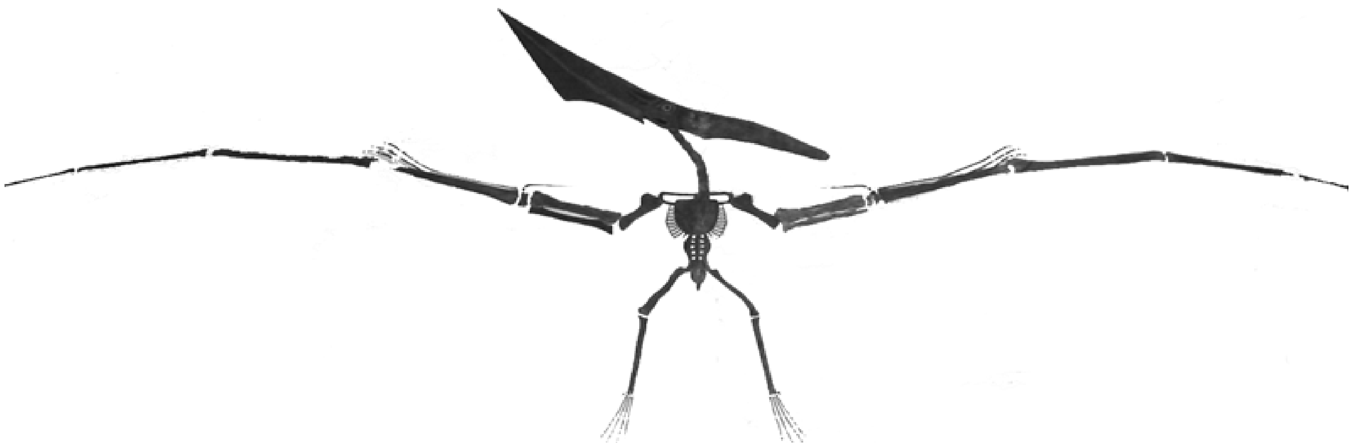
THE EARTH AND LIFE THROUGH TIME:
Laboratory Manual



Rewritten by Amy C. Smith

Based on Earth and Life Through Time, Laboratory Manual, edited by Frederick A. Sundberg and Norman L. Gilinsky (1988), with additions by Susan Barbour Wood, David Rodlans, and Jennifer Stempien (2003)

Illustrations by Kathryn A. Hawkins, Susan Barbour Wood, and Amy C. Smith

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Lab 7: Biostratigraphy

In biostratigraphy, fossils are frequently used as an additional tool in the chronological correlation of rock strata and geologic events. Sometimes a fossil taxon is restricted to specific environments, such as nearshore lagoons, but it survives for millions of years. The fossils of species that fit this profile are good environmental indicators and can be used as part of lithologic or environmental correlation. On the other hand, some fossils represent species that were very short-lived but extremely widespread, and can be found in many different environments during a brief interval of geologic time. These are useful for understanding the chronology of the depositional setting. In fact, early chronological correlations of geologic strata were performed entirely on the basis of faunal correlation and index fossils. Each of the eras and periods of geologic time are distinguishable from one another partly on the basis of their fossil assemblages, due to the ongoing processes of species evolution and community change through time.

Lab Objectives:

- Apply fossil identification skills learned in Lab 6 to figure out which taxa comprise given assemblages, then use the combination of time periods of these taxa to assign a specific time period to each assemblage.
- Relate assemblage ages to their corresponding lithologies in a stratigraphic column and use geologic principles to determine if the assigned ages are logical.

Fossil taxa that are useful for chronological correlation are called **index fossils**, and by definition have several important characteristics. First, they must be readily preserved and easily identified and distinguished from other taxa. The index fossil should also be relatively common and distributed widely among different depositional environments because any environmental restrictions of a taxon limit its use in correlation. A chronologically useful fossil taxon should have existed for only a short period of time before going extinct or evolving into a new form. For instance, because ammonite lineages often lasted less than one million years, while inarticulate brachiopods have been around since the early Paleozoic, ammonites are better index fossils than are inarticulate brachiopods.

Each taxon has a stratigraphic range (Figure 7.2), which is a distribution in sedimentary units that corresponds to the interval of time during which the taxon was alive. The base of a taxon's range corresponds to its first (lowest) appearance in the geologic record, which must post-date the evolutionary origin of the lineage. The youngest (highest) appearance in the geologic record is the top of its stratigraphic range, and represents its last known occurrence. Often the last occurrence of a taxon is due to its sudden extinction (as with the dinosaurs), but sometimes it is simply because the geographic or environmental conditions change in such a way that the animal no longer lives in an area where it is likely to be preserved. A classic example of this is the coelacanth, a lobe-finned fish that made its last fossil appearance in the Cretaceous, but remains alive today in isolated parts of the Indian Ocean. Sometimes these disappearing-reappearing fossil lineages are called "Lazarus taxa", referring to their apparent 'rise from the dead'. Even more bizarre are "Elvis taxa", which 'imitate' the appearance of an extinct lineage but are not actually related.

Biostratigraphers often subdivide units into **biozones**, stratigraphic units defined by their faunal composition, regardless of lithology. Sometimes these are defined by a single index fossil, but there are a variety of other types of biozones as well. It is possible to narrow the stratigraphic resolution of a given unit by looking at assemblage biozones. This process combines range data where the ranges of index fossils overlap (Figure 7.1). In other cases, the relative abundance of a taxon may be used to define a biozone. This lab, however, will deal only with assemblage biozones.

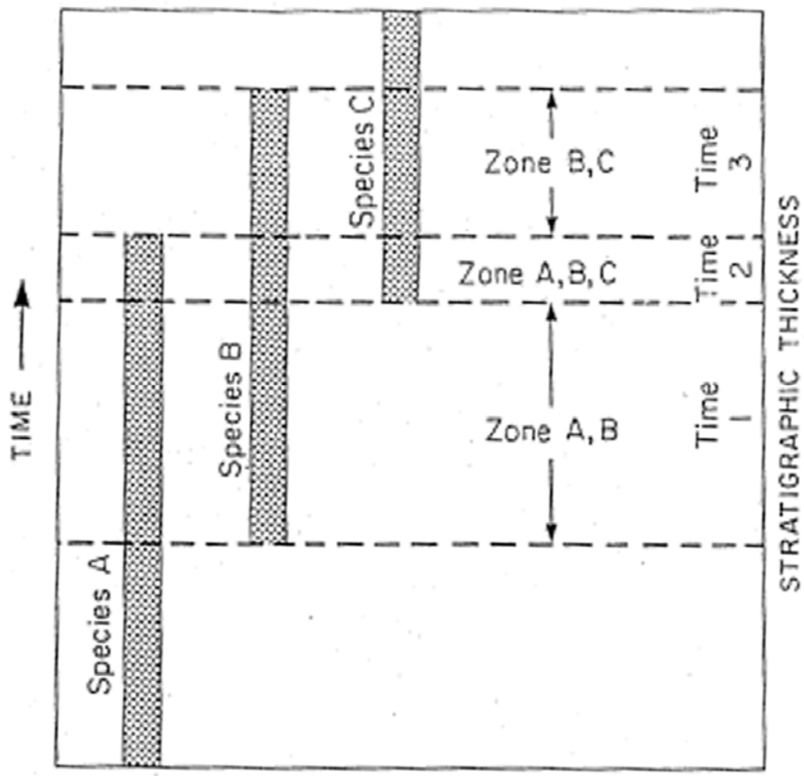


FIGURE 7.1. Time ranges of three hypothetical taxa within a given assemblage, with the three assemblage biozones differentiated. In this case, the age of the assemblage is Time 2 because this is the only time period in which all three taxa are present.

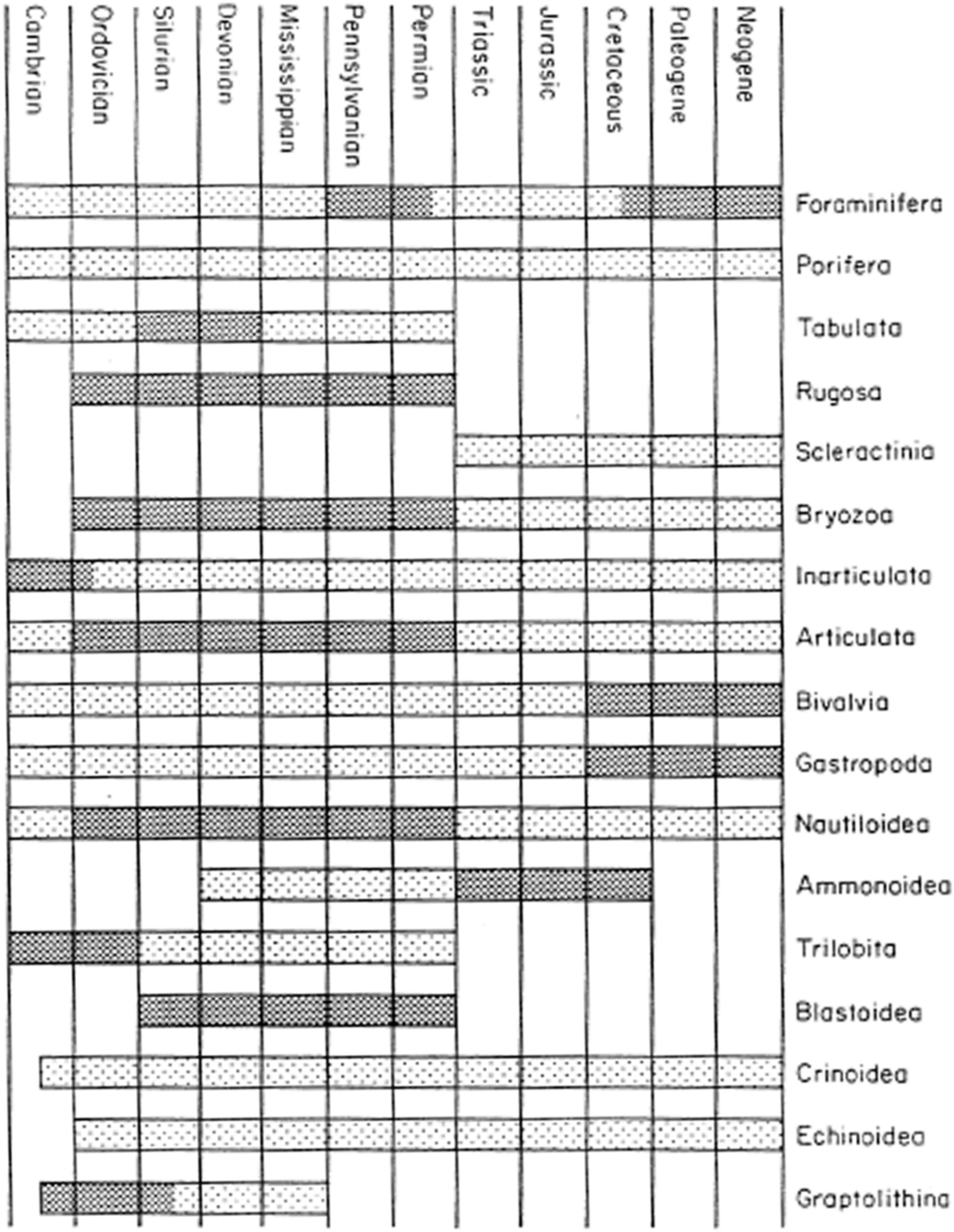


FIGURE 7.2. Stratigraphic ranges of major invertebrate fossil groups. The dark bars are more useful for narrowing down ages and should be considered first when analyzing the age of an assemblage. The light bars denote occurrence but are less useful for specific age determination.

Exercise 7.1: Determining the Ages of Rock within a Single Column

Using information and identification skills gained from Lab 6, identify and list all of the specimens contained within each assemblage. Once all fossil specimens have been identified, use the biostratigraphic chart on page 71 to determine the period or periods during which all members of the assemblage lived concurrently. Please narrow down to as specific a time as possible.

Assemblage 1

Fossil Types:

Age:

Assemblage 2

Fossil Types:

Age:

Assemblage 3

Fossil Types:

Age:

Assemblage 4

Fossil Types:

Age:

Assemblage 5

Fossil Types:

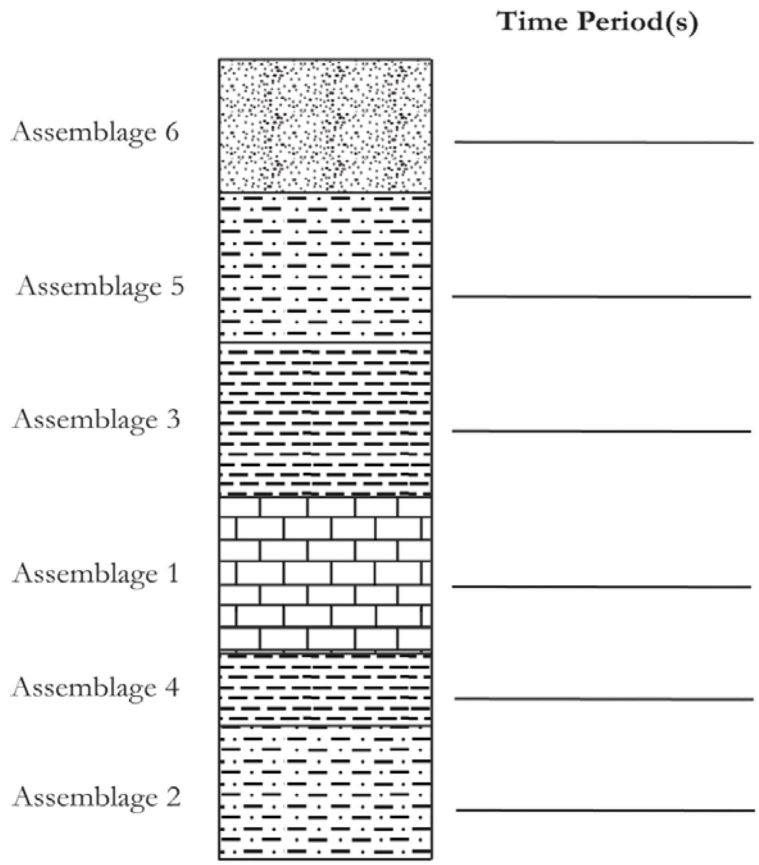
Age:

Assemblage 6

Fossil Types:

Age:

Below is a stratigraphic column representative of the outcrop from which the differenet assemblages were collected. On the provided lines, label the age(s) of the lithologic unit corresponding to each assemblage. Next, answer the questions below.



1. Is the sequence of ages in the stratigraphic column logical? Why or why not?

2. Are there regressions or transgressions taking place through time? Identify all transgressions and/or regressions, bracketing them with the time spans over which they occurred.

3. When did the maximum regression and/or transgression occur?

4. If assemblage 1 and assemblage 3 switched places with each other, would the sequence of ages within the stratigraphic column still make sense? Why or why not?

5. If assemblage 2 and assemblage 4 switched places with each other, would the sequence of ages within the stratigraphic column make sense? Why or why not?

6. Why would a lithologic unit be able to represent the same period as then one below it?

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