

# NATURAL AND SEXUAL VARIATION

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## INTRODUCTION

The Darwinian concept of evolution via natural selection is based on three empirical facts: (1) organisms produce a large number of offspring; (2) these offspring are variable; and (3) some individuals survive and reproduce whereas others do not. Today we will convince ourselves that quantitative and qualitative variation exists within natural populations of animals.

## LEARNING OBJECTIVES

You will:

- demonstrate individual quantitative variation in fundamental physical traits,
- demonstrate quantitative and qualitative variation in male courtship characteristics,
- learn the difference between natural and sexual selection

## MATERIALS

study skins of 1 male and 1 female House Sparrows (*Passer domesticus*)/student  
1 male House Finch (*Carpodacus mexicanus*)/student  
1 set of calipers/two students  
color chart (e.g., Smithe 1975)

## PROCEDURE

### House Sparrows

House Sparrows, which are native to Europe, were first introduced to this country in 1850 with repeated introductions thereafter. Since those initial introductions House Sparrows have spread across North and South America (Dott 1986, van den Bosch et al., 1992) and diversified anatomically (Hamilton and Johnston 1978; Johnston and Fleischer 1981, Johnston and Selander 1964, 1971). We will look at several characteristics of House Sparrows and discuss the different ways in which selection acts on these characteristics.

Your instructor will give you two House Sparrow study skins. These are real House Sparrows that have been skinned and stuffed with a small dowel wrapped in cotton. The

specimens have been stored in a drawer in a museum cabinet where they are dry and protected from insects. When you handle a specimen, grasp it by the body. It is fragile and should not be grasped by a wing, the head, tail or legs.

You also have a set of calipers for accurate measurements of small structures. All measurements should be in millimeters. Record your measurements and those of your classmates in the tables provided below.

### **Bill dimensions**

Holding the specimen in one hand use the calipers to measure the length of the upper mandible. Do this by placing the inner edge of the immovable caliper arm at the point where the ridge, called the culmen, of the upper mandible meets the feathers of the forehead (Fig. 1). Open the calipers until the inner edge of the movable arm is at the tip of the bill (Fig. 1). This is the culmen length.

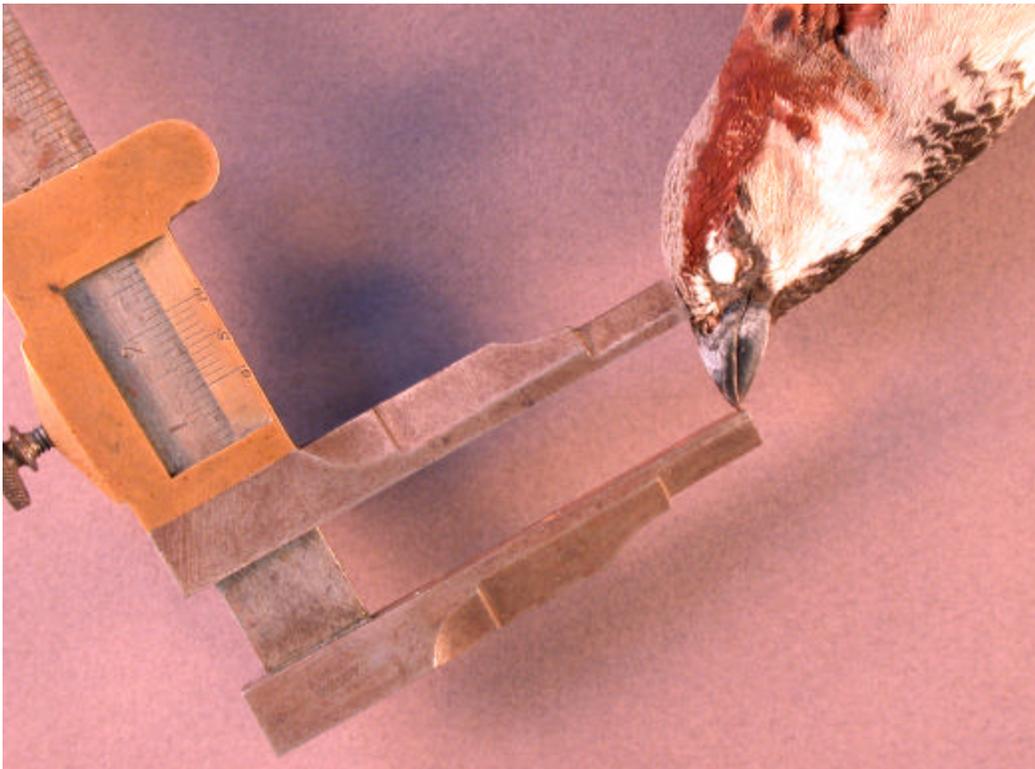


Fig. 1. The immovable arm of the calipers is just touching the tip of the bill and the movable arm is at the point on the forehead where the culmen meets the feathers.

Now read the length from the scale on the caliper arm and the vernier scale (Fig. 2).

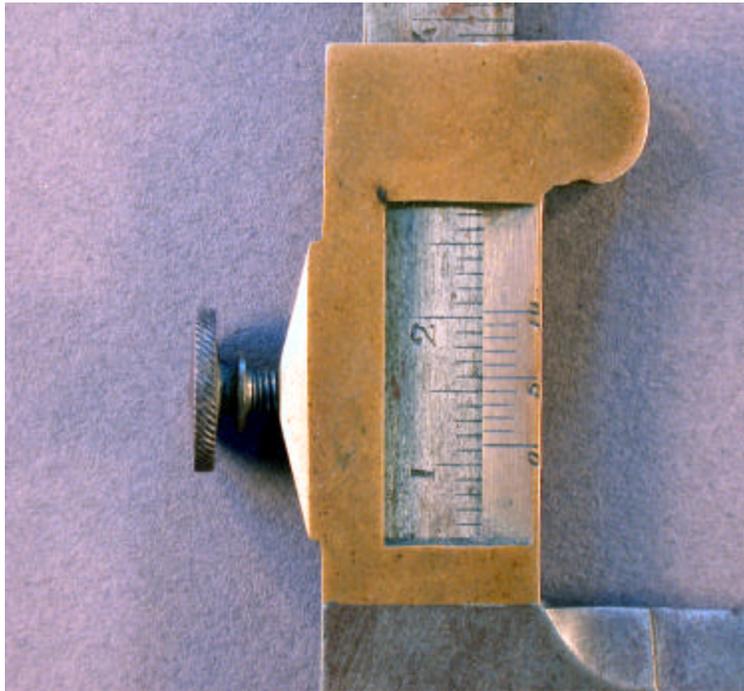


Fig. 2. The culmen length is read with the vernier scale, which runs from 0 to 10 on the brass colored window in the figure. Read the millimeter from the engraved lines of the caliper closest to the line marked 0 on the vernier scale. In the figure the 0 line is just past 11 mm (1.1 cm). Now scan toward the 10 on the vernier scale until one of the vernier lines is precisely aligned with one of the lines on the handle, the fourth line on the vernier scale in the figure above. This is the tenths of a millimeter. The culmen length in this example is 11.4 mm.

Measure the depth of the bill (Fig. 3) by placing the movable arm of the calipers at right angles to the culmen at the point where it meets the feathers. Have the calipers open so that you can slide the immovable arm below the bill and close the calipers until the arm just touches the lower mandible directly below the point where the feathers meet the culmen. Read the depth from the scale on the calipers and the vernier scale.



Figure 3. The movable arm is at the point where the culmen ends in feathers and the immoveable arm is where the lower bill and feathers of the throat meet.

Measure the width of the bill (Fig. 4) by opening the calipers wider than the bill placing



Figure 4. The arms of the calipers are closed on the sides of the bill level with the point at which the culmen meets the feathers of the forehead.

one arm against the side of the bill level with the point where feathers and bill meet and closing the calipers until the opposite arm just touches the opposite side of the bill. Read the width from the scale on the calipers and the vernier scale.

Sum the dimensions to get an index of bill size.

Class data. --

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Student	House Sparrow bill			Sum of dimensions
	Length	Depth	Width	

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How might differences in bill dimensions affect foraging behavior?

How might differences in foraging behavior affect survival?

Are the length, depth, and width correlated with one another?

Rosemary and Peter Grant (1989) and Peter Grant (1981, 1999) have made measurements similar to those you just made in an effort to answer the very same questions in Darwin's Finches. Their work is described in the Pulitzer Prize-winning book "The Beak of the Finch" by Jonathan Weiner (1994).

### **Wing length**

Many variations may be benign under ordinary circumstances, but life threatening on rare occasions (Bumpus 1899, Johnston et al. 1972). Open the calipers to about 9 cm. Place the movable arm of the calipers against the anterior bend of the right wing (Fig. 5) and close the calipers until the immoveable arm barely touches the feather tip furthest from the wrist.



Figure 5. With the movable arm against the bend (wrist) of the wing the immoveable arm is closed until it brushes the feather tip furthest from the wrist.

Record the length in mm.

Class data. --

Student

House sparrow right  
wing length

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Mean length =

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What variables may affect wing length?

How would you control for one of these variables?

Under what conditions might wing length dramatically affect survival?

### **Bib length**

House Sparrows are sexually dimorphic. The male has a gray crown and nape, chestnut behind the eyes and down the neck, light gray cheeks, and black bib. The female is brown. Sexual selection refers to a process that creates and maintains characters that are used to obtain and retain mates, but are unrelated to individual survival, for example the male House Sparrow's bib is displayed prominently to the female during courtship (Summers-Smith 1963). Presumably some bibs are better than others at attracting females and repulsing rival males (Johnston and Selander 1973). We will measure variation in bib length as one characteristic of the bib.

Record the date of capture of your specimen. Use the calipers to measure from the chin at the base of the bill to the far edge of the farthest black feather (Fig. 6). Use the culmen length, as measured previously to control for the male's body size. Why is this

necessary? Divide the length of the bib by the culmen length to obtain an index of bib-length.

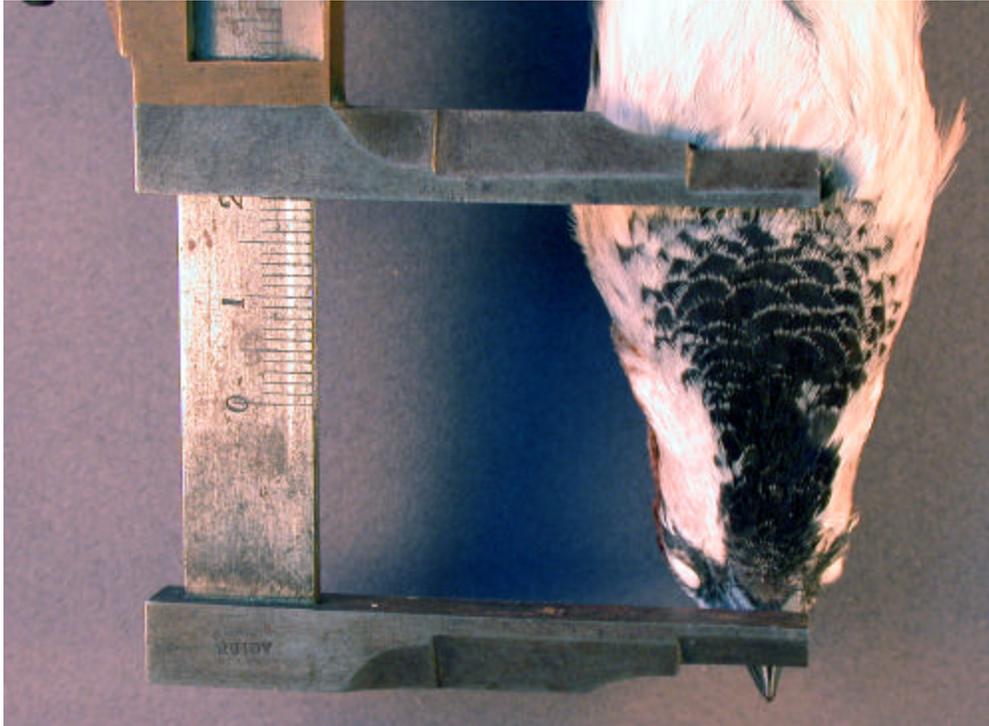


Figure 6. The immovable arm of the calipers is at the point where the lower mandible ends and the feathers of the chin begin. The movable arm is at the tip of the black feather furthest from the chin.

Class data. --

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Student	Bib Length	<u>House Sparrow</u> Culmen length	Index	Capture date
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Are House Sparrow bibs uniform in length?

Is the variation correlated with culmen length? season?

What other factors might explain variation in bib size?

Some of these questions have been studied in House Sparrows by Moeller (1988), Moeller and Erritzoe (1992), Price (1996), and Veiga (1993), but the most complete analysis of the adaptive significance of secondary sex characteristics comes from recent work on House Finches.

### **House Finches**

Female House Finches are brown-striped whereas males have a reddish wash over the brown-striped head and rump. Hill (1991, 1994, 1995, 1996; Hill et al. 1994) has shown that males must eat foods rich in the chemical precursor of the red pigment and that females can assess the foraging ability of males based on the extent and color of their red plumage. How variable is the plumage?

Your instructor will provide you with a specimen of a male House Finch. As with your measurement of the bib of the male House Sparrow (above) use the calipers to measure from the chin at the base of the bill to the far edge of the farthest, in this case, red feather on the chest. Be sure to measure the culmen length and divide the length of the red patch by culmen length to control for male size. Now look at the color guide available in the laboratory and find the chip that best matches the red color on the throat of your male House Finch. Record the hue as listed in your color guide.

Class data.--

Student	Red patch length	Culmen length	Index	Color patch
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Is the extent of color variable?

Is the hue variable?

Are hue and extent correlated?

Is the variability related to time of year? age?

What other factors may affect the extent or shade of color?

Is this an honest signal of foraging ability or could males cheat on the system? Explain your answer.

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