Advice from Two Old-Timers for Beginning Marine Biology Grad Students

Advice for New Grad Students

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Now that you are a graduate student, you are beginning your professional life as a marine scientist. Yes, you are still a student, but the transition from undergrad to grad is a significant one. Because many new grad students are unsure about what to expect or what they should focus on as they begin their graduate education, I've taken this opportunity to jot down some things that come to mind. Following my recommendations is an excellent narrative addressing your graduate research experience by Dr. Ray Birdsong of Old Dominion University. After our thoughts and suggestions, I offer some advice regarding your writing skills.

Above all, don't hesitate to ask questions...from faculty members, researchers, and veteran grad students. They've all been where you are right now and they remember their concerns about classes and research and about the graduate experience as a whole. They will be happy to answer any of your questions — after all, you will be doing the same in the not-too-distant future.

Here are some things to keep in mind as you begin your professional education:

1. All of the graduate students who entered the program with you are facing the same things you are, so be mutually supportive, not competitive. Don't isolate yourself from students, faculty, or other researchers. If there is a Graduate Student Association, be an active member — the mutual support, sharing of problems & achievements, and camaraderie will be both enjoyable and rewarding.

2. As a graduate student, expectations will be higher for you than was the case when you were an undergrad. You will find yourself being treated as a junior professional, "talking shop" with your profs and other professionals. Therefore, make sure you act as a professional would: organize your time well, expect to work harder than you did as an undergrad, have exacting self-discipline, and develop very high personal expectations.

Also, develop the capability of “creative intelligence” — don’t examine a topic or scientific publication superficially; evaluate with a critical eye any research methods that were used, think about the implications of the results, whether you agree or disagree with conclusions that are expressed, etc. Scientists are skeptical folks who think outside of the box and think creatively.

3. As a budding professional, ensure that all of your correspondence with profs, scientists, and others with whom you will interact is well written and free of any grammatical and spelling errors…*this includes e-mails!* Many of these people will know you only through your correspondence; therefore, you want to make as professional an impression as possible. Writing sloppy e-mails (or letters) suggests to anyone receiving them that you consider the message to be of minimal importance and that you may, in general, operate under the adage of “good enough” rather than “the best I can do.” You don’t want to take the chance of anyone reaching that conclusion.

4. Sometime during your second semester, plan to connect with a professor under whom you will do your research. What you should plan on doing during your first semester is contacting each prof who seems to be doing research that sounds interesting, let him or her know that you’d like to make an appointment to talk about possible research projects, and then do so. Ask each faculty member to suggest possible research projects, find out if there is any money available (through a grant) to support you if you were to do the research, and also ask...if one or more of the research projects sounds appealing...if that prof is open to accepting a grad student if your interests turn out to be in his or her area of research focus. Also ask the advice of veteran grad students. They will give you the low-down on which prof’s would be good to talk with — in essence, who among them have a good reputation among students and who have a quite different reputation.

5. Once you have a research problem roughed out and you have about four faculty members who have indicated a willingness to be on your advisory committee, prepare an outline of your research project and call a meeting of your committee to chat about it. Don’t wait until you have a formal proposal put together to have such a meeting — you want your advisors’ advice sooner rather than later as you develop your research design. Meeting with them together as a group enables all of them to share ideas with each other, something that won’t occur if you simply see them individually.

6. After you receive your degree, you’ll be considered an expert on the subject of your thesis research, which of course you will be. But you will also be expected to have a broad, non-superficial knowledge about marine biology as a whole, as you would expect from someone who has a graduate degree in marine biology. Therefore, avoid tunnel vision. Just because your world revolves around the ultrastructure of blue crab ovaries doesn’t mean that is the only thing you should focus on. You will be learning a great deal outside of class that will be of great importance during your career. In the library will be large numbers of professional journals — take advantage of those. You should establish a reading program while you are in grad school...indeed, for the rest of your career. For example, I suggest you use a 3x5 note card for each journal and record on each card the issues you’ve perused (for example, during my career I surveyed over two

dozen journals). Read or skim those papers that sound interesting, even if they have no obvious connection with the subject of your research. You'll be surprised how much you'll learn that way. And don't restrict your reading to journals. If you are doing research on the taxonomy or growth of a particular species of fish, for example, scan the fish section on the book racks in the library and pull off and read portions (or the entire text) of ichthyological books that seem interesting. When you leave grad school, you will be considered to be a marine ichthyologist, not simply a snapper biologist. Also look through general marine biology books. For example, there's an excellent series called *Advances in Marine Biology* that comes out with a yearly volume (which summarizes what is known to date about several specific marine topics)— check it out — you may notice that one or more of the topics it has covered is of interest. It is important to note that similar broad marine biological learning should be take place if you are working on a molecular or cellular level. Keep in mind that you are getting a degree in Marine Biology, not Biology – just because your interests lie in the area of genomics, second messengers, transcription factors, or cellular effects of PAHs doesn't change the fact that you will be expected to have a broad and expert understanding of marine biology.

7. Attend as many professional seminars as you can. I cannot emphasize enough how much you will learn by doing this.

8. Plan to join appropriate professional societies. Your major advisor, as well as other faculty members and grad students, can advise you on which ones would be appropriate. Dues are cheaper for grad students. Attend society meetings, meet and mingle with the professionals and fellow grad students you will meet, and, when your research reaches an appropriate point, present a paper at a meeting. Making such professional contacts and learning about current research being done (with an opportunity to discuss the research with the researcher) are important.

9. An excellent, though inexpensive, guide for graduate students is the very popular *A Short Guide to Writing About Biology*, by Jan A. Pechenik (Pearson Longman Publishers: http://www.ablongman.com); its fifth edition was published in 2004. It includes valuable information about writing term papers, publishable papers, research proposals, and professional resumes; using statistics and spreadsheets; and preparing poster and oral presentations. I highly recommend purchasing it.

10. You don't want to make a career out of being a grad student. Therefore, try to finish your program expeditiously so that you can move on with your career.

11. Finally, not withstanding all of the above, have fun and enjoy your graduate-school experience. Many professionals say that the most enjoyable times in their lives were spent in grad school. The thrill of gaining knowledge about exciting things that interest you and the warm camaraderie with your fellow students and profs will make for a wonderful time in your life. You'll work your butt off, no question about that, but you can also have the time of your life. Enjoy!!

A Brief Primer for the Beginning Researcher

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After a number of years of guiding and assisting students through their first research attempts and remembering the agonies of my own research beginnings, I have attempted here to put down a few of the lessons I have learned with the hope that they will help the beginner over the initial rough spots.

There are no great revelations here, just statements of the obvious; however, it is the obvious that is so frequently overlooked by the would-be researcher.

Successful research stems from four basic components:

1. Organization and logical thinking
2. Ingenuity
3. Insight and experience
4. Hard work

There is little that I can say about most of these components. Experience comes with time; insight is born of experience and intelligence; ingenuity is simply creative intelligence; and hard work is hard work. It is organization and logical thinking that is the main thrust of this discourse for it is in these that many beginners fail and without these, ingenuity, insight, and hard work cannot be effectively and efficiently applied to the solution of a research problem. Furthermore, it is a shortcoming that is remediable.

What is the question? Research is basically posing a question and finding an answer through some logical course of observations or experiments. The initial step in any research endeavor is to pose a question and not just any question will do. The question may be a very general question to begin with, but it must be asked in such a way that some goal is implied. "What about photosynthesis?" is not such a question! Nor are such statements as, "I want to study photosynthesis." Interrogatives and statements such as these are expressions of interest and desire, but by themselves cannot form the basis of a research plan because they do not imply any goal and suggest no specific course of action.

Divide and Conquer. Almost any scientific question that might serve as the basis of a research project is likely to be divisible into subquestions. The more specific the question, the more specific the action is likely to be which will provide the answer. The object here is to break general questions into sub-questions and into sub-sub-questions and so on until you can come to grips with each of them by some specific action.

For example, the question, “What controls the periodicity of spawning in bluegill sunfishes?” does not suggest any specific activity by the researcher. Subquestions such as the following may be posed:

1. What is the periodicity of spawning?
2. What is the effect of difference in day length?
3. What is the effect of difference in light intensity?
4. What is the effect of difference in diet?
5. What is the effect of differences in temperature?
6. What hormonal systems are involved?
7. What sensory systems are involved?
8 Etc., etc.

These, and many other sub-questions, may be broken out of the general question. I think you will see in the sub-questions that more specific approaches, actions, and hypotheses begin to come to mind.

In all of this discussion I do not mean to imply that the researcher will be able to formulate all of the proper questions and conceive of the most appropriate approach to a solution before any research begins. Frequently, what appears to be a specific question will turn out to be more complex and must be again subdivided. Also, the answer to a specific question will often dictate the next appropriate question. Even though initial results may alter the approach, the researcher must begin with a firm starting point, a plan of attack and a goal.

Hypothesis or no hypothesis? An hypothesis is a statement that goes beyond available observations. An hypothesis must be tested. With repeated testing (attempts to falsify the hypothesis), it may be accepted as fact. If an hypothesis is not testable, then it is of little scientific use except as a thought provoker. Hypothesizing is easy; testing hypotheses can be most difficult. A good hypothesis is based on, and is consistent with, all available information that bears on it.

Although hypotheses can be formed for all scientific questions, it is not always useful to do so. Areas of scientific investigation that are at the “descriptive” stage of knowledge frequently do not require the formulation of formal hypotheses. For example, the question, “Which species of zooplankton occur in Chesapeake Bay in the spring?” does not lend itself to, nor benefit from, the formulation of an hypothesis. The question, “What factors control the seasonal occurrence of zooplankton in Chesapeake Bay?” would require the formulation of hypotheses.

What’s the plan? After posing the general question that forms the basis of the research project, the researcher should head directly to the library. The vast portion of all the necessary literature accumulation and digestion should be completed before any data gathering begins, although literature work on specific aspects will likely continue throughout the course of the project.

At this point the researcher is ready to formulate the initial specific subquestions and hypotheses and to plan experiments, observations, sampling schedules, etc. It is often more useful for the beginning researcher to outline the research plan in the form of a flow diagram. Flow diagramming will assist in the phasing of activities and will show how various sub-questions and answers fit together. Even though the plan is subject to change as the research progresses, it is essential to begin with a well-considered course of action.

Your research plan should include (among other things):

1. *Data gathering (or sampling design) and data analysis plan*. Both the form of your data and the sampling regime are intimately related to the sort of analysis that you will be able to perform. Plan your data gathering from the beginning with firm ideas on how you will later analyze the data.

2. *Logistics plan*. Consider where you are, what you have to work with, space requirements, seasonal constraints, costs, etc. in formulating your plan.

3. *Time plan*. Start out with a plan based on real time. Know where in your research progress you would like to be on given dates. This will be the most likely part of your plan to change, but it will prove to be a useful yardstick for progress and it will provide incentive.

A few Final Bewares:

1. Beginning researchers are often more “technique oriented” than “result oriented” (something I call the “I-like-to-scuba-dive” syndrome). Beware of becoming overly enamored with some apparatus or technique and trying to build a research project around it. This sort of orientation, if used as the sole basis of a research project, usually leads to the answering of trivial questions.

2. Expect a certain portion of your research efforts to be something less than fun. To be more honest, I should say, “expect some drudgery.” Hang in there — the thrill of success is usually compensating.

3. Don’t be too discouraged if your research doesn’t work out as you had planned. It never does.

Thoughts About Writing and Things To Look Out For

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Writing well will be an extremely important element in your graduate student experience, as it will be for the rest of your career. You will be writing letters, grant proposals, published papers, and miscellaneous documents. Keep in mind that many of your colleagues will know you only through what you write -- therefore, it must be done well. But don't let the importance of quality writing be overly intimidating to those of you who are concerned about how you write at the present time. I've found that writing is much like learning how to play a musical instrument -- you become good at it through a great deal of practice and experience. That means you should take great care to ensure that everything you write is as good as you can make it. As time goes by, you'll notice that it is, indeed, getting better and better. Remember, the thoughts in your mind are eloquent -- you want to make their representation on paper the same.

As a technical aid, I have included below some suggestions of things to think about as you write a paper (applicable to any significant piece of written material) as well as common errors that writers make. Many of these come from Jan Pechenik's excellent book, *A Short Guide to Writing About Biology* (see above). Refer to this list as you complete important documents and, ultimately, commit its points to memory.

1. As you outline, compose, write, and polish your paper, ask yourself the following questions:

    a. Does your title accurately reflect the subject(s) covered in your paper?

    b. Does your introductory paragraph give the thesis of your paper? Does it adequately introduce the reader to the subject of your paper and prepare the reader for the narrative that is to come?

    c. Think about the organization of your paper. Does your coverage of the subject of the paper follow a logical progression or does it seem to jump around from topic to topic? Do you need to rearrange some paragraphs so that the progression from topic to topic is more logical? As stated by Jan Pechenik (2004, pp. 37-38), "State your case, and build it carefully. Use your information and ideas to build an argument, to develop a point, to synthesize. Avoid the tendency to simply summarize papers one by one.... Instead, set out to compare, to contrast, to illustrate, to discuss."

    d. Look at each paragraph. Is there an initial topic sentence that indicates or suggests to the reader what will come in the paragraph?

e. Does the narrative within each paragraph flow? Are such devices as transitional phrases or introductory words (*e.g.*, in contrast, however, although, thus, whereas, even so, moreover, nevertheless, despite the, in addition to) necessary anywhere?

f. Is all of your writing unambiguous, precise, and accurate?

g. Are there any directly quoted passages that can be put into your own words? (Directly quoted passages should be <u>very</u> rare in a term paper for a course.)

h. Have you properly cited all statements of fact or opinion?

i. Is there a clear transition from paragraph to paragraph? Do transition sentences need to be inserted anywhere?

j. Are <u>all</u> of the citations in the text of your paper found in the Literature Cited section and <u>all</u> references in your Literature Cited section cited somewhere in your paper?

2. Watch your spelling, subject-verb agreement, word use, sentence structure, punctuation, capitalization, etc.

3. Try to be concise; don't be "wordy."

4. Do not use contractions (isn't, don't, it's, aren't, and the like) in a formal paper. It's considered poor form.

5. Do not confuse the use of "affect" (a verb) with "effect" (a noun).

6. Do not confuse the use of "too," "to," and "two," or "there" and "their" ("they're" would not be in your paper -- see above).

7. it's = "it is" (this would not appear in your paper -- see above)
its = possessive

8. "A lot" is two words; it is not "alot."

9. Watch your use of the apostrophe (...'s). It typically indicates the possessive case, not a plural. You will not be using it for contractions (see above).

10. "Develop" does not have an "e" on the end. Also note the spelling of "development."

11. It is "etc.," not "ect."

12. If you use "*et al*." when citing a multiauthored source (three or more authors) in the text of your paper, note that it is typically placed in italics (due to its foreign derivation). Also note where the period is placed. Remember that *all* of the authors must be given in the reference to the publication in the Literature Cited section.

13. *e.g.* = "for example": Molluscs include a wide variety of animals, *e.g.* snails, clams, and squid.

i.e. = "namely": Endothermic organisms include those having an elevated internal temperature, *i.e.* birds, mammals, and perhaps some dinosaurs.

Do not confuse the use of the above two abbreviations. Note that both are commonly (but not always) italicized because they come from a foreign language.

14. The word "data" is plural; "datum," which is rarely used, is singular.

Wrong use: The data collected by Jones (1993) (see Table 2) clearly *shows* that....

Correct use: The data collected by Jones (1993) (see Table 2) clearly *show* that....

15. Remember to italicize genus and species names (but not other taxa). Also remember that the genus name is always capitalized; the species name, which always has the genus name preceding it, never is. You can abbreviate the genus name (but not the species name) after you have written it out in full earlier in your paper. For example:

One of the most common amphipod species in this habitat is *Corophium acutum*. When males of *C. acutum* seek a mate, they leave their tubes and investigate adjacent tubes for the presence of females (Peterson, 1987).

16. Capitalize all taxon names, except for species. Do not capitalize any variation of the spelling of the taxon name. For example: capitalize Bivalvia, Gastropoda, Decapoda, Amphipoda; do not capitalize bivalves, gastropods, decapods, amphipods. Do not capitalize the words "phylum," "class," "order," "genus," etc.

17. Do not right-justify your paper. Manuscripts submitted for publication are never right-justified; such right-justification could confuse the "type-setter" (an admittedly archaic term) if he or she must interpret the width of spaces. (This document is not right-justified).

18. <u>PROOF YOUR PAPER WELL</u>! Paraphrasing Pechenik, a poorly proofed paper suggests carelessness or laziness on your part; it may also suggest to the reader that you take little pride in your work. Remember that the use of "spell-check" does not constitute proofing, nor will it catch all of your misspellings or typographical errors (you may misspell a word in such a way that it becomes another word).

19. As a cautionary note, beware of plagiarism! You may, of course, use quoted passages (sparingly) in your paper or manuscript, but use quotation marks and cite the source. It is customary to give the page number in the source on which the quoted passage was found, in contrast to citing the source of non-quoted information. For example, the following passage may appear in a paper (note the comma before the quoted passage if it begins in the middle of a sentence):

> *Octopus vulgaris* is commonly caught in California for the aquarium trade and for restaurants (Paulson, 1977). In Italy, there are even, "street corner stalls selling hot octopus -- served whole on a fork. At Elba, on Saints' days, half the island goes octopus fishing -- with a twig and a bent pin, and hermit crab bait" (Lane, 1960, p. 162).

Note that simply changing one or two words in someone else's sentences does not change the text sufficiently to say that it is in your own words; this “misquote” would still be plagiarism. One way to avoid plagiarism is to not use complete sentences when you take notes from your sources. This can decrease the chance of inadvertently quoting someone else.

20. Do not use teleological thinking -- this is a very important point. Teleology is giving a sense of purpose to living organisms or processes, especially to the process of evolution. This is one of the most common errors students and many professionals make in their writing; therefore, it is something you should look for in your phrasing. Jan Pechenik describes this problem (p. 12):

> Giraffes did not evolve long necks “in order to reach the leaves of tall trees.” Snails did not evolve shells “in order to confound predators.” Birds did not evolve nest-building behavior “in order to protect their young.” Insects did not evolve wings “in order to fly.” Plants did not evolve flowers “in order to attract bees for pollination.” Evolution proceeds through a process of differential survival and reproduction, not with intent. Long necks, hard shells, complex behavior, and other such genetically determined characteristics may well have given some organisms an advantage in surviving and reproducing unavailable to individuals lacking these traits, but this does not mean that any of these characteristics were deliberately evolved in order to achieve something. Organisms do not evolve structures, physiological adaptations, or behavior out of desire. [S]election is imposed on the individual by its surroundings; it never involves conscious, deliberate choice. Don't write, “insects may have evolved flight in order to escape predators.” Instead, write, “Flight in insects may have been selected for in response to predation pressure.”