

Lecture 21: Chick Growth and Development

Class Business

- THE FINAL EXAM WILL NOT BE IN OUR USUAL LECTURE HALL!!! Final exam is 10:30-12:30, Wed. May 7th, BioPhysics Room 131.

Reading for this lecture

Required. Gill: Chapter 16 (pg. 467-482)

1. Hatching

A) PRE-HATCHING DEVELOPMENT

- i) The amount of time it takes for eggs to hatch varies among different species. Albatross eggs can take 11 weeks, some passerines little more than a week.
- ii) Despite this variation, the sequence of developmental events is very similar among species. There are 42 standard developmental stages that the embryo passes through on its way to becoming a hatchling.
- iii) There is, however, variation in the time it takes to complete each stage, and this influences the chick's abilities when it finally hatches.
- iv) Other aspects of the egg also change as the embryo develops. As the bird grows, water is lost from the egg and is replaced with air. Consequently, as the embryo develops the eggs become increasingly buoyant when placed in water (this feature allows researchers to determine the age of a developing egg). The egg shell also gradually thins as calcium is redirected from the shell to the embryo for use in bone growth.

B) EGG BREAKING

- i) Hatching itself involves a sequence of events that starts with the chick getting into a position that makes it relatively easy to break the egg shell. Once it is in position, the chick breaks the membrane that separates itself from the air chamber inside the egg. Then it begins to peck away at the shell, gradually causing tiny cracks to appear. As it pecks, the chick rotates its body using its feet so that it can create cracks all around the egg. This stage is referred to as **pipping** and can last a couple of days. Once the egg is pipped the bird uses its body to push the egg shell apart.
- ii) Chicks have several anatomical features that allow them to accomplish the difficult task of getting out of a shell. First, they have a special hardened **egg tooth** (not a real tooth) on the tip of the bill which helps them crack the egg. The egg tooth either falls off or is absorbed back into the body during the days following hatching. Second, chicks have a special muscle on the back of the neck, which gives them extra strength to peck with. This muscle also diminishes once the bird is out.
- iii) The method of breaking the shell varies among species, however, most birds break out a hole in the side of the egg, and then split the shell around the short axis. See the text book for a discussion of alternative methods.
- iv) Once the chick is out, many adult birds will remove the shell fragments from the nest. Why do you think they do this? Which types of birds would you guess do not remove shells from nests?

2. Types of development

A) DEFINITIONS

- i) Birds are often simplistically divided into those that have altricial young and those that have precocial young. **Altricial** means that the young are born unable to move around on their own, largely naked, with eyes closed, unable to thermoregulate, and essentially helpless. **Precocial** chicks on the other hand are capable of moving around on their own, have a full covering of down feathers, open eyes, are soon able to maintain body temperature, and typically require less care from their parents.

- ii) At the altricial extreme are birds with chicks that are utterly helpless and need to have everything done for them (feeding, keeping them warm, etc.). This group includes most passerines, plus some nonpasserines like kingfishers and woodpeckers. At the other extreme are birds with chicks that take complete care of themselves from the day they hatch. In the megapodes, the adults do not even sit on the eggs, instead burying them in a mound of rotting vegetation, which keeps the eggs warm.
- iii) In reality, there is a lot of variation between these two extremes, and at least 6 different categories into which the range of variation is subdivided. Details of these types and examples are given in Gill pages 432-433.
- iv) In general, birds with precocial chicks (e.g., shorebirds, ducks, quail) have larger eggs with more yolk than birds with altricial chicks. Why do you think more yolk is important?

B) EVOLUTION OF DEVELOPMENTAL MODES

- i) Precocial young is ancestral state in birds.
- ii) Altricial development has evolved multiple times in different lineages.
- iii) In some cases, “intermediate” modes of development have evolved from altricial ancestors.

3. Chick growth

A) GROWTH PATTERNS

- i) Growth rates are typically S-shaped. Exceptions include (a) some seabirds and aerial-feeders, in which the young “overshoot” the adult mass and then lose weight, and (b) some ground nesting birds (e.g., doves) in which growth slows well before they reach adult size.
- ii) Growth rates vary among species. Big birds grow more slowly than small birds. Altricial birds tend to grow faster than precocial birds. See the text book for more on the differences among species.
- iii) The way in which growth occurs also varies. E.g., in quail the chicks can fly long before they reach adult size, but in many other birds the young do not leave the nest until they are almost the size of adults.
- iv) Note that in general birds get to adult size very quickly. Even in very long lived birds (such as parrots), the adult size is reached within a few months of hatching. In passerines, young typically reach adult size – or close to it – by the time they leave the nest.

B) EXPLANATIONS FOR VARIATION

- i) Various hypotheses have been proposed to explain the variation in growth patterns that is seen among birds.
- ii) The “competition hypothesis” (Lack) suggests that there is a trade off between the young bird’s need to grow rapidly enough to minimize vulnerability to predators and its need to grow slowly enough to not exceed its parents food provisioning ability.
- iii) The “tissue allocation hypothesis” (Ricklefs) suggests that in some species energy and nutrients are invested into getting to adult size quickly, and in others they are invested into maturing certain tissues that are needed for survival. Which of these goals is more important for a particular species situation will determine which strategy is favored.

C) INTRASPECIFIC VARIATION

- i) Growth rates can vary within a species (often within a brood) for a variety of reasons.
- ii) Within species variation can depend on food availability, weather (which may directly affect growth by altering thermoregulation needs or indirectly affect growth via the parents ability to gather food), etc.
- iii) Sibling rivalry (i.e., competition for food or brooding between nest mates) can also result in some birds growing faster, although adults frequently influence food allocation among their young.
- iv) Asynchronous hatching (see egg lecture) can exacerbate sibling rivalry because it creates a size hierarchy among the young. This system has advantages for adults living in variable environments where they are unsure how many young they will be able to raise. In poor conditions, the smallest young are just ignored and left to die. In good conditions, all the young will have a good chance of surviving. In some cases, this hierarchy results in

siblicide, in which one chick acts to hasten the demise of its siblings (more on this next lecture).