematic drawing of avian heart & pericardium, dorsal view: (1) right common carotid artery; (2) right subclavian artery; (3) right pulmonary vein; (4) aorta; (5) right cranial vena cava; (6) right atrium; (7) left cranial vena cava; (8) caudal vena cava; (9) right ventricle; (10) coronary groove; (11) subsinuosal interventricular groove; (12) pericardial cavity; (13) visceral serous pericardium (epicardium); (14) parietal serous pericardium; (15) fibrous pericardium; (16) reflection of 15 between lobes of liver forming hepatopericardiac ligament; (17) left ventricle (opened); (18) 2 of 3 papillary muscles; (19) chordae tendineae; (20) 2 of 3 cusps of left AV valve; (21) left free margin of pulmonary chamber extending through AV ostium and forming valve to prevent back-flow into 23; (22) left auricle; (23) pulmonary chamber (camera pulmonalis) protruding into lumen of left atrium; (24) pulmonary trunk; (25) left pulmonary vein; (26) left subclavian artery; (27) left common carotid artery; (28) left pulmonary artery; (29) right pulmonary artery.

The **right external jugular vein** is typically much larger than the left (Fig. 9-1), and in some species, the left vein may be absent.

Lymphatic System: Phylogenetically, birds are the first vertebrates to have valves in their lymphatic ducts to produce unidirectional flow toward the venous connection. Likewise, birds introduced the concept of consolidating lymphatic tissue into definitive structures we recognize as **lymph nodes**. Albeit a modest attempt, **cervicothoracic and lumbar lymph nodes** have been described in the duck and goose. **Generally speaking though, lymph nodes are not routinely observed in birds.**

Although short on lymph nodes, birds do have numerous collections of lymphoid tissue associated with the walls of the oropharynx and gut. Some of these

aggregated lymphoid nodules are grossly evident, and are frequent termed “**tonsils**” (*viz.*, ileal tonsil, cecal tonsils, etc.).

The age-dependent aggregation of lymphoid tissue associated with the wall of the **cloacal bursa** (Fig. 5-14) is **important immunologically** in the synthesis of circulating antibodies and is the site of differentiation of **B-lymphocytes**. This bursa, commonly referred to as the bursa of Fabricius, is obviously very active during early life, when the bird is developing a lot of antibodies. Once the early surge of antibody synthesis subsides (about 5-6 weeks in the chicken), the bursa begins to atrophy, much like the thymus of mammals.

Selected blood vessels of the wing and pelvic limb are shown in figures 9-3 & 9-4.

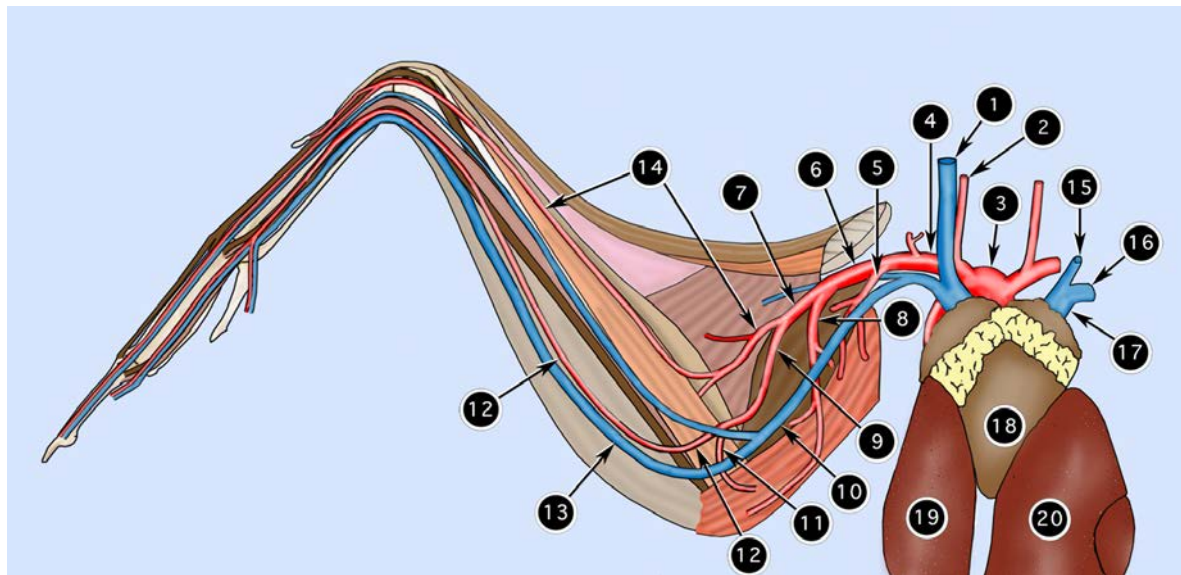


Figure 9-3. Selected vessels of wing, ventral view: (1) right external jugular vein; (2) right common carotid artery; (3) aorta; (4) right subclavian artery; (5) pectoral trunk; (6) axillary artery; (7) brachial artery; (8) collateral ulnar artery; (9) ulnar artery; (10) ulnar vein; (11) recurrent ulnar artery; (12) superficial ulnar artery; (13) superficial ulnar vein; (14) radial artery; (15) left external jugular vein; (16) left subclavian vein; (17) left cranial vena cava; (18) left ventricle of heart; (19) right lobe of liver; (20) right lobe of liver.

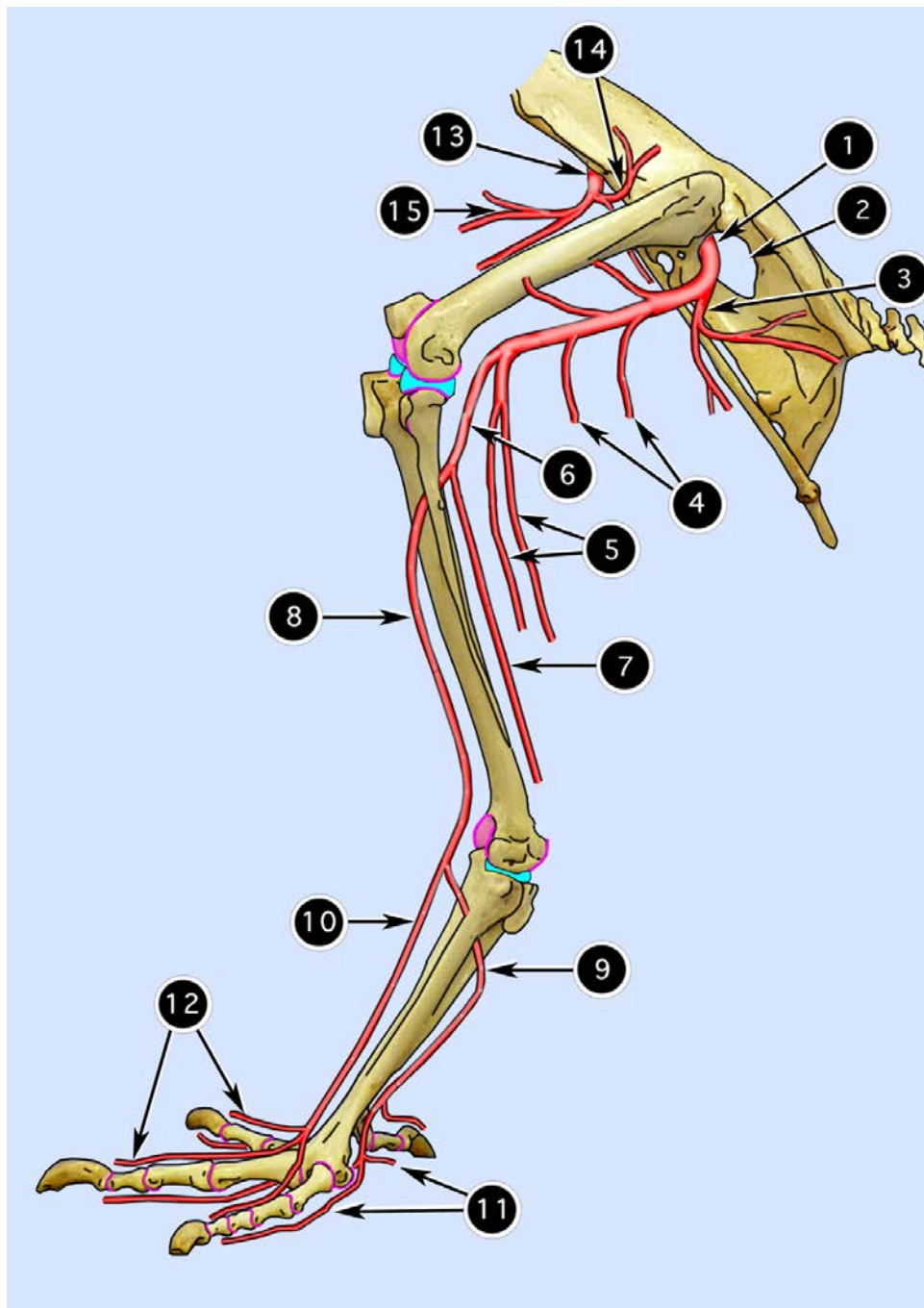


Figure 9-4. Selected arteries of pelvic limb, lateral view: (1) ischiadic artery; (2) ilioischiadic foramen; (3) caudal coxal artery; (4) caudal femoral arteries; (5) caudal sural arteries; (6) popliteal artery; (7) caudal tibial artery; (8) cranial tibial artery; (9) plantar metatarsal artery; (10) dorsal metatarsal artery; (11) plantar digital arteries; (12) dorsal digital arteries; (13) femoral artery; (14) cranial coxal artery; (15) cranial femoral artery.

Chapter 10: The Nervous System

Although one sometimes hears an intended derogatory comment about being a “bird brain,” this may actually be a **complement in disguise**. Birds, it turns out, are anything but mentally challenged. In fact, **birds are highly intelligent animals**, capable of not only using tools, but even making, or at least modifying them. In case you doubt this statement, I refer you to the following videos:

<http://www.flickr.com/photos/36846407@N02/3394656254/in/photostream/>

https://www.youtube.com/watch?v=AVaIT_A7eBZE

Cerebrum (telencephalon): One anatomic reason, birds might be considered less intelligent than mammals is the more or less smooth (lissencephalic) surface of their cerebral hemispheres (Fig. 10-1), which is considered a pathologic condition in mammals, except in rodents. Actually, the cerebral hemisphere of the bird is not without some external demarcation in that there is a groove on the dorsal surface known as the **cerebral vallecule**¹ (Fig. 10-1). This depression separates the cerebral hemisphere into two areas, the major part lying lateral to the vallecule, and a ridge medial to the groove known as the **sagittal eminence**.

As has been mentioned previously, birds, with few exceptions (*viz.*, vultures, kiwi), **have essentially lost their sense of smell**. Thus the **olfactory bulbs** are quite small (Figs. 10-1 & 10-2). We have also noted that birds have **remarkable vision**,

and it should come as no surprise that the **visual part of the brain is very well developed**.

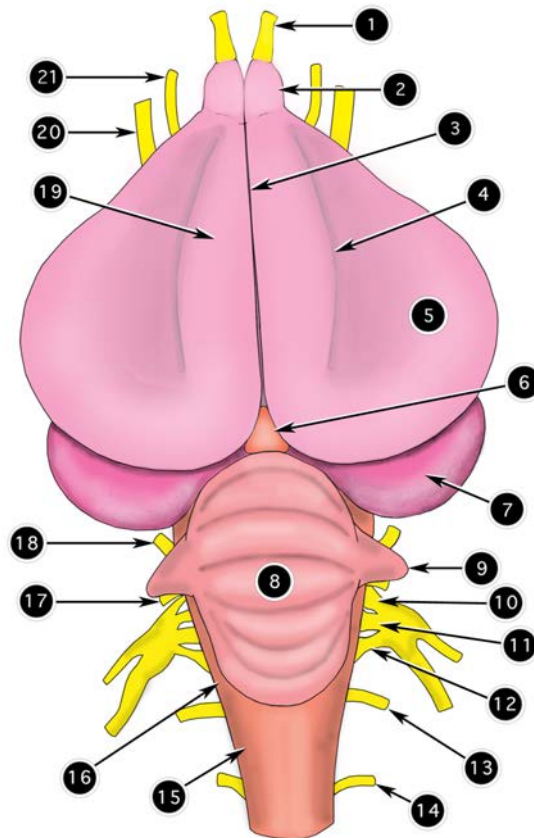


Figure 10-1. Brain and cranial nerves of chicken, dorsal view: (1) CN I- olfactory nerve; (2) olfactory bulb; (3) interhemispheric fissure; (4) cerebral vallecule; (5) cerebral hemisphere; (6) pineal body; (7) mesencephalic colliculus (optic lobe); (8) cerebellum; (9) cerebellar auricula; (10) CN IX- glossopharyngeal nerve; (11) CN X- vagus nerve; (12) CN XI- accessory nerve; (13) C1- first cervical spinal nerve; (14) C2- second cervical spinal nerve; (15) spinal cord; (16) myelencephalon (medulla oblongata); (17) CN VIII- vestibulocochlear nerve; (18) CN VII- facial nerve; (19) sagittal eminence; (20) ophthalmic nerve; (21) CN IV- trochlear nerve. (Modified after *Anatomy of the Domestic Birds*, R. Nickel, A. Schummer, E. Seiferle, Springer-Verlag, New York, 1977, page 116.)

¹ vallecule- *L.* little valley; any crevice or depression on the surface of an organ or structure.

The **optic nerves** are large, and the **optic tracts** lead directly to prominent bulbs just

caudal to the cerebral hemispheres (Figs. 10-1 & 10-2). These so-called “**optic lobes**” are enlargements of the **mesencephalon** (mid-brain) and are not even part of the cerebral hemispheres. Many or most of the fibers within the optic nerve decussate (cross-over) at the **optic chiasma** (Fig. 10-2).

Although located more ventrally, the **optic lobes** correspond with what is called the rostral colliculi of mammals, and there is no external evidence of caudal colliculi in birds. **In mammals, the rostral colliculus functions in visual reflexes.** When one considers the many “split-second” corrections in wing, tail and body position of birds in flight, it seems reasonable that **many of these rapid responses to the demands of flight, are almost reflexive as opposed to deliberate thought processes.** There is no time to think about what adjustments need to be made to avoid obstacles in rapid flight through tree branches, etc. The goshawk is an expert at flying through dense forests without colliding with the tree branches.

Another feature of the avian brain that is particularly well developed is the **pineal body** (Fig. 10-1). **The pineal body of birds is a neuroendocrine gland responsible for the production of melatonin.** Because of its largely secretory function in most birds, it is frequently referred to as the “pineal gland.” **The pineal is believed to be sensitive to light,** which reaches it *via* the optic nerve or directly through the thin-walled skull of the bird. **The pineal is generally believed to be strongly influential on the reproductive behavior in birds in response to the light/dark photoperiod.** Thus reproductive behavior increases during the spring, when days are

getting longer, and is diminished in the fall, when the daylight period is shortening.

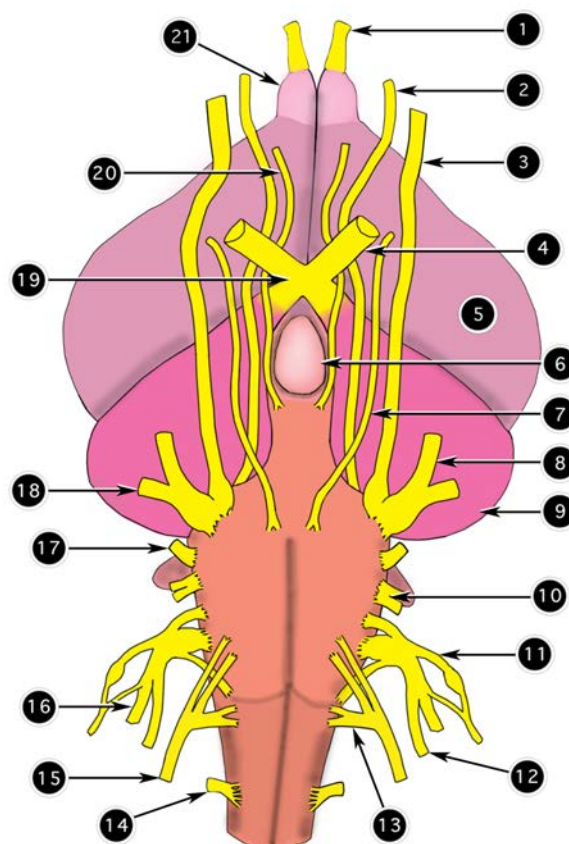


Figure 10-2. Brain and cranial nerves of chicken, ventral view: (1) CN I- olfactory nerve; (2) CN IV- trochlear nerve; (3) CN V- ophthalmic nerve; (4) CN II- optic nerve; (5) cerebral hemisphere; (6) hypophysis cerebri (pituitary gland); (7) CN VI- abducent nerve; (8) CN V- maxillary nerve; (9) mesencephalic colliculus (optic lobe); (10) CN VIII- vestibulocochlear nerve; (11) CN IX- glossopharyngeal nerve; (12) CN XI- accessory nerve; (13) C 1- first cervical spinal nerve; (14) C 2- second cervical spinal nerve; (15) CN XII- hypoglossal nerve; (16) CN X- vagus nerve; (17) CN VII- facial nerve; (18) CN V- mandibular nerve; (19) optic chiasma; (20) CN III- oculomotor nerve; (21) olfactory bulb. (Modified after *Anatomy of the Domestic Birds*, R. Nickel, A. Schummer, E. Seiferle, Springer-Verlag, New York, 1977, page 116.

Chapter 11: The Amazing Eye

We will consider the amazing eye of the bird in two parts. First, we will look at those structures “associated with the eye” such as eyelids, tear ducts, etc., which are termed the **adnexa** of the eye. Then we will move on to the **eyeball** itself.

Adnexa of Eye

The adnexa of the eye include the eyelids, the conjunctiva, the lacrimal apparatus, the eye muscles, and other

structures associated with the eyeball. **The eyelids function to protect and clean the exposed surface of the eye.** The anatomically correct terms for the upper and lower eyelids are the **superior** (dorsal) and **inferior** (ventral) **palpebrae**, and the opening between them, through which the eye is visible, is the **palpebral fissure** (Fig. 11-1). The upper and lower eyelids come together at the medial (nasal) and lateral (temporal) **angles** of the eye.

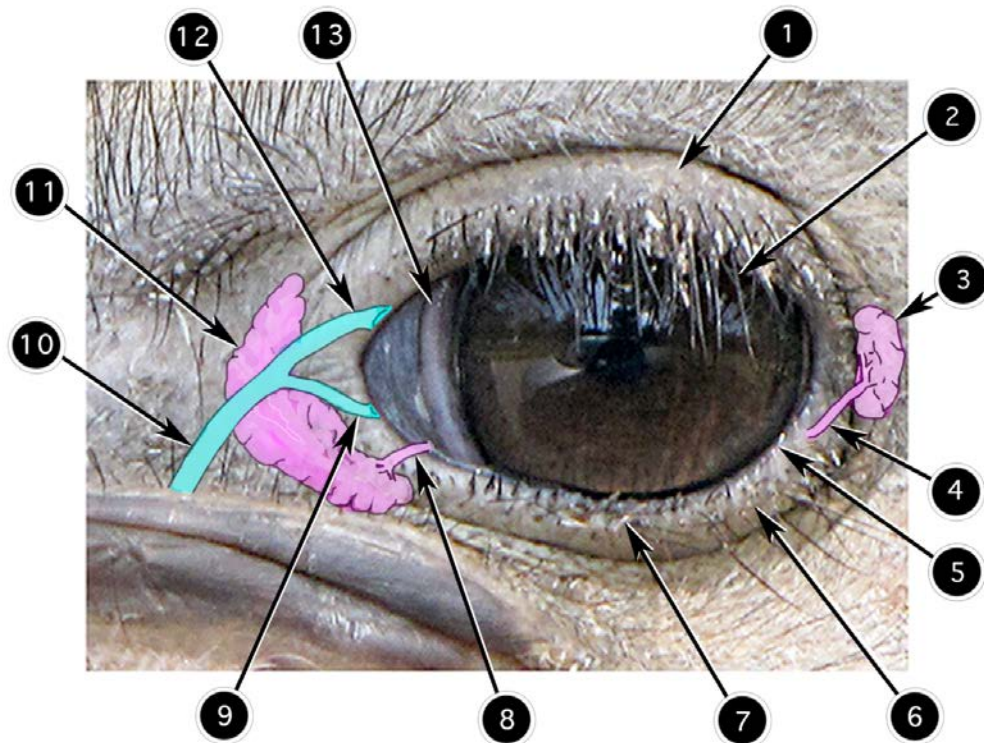


Figure 11-1. Left eye of ostrich showing eyelids and associated structures: (1) superior (dorsal) eyelid; (2) superior cilia; (3) lacrimal gland; (4) single duct of 3; (5) plicated margin of eyelid; (6) inferior (ventral) eyelid; (7) inferior cilia; (8) duct of gland of nictitating membrane; (9) inferior lacrimal ostium & canaliculus; (10) nasolacrimal duct; (11) gland of nictitating membrane; (12) superior lacrimal punctum & canaliculus; (13) free edge of nictitating membrane reinforced with connective tissue band. (Original photo courtesy: <http://tulsagentleman.blogspot.com/2011/01/macro-monday-high-as-ostrichs-eye.html>).

The inferior (lower) eyelid of birds is typically thinner and much more moveable than the upper lid. **When the lids are closed, it is the lower eyelid that does most of the movement** resulting in a closed

slit taking the form of an arch, well above the middle of the pupil. Relative to that of mammals, the open palpebral fissure is small and completely hides the sclera, leaving only the cornea exposed.

Movements of the eyelids are produced by several skeletal muscles.

Unlike the situation in mammals, **the lacrimal gland is not the largest tear producer**. In fact, it is relatively small and is associated with the lateral angle of the eyelids. Its single duct empties into the conjunctival sac on the back surface of the lower eyelid (Figs. 11-1 & 11-2). The much

larger **gland of the nictitating membrane** is located on the ventral and caudomedial surfaces of the eyeball, and its single duct empties into the conjunctival sac between the nictitating membrane and the eyeball (Fig. 11-2). This gland contains cells, which are derived from the cloacal bursa, and it **plays a role in the immunologic response** to proteins introduced into the conjunctival sac.

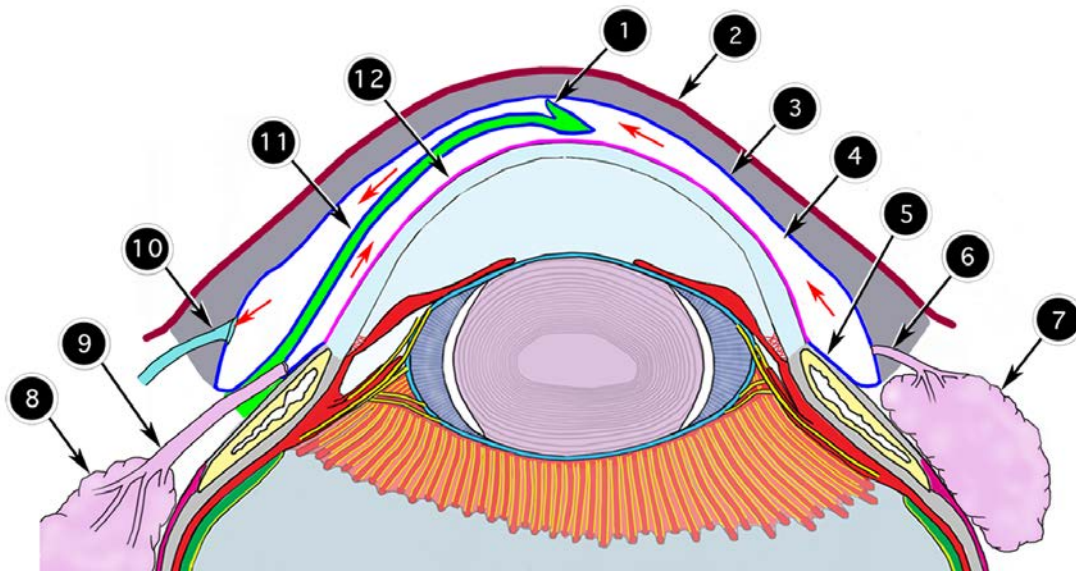


Figure 11-2. Dorsal section through right eye through inferior eyelid: (1) marginal fold; (2) skin of lower eyelid; (3) palpebral conjunctiva; (4) conjunctival sac; (5) bulbar conjunctiva; (6) duct of lacrimal gland; (7) lacrimal gland; (8) gland of nictitating membrane; (9) duct of 8; (10) inferior lacrimal ostium & canaliculus; (11) nictitating membrane; (12) anterior epithelium of cornea. Red arrows → show direction of tear film flow. (Modified after Slonaker, 1918).

Distribution of the **tear film** across the cornea is primarily effected by movement of the **nictitating membrane** (third eyelid), which pushes the fluid to the medial (nasal) aspect of the conjunctival sac. Here it is aspirated into the **superior and inferior lacrimal ostia** (punctae). These punctae are located on the back surface of the eyelid margins a few mm from the medial angle. The superior punctum is several times larger than the inferior one, and each ostium is continued by their respective **superior and**

inferior lacrimal canaliculi¹ (Fig. 11-1). These canaliculi converge within a few mm to form a single **nasolacrimal duct**, which passes through the dorsal and medial walls of the infraorbital sinus and conducts the “used” tears to the nasal cavity just dorsal to the **choana**. Thus, the tears continue through the choanal cleft to the oropharynx.

One unique feature of the nictitating membrane of the bird vs. the mammal is the presence of the **marginal fold** along the free

¹ canaliculi = little canals

edge of the nictitating membrane (Fig. 11-2). When the nictitating membrane is pulled across the eye, the marginal fold lies flat against the anterior (front) surface of the membrane, but as the membrane retracts toward its home medial to the eyeball, this fold lifts away from the membrane, acting much like a “squeegee” to push the tear film toward the lacrimal ostia located near the medial angle of the eye.

Unlike the more or less passive excursion in mammals, movement of the nictitating membrane across the cornea is

accomplished by two skeletal muscles, the **pyramidalis** and the **quadratus** (Fig. 11-3A).

The pyramidalis and quadratus muscles lie flat against the posterior (back) aspect of the eyeball, and have a unique relationship to one another. The flat tendon of the quadratus muscle forms a fibrous canal or pulley for the cylindrical tendon of the pyramidalis muscle to pass through as it arches up and over the optic nerve (Fig. 11-3A).

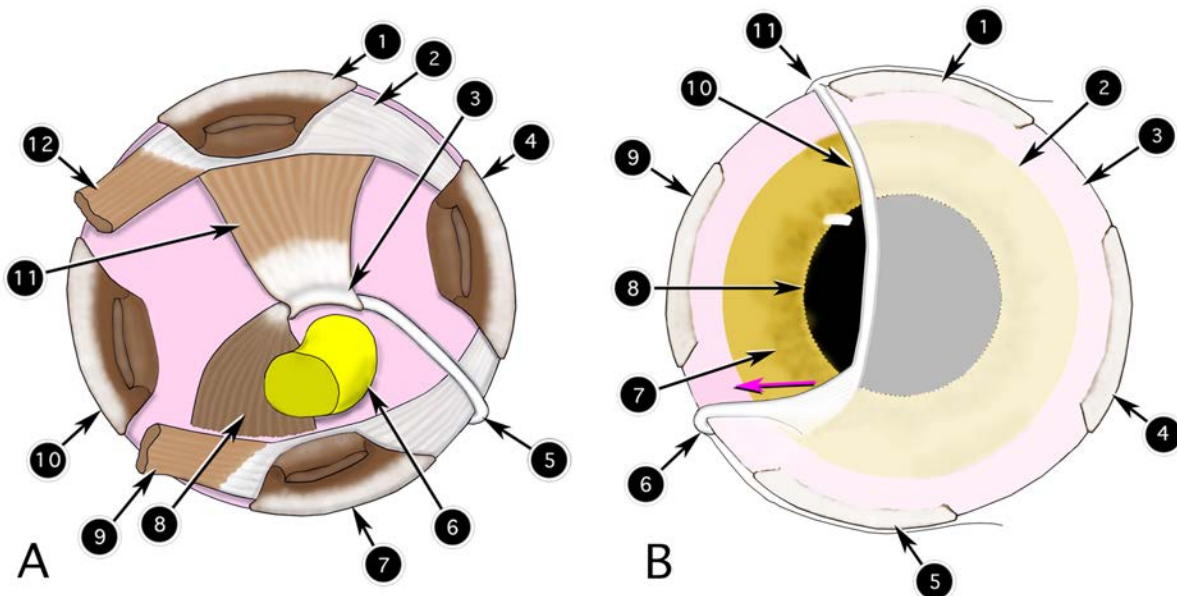


Figure 11-3. Posterior view of right avian eyeball (A): (1) dorsal rectus muscle; (2) tendon of dorsal oblique muscle; (3) aponeurosis of quadratus muscle forming a sleeve-like trochlea for the tendon of the pyramidalis muscle; (4) lateral rectus muscle; (5) tendon of pyramidalis muscle; (6) optic nerve; (7) ventral rectus muscle; (8) pyramidalis muscle; (9) ventral oblique muscle; (10) medial rectus muscle; (11) quadratus muscle; (12) dorsal oblique muscle, originates from medial side of orbit. **Anterior view of right avian eyeball (B):** (1) tendon of dorsal rectus muscle; (2) corneoscleral junction; (3) sclera; (4) tendon of medial rectus muscle; (5) tendon of ventral rectus muscle; (6) continuation of tendon of pyramidalis muscle in free edge of nictitating membrane; (7) iris; (8) plicated margin of papillary border; (9) tendon of lateral rectus muscle; (10) free edge of nictitating membrane, reinforced by connective tissue band; (11) dorsal aspect of nictitating membrane attached to the sclera. The magenta arrow → indicates movement of nictitating membrane from medial to lateral.

The tendon of the pyramidalis muscle continues ventrally, then passes along the ventrolateral aspect of the eyeball to reach

the ventral part of the free edge of the nictitating membrane (Fig. 11-3B). Because the dorsal part of the free edge of this

membrane is attached to the eyeball, contraction of the pyramidalis and quadratus muscles pulls the nictitating membrane across the cornea from medial (nasal) to lateral (temporal). Although there is species variation, **the nictitating membrane moves across the cornea about every 2 seconds**, which spreads and redistributes the tear film. It also moves across the eye in a reflex action whenever any object approaches the eye.

Other muscles of the Eyeball (Fig. 11-3A): The large eyeball of the bird completely fills the orbit, leaving little room for fat and/or muscles as we see in mammals. The remaining eyeball muscles consist of three antagonistic pairs, designed to rotate the eyeball around three axes, vertical, horizontal, and optic (anteroposterior).

The **dorsal, ventral, medial, and lateral rectus**, and the **ventral oblique muscles** of the eyeball resemble those of the mammalian eye, both in structure and innervation. One notable difference in the avian eye is that the **dorsal oblique muscle** is similar in design to that of the ventral oblique, such that it originates directly from the medial wall of the orbit, and does not require a trochlea to change the direction of its tendon.

Avian Eyeball (bulbus oculi)

The eye of the bird is truly an amazing structure. The difference between what we see and what birds see is, at the very least, the difference between old-fashioned regular television for mammals and HD-TV for birds. The eyes of the bird are so large that there is only a thin **interorbital septum** between them (Fig. 2-2). In fact, the eye of the ostrich is said to be the largest eye of any land animal, measuring some 5 cm along its

optic axis from cornea to retina. **In most birds the weight of the two eyes is equal to or heavier than the brain.**

The shape of the eye also shows considerable variation among avian species. In most bird species, the eye is compressed from anterior to posterior forming a more or less “flattened” structure. The eye of other birds is more globe-like, while the large eye of owls and some eagles is elongated in the anterior-posterior dimension forming a “tubular” shape. **The poorest vision among birds is likely that of the kiwi.** The kiwi has relatively small eyes, **but to compensate, they have retained a keen sense of smell**, which is not present in most other avian species. The kiwi is a nocturnal bird and finds food by scent. Its nostrils are located near the tip of its beak.

The anatomy of the avian eyeball is in many ways similar to that of mammals in that it consists of the same three tunics or coats- fibrous, vascular, and nervous (Fig. 11-4). There are, however, some marked differences in the avian eye. The **fibrous tunic** consists of the cornea and the **sclera**, which is reinforced by the **scleral ossicles**.³ It is further reinforced in many birds by a wrapper of cartilage, forming a **cartilaginous lamina**, external to the fibrous part of the sclera (Fig. 11-4).

The anterior segment of the fibrous coat is formed by the transparent **cornea** (Figs. 11-2 & 11-5). **The refractive power of the cornea of birds is about equal to or even greater than that of the lens**, depending on the species. The layers of the avian cornea are similar to those of mammals.

³ ossicles = little bones

The **ciliary body** is the anterior continuation of the choroid, and is primarily formed by the **ciliary processes** (Figs. 11-4 & 11-5). Associated with the ciliary processes are the **zonular fibers**, which attach to the lens capsule. Also associated with the ciliary body are **ciliary muscles**, which function in **accommodation**.² There are several differences between the ciliary muscles of mammals and those of birds.

The smooth ciliary muscles of mammals are composed of fibers in two directions. **In contrast, all ciliary muscles of birds are in one direction, and most remarkably, they are composed of striated muscle fibers.** Being striated would imply some voluntary accommodation ability in birds, but I doubt that is the case. I would reason that the **striated muscle allows for more rapid accommodation**, but that it most likely occurs automatically, without conscious control. Birds would certainly benefit from an “auto-focus” setting that would enable them to change focus for rapidly approaching objects (prey or obstacle) using “split-second timing.”

The ciliary muscles of birds also work differently in the accommodation process, affecting not only changes in lens curvature (as in mammals), but they also have the ability to alter the curvature of the cornea.

The mechanism of lens accommodation may also be different than in mammals. Rather than just pulling the ciliary body anteriorly to release tension on the zonular fibers, it is thought **that contraction of the posterior ciliary muscle causes the ciliary processes to push against the annular pad of the lens**, thus

causing active compression of the entire lens structure. This would increase the convexity of the central lens making it more convergent for near-vision accommodation.

Continuous with the ciliary body anteriorly is the **iris**, which controls the aperture of the pupil (Figs. 11-4 & 11-5). **The iris of birds is highly mobile, and the diameter of the circular pupil can change quickly.** Similar to the avian ciliary muscles, and in contrast to those of mammals, the constrictor and dilator muscles of the avian iris are **striated**. Again, striated muscles would imply voluntary control, but this is not something the bird needs to think about. The iris (pupil diameter) is adjusted automatically in response to the amount of ambient light.

Pigmentation of the iris is highly variable among avian species, including blues, browns, greens, yellows, and reds. In some species the color of the iris displays seasonal variation, and iris color may be different in males vs. females.

The **nervous tunic** of the eyeball consists of the retina. The **retina** is further subdivided into the optic part, which covers the choroid and contains the photoreceptive cells, and the non-visual parts covering the ciliary processes, and the posterior surface of the iris. The optical part of the retina covers the **fundus** (deepest part) of the eye, and extends anteriorly to the posterior border of the ciliary processes. (Fig. 11-5).

The axons from the **rods** and **cone cells** extend inward to form some additional connections before converging at the **optic disc**, where they turn outward to penetrate the choroid and sclera to form the **optic nerve**. **The optic disc is technically the beginning of the optic nerve.**

² Visual accommodation is the process by which the lens (and cornea in birds) changes shape or curvature to focus on far or near objects.

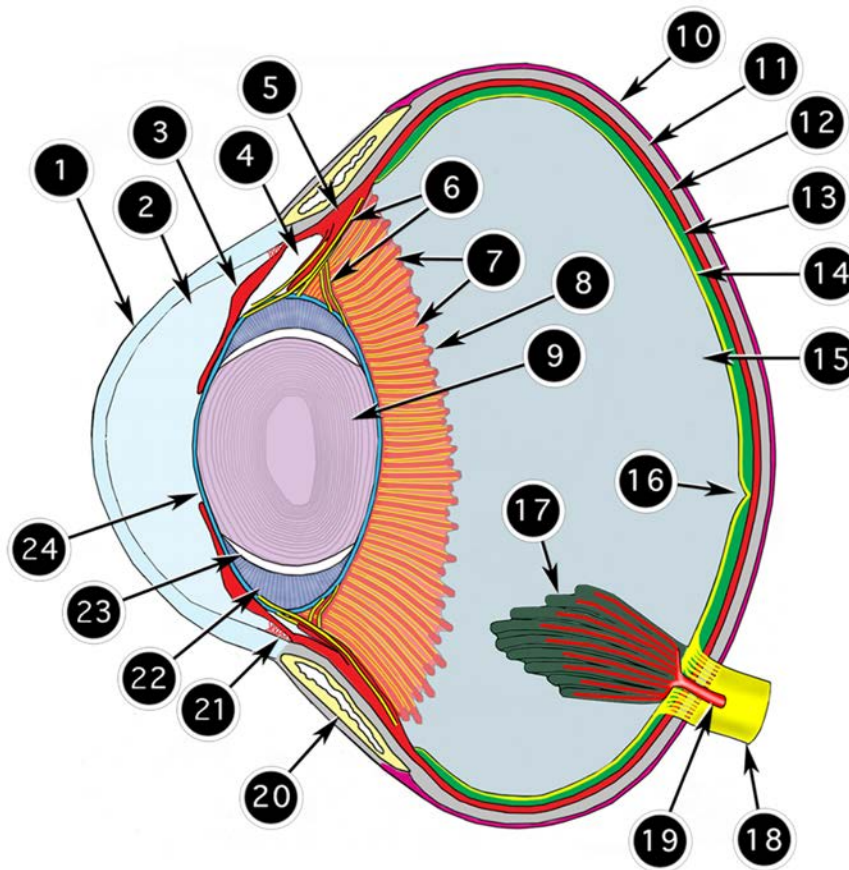


Figure 11-4. Semischematic drawing of avian eye, meridional section: (1) cornea; (2) anterior chamber; (3) iris; (4) posterior chamber; (5) ciliary body; (6) zonular fibers; (7) ciliary processes; (8) ora serrata; (9) central lens body (concentrically arranged lens fibers); (10) cartilaginous lamina of sclera; (11) fibrous lamina of sclera; (12) choroid; (13) pars optica retinae; (14) axons of photoreceptive cells converging to form optic nerve; (15) vitreous chamber; (16) fovea centralis; (17) pecten oculi; (18) optic nerve; (19) blood supply to pecten *via* ophthalmotemporal artery; (20) sclera ossicles forming scleral ring; (21) iridocorneal angle containing pectinate ligament (reticulum trabeculare); (22) annular pad of lens with radial fibers; (23) lens vesicle containing fluid; (24) lens capsule.

Because there are no photoreceptive cells (rods & cones) at the optic disc, there is no image formation over this area, which accounts for the so-called “blind spot” in each eye. However, when an image is formed by both eyes (binocular vision), each blind spot is negated or cancelled out by the image formed in the opposite eye.

There are several differences between the optical part of the retina in the bird compared with that of our common domestic mammals. Although our domestic mammals

have at least one area centralis, where there is a concentration of photoreceptive cells for higher resolution imaging, they do not typically have a distinct **fovea centralis** as is found in the human eye. In addition to an area centralis, many birds, like the human, have at least one fovea, and some species have two. The **fovea centralis** (Fig. 11-4) is positioned along the optic axis, while some bird species (*viz.*, owls, kingfishers, hummingbirds) also have a **fovea temporalis**.

The most remarkable difference between the retina of mammals vs. birds is the presence of the avian **pecten oculi** (Fig. 11-4). This structure projects from the optical part of the retina into the vitreous body. There is considerable variation in the development of the pecten across avian

species, and its function has been the subject of much study and debate. Most contemporary authors believe that **the pecten functions in nourishment of the retina, which in birds lacks retinal vessels.**

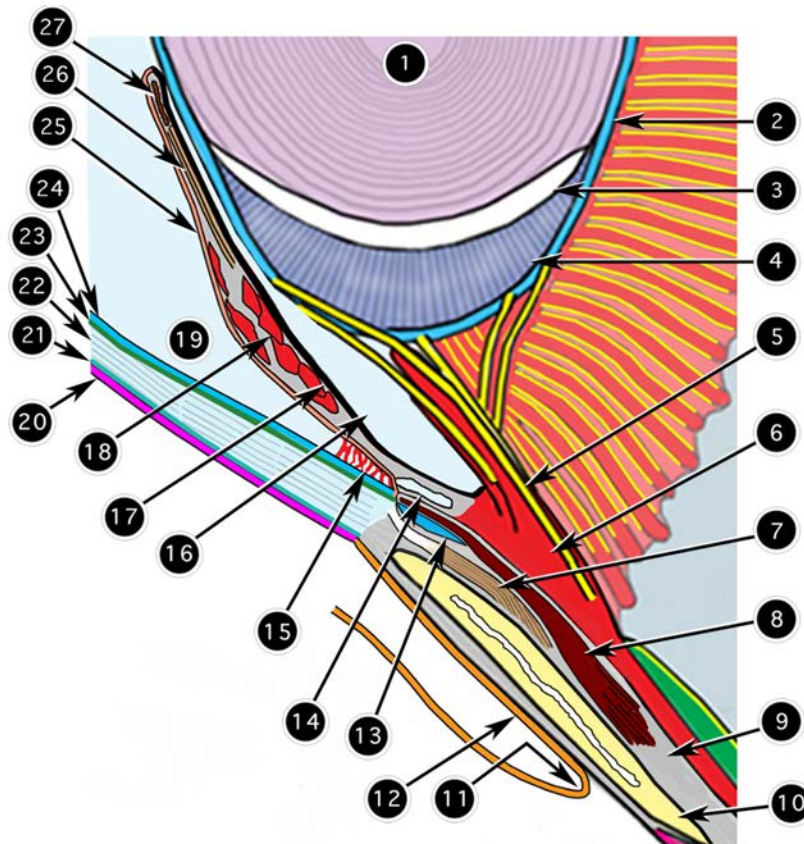


Figure 11-5. Semischematic drawing of iridocorneal angle of avian eye, meridional section: (1) central lens body with concentrically arranged lens fibers; (2) lens capsule; (3) lens vesicle containing fluid; (4) annular pad of lens with radial fibers; (5) zonular fibers; (6) ciliary processes; (7) anterior part of ciliary muscle (Crampton's m.); (8) posterior part of ciliary muscle (Brücke's m.); (9) sclera; (10) sclera ossicles forming scleral ring; (11) conjunctival fornix; (12) bulbar conjunctiva; (13) scleral venous sinus; (14) ciliosccleral sinus; (15) pectinate ligament (reticulum trabeculare); (16) posterior chamber; (17) pigmented layer of iris combined with pars iridica retinae; (18) iridocyte body; (19) anterior chamber; (20) anterior epithelium of cornea; (21) anterior limiting (Bowman's) membrane of cornea; (22) substantia propria (stroma) of cornea; (23) posterior limiting (Descemet's) membrane of cornea; (24) posterior epithelium of cornea; (25) anterior epithelium of iris; (26) dilator pupillae muscle; (27) constrictor pupillae muscle.

The pecten is a highly vascular structure, but its blood supply is not derived from the choroid. Blood flow to the pecten comes from the ophthalmotemporal artery (Fig. 11-4), which gives rise to

numerous arterioles that open into a rich capillary network. **At least three types of pecten oculi have been described in birds**, ranging from a simple **conical type** in the kiwi, a **vaned type** in the ostrich, rhea, and

tinnamous, and the **pleated type found in most other avian species**. If the pecten oculi does serve a nutrient function, one would expect that nutrients would diffuse out of the pecten into the vitreous body, and be transferred to the retina. This idea is supported by the two fundic photographs in figures 11-6 & 11-7.



Figure 11-6. Photograph of barred owl ocular fundus showing pleated nature of the pecten oculi. The highly vascular pecten projects into the vitreous body from the area of the optic disc (hidden by pecten in this photograph).

More on the lens of the bird vs. that of mammals: The lens of the bird is more complex than that of mammals. The mammalian lens would correspond to the central lens of the bird. **In addition to the central part, birds have a surrounding annular pad of fibrous tissue, and the annular pad is separated from the central lens by a lens vesicle, which contains fluid** (Fig. 11-4).

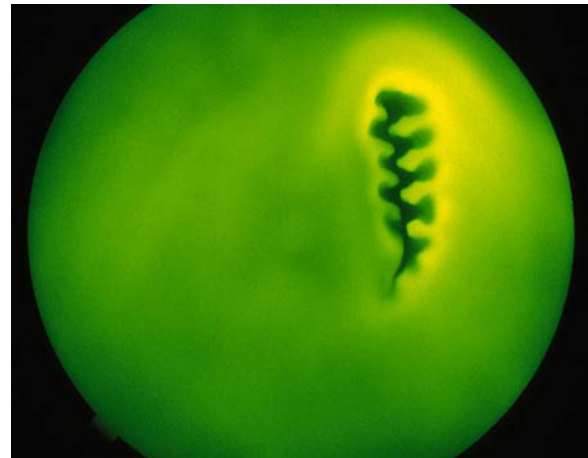


Figure 11-7. Photograph of barred owl ocular fundus following IV injection of fluorescein dye. Effusion of the dye (yellow color) from the pecten into the vitreous body is compatible with its proposed nutritive function of the pecten oculi.

This configuration undoubtedly affects visual accommodation in birds. Visual accommodation in mammals is effected by the ciliary muscles pulling the ciliary body forward, which loosens tension on the zonular fibers, allowing the lens to become fatter or more convergent for near vision.

In birds, the ciliary processes actually push against the annular pad, compressing it against the central lens. This compression is apparently facilitated by the fluid in the lens vesicle, which would make compression of the central lens more uniform by distributing the forces evenly around the periphery of the central lens. Also, the ciliary muscles of the bird are striated, and the anterior ciliary muscle attaches to the cornea (Fig. 11-5), which it does not do in mammals. The anterior ciliary muscle of birds could thereby change the refractive strength of the cornea as well as changing the refractive strength of the lens itself.

Chapter 12: Hearing

Second only to vision, the sense of hearing is typically very well developed in birds. Birds use their keen sense of hearing in: (1) avoiding predators; (2) in the complex vocal communication with members of their own specie; and (3) in the detection and location of prey. In fact, **owls have all but perfected localization of sounds coming from potential prey.** Not only can owls determine the horizontal direction, from which the sound is coming, but also can detect the origin of that sound in the vertical plane; *i.e.*, **owls have a more developed “three-dimensional hearing.”**

The external opening of the ear canal may be obvious in a few avian species such as the rhea (Fig.12-1) or more likely inconspicuous as it is in many avian species. In most birds, the external ear canal (meatus) is a short opening concealed by small covert feathers.



Figure 12-1. Head of American rhea showing an obvious external ear opening (red arrow). (Photo courtesy:http://en.wikipedia.org/wiki/File:Greater_rhea_pair_arp.jpg).

These feathers are specialized, forming an **operculum** or **pre-aural flap**. **This flap serves, not only to funnel sound into the ear canal, but also to protect the ear from**

the turbulence of airflow across the opening. Some birds, such as the chicken, have a fold of skin, termed an **earlobe**, associated with the external opening of the ear canal. (See Fig. 4-4.) Diving birds can diminish or even close the external ear canal when going under water.

The **external acoustic meatus** (ear canal) is a short tube located just behind the quadrate bone (Fig. 12-2). **Owls can even alter the shape of the meatus for better sound localization** by manipulating a feathered skin fold (operculum) located just in front of the ear opening. Using striated muscles, the operculum can be moved rostrally or caudally to alter the size and shape of the external acoustic meatus.

To make things even more interesting, **some owls show asymmetry of their external ear structures**, which may even be accompanied by asymmetry of their skull. For example, in the Boreal owl, the right ear is actually located higher in the skull than the left, which is believed to further assist these owls in sound localization, especially in the vertical plane.

Similar to mammals, the **middle ear** of the bird consists of an air-filled cavity. Unlike that of mammals, **there is no malleus, stapes, and incus**, and the tympanic membrane tends to protrude outward rather than inward. Air within the tympanic cavity communicates with air spaces in the surrounding bones, and *via* the auditory tube with the oropharynx. Transmission of eardrum vibrations to the vestibular (oval) window of the inner ear is accomplished *via* a **single auditory ossicle, the columella**, which is homologous to the mammalian stapes (Fig. 12-2). The

mammalian malleus and incus are homologous to the articular and quadrate bones of birds.

Tension on the eardrum is accomplished by the **columellar muscle**, which originates from the occipital bone. This muscle is derived from the second branchial arch and is innervated by the CN VII, which would indicate that the columellar muscle of birds is homologous morphologically to the stapedius muscle of mammals. Interestingly, it is functionally similar to the tensor tympani muscle. The avian **cochlea**

does not form a spiral as it does in mammals, but consists of a slightly curved tubular structure. The **cochlear duct** is much shorter than that of mammals and the **scala vestibuli** is greatly reduced in birds.

The organs of hearing and balance (inner ear) are housed within a complex of osseous elements forming the **ossa otica**, which become incorporated with one another and adjacent parts of several bones, including the squamous temporal and exoccipital bones.

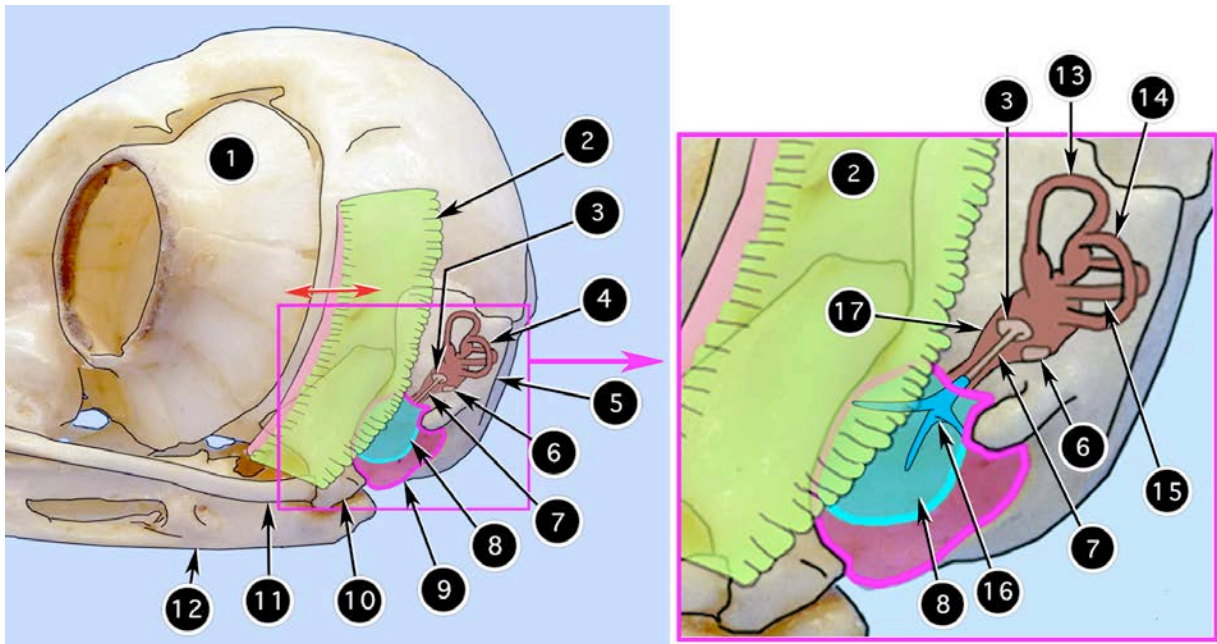


Figure 12-2. Skull of a barred owl, with superimposed structures of the ear, lateral view: (1) scleral ossicles; (2) operculum, consisting of skin fold covered with short feathers; (3) vestibular (oval) window; (4) semicircular canals, surrounded by osseous canals; (5) ossa otica, incorporated into adjacent parts of several other bones; (6) oval fenestra; (7) columella; (8) tympanic membrane; (9) external acoustic meatus; (10) quadrate bone; (11) zygomatic (jugal) arch; (12) mandible; (13) rostral semicircular canal; (14) caudal semicircular canal; (15) horizontal semicircular canal; (16) extracolumellar cartilage- attaches 7 to 8; (17) cochlea. The **red arrow** indicates the rostrocaudal movement of the operculum, which alters the shape & size of the external acoustic meatus.

Chapter 13: Ratites- Ostriches, Emus, Kiwis, and More

There are only two orders of living birds in the “old jaw” group- the **Struthioniformes** or **ratites** and the **Tinamiformes** or **tinamous**. Tinamous are one of the most ancient groups of living birds. They are ground dwellers, ranging in size from a few ounces to about 5 pounds, and are found in Central and South America.

Most birds in the order Struthioniformes, including the elephant bird, are now extinct, but the surviving species of **ratites** form a rather diverse group of flightless birds, which can be found on **three continents**. How these few remaining species ended up in Africa, South America and Australia/New Zealand apparently stems from the break-up of the prehistoric landmass, *Gondwana*. Ratites get their name because they have no keel on their flat, **scoop-like sternum** (Fig. 12-1), which makes it resemble a raft, or in Latin “*ratis*.”

The African Ostrich (*Struthio camelus*) is the largest living bird, with some adult males weighing in at over 300 lbs. and standing more than 9 feet tall (Fig. 13-2). Ostriches, which may live to be 40-45 years old, are also **the fastest running birds**, being able to reach speeds greater than **40 miles per hour**. The ostrich is important because of its **commercial value in terms of meat, skin, and feathers**. Adult males are easily distinguished from females by their mostly black feathers with white feathers on the wings and tail. Females and immature males are grayish-brown and white.

Unlike most birds, the **urates and fecal material of the ostrich do not mix** in the cloaca. The fecal matter is retained in the coprodeum and does not mix with the urates, which enter the urodeum. **Ostriches retain**

two claws on their wings, one on the alula (digit 1) and another on the major digit (digit 2). The foot of the ostrich is also unique in that it has **only two digits** (Fig. 13-3). The larger digit (digit 3) has a claw, while the smaller digit (digit 4) does not.



Figure 13-1. Skeleton of an Ostrich. Note the raft-like sternum, which lacks a keel. Also, note the unusual foot of the ostrich- only two digits.

The second tallest, but not heaviest, living bird is the **Australian Emu** (*Dromaius novaehollandiae*), which may reach a height of over 6 feet, and may weigh more than **100 lbs.** (Fig. 13-4). Although not as fast as ostriches, emus can travel great distances at a fast trot and can reach speeds of about **30 miles an hour**.



Figure 13-2. Male Ostrich (*Struthio camelus*). (Photo courtesy: animals.howstuffworks.com).

Males and females look alike, but the two can be distinguished by differences in the sounds they produce. Emus can alter these sounds by manipulating an **inflatable tracheal sac** associated with their cervical trachea. Emus can live to be about **20 years old** in the wild. Although not as extensively farmed as the ostrich, emus are **raised commercially for their meat, oil, and leather**. The emu is a **cultural icon in Australia**.



Figure 13-3. Right foot of ostrich, medial view. (Photo courtesy: http://en.wikipedia.org/wiki/File:Ostrich_foot).



Figure 13-4. Adult Emu. (Photo courtesy: <http://en.wikipedia.org/wiki/Emu>).

The **South American Rhea** is slightly smaller than the emu, and there are **two recognized species**- the Lesser or Darwin's Rhea and the Greater or **American Rhea** (Fig. 13-5). Adult male greater rheas may be up to 5.5 ft. tall and weigh in at about **85 lbs.**

Rheas have 3 pelvic digits and **large wings for a ratite**. When running, they spread their wings, which may help with some “lift.” Like the ostrich, the rhea **does not mix the urates and fecal matter** in their cloaca. They do not have as much commercial value as the ostrich or emu; however, their meat and feathers are used.



Figure 13-5. Adult American Rhea (*Rhea americana*). (Photo courtesy: <http://en.wikipedia.org/wiki/Rhea>).

Another large ratite is the **Cassowary**, of which there are 3 species, **all native to the tropical forests of New Guinea, nearby islands, and northeastern Australia**. The cassowary is second only to the ostrich in terms of body weight, with females being larger and more brightly colored than males.

An adult female **Southern Cassowary** may weigh in at more than **125 lbs.** (Fig. 13-6). Cassowaries do not have rectrices (tail feathers) and lack a uropygial (preen) gland. Like the ostrich, the cassowary **retains a claw on the primary digit of the wing**. Cassowaries have heavy, powerful legs with 3 digits and sharp claws. The **claw of digit 2 is dagger-like and about 5 inches long** (Fig. 13-7).

Cassowaries are very dangerous birds, capable of inflicting serious bodily injury. Cassowaries can run about **30 mph** and can jump almost **5 ft. high**. They can live up to 50 years.



Figure 13-6. Adult Southern Cassowary (*Casuaris casuaris*). (Photo courtesy: <http://en.wikipedia.org/wiki/Cassowary>)

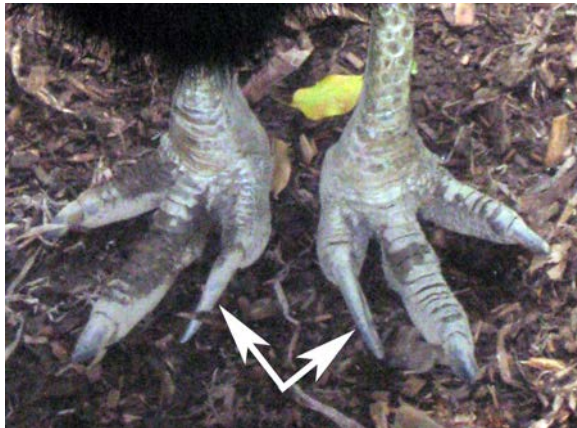


Figure 13-7. Adult Southern Cassowary (*Casuaris casuaris*): arrows indicate dagger-like claw of digit 2. (Photo courtesy: <http://en.wikipedia.org/wiki/Cassowary>).

The smallest of the living ratites is the Kiwi (*Apteryx australis*), which is the national symbol of New Zealand (Fig. 13-8). The kiwi is **about the size of a chicken** and there are 5 recognized species. Kiwis are mostly **nocturnal**, and their **single egg per season** is the **largest relative to body size of any bird- about 5 times the size of**

a chicken egg. It takes the female about **30 days of hard work to produce a single egg.** Unlike most birds, **kiwis have two functional ovaries, a keen sense of smell, and their nostrils are at the tip of their upper beak.** **Kiwis probably have the poorest vision of any living bird.**



Figure 1-9. Adult Southern Brown Kiwi (*Apteryx australis*). (Photo courtesy: <http://en.wikipedia.org/wiki/Kiwi>)

Chapter 14: Anseriformes- Ducks, Geese, and Swans

The order **Anseriformes** contains about **150 living species** of birds in three families. By far the largest family is **Anatidae**, which includes 40 genera and over 140 species of ducks, geese, and swans. Anatidae can be found on every continent except Antarctica and on practically every island on the planet. Anatidae vary in size from the tiny cotton pigmy goose (≈ 6 oz) to the trumpeter swan, weighing in at up to 38 lbs.

The genus *Cygnus* includes **6 or 7 species of swans**, which are the largest members of Anatidae. The **Trumpeter Swan** (*Cygnus buccinator*) is the largest living species of waterfowl (Fig. 14-1). Swans have a very interesting trachea, which makes numerous loops associated with the sternum (See Fig. 6-6).



Figure 14-1. Adult Trumpeter Swan (*Cygnus buccinator*). (Photo courtesy: <http://en.wikipedia.org/wiki/File:Tumpeter>)

The genus *Anser* includes the grey geese and some white geese. **Wild species of geese have been domesticated, primarily for meat or their fattened liver (foie gras)**, which is a popular food in some European countries. There are many breeds of domestic geese (Fig. 14-2), and some breeds (viz., pilgrim goose) can be sexed by their

color, with ganders being white and females being grey.



Figure 14-2. Domesticated Greylag Goose (*Anser anser*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Domesticated_greylag_goose)

The genus *Branta* consists of **7 species of black geese, including the Canada Goose (*Branta canadensis*)**. Although naturally migratory, large flocks of Canada geese have more recently become “**permanent residents**” in various regions of the US, including the Raleigh-Durham, NC area (Figs. 14-3 – 14-6).

The **Canada Goose** is a large goose species with a black head and neck, white patches on the face, and a brown body. It is native to arctic and temperate regions of North America. Like most geese, the Canada goose is primarily herbivorous and tends to be found on or close to fresh water. **These geese are able to establish breeding colonies in urban areas, where food is available and there are few natural predators. They are often considered pests because of their noise and droppings** (Fig. 14-3).

During their second year Canada geese find a mate, with which they bond for life. If something happens to one of the pair, the other may find a new mate. The female lays an average of 5 eggs, and both parents protect the nest while the eggs incubate. The incubation period is 24-28 days.



Figure 14-3. Resident Canada Geese (*Branta canadensis*) with juveniles, eating and pooping in my back yard. This photo was made in Raleigh, NC on June 2, 2013.



Figure 14-4. Adult Canada Geese (*Branta canadensis*). This photo was made in Raleigh, NC on February 6, 2015.

The adults go through their summer molt while the goslings are young, and the adults cannot fly well for about 20-40 days after the young hatch. They fiercely protect the young goslings, and are very reluctant to leave them, even if they could fly away. Among predators of eggs and goslings are coyotes, foxes, and raccoons. I also think that a Great Blue Heron would not hesitate to steal a young gosling that strays too far from the parents. If the juveniles

survive their first year, they may well live to be 20 years old.



Figure 14-5. Adult Canada Goose with Goslings. This photo was made in Raleigh, NC on April 27, 2014.



Figure 14-6. Adult Canada Geese (left) with 2 juveniles (right). This photo was made in Raleigh, NC on June 2, 2013.

There are only 3 species of wild white geese in the genus *Chen*. White geese are native to North America, breeding in the subarctic and migrating south in the winter. The most familiar of these is the **Snow Goose, *Chen caerulescens*** (Fig. 14-7). You should know that **not all snow geese are white because there are two versions—the white (snow) version and a grayish-blue variant.**

The blue variant has bluish-gray feathers replacing the white ones, except on their head and tip of their tail. Both types have reddish feet and legs, and pink bills except for the cutting edges or tomia, which are black. The two variants flock and migrate together, and will interbreed with one another.



Figure 14-7. Snow Geese (*Chen caerulescens*). This is the more familiar white variant, but there is also a blue-gray variant. (Photo courtesy: http://en.wikipedia.org/wiki/File:Anser_caerulescens)

What about those white farm geese we see? Well, there is no doubt that these geese are white, and that they are a common type of domestic goose. However, **these domestic geese are actually grey geese**, which have been derived from either the greylag goose (Fig. 14-2) or the swan goose. One domesticated descendent of the greylag goose is the **Embden Goose** (Fig. 14-8). This is a fast growing breed of European domestic goose, with geese reaching 20 lbs. and ganders reaching 30 lbs. by about 2 years of age.

Another common breed of farm goose is the Chinese Goose (Fig. 14-9), which is a descendent of the wild swan goose (*Anser cygnoides*). These geese can be easily distinguished from the European geese by the large, **knob-like protuberance over their bill**, which is typically larger in the gander (Fig. 14-10).



Figure 14-8. Embden Goose (*Anser anser domesticus*). (Photo courtesy: http://en.wikipedia.org/wiki/Domestic_goose).

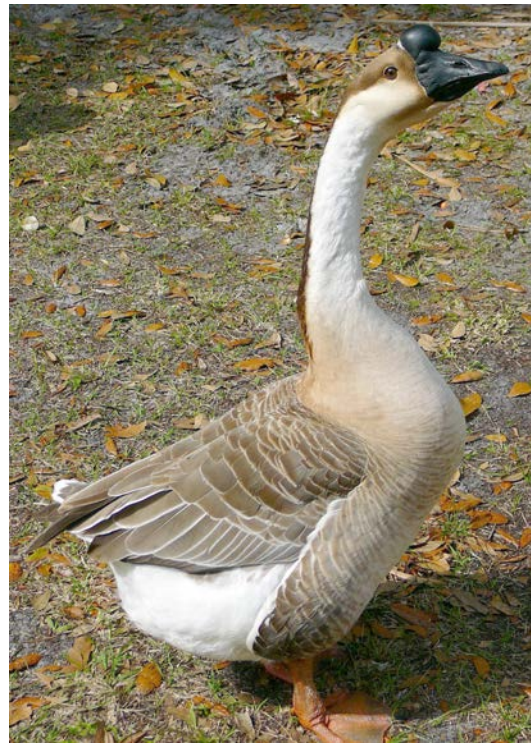


Figure 14-9. Chinese Goose (*Anser cygnoides*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Anser_cygnoides).



Figure 14-10. Head of white Chinese Gander (*Anser cygnoides*). (Photo courtesy: http://en.wikipedia.org/wiki/Domestic_geese).

The genus *Anas* consists of more than 40 species of “dabbling ducks,” including mallards, widgeons, teals, pintails, and shovelers. Mallards are a common species in the United States.

The **Mallard Duck** (*Anas platyrhynchos*) is a dabbling duck native to the temperate and subtropical regions of the Americas, Europe, Asia, and North Africa. This duck belongs to the family Anatidae. Adult males have a glossy green head and are gray on the wings and belly (Fig. 14-11).

Females have primarily brown-speckled plumage (Fig. 14-12). Mallards live in wetlands and eat water plants and small animals. **This species is the ancestor of most breeds of domestic ducks. Mallards frequently interbreed with other ducks** such as the American black duck or domestic ducks leading to various hybrids (Fig. 14-13).

Both drakes and hens have an iridescent purple-blue wing-patch or “speculum” edged with white. **As is typical of many bird species, immature birds tend to have the plumage coloration of the female;** however, as the males approach maturity, the breast feathers become reddish-brown, and the head becomes darker (Fig. 14-14).

The center tail feather, or “drake feather” is curled in the male, which is also

true for domestic drakes, such as the popular Pekin duck. Mallards do not reach sexual maturity until about 14 months, and their life expectancy in the wild is only about 3 years. In captivity they can live to be 20 years old.



Figure 14-11. Adult Mallard Drake (*Anas platyrhynchos*). Note curled tail feather. This photo was made in Raleigh, NC on February 5, 2015.



Figure 14-12. Adult Mallard Hen (*Anas platyrhynchos*). Note blue wing patch or speculum. This photo was made in Raleigh, NC on March 16, 2014.



Figure 14-13. Mallard Hybrid resulting from interbreeding with another species- probably the American black duck. This photo was made in Raleigh, NC on January 27, 2015.



Figure 14-14. Mallard Hen (center front) with two juvenile males. Coloration of juveniles approximates that of the adult female, but males begin to take on the coloration of the adult drake as they mature. This photo was made in Raleigh, NC on September 8, 2014.

One of the mallard-descent breeds of domestic duck is the **Pekin** or **Long Island Duck**, which was originally, domesticated in China (Fig. 14-15). **From just nine ducks originally imported from China to Long Island, NY in 1873, the Pekin duck has become by far the most popular commercial duck in the US.**

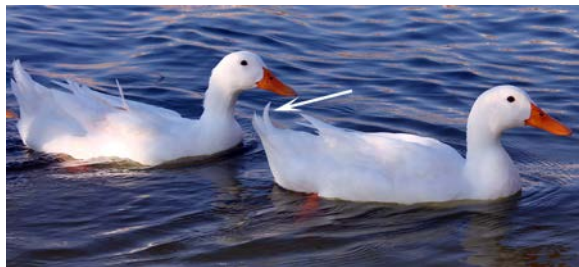


Figure 14-15. Pekin or Long Island ducks (*Anas platyrhynchos domestica*). The drake (right) can be distinguished from the hen (left) by his “drake feather” (arrow). (Photo courtesy: <http://en.wikipedia.org/wiki/File:Barvas>).

Pekin ducks account for more than 90% of all ducks raised for meat and eggs. Male and female Pekin hatchlings look alike, but can be distinguished by “vent-sexing.” As the hatchlings mature, the drakes acquire a curled tail feather and their quack becomes softer; the females lack this curled “drake feather,” and their quack becomes stronger. This vocal change is

typical of many duck species, and there may be an anatomic reason why the quack of the mature male is softened or muted (See Fig. 6-7).

There is one type of domestic duck that is not a member of the genus *Anas* and that is the **Muscovy Duck** (*Cairina moschata*). Although the term “Muscovy” suggests some connection to Moscow, this large duck is **native to Mexico**, and South and Central America, and a feral population still exists along the Rio Grande and in other locations (Fig. 14-16).



Figure 14-16. Muscovy Ducks (*Cairina moschata domestica*). The drake (left) is much larger than the hen (right), and these domestic ducks are heavier than their closely related wild cousins. (Photo courtesy http://en.wikipedia.org/wiki/File:Cairina_moschata).

These ducks have been kept and bred by Native Americans since before Columbus arrived in the Americas, and even though they were later imported to Europe, there is some debate as to how they became known as “Muscovies.”

Males, which may weigh up to 15 lbs., are twice the size of females (≈ 7 lbs). Both sexes have reddish caruncles forming a sort of “facial mask” around their eyes and the base of their bill. The facial mask of the male is more colorful and prominent (Fig. 14-16).

Although this is the only species in the genus *Cairina*, there are two subspecies.

Cairina moschata sylvestris is used for the wild form and *Cairina moschata domestica* is used to describe the domesticated version, which is also known by several common names— the “creole duck” or the “mute duck.” The latter designation comes from the fact that these ducks don’t really “quack.” Females are more vocal and make a sort of “thrill” sound, while males make more of a “hissing” sound, often accompanied by “tail-wagging.” Their relative silence might be one reason why Muscovies are often kept as “backyard” ducks. These ducks are raised for meat, and in the culinary sense are referred to as “**Barbary Duck.**”

The Hooded Merganser (*Lophodytes cucullatus*) is the only living species in the genus *Lophodytes*. Like the mallard, this duck is in the family, Anatidae. Hooded Mergansers are not seen often in our neighborhood, but they do come through here from time to time. These are small **diving ducks**, unlike the mallard, which is a dabbling duck. The male is particularly colorful in its **breeding plumage** (Fig. 14-17). His upper body, neck, and sides of its head are mostly black, but there is a large white patch on either side of his crest. The lower body is a chestnut brown. In the non-breeding season, the male looks much like the female.



Figure 14-17. Hooded Merganser Male (*Lophodytes cucullatus*). This photo was made in Raleigh, NC on February 19, 2015.

The body of the adult female is mostly gray below, with a darker, almost black, upper body (Fig. 14-18). She has a reddish-brown crest. Juvenile birds differ from adult females in that they have a gray-brown neck and upper parts (Fig. 14-19).

As a diving duck, the hooded merganser feeds primarily on fish, but will also take aquatic insects and invertebrates such as crayfish. Males and females form monogamous pairs and remain together until the female has selected a nesting site and laid her clutch of about 10-12 eggs. The eggs are incubated by the female only, and young leave the nest within 24 hours of hatching. The hatchlings are immediately capable of diving and foraging for themselves, but will remain with the female for warmth and protection.



Figure 14-18. Hooded Merganser Female (*Lophodytes cucullatus*). This photo was made in Raleigh, NC on February 19, 2015.



Figure 14-19. Hooded Merganser Juvenile (left) and adult female (right). This photo was made in Raleigh, NC on February 19, 2015.

Hooded mergansers winter in the US where temperatures allow for **ice-free conditions** on ponds, lakes and rivers. They range from southern Canada, along the Atlantic Coast all the way to the Gulf of Mexico.

The **Wood Duck** or **Carolina Duck** (*Aix sponsa*) is a medium-sized **perching duck** found in North America. In its breeding plumage, the male is a very colorful bird (Figs. 14-20 & 14-21), and the species is related closely to the Asian Mandarin Duck, (*Aix galericulata*). The male has red eyes and displays multicolored, iridescent feathers.



Figure 14-20. Wood Duck Male (*Aix sponsa*) in breeding plumage. This photo was made in Manvel, TX on April 7, 2014.



Figure 14-21. Wood Duck Male (*Aix sponsa*) in breeding plumage. This photo was made in Manvel, TX on April 7, 2014.

The female wood duck is much less colorful with a white ring around her eye and a white throat (Fig. 14-22).



Figure 14-22. Wood Duck Female (*Aix sponsa*). (Photo courtesy: http://en.wikipedia.org/wiki/Wood_duck#/media/File:Female_Wood_Duck_%28Aix_sponsa%29,_Parc_du_Rouge-Clo%C3%A9tre,_Brussels.jpg).

Wood Ducks like wooded swamps, shallow lakes, and rivers in eastern North America and the west coast of the US. They breed as far north as Canada and some winter in Texas and Mexico. **They are year-round residents in NC.** They usually nest in tree cavities near water, and will make use of nesting boxes if available. Females lay between 7-15 eggs that hatch in about 30 days. **One caution about nesting boxes** is that if they are placed too close together, females may lay eggs in boxes where other females have already laid, creating a “box overload” and resulting in a failure to hatch.

Due to overhunting for both meat and feathers, wood duck numbers greatly declined in the early 1900s. Through diligent conservation efforts, lowering hunting limits, and the construction of nesting boxes, their numbers have greatly increased. **Unlike any other NA duck, the wood duck can produce 2 broods a year in the southern parts of the US.**

Chapter 15: Galliformes- Chicken, Turkey, Peafowl, More

The order Galliformes consists of about 290 species, which are distributed across most continents except for deserts, oceanic islands, and extremely cold regions. Galliformes contains five families of which **Phasianidae** (chicken, quail, partridges, pheasants, turkeys, and grouse) is the largest.

Members of Megapodiidae are known as “mound builders” and are heavy-bodied, chicken-like birds with small heads and big feet. There are about 20 species distributed in and around Australia, including Fiji. Rather than incubating their eggs with their own body heat, they construct large nesting mounds of decaying vegetation (Fig. 15-1). Although once proposed that the sex ratio of hatchlings was temperature dependent, this is apparently not true.



Figure 15-1. Australian Brushturkey (*Alectura lathami*) on incubation mound of decaying vegetation. (Photo courtesy: <http://en.wikipedia.org/wiki/Megapode>).

Odontophoridae consist of 9 genera and some 32 species of New World quail ranging from Canada through southern Brazil. There are 22 subspecies of the northern **bobwhite quail** (Fig. 15-2), which is a popular game species in the US.



Figure 15-2. Northern Bobwhite Quail male (*Colinus virginianus*). (Photo courtesy: http://en.wikipedia.org/wiki/Northern_Bobwhite).

Bobwhites are raised in captivity in the US for purposes of future release for hunting. In the wild they travel, mostly on the ground, in groups known as “coveys.” Here is where a good pointer or setter comes in to “point” or locate the covey prior to “flushing” them. When the covey flushes, you have a good example of an *auditory reflex* in that it is almost impossible not to be startled and jump when they take off.

Numididae is the family of galliformes known as guineafowl or guineahens. Guinea fowl are native to Africa, but the **helmeted guineafowl** (Fig. 15-3) has been domesticated and distributed to many areas including the US. Domestic variants of the wild guineafowl come in two colors- **speckled and white**, and are commonly kept as barnyard birds for meat. **Guineas are really good “watchdogs”** in that they make a lot of racket when any intruder (fox, coyote, raccoon) comes around the

barnyard. **They are also good at finding and eating a large number of ticks**, which otherwise would be available to spread diseases such as Lyme disease.



Figure 15-3. Helmeted Guinea fowl (*Numida meleagris*). This is the speckled or more native variant, but we also have white domestic guineas. (Photo courtesy: http://en.wikipedia.org/wiki/File:Numida_meleagris).

Which came first, the chicken or the egg?

That's easy. **The egg has been around a lot longer than any chicken.** Dinosaurs laid eggs thousands of year before a chicken, or even a bird for that matter, was ever conceived. **OK, so what laid the egg that hatched the first chicken?** Well, that's not too hard to answer. That egg was laid by a **Red Junglefowl** (Figs. 15-4 & 15-5).

By far the largest family of galliformes is Phasianidae, containing more than 150 species, including the red junglefowl, turkeys, grouse, pheasants, partridges, Old World quail, and peafowl. **The Red Junglefowl (*Gallus gallus*) is the principal (if not the only) ancestor of the domestic chicken**, and was originally domesticated in Asia more than 5000 years ago. The cock (rooster) is much larger than the hen, and is brightly colored (Fig. 15-4). The hen is much less impressive (Fig. 15-5), with a more muted color for camouflage, especially when she is on the nest.



Figure 15-4. Red Junglefowl Cock (*Gallus gallus*). (Photo by Wameng Chue).



Figure 15-5. Red Junglefowl Hen (*Gallus gallus*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Gallus_gallus).

The domestic chicken has been selectively bred for many years, and hundreds of breeds have been developed and crossed with other breeds. We will consider just a few of the many breeds raised in the United States.

Some of the more popular breeds raised in the US are the white leghorn, the Cornish, the Plymouth Rock, the Buff Orpington, the Rhode Island Red, the Cochin, the Wyandotte, the Australorp, the Silkie, and the Dominique. **Some of these breeds are considered dual-purpose breeds**, which

means they are raised for both eggs and meat, but almost **all commercial chickens are highly-specialized and consist of hybridized lines of birds that are bred exclusively for one purpose or the other.**

Nearly all the eggs you find in American grocery stores come from **genetically selected commercial layers.** The foundation breed for modern layers is the **leghorn**, which originated in the Tuscany region of Italy, and was imported into the US in 1828. In fact, the English word “leghorn” is a translation of the Italian “Livorno,” which was the port city from which the original birds were exported to the US.

Although there are numerous variants of the leghorn breed, the **white leghorn** (Fig. 15-6) has been selected as the most prolific layer. **These hens can produce more than 300 eggs per year**, and have an excellent feed-to-egg production ratio. Major poultry companies, both for layers and broilers, are continually experimenting with the genetics in these birds, and they employ nutritionists to develop the most efficient diets.

Commercial broiler production is equally, if not more, specialized. **The foundation breeds for the now highly selected broiler birds are the Cornish (Fig. 15-7) and Plymouth Rock (Fig. 15-8) breeds.** This “cornish-rock” crossbreeding was initiated in the 1930s, and initially was plagued with problems of low fertility, slow growth-rates, and disease susceptibility. However, through diligence selective breeding and improvements in husbandry and nutrition, the modern meat bird (Fig 15-9) is a far cry from those early hybrids.

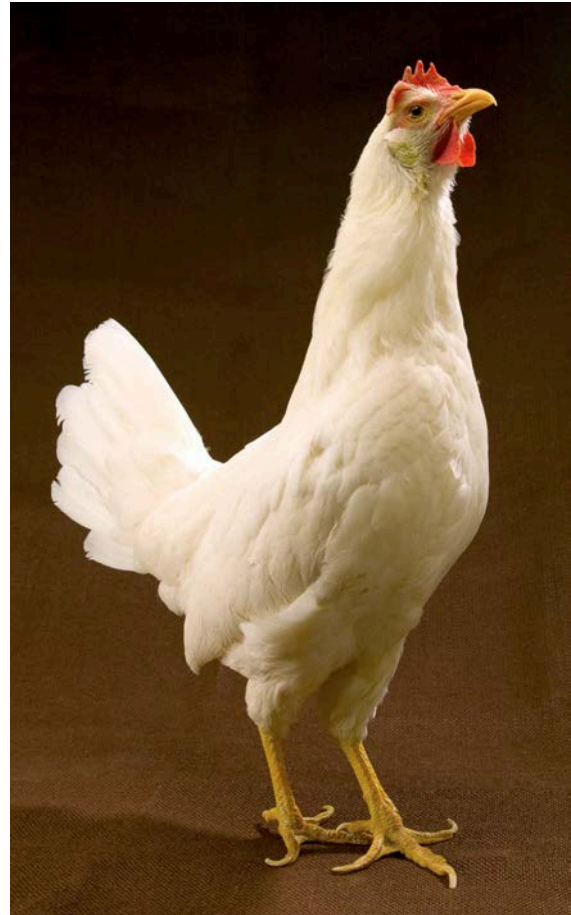


Figure 15-6. White Leghorn Hen (*Gallus gallus domesticus*). (Photo courtesy: http://en.wikipedia.org/wiki/File:ARS-White_Leghorn_hen).

In fact, modern-day broiler production is one of the most efficient operations for any industry. It is truly amazing how they can produce such high-quality protein in the form of chicken for such a relatively low price. And this didn’t happen by accident. It was the result of industry specialists collaborating with faculty at major research universities like NC State, and the implementation of vertical integration into the broiler production industry. Due to their high feed conversion ratio, **today’s broilers can reach a dressed slaughter weight of 4-5 lbs. in less than 5 weeks.** Truly remarkable!!



Figure 15-7. Dark Cornish Hen (*Gallus gallus domesticus*). (Photo courtesy: <http://en.wikipedia.org/wiki/File:DkCornishHen>).



Figure 15-7. White Plymouth Rock Pullet. (*Gallus gallus domesticus*). (Photo courtesy: http://en.wikipedia.org/wiki/File:First_Root_Farm_chicken).



Figure 15-8. Modern-day Broiler (*Gallus gallus domesticus*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Poultry_Classes_Blog_photo_-_Flickr_-_USDAgov).

One of the more popular “backyard” chicken breeds is the **Buff Orpington** (Fig. 15-9). This English breed is popular because it is both an excellent layer, and is a good-quality meat bird. There is also a bantam variety of the Buff Orpington, and there are several other colors of the Orpington.

Another of these “dual purpose” breeds is the **Rhode Island Red** (Fig. 15-10). This breed was developed in Rhode Island and Massachusetts, and these hardy birds are good layers. There are at least 3 varieties: Asiatics, Game, and Mediterranean. Although usually friendly, these birds can be quite aggressive toward people, and

especially toward other breeds when kept together in the same coup.



Figure 15-9. Buff Orpington Hen (*Gallus gallus domesticus*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Buff_Orpington).



Figure 15-10. Rhode Island Red Rooster (*Gallus gallus domesticus*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Rhode_Island_Red_rooster).

The **Wyandotte** is another dual-purpose breed known for their pale brown or tan eggs. This breed, which originated in the US, comes in 17 colors, with the silver-laced being the original pattern (Fig. 15-11). They typically have white feathers on their neck,

with a rose comb and no feathers on their legs. There is also a bantam variety.



Figure 15-11. Silver-laced Wyandotte Hens (*Gallus gallus domesticus*). Note the rose comb and small wattles. (Photo courtesy: http://en.wikipedia.org/wiki/File:Silver_Laced_trio).

Originating in Australia, the **Australorp** is a large, hardy breed with black legs and beak, but with white claws (nails). They have a single comb with 5 distinct points. Australorps come in both standard and bantam varieties, and two or three colors including black and blue. The black Australorp (Fig. 15-12) is the most common, having glossy black feathers with a greenish sheen.

One of the more unusual backyard breeds is the **silkie** (Fig. 15-13). Silkies have a very fluffy plumage, dark flesh and bones, blue earlobes, and 5 pelvic digits rather than 4. They have feathers all the way down to their feet, and silkies come in several colors. Although generally considered to have come from China, there

seems to be some debate that they may have originated in Southeast Asia.



Figure 15-12. Black Australorp Rooster (*Gallus gallus domesticus*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Australorp_Rooster).

Most US strains of Silkies are of the bantam size, but in Europe the somewhat larger version is common. Even the large version, however, is not very large with roosters weighing about 4 lbs. and hens about 3. **The fluffy nature of the silkie is due to the lack of barbules on their feathers.** And without the barbules to stiffen their feathers, silkies are essentially unable to fly.

Silkies are one of the most popular “ornamental” breeds of chicken, and because of their docile nature are often kept as pets. **And, because they are so “broody,” silkies have been used to incubate the eggs of waterfowl and other game fowl such as quails and pheasants.**

Dr. Smallwood’s notes on backyard chickens, if you decide to raise them. Be sure and buy your chicks from a **reputable dealer**, and be sure they have been

vaccinated against **Marek’s Disease**. The virus that causes this severe debilitating condition is everywhere in the environment, and unvaccinated birds are likely to become infected. **Every flock, except for those raised under pathogen-free conditions, is presumed to be infected.**

There are several manifestations of Marek’s Disease, ranging from a subclinical form with reduced growth rate and egg production to the most serious form, characterized by the formation of lymphoid **neoplasms** (tumors). These neoplasms affect the nerves, particularly the sciatic nerve, resulting in **paralysis** and **death**.

One last note: Be sure to **cover** with wire or other material any **outdoor enclosure** for your chickens. If you leave it open at the top, you will be thanked by local hawks, especially the **red-tailed hawk**, for providing them with a **captive food supply**.



Figure 15-13. Bantam White Silkie Hen (*Gallus gallus domesticus*). Note the blue earlobe (arrow); some silkies lay blue-tinted eggs. (Photo courtesy: http://en.wikipedia.org/wiki/File:Silky_bantam).

The **Wild Turkey is native to North America**, and the domestic turkey is a **descendent of a Mexican subspecies** of the wild turkey, *Meleagris gallopavo* (Fig. 15-14), which was **originally domesticated by the Aztecs**. These “tame” turkeys were brought back to Spain in the mid-16th century, and from there the bird was imported to France and Britain. **By 1620, the “domestic turkey” was brought back to the US by the pilgrims**, not knowing that it had a larger cousin already plentiful in the forests of Massachusetts.

The wild turkey played a major role in the culture of the Eastern tribes of Native Americans. They prized the bird for both its meat and eggs, and even cleared some forests to make meadows for them (and to provide for a better shot of course).

The wild turkey is an example of how game management can be successful. By the **1940s**, due to excessive hunting and loss of habitat, the wild turkey had virtually disappeared from Canada, and was reduced to as low as **30,000 birds** in the US. Thanks to efforts by game officials and hunters, birds were bred in protected areas. By the 1970s, numbers had rebounded to about 1.3 million, and **2012 estimates place the US wild turkey population at about 7 million.**

So how does the modern domestic turkey differ from its wild ancestor? Much like the situation with our modern broiler chickens, the **modern meat-turkey has resulted from many generations of careful selection** (genetics) for rapid and efficient weight gain. Although some bronze turkeys are still raised, **most commercially produced turkeys are now white** because their small pinfeathers (new replacement feathers) are less visible on the dressed carcass.



Figure 15-14. Wild Turkey Gobbler (*Meleagris gallopavo*). The beard (arrow) of the gobbler is the trophy of the turkey hunter. (Photo courtesy: <http://en.wikipedia.org/wiki/File:Gall-dindi>).

The native color of the wild turkey is **bronze** (Fig. 15-14), and gobblers are more colorful than hens. Wild gobblers can reach a weight of nearly 25 lbs; hens are much smaller and only grow to about 10-12 lbs.

Although numerous heritage breeds are still raised for meat, **almost all commercially produced turkeys in the US are Broad-breasted Whites** (Fig. 15-15). The broad-breasted white is not really a breed of turkey, but much like the cornish-rock of the broiler world, is a **hybrid** resulting from crossing the White Holland and the broad-breasted bronze.

These hybrids have very large breasts, and the **toms can weigh in excess of 50 lbs.** Because they are so large, with short, widely spaced legs, they are not able to breed the hens naturally. **Most hens are inseminated artificially.** Remarkably, breast meat makes up about 73% of the carcass yield, with only

1% fat. The broad-breasted white hybrid was developed to grow faster than pure varieties and to have an excellent feed-meat conversion ratio. With nutritionists focusing on the best diets, and geneticists focusing on the best bird, **the broad-breasted white may reach 13 lbs. by 10 weeks of age.**



Figure 15-15. A commercial flock of Broad-breasted White Turkeys (*Meleagris gallopavo*). (Photo courtesy: <http://en.wikipedia.org/wiki/File:Turkeys>).

Peafowl, originally from Asia, are in the pheasant family. There are two species in the genus, *Pavo*— the **Indian Peafowl** (*Pavo cristatus*) (Fig. 15-16) and the **Green Peafowl** (*Pavo muticus*) (Fig. 15-17). There is also a Congo peafowl, but it is not common in the US. **The male is known as a peacock, while the female is called a peahen.**

When a peafowl spreads its “fan” does it spread its tail feathers? Contrary to what you might think, the elongated fan feathers of the peacock are not the rectrices (primary flight feathers of tail), but are **highly modified covert feathers located just above the base of the tail.**

When the peacock fans its tail, the “eyes” of the specialized covert feathers are displayed, and **the fan actually helps direct sound to its ears.** There are several color mutations of Indian peafowl, which have

been produced by selective breeding in captivity.



Figure 15-16. Male (cock) Indian Peafowl (*Pavo cristatus*). (Photo courtesy: <http://en.wikipedia.org/wiki/File:Paonroue>).



Figure 15-17. Male (cock) Green Peafowl (*Pavo muticus*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Siamese_Dragon).

One mutant variety of the Indian peafowl is the White Peafowl (Fig. 15-18). **These birds are not albinos, but represent an example of leucism.** Unlike *albinism*, where only the melanin-producing cells are affected, **leucism affects all pigment producing cells.** In leucistic phenotypes, the **eyes are not typically affected** so the animal does not have the characteristic “red” eye of the albino (Fig. 15-18).

Peafowl are commonly kept as back yard or farm-yard birds, and like guineafowl;

peafowl can serve as “watchdogs.” Both cocks and hens vocalize with several different “alarm calls.”



Figure 15-18. Male (cock) White Mutation of Indian Peafowl (*Pavo cristatus*). Note dark eyes. (Photo courtesy: http://en.wikipedia.org/wiki/File:Indian_peafowl_white_mutation).

Most pheasants originated in Asia. Although there are many types of pheasants, the one we are most familiar with is the common or **Ring-necked Pheasant**, which is in the genus *Phasianus*. There are, however, numerous subspecies, and there has been substantial **hybridization** since introduction to Europe and the US, where it has become a popular game bird (Figs. 15-19 & 15-20).

In fact, many hybrids are crosses between the common pheasant and the green pheasant from Japan. Originally introduced to the US in 1881, **these birds are now bred to be hunted**, especially in the Great Plains states. **South Dakota alone has an annual harvest of over a million birds a year.** Pheasant farms have some 10 million birds in the US and 35 million in the UK. As mentioned previously, pheasant hens are not very broody, and do not like to incubate their eggs. For this reason, the silkie chicken is often used to incubate pheasant eggs.



Figure 15-19. Male (cock) Ring-necked Pheasant hybrid (*Phasianus colchicus*). (Photo courtesy: [http://en.wikipedia.org/wiki/File:Phasianus_colchicus_2_tom_\(Lukasz_Lukasik\)](http://en.wikipedia.org/wiki/File:Phasianus_colchicus_2_tom_(Lukasz_Lukasik))).



Figure 15-20. Female (hen) Ring-necked Pheasant hybrid (*Phasianus colchicus*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Phasianus_colchicus_-Rutland_Water_-female-8).

Chapter 16: Psittacines- Parrots, Parakeets, and More

The order psittaciformes consists of more than 370 species of parrots. The so-called true parrots are in the family psittacidae, the cockatoos are in the family cacatuidae, and the New Zealand parrots are in the families Nestoridae and Strigopidae. One of the anatomical features of parrots is that they have zygodactyl feet (2 toes forward & 2 toes back). This design, which is an adaptation for clinging to a vertical surface, is not unique to parrots, and is also seen in woodpeckers, cuckoos, and some owls. Most parrot species show little to no sexual dimorphism,¹ but there are exceptions. Parrots are found mostly in tropical or subtropical regions, but some have explored into more temperate zones.

The family cacatuidae consists of 21 species of cockatoos, most of which originate in and around Australia, including the Philippines, Solomon Islands, and New Guinea. The most characteristic feature of a cockatoo is the crest, and with the exception of the cockatiel, most cockatoos are rather large parrots. The genus, *Calyptorhynchus* contains 5 species of Black Cockatoos, including the red tailed cockatoo (Fig. 16-1).

Within the genus, *Cacatua*, are 11 species of mostly white-feathered cockatoos, with a few variations toward pink and grey. There is even one grayish-black cockatoo in this genus. One of the favorite members of this group is the White (umbrella) Cockatoo (Fig. 16-2), which originated in Indonesia. Although mostly white, these birds have some yellow on the ventral surface of their primary and secondary flight feathers.

¹ Sexual dimorphism- males and females look different due to color markings or other differences.

One reason these parrots are favored as pets is because they are quite affectionate, appear to really like people, and even “cuddle” with people they know. Cockatoos are a bit noisier than most parrots, but not particularly good talkers. One should keep in mind that a white cockatoo is capable of living 100 years, and that they can crush a walnut with their beak; your finger would not present much of a challenge.



Figure 16-1. Red-tailed Black Cockatoo (*Calyptorhynchus banksii*). (Photo courtesy: [http://en.wikipedia.org/wiki/File:RedTailedBlackCockatoo_\(Redphoenix\).](http://en.wikipedia.org/wiki/File:RedTailedBlackCockatoo_(Redphoenix).))

The family psittacidae (true parrots) contains most of the psittacines, which includes the typical parrots, the conures, the parakeets, the parrotlets, the lorries, and the lorikeets. There are two genera of African parrots- the African Grey and 9 species in the genus *Poicephalus*. There are two subspecies of African greys- the Congo (Fig.

16-3) and the Timneh. An African grey parrot may live to be more than **50 years old**. If you want to see an African grey parrot that has an **amazing vocabulary** go to:

<https://www.youtube.com/embed/nbrTOcUnjNY>



Figure 16-2. White or Umbrella Cockatoo (*Cacatua alba*) displaying its crest. (Photo courtesy: [http://en.wikipedia.org/wiki/File:Umbrella_Cockatoo_\(Cacatua_alba\)_-Free_Flight_Aviary_-San_Diego](http://en.wikipedia.org/wiki/File:Umbrella_Cockatoo_(Cacatua_alba)_-Free_Flight_Aviary_-San_Diego)).

The **neotropical parrots** belong to the subfamily Arinae, which are divided into short-tailed and long-tailed groups. Examples of the long-tailed group are the **macaws, which are typically colorful birds in six genera native to Mexico, and Central and South America**. Examples of

macaws are the **Blue and Gold Macaw** (Fig. 16-4) and the **Hyacinth Macaw** (Fig. 16-5).



Figure 16-3. Congo African Grey Parrot (*Psittacus erithacus*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Psittacus_erithacus_perching_on_tray-8d).

So what's the difference between a parrot, a parakeet, a conure, a lorie, a lorikeet, a pigmy parrot, a rosella, and a lovebird? It gets confusing doesn't it? Well here's my explanation of the terminology. A **parrot is any member of the order Psittaciformes**, including the cockatoos, African parrots, Neotropical parrots, and two genera of New Zealand parrots. However, within the Neotropical parrots, there are some birds that carry other names.

Examples of short-tailed parrots are the Amazon Parrots. One species that is often kept as a pet is the **Red-crowned Amazon** (*Amazona viridigenalis*), which is also known as the green-cheeked Amazon or the Mexican redheaded parrot (Fig. 16-6). Wild red-crowned Amazons range as far north as southern California, Florida, and along the Rio Grande. They are also found on the island of Oahu. Like most parrots, these birds nest in tree cavities, and feed on seeds, fruits, flowers, and nectar. They are great mimickers, and some are excellent talkers.



Figure 16-4. Blue and Gold Macaw (*Ara ararauna*). (Photo courtesy: <http://en.wikipedia.org/wiki/File:Blue-and-Yellow-Macaw>).



Figure 16-5. Hyacinth Macaw (*Anodorhynchus hyacinthinus*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Anodorhynchus_hyacinthinus_Australia_Zoo_-8-2c).



Figure 9-6. Red-crowned Amazon Parrot (*Amazona viridigenalis*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Red_Crowned_Amazon).

A parakeet is any one of a large number of unrelated small to medium-sized parrots that typically have long tail feathers. The most familiar example of a parakeet is the popular pet bird, the **Budgerigar** or “**budgie**” (Fig. 16-7). This bird is also referred to as the common parakeet or shell parakeet. **All budgies are parakeets, but this term is also applied to many small parrots with long flat tails.**

The **native color** of the budgerigar is green and yellow with black, scalloped markings on the nape, back, and wings (Fig. 16-7). **These small parrots have survived the dry, harsh climate of inland Australia for at least several million years.** Once they became popular as pet birds, they have been selectively bred to produce the additional colors of blue, white, yellow, and grey. Although there are several ideas as to how the budgerigar got that name, the one I like the best is that it is derived from the

Australian slang words “budgery” meaning “good,” and “gar,” meaning cockatoo.



Figure 16-7. Male Australian Budgerigar (*Melopsittacus undulatus*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Melopsittacus_undulatus-Fort_Worth_Zoo-8a-4c).

The term conure is used to describe a loosely defined group of small to medium-sized parrots that belong to several genera within the long-tailed group of New World parrots. The American Ornithologists' Union refers to all conures as parakeets, and in fact, **the same bird is often called a parakeet in the wild, but becomes a “conure” when raised in captivity.**

One example is the **Mitred Conure** or mitred parakeet (Fig. 16-8). Although native to the forests of the Andes from Peru to Argentina, these birds have been introduced to the wild in California, Florida, and Hawaii. In fact, these little birds are not too welcome in Maui, and the Invasive Species Committee has been trying to get rid of them. From about 200 birds in 2003, they have killed almost all of them, and it is

anticipated that they will soon be totally removed from Maui. Last note- **the now extinct Carolina parakeet (Fig. 16-15) was considered a conure, thus the name *Conuropsis carolinensis*.**



Figure 16-8. Mitred Conure or Parakeet (*Aratinga mitrata*) (Photo courtesy: http://en.wikipedia.org/wiki/File:Mitred_Parakeet,_Inka_Trail,_Peru).

The terms, lorries and lorikeets, are used to describe certain small to medium-sized arboreal parrots with unique brush-tipped tongues for feeding on the nectar of various blossoms and berries. The names are derived from their tribe, Lorini, and they are closely related to the budgerigar and the fig parrots. An example of this group is the rainbow lorikeet (Fig. 16-9). You can appreciate the specialized tongue of the lorikeet in figure 16-10.

A rosella is one of about 6 species of broad-tailed Australian parrots in the genus *Platycercus*, meaning flat tail. When Europeans first came upon these parrots, they called them Rosehill parakeets, which was later shortened to “rosellas.” An example of this small group of parrots is the crimson rosella (Fig. 16-11).



Figure 16-9. Rainbow Lorikeet (*Trichoglossus haematodus*). Photo courtesy: [http://en.wikipedia.org/wiki/File:Rainbow_Lorikeet_\(Trichoglossus_haematodus\)_Nelson_Bay_NSW](http://en.wikipedia.org/wiki/File:Rainbow_Lorikeet_(Trichoglossus_haematodus)_Nelson_Bay_NSW). I guess this bird slept through camouflage classes.

A **lovebird** is one of 9 species in the genus, *Agapornis*. They get their common name because they are very affectionate birds. Lovebirds are **native to Africa** and Madagascar (one species). One of the more common pet species is the rosy-faced lovebird (Fig. 16-12). Actually, their species name means rose-colored neck. This bird is often kept in pairs, but it can be aggressive toward one another or toward people. They have a tendency to bond with one person and not get along with others.

Wild Parrots in Brooklyn - A Lesson in Adaptability. Are parrots supposed to live in NY City? Well, not really, but there is a feral population of **Monk Parrots** (*Myiopsitta monachus*) that have taken up residence in **Brooklyn** and other boroughs of NYC, and have even spread to surrounding areas such as Staten Island and Long Island. Monk parrots, also known as **Quaker parrots**, (Fig. 16-13) are native to the temperate and subtropical areas of

Argentina. These small parrots or parakeets are only about 10" in length.



Figure 16-10. Rainbow Lorikeet (*Trichoglossus haematodus*) drinking water. (Photo courtesy: [http://en.wikipedia.org/wiki/File:Rainbow_Lorikeet_\(Trichoglossus_haematodus\)_drinking](http://en.wikipedia.org/wiki/File:Rainbow_Lorikeet_(Trichoglossus_haematodus)_drinking)).



Figure 16-11. Crimson Rosella (*Platycercus elegans*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Platycercus_elegans_Wilsons_Prom). Talk about a "fashion statement."

The Monk Parakeet is the only species of parrot that builds a nest from sticks, and they typically construct large "apartment house" nests with a separate entrance and "apartment" for each pair. These **huge "communal" nests** can be built in a tree or on various man-made structures.



Figure 16-12. Rosy or Peach-faced Lovebird (*Agapornis roseicollis*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Agapornis_roseicollis_-_Namibia-8.jpg.)

So how did an Argentine parakeet end up living in NY City? What is their immigration status? How can they survive the winters in New York? Those are some good questions.

One of the more popular theories regarding the origin of the Brooklyn parrots is that a shipment of birds destined for sale in NYC pet shops was **accidentally released** when their crate was opened at JFK Airport about 1967.

As a matter of fact, large numbers of Monk parakeets were imported as pets to the US in the late 1960s. Many of these birds either escaped or were released. **These feral populations adapted to their new homes**, and by the early 1970s, Monk parakeets were found in at least seven states. By the 1990s feral populations had spread to eight more states, and it is now thought that there are about 100,000 feral parrots in FL alone.²

Several factors contribute to their ability to survive the colder winters of NY. First, they are **native to a more temperate part of Argentina**. Second, their unique

communal nesting on man-made structures allows them to utilize power poles with heat-producing transformers, and light poles with heat-producing lights (Fig. 16-14).



Fig. 16-13. Monk Parrot (*Myiopsitta monachus*) in native Argentina. (Photo courtesy: [wikimedia.org/wiki/commons/9/91/Monk_Parakeet_\(Myiopsitta_monachus\)_-Argentina-8.jpg](http://wikimedia.org/wiki/commons/9/91/Monk_Parakeet_(Myiopsitta_monachus)_-Argentina-8.jpg))



Fig. 16-14. Monk Parrot nest on power pole near transformer. (Photo courtesy: <http://www.brooklynparrots.com/2013/08/how-to-wild-quaker-parrots-keep.html>)

² You have to wonder if some of those Florida parrots were “New Yorkers,” who after a few cold winters said to heck with this weather- we’re moving to Florida.

Originally, it was thought that these “wild parrots” were a nuisance, and would surely lead to all sorts of problems. But **they have turned out to be quite an attraction** to the area, and in fact, a whole “cult” of followers blog their adventures. There is even movement in the Albany legislature to protect these beautiful little birds from being killed, and to not remove their nests unless absolutely necessary.

Although the monk parrot’s introduction to NY was apparently an accident, **they were not the first psittacines birds to live there. One now-extinct species of interest is the Carolina Parakeet (*Conuropsis carolinensis*) (Fig. 16-15), which once explored the more temperate zone of the eastern US up to New York and Wisconsin.**

Apparently, the last wild bird was killed in Florida in **1904**, and the last captive bird died in the Cincinnati Zoo in **1918**. Although **many of these birds were killed as pests or for their feathers**, it is even thought by some that introduction of the honeybee may have contributed to the extinction by taking many of its nesting sites. As a backyard beekeeper, I doubt very seriously that the honeybee had anything to do with the extinction of this bird. Just leave my honeybees out of this.



Figure 16-15. Mounted specimen of a Carolina parakeet (*Conuropsis carolinensis*); now extinct. (Photo courtesy:http://en.wikipedia.org/wiki/File:Karolinasittich_01).

Chapter 17: Small Passerines- Wrens, Finches, and More

Did you know that more than half of the 10,000 species of birds belong to the order Passeriformes? There are more species of passerines than there are species of mammals on the planet. Needless to say, they have been a most successful group. Passerines get their name from the single genus *Passer*, which contains the Old World sparrows, including the house sparrow (*Passer domesticus*).

By far the largest suborder of passeriformes is **Passeri**, which contains some **4000 species**. This group is also known as the “**songbirds**” or in Latin, the “**oscines**.” The passeri have a more complex musculature of their syrinx, allowing them to produce more elaborate bird songs— thus the name songbirds.

One of the best-known families of **passerines** is the **finch family** or Fringillidae. Members of this family are mostly native to the northern hemisphere, and **there are many types of finches in the US**.

The most common finch I see in our neighborhood is the **House Finch** (*Haemorrhous mexicanus*). **Its range across North America has dramatically increased since the 1950s.** Adults have a long, square-tipped tail and are brown across the back, with some shading into deep gray on the wing feathers (Fig. 17-1). Breast and belly feathers may be streaked, and adult males typically have a reddish head, neck and shoulders (Fig. 17-2).

Originally native only to Mexico and the southwestern US, house finches were introduced into the eastern US in the 1940s. They were sold illegally as

“Hollywood Finches,” but to avoid prosecution, dealers and owners began releasing the birds, and since that time, **this species has largely displaced native birds such as the purple finch.** They like to visit bird feeders throughout the year and are aggressive enough to drive other birds away (Fig. 17-3).



Figure 17-1. Female House Finch (*Haemorrhous mexicanus*). This photo was made in Raleigh, NC on March 18, 2015.

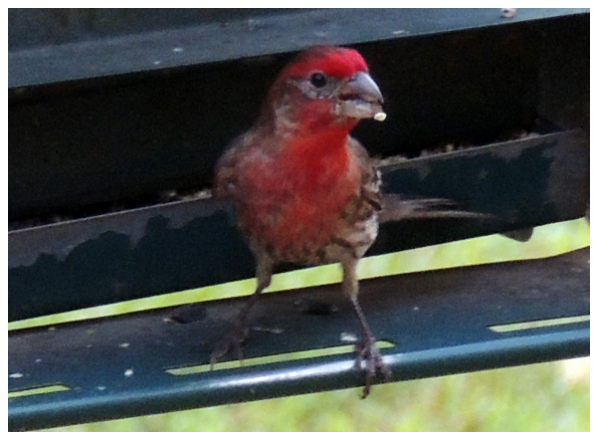


Figure 17-2. Male House Finch (*Haemorrhous mexicanus*). This photo was made in Raleigh, NC on June 2, 2013.

As part of the courtship behavior, the male will touch bills with the female, and may present her with choice bits of food. The male also feeds the female during the breeding and incubation periods, and **the male is the primary feeder of the nestlings**. Females are attracted to males with the deepest pigment of red on their head. **There is also a yellow variant of the house finch**, which is quite common around our feeder (Fig. 17-4)

The female lays eggs from February-August; usually laying 2 or more clutches per year of about 4 or 5 eggs per clutch. The female incubates the eggs for 12-14 days. Dandelion seeds are among the preferred seeds fed to the nestlings. **Although most birds tend to feed their nestlings animal matter for more protein, house finches feed their young only plant material.**



Figure 17-3. Female House Finches (*Haemorhous mexicanus*) taking over a feeder. This photo was made in Raleigh, NC on February 6, 2015.



Figure 17-4. Yellow Variant of House Finch. This photo was made in Raleigh, NC on February 21, 2015.

Another finch common to our feeder is the **Eastern Goldfinch** (*Spinus tristis*). This little bird is also known as the **American Goldfinch**. It is migratory, ranging from Alberta, Canada to North Carolina during the breeding season, and from the Canadian border to Mexico during the winter.

This little bird is the **only finch in its subfamily to undergo a complete molt twice a year, in the spring and fall**. The male is a vibrant yellow in the summer (Fig. 17-5) and an olive color in the winter. The female is a dull yellow-brown shade that brightens slightly during the summer (Figs. 17-6 & 17-7).



Figure 17-5. Eastern Goldfinch (*Spinus tristis*) male showing summer plumage. This photo was made in Raleigh, NC on August 24, 2014.



Figure 17-6. Eastern Goldfinch (*Spinus tristis*) female showing summer plumage. This photo was made in Raleigh, NC on July 4, 2013.

The male displays brightly colored plumage during the breeding season to attract a mate. After the autumn molt, the bright summer feathers are replaced by duller plumage, becoming buff below and olive-brown above. The autumn plumage is almost identical in both sexes; however, in some cases, **the male may retain some yellow shoulder patches.** Eastern goldfinches lay 4-6 bluish-white eggs. The eggs are incubated by the female, but the male brings her food.



Figure 17-7. Eastern goldfinches (*Spinus tristis*) female (left) and male (right). This photo was made in Raleigh, NC on July. 4, 2013.

The **Carolina Chickadee** (*Poecile carolinensis*) is a small passerine bird in the “tit” family (Paridae). Adults have a black cap and bib with white sides to their face (Fig. 17-8). Under-parts are white with rusty brown on the flanks; their back is grey. Similar to the black-capped chickadee, the Carolina chickadee is distinguished by a browner wing, and a shorter tail that has a more square ending.

Carolina chickadees are so similar to black-capped chickadees that they sometimes have trouble telling themselves apart. The two species sometimes mate producing hybrids. The most obvious difference between the three chickadees is that the Carolina chickadee sings a four-note song (*fee-bee-fee-bay*), black-capped sing

two-note songs, and the hybrids sing three-note songs.



Figure 17-8. Carolina Chickadee (*Poecile carolinensis*). This photo was made in Raleigh, NC on Dec. 20, 2013.



Figure 17-9. Carolina chickadee (*Poecile carolinensis*). This photo was made in Raleigh, NC on Dec. 20, 2013.

Carolina chickadees like mixed or deciduous woods from New Jersey west to southern Kansas and south to Florida and Texas. **They are not found at higher altitudes in the Appalachians Mountains, where they are replaced by the black-capped chickadee.** They are permanent residents, not migrating south even in severe winter weather.

Carolina chickadees can lower their body temperatures to induce a state of

hypothermia called torpor. (See page 30.) They do this to conserve energy during cold winters. In extreme cold, they may hide in tree cavities and spend up to 15 hours in torpor. **During torpor, they are unresponsive, but should not be picked up and handled.**

Another member of the “tit” family, Paridae is the **Tufted Titmouse** (*Baeolophus bicolor*). These little birds are gray above and white below, with a gray crest and dark forehead (Figs. 17-10 & 17-11). They also have rust-colored flanks. Their range is primarily in the eastern U.S., but they do extend as far north as southeaster Canada, near the Great Lakes. **Here in NC, they are year-round residents, and one of the most common visitors to our bird feeder.**

Besides the bird feeder, tufted titmice like to forage on the ground, looking for insects and caterpillars. They also eat berries, and like the chickadee will hide food in the fall for use in the winter.



Figure 17-10. Tufted Titmouse (*Baeolophus bicolor*). This photo was made in Raleigh NC on February 5, 2015.

Tufted titmice typically find a tree cavity or a nesting box to lay their eggs. Pairs may

remain together year-round, but they may join small mixed flocks in the winter.

Titmice typically lay 5-6 eggs that are incubated by the female for about 13 days. The female stays with the nestlings at first, with the male bringing her food. Later both sexes participate in feeding. In fact, **a young bird from a previous brood may help in feeding the new chicks.** The nestlings will typically fledge at about 16 days.



Figure 17-11. Tufted Titmouse (*Baeolophus bicolor*). This photo was made in Raleigh NC on February 5, 2015.

The **Carolina Wren** (*Thryothorus ludovicianus*) is small passerine bird in the family, Troglodytidae. There are about 80 species of wrens in approximately 20 genera. The Carolina wren has a range from Ontario to Mexico. This year-round resident of NC is **a small bird with a big voice**, and there are 7 subspecies. The subspecies we have here is *Thryothorus ludovicianus ludovicianus*.

These birds have a rich brown crown, wings, and tail, with lighter gray or buff under-parts (Figs. 17-12 - 17-14). There is a white streak over the eye, and many small

white spots on some of the covert feathers of the wing. The male is the more vocal, and has a greater repertoire of calls; however, the female is the only one that does the so-called “chatter call.”



Figure 17-12. Carolina Wren (*Thryothorus ludovicianus*). This photo was made in Raleigh NC on March 5, 2015.

Carolina wrens are monogamous and typically mate for life. They can build a nest just about anywhere that looks like a protected cavity. I’ve found their nests in flowerpots, hanging baskets, and in two different boats I’ve owned. And it seems like they build a nest in about an hour or two. They can raise 2-3 broods per season, and build a new nest for each brood.

Here in NC, they tend to lay 4-5 eggs per clutch. Females incubate the eggs for about 2 weeks, and the nestlings fledge at about 2 weeks after hatching. **The nestlings are fed exclusively insects or other invertebrates.** Like many other passerines, this little bird frequently falls victim to brood parasitism by the brown-headed cowbird.

Although in 1939, the northern mocking bird was named the State Bird of South Carolina, this decision was repealed in 1948, making the “Great Carolina Wren” the state bird. No worries, Texas, and 4 other states, still claim the northern mocking bird as their state bird.



Figure 17-13. Carolina Wren (*Thryothorus ludovicianus*). This photo was made in Raleigh NC on December 20, 2013.



Figure 17-14. Carolina Wren (*Thryothorus ludovicianus*). This photo was made in Raleigh NC on March 2, 2015.

The **Eastern Bluebird** (*Sialia sialis*) is found east of the Rockies, southern Canada to the Gulf States, and southeastern Arizona to Nicaragua. **The bright-blue breeding plumage of the male makes this species a favorite of many bird watchers** (Figs 17-15 – 17-17). The diet of an adult bluebird consists primarily of insects and other invertebrates, but they also eat wild fruits and berries. Favored foods include

grasshoppers, crickets, katydids, and beetles, earthworms, spiders, millipedes, centipedes, sow bugs, and snails. **Note: These birds can be easily attracted to a “mealworm plate.”** Dried mealworms are readily available at most stores that sell birdseed and suet.



Figure 17-15. Adult Eastern Bluebirds (*Sialia sialis*) at the mealworm plate. There are two females on the left and two males on the right. This photo was made in Raleigh, NC on March 1, 2015.



Figure 17-16. Adult Eastern Bluebird female (*Sialia sialis*) eating dried mealworm. This photo was made in Raleigh, NC on June 6, 2014.

Eastern bluebirds are social birds that may occasionally form large flocks. However, **they become very territorial during the breeding season** and may continue to defend a feeding area through the winter. A mature female may raise two or even 3 broods each season. The female incubates the eggs, which hatch after 13 to 16 days, and she continues to brood the chicks for up to 7 more days. Fledglings

leave the nest about 15-20 days after hatching. **Fledglings are gray, with speckled breasts** (Fig. 17-18). The blue color becomes more prominent and the speckles on their breasts disappear as they mature.



Figure 17-17. Adult Eastern Bluebird male (*Sialia sialis*). This photo was made in Raleigh, NC on March 5, 2015.



Figure 17-18. Fledgling Eastern Bluebirds (*Sialia sialis*) at the mealworm plate. **“Hey, we found these all by ourselves.”** This photo was made in Raleigh, NC on June 16, 2014.

Eastern bluebirds have increased in numbers significantly in recent years because bird lovers have put up **bluebird boxes** (Fig. 17-19) in their yards. These boxes can be purchased from many sources, but here are **a few things I’ve learned:**

(1) bluebirds do not like their box attached to a tree or building. They like it out in the open, away from trees and

shrubs; a post is the best choice, and the box needs to be about 4-5 feet off the ground;

(2) bluebirds are very territorial, and they need their space. Do not put boxes too close together (at least 100')—the more space between them, the better;

(3) Bluebirds do not like to lay their eggs in a “used” nest; they like to build a new nest for each brood. Remove the old nest from the box as soon as the nestlings have fledged; and

(4) Be sure the entrance hole is 1½” in diameter—no larger. If the hole is larger than 1½”, a brown-headed cowbird can parasitize the nest.

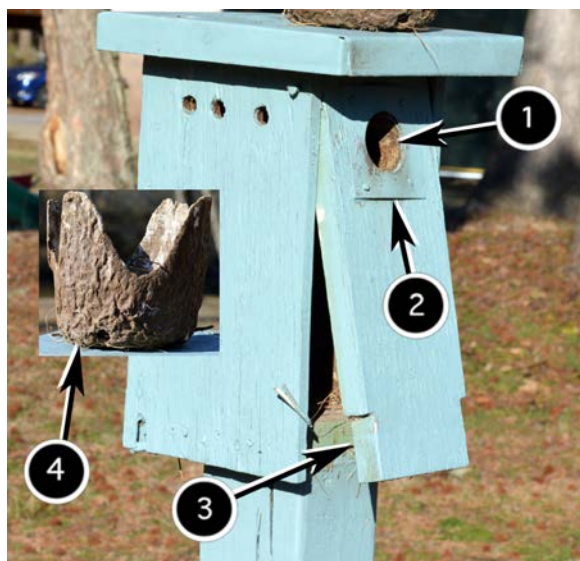


Figure 17-19. A really good bluebird box- many clutches have been raised in it; (1) hole is 1½” in diameter; (2) metal plate tacked over hole prevents enlargement; (3) front swings out for cleaning; (4) tough cardboard nest cup- makes cleaning easier. Just dump out the old nest and return cup to box.

The **Dark-eyed Junco** (*Junco hyemalis*) is the best-known of the juncos, which is a genus of small grayish American sparrows. This bird is common across much of temperate North America and in summer

ranges far into the Arctic. I often refer to these birds as **Slate-colored Juncos**, which used to be considered a separate species. **Males tend to have darker, more conspicuous markings than the females.** The outer white tail feathers flash in flight, and the bill is pale pink in both sexes (Figs. 17-20 – 17-22).

Juncos are common at our feeders during the winter months, but they typically begin to migrate further north in April. They mainly eat insects and seeds. Although they do feed directly from the feeder, they often prefer foraging on the ground below for dropped seeds.



Figure 17-20. Dark-eyed Junco male (*Junco hyemalis*). This photo was made in Raleigh, NC on December 30, 2013.

Typically, the female will lay two clutches of 4 eggs each during the breeding season. The eggs are incubated by the female for about 2 weeks, and chicks usually leave the nest about 14 days after hatching.

There are several subspecies of dark-eyed juncos, making up about 5 basic groups. These groups were formerly considered separate species (such as the slate-colored junco), but because of interbreeding, they are now considered as a single species.



Figure 17-21. Dark-eyed Junco female (*Junco hyemalis*). This photo was made in Raleigh, NC on December 30, 2013.



Figure 17-22. Dark-eyed Junco (*Junco hyemalis*). This photo was made in Raleigh, NC on February 21, 2015.

The **Indigo Bunting** (*Passerina cyanea*) is a small passerine bird in the family Cardinalidae. Its range is from southern Canada to north Florida during the breeding season, and from south Florida to northern South America during the winter. **It typically migrates at night, using the stars to navigate.** The male is a vibrant blue (Figs. 17-23 – 17-24) in the summer and a brown color during the winter; while the female is brown year-round. The male displays its vivid plumage during the breeding season to attract a female. Nest-building and incubation are done entirely by the female. Indigo buntings feed primarily

on insects during the summer and seeds during the winter.

These sparrow-sized birds are considered monogamous, but are not always faithful to their partner (oops). In the western part of their range, they often interbreed with the lazuli bunting. The clutch size is 3-4 eggs, which are incubated for 17-13 days. The chicks fledge at about 17-13 days, and most pairs raise 2 broods per year.



Figure 17-23. Indigo Bunting male (*Passerina cyanea*). This photo was made in Raleigh, NC on June 23, 2014.



Figure 17-24. Indigo Bunting male (*Passerina cyanea*). This photo was made in Raleigh, NC on June 23, 2014.

During the breeding season, the indigo bunting feeds on insects, seeds and berries, including caterpillars, grasshoppers, spiders, beetles, and grass seeds. Grass seeds make

up most of its winter diet; however, buds, and insects are eaten when available. The young are fed mostly insects, to provide them with protein.

These birds are not common visitors to our feeder. In fact, these are the only photos I have of one. Females have probably been there too, but I did not distinguish them from other small brown birds. Here's what one looks like (Fig. 17-25).



Figure 17-25. Indigo Bunting female (*Passerina cyanea*). (Photo courtesy of: http://en.wikipedia.org/wiki/Indigo_bunting#mediaviewer/File:Indigo_Bunting_Female_by_Dan_Panca).

Like other passerine birds, indigo buntings can fall victim to “brood parasitism” by the brown-headed cowbird. The cowbird lays her egg in the bunting’s nest, and the cowbird chick typically hatches first, grows faster and often starves the the bunting chicks or pushes them out of the nest. Note: This not the only bird species parasitized by the brown-headed cowbird.

The **White-breasted Nuthatch** (*Sitta carolinensis*) is a bird in the family, Sittidae and is commonly seen in NC (Figs.17-26 & 17-27). Like other nuthatches, it has a large head, short tail, powerful bill, and strong feet. The upperparts are pale blue-gray, and the face and under-parts are white. It has a black cap and a chestnut lower belly.

Like other nuthatches, this bird forages for insects on trunks and branches, and is able to move headfirst down trees. Seeds form a substantial part of its winter diet, as do acorns and hickory nuts that were stored by the bird in the fall. The breeding habitat of the white-breasted nuthatch is from southern Canada to southern Mexico.

The white-breasted nuthatch is the only North American nuthatch typically found in deciduous trees. Other species prefer pine forests. This nuthatch is non-migratory, and adults typically stay in their territory year-round. These birds are monogamous, and will remain together year-round until one partner dies. The nest cavity is typically a natural hole in a decaying tree.



Figure 17-26. White-breasted Nuthatch (*Sitta carolinensis*). This photo was made in Raleigh, NC on June 6, 2013.

The clutch is about 7 eggs, which are incubated by the female for 13-14 days; the chicks fledge about 22 days after hatching. Both adults feed the chicks in the nest and for about two weeks after fledging, and the male also feeds the female while she is incubating. This nuthatch typically roosts in

a tree hole and removes its feces from the roost site in the morning.



Figure 17-27. White-breasted Nuthatch (*Sitta carolinensis*). This photo was made in Raleigh, NC on March 20, 2015.

When a white-breasted nuthatch leaves the nesting hole, it wipes around the entrance with a piece of fur or vegetation, which apparently masks the smell of the eggs or nestlings. The nuthatch may also smear blister beetles around the entrance to its nest, and it has been suggested that the unpleasant smell from the crushed insects deters squirrels, its primary competitor for natural tree cavities. The white-breasted nuthatch may flock with other species during winter. These flocks may include titmice, chickadees, and downy woodpeckers.

The **Brown-headed Nuthatch** (*Sitta pusilla*) is a small songbird found in pine forests throughout the southeastern US (Figs. 17-28 – 17-30). Like other nuthatches, this bird has a sharp nail-like beak, which it uses to pound open seeds. It is a frequent visitor to feeders and is especially fond of sunflower seeds and suet. **The brown-headed nuthatch is one of the**

world's smallest nuthatches, weighing in at about 4 oz. This bird has a brown cap, with a dark eye-line and white cheeks. It also has a small white patch on the nape of its neck.



Figure 17-28. Brown-headed Nuthatch (*Sitta pusilla*). This photo was made in Raleigh, NC on March 18, 2015.



Figure 17-29. Brown-headed Nuthatch (*Sitta pusilla*). This photo was made in Raleigh, NC on March 5, 2015.

Nuthatches, of which there are many species worldwide, are omnivorous birds, feeding mostly on insects, nuts and seeds. They like to forage for insects hidden in or under bark by climbing along tree trunks and branches, often upside-down. **In fact, they are sometimes referred to as “upside-down” birds because they are commonly seen in that position.** Their

habit of wedging a large food item in a crevice and then hacking it with their strong bills gives this group its common name.



Figure 17-30. Brown-headed Nuthatch (*Sitta pusilla*). This photo was made in Raleigh, NC on March 18, 2015.

In recent years, there has been growing concern about declining numbers of brown-headed nuthatches in NC. Folks are now being encouraged to put up **nesting boxes for these birds**, similar to what we do for the eastern bluebird. You can buy nuthatch boxes already made, or you can do what I did and convert a bluebird box to accommodate the brown-headed nuthatch. All you have to do is cover the 1½” entrance hole of the bluebird box with a “**restrictor plate**” having the **smaller diameter of 1” needed for the nuthatch.**

Here’s how I did it. I took two bluebird boxes and modified them for the brown-headed nuthatch. I bought a small sheet of Lexan, and cut two 4” squares. I centered and drilled a 1” hole in the Lexan plates. I then attached the plates over the existing 1½” entrance holes of the bluebird boxes, using 4 small screws for each plate. Next, I painted the plates to match the boxes (Fig. 17-31).

For more information on brown-headed nuthatch boxes go to:

<http://nc.audubon.org/make-little-room-brown-headed-nuthatch>

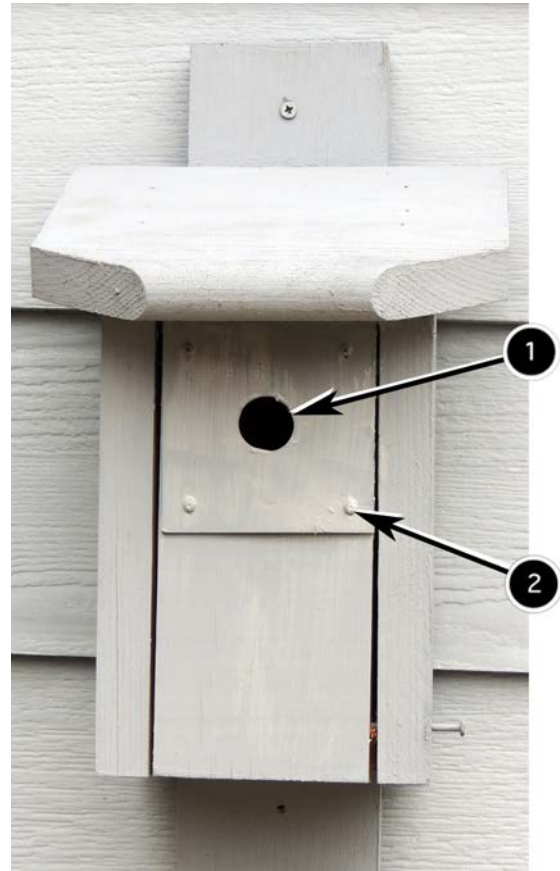


Figure 17-31. Finished Nuthatch Box: (1) 1” hole¹ centered in plate; (2) plate attached by 4 small screws and then painted to match box.

The **White-throated Sparrow** (*Zonotrichia albicollis*) is a bird of the family, Emberizidae, and is quite different from the house sparrow, *Passer domesticus*. We are in the migratory range of this bird, which breeds mostly in Canada and New England. They are only in our neighborhood during the winter months.

¹ Even though the NC Audubon Website recommends a 1” hole for the brown-headed nuthatch, I have yet to see a nuthatch enter one of my “modified bluebird boxes.” I am of the opinion that a 1” hole may be too small, even for the tiny nuthatch. I recently used a file to slightly enlarge the hole; we’ll see if that makes a difference.

There are two distinct plumage patterns seen in this species: tan-striped and white-striped forms. In the white-striped form, the crown is black with a white central stripe. In the tan form, which is what is shown here, the crown is dark brown with a tan central stripe (Figs. 17-32 – 17-34). Both variations have dark eyes, a white throat, and a gray bill. The upper part of these birds has a reddish tint, with two white wing bars. Oddly enough, they almost always pair with the opposite color type for mating.



Figure 17-32. White-throated Sparrow (*Zonotrichia albicollis*). This photo was made in Raleigh, NC on December 30, 2013.

White-throated sparrows eat seeds, insects, and berries, and are frequent visitors to our bird feeders in the winter. Although they like to nest on the ground under shrubs or in the lower branches of deciduous trees, we won't be finding their nests around here. You'll need to go north to the New England states or central Canada to find one.



Figure 17-33. White-throated Sparrow (*Zonotrichia albicollis*). This photo was made in Raleigh, NC on March 6, 2015.



Figure 17-34. White-throated Sparrow (*Zonotrichia albicollis*). This photo was made in Raleigh, NC on February 6, 2015.

The **Eastern Towhee** (*Pipilo erythrophthalmus*) is a large New World sparrow in the family, Emberizidae, which also includes juncos and many species of buntings. Because of its distinct call, “*chee-wink*,” **this bird is also known as the chewink**. Their breeding range is across the eastern U.S., and northern birds migrate to the southeastern U.S during the winter.

Adults of both sexes have red-orange sides, with a white belly and a long tail with white edges (Figs. 17-35 – 17-37). As the species name, *erythrophthalmus*, denotes, these birds typically have red eyes; however, not all of them do. Males are darker than

females, having a black head, upper body, and tail. In the female, these parts are brown. Juveniles are pretty much brown all over.



Figure 17-35. Eastern Towhee Female (*Pipilo erythrophthalmus*). This photo was made in Raleigh NC on June 1, 2013.

Breeding typically begins in the spring and continues to late summer, and they can raise up to 3 broods per year in Florida; 2 more likely in NC. Clutch size can range from 2-6 eggs, with 3 being more typical. Towhees become reproductively active in their second year, and their lifespan in the wild can be up to 12 years. Eastern towhees have quite a wide summer breeding range, from near sea level to as high as 6500 ft. along the Tennessee-North Carolina border.

Eastern towhees spend a good deal of their time foraging on the ground, hopping along looking for seeds, insects or spiders. They may even take an occasional amphibian or small reptile. In terms of predation of eggs and nestlings, raccoons, domestic cats, and snakes are known nest thieves; even blue jays may rob their nests. If that weren't enough, the brown-headed cowbird will parasitize the nests of the eastern towhee. Adult towhees can fall victim to predation by foxes, house cats, and other mammals, as well as by several species of hawks and the barred owl.



Figure 17-36. Eastern Towhee Male (*Pipilo erythrophthalmus*). Note the red eye. This photo was made in Raleigh NC on June 1, 2013.



Figure 17-37. Eastern Towhee Male (*Pipilo erythrophthalmus*). This photo was made in Raleigh NC on March 4, 2015.

As noted elsewhere, I have the opportunity to travel twice a year to teach at St. George's University in **Grenada, WI**. While there, I can't pass up the opportunity to photograph some of the birds. One of my very favorite and unique little passerines is the nectar-feeding Bananaquit (Figs. 17-38 & 17-39).

The Bananaquit (*Coereba flaveola*) is a small passerine bird with a curved bill, which is adapted to taking nectar from flowers. It is the only member of the genus *Coereba* (Vieillot, 1809) and is typically placed in the Tanager family; however, its exact classification is listed as uncertain. This small bird is commonly found in warmer parts of the Americas, especially in the Caribbean. It feeds on nectar and on the sweet juices of fruit such as oranges. Bananaquits are occasional visitors to south Florida, probably coming over from the Bahamas.



Figure 17-38. Bananaquit (*Coereba flaveola*). This photo was made in St. Georges, Grenada, WI on December 3, 2013.

Anatomically, the bananaquit is not equipped with a highly flexible shoulder

joint like the hummingbird, and is **not capable of hovering over a flower** to get to the nectar. Therefore, it uses an entirely different strategy of landing adjacent to the bloom and **using its sharp, curved bill to pierce the flower from the side**. This allows it to feed on the nectar, but this “side-entry” method would not serve to pollinate the plant.

The bananaquit also uses its sharp bill to access the juice of oranges and other fruits, and it may feed occasionally on small insects. It also adapts well to people and can be attracted to a bowl of sugar water.



Figure 17-39. Bananaquits (*Coereba flaveola*). (Photo courtesy of: <http://en.wikipedia.org/wiki/Bananaquit#/media/File:Bananaquits.jpg>).

There are many more species of passerine birds. Some of the larger species, including Cardinals, Blue Jays, Mockingbirds, Robins, Crows and more are covered in Chapter 18.

Chapter 18: Larger Passerines- Cardinals, Crows, More

The **Northern Cardinal** (*Cardinalis cardinalis*) is a medium-sized passerine bird native to North America. It is also known as the cardinal-grosbeak and cardinal bunting. Cardinals are seed-eating birds with strong bills, and are typically found in open woodlands. It has a distinctive crest on the head and a mask on the face, which is black in the male and gray in the female. **The northern cardinal was named by early American colonists for the male's red crest, which apparently reminded them of a Catholic cardinal's mitre hat.**



Figure 18-1. Northern Cardinal Male (*Cardinalis cardinalis*). This photo was made in Raleigh, NC on February 18, 2015.

The male is a vibrant red (Figs. 18-1 & 18-3), while the female is a dull red-brown (Fig. 18-2). Although primarily a seedeater, the cardinal also feeds on insects and fruit. **The male is very territorial, and during courtship, feeds seeds to the female beak-to-beak.** The clutch size is 3-4 eggs, and 2-4 clutches are produced each year. **Pairs mate for life, and they stay together year-**

round. Mated pairs sometimes sing together before nesting.



Figure 18-2. Northern Cardinal Female (*Cardinalis cardinalis*). This photo was made in Raleigh, NC on July 4, 2013.

Northern cardinals fall victim to a wide variety of predators, including falcons, hawks, shrikes, and owls. Predators of chicks and eggs include snakes, blue jays, squirrels, and domestic cats. During the summer months, cardinals prefer seeds that are easily husked, but they also eat insects. **Like many passerines, they feed their young almost exclusively insects.**

The **Brown-headed Cowbird** (*Molothrus ater*) is a passerine bird in the family, Icteridae (Figs 18-4 & 18-5). **They are permanent residents in NC and are brood parasites of numerous other birds.** The female cowbird lays only one egg in each “host” nest, and cowbirds have been documented to have laid their eggs in the nests of at least 220 host species, including many passerine species, hummingbirds, and even raptors. Thus, **the brown-headed cowbird is a “brood parasite,” capable of**

destroying many nestlings of other species, particularly song birds. In other words, its not a very nice bird.



Figure 18-3. Northern Cardinal Male (*Cardinalis cardinalis*). This photo was made in Raleigh, NC on March 18, 2015.



Figure 18-4. Brown-headed Cowbird Male (*Molothrus ater*). This photo was made in Raleigh NC on June 23, 2014.

Female cowbirds can lay as many as 40 eggs in a single breeding season, each one in a different nest (Fig. 18-6). Because of their short incubation period (≈ 10 days), the cowbird egg is typically the first to hatch, and the host parents begin feeding the “parasite.” The fast-growing cowbird chick will take most of the food, either starving the host chicks or crowding them out of the nest.

More than 140 species of birds have been known to raise cowbird chicks. One reason the house finch has been so successful is that it feeds its chicks a totally plant-material diet, which is not sufficient for the cowbird chick to survive. Other brood-parasite species include some of the Old World (European) cuckoos.



Figure 18-5. Brown-headed Cowbird Female (*Molothrus ater*). This photo was made in Raleigh NC on June 23, 2014.



Figure 18-6. Parasitized nest of Eastern Phoebe with cowbird egg (left). (Photo courtesy:http://en.wikipedia.org/wiki/Brown-headed_cowbird#/media/File:Eastern_Phoebe-nest-Brown-headed-Cowbird-egg.jpg).

Host birds that do recognize the cowbird egg react in different ways.

Some species will abandon the nest, others will bury the egg under the nesting material, and some will just throw the egg out of their nest.

The **American Robin** (*Turdus migratorius*) is a member of the thrush family, Turdidae (Figs. 18-7 – 18-9). **Although named after the European robin because of its red-orange breast, the two birds are not closely related.** The American robin is found throughout North America, wintering from southern Canada to central Mexico and along the Pacific Coast. **It is one of the most prevalent birds in the US.**



Figure 18-7. American Robin (*Turdus migratorius*). This photo was made in Raleigh, NC on March 9, 2015.

Although often referred to as the “harbinger of spring,” **the robin is actually a year-round resident of NC.** Active during the day, its omnivorous diet consists of grubs, earthworms, caterpillars, fruits, and berries. **In the more northern regions, where it does migrate for the breeding season, it is one of the earliest bird species to arrive, and the first to lay its eggs.**



Figure 18-8. American Robin (*Turdus migratorius*). This photo was made in Raleigh, NC on July 3, 2013.

Adult robins are a favorite target of numerous predators, including hawks, house cats, and some snakes. **The brown-headed cowbird** may lay her egg in a robin’s nest, but **the robin typically rejects it** so as to save its own nestlings. The adult American robin has a brown back and a red-orange breast. The bill is mostly yellow with a variably dark tip; the legs and feet are brown. **There is little to no sexual dimorphism, but the female tends to be a bit duller than the male.**

The American robin is a known reservoir and carrier of the West Nile Virus, which is particularly deadly to American crows and blue jays. The virus can be **spread by mosquitoes** from the robin to other species, including humans.

The **Northern Mockingbird** (*Mimus polyglottos*) is **the only mockingbird commonly seen in North America** (Figs. 18-10 – 18-12). It is largely a permanent resident in most areas, but some birds do migrate south during extremely cold weather. Well known for its ability to mimic other animals, its scientific name, *Mimus polyglottos*, literally translates to “**many-tongued mimic.**” This medium-

sized bird is primarily gray with a pale belly, and its wings have white patches that are clearly visible during flight. **They are also “bullies” in that they tend to dominate an area, chasing other birds away from the feeder or other food source.** They are not afraid of anything, and will even attack people who come too near their nest.



Figure 18-9. American Robin (*Turdus migratorius*). This photo was made in Raleigh, NC on December 21, 2013.



Figure 18-10. Northern Mockingbird (*Mimus polyglottos*). This photo was made in Raleigh, NC on February 24, 2015.

The northern mockingbird is an omnivore, and its diet includes both insects and fruits. This bird's breeding range extends from southeastern Canada to Puerto Rico. **Mockingbirds are thought to be**

very intelligent birds, apparently capable of recognizing individual humans.

The northern mockingbird is a medium-sized member of the family, Mimidae, which also includes thrashers and some catbirds. **Males and females look alike, with males being slightly larger.** Juveniles are marked with streaks on their backs and chests. These birds have been observed to live up to 8 years in the wild, and up to 20 years in captivity.



Figure 18-11. Northern Mockingbird (*Mimus polyglottos*). This photo was made in Raleigh, NC on February 9, 2015.

The **Brown Thrasher** (*Toxostoma rufum*) is a bird in the family, Mimidae, which also includes the New World catbirds and mockingbirds (Figs. 18-13 – 18-15). This is a common bird in the central and eastern US, and its range extends into south central Canada. **It is the only thrasher to live primarily east of the Rockies, and is a year-round resident in NC.**



Figure 18-12. Northern Mockingbird (*Mimus polyglottos*). This photo was made in Raleigh, NC on March 4, 2015.

Its upper parts are deep brown, and its under parts are buffy-white, with dark streaks. **Both sexes are similar in appearance, and juveniles look much like the adults. The brown thrasher male is said to have well over 1000 songs (note combinations)- the largest repertoire of any North American bird.**



Figure 18-13. Brown Thrasher (*Toxostoma rufum*). This photo was made in Raleigh, NC on June 6, 2013.

As an omnivore, its diet includes insects, fruits, seeds, and nuts. **They are often seen foraging around in leaves for insects or other tidbits.** The usual nesting areas are shrubs, small trees, or at times on the ground. Brown thrashers are territorial birds, and **when defending their nests, they will attack mammals, including people.**

Typically, they are elusive birds, rarely flying very high off the ground.

Brown thrashers are monogamous, but some mate switching does occur. In NC the breeding season may begin in February and March. Both sexes participate in nest building. The female lays 3-5 eggs, which typically hatch in about 12-14 days. Both parents incubate the eggs and feed the nestling, which fledged about 12 days after hatching. Brown thrashers can raise 2-3 broods per season.

Although this bird is vulnerable to brood parasitism by the **brown-headed cowbird, they are fairly resistant because they typically get rid of the cowbird's egg.** Predators of this bird include domestic cats, snakes, and raptors.



Figure 18-14. Brown Thrasher (*Toxostoma rufum*). This photo was made in Raleigh, NC on February 20, 2015.

The **Blue Jay** (*Cyanocitta cristata*) is a passerine bird in the family Corvidae (Figs. 18-16 – 18-18). It is resident through most of eastern and central United States and southern Canada. The blue jay is predominantly blue with a white chest and under-parts, and a blue crest. It has a black collar around its neck and a black border behind the crest. The blue jay feeds

primarily on nuts and seeds such as acorns, soft fruits, and arthropods.



Figure 18-15. Brown Thrasher (*Toxostoma rufum*). This photo was made in Raleigh, NC on February 20, 2015.



Figure 18-16. Blue Jay (*Cyanocitta cristata*). This photo was made in Raleigh, NC on March 7, 2015.

The blue jay is a noisy and aggressive passerine. Due to its slow flying speeds, this species makes easy prey for hawks and owls when flying in open areas. The blue jay may benefit other bird species, as it may chase predatory birds, such as hawks and owls and will scream if it sees a predator within its territory. It may occasionally mimic the calls of raptors, especially those of the red-tailed and red-shouldered hawks, possibly to test if a hawk is in the area. It may also be aggressive towards humans who come close to its nest, and if an owl roosts near the nest during the daytime the blue jay mobs it until it takes a new roost. Jays are very territorial,

and they may chase smaller birds from a feeder.



Figure 18-17. Blue Jay (*Cyanocitta cristata*). This photo was made in Raleigh, NC on February 17, 2015.



Figure 18-18. Blue Jay (*Cyanocitta cristata*). This photo was made in Raleigh, NC on January 1, 2014.

Like other corvids (crows, ravens, etc.), **blue jays are curious and are considered highly intelligent.** Young jays snatch objects, such as bottle caps or pieces of aluminum foil, and carry them around until they lose interest. While not confirmed to have engaged in tool use in the wild, **blue jays in captivity have been observed using strips of newspaper as tools to obtain food, while captive fledglings have been observed attempting to open their cage**

door. Beyond predation and accidents, a recent cause of mortality has been the **West Nile Virus**, to which corvids are highly susceptible.

The **American Crow** (*Corvus brachyrhynchos*) is a large passerine bird in the family Corvidae, that is found throughout much of North America (Figs. 18-19 – 18-21). **These birds are widespread and adaptable**, but they are highly susceptible to the **West Nile Virus**. The crow has iridescent black feathers, with black feet and bill. The American crow has a smaller bill than the raven. Crows typically move their heads up and down as they give out their distinctive *caaw-caaw-caaw* call. In addition to their trademark call, **crows can mimic sounds produced by many animals, including other birds.**

The American crow is omnivorous, and will eat just about anything, including invertebrates, carrion, seeds, eggs, mice, frogs, and other small animals. **Crows are highly intelligent birds, and are one of the a few birds that have been observed modifying and using tools to obtain food.** (See videos referenced on page 66).



Figure 18-19. American Crow (*Corvus brachyrhynchos*). This photo was made in Raleigh, NC on February 14, 2015.

American crows are monogamous, and mated pairs form large families of up to 15 birds from several breedings. **Offspring from a previous season will often remain with the family to help raise new nestlings.** American crows reach sexual maturity at about 2 years, but may not breed until they are 4-5 years old. **Despite attempts by humans to eliminate them, crows remain widespread.** The total number of American crows is estimated by BirdLife International to be around 31,000,000.



Figure 18-20. American Crow (*Corvus brachyrhynchos*). This photo was made in Raleigh, NC on February 3, 2015.

The **Tropical Mockingbird** (*Mimus gilvus*) (Figs. 18-22 -18-24) is found from southern Mexico south to northern Brazil, and in the Lesser Antilles and other Caribbean islands. It is a close relative of the Northern Mockingbird (*M. polyglottos*).

Although these birds will eat some berries, they typically feed on the ground and often swoop down from a perch to capture insects. **Mockingbirds are fearless defenders of their territory and nests against any and all intruders, including large mammals and reptiles.**



Figure 18-21. American Crow (*Corvus brachyrhynchos*). This photo was made in Raleigh, NC on February 24, 2015.



Figure 18-23. Tropical Mockingbird (*Mimus gilvus*). This photo was made in St. Georges, Grenada, WI on December 3, 2013.



Figure 18-22. Tropical Mockingbird (*Mimus gilvus*). This photo was made in St. Georges, Grenada, WI on December 2, 2013.

The tropical mockingbird is gray on its head and upper parts. It has a yellowish eye and a white stripe above its eye. These birds have long tail feathers with white tips, and a dark bill with a slight downward curve. Their legs and feet are dark. Figure 18- 24 shows a comparison between the northern and tropical mockingbirds.



Figure 18-24. Comparison between the Northern Mockingbird (above) with the Tropical Mockingbird (below). Photographs were made in Raleigh, NC and St. George's, Grenada respectively.

The **Gray Kingbird** or “Pitirre” (*Tyrannus dominicensis*) (Figs. 18-25 – 18-

27) is a **Tyrant flycatcher** found in Florida, through Central America, across the Lesser Antilles, south to Trinidad, Tobago, and northern South America. **Gray Kingbirds are very territorial, and like to perch high in a tree, watching for intruders or insects, which are their primary prey.**

The gray kingbird is an average-sized kingbird, measuring about 9" in length and weighing about 1.5 oz. It is mostly gray above with some brown on its wings and tail. It has a fairly heavy bill and a dark mask around its eye. It is mostly light gray or white below.



Figure 18-25. Gray Kingbird (*Tyrannus dominicensis*). This photo was made in St. Georges, Grenada, WI on December 3, 2013.



Figure 18-26. Gray Kingbird (*Tyrannus dominicensis*). This photo was made in St. Georges, Grenada, WI on December 3, 2013.



Figure 18-27. Gray Kingbird (*Tyrannus dominicensis*). This photo was made in St. Georges, Grenada, WI on December 3, 2013.

Chapter 19: Podicipediformes– Grebes

“It looks like a duck, it swims like a duck, it must be a duck.” No, it’s a grebe. Grebes are the only birds in the order Podicipediformes, which contains a single family, Podicipedidae, consisting of 6 genera and 22 species. **The only grebe I have seen in our neighborhood is the Pied-billed Grebe (*Podilymbus podiceps*) (Figs 19-1 & 19-2), which is the only living member of the genus *Podilymbus*.**

Some of the common names for this grebe include: American dabchick, **Carolina grebe**, devil-diver, helldiver, pied-billed dabchick, thick-billed grebe, and water witch. **This grebe does not have webbed feet, but its feet have pads that come out the side of each toe. Thus, each of the 3 forward toes acts as an effective paddle while swimming.**

When flying, the feet appear behind the body due to their placement far back on the body. They make frequent slow dives, especially when in danger. They dive for about 30 seconds and may move to a more secluded area of the water, allowing only the head to be visible. **They rarely spend time in flocks, and whenever I have seen one, it is typically a solitary bird.** In April, I have seen as many as four together in a loosely formed group.

Pied-billed grebes are mostly brown, with a darker crown and back. They do not have white under their wings like other grebes, but the underside of their tail is white. These birds have a blunt, **chicken-like bill** that is mostly gray; however, **in the breeding season, the bill is encircled by a broad black band** (thus the name, **pied-billed- meaning multicolored bill**). In the breeding season, its throat is black. Juveniles have black and white stripes and look more like winter adults.



Figure 19-1. Pied-billed Grebe (*Podilymbus podiceps*). This photo was made in Raleigh, NC on March 11, 2014. Note the “pied” or multicolored bill.



Figure 19-2. Pied-billed Grebe (*Podilymbus podiceps*). This photo was made in Raleigh, NC on December 18, 2013.

Grebes have a dense, waterproof plumage, and the feathers on their underparts stick out, curling at the tips. **By compressing these feathers against its body, a grebe can adjust its buoyancy to swim low in the water, with just its head and neck exposed.**

When preening, grebes often eat their own feathers, and they also feed them to their young. Grebes make floating nests of plant material concealed among reeds on the surface of the water. The young are able to swim immediately after hatching.

The Western Grebe (*Aechmophorus occidentalis*) (Figs. 19-3 - 19-5) is the largest of the North American grebes, measuring some 22-30" in length.



Figure 19-3. Western Grebe Swimming. (Photo courtesy of: http://upload.wikimedia.org/wikipedia/commons/thumb/d/d2/Western_Grebe_swimming.jpg/1015px-Western_Grebe_swimming.jpg).

Western grebes nest in large colonies on inland lakes and coastal marshes, in western North America. **These are one of the grebes that have a spectacular courtship display, with two birds raising up and pattering together across the water** (Fig. 19-6). Northern birds migrate to coastal waters during in winter, while birds in the southwest and Mexico may be permanent residents.

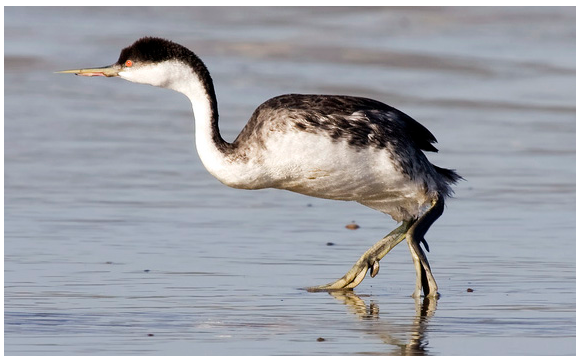


Figure 19-4. Western Grebe Walking. Note how far back the legs are placed on the body; obviously this bird was not designed for walking. (Photo courtesy of: http://upload.wikimedia.org/wikipedia/commons/a/af/Western_Grebe.jpg).



Figure 19-5. Western Grebes Performing Courtship Dance. (Photo courtesy of: Monte Stinnett-http://photo.net/photodb/photo?photo_id=8594480&size=lg).

When I was in Europe in 2015, I lucked upon a pair of **Great Crested Grebes** (*Podiceps cristatus*) feeding two young (Fig. 19-6). This species is native to Europe and Asia, and there are subspecies native to Africa and Australia.

Although new hatchlings are capable of swimming, it is typical behavior for young “grebelings” to ride on the backs of the parents. At times, the parent bird will dive underwater and leave the young on the surface. In this way, the young are taught the skills of swimming and diving for foods.



Figure 19-6. Great Crested Grebes (*Podiceps cristatus*) feeding fish to their young, while the two “grebelings” are riding on the back of one parent. This photo was made in Amsterdam, NL on July 21, 2015 from the top deck of a Viking Cruise Ship.

Chapter 20: Sphenisciformes- Penguins

The order **sphenisciformes** consists of one of the most amazing groups of birds on the planet, the **penguins**. The mere fact that penguins can survive in one of the harshest environments on earth provides an object lesson in anatomic and physiologic **adaptability**. As a result of some debate among ornithologists, **there are about 19 species of living penguins**. All penguins are in the family **Spheniscidae**, and there are 6 genera.

Can penguins fly? Well yes, they are excellent flyers, **jut not in the air**. These birds are designed to fly underwater, not in the air. Their wings have become modified to act as “flippers,” but they are still wings. Penguins derive their propulsion underwater by flapping their wings, not from their feet. The feet act in a rudder-like fashion to guide them, and allow them to make quick turns in pursuit of fish.

The **great penguins** include the **King** and **Emperor Penguins** (Fig. 20-1). These are the two largest species, with emperors being **up to 4 ft. tall** and males weighing in at up to **90 lbs.** Kings are considerably smaller- standing about 3 ft. tall and weighing in at about 30 lbs. King penguins breed on the sub-Antarctic islands and northern Antarctica, while the gigantic emperors are the ones that move inland about 50 miles and breed during the harsh Antarctic winters. Their annual journey and reproductive cycle were well documented in the movie, *March of the Penguins*. Even the movie, *Happy Feet*, features the emperor penguins.

While diving, the emperor penguin’s heart rate is reduced to about 20 bpm, and their hemoglobin can bind with and transport very low blood concentrations of

oxygen. **The emperor penguin has the highest feather density of any bird, with more than 100 feathers per square inch of body surface.** These dense feathers, coupled with a thick layer of subcutaneous fat provide the insulation necessary for these birds to survive in temperatures of **-40°F**. It is not surprising that the largest penguins inhabit the coldest regions because they have the **lowest surface area to body mass ratio**, which reduces heat loss from the body core.



Figure 20-1. King Penguins (*Aptenodytes patagonicus*) (left) & Emperor Penguins (*Aptenodytes forsteri*) (right). (Photos courtesy: http://en.wikipedia.org/wiki/File:Manchot_royal_King_Penguin-http://en.wikipedia.org/wiki/File:Aptenodytes_forsteri_Snow_Hill_Island,_Antarctica_-_adults_and_juvenile-8).

The brush-tailed penguins include the Adelie, the gentoo, and the chinstrap (Fig. 20-2) penguins. **Chinstrap penguins** are about 2 ft. tall and weigh about 13 lbs. They live on barren islands of the sub-Antarctic region and the Antarctic Peninsula, and they require solid, snow-free ground for nesting.

The genus *Eudyptula* consists of two species of small penguins that are found in southern Australia, Tasmania, New Zealand, and the Chatham islands. The white-flipped penguin and the **Little Blue Penguin** (Fig. 20-3) make up this genus of

“little penguins.” These guys are only about a foot tall and weigh in at a little more than 3 lbs. On most days, little penguins spend the entire day swimming.



Figure 20-2. Chinstrap Penguins (*Pygoscelis antarctica*). (Photo courtesy: http://upload.wikimedia.org/wikipedia/commons/6/69/Manchot_01).



Figure 20-3. Little Blue Penguin (*Eudyptula minor*). (Photo courtesy: http://en.wikipedia.org/wiki/Little_Penguin).

The genus *Spheniscus* consists of 4 species of banded penguins that live in the more temperate climates around South Africa, the southern coasts of Chile and Argentina, and the Galapagos Islands. Among these is the **Magellanic Penguin**

(Fig. 20-4). This species grows to about 26 inches, and weighs about 10 lbs.

The genus *Megadyptes* has only one living species, the **Yellow-eyed Penguin** (Fig. 20-5), which is found around the south island of New Zealand and nearby smaller islands. This is another medium-sized penguin standing about 27 inches and weighing in at about 10-15 lbs. The weight of these birds varies a lot before and after molting.



Figure 20-4. Magellanic Penguin (*Spheniscus magellanicus*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Magellanic_penguin,_Valdes_Peninsula_e).

The genus *Eudyptes* contains 8 species of crested penguins. Among these are the 2 species of **Rockhoppers** and the **Macaroni Penguins** (Fig. 20-6). The southern rockhopper lives in the sub-Antarctic waters of the western Pacific and Indian Oceans, while the macaroni penguin explores from the Falkland Islands south to the Antarctic Peninsula. The southern rockhopper is about 20 inches tall, while the macaroni penguin stands about 27 inches, with a highly variable body weight.



Figure 20-5. Yellow-eyed Penguin (*Megadyptes antipodes*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Yellow-eyed_Penguin_MC).



Figure 20-6. Southern Rockhopper (*Eudyptes chrysocome*) (left) and Macaroni (*Eudyptes chrysolophus*) (right) Penguins. Photo courtesy: http://en.wikipedia.org/wiki/File:Gorfou_sauteur_-_Rockhopper_Penguin & [http://en.wikipedia.org/wiki/File:Macaroni_Penguins_\(js\)](http://en.wikipedia.org/wiki/File:Macaroni_Penguins_(js)).

Chapter 21: Pelicaniformes – Pelicans, Herons, and Egrets

The Pelecaniformes is an order of water birds, which formerly including frigate birds, gannets, boobies, cormorants, shags, anhingas and tropicbirds. These groups have now been separated out to different orders. Today, this order contains the pelicans, herons, the shoebill, the hamerkop, ibises, and spoonbills. **Pelecaniformes typically have a bare throat or gular pouch, and slit-like nostrils that do not work.** These birds breathe only through their mouth, and feed on fish or other marine life.

Pelicans belong to a single genus, *Pelecanus* in the family, Pelecanidae. **There are 8 living species of pelicans found in the tropics to more temperate areas.** They are found along inland and coastal waterways, where they feed on fish. They tend to hunt in groups, working together. They even nest in colonies, with the lighter-colored pelicans nesting on the ground, and the darker-colored ones nesting in trees.

The most common pelican we see in NC is the **Brown Pelican** (*Pelecanus occidentalis*) (Figs. 21-1 & 21-2), which ranges from North America and the Caribbean to northern South America and the Galapagos. Although most of us would say the brown pelican is a large bird, it is actually **the smallest pelican species, and is one of only two species that feeds by diving into the water.** The other is the Peruvian pelican.

When fishing, the brown pelican dives into the water bill-first, typically going under water for a brief time, before snapping back to the surface with a pouch full of fish. **Before they swallow the fish, they force out or “spill” most of the seawater from**

their mouth. **Juvenile brown pelicans may fish more like the non-diving pelican species in that they cooperatively “corral” and catch fish while swimming on the surface.**

Of the fish species that brown pelicans eat, **menhaden are one of their primary prey.** They also feed on other fish such as anchovies, pinfish, and on crustaceans (shrimp). The brown pelican is the **State Bird of Louisiana.**



Figure 21-1. Brown Pelican (*Pelecanus occidentalis*) in flight. (Photo courtesy of: http://en.wikipedia.org/wiki/Brown_pelican#/media/File:Pelecanus_occidentalis_in_flight_at_Bodega_Bay.jpg).



Figure 21-2. Brown Pelican (*Pelecanus occidentalis*). This photo was made at Tropic Star Lodge, Piñas Bay, Panama on February 17, 2016.

Herons belong to the family, Ardeidae, which includes some 64 species of long-

legged water birds, including bitterns and egrets. **Actually egrets and herons are not biologically distinct**, it is just that some species of herons are called egrets.

Living on the Neuse River affords me ample opportunity to observe several species of herons. The most common one I see is the **Great Blue Heron** (*Ardea herodias*) (Figs 21-3 – 21-5). The great blue is the **largest North American heron**, and is common in wetlands over most of North and Central America as well as the Caribbean and the Galápagos Islands. An all-white population found in the Caribbean and southern Florida was once thought to be a separate species known as the great white heron, but it now is considered to be a **white variant of the great blue**.



Figure 21-3. Great Blue Heron (*Ardea herodias*). This photo was made in Raleigh, NC on January 15, 2014.

Great blue herons are mostly gray having a slight blueish tint. The thighs are reddish-brown, and the neck is a rusty-gray. The face is white, with a pair of black plumes running from just above the eye to the back of the head. The bill and upper legs are yellow, and the lower legs are dark gray.

The primary food of the great blue heron is fish, **but it will also feed on a wide range**

of shrimp, crabs, aquatic insects, rodents, amphibians, reptiles, and small birds.

Hérons locate their food by sight and typically swallow it whole. **These large birds routinely forage while wading, but they may also drop from the air or from a perch into water after its prey.** On multiple occasions, I have seen them perch on a log, and dive in after fish as they pass by. Although this is not their preferred method of fishing, it works when needed.



Figure 21-4. Great Blue Heron (*Ardea herodias*). This photo was made in Raleigh, NC on January 6, 2015.



Figure 21-5. Great Blue Heron (*Ardea herodias*). This photo was made in Raleigh, NC on June 16, 2013.

Great blue herons typically breed in colonies, in trees close to lakes or other wetlands. These groups are called a **heronry** (more specific than "rookery"). The

size of these colonies may be large, with an **average of about 160 nests**. Although nests may be reused for years, herons are monogamous during a single breeding season. Eggs are usually laid at 2-day intervals, incubated for around 27 days and hatch over a period of several days. Both males and females share in incubation duties. Both parents also feed the young at the nest by regurgitating food.

The **Green Heron** (*Butorides virescens*) (Figs. 25-6 & 21-7) is a smaller and more colorful relative of the great blue heron. Green herons only stand about 17 inches high, and are found in North and Central America. Adults have a glossy, greenish-black cap, a greenish back and wings, chestnut brown neck, and short yellow legs. Females tend to be slightly smaller than males and have less vivid plumage, especially during the breeding season. Juveniles are duller in color with brown and white streaking over their neck and underparts. **These birds are found in NC during much of the year, but typically migrate south to Mexico during the winter months.**

Green herons are mostly seen near dawn or dusk because they are **largely nocturnal**. They feed primarily on small fish, frogs, and aquatic arthropods, but they will take other prey if available, including mice and other small rodents. **Green herons are very intelligent birds**, and on numerous occasions have been seen using bait such as bread to “lure” small fish into their striking range. Thus, **they are tool-using birds**. If you want to see an actual demonstration of this behavior, there is a neat YouTube video at:

<https://www.youtube.com/watch?v=Porp5v5ILKk>



Figure 21-6. Green Heron (*Butorides virescens*). This photo was made in Raleigh NC on July 25, 2014.



Figure 21-7. Green Heron (*Butorides virescens*). This photo was made in Raleigh NC on July 25, 2014.

Green herons pair for the breeding season and typically nest in trees near water; however, they may also nest on the ground. The clutch is about 4 eggs, laid every other day. Both parents share in the incubation ($\approx$ 20 days) and in feeding the young. Although some may leave the nest earlier, nestlings are not really ready to fledge until about 4-5 weeks.

Another heron I have photographed in Florida is the **Yellow-Crowned Night Heron** (*Nyctanassa violacea*) (Fig. 21-8). This relatively small heron is also called the American night heron or “squawk.” It is found primarily in the warmer coastal regions of the Americas and Caribbean, ranging from as far south as eastern South America to as far north as the mid-Atlantic states; occasionally further north. They are also found along the Gulf Coast from Florida to Texas.



Figure 21-8. Yellow-Crowned Night Heron (). This photo was made in Nokomis, FL on January 16, 2010.

As their name implies, **these herons hunt mostly at night** by stalking their prey or waiting in ambush by the water’s edge. They feed mainly on crustaceans, mollusks, frogs, aquatic insects and small fish.

The **Great Egret** (*Ardea alba*) (Figs. 21-9 & 21-10) is also known as the common or large egret, and by several other names worldwide. It is found in most tropical and warmer regions, including southern Europe and the US. **This bird is frequently confused with the so-called great white heron**, which as noted above is **a white morph of the great blue heron**. The great egret is only slightly smaller than the great

blue or grey heron, and can be distinguished from other white egrets by its **yellow bill and dark legs and feet**.



Figure 21-9. Great Egret (*Ardea alba*). This photo was made in Nokomis, FL on October 30, 2014.

The great egret typically feeds in shallow water on fish, frogs, small mammals, and occasionally small reptiles and insects.

The **Snowy Egret** (*Egretta thula*) (Figs. 21-10 - 21-11) is a small white heron, which for rather obvious reasons is sometimes called the “yellow-footed” egret. These birds have a large breeding range, extending from the lower Great Lakes and southwestern US to South America. Like many herons, snowy egrets nest in colonies,

typically on platforms of sticks in trees or shrubs.



Figure 21-9. Great Egret (*Ardea alba*) in flight. Note the retracted neck, which is typical of herons vs. cranes or ibises that fly with their necks extended. (Photo courtesy of: http://upload.wikimedia.org/wikipedia/commons/thumb/7/76/Ardea_alba_San_Francisco_Bay%2C_California%2C_USA_-flying-8-1c.jpg/919px-Ardea_alba_San_Francisco_Bay%2C_California%2C_USA_-flying-8-1c.jpg).



Figure 21-10. Snowy Egret (*Egretta thula*) in flight. Photo courtesy of: <http://upload.wikimedia.org/wikipedia/commons/6/6c/SnowyEgretBolsa.JPG>.



Figure 21-11. Snowy Egret (*Egretta thula*) in flight. Photo courtesy of: upload.wikimedia.org/wikipedia/commons/thumb/f/f9/Egretta_thula_at_Las_Gallinas_Wildlife_Ponds.jpg/790px-Egretta_thula_at_Las_Gallinas_Wildlife_Ponds.jpg.

Chapter 22: Falconiformes- Falcons, Hawks, Eagles, More

Falconiformes is the order of birds that includes the **diurnal birds of prey**. This order contains about **290 species** of diurnal raptors, which includes caracaras, falcons, falconets, hobbies, eagles, hawks, goshawks, harriers, kites, buzzards, vultures, condors, and the secretary bird.

The family **Falconidae** contains about 60 species of falcons and caracaras. **Caracaras** (Fig. 22-1) are relatively slow-flyers, and are primarily indigenous to South and Central America, extending to the southern US. **Like many raptors, caracaras act frequently as scavengers.**



Figure 22-1. Caracara in flight (Photo courtesy: http://en.wikipedia.org/wiki/File:Caracara_by_Dan_Pancamo).

Falcons may be defined as any member of the genus *Falco*, of which there are some **37 recognized species**. Falcons are characterized by their **thin, tapering wings**, which allow these raptors to fly at high speed, and to change directions quickly. **Peregrine falcons** (Fig. 22-2) **have been clocked at speeds up to 200 mph, making them the fastest animal on the planet.** This amazing bird is found in every part of the world except the Polar Regions, making it one of the most widespread raptors. They feed primarily on other birds, including

ducks, and in North America, they are sometimes called the “duck hawk.”

Why in the world would a master killer like the peregrine falcon ever take up residence in such an unnatural environment as downtown Manhattan? Well the high-rise building ledges do provide **suitable nesting sites**, but I suspect the main reason is **an adequate supply of “people-fattened” pigeons.** **If you want to know why birds live where they do—follow the food.**



Figure 22-2. Peregrine Falcon (*Falco peregrinus*) with a kill. (Photo courtesy: http://en.wikipedia.org/wiki/File:Falco_peregrinus_-_Nova_Scotia,_Canada_-_eating-8).

The terms, **falconets**, **hobbies**, and **kestrels** are used to describe small falcons, with some being about the size of a sparrow. One example of these smaller falcons is the **American Kestrel** (Fig. 22-3), which is the only New World kestrel and is sometimes called the “sparrow hawk.” This is also **the smallest falcon in North America**, measuring only 7-8 inches long, with females being slightly larger than males.

Kestrels are known for their “hovering” technique while hunting. From this hovering position, they can quickly swoop in on insects, lizards, mice, or small birds. **The American kestrel shows more sexual dimorphism in plumage than most falcons.** Males have blue-grey and black wings with black and white spots (Fig. 22-3), while females are reddish-brown with dark brown barring on their back and dorsal wings (Fig. 22-4).



Figure 22-3. Male American Kestrel (*Falco sparverius*) showing dorsal feather coloration. (Photo courtesy: http://en.wikipedia.org/wiki/File:Male_American_Kestrel).



Figure 22-4. Female American Kestrel (*Falco sparverius*) with a kill. (Photo courtesy: http://en.wikipedia.org/wiki/File:Falco_sparverius-San_Luis_Obispo,_California,_USA_-female-8).

So what’s a kite? Kites are a group of **soaring falcons**, characterized by long wings and weak legs. All kites belong to the family Accipitridae, and there are about 20 species belonging to 12 genera. **Some kites**

are scavengers, feeding primarily on carrion, while other species take live prey. One example is the **swallow-tailed kite** (Fig. 22-5), which is found in the southeastern US. This bird feeds mainly on snakes, lizards, frogs, large insects, and on small birds and mammals.



Figure 22-5. Swallow-tailed Kite (*Elanoides forficatus*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Elanoides_forficatus02).

During a January 2015 trip to Panama, we spent one day on Lake Gatun near Gamboa, where we saw many **Snail Kites** (*Rostrhamus sociabilis*) circling the area in search of their favorite food, the large **apple snails**. For this reason, it is considered a **molluscivore**. Females are slightly larger than males and have a lighter plumage.



Figure 22-6. Snail Kite (*Rostrhamus sociabilis*) circling overhead in search of apple snails. This photo was made on Lake Gatun, Panama on January 16, 2015.



Figure 22-7. Female Snail Kite (*Rostrhamus sociabilis*) eating an apple snail. This photo was made on Lake Gatun, Panama on January 16, 2015.

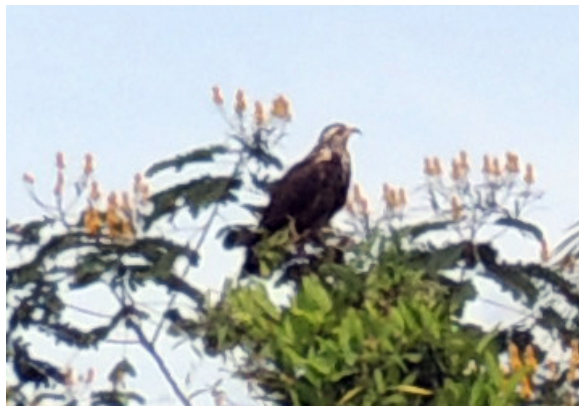


Figure 22-8. Male Snail Kite (*Rostrhamus sociabilis*). The male is smaller than the female and has darker plumage. This photo was made on Lake Gatun, Panama on January 16, 2015.

The term “hawk” has different meanings in different parts of the world. In North America, the term has a more general meaning and describes various birds including falcons, any of the 46 species within the genus *Accipiter* as well as some *buteos*. Some of the more common hawks in the US include the **Cooper’s Hawk** (Fig. 22-9), the **Red-tailed Hawk** (Fig. 22-10), and the **Red-shouldered Hawk** (Figs. 22-11 – 22-13).



Figure 22-9. Cooper’s Hawk (*Accipiter cooperii*) with a kill. (Photo courtesy: http://en.wikipedia.org/wiki/File:Cooper's_Hawk_Eating_a_Finch).



Figure 22-10. Red-tailed Hawk (*Buteo jamaicensis*). (Photo courtesy: <http://en.wikipedia.org/wiki/File:RedTailDisplay>).

Both the red-tailed and red-shouldered hawks are *buteos*. **Buteos** have broad wings compared with the long, slender wings of accipiters. **Buteos tend also to be more**

opportunistic than accipiters, feeding on whatever is available.



Figure 22-11. Red-shouldered Hawk (*Buteo lineatus*). This photo made in Raleigh, NC on December 18, 2013.



Figure 22-12. Red-shouldered Hawk (*Buteo lineatus*). This photo was made in Raleigh, NC on June 4, 2014.

Red-shouldered hawks often search for prey while perched in a tree or while soaring. They kill by dropping directly onto their prey. **Their talons are capable of killing animals at least as large as they are.** Small mammals, especially rodents (voles, gophers, mice, moles and chipmunks) are their preferred prey, but they

may also take rabbits and squirrels. Other prey can include amphibians, reptiles (especially small snakes), small birds, and large insects. Breeding habitats include mixed wooded areas, often near water. **Like most raptors, these hawk are monogamous and territorial.**



Figure 22-13. Red-shouldered Hawks (*Buteo lineatus*). Larger female on left; smaller male on right. This photo was made in Raleigh, NC on January 26, 2015.

The **Osprey** (*Pandion haliaetus*), is a fish-eating bird of prey in the family, **Pandionidae** (Figs. 22-14 – 22-16). In fact, **it is such a unique bird, it has been given its on genus, and is the only bird in its family.** Adult ospreys have a rather basic coloration, dark brown on the upper parts, and grayish-white below. **It is the world's most widespread raptor, being found on all continents except Antarctica.** Although I have photographed these birds in our neighborhood, my best close-up photos were made in Florida.

Common names for the osprey include: sea hawk, river hawk, and fish hawk. Although sometimes called the “sea eagle,” this name is misleading because it is not an eagle. As the name, fish hawk, implies,

ospreys feed almost exclusively on fish, and they are excellent at catching them. They have some **special anatomic features that allow them to crash into the water at a steep angle, and to snatch fish securely with their sharp talons.**



Figure 22-14. Osprey (*Pandion haliaetus*). This photo was made in Venice, FL on January 16, 2009. Note this bird is on the nest in mid-January in FL.

One unique feature of the osprey is its **ability to rotate its fourth (outside) digit** from pointing forward for perching to facing backward along with their first digit (Fig. 22-16). This gives them the “clamp-like” benefit of two toes forward and two toes back. For an absolutely amazing video showing how ospreys catch fish go to:

<https://www.youtube.com/watch?v=nA3LtXnNito>

The **Bald Eagle** (*Haliaeetus leucocephalus*) is the **National Symbol of the US**, and builds the largest nest of any North American bird. Once considered endangered in the lower 48 states, it has now been removed from the US government’s list of endangered species. Although an opportunistic bird, many bald eagles **feed primarily on fish**, which they swoop down and “snatch” with their talons.



Figure 22-15. Osprey (*Pandion haliaetus*). This photo was made at Capitiva Island, FL on October 30, 2014. Note the fish in the bird’s talons.



Figure 22-16. Osprey skeleton showing the “snatch position” of the toes. When perching the fourth (outside) toe rotates to the forward position.

The sexes are identical in color, but the females are about 25% larger than males. **The adult is mainly brown with a white head and tail** (Figs. 22-17 & 22-18). **Immature birds are brown, with some messy white streaking** (Fig. 22-19). **Bald eagles do not reach maturity and show the white head and tail until about 4–5 years of age.** Another distinguishing feature of the immature bald eagle is its black-tipped beak; the mature eagle has a fully yellow beak with a yellow cere.

The beak is large and hooked. The highly developed talon of the first digit (hind toe) is used to pierce the vital organs

of the prey while it is held immobile by the front toes (digits 2-4).

Behind fish, the next most popular prey for bald eagles consists of other **water birds**. **Water birds can seasonally comprise more than 50% of the prey selection for bald eagles.** Preferred avian prey includes grebes, ducks, gulls, coots, herons, egrets, and geese. Bald eagles may also feed on mammals, including rabbits, hares, ground squirrels, and even raccoons, muskrat, and beaver.

As you may know, Benjamin Franklin did not agree with his colleagues in making the bald eagle our national symbol. Although he never made a public issue of it, **Franklin considered the bald eagle to be “a bird of bad moral character”** because it often stole fish from the hard-working osprey.



Figure 22-17. Adult Bald Eagle (*Haliaeetus leucocephalus*). This photo was made in Raleigh, NC on January 7, 2015.



Figure 22-18. Adult Bald Eagles (*Haliaeetus leucocephalus*) enjoying a meal. This photo was made in Raleigh, NC on January 28, 2015.

The other North American eagle is the **Golden Eagle** (*Aquila chrysaetos*) (Figs. 22-20 & 22-21), which is also found in Eurasia and parts of Africa. **These are one of the most fearsome predators, being able to take down mammals the size of young deer and goats.** Like most raptors, they will also eat carrion when necessary as well as reptiles.

Golden eagles are also used in falconry (Fig. 22-21), especially in Eurasia, where they have been trained to attack unnatural prey. They are still used by the **Kazakh eagle hunters** to hunt foxes and other large prey in Mongolia. Golden eagles can have a wingspan of up to 7.7 ft., and an adult female can weigh in at close to 14 lbs. Golden eagles have also been filmed grabbing goat kids off a mountainous ledge

and dropping them to their death. Then they just swoop down and enjoy their now tenderized meal.



Figure 22-19. Immature Bald Eagle (*Haliaeetus leucocephalus*). Note the irregular white streaking. This photo was made in Ketchikan, AL on June 9, 2016.

Although the golden eagle is certainly a large and powerful bird, it is not the largest eagle in the Americas. That distinction belongs to the **Harpy Eagle** (*Harpia harpyja*) (Figs. 22-22 & 22-23). This is a neotropical bird and does not venture as far north as the US. Its range is primarily South and Central America, extending north into the southern part of Mexico.

Female harpy eagles are very large birds, with some weighing in at more than 20 lbs. **Males are much smaller**, weighing only about half as much as an adult female. The harpy eagle in figure 22-22 is a captive

bird being fed a rabbit, but in the wild these “apex predators” fed primarily on tree-dwelling mammals such as **monkeys and sloths**. **The harpy possesses the largest talons of any living eagle, and can exert a grasping force of over 500 lbs. per square inch.** Adult females have been observed to grab an adult howler monkey or mature sloth weighing up to 20 lbs on the fly.



Figure 22-21. Golden Eagle (*Aquila chrysaetos*). (Photo courtesy of: http://en.wikipedia.org/wiki/File:Golden_Eagle_in_flight_-_5).



Figure 22-21. Kazakh Eagle Hunters with Golden Eagles. (Photo courtesy of: <http://www.theepochtimes.com/n2/world/kazakhstan-eagle-hunting-26096>).



Figure 22-22. Harpy Eagle (*Harpia harpyja*) being fed a rabbit at Miami Zoo. (Photo courtesy of: http://upload.wikimedia.org/wikipedia/commons/9/9d/Harpia_harpyja_-Miami_MetroZoo_-feeding-8a.jpg).



Figure 22-23. Harpy Eagle (*Harpia harpyja*) in flight. This is something you would not want to see coming at you. (Photo courtesy of: <http://upload.wikimedia.org/wikipedia/commons/9/95/Harpia-harpyja-001.jpg>).

Like the term “hawk,” the name “buzzard” tends to have multiple meanings, depending on where you live. The term “buzzard” can be applied to numerous large raptors in several genera of accipiters, including *Buteo*. For example, the **Common Buzzard** (Fig. 22-24) of Europe and Asia is not what most of us in the US think of when we hear the word “buzzard.” Even though “buteo” is Latin for buzzard, we call many buteos hawks.

In the US, when the term “buzzard” is used, we typically think of a carrion-feeding bird such as the **Turkey Vulture** (Fig. 22-25). The turkey vulture or buzzard is the

most widespread of the New World vultures, ranging from Canada to the southern tip of South America. In some areas of the Caribbean it is even called the “John Crow.”

Unlike most birds, the turkey vulture uses its sense of smell in addition to its keen eyesight to help locate carrion. There are 5 subspecies of this bird, and it is one of 6 species of New World vultures. The turkey vulture has a wingspan of about 6 feet and it can weigh up to 5 lbs. The common name “turkey vulture” is derived from the almost featherless head, which somewhat resembles that of a turkey (Fig. 22-26).

The last, but certainly not least of the Falconiformes we will consider is the **Secretary Bird** (*Sagittarius serpentarius*) (Fig. 22-27). Until you have seen one of these birds up-close and personal, you have no idea just how big they are. **Adults can weigh as much as 9.9 lbs., and with those “crane-like” legs, these birds stand about 50 inches tall, which makes them the tallest raptor.**

Secretary birds are found mostly in the open grasslands of sub-Saharan Africa, and they are the only member of the family Sagittariidae. **Although these birds can definitely fly, they prefer to hunt on foot, often hunting in pairs.** One of their favorite killing strategies involves stomping their prey (especially reptiles) with their powerful legs and feet. They also feed on insects and small mammals, which they flush from the grass.

Oddly enough, the secretary bird apparently gets its name from the fact that the long feathers on the back of its head reminded someone of the quill pens that old-time secretaries would stick behind their ears. Go figure?



Figure 22-24. Common Buzzard (*Buteo buteo*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Buteo_buteo_-Netherlands-8).



Figure 22-25. Turkey Vulture (*Cathartes aura*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Cathartes_aura_-Florida_-USA_-flying-8-4c).



Figure 22-26. Head of Turkey Vulture (*Cathartes aura*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Cathartes_aura_-Florida_-USA_-upper_body-8).



Figure 22-27. Secretary bird (*Sagittarius serpentarius*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Sagittarius_serpentarius_Sekretär).

Chapter 23: Columbiformes- Doves and Pigeons

The order **Columbiformes** consists of about 312 species of birds including Old World pigeons, American pigeons, bronzewings, American ground doves, crowned pigeons, and many other groups.

Although the terms **pigeon and dove are not scientifically distinct**, the terms are used to describe similar birds, with pigeons being typically larger than doves. Pigeons and doves belong to the family **Columbidae, which includes some 310 species**. A rather unique feature of pigeons and doves is that they produce a substance known as “**crop milk**,” which consists of fat-filled epithelial cells sloughed from the lining of their crops. **This highly nutritious liquid is regurgitated by both sexes to feed their young, which are known as squabs.**

The largest members of the family Columbidae are the **Crowned Pigeons** (Fig. 23-1), which are almost the size of a turkey. There are 3 species of crowned pigeons, all native to New Guinea and surrounding islands.

One of the more common doves we have in the US is the **Mourning Dove** (*Zenaida macroura*), which was formerly called the **Carolina Pigeon** or **Carolina Turtledove** (Figs. 23-2 & 23-3). **The mourning dove is one of the most prevalent of all North American birds, and is the leading game bird**, with at least 20 million birds shot annually in the U.S (likely 2-3 times that number). Their wings make a unique whistling sound during take-off and landing, and **this bird can fly up to 55 mph.**

The genus name, “*Zenaida*” was given to it by French zoologist, Charles Bonaparte, in honor of his wife, Princess Zénaïde. The

"mourning" part of its name comes from its call-“*woo-OO-oo-oo-oo*.” It may well be the now extinct passenger pigeon's closest living relative.



Figure 23-1. Victoria Crowned Pigeon (*Goura victoria*). This photo was made at Sylvan Heights Bird Park in Scotland Neck, NC on May 22, 2015.



Figure 23-2. Mourning Dove (*Zenaida macroura*). This photo was made in Raleigh, NC on June 11, 2013.

Courtship of mourning doves involves a noisy flight by the male, followed by a glide with outstretched wings. After landing, the male will approach the female with a puffed out breast, bobbing head, and loud calls. Mated pairs will often preen each other's feathers. **The male leads the female to potential nest sites, and she chooses one.** The female builds the nest, while the male gathers material for it.



Figure 23-3. Mourning Dove (*Zenaida macroura*). This photo was made in Raleigh, NC on Feb. 6, 2015.

The clutch consists of 2 eggs; however, a female may lay her eggs in the nest of another pair, leading to 4 eggs. Both sexes incubate the eggs. **When flushed from the nest, a dove may perform a “broken-wing” display to distract the intruder from the nest, then fly away when the predator approaches.**

Two other doves I have had the opportunity to photograph are the white-winged dove and the ground dove. The **White-winged Dove** (*Zenaida asiatica*) (Figs. 23-4 & 23-5) is **not seen in NC**, because we are beyond its range, which includes the southwestern US (particularly AZ) through Mexico, Central America and the Caribbean. **More recently, it has expanded its range into Texas, Louisiana, and coastal Mississippi, and has been introduced into Florida.**

Adult white-winged doves have a patch of blue, featherless skin around each eye and a dark mark on the lower face. Like the mourning dove, the white-winged dove is a popular game bird.



Figure 23-4. White-winged Dove (*Zenaida asiatica*). This photo was made in Manvel, TX on April 3, 2014.



Figure 23-5. White-winged Dove (*Zenaida asiatica*). This photo was made in Manvel, TX on April 3, 2014.

Traveling to **Grenada, WI** twice a year has given me the opportunity to photograph numerous birds in that Island Nation, located about 12.4 degrees North of the Equator. One of the birds I have photographed there is the **Common Ground Dove** (*Columbina passerina*) (Figs. 23-6 & 23-7). In addition to the Caribbean, this small dove ($\approx 6.5''$ long) is found in the

southern US, parts of Central America, and northern South America.

As its common name implies, this little dove spends much of its time on the ground. The feathers near the head have a scale-like appearance, the tail feathers are short, and the beak is yellow with a black tip.



Figure 23-6. Common Ground Dove (*Columbina passerina*). This photo was made in St. George's, Grenada, WI on December 1, 2013.



Figure 23-7. Common Ground Dove (*Columbina passerina*). This photo was made in St. George's, Grenada, WI on December 1, 2013.

Another Columbiforme bird I have the opportunity to photograph in Grenada is the **Scaly-naped Pigeon** (*Patagioenas squamosa*) (Fig. 23-8). Also known as the **Red-necked Pigeon**, this large ($\approx 15''$ long), slate-gray bird is found throughout the Caribbean in both the Greater and Lesser Antilles. The maroon colored feathers on this bird's neck appear scaly and give rise to its common name. There is a bare ring of skin around the eyes, which is red in the male and more yellow in the female. These

birds nest in trees and feed mostly on the fruits and seeds of trees.



Figure 23-8. Male Scaly-naped Pigeon (*Patagioenas squamosa*). This photo was made in St. George's, Grenada, WI on November 30, 2013.

Pigeons and doves have a wide geographic distribution, inhabiting most of the planet, except the driest areas of the Sahara desert, Antarctica, and the coldest arctic regions. The typical "wild pigeon" we see in the southeastern US is the **Common Pigeon**, *Columba livia* (Fig. 23-9), which is sometimes called the "**rock dove**."



Figure 23-9. Common feral pigeon (*Columba livia*). This photo was made at Indian Beach, NC on October 17, 2015.

The species includes the domestic pigeon, and escaped domestic pigeons have given rise to **feral populations** around the world. One characteristic of pigeons is their ability to drink continuously by merely

dipping their bills into the water, without having to tilt their heads back to swallow. The rock dove or **rock pigeon** is native to Europe, North Africa, and South Asia. It was originally introduced into North America (Nova Scotia) in 1606. These pigeons live about 5 years in the wild and up to 15 years in captivity.

The **Homing Pigeon**, also known as the messenger pigeon or carrier pigeon is a **variety** of domestic pigeon (*Columba livia domestica*) that was developed through the selective breeding for those birds that could find their way home over very long distances (Fig. 23-10). As **Carrier** or **Messenger Pigeons**, these birds have been used to carry messages since at least the 12th century. Even the outcome of the Battle of Waterloo was delivered by pigeon to England, and **these birds were used extensively during World War I.**



Figure 23-10. White Homing Pigeon (*Columba livia domestica*). (Photo courtesy: http://upload.wikimedia.org/wikipedia/en/6/6d/White_homing_pigeon.jpg).

Although the **sexual dimorphism** in homing pigeons is subtle, accomplished breeders can distinguish the genders of most, but not all strains. Males (cocks) typically stand taller, have larger beaks, more rounded heads, and thicker necks.

Females (hens) tend to be shorter, with smaller beaks, flatter heads, and fuller

breasts. **After mating the male will build a nest out of sticks, with the female supervising the job, and making changes as needed.** The female typically lays two eggs, which will hatch in about 20 days. Both parents aid in raising the squabs, and nestlings typically fledge 3-4 weeks after hatching.

Homing pigeons are often bred for racing. Although no match for the peregrine falcon, good racing pigeons may fly in excess of **130 mph** over short distances. The most common strain or breed of white homing pigeon is the Stielbacht (Fig. 23-11). White homing pigeons are often used as “**release birds**” at various celebrations. **What better bird to release that one that will beat you home?**



Figure 23-11. White Homing Pigeon (*Columba livia domestica*). (Photo courtesy: <http://en.wikipedia.org/wiki/File:WhiteBandits012.jpg#/media/File:WhiteBandits012.jpg>).

Just how do they find their way home? Although many theories (magnetic fields, low-frequency sound waves, etc.) have been proposed, and many experiments conducted, scientists are still not sure. Most researchers now believe that homing ability is based on a "map and compass" model, with the compass feature allowing birds to orient and the map feature allowing birds to determine their location relative to a home site.

Chapter 24: Strigiformes- Owls

Strigiformes contains more than 200 species of mostly nocturnal predatory birds, commonly called owls. **Owls** are distributed almost world wide except for Antarctica, the arctic regions of Greenland, and some remote islands. They feed primarily on small mammals, insects, and other birds, but a few species even specialize in hunting fish.

Owls are absolutely amazing hunters, having specialized flight feathers to virtually eliminate sound as they swoop in on their prey— the original “stealth technology.” (See Figure 3-8.) Not only are they recognized as “wise” birds, but they also have (like many other birds) “opposable thumbs,” which I think has been associated with the development of tool using and with the high level of intelligence attributed to primates. Strigiformes are divided into two families, **Strigidae** (typical owls), and **Tytonidae**, the barn owls.

Within the family **Strigidae** are some 23 genera of typical owls, and one of the larger genera in the family is the genus *Bubo*, which includes several familiar species. Among these are the great-horned owl (Fig. 24-1), and the snowy owl. The **Great-horned Owl** is one of the largest and most widely distributed owls in the Americas, ranging from subarctic North America to the southern tip of South America.

Depending on the subspecies, great-horned owls can weigh up to 5 lbs., with females being larger than males. When spotted during their daytime roost, they will often be harassed for hours by crows. Owls are a primary predator of crows, but not when the crows gang up on them. In case you are wondering, **owls have been estimated to have a crushing force with**

their talons (Fig. 24-2) of about 300 lbs. per square inch.



Figure 24-1. Great-horned Owl (*Bubo virginianus*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Bubo_virginianus_-Canada-6).



Figure 24-2. Talons of great-horned owl (*Bubo virginianus*). (Photo courtesy: <http://en.wikipedia.org/wiki/File:Claws1a>).

A close relative of the great horned owl is the **Snowy Owl** (Fig. 24-3), which extends the “*Bubo*” range well north of the Arctic Circle. Snowy owls, like its great-horned cousin, are large birds, and may weigh even more than the great-horned (up to 6.6 lbs.). The adult male is pure white,

while the female and immature birds have some dark scalloping (Fig. 24-3).

Because snowy owls range north of the tree line in the arctic tundra, they nest on the ground. Being opportunistic hunters, their prey species vary considerably, especially in winter. They feed on small mammals such as lemmings, but when available, they also feed on hares, ducks, and even other owl species. Snowy Owls, like many other owls, typically swallow their small prey whole. Their strong gastric enzymes digest the flesh, while the indigestible bones, teeth, fur, and feathers are compacted into oval **pellets**, which are regurgitated about 24 hours after their meal (See Figure 5-10).



Figure 24-3. Female (left) & Male (right) Snowy Owl (*Bubo scandiacus*). (Photos courtesy: http://en.wikipedia.org/wiki/File:Snowy_Owl_Schnee-Eule & [http://en.wikipedia.org/wiki/File: Bubo_scandiacus_qtl3](http://en.wikipedia.org/wiki/File:Bubo_scandiacus_qtl3)).

Although there are no fish owls indigenous to the Americas, there are 7 species of the genus *Bubo* that specialize in hunting fish. One of these is the **Brown Fish Owl** (Fig. 24-4), which is found in the subtropical and tropical parts of Asia and some nearby islands. This large owl (up to 5 lbs.) feeds primarily on fish, frogs, and aquatic crustaceans, but like most owls will resort to eating carrion if need be. The feet of this fish owl are adapted for catching fish and resemble those of the “eagle owls.”



Figure 24-4. Brown Fish Owl (*Bubo zeylonensis*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Brown_fishing_owl).

One of the more common owls we see in North Carolina is the **Barred Owl** (Fig. 24-5), which is one of about 15 species of “earless” owls in the genus *Strix*. Actually, earless owls hear very well, and this description simply means that have no “ear tufts” like those in the genus, *Bubo*. Barred owls are considerably smaller than the great-horned owl, and weigh in at about 2 lbs. They also have brown eyes rather than the typical yellow irises of the great-horned owl. Barred owls tend to prefer suburban neighborhoods rather than dense forest environments.



Figure 24-5. Barred owl (*Strix varia*). (Photo courtesy: <http://en.wikipedia.org/wiki/File:Strix-varia-005>).

And here's an interesting fact—the **major predator of the barred owl is the great-horned owl**. Since they compete for the same prey, the great-horned owl is not opposed to eliminating the competition. Barred owls, like many other species, typically hunt from a high perch overlooking an open, grassy area, where they can spot an unsuspecting vole or mouse, and swoop down quickly for the kill. They also feed on other birds, large insects, and will even venture into shallow water to snatch crayfish, fish, and salamanders. Humans often spot barred owls because **they tend to start hunting before dark**.

So what is an owlet, pigmy owl, an eagle owl, a hawk owl, or a screech owl? As the names imply, **owlets** and **pigmy owls** are small owls, many of which are in the genus *Glaucidium*, that feed primarily on large insects or other small prey. One such owl that is native to North and Central America is the **Northern Pigmy Owl** (Fig. 24-6). This little owl is less than 6 inches long and can be found in southeastern Arizona. Unlike most owls, **these birds are diurnal**, and hunt from dawn to dusk. To my knowledge, there are no “owlets” indigenous to the Americas, but this term is applied to a group of small Old World owls.



Figure 24-6. Northern (mountain) pigmy owl (*Glaucidium gnoma*). (Photo courtesy: http://en.wikipedia.org/wiki/File:Northern_pygmy-owl).

Before you get to thinking that the pigmy owl is the smallest owl alive, it is not. The smallest known owl is the tiny **Elf Owl** (Fig. 24-7), which can be found in Arizona and New Mexico during the spring and summer. The average weight of these sparrow-sized owls is only about 1.4 ounces. They tend to nest in woodpecker holes made in the saguaro cactus or in hardwood trees. These tiny predators feed primarily on insects.



Figure 24-7. Elf Owl (*Micrathene whitneyi*). (Photo courtesy: http://guardiansofgahoole.wikia.com/wiki/File:Elf_owl_2).

Eagle Owls are very large Old World members (≈ 15 species) of the genus *Bubo*, and some of these owls are even larger than the great-horned and snowy owls of North America. An example of this group would be the **Eurasian Eagle Owl** (Fig. 24-8), which is a very large owl, with some females weighing more than 9 lbs. Europeans are likely to claim that the Eurasian eagle owl is the largest owl on the planet, and there is no doubt it is the heaviest. Canadians and Americans might argue with limited justification that the longest owl is the **Great Grey Owl** (Fig. 24-9), which is distributed all across the northern hemisphere. Although lighter than the eagle owl, great grey owls may be a little longer, measuring about 27 inches.



Figure 24-8. Eurasian Eagle Owl (*Bubo bubo*). (Photos courtesy: <http://en.wikipedia.org/wiki/File:Uhu-muc>).



Figure 24-9. Great Grey Owl (*Strix nebulosa*) coming at you. (Photo courtesy: http://en.wikipedia.org/wiki/File:Strix_nebulosa_in_flight).

Screech owls form a group of about 23 species within the genus *Megascops*, all of which are found only in the Americas. An example of this group is the **Eastern Screech Owl** (Fig. 24-10), which is relatively common in eastern North America. Screech owls are small owls, having a wingspan of about 20 inches. They prey on insects, reptiles, small mammals, and small birds, and they tend to carry their prey back to their nests before eating it. Screech owls produce a wide variety of distinctive sounds, in addition to a high-pitched “screech.”



Figure 24-10. Eastern Screech Owl (*Megascops asio*). (Photo courtesy: <http://en.wikipedia.org/wiki/File:EasternScreechOwl-Rufous>).

Although there are numerous species called “hawk-owls” in Indonesia and Australia, the only one indigenous to North America is the **Northern Hawk-Owl** (Fig. 24-11), which is one of a few owls that is partly diurnal. As the only member of the genus *Surnia*, it is found in the circumpolar regions of the northern hemisphere, including northern Canada and Alaska, but it does not extend into the snowy owl’s territory north of the tree line. Occasionally this owl ventures south into the northern US.

The other family of Strigiformes is **Tytonidae**, which includes about 15 species of barn owls and 2 species called bay owls. **Barn Owls** have large heads and a characteristic heart-shaped face. Different species of barn owls are referred to as sooty owls, masked owls, and grass owls. An example of this group is the **Common Barn Owl** (Fig. 24-12), which has about 20 other common names, and there are many subspecies. The common barn owl is widely distributed around the world, except in Polar

Regions, deserts, northern Asia and most of Indonesia.



Figure 24-11. Northern Hawk-Owl (*Surnia ulula*). (Photo courtesy: <http://en.wikipedia.org/wiki/File:Surnia-ulula-002>).

Unlike typical owls (Strigidae), **barn owls do not hoot**, but produce a scream that can be earsplitting at close range. Barn owls tend to prefer open land with only interspersed woodlands, where they can swoop in and snatch rodents. **And, because they eat so many rodents, they serve a very useful purpose around farms.** Barn owls are not only predators, but just as often prey. Few birds live more than 2 years in the wild, and most don't even make it to breeding age. Among their major predators are the great-horned owl in North America and the Eurasian eagle owl in Europe and Asia. **Also, humans and domestic cats take their share of barn owls.**



Figure 24-12. Common Barn Owl (*Tyto alba*). (Photo courtesy: [http://en.wikipedia.org/wiki/File:Tyto_alba_British_Wildlife_Centre,_Surrey,_England8a_\(1\)](http://en.wikipedia.org/wiki/File:Tyto_alba_British_Wildlife_Centre,_Surrey,_England8a_(1))).

Chapter 25: Trochiliformes - Hummingbirds

The order **Trochiliformes**¹ consists of nearly **450 species** of hummingbirds, making it a far distant second in terms of diversity behind the order Passeriformes (5000+ species). Hummingbirds are New World birds that belong to the family **Trochilidae**. The smallest living bird on the planet is the **Bee Hummingbird**, which is only about 2" long and weighs less than a US penny.

The feet and legs of hummingbirds are covered with bare skin rather than the scales (scutes) that other birds have. **Anatomically, the shoulder joint of the hummingbird is more flexible than that of other birds, allowing the wings to move more freely, and enabling them to hover over flowers.** During hovering, hummingbirds flap their wings at an amazing **50-200 strokes per second**, allowing them to fly **backwards**, and even **upside down**. They are capable of flying forward at speeds **over 30 mph**.

The **Ruby-throated Hummingbird** (*Archilochus colubris*) (Figs. 25-1, 25-2) belongs to the family Trochilidae, and is the only species of hummingbird we see in NC. They are about 3 inches long and weigh in at about 3.7 grams (see figure 25). I used to say this was the only hummingbird in the southeastern US, but that may be changing. Some rufous hummingbirds of the western US may now be wintering along the Gulf Coast and in Florida.

The ruby-throated hummingbird is the smallest bird that breeds in the Eastern U.S, weighing in at about 3.75 grams (Fig. 25-3), with females being just slightly larger (3.8

grams) than males (3.2 grams). Adults are metallic green above and greyish white below, with nearly black wings. Their slender bill can be 2 cm long. The adult **male** has an **iridescent ruby-red throat patch, trimmed in black**. Juvenile males resemble adult females, though usually with heavier throat markings. These tiny birds molt once a year in late summer.



Figure 25-1. Male Ruby-throated Hummingbird (*Archilochus colubris*). This photo was made in Raleigh, NC on April 16, 2015.



Figure 25-2. Female Ruby-throated Hummingbird (*Archilochus colubris*). This photo was made in Raleigh, NC on July 9, 2013.

Ruby-throated hummingbirds breed throughout most of eastern North America and Canadian prairies, which is the largest breeding range of any US hummingbird. These hummingbirds are migratory, spending most of the winter in southern Mexico and Central America, as far south as western Panama and the West Indies.

¹ In older books, you will find hummingbirds grouped with the swifts and tree swifts in the order Apodiformes.

During migration, these tiny birds can fly non-stop 600 miles (20+ hours), across the Gulf of Mexico.



Figure 25-3. Ruby-throated hummingbirds weigh about 3.75 grams, which is about the weight of 1.5 US pennies.

Updated Migratory Pattern for Ruby-throated hummingbirds: Over the past several years, an interesting change in the migration pattern of these tiny birds has been documented. Researchers have noticed that some of these birds have given up their arduous trip across the Gulf of Mexico. Some have elected to forego this dangerous trip and over-winter along the US Atlantic coast, extending from Florida as far north as the outer banks of North Carolina (Fig.25-4).



Figure 25-4. Summer-Winter and migratory pattern of ruby-throated hummingbird.

This is just one more example of the great adaptability of birds to a changing environment. Their ability to adapt is one of

the primary reasons why birds have been so successful as a group of animals.

Ruby-throated hummingbirds are solitary, except during a few minutes of courtship and breeding; only the female cares for the offspring. Both males and females are very aggressive toward other hummingbirds, and vigorously defend feeding territories (feeders).

Hummingbirds have one of the highest metabolic rates of any animal, with heart rates up to 1260 beats/minute, and a respiration rate of about 250 breaths/minute. During flight, oxygen consumption/gram of muscle is about 10 times greater than that seen in elite human athletes. They feed almost continuously during the day, and they can conserve energy by entering hypothermic torpor on cold nights (See page 30).

As you know, hummingbirds are primarily **nectarivores** that feed on ornithophilous² flowers. They supplement their diet with small insects and spiders, which are necessary for protein. Ornithophilous flowers typically have a lower sugar-content nectar containing more sucrose than many flowers pollinated by insects.

Ever heard the expression—eats like a bird? This would typically denote someone who is a light or picky eater. Well that's a myth. With their high metabolic rate, hummingbird can consume twice their body weight in nectar every day, meaning they must work continuously to keep from starving. Under normal circumstances, they can store just enough energy to survive the night before they must start eating again.

² ornithophilous = love for birds; these are flowers that are normally pollinated by birds.

Unbelievably, if they survive fledging these little food machines with a heart rate of over 1000 bpm can live to be 9 years (females) old; more typically about 3-5 years (males).

If we only have one species in NC, where are other 449 species? By far the majority of hummingbird species occur in the tropical and subtropical regions of Central and South America, although there are some species that do migrate long distances to some cooler regions; *i.e.*, the ruby-throated hummingbird. If you want to go to “hummingbird haven,” travel to where their flowers bloom year-round- Mexico, Central America, Colombia, and the Caribbean. Most hummingbirds stay where their flowers are.

There are fewer than 25 species in the US. The most widespread species in western North America is the **Rufous Hummingbird** (*Selasphorus rufus*) (Figs. 25-5 & 25-6). These remarkable travelers have been known to migrate as far as 2000 miles from their wintering grounds in southwestern Mexico to their summer feeding areas in the western US.

More recently, the rufous humming bird has been known to stray to the southeast rather than going to Mexico, some even showing up in Florida and along the Gulf Coast. This means they would have to migrate over the Rocky Mountains.



Figure 25-5. Male Rufous Hummingbird (*Selasphorus rufus*). (Photo courtesy of: http://commons.wikimedia.org/wiki/File:Selasphorus_rufus1.jpg).

commons.wikimedia.org/wiki/File:Selasphorus_rufus1.jpg.



Figure 25-6. Female Rufous Hummingbird (*Selasphorus rufus*). (Photo Courtesy of: http://upload.wikimedia.org/wikipedia/commons/7/7b/Rufous_hummingbird_female.jpg).

The most common hummingbird in the southwestern US is the **Black-chinned Hummingbird** (*Archilochus alexandri*) (Figs. 25-7). These birds are known to hybridize with both the Anna's and Costa Hummingbirds.

Black-chinned hummingbirds are found in the Western US, as well as parts of British Columbia, and Mexico. Although they feed primarily on nectar, they also catch insects on the fly, using their long tongue. They are very adaptable birds and can be found in varied habitats from mountains to woodlands, to orchards and meadows. They mostly winter along the western coast of Mexico.



Figure 25-7. Male Black-chinned Hummingbird (*Archilochus alexandri*).

Some Hummingbird Myths

Myth #1: Hummingbirds hitch rides on the backs of Canada Geese during their fall migration.

Although this makes for a good story, it is just not true. Geese and hummers migrate at different times, and to different destinations.

Myth #2: You need to take your hummingbird feeders down in the fall so that the hummers will leave and migrate south.

Hummers start their southern migration after the autumnal equinox. Your hummingbird feeder has nothing to do with it. In fact, you should NOT take your feeder(s) in until at least two weeks after no hummingbirds have been seen. Leaving them in place is actually useful for hummers moving south through your area. It gives them a “pit stop” to refuel as they continue southward.

Myth #3: You should add red food-coloring or dye to your sugar water to attract hummingbirds.

While it is true that hummers are attracted to the color red, if your feeder has some red on it, there is no need to add coloring. In fact, there is a low potential that the food-coloring or dye might have an adverse effect on the hummingbirds.

Myth #4: Hummingbirds feed exclusively on nectar (sugar water).

While nectar does make up the bulk of their diet, hummers also catch small insects and spiders. These insects provide much needed protein, whereas nectar provides only energy. Female hummers feed insects to their young to provide protein necessary for development.

Myth #5: Hummingbirds feed only on red flowers.

Yes hummers are attracted to red flowers, but they will also feed on other flowers if nectar is available.

Myth #6: Humming birds suck nectar up through their bills.

Actually, hummers use their long tongue to dip into the nectar and pull it up into their mouth. Their tongue can move in and out of their bill numerous times per second when they are actively feeding. Hummers can consume nectar in one day equal to 1.5 to twice their body weight. Average body weight of a ruby-throated humming bird is about 3.75 grams—the approximate weight of 1.5 US pennies (see figure 25-3).

Chapter 26: Coraciiformes– Kingfishers

Kingfishers constitute a group of birds in the order Coraciiformes, which also includes other birds known as bee eaters, rollers, motmots, and todies. Many kingfishers are tropical birds and are not found in the US. The approximately **90 species** of kingfishers, can be divided into three families: Alcedinidae, Halcyonidae, and Cerylidae. Today, most kingfisher species are found in Australasia.¹

All kingfishers have large heads and long pointed bills, and many have brightly colored plumage. **Contrary to popular thought, many species of kingfishers do not live near water and do not eat fish.** Actually, they are a very diverse group of birds, coming in many shapes and sizes, and **some are not even called kingfishers; i.e.,** Australian Laughing Kookaburra.

The kingfisher we have in NC is the **Belted Kingfisher** (*Megaceryle alcyon*) (Figs 26-1 – 26-3), which is the only species commonly found in the US and Canada and is in the family Cerylidae. **These are skittish birds, and it is difficult to get close enough to get a really good photograph.** The belted kingfisher is a medium-sized bird, and the female is slightly larger than the male.

Although the belted kingfisher is a **year-round resident here in NC**, these birds do migrate from Alaska to as far south as South America in winter. **Unlike most birds, the female is actually the more colorful of the two sexes**, displaying a bronze marking on its belly (Fig. 26-3) that is absent in the male. The kingfisher likes to perch near the water, using its keen eye site to spot surface

activity before plunging headfirst into the water after its fish prey.



Figure 26-1. Male Belted Kingfisher (*Megaceryle alcyon*). This photo was made in Raleigh, NC on March 24, 2015.

Like many “fish-eaters,” belted kingfishers are opportunistic, and will not hesitate to take a frog, a crayfish, a mouse, or a lizard, especially if fish are scarce. **These birds nest in a horizontal tunnel, which they dig in the riverbank.** The tunnel turns up near the end to provide an **air chamber** for the nest in case of rising water. The female lays 5-8 eggs and both adults incubate the eggs and feed the young.



Figure 26-2. Male Belted Kingfisher (*Megaceryle alcyon*). This photo was made in Raleigh, NC on March 24, 2015.

¹ Australia, New Zealand, New Guinea, and neighboring islands in the Pacific Ocean



Figure 26-3. Female Belted Kingfisher (*Megaceryle alcyon*). Note the bronze marking on the belly and flanks that is absent in the male. Photo courtesy of: http://en.wikipedia.org/wiki/Belted_kingfisher#/media/File:Megaceryle_alcyon_femelle.jpg.

Although some kingfishers do specialize in eating fish, overall these birds feed on many different things, including crustaceans, frogs, worms, mollusks, insects, spiders, reptiles, mammals, and other birds.

One of the more beautiful of the kingfishers is the **Azure Kingfisher** (*Alcedo azurea*) (Fig. 24-4), which is a member of the family, Alcedinidae. This bird is found in Australia and Tasmania, New Guinea, and neighboring islands. Interestingly, it has a coloration pattern similar to our own eastern bluebird, which is probably why I think it is so beautiful.

Another interesting bird is **Australian Kookaburra** (*Dacelo novaeguineae*) (Fig. 24-5), which is a “tree kingfisher” in the family, Halcyonidae. This bird is frequently referred to as the “**laughing kookaburra**” because its call sounds much like echoing human laughter. The kookaburra is native to eastern Australia, and is one of the kingfishers that are not associated with water.



Figure 26-4. Azure Kingfisher (*Alcedo azurea*). This photograph was made in Queensland, Australia. (Photo courtesy of: http://en.wikipedia.org/wiki/Kingfisher#/media/File:Alcedo_azurea_Julatten.jpg).

The kookaburra is one of the largest kingfishers, measuring about 18” in length. They live in wooded areas, including forest, in family units, with offspring helping the parents hunt and care for the chicks. **They feed on small mammals, insects, lizards, small birds, and most notably snakes, including venomous ones.** They also hang around urban gardens, and have been known to swoop down and steal food right out of people’s hands. Some folks even feed them meat.



Figure 26-5. Australian Kookaburra (*Dacelo novaeguineae*). (Photo courtesy of: http://en.wikipedia.org/wiki/Kingfisher#/media/File:Alcedo_azurea_-_Julatten.jpg).

Chapter 27: Piciformes– Woodpeckers and Toucans

In addition to woodpeckers, the order **Piciformes** includes jacamars, puffbirds, barbets, **toucans**, and honeyguides. In all there are about 67 living genera of piciformes with **more than 400 species**. By far the largest family is **Picidae**, which contains woodpeckers, sapsuckers, and some other birds-- a total of about 30 genera and some 200 species.

I see woodpeckers every day at the **suet cake**, and sometimes on the bird feeder. One of the most common visitors is the **Downy Woodpecker** (*Dryobates pubescens*) (Figs. 27-1 - 27-3), which is the **smallest** North American woodpecker.



Figure 27-1. Adult Male Downy Woodpecker (*Dryobates pubescens*). Note red patch on back of head. This photo was made in Raleigh NC on February 13, 2015.

The downy woodpecker is mostly black on the top of its wings and tail, with a white back, belly, and throat. There are also white spots on its wings. Adult males (not

females) have a **red patch** on the back of their head, while **juvenile** birds have a **red cap**. The downy woodpecker is almost **identical in plumage (although not closely related)** to the larger hairy woodpecker, but the latter has a much longer bill and has black spots on its white tail feathers. The **outward similarity of these two different species is a notable example of “convergent evolution.”**¹

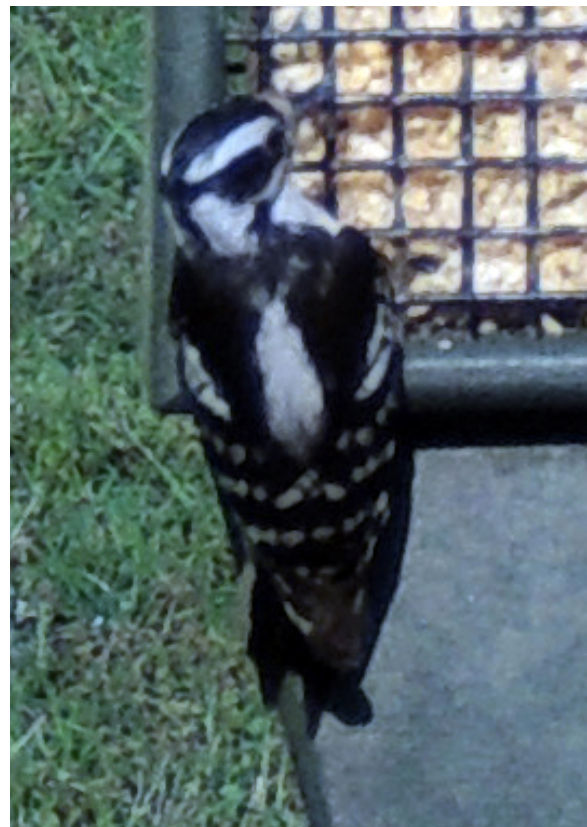


Figure 27-2. Adult Female Downy Woodpecker (*Dryobates pubescens*). This photo was made in Raleigh NC on May 29, 2013.

These small woodpeckers breed primarily in deciduous forests across most of North and Central America. They nest in a cavity excavated by the nesting pair,

¹ Convergent Evolution- the independent evolution of similar features in species of different lineages.

typically in a dead tree. The downy woodpecker, like so many other bird species, is a **year-round resident in NC**. Downy woodpeckers typically forage on trees, and feed primarily on insects, seeds and berries.



Figure 27-3. Juvenile Downy Woodpecker (*Dryobates pubescens*). Note the red cap. This photo was made in Raleigh NC on June 2, 2013. This youngster is trying to raise the flag.

Another frequent (daily) visitor to the suet cake is the **Red-bellied Woodpecker** (*Melanerpes carolinus*) (Figs. 27-4 & 27-5). The red-bellied woodpecker is a medium-sized woodpecker. Its breeding range is from southern Canada, and extends as far south as Florida and Texas. One thing that is obvious is that this bird has a mostly red head and not much of a red belly; however, the name, red-headed woodpecker, is assigned to another closely related bird.



Figure 27-4. Female Red-bellied Woodpecker (*Melanerpes carolinus*). Note gap in red across top of head. This photo was made in Raleigh NC on June 6, 2013.



Figure 27-5. Male Red-bellied Woodpecker (*Melanerpes carolinus*). Note that red completely crosses top of head. This photo was made in Raleigh NC on December 24, 2013.

Adult red-bellied woodpeckers are light gray on the face and under parts, with a black and white barred pattern on their back, wings and tail. **Adult males have a complete red cap over their head and down the nape of their neck. Females also have red on their neck and back of their head, but it does not come all the way over the top of the head.** Females also have another patch of red above their bill.

As is the case with other woodpeckers, these birds are omnivores, eating whatever is available, including insects or other arthropods, fruits, seeds, and nuts. They prefer deciduous forests, nesting in tree cavities, either in a dead tree or in a soft-wood live tree. Areas around their nesting cavities are usually marked with drilling holes to warn others away. **The red-bellied woodpecker is a major predator of the invasive emerald ash borer,** which is certainly beneficial to ash trees. Significant predators of these birds include raptors, black snakes, and domestic cats.

Although I do see the **Pileated Woodpecker** (*Hylatomus pileatus*) (Fig. 27-6 & 27-7) occasionally in our neighborhood, I have yet to get a really good photograph of one. **Typically, when I see one of these big, crow-sized birds, its mate is close-by.** These are the largest woodpeckers in North America, unless you consider the probably extinct Ivory-billed Woodpecker. Adults are about 18" long and weigh about 11 oz.

When a pileated woodpecker starts pounding (drumming) on a hollow tree, it makes such a loud noise, that there is little doubt that this is a **big** woodpecker. **They use this drumming to scare other woodpeckers away from their territory.**

Their range is from the Great Lakes and much of Canada, the entire eastern US, and along the Pacific Coast to California.



Figure 27-6. Male Pileated Woodpecker. (Photo courtesy of: <http://upload.wikimedia.org/wikipedia/commons/thumb/1/13/PileatedWoodpeckerFeedingonTree.jpg/1024pxPileatedWoodpeckerFeedingonTree.jpg>).



Figure 27-7. Female Pileated Woodpecker. (Photo courtesy of: <http://upload.wikimedia.org/Wikipedia/commons/3/32/PileatedWoodpeckerOnLog1.jpg>).

Adult males have a red line from their bill to the throat (Fig. 27-6, while in adult females this line is black (Fig. 27-7). These birds feed primarily on insects and have a particular preference for **carpenter ants** and **wood-boring beetle larvae**. They will also eat fruits, nuts, and berries.

Typically, pileated woodpeckers dig out large nest cavities in dead trees. The hole is made by the male to attract a female for mating. The cavity is not lined except for the wood chips. Both parents incubate the clutch of 3-5 eggs for about 15 days, and the young take about a month to fledge. After the nestlings fledge, the pair will abandon the hole and not use it again. Thus, **woodpeckers construct and leave homes for many other birds and mammals.**

Pileated woodpecker pairs stay together year-round, which is why you often see the two together. These birds are very territorial, and will defend their home area vigorously against all intruding pairs.

One of the more interesting and beautiful NC woodpeckers is the **Northern Flicker** (*Colaptes auratus*) (Figs. 27-8 – 27-10). I refer to these birds as the “**ground woodpecker**” because they are most often seen rustling around on the ground rather than clinging to the trunk of a tree. The flicker is a medium-sized woodpecker that is native to most of North America, some parts of Central America, Cuba, and the Cayman Islands. **It is one of the few woodpeckers that migrate.** Of the more than 100 common names for the northern flicker are: yellowhammer, clape, gaffer woodpecker, harry-wicket, and gawker bird.

Adult flickers are brown with black bars on the back and wings. A black patch is found on the upper breast, while the lower breast and belly are beige with black spots. **Males have a black or red stripe at the base of their beak.** The tail is dark on top, with a **white rump patch, which is conspicuous in flight.**



Figure 27-8. Male Northern Flicker (*Colaptes auratus*). Note the black stripe at the base of its beak. This photo was made in Raleigh, NC on March 6, 2014.



Figure 27-9. Male Northern Flicker (*Colaptes auratus*). This photo was made in Raleigh, NC on February 7, 2015.



Figure 27-10. Male Northern Flicker (*Colaptes auratus*). This photo was made in Raleigh, NC on February 7, 2015.

Flickers are the only woodpeckers that typically feed on the ground, probing with their beak. Although they may eat fruits, berries, seeds and nuts, their primary food is insects. **Flickers often go after underground ant larvae**, hammering into the soil much like other woodpeckers drill into wood. Their tongues can extend 2 inches beyond the end of their bill. As well as eating ants, flickers have a behavior called “**anting**,” in which they use the formic acid from the ants to assist in preening. Apparently this helps in keeping them free of parasites.

Northern flickers typically nest in tree holes like other woodpeckers; however, they have been found nesting in ground burrows made by belted kingfishers. Flickers typically lay 6-8 large white eggs. Both sexes help incubate the eggs for 11-12 days. The young are fed by regurgitation and fledge about 25-28 days.

Until recently, I had thought that toucans were psittacines birds, closely related to parrots. Well, surprise-- **toucans are actually members of the order piciformes, making them more closely related to woodpeckers.**

Toucans are members of the family **Ramphastidae** of “near passerine birds” from the Neotropics. They are most closely related to the American barbets. The family includes 5 genera and about 40 species of toucans, aracarís, and toucanets. Toucans have short, compact bodies with a **short thick neck**. (You would need a strong neck to hold up that bill.) As forest birds that don’t need to travel very far, they have rather small wings for their size. **Their feet are similar to parrots and woodpeckers in that they have the 2-forward, 2-back design (zygodactyl)**. With few exceptions, toucans show no sexual dimorphism.



Figure 27-11. Keel-billed Toucan (*Ramphastos sulfuratus*). Photo courtesy of: http://upload.wikimedia.org/wikipedia/commons/thumb/4/47/Keel-billed_toucan%2C_costa_rica.jpg/800px-Keel-billed_toucan%2C_costa_rica.jpg.



Figure 27-12. Toco or Common Toucan (*Ramphastos toco*). Photo courtesy of: http://upload.wikimedia.org/wikipedia/commons/thumb/a/a4/Ramphastos_toco_Birdworld%2C_Farnham%2C_Surrey%2C_England-8a.jpg/731px-Ramphastos_toco_Birdworld%2C_Farnham%2C_Surrey%2C_England-8a.jpg.

Chapter 28: Cuculiformes– Cuckoos, Roadrunners, Anis

The order **Cuculiformes** contains only one family of birds, **Cuculidae**, which includes cuckoos, roadrunners, koels, malkohas, couas, coucals and anis.

Growing up in Texas, I am very familiar with roadrunners, and my travels to Grenada introduced me for the first time to the mangrove cuckoo. **Most cuckoos are tropical, and some are brood parasites, much like our brown-headed cowbird.** Although they feed primarily on insects, they also eat fruit.

Like parrots, woodpeckers and toucans, cuckoos are **zygodactyl**, having two digits forward and two back. Cuckoos are commonly divided into two groups: **arboreal** or those that live in trees, and **terrestrial**, or those that live primarily on the ground. The roadrunner is certainly an example of the latter group. As a group, cuckoos tend to have large bills, sometimes very large ones like the **channel-billed cuckoo** of Australia, Papua New Guinea and Indonesia.

The **Mangrove Cuckoo** (*Coccyzus minor*) (Figs. 28-1 – 28-3) is native to the neotropics, and is best distinguished by its **black facial mask and buffy under parts**. Adults have a long tail, brown above and black-and-white below, and a black curved bill with yellow on the lower bill. Some, but not all of these birds have a yellow ring around the eye. Despite its name “minor” this is one of the larger New World cuckoos, measuring about 12” in length and weighing in at about 3-3.5 oz.

Unlike many species of mostly Old World cuckoos, which lay their eggs in the nest of other birds (brood parasites), **the mangrove cuckoo builds its own nest.** The

female lays 2-4 eggs and both adults share in feeding the young. The mangrove cuckoo’s range includes south Florida, Mexico, South America, and the Caribbean. These birds are not restricted to mangroves, but live in a variety of lowland habitats.



Figure 28-1. Mangrove Cuckoo (*Coccyzus minor*). This photo was made in St. George’s, Grenada, WI on November 30, 2013.



Figure 28-2. Mangrove Cuckoo (*Coccyzus minor*). This photo was made in St. George’s, Grenada, WI on November 30, 2013.

Mangrove cuckoos prefer to eat caterpillars and grasshoppers, but like most birds, they will eat whatever is available at the time, including other insects, spiders, snails, lizards, and fruit.



Figure 28-3. Mangrove Cuckoo (*Coccyzus minor*). This photo was made in St. George's, Grenada, WI on November 30, 2013.

The **Greater Roadrunner** (*Geococcyx californianus*) (Figs. 28-4 & 28-5) is a large bird in the family, Cuculidae. It is one of two species of roadrunner, the other being the lesser roadrunner, which does not venture as far north as the US. Common names for the greater roadrunner are the **chaparral** cock, ground cuckoo, and snake killer. This is the largest North American cuckoo, measuring about 22" long and weighing in at about 16 oz.

Like other cuckoos, the roadrunner is **zygodactyl**, with 2 digits forward and two digits back, **which I find to be somewhat unusual for a running bird**; the 3-1 arrangement is a better arrangement for walking in most cases. In any event, it doesn't seem to slow him down any.



Figure 28-4. Greater Roadrunner (*Geococcyx californianus*). (Photo courtesy of: http://en.wikipedia.org/wiki/Greater_roadrunner#/media/File:Geococcyx_californianus.jpg).

The **greater roadrunner** is found in the **southwestern US** from southern California along the Mexican border to Texas, and as far east as Louisiana and Arkansas. Its range extends from the US border, along the Baja Peninsula, and southward to about the middle of Mexico.



Figure 28-5. Greater Roadrunner Running (*Geococcyx californianus*). (Photo courtesy of: http://upload.wikimedia.org/wikipedia/commons/1/1f/Roadrunner_running.jpg).

When I was a kid growing up on a Texas farm near Fort Worth, I used to chase these birds, but never came close to catching one. No wonder, **they run more than 20 mph**. I really don't know what I would have done had I caught one. Even though they spend most of their time on the ground, they are **capable of limited flight when necessary**.

Greater roadrunners are beneficial birds in that they feed on rodents, insects, spiders, scorpions, small birds, and especially on lizards and snakes. They even take small rattlesnakes, which they kill by grabbing them in their beak and beating them against the ground.

Anis are birds in the genus *Crotophaga* in the family, **Crotophagidae**.¹ There are three species and are tropical and subtropical birds. **Anis are not brood parasites, and form communal nests.** Several females

¹ Until recently, anis were considered members of the cuckoo family, Cuculidae. Recent DNA evidence has placed them in their own family.

will lay in a single nest and they share in the incubation and feeding of the nestlings.

These are large black birds with a long tail and a relatively heavy bill. Anis are weak flyers and spend a good deal of time feeding on the ground. They eat termites, large insects, ticks, lizards and frogs.

The **Smooth-billed Ani** (*Crotophaga ani*) (Fig. 28-6 & 28-7) is a large bird that's breeding range extends from southern Florida and the Bahamas, through the Caribbean, parts of Central America, and south to Argentina.

When I was in Grenada in November 2014, I learned something very interesting about the smooth-billed ani. **It is apparently the only bird thus far to figure out how to eat the plumeria caterpillar** (*Pseudosphinx tetrio*).

These moth larvae will completely defoliate the white frangipani or plumeria tree (*Plumeria alba*); however, it doesn't kill the tree. Even though these caterpillars look like perfect bird fare, most birds shy away from them because they are **highly toxic**. It seems that the toxicity is in the gut of the caterpillar, **and the smooth-billed ani has figured out how to eat the caterpillar and avoid ingesting the gut material**.

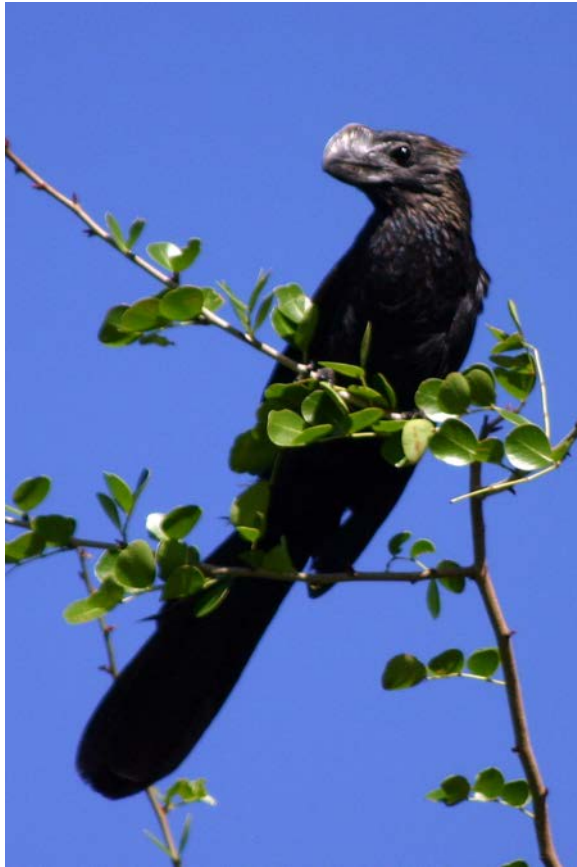


Figure 28-6. Smooth-billed Ani (*Crotophaga ani*). (Photo courtesy of: http://en.wikipedia.org/wiki/Smooth-billed_an#/media/File:Smoothbilled_an.jpg).



Figure 28-7. Smooth-billed Ani (*Crotophaga ani*). (Photo courtesy of: http://upload.wikimedia.org/wikipedia/commons/5/56/Smoothbilled_an_%28Crotophaga_an%29_To.jpg).

Chapter 29: Suliformes- Frigate Birds, Cormorants, More

The order **Suliformes** includes frigate birds, boobies, gannets, cormorants, shags, and anhingas. Suliformes is a relatively new (*ca.* 1995) order of birds that were previously grouped with the pelicans in the order, Pelicaniformes. This “break-out” was based on genetic research, which showed that the **suliformes were distinct from the pelicaniformes**.

The **Magnificent Frigate bird** (*Fregata magnificens*) is a seabird in the family, Fregatidae (Figs. 29-1 – 29-2). This seabird is found over tropical and subtropical waters in the Caribbean, and along the Atlantic and Pacific Oceans.



Figure 29-1. Male Magnificent Frigate Bird in flight. (Photo courtesy of: http://en.wikipedia.org/wiki/Magnificent_frigatebird#/media/File:Magnificent-Frigate-male.jpg).

The magnificent frigate bird has brownish-black plumage, long narrow wings and a deeply forked tail. **The male has a red throat (gular) pouch that it inflates to attract a female** (Fig. 29-2), which has a blue eye ring, a white breast, and is slightly larger than the male. Frigate birds feed on fish that it takes in flight over the water, and is known to steal fish from other birds.



Figure 29-2. Male Magnificent Frigate Bird with inflated gular pouch. (Photo courtesy of: Dr. Kate Barger.)

The **Double-crested Cormorant** (*Phalacrocorax auritus*) is a member of the cormorant family of seabirds (Figs. 29-3 – 29-5). This species is widely distributed across North America and is found near rivers, lakes and along the coastline. It primarily eats fish and hunts them by **diving and swimming underwater**. Like other cormorants, its **feathers are not waterproofed**, which would interfere with its underwater agility. **After fishing, it spends time drying its feathers for better flying** (Fig. 29-4).

Adults typically have a dark-colored plumage with bare skin near the bill that is yellow or orange (Fig. 29-5). **Breeding plumage** will be mostly black with the back and coverts being a dark grayish towards the center. **Nuptial crests**, for which the species is named, are either white, black or a mix of the two (Fig. 29-5). These crests are located just above the eyes with the bare skin on the face of a breeding adult being orange. A non-breeding adult will lack the crests and have more yellowish skin around the face (Fig. 29-4).



Figure 29-3. Juvenile Double-crested Cormorant (*Phalacrocorax auritus*). Note how low the body rides in the water with only the back above the surface. This photo was made in Raleigh, NC on January 28, 2015.

The double-crested cormorant **swims low in the water** (Fig. 29-3), often with just its neck and head visible, and dives from the surface. Using its feet for propulsion, it can dive to a depth of more than **20 feet** and stay under for more than **60 seconds**.

Did you know that people have been using cormorants for fishing for thousands of years? Well, certain fishermen in China have used “trained” cormorants to fish since the 10th century AD. It has apparently been used in Japan since the 7th century AD.

To control the cormorant, the fisherman ties a snare around the base of the bird’s neck, which prevents it from swallowing the larger fish (Fig. 29-6). **When the cormorant has caught a fish, the fisherman hauls the bird back to the boat and makes the bird regurgitate the fish.** Although this method was once used for real fishing, it is largely used as a tourist attraction today.

Another bird, related to the cormorant is the **Anhinga** (*Anhinga anhinga*) (Figs. 29-7 & 29-8). Common names for this bird

include snakebird, darter, and water turkey. The anhinga’s range is from the southeastern US, along the coasts of Mexico and Central America, the Caribbean, and extending south into the northern half of South America.



Figure 29-4. Adult Double-Crested Cormorant drying its feathers after a dive. (Photo courtesy of: <http://upload.wikimedia.org/wikipedia/commons/f/fb/Phalacrocorax-auritus-007.jpg>).

The anhinga swims even lower in the water than the cormorant, with only its head and neck are above the surface. The Anhinga **does not have nostrils, and breathes only through its mouth**. Like the cormorant, anhingas **do not waterproof their feathers**, and following a dive must dry them before they are capable of normal flight.

The **Blue-footed Booby** (*Sula nebouxii*) is a member of the family Sulidae, which includes 10 species of seabirds (Figs. 29-9 - 29-11). This bird is easily distinguished by its characteristic blue feet. In fact, the blue feet are what attract a female to a male, which shows them off during their courtship display. The male blue-footed booby has a

small pupil with a yellow iris (Figs. 29-9 & 29-10), while the female has a larger pupil (Fig. 29-11).



Figure 29-5. Adult Double-Crested Cormorant in breeding plumage. (Photo courtesy of: http://upload.wikimedia.org/wikipedia/commons/8/85/Double-crested_cormorant_during_breeding_season.jpg).

Blue-footed boobies breed on tropical and subtropical islands in the Pacific Ocean. It can be found from the Gulf of California to Peru, and **especially on the Galápagos Islands**. This bird fishes by **diving** and by swimming under water, and it typically hunts in groups. **These birds can dive from heights over 300 feet, enter the water at a speed of about 60 mph, and reach depths of up to 80 feet.** Bobbies eat the fish while still under water, and both parents feed their chicks *via* regurgitation.



Figure 29-6. Chinese fisherman with a fishing cormorant, (Photo courtesy of: http://commons.wikimedia.org/wiki/File:Peche_cormorans.jpg).



Figure 29-7. Anhinga (*Anhinga anhinga*) in flight. (Photo courtesy of: http://upload.wikimedia.org/wikipedia/commons/e/ee/Anhinga_in_flight.jpg).

The blue-footed booby typically lays 1-3 eggs, which **hatch sequentially** so that the **chicks are not the same age or size**. **When food is scarce, the older chicks may resort to eating some of the youngest chicks.**

The term “**booby**” indicates that this bird is sort of a “clown,” which was derived from their **clumsy walking** on land. This characteristic is certainly **not unique to boobies**, as many marine birds that are excellent flyers and swimmers are not anatomically adapted for walking; thus they are relatively awkward on land.



Figure 29-8. Anhinga (*Anhinga anhinga*). (Photo courtesy of: http://upload.wikimedia.org/wikipedia/commons/7/7e/Anhinga_anhinga_Costa_Rica-8.jpg).



Figure 29-10. Male Blue-footed Booby with Eggs. (Photo courtesy of: Dr. Kate Barger).



Figure 29-9. Male Blue-footed Booby. (Photo courtesy of: Dr. Kate Barger).



Figure 29-11. Female Blue-footed Booby with Chicks. (Photo courtesy of: Dr. Kate Barger).

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Answers to Questions on Back Cover

- Do some birds hibernate? **Yes, sort of.** See **torpor**, pages 30, 108.
- Why do some birds migrate? **To find readily available food.** See page 30.
- Why does a Toucan have such a large bill? **To dissipate heat.** See page 29.
- Why do birds sometimes stand on one leg? **To conserve heat.** See page 30.
- Which came first, the chicken or the egg? **The egg.** See page 90.
- Which came first, the feather or the bird? **The feather.** See page 17.
- Did feathers evolve for flight? **No, for warmth.** See page 17.
- What is that “white blob” attached to the egg yolk? **The chalaza.** See page 56.
- How can we help the brown-headed nuthatch? **Put up a nuthatch box.** See page 115.
- If you touch a bluebird nest can they detect your scent? **No, most birds don’t smell.** See pages 40 & 66
- Do birds have a cleft palate? **Yes, this is perfectly normal in birds.** See page 31.
- Do all birds have nostrils? **No, some do not and some don’t work.** See pages 40 & 133.
- How can owls fly so quietly? They have **special flight feathers.** See pages 19 & 23.
- Do some birds have rocks in their stomach? **Yes, it’s called grit.** See pages 35 & 36.
- Do some birds “throw up” after eating? **Yes, many birds do.** See page 36.
- Can some birds drink seawater? **Yes, some birds can.** See page 41.
- How can a bird breathe without a diaphragm? **They don’t need a diaphragm.**
See pages 42 & 43.
- How can birds sing without vocal cords? **They use their syrinx to produce sound.**
See page 42.
- Do most adult female birds have two ovaries? **No, one degenerates after hatching.**
See page 52.
- Which determines the sex of the chick, the male or the female? **The female.** See page 58.
- Why can’t birds lay more than one egg a day? **It’s the shell that takes so long.**
See pages 54 & 56.
- When a peacock spreads his fan, are those his tail feathers? **No, it is special covert feathers just in front of its tail feathers.** See pages 21 & 96.
- Just why did the chicken cross the road? **Now that’s a good question.** See page 175.

Just why did the chicken cross the road?

This question has been around a long time, and many explanations, including, “to get to the other side,” have been proposed. **Here’s my best shot at answering this question.**

Well, in order for a chicken to cross the road, all you need is a mobile chicken and a road. **Both the chicken and the road have been around a long time, so we’ll assume that the first time a chicken crossed a road was several thousand years ago.**¹ With no eyewitness reports, we’ll have to speculate a bit and consider the possible explanations.

Other than being chased by a predator or a rooster, **there are several possible reasons why a chicken would voluntarily cross a road:**

(1) the chicken was looking for a mate—this is not too likely because at least the hen doesn’t go around looking for a rooster every day. To be generous, let’s say that this reason would be about a **5% probability**;

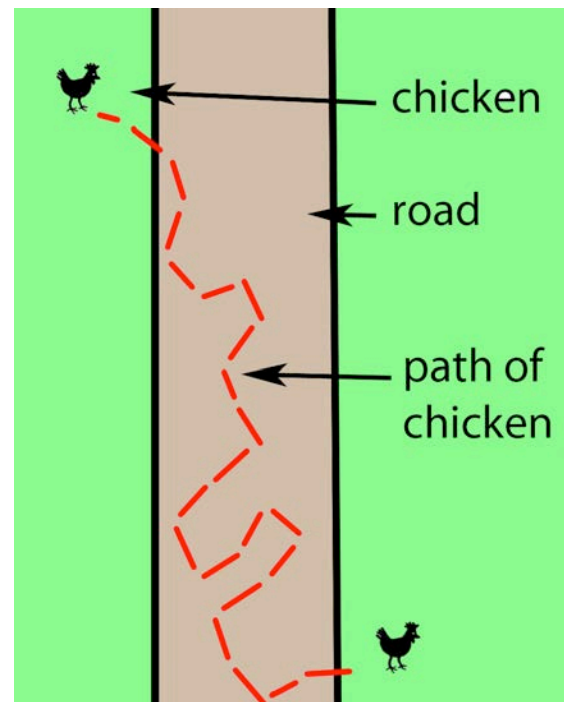
(2) another reason a chicken might venture across a road would be to find a nesting site or a roosting site. Again, this is not a very probable explanation, but to be generous, let’s give this one a **5% probability**; and

(3) the chicken was in search of food—now this is by far the most likely explanation because birds are all about finding food. They spend much of their waking hours in search of something to eat. **They may travel a short distance or**

they may migrate thousands of miles in search of food. My thought is that this reason would merit at least a 90% probability.

But did the chicken just cross the road in a perpendicular manner? I would doubt that it did. **Any chicken worth its wattles would recognize that a road is a very good place to find food.** Rather than just crossing the road, the chicken would most likely meander along the road, and in the process, might eventually reach the other side (see figure below).

Some morsel of food might have fallen out of a Roman chariot or maybe it was thrown out (early litterers). Or perhaps one or more of the horses pulling the chariot “dropped” something of gastronomic interest to the chicken. Horses are not the most efficient digesters, and some grain may have passed through the horse in perfectly good condition, at least to the chicken. They don’t call horse poop “road apples” for nothing.



¹ The red junglefowl, predecessor of the chicken, has been domesticated for about 5000 years. Roads have been around since at least the days of the Roman Empire (*ca.* 2500 years).

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Some Questions Answered in this Book.

- **Do some birds hibernate?**
- **Why do some birds migrate?**
- **Why does a Toucan have such a large bill?**
- **Why do birds sometimes stand on one leg?**
- **Which came first, the chicken or the egg?**
- **Which came first, the feather or the bird?**
- **Did feathers evolve for flight?**
- **What is that “white blob” attached to the egg yolk?**
- **If you touch a bluebird nest can they detect your scent?**
- **Do birds have a cleft palate?**
- **How can owls fly so quietly?**
- **Do some birds have rocks in their stomach?**
- **Do some birds “throw up” after eating?**
- **Can some birds drink seawater?**
- **How can a bird breathe without a diaphragm?**
- **How can birds sing without vocal cords?**
- **Do most adult female birds have two ovaries?**
- **Which determines the sex of the chick, male or female?**
- **Why can’t birds lay more than one egg a day?**
- **When a peacock spreads his fan, are those his tail feathers?**
- **Just why did the chicken cross the road?**

