Modeling with Logs: Logs and Frogs, and *rigor mortis*!

As we saw in our previous lab, one of the most important jobs logs do is help us to model real-world phenomena, or variables.

Example 1. In the previous lab, the log's job was to help us to model an exponential phenomenon. Sometimes, however, it's the log that serves as the model. Here's a graph for which we might realize that a log itself might be the appropriate model:

Figure 1: Source: Freeman, S. & Herron, J. (2007). Evolutionary Analysis 4th Ed. Sexual Selection, pp 404-441.

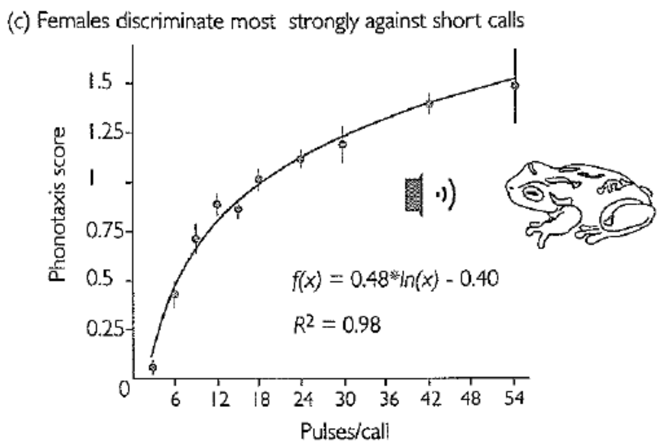


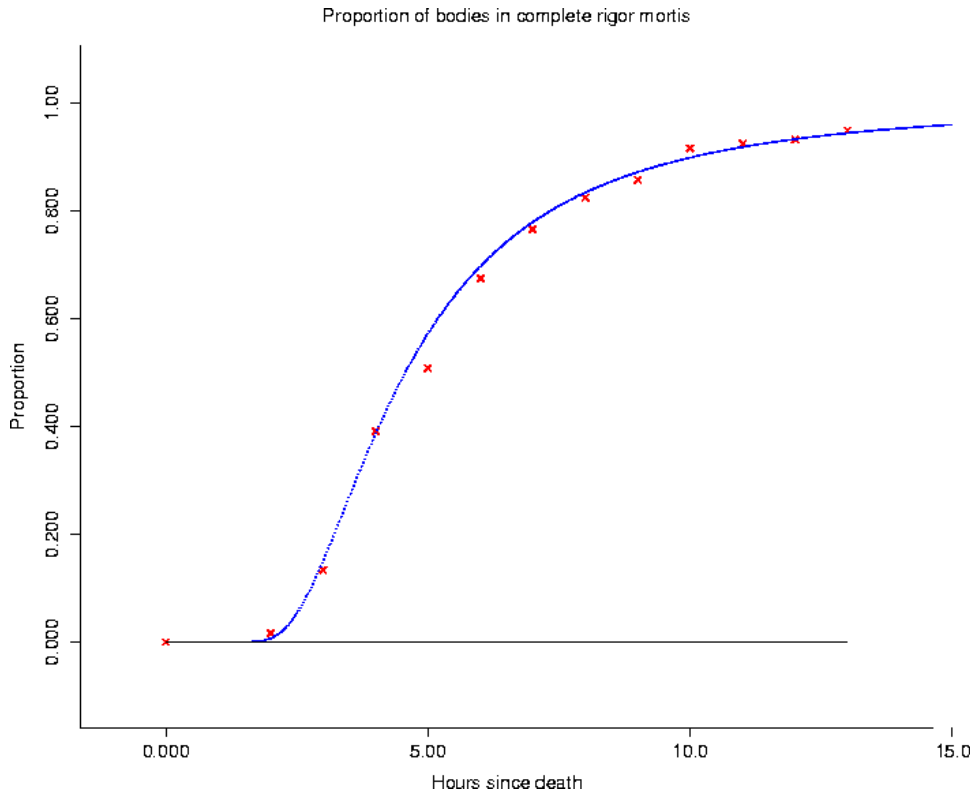
Figure 11.21 **Gerhardt et al.'s data on the preferences of female gray tree frogs** (a) Most females prefer long calls to short calls, even when the short calls are initially louder ($P < 0.001$). After Gerhardt el al. (1996). (b) Most females will pass a loudspeaker playing short calls to approach a loudspeaker playing long calls ($P < 0.001$). After Gerhardt el al. (1996). (c) Females discriminate most strongly against short calls. A female's "phonotaxsis score" for a particular test call is the time it took her to approach a control call with 18 pulses per second divided by the time it took her to approach the test call. Higher scores indicate a stronger preference for the test call relative to the control. Each data point is the average score of 10 females; the whiskers show ±1 standard error. From Bush et al. (2002).

1. What do you think of the model? What do the "error bars" contribute?

2. Do you see the "linear model"? How would we transform our data so as to get a straight line?

Example 2. When we die, our bodies become rigid (*rigor mortis* sets in). Niderkorn's (1872) observations on 113 bodies provides the main reference database for the development of *rigor mortis* and is commonly cited in textbooks. I fit a lovely model to this somewhat unlovely data, for the proportion $p(t)$ of bodies in *rigor mortis* after t hours. It is illustrated in the graph below: the model is

$$p(t) = e^{\left(-26.28/t^{2.39}\right)}$$



1. You are called to the scene of an act of genocide, and find 100 bodies strewn over the landscape. 87 of the bodies show complete *rigor mortis*. In the space above, find the time that the act occurred, as predicted by the model. (Show how you arrive at the answer – using the "solve" button on your calculator is a start, but not the end: you should be able to find the solution analytically – that is, by hand, without recourse to the calculator).

2. Compute the average proportion of bodies in *rigor mortis* in the time from 3 to 5 hours after death (write the integral, but you may use your calculator!).

3. Compute the derivative $p'(t)$ by hand, and carefully plot it in the graph above.

4. How do you interpret areas such as $\int_{t_1}^{t_2} p'(t)dt$?

5. How do we know that p is invertible, and what properties can you deduce about the inverse from the study we've done so far? (A graph would be a good way to summarize! I can think of at least five things that I know about the inverse....)

6. "Extra credit": From the graph you can guess that the limit of $p(t)$ as $t \to \infty$ is 1: demonstrate that it is so.