

**Assignment 1:**  
**Fasteners as Fossils: A Screwed-Up Situation**

*Due date: 4:00 p.m., Friday, March 10, 2006*

*Hand in to drop box outside B&G Rm. 118*

**Introductory Comments:**

This exercise is designed to illustrate the challenges of interpreting the fossil record. It will also hopefully give you an appreciation of the relationships between form and function of organisms and how fossil organisms can be used to interpret aspects of the environment in which they lived. Lastly, we will consider how an investigator's preconceptions of how fossil assemblages represent might influence the way he/she ultimately interprets the available data and the importance of considering other interpretations.

**The Scenario**

It is 1 million years in the future. Humans, once the "ruling organisms" of Earth are now extinct; it is suspected that they became too specialized for their own good and could not adapt to changes in the environment brought about by war, resource depletion and disease. Since the demise of humans, cockroach intelligence has increased to a level on par with that of the now-extinct humans.

An honours graduate from Six Legs Academy, you have been conducting paleontological research on the evolutionary history of an enigmatic group of organisms called the Fastenerzoa (more commonly called fasteners). The metallic remains of these organisms have proven effective as index fossils of the human age (the Plasticene epoch). The morphology of fasteners varies widely, ranging in shape from simple spikes to complex loops. Both solitary and colonial forms have been documented.

**Ecological Aspects of Fasteners**

The traditional view held by the majority of the scientific community is that fasteners were more or less sessile organisms that lived a variety of substrates, including wood, metal and composite materials. The simplest species of fasteners bored into hard substrates, producing rigid structures to support their large colonies. Humans apparently took advantage of the stability of these rigid structures, ultimately using them for dwellings, livestock partitions and storage facilities. Some of these organisms apparently coevolved with robust creatures (collectively called "tools") that, according to rare inscriptions found on their bodies (presumably a form of tattooing) were divided into three main families: *hammers*, *screwdrivers* and *staplers*. More delicate fasteners are speculated to have become so domesticated by humans that they depended on humans to provide suitable substrates for their survival, namely thin sheets of wood pulp.

**Materials**

The fasteners have been sent to you in a sealed plastic bag, accompanied with a schematic depiction of the stratigraphic occurrence of each assemblage (assemblage 1, 2, 3 and 4) and the names of species (A through O) within each assemblage. Consistent with stratigraphic convention, the assemblages are numbered in ascending order relative to their stratigraphic occurrence. In other words, Assemblage 1 (at the bottom) is oldest and Assemblage 4 (at the top) is youngest. Unfortunately, no information was sent to you regarding specific characteristics of the sedimentary deposits from which fossils of the four assemblages were collected, so you only have the fastener fossils for interpretation.

**Your Mission**

***Part 1. Identifying possible evolutionary relationships among taxa***

In this part of the assignment, you will interpret the fasteners as organisms that were capable of evolving through time. Based on comparisons of the morphology (shape) of the fasteners (both general form and "ornamentation" such as threads, indentations, etc.), draw an evolutionary tree that links the numbered fasteners in assemblage to the most likely ancestor in the preceding assemblage (obviously, you can only do this for Assemblages 2 through 4). You can ignore differences in the composition of the fasteners for this part (only focus on morphology). To make the task easier, each "species" in assemblage 2 through 4 has a logical ancestor in the preceding assemblage. Keep in mind, however, that a single ancestor can give rise to more than one descendent species. Also, it is assumed here that the appearance of new species is accompanied by the extinction of its ancestor (actually rather rare in nature). It is also possible that some species went extinct without giving rise to descendent species. **6 marks.**

Now justify your reasoning for each evolutionary link illustrated in your evolutionary tree (e.g. origination of species C from A, origination of species E and H from species C, etc.). In other words, explain why one species more likely to be an ancestor of a given fastener than others, focusing on the link with the minimal number of changes in form required. If referring to specific fastener characters, discuss them in context of the fastener head (where applicable), shank(s), and tip(s). Two or three sentences for each link will do. **12 marks.**

***Part 2: Investigating the functional morphology and ecology of fossil taxa.***

In this part of the assignment, you will relate the morphology of the fasteners to their function. It is unlikely that any information (in printed or audio-visual form) would survive for 1 million years, so we will cheat a bit here. You have access to a variety of information sources that can aid you in identifying what each of the fasteners is used for, including your general knowledge, books, brochures, catalogues, and your local hardware store. Based on your research, explain the function of each type of fastener and **how the morphological characteristics of each fastener relate to its function.** Discuss features of the shank(s), head (if present) and tip (s), and possible significance of the size of the fastener (where applicable). **24 marks.**

***Part 3: Environmental conditions represented by assemblages***

Reconstruct the “environment” represented by each assemblage, based on the known functions of their constituent fasteners (as you determined in part 2) and the composition of the fasteners (i.e., what the fasteners are made of). Name this environment as specifically as you can (e.g. wall, floor, living room, barn). Environments can represent an entire structure (e.g. barn, fence, etc.) or a smaller component of a structure (e.g., wall, floor, ceiling, etc.) of a larger structure (e.g., house). **8 marks.**

***Part 4: Possible alternative interpretations of assemblages.***

Clearly, the interpretation that differences in the species composition of successive fastener assemblages manifest the effects of evolutionary change and extinction is based on the fundamental assumption that fasteners were once-living things. Now suppose that fasteners are essentially “trace fossils” (or artifacts if viewed in the archeological sense) that record the activities of organisms (humans in this case) rather than representing actual remains of organisms. This completely changes the time context for the four assemblages examined because the long time required for evolutionary change is irrelevant. Consider the possibility that the sedimentary strata containing the assemblages were deposited in a much shorter period of time than that implied in the traditional cockroachian approach to interpreting fossil assemblages. Three alternative interpretations are provided here:

- a) Single event burial interpretation: Perhaps the succession represents fastener habitat differences within a single human dwelling that was catastrophically buried and collapsed during a single event and that the four assemblages merely reflect the natural tiering of habitats (e.g. floor under walls under ceiling under roof).
- b) Multi-event burial interpretation. Perhaps the succession is the result of four events of deposition involving material that was imported from different habitats and from different localities (e.g. in a landfill site).
- c) Multiple colonization interpretation. Perhaps the succession represent four separate construction events, in which structures were repeatedly leveled and rebuilt (e.g. barn replaced by house replaced by apartment complex).

Discuss the evidence provided in the assemblages both for and against each of these three alternative interpretations (a short paragraph for each).

Assess the plausibility of these three interpretations based solely on the data at hand in two or three sentences each. **6 marks.**

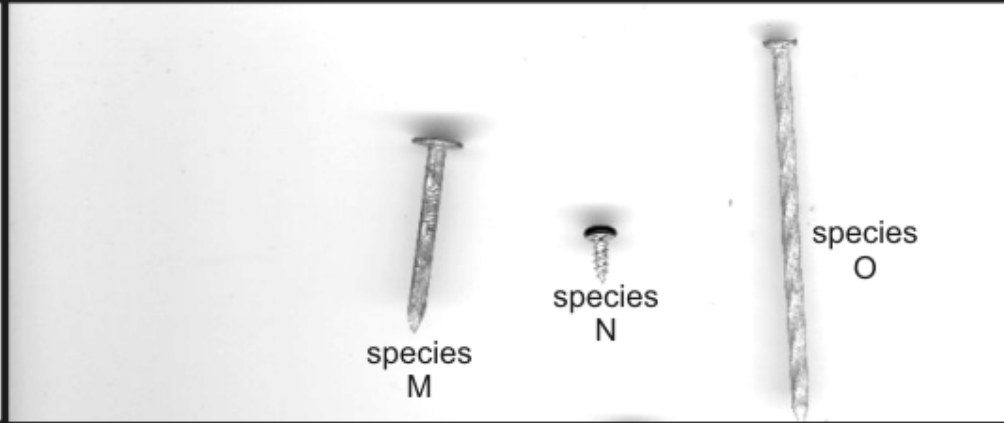
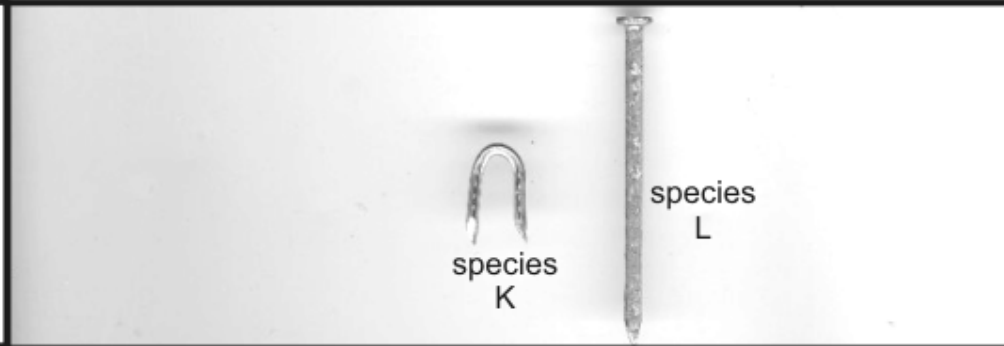
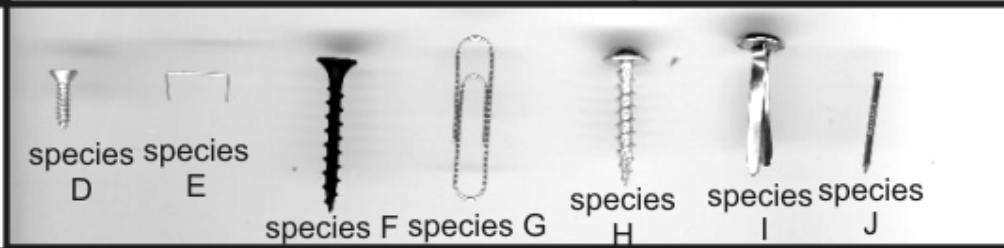
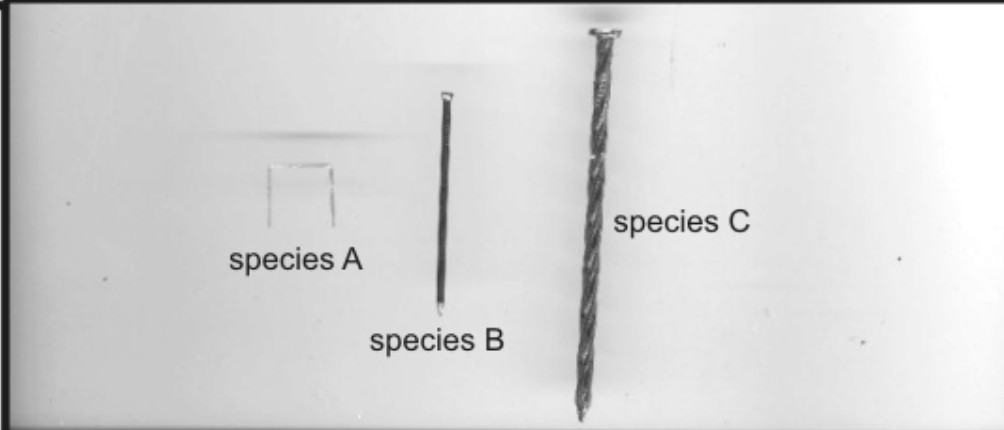
***Part 5: Suggestions for future studies***

Hopefully by now, you have come to appreciate the very different ways in which fossils can be interpreted, and the impact that an investigator’s preconceptions can have on such interpretations. Suggest two additional types of information that might allow you to support or refute the original interpretation described in Part 1, explaining why such information would influence the credibility of this interpretation. **4 marks.**

**Total Marks: 60**

# Identification Key for Fasteners in Assemblages 1 to 4

younger  
↑

Assemblage 4	 <p>species M      species N      species O</p>
Assemblage 3	 <p>species K      species L</p>
Assemblage 2	 <p>species D    species E    species F    species G    species H    species I    species J</p>
Assemblage 1	 <p>species A      species B      species C</p>

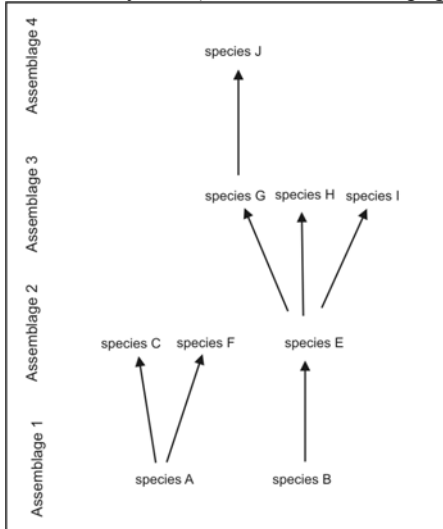
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## **Instructions for Format of Report**

Your report should be divided into easily identifiable sections with the following subheadings (in bold)

### **Part 1: Identifying possible evolutionary relationships among taxa**

Provide evolutionary tree in diagram form and justification for the ancestor-descendent relationships. Your evolutionary tree (which should fill a page) should look something like this: (note: this is only an example):



For the second part of this question, systematically explain the links in your evolutionary tree (note: this can only be done for fasteners in assemblages 2 to 4)

For example:

Assemblage 2 Species

- Origination of species C from A  
(explain)
- Origination of species F from A  
(explain), etc...

### **Part 2: Investigating the functional morphology and ecology of fastener taxa.**

Relate form of fasteners to their function

For example:

Assemblage 1 Species

- Species A.  
(explain)
- Species B  
(explain), etc.

### **Part 3: Environmental conditions represented by assemblages**

Interpret the environment indicated by characteristics of fasteners (as indicated in the assignment outline).

### **Part 4: Possible alternative interpretations of assemblages.**

Discuss plausibility of each of the three alternative interpretations as described in the assignment outline in two or three sentences each. Use headings: single event burial interpretation, multi-event burial interpretation, multiple colonization interpretation to denote discussions of each interpretation.

### **Part 5: Suggestions for future studies**

(See instructions in outline)

*Note: No references are required for this report, but will be necessary in the final assignment (term paper).*