

## **Research projects in Biology Evolving Communication, Winter 2008**

Research projects in biology should comprise your own original hypotheses and logical arguments, supported with extensive review of the existing research (“literature”) alone, or with a literature review and with original data of your own generation. These two very different sorts of projects are outlined below as “Review Papers” and “Field Projects.”

### **Two Types of Projects:**

#### **Review Papers**

Generate a question about something in biology (evolution, animal communication, human culture...) that has some relevance to the central theme of this program: communication. Preferably, this will be a question about which researchers are still unsure of the answer, or about which some people feel certain that they know the answer, but about which there is considerable debate. Once you have a question, do some preliminary research, and begin generating hypotheses that might answer the question. You will work alone on these papers, but are encouraged to collaborate with others to generate ideas, share resources, research ideas, etc.

A review paper, or literature review, is a critical, interpretative synthesis of already published research (the primary literature) on a topic of your choosing. In your review paper, your aim will be to find, organize, and evaluate previously published material, considering the progress of current research toward clarifying an unanswered question.

A successful review paper:

1. Defines and clarifies the question or problem (often an observation)
2. Identifies and/or poses all possible hypotheses that might explain the observation.
3. Identifies all of the kinds of arguments that have been made for and against each of the possible answers: What does the evidence look and sound like?
4. Concisely explains the relevance of previous investigations in order to inform the reader of the state of current research: What, precisely, is the evidence?
5. Makes connections between kinds of evidence, different hypotheses, etc, that help make better sense of the issue than can already be found in the literature.
6. identifies contradictions, gaps, and inconsistencies in the literature; and suggests the next step or steps in solving the problem.
7. Contains clear indication of your own thinking, and includes not just a broad question, but a specific hypothesis or hypotheses. After all of the research that you have done, what is your position, and what is your evidence to support that position?

### How to generate topics for a review paper:

1. Look in our program texts for ideas. Examples:
  - On p14 of *Baboon Metaphysics*, Cheney & Seyfarth briefly discuss “animal cognition,” and give two references for recent reviews that interested readers can look to for more information. If animal cognition seems interesting to you, but you have no idea what *question* or *hypothesis* about it might be worth pursuing, start by getting those two review papers and getting ideas from them.
  - On pp 410-413 of Hauser, the hypotheses for the existence of sexual swellings in some species of female primates are briefly reviewed. We discussed this some last quarter, in part because this is such a good model of how to proceed with a scientific question—he has effectively begun a review paper on these pages.
2. Consider the topics that we discussed in class in Fall quarter, and generate questions from those. For all topics, you will likely need to constrain the taxa that you are discussing, for instance to birds, or mammals, or hymenopterans. Examples:
  - How does the song of sub-oscine birds differ from that of oscines (songbirds)? What ecological or evolutionary parameters might explain these distinctions?
  - Is communication between individuals without a “brain” (e.g. squid, bees) fundamentally different from that in species with a brain (all vertebrates)? If so, how?
  - How has the appropriation of the telencephalon for “higher-order processes” like memory and planning affected sensory communication in mammals?
  - Why has the vertebrate brain become lateralized? (You could pick any number of specific examples on which to focus.)
  - How do different sensory reception abilities between species affect communication? Or—how do different sensory abilities within a species affect communication?
  - How do birds (or mammals, frogs—some defined taxon) deal with the problem of communicating auditorily (visually, chemically, etc) in a noisy (cluttered, smelly...) environment?
  - Under what circumstances are naturally selected and sexually selected communication signals identical? What generalizations can you make about these? When do they differ, and what generalizations can you make about these?
  - What traits that do not at first appear to be “handicaps” can in fact be best understood as such? Why?
  - Why and under what ecological circumstances would females copy the mate choice of other females, rather than make their own independent choices?
  - What is communicated through dominance hierarchies? What is maintained through them? Who benefits from the presence of dominance hierarchies.
  - Under what circumstances are maternal and paternal interests likely to be so divergent, that genomic imprinting is predicted to be the most likely? Why?
3. Take almost any question in animal communication and apply Tinbergen’s four approaches to it, in a rigorous, hypothesis-driven way (see Hauser, notes from 10/10/07, or the alternate final exam from Fall quarter).

## Field Projects

If you are really itching to get outside and generate your own data, and you have a partner in crime who is ready and willing and in our program, and at least one of you has prior experience conducting independent field research (even better if one of you has some statistics background), then you may consider a field-based research project. Be aware, though, that it is Winter, and field conditions are less than optimal. The taxa that you are most likely to find in enough abundance to work on in the wild are amphibians, thatch ants and a few other inverts (but only on sunny days), and non-migratory birds. You could also do a zoo-based project, but need to consider the additional time and money that that will involve, given that we don't have any zoos in Olympia.

As with review papers, you need to begin with a question or observation, pose hypotheses, and then try to figure out what the evidence will look like. In a field project, however, the evidence will come both from the literature, and from your own empirical results, so you will also need to design experiments or careful observation protocols. Because this is not a field biology program, I don't have time to teach methods or statistics. You will be getting an introduction to sound recording and analysis in weeks 2 and 3, however, so you might conduct playback experiments, e.g. in which you record calls of some species, and play them back to other members of the species in order to test a particular hypothesis.

Your completed paper will include a Title, Abstract, Introduction, Methods, Results, Discussion, and References Cited. Each pair of students will co-write the Abstract, Introduction, Methods, and Results for their paper, but will write individual Discussions, presumably have a slightly different list of References, and give each paper their own unique Title. In addition, pairs of students will present a single talk on their research at the end of the quarter (and will be given slightly longer to do so than for the other projects, on which people are working alone).

### **Regardless of which type of Biology Research Project you take on:**

Doing literature review / library research:

- Science Citation Index should be your primary search database. This is the best indexing database out there, and will immediately give you access to abstracts and reference lists from most of the articles you are finding. While you will often have to order the full-text of articles separately, reading abstracts from many papers is a great way to start a research project.

Citation of papers:

- Do not summarize each paper that you cite. The authors of the paper have already done that for you, with an abstract. Instead, you should figure out how the arguments and data in each paper fit in to your own arguments, and very briefly explain that in your paper. Believe it or not, Hauser's style is a good model for this.
- Citation style, as last quarter, should be in APA format.

Length of paper and Number of references:

- A paper should be as long as it needs to be to answer your question completely, logically, creatively, and rigorously, while being well-written and concise. No paper should be more than 3,500 words (not including references), and most should be substantially shorter than that.
- Literature reviews should include at least 20 references from the primary literature, preferably more. Field projects should include at least 12 references. You should look to published examples of these kinds of research for examples.
- Some people are interested in working towards upper-division science credit with these projects. If that is the case, you should identify that fact in your proposal. Also, there will be a higher bar with regard to number of references, level of scientific thinking, generation of hypotheses, and clarity and concision of writing. A paper that receives upper-division credit should not necessarily be longer than one that receives lower-division credit. The best scientific writing is concise and well-reasoned, not wordy.

## **Research Proposals**

Initial Research proposals, due at 9:00 am on January 10, should include:

1. Three possible research topics, in the form of questions and/or hypotheses, in ranked order.
2. For your top ranked topic, you should also include:
  - A paragraph explaining what you already know about this question, and what you think possible answers might be. Enumerate as many possible answers as possible.
  - A paragraph explaining your interest in this question.
  - A list of references that you already know or think you might use; you should generate at least a few of these during your preliminary research this week.
  - An indication of whether you would like to try to earn upper-division credit for this project. Some projects will not be of broad enough scope for upper-division credit.

Final drafts of research proposals, due Wednesday, January 16, should include all of the same information as your initial research proposal, but with only a single topic identified, and with changes made following suggestions from both your peers and faculty.