Lab # 11 - DISSECTION OF A DINOSAUR

INSTRUCTIONS FOR DISSECTION OF THE PIGEON

The main point of this exercise is to familiarize you with basic avian and hence extant dinosaurian anatomy. You will work one pigeon per person. ***Do not dissect your fingers - the scalpels are very sharp!!!***

1. Examine the mounted pigeon skeleton & identify the components of the fore- & hind-limbs, as well as the pelvic area. Compare the pigeon skeletal anatomy with that of the *Allosaurus* model (see Fig. 1). Note that the pubes do not join as in non-avian dinosaurs but instead form a rather wide opening. This is to allow the passing of a large egg. As fliers, pigeons have developed an extra structure on the sternum called the keel. Now turn to your specimen, examine basic external anatomy, noting how limbs are attached, feather tracts, various incisions used for injecting latex etc. (Fig. 2).

2. Examine wing paying special attention to how feathers are attached to hand & arm. Go back to the mounted skeleton & note the several raised bumps on the humerus where the large flight feathers attach to the bone. Pluck feathers from wing (Fig. 3) & compare forelimb anatomy with theropod anatomy (use Fig. 4). The bird wing is a unique structure not similar to the wings of other fliers (i.e. bats). The two main flight muscles are the **pectoralis** (the "breast" of the pigeon), & the **supracoracoideus** (which lies deep to the pectoralis) (Fig. 5). Just as in humans, the pectoralis is a chest muscle which pulls the wings (or arms) forward. We humans are strange in that we have adopted an erect, bipedal posture such that our dorsal side points straight back, but in birds, as in most other animals, the dorsal side is the "top" and points towards the sky. Thus, *when the pectoralis contracts in a pigeon it pulls the wings down*. The *supracoracoideus serves to pull the wing in the opposite direction - up*. Now, getting back to the uniqueness of bird wings...<u>both</u> the pectoralis & the supracoracoideus are located on the ventral side of the pigeon which is counter-intuitive if you want one muscle to pull the wing up & another to pull it down. You would expect the up-pulling muscle to be on the <u>dorsal side</u> so that when it contracts & shortens it pulls the wing up. So how do birds manage to pull their wing up with a muscle on the ventral side? *Over time this muscle has moved its insertion point via evolution through a small hole in the upper part of the coracoid so that it actually inserts on the dorsal side of the humerus.* When a bird flaps its wings it has power on both the up & the down stroke.

3. Pluck the entire chest area clean from the neck to the cloaca, taking care not to damage the crop, & note the arrangement of the clavicle and sternum from the exterior, also note the bulging pectoralis muscle. We will dissect these structures out shortly so that you can see their internal arrangement. Look closely at the mounted pigeon skeleton and identify the position of the sternum, coracoid, scapula & clavicle.

Now it is time to dissect so here are some helpful hints: 1) since birds are bilaterally symmetrical if you mess up one side you can always salvage the other side; 2) hold the scalpel in your hand as if it were a pencil. When you cut use the tip to make small, stroke-like cuts so that you only go through one tissue-type at a time. Use Fig. 6 for reference.

4. Make the first cut down the middle of the crop from the top of the neck to the top of the sternum. You are cutting through extremely thin skin so go gently. Underneath the skin you may see many pieces of corn and grain - the birds eats the grain and stores it in this pouch. Next make 2 cuts at the top of the sternum through the crop skin perpendicular to the first cut. This will allow you to

peel back the entire crop. Empty the grain & note the entrance to the esophagus at the bottom of the crop.

5. Your next cut will be down the side of the sternum from the clavicle all the way to the base of the sternum. You are now cutting through the pectoralis which is about 1/2 inch thick. At the base of the sternum make a perpendicular cut so that you can deflect the pectoralis up & away from this bone. Staring you right in the face should be the supracoracoideus: a smaller, feather-shaped muscle that lies along the base of the keel. Follow the origin of the supracoracoideus through the hole in the coracoid to the back side. Note how the two main muscles of the flight stroke act to flap the wing (Fig. 3). Examine the leg muscles & their attachment to pelvic girdle.

6. Cut out the sternum by making an identical cut through the muscles of the opposite side, taking care not to cut the internal organs. The easiest way to remove the sternum is to insert 2 fingers underneath it, holding the thumb firmly on the top surface and bending it backwards up toward the head of the bird until you hear the ribs break (it sounds disgusting, but it works). Examine the arrangement of the lungs, heart, gizzard, & air sacs (Figs. 6-8). Try to follow pathways of air through the system. You can easily trace the trachea since it is injected with latex from the neck & to the branching point into the air sacs. Note the ring-like structures on the trachea - these are called hyoid cartilage (compare them to your own by feeling your throat, or ask your lab partner to tip their head back & you will see the rings through the skin). The hyoid cartilage keeps the trachea stiff at all times so that the air passage is never blocked, e.g. during sleep or if the animal becomes unconscious.

7. Examine the air sac system of the pigeon (Fig. 8). The respiratory system of birds consists of not only the lungs but a series of air sacs in the body cavities & air spaces inside many of the bones. The lungs of the pigeon contain less than 17% of the total air volume, whereas the air sacs contain 82%, and the remaining 1% is in the trachea. When birds breathe, air is taken into the air sacs & through the various hollows, & then through the lungs where CO_2/O_2 exchange occurs. Oxygen-depleted air is then exhaled, all in a one-way system. Humans, in comparison, have a respiratory system in which newly-oxygenated air must pass oxygen-depleted air in the lungs, causing a certain amount of "stale" air to remain with each breath. In fact, it takes us several breaths to completely replace all the air in our lungs. These birds have been injected with pink latex via the trachea (after death) so that the air sac system is highly visible. Trace out as many air sacs as you can. Locate the lungs which lie between the ribs and the back muscles, dissect out a lung by cutting through the ribs at the attachment to the vertebrae after you have completed step 8.

8. Move around the internal organs, looking at various parts (Figs. 6-8). Remove the heart by cutting off the aorta and main veins - if you feel adventurous you can cut it lengthwise to examine the 4 chambers (2 ventricles & 2 atria). Pay special attention to the crop-stomach-gizzard-small intestine relationship. Trace the esophagus from the crop to the gizzard & find the exiting intestine on the other side of the gizzard. Remove the gizzard by severing these 2 attachments. Open the gizzard by cutting along the natural "seam" and take a look at what's inside. Determine if your bird is male or female & where it is in the breeding cycle (Fig. 6). To avoid carrying extra weight when flying birds only enlarge their reproductive organs when they are ready to breed, so if your bird is not in "breeding-mode" the organs will be very tiny.

Feel free to explore any other parts of the bird before you go home.
Besides the actual dissection, the work you need to do for this lab is:

A. Sketch the following:

1) The hind and fore-limbs, labeling the bones.
2) The wing, indicating the main flight feathers & the approximate position of digit 1.
3) The general position of the internal organs; label them.
4) The approximate arrangement of the air sac-lung system.

B. Questions:

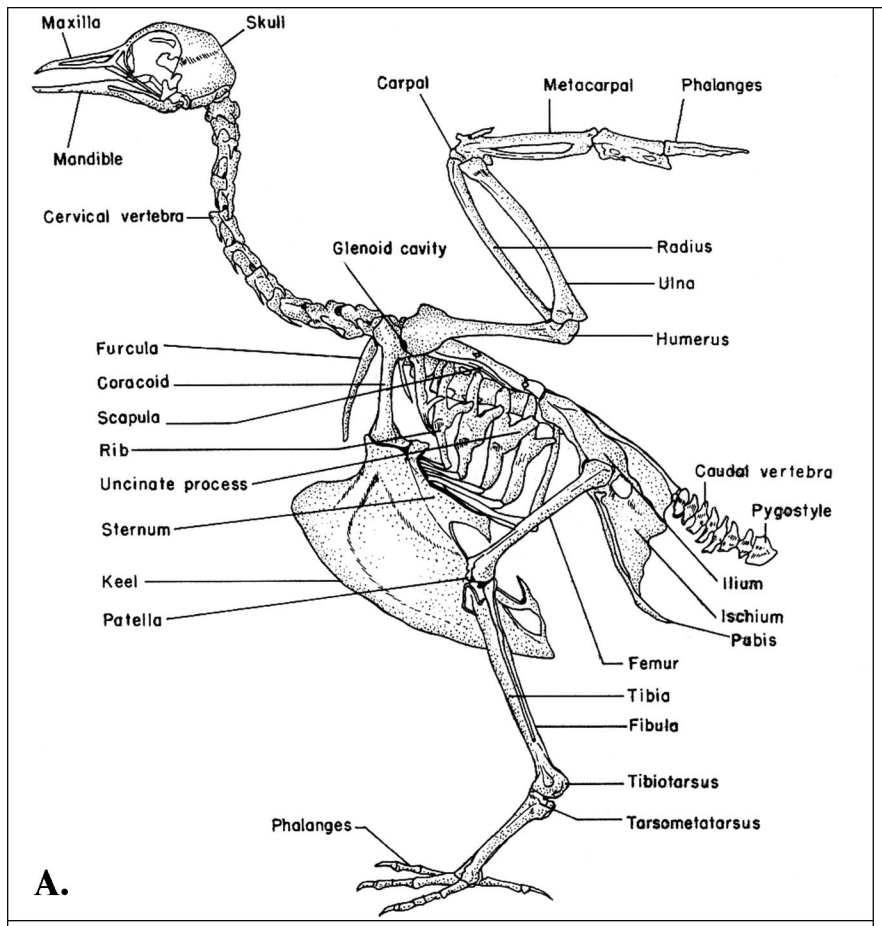
1. What is the function of the keel on the sternum?

2. What is the grit inside the gizzard?

3. Is your bird male or female?

References

Alexander, R. M. 1992. Exploring Biomechanics. Scientific American Library, 247 p.
Bakker, R. T. 1986. The Dinosaur Heresies. Zebra Books, 481 p.
Chiasson, R. B. 1984. Laboratory anatomy of the pigeon, 3rd edn. Wm. C Brown & Co, 104 p.
Dingus, L. & T. Rowe. 1997. The Mistaken Extinction. Freeman, 332 p.
Feduccia, A. 1996. The Origin and Evolution of Birds. Yale Univ. Press, 420 p.
Heilmann, G. 1926. The Origin of Birds. Witherby.
Levi, W. M. 1974. The Pigeon. Levi Publishing Co., 667 p.
Paul, G. S. 1988. Predatory Dinosaurs of the World. Simon & Schuster, 464 p.
Welty, J. C. 1975. The Life of Birds, W. B. Saunders & Co, 623 p.



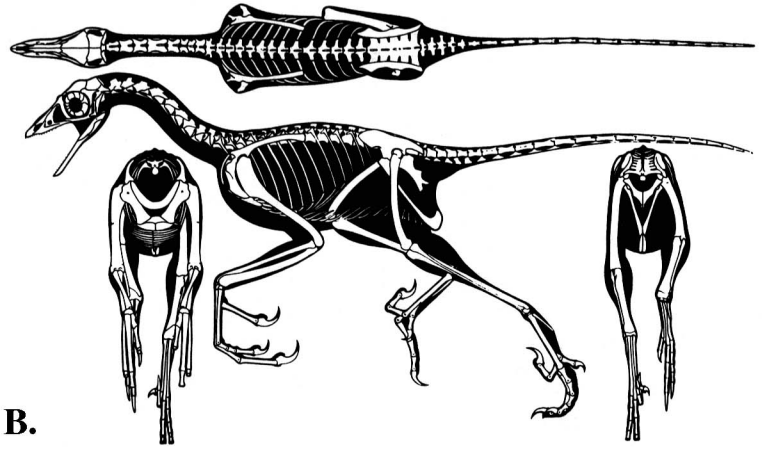


Fig. 1. Skeletal anatomy

A. Pigeon
B. Archaeopteryx reconstruction
C. Archaeopteryx (left) and pigeon (right).

Abbreviations on p.3 of handout.
Sources: Welty (A), Paul (B), Heilmann (C).

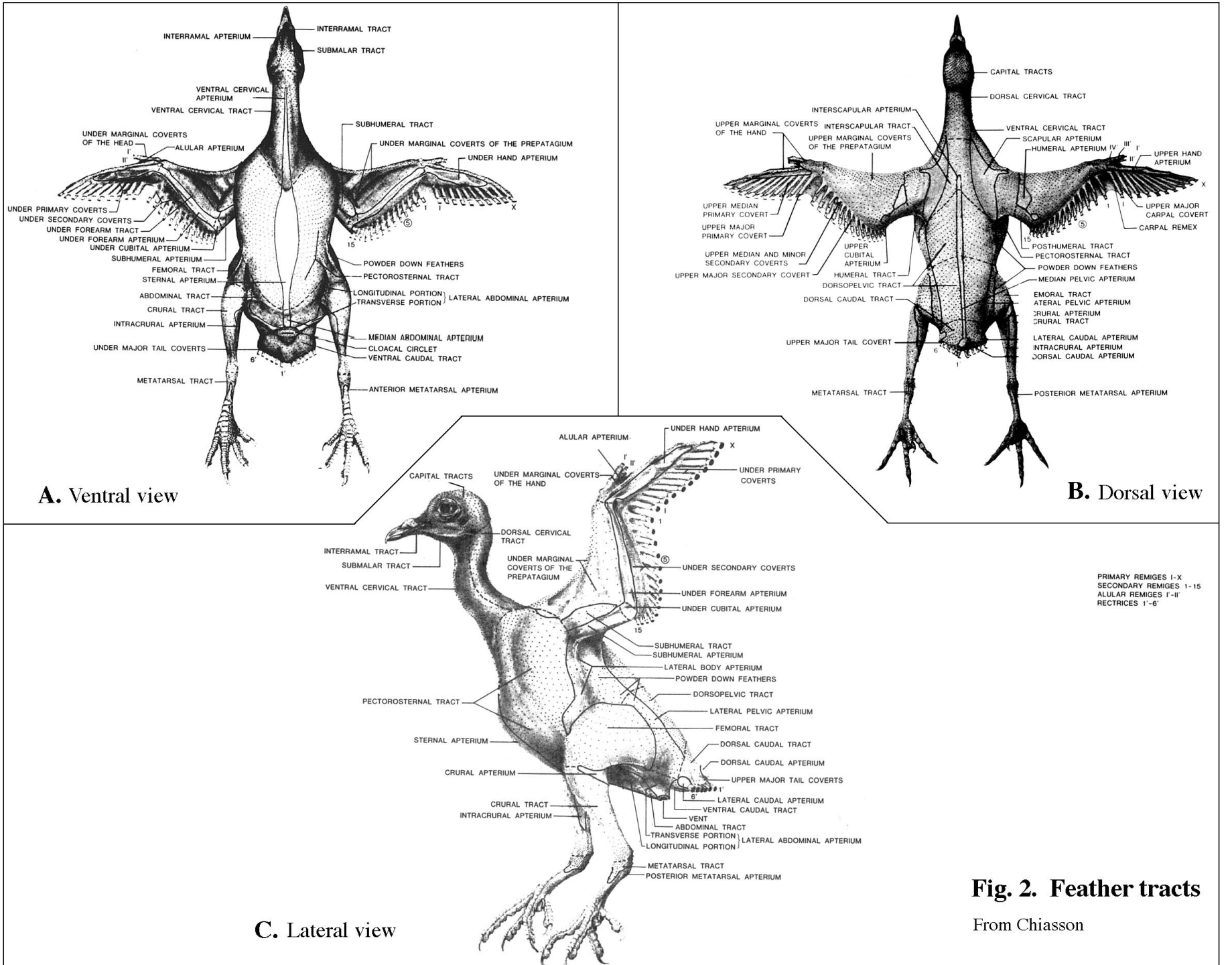


Fig. 2. Feather tracts

From Chiasson

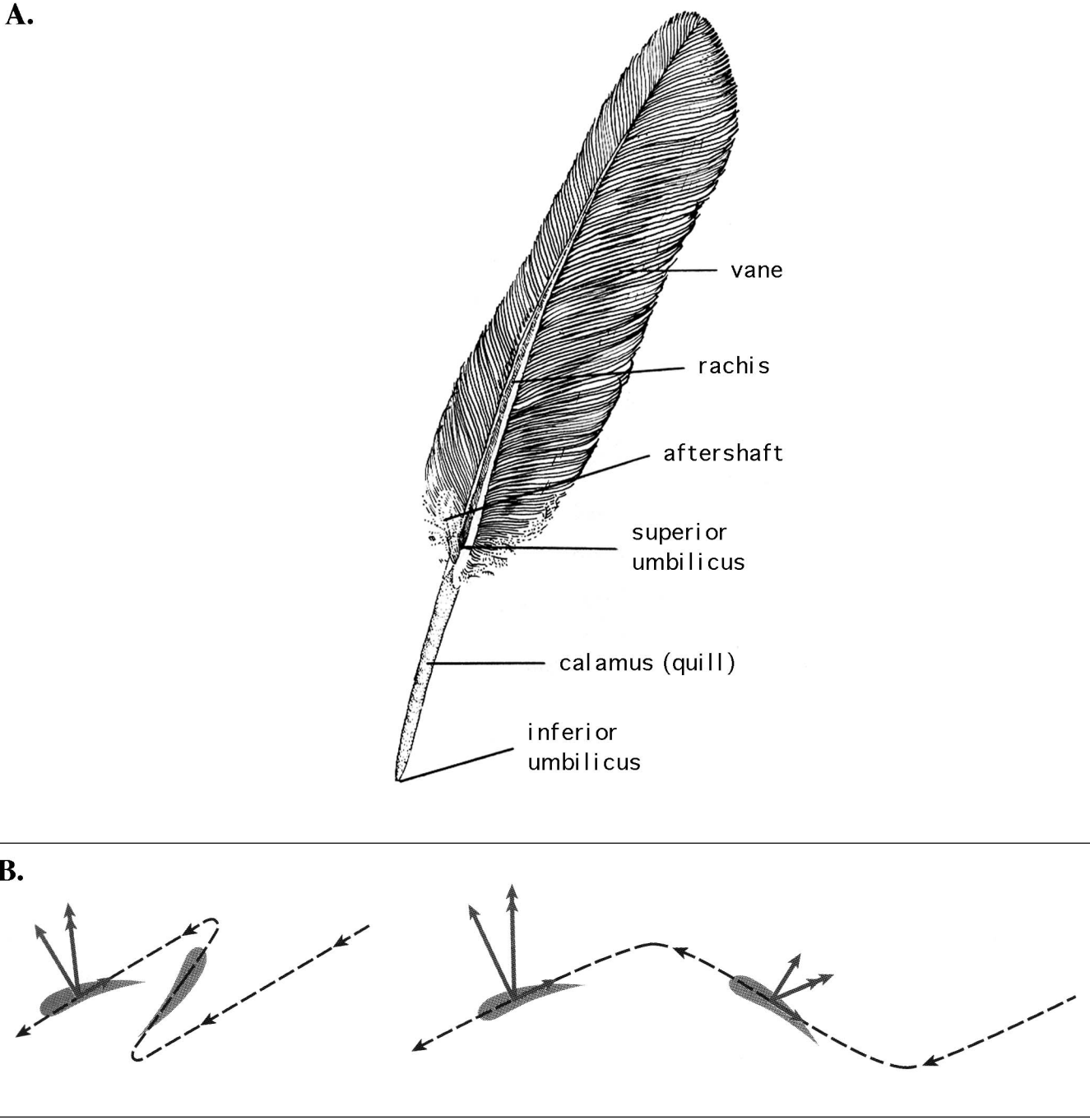


Fig. 3. Feathers

A. Feather anatomy
B. Hydrofoil effect of feathers

Sources: Welty (A), Alexander (B)

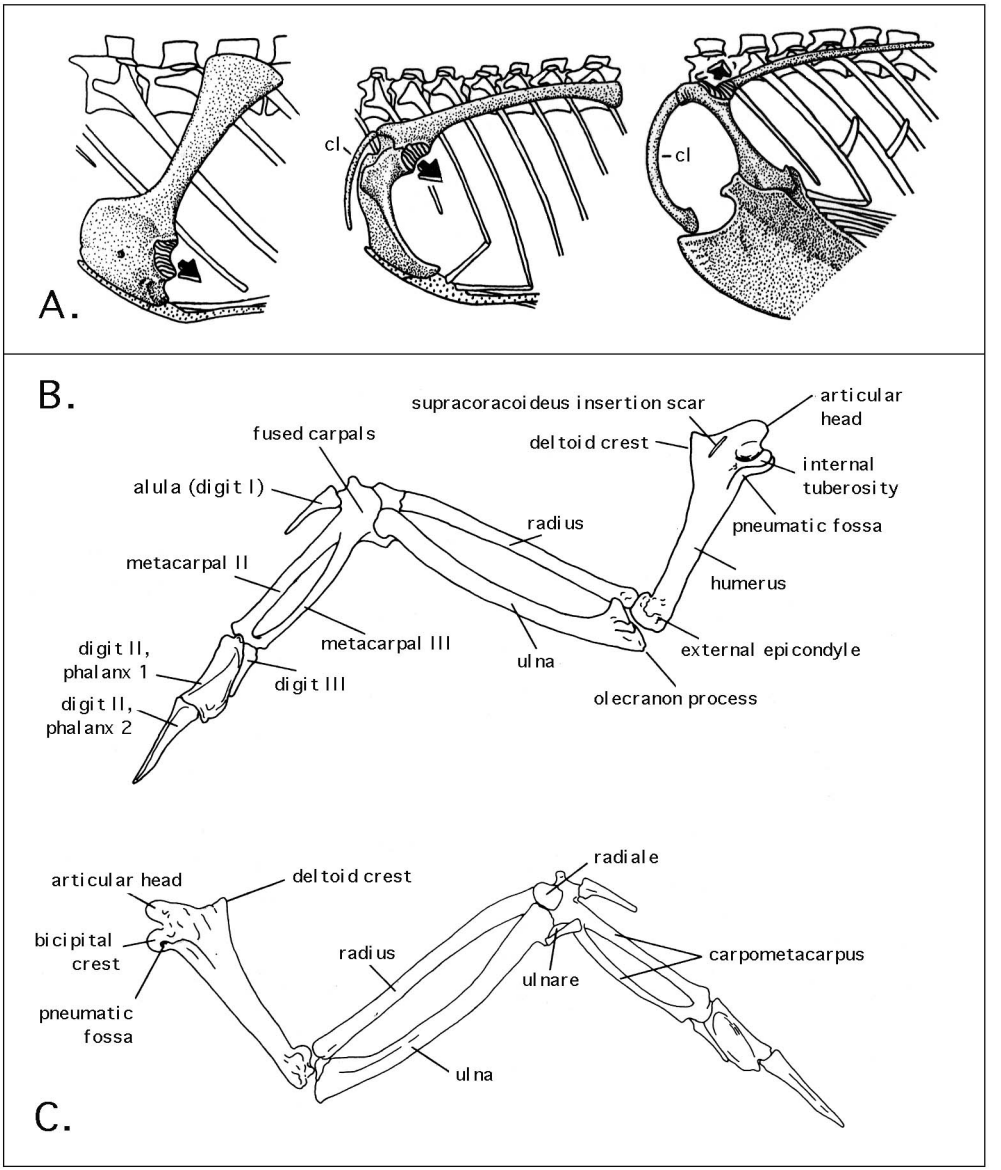
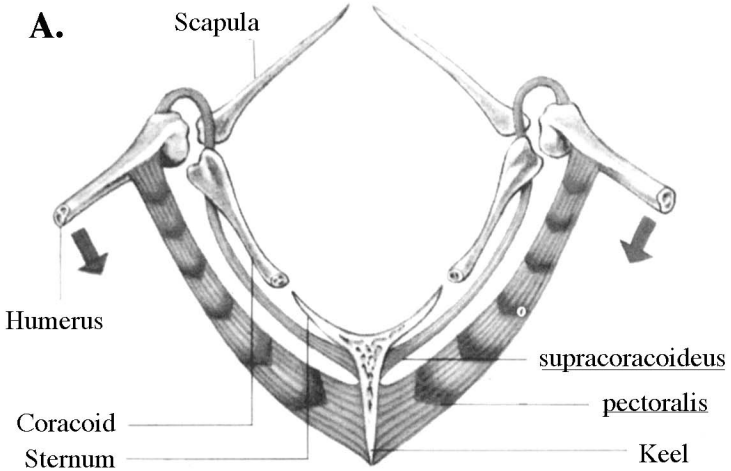
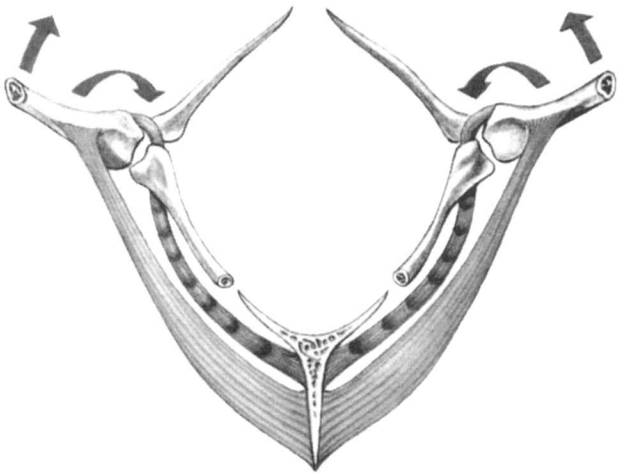


Fig. 4. Forelimb anatomy

A. Pectoral girdles of (left to right): Coelophysis, Archaeopteryx, flying birds
B. Lateral (dorsal) view of pigeon wing skeleton.
C. Medial (ventral) view of pigeon wing skeleton.

Sources: Paul (A), Chiasson (B,C)





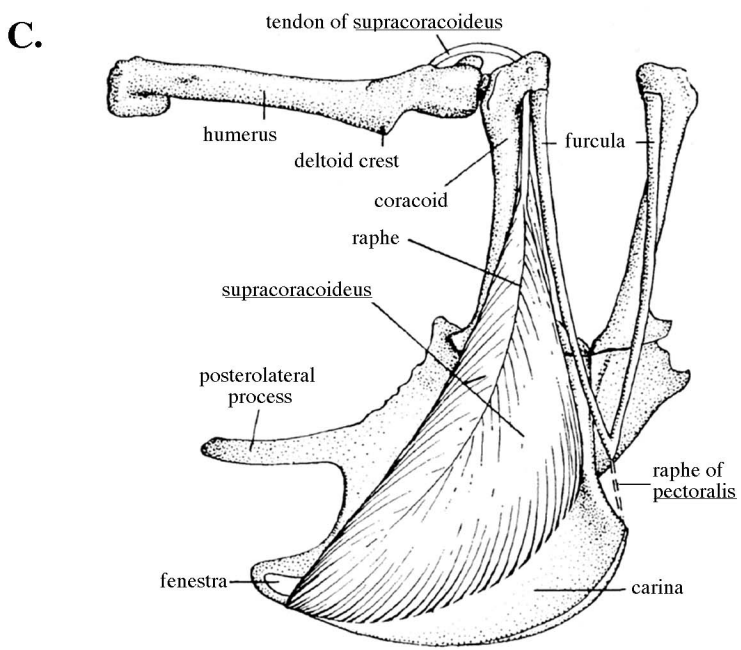


Fig. 5. Wing musculature

A. Contraction of pectoralis pulls wing down
B. Contraction of supracoracoideus pulls wing up
C. Anterior-lateral view of pigeon sternum & pectoral girdle

From Feduccia

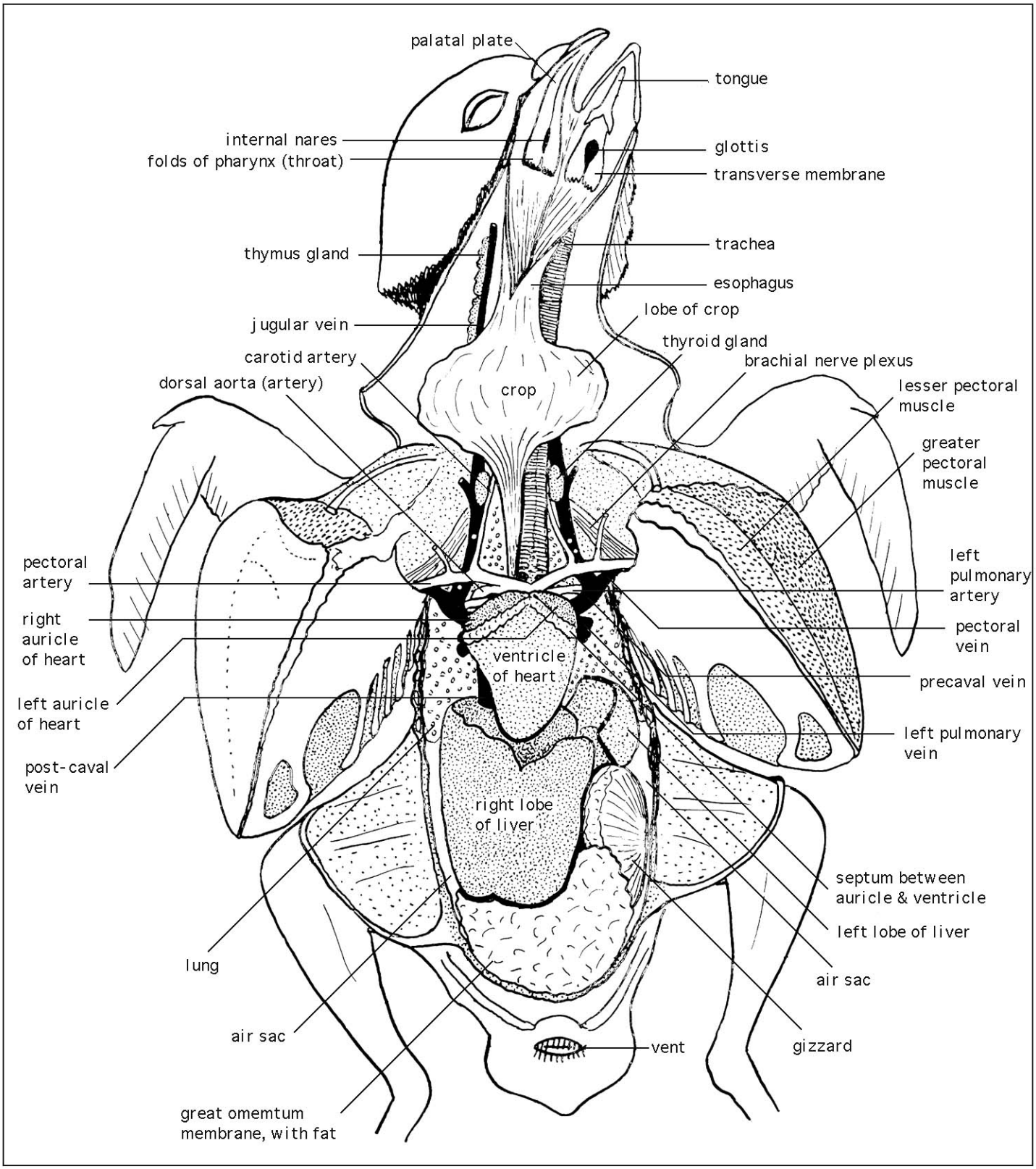


Fig. 6. Gross internal anatomy

From Levi.

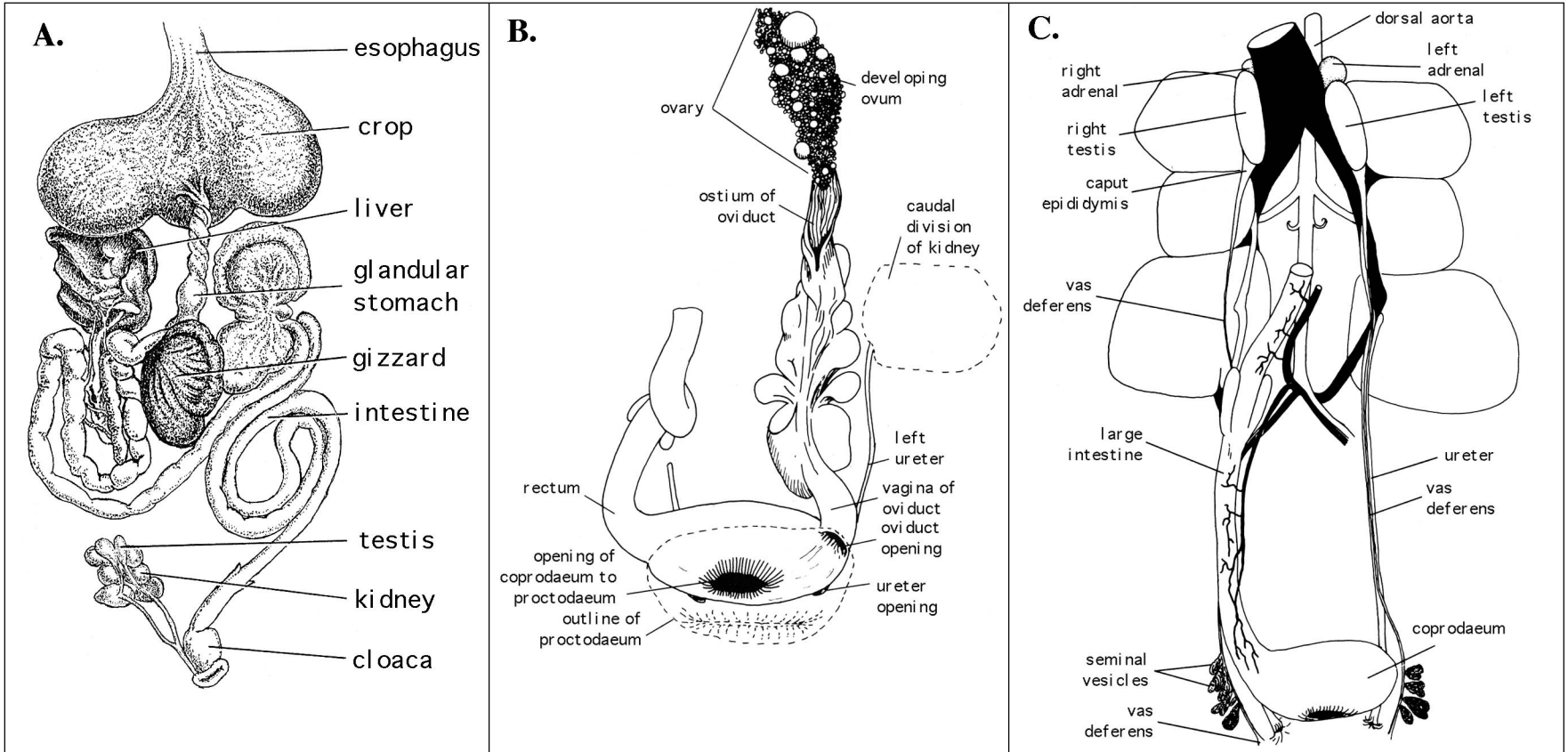


Fig. 7. Internal organs

A. Digestive tract
B. Female reproductive system
C. Male reproductive system

Sources: Welty (A), Chiasson (B,C)

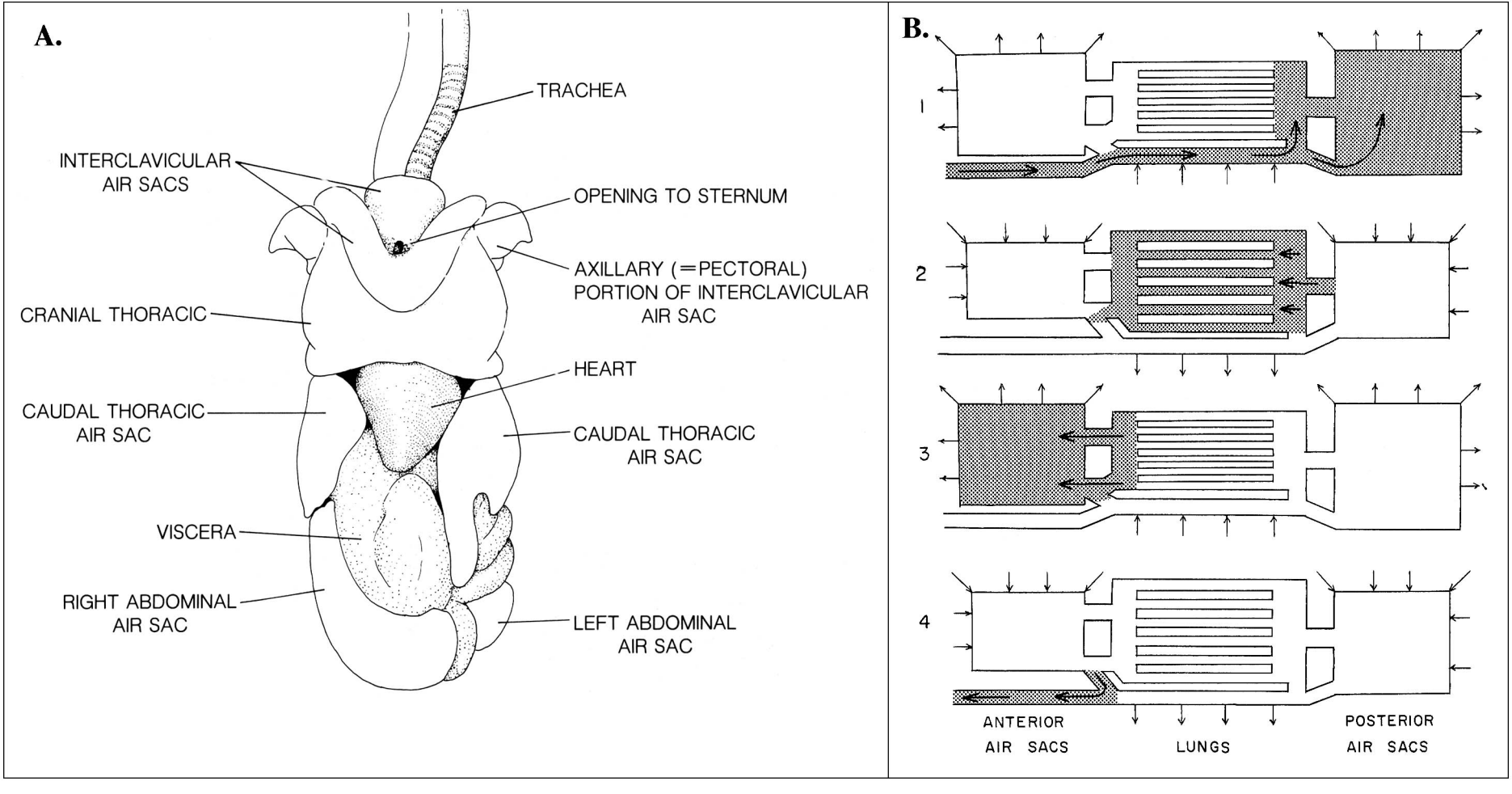


Fig. 8. Air sacs

A. Ventral view of pigeon's air sacs.
B. Schematic diagram showing passage of a single breath of air (shaded) through a bird's respiratory tract.

Sources: Chiasson (A), Welty (B)