

Digestion, excretion and water balance

Class Business

Midterms will be handed back today; note that you will have another 50 point test on March 28.

Reading for this lecture

Required. Gill: Chapter 6, pages 164-179

Optional. Procter & Lynch: Pages 175-188, 219-239

1. The digestive system

A) OVERVIEW

- i) Digestion is the process by which food is turned into the fuel that birds use to grow, fly, stay alive, reproduce, etc. This process involves the following stages: maceration, digestion, assimilation, and excretion.
- ii) The key parts of the digestive system that you will be expected to know the names and function of are: **esophagus, crop, proventriculus, gizzard, small intestine**, and **ceca**.
- iii) Details of the digestive system vary considerably among birds depending on what they are eating.

B) MACERATION

- i) A defining feature of digestion in birds is that birds do not have teeth with which to chew up (macerate) their food.
- ii) Maceration can be important because it breaks food up into small pieces which makes them easier to swallow and increases the rate of digestion (because the surface area over which digestion can occur is increased).
- iii) Some birds macerate their prey externally. Raptors often rip large prey up into little pieces before swallowing them. Kingfishers beat their prey against a branch repeatedly to break up the bones. Some fruit eaters will crush berries with their bills prior to swallowing.
- iv) Most birds macerate their prey internally, using the muscular portion of the stomach (the gizzard). Often birds will eat grit, which accumulates in the gizzard and presumably helps with grinding up the food.

C) DIGESTION

- i) Birds tend to digest food very rapidly and food passes through their bodies at a high rate.
- ii) Digestion begins in the proventriculus where gastric acids and digestive enzymes are produced. It then continues as the food passes through the gizzard and the small intestine.
- iii) The length of the small intestine varies depending on the bird's diet. Birds that eat poor quality food, or food that takes time to digest, tend to have longer small intestines than those that eat easily digested food. Increasing the length increases the amount of time it takes for food to pass through the system, maximizing the amount of nutrition that can be obtained. In birds that switch diets seasonally, intestine length can also change to accommodate diet shifts.

D) ASSIMILATION

- i) The uptake of nutrients occurs in the small intestine.
- ii) Assimilation efficiency varies depending on the type of food (e.g., nectar is assimilated with great efficiency; old leaves and pine needles are not), the rate at which food passes through the gut (assimilation increase with higher passage rates), and with acclimation to a particular food type.

E) EXCRETION

- i) Waste materials are excreted from the small intestine through the **cloaca**.
- ii) In birds, nitrogenous wastes are excreted as **uric acid**. In contrast, mammals excrete urea. But, urea is toxic unless it is greatly diluted. Consequently, mammals need to drink a lot of water, while birds are able to store nitrogenous wastes at very high concentrations

without using so much water. This water conservation gives birds advantages, especially in arid conditions. Uric acid also has big advantages for egg layers because it doesn't need dilution and is insoluble in water. Consequently, much more nitrogenous waste can be stored in the small space within the egg than if it were in the form of urea.

- iii) **Salt glands** are not a part of the digestive system, but they are involved in excreting waste products from the body. They are used to pump salts out of the blood and to help birds to maintain water balance. Not all birds have these glands (which lie just above the eyes); they are especially common in waterbirds that are associated with salt water. In some species, they allow birds to drink salt water without ill effects.

F) FOOD FLOW IS NOT NECESSARILY ONE WAY

- i) Bringing food to young: gulls will regurgitate partially digested fish to feed to their young.
- ii) Birds that feed on prey with hard indigestible parts (bones, fur, shells, exoskeletons) regurgitate the material that they cannot digest in the form of **pellets**.
- iii) Some birds produce food for their young in parts of their digestive systems. Petrels produce fatty stomach oils in their proventriculus which they feed to their chicks (they can also projectile vomit these oils at unwary predators and seabird biologists they're nasty!). Pigeons and doves produce a substance referred to as "crop milk".