BONE CHEMISTRY

Now it's your turn. You are an isotope archaeologist. You have been sent a large batch of bones for analysis, but the labels on the bones have fallen off and you cannot tell which is which. All you know is that there are bones from four different places in the box: the Northwest Coast of North America, Pecos (*PAY-koss*) Pueblo in the southwestern United States, Archaic Ontario, and St. Catherine's Island off the coast of Georgia.

You decide to go ahead and analyze the samples in spite of the problems of identification. Most of the samples appear to be reasonably well preserved, and the carbon:nitrogen ratios you measure seem to confirm the quality of the collagen in the bone (Table 15.1). The carbon:nitrogen (C:N) ratio of pure, fresh collagen is 3.21. A carbon:nitrogen value between 2.9 and 3.6 is considered necessary for a sample to be reliable.

You measure both stable carbon and stable nitrogen ratios in the collagen extracted from the bone samples using a mass spectrometer. It takes a while. Table 15.1 lists your measurements.

Now it's time for some analysis. You may want to refer to the discussion of data and numbers in Chapter 7. First, look at the number to see if you notice any patterns or relationships. It's hard because there is a lot of variation. Also try to see if there are any values that appear aberrant or out of range. You may have entered a number incorrectly or perhaps there was an error in the spectrometer. These things happen all the time. Aberrant data should be deleted from the study.

Histograms

You need to draw three histograms, one for each set of data in the table: the carbon:nitrogen ratio, the carbon isotope ratios, and the nitrogen isotope ratios. Determine the range of values for each data set, the maximum and minimum numbers. Subtract the minimum from the maximum in each set to get the numerical distance. Now you need to determine how many intervals you want to see in your histogram. There is no fixed rule for this but fifteen intervals might be a good place to start. If you don't like the fifteen intervals, use another number.

Now divide the numerical distance of the range in your data set by fifteen, or the number of intervals you choose. That will give you the range of each interval. Draw a horizontal line on the graph paper and mark the left end of the line with a vertical line and write the minimum value in the data set under it. The first interval will be the minimum value in the data set plus this interval range. The second interval will be this new value plus the interval range. Continue this until you have all of your intervals marked across the line. The value on the right end of your line will be the maximum value in the data set.

Now look at each value for the data set in the table and put a mark in the interval on the line where it belongs. If you make all your marks the same size, they become a picture of your data. Stack tally marks on top of one another where there is more than one value in a single interval. The tally marks provide a visual summary of all the information in the data set.

It is important to look also for what is missing in the graph, for gaps between bars, or for significant differences in the lengths of the bars. Peaks and valleys in the graph show that there may be groups in the data. If you find groups, what do they represent?

TABLE 15.1 Measurements of bone collagen isotope ratios for carbon and nitrogen, and the carbon:nitrogen ratio for thirty-nine samples of bone.

Sample Number	C:N	$\delta^{13}C$	$\delta^{15}N$
1	3.1	−21.9	12.8
2	3.2	−12.3	10.2
3	2.9	−17.6	14.0
4	3.0	−13.8	18.2
5	3.3	−13.0	18.6
6	3.4	−14.2	17.4
7	3.2	−7.9	9.4
8	3.0	−22.1	12.6
9	2.9	−7.6	9.5
10	3.1	−22.0	12.1
11	3.5	−18.0	13.9
12	3.0	−12.8	18.2
13	3.1	−19.2	12.3
14	3.2	−12.5	18.1
15	3.3	−19.4	13.5
16	3.5	−13.1	10.1
17	3.0	−21.8	11.0
18	3.2	−21.4	10.8
19	3.3	−12.3	18.2
20	3.2	−7.7	8.6
21	3.1	−17.6	13.5
22	3.5	−12.1	18.3
23	3.6	−7.9	9.9
24	3.0	−7.4	8.4
25	3.3	−21.5	14.0
26	3.2	−7.1	10.3
27	3.4	−7.5	9.1
28	3.1	−14.2	11.1
29	3.3	−19.8	11.2
30	3.4	−14.3	10.1
31	3.0	−4.4	13.9
32	3.3	−16.3	10.0
33	3.1	−13.8	9.5
34	3.5	−7.5	9.5
35	2.9	−6.9	10.2
36	3.5	−19.5	11.6
37	3.1	−7.8	9.6
38	3.2	−13.9	9.2
39	3.2	−19.4	12.1

Scatterplots

Now you need to make some scatterplots of the data, comparing two variables simultaneously. Draw two lines on the graph paper, one horizontal and one vertical. The vertical line should rise from the left end of the horizontal line. The horizontal line will be the carbon isotope values. Mark the left end of the line with the minimum value in the data set and the right end of the line with the maximum value. You will need to indicate some of the values for the grid lines between the minimum and maximum values to make it easier to plot the bone samples. Now do the same thing for the nitrogen isotope values along the vertical line. Minimum value at the bottom; maximum value at the top. Put values on some of the grid lines in between.

Now you are ready to make a scatterplot. Look at the first sample; read the value for carbon isotopes and find this point on your horizontal line. Now read the value for the nitrogen ratio for the same sample. Find this point on your vertical line. Now draw an imaginary horizontal line from your nitrogen value and an imaginary vertical line from your carbon value. Mark a dot or small circle at the point where those two imaginary lines cross. Now you have reduced two numerical values to a single point on the graph. Continue this process for the rest of the bone samples. You should end up with one dot on the graph for each sample.

Now think about this—it's time for interpretation. What does this scatterplot of isotope data tell us? Do you see distinct clusters or linear patterns? If so, what do these mean?

Back to the Start

You received a box of bones with mixed-up labels indicating they came from four different places: the Northwest Coast of North America, Pecos Pueblo in the U.S. Southwest, Archaic Ontario, and St. Catherine's Island off the coast of Georgia. We know a bit more about these places from the archaeology that has been done. The Northwest Coast Indians were hunter-gatherer-fisher people living on the Pacific Coast of Washington state and British Columbia. Seafood was an important part of their diet and salmon were captured in huge numbers in the summer and fall. They also ate land mammals and some plants. The Pecos Pueblo site in New Mexico was occupied in the fifteenth century AD; corn, beans, and squash were major components of the diet along with some meat. Corn is a tropical plant introduced from Mexico and has a less negative carbon isotope ratio than most temperate area species. Archaic Ontario refers to groups of hunter-gatherers living in the temperate forest and lake regions of Ontario, a very long distance from the sea. These groups date from a time before agriculture and would have subsisted on wild game and plants and fish from the Great Lakes. St. Catherine's Island along the coast of Georgia is a sea island on the Atlantic shore with a Spanish mission dating to around 1700. Excavations at the site uncovered the graves of many Native Americans and a few Franciscan friars who were buried there. Their diet probably included a predominance of corn and seafood as well as a variety of wild plants and animals.

Given your analysis of the isotope data and this information on the sites, what sense can you make of the data in your scatterplot? Please answer each of the following five questions in a brief paragraph.

1. Did you find any aberrant data in your measurements? What did you do?
2. What did you see in the histograms you made? Were there any clear patterns?
3. Did you find any linear relationships? Please describe any linear patterns in terms of the specific points on the line and its location.
4. Did you find any clusters or groups in your scatterplot? How did you distinguish groups? Please describe the groups in terms of the range of values and the number of members of each group.
5. Can you make a reasoned guess about which of the four places that you know are present can be distinguished in the groups that you found?

If you want to know more about bone chemistry and isotope studies, you might take a look at the article by Schoeninger and Moore (1992) listed in the Bibliography.