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SOME MODEST ADVICE FOR GRADUATE STUDENTS
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Always Prepare for the Worst

Some of the greatest catastrophes in graduate education could have been avoided by a little intelligent foresight. Be cynical. Assume that your proposed research might not work, and that one of your faculty advisors might become unsupportive - or even hostile. Plan for alternatives.

Nobody Cares About You

In fact, some professors care about you and some don't. Most probably do, but all are busy, which means in practice they cannot care about you because they don't have the time. You are on your own, and you had better get used to it. This has a lot of implications. Here are two important ones:

1) You had better decide early on that you are in charge of your program. The degree you get is yours to create. Your major professor can advise you and protect you to a certain extent from bureaucratic and financial demons, but she should not tell you what to do. That is up to you. If you need advice, ask for it: that's her job.

2) If you want to pick somebody's brains, you'll have to go to him or her, because they won't be coming to you.

You Must Know Why Your Work Is Important

When you first arrive, read and think widely and exhaustively for a year. Assume that everything you read is hogwash until the author manages to convince you that it isn't. If you do not understand something, don't feel bad ? it's not your fault, it's the author's. He didn't write clearly enough.

If some authority figure tells you that you aren't accomplishing anything because you aren't taking courses and you aren't gathering data, tell him what you're up to. If he persists, tell hin to bug off, because you know what you're doing, dammit.

This is a hard stage to get through because you will feel guilty about not getting going on your own research. You will continually be asking yourself, "What am I doing here?" Be patient. This stage is critical to your personal development and to maintaining the flow of new ideas into science. Here you decide what constitutes an important problem. You must arrive at this decision independently for two reasons. First, if someone hands you a problem, you won't feel that it is yours, you won't have that possessiveness that makes you want to work on it, defend it, fight for it, and make it come out beautifully. Secondly, your Ph.D. work shape your future. It is your choice of a field in which to carry out a life's work. It is also important to the dynamic of science that your entry be well thought out. This is one point where you can start a whole new area of research. Remember, what sense does it make to start gathering data if you don't know - and I mean really know - why you're doing it?

Psychological Problems Are the Biggest Barrier

You must establish a firm psychological stance early in your graduate career to keep from being buffeted by the many demands that will be made on your time. If you don't watch out, the

pressures of course work, teaching, language requirements and who knows what else will push you around like a large, docile molecule in Brownian motion. Here are a few things to watch out for:

1) The initiation-rite nature of the Ph. D. and its power to convince you that your value as a person is being judged. No matter how hard you try, you won't be able to avoid this one. No one does. It stems from the open-ended nature of the thesis problem. You have to decide what a "good" thesis is. A thesis can always be made better, which gets you into an infinite regress of possible improvements.

Recognize that you cannot a perfect thesis. There are going to be flaws in it, as there are in everything. Settle down to make it as good as you can within the limits of time, money, energy, encouragement, and thought at your disposal.

You can alleviate this problem by jumping all the explicit hurdles early in the game. Get all of your course requirements and examinations out of the way as soon as possible. Not only do you thereby clear the decks for your thesis, but you also convince yourself, by successfully jumping each hurdle, that you probably are good enough after all.

2) Nothing elicits dominant behavior like subservient behavior. Expect and demand to be treated like a colleague. The paper requirements are the explicit hurdle you will have to jump, but the implicit hurdle is attaining the status of a colleague. Act like one and you'll be treated like one.

3) Graduate school is only one of the tools that you have at hand for shaping your own development. Be prepared to quit for awhile if something better comes up. There are three good reasons to do this.

First, a real opportunity could arise that is more productive and challenging than anything you could do in graduate school and that involves a long enough block of time to justify dropping out. Examples include field work in Africa on a project not directly related to your Ph.D. work, a contract for software development, an opportunity to work as an aide in the nation's capital in the formulation of science policy, or an internship at a major newspaper or magazine as a science journalist.

Secondly, only by keeping this option open can you function with true independence as a graduate student. If you perceive graduate school as your only option, you will be psychologically labile, inclined to get a bit desperate and insecure, and you will not be able to give your best.

Thirdly, if things really are not working out for you, then you are only hurting yourself and denying resources to others by staying in graduate school. There are a lot of interesting things to do in life besides being a scientist, and in some the job market is a lot better. If science is not turning you on, perhaps you should try something else. However, do not go off half-cocked. This is a serious decision. Be sure to talk to fellow graduate students and sympathetic faculty before making up your mind.

Avoid Taking Lectures -They're Usually Inefficient

If you already have a good background in your field, then minimize the number of additional courses you take. This recommendation may seem counterintuitive, but it has a sound basis. Right now, you need to learn how to think for yourself. This requires active engagement, not passive listening and regurgitation.

To learn to think, you need two things: large blocks of time, and as much one-on-one interaction as you can get with someone who thinks more clearly than you do.

Courses just get in the way, and if you are well motivated, then reading and discussion is much more efficient and broadening than lectures. It is often a good idea to get together with a few colleagues, organize a seminar on a subject of interest, and invite a few faculty to take part. They'll probably be delighted. After all, it will be interesting for them, they'll love your initiative - and it will give them credit for teaching a course for which they don't have to do any work. How can you lose?

These comments of course do not apply to courses that teach specific skills: e.g., electron microscopy, histological technique, scuba diving.

Write a Proposal and Get It Criticized

A research proposal serves many func-tions.

1) By summarizing your year's thinking and reading, it ensures that you have gotten something out of it.

2) It makes it possible for you to defend your independence by providing a concrete demonstration that you used your time well.

3) It literally makes it possible for others to help you. What you have in mind is too complex to be communicated verbally - too subtle, and in too many parts. It must be put down in a well-organized, clearly and concisely written document that can be circulated to a few good minds. Only with a proposal before them can they give you constructive criticism.

4) You need practice writing. We all do.

5) Having located your problem and satisfied yourself that it is important, you will have to convince your colleagues that you are not totally demented and, in fact, deserve support. One way to organize a proposal to accomplish this goal is:

a) A brief statement of what you propose, couched as a question or hypothesis.

b) Why it is important scientifically, not why it is important to you personally, and how it fits into the broader scheme of ideas in your field.

c) A literature review that substantiates (b).

d) Describe your problem as a series of subproblems that can each be attacked in a series of small steps. Devise experiments, observations or analyses that will permit you to exclude alternatives at each stage. Line them up and start knocking them down. By transforming the big problem into a series of smaller ones, you always know what to do next, you lower the energy threshold to begin work, you identify the part that will take the longest or cause the most problems, and you have available a list of things to do when something doesn't work out

6) Write down a list of the major problems that could arise and ruin the whole proj-ect. Then write down a list of alternatives that you will do if things actually do go wrong.

7) It is not a bad idea to design two or three projects and start them in parallel to see which one has the best practical chance of succeeding. There could be two or three model systems that all seem to have equally good chances on paper of providing appropriate tests for your ideas, but in fact practical problems may exclude some of them. It is much more efficient to discover this at the start than to design andexecute two or three projects in succession after the first fail for practical reasons.

8) Pick a date for the presentation of your thesis and work backwards in constructing a schedule of how you are going to use your time. You can expect a stab of terror at this point. Don't worry - it goes on like this for awhile, then it gradually gets worse.

9) Spend two to three weeks writing the proposal after you've finished your reading, then give it to as many good critics as you can find: Hope that their comments are tough, and respond as constructively as you can.

10) Get at it. You already have the introduction to your thesis written, and you have only been here 12 to 18 months.

Manage Your Advisors

Keep your advisors aware of what you are doing, but do not bother them. Be an interesting presence, not a pest. At least once a year, submit a written progress report 1-2 pages long on your own initiative. They will appreciate - it and be impressed.

Anticipate and work to avoid personality problems. If You do not get along with your professors, change advisors early on. Be very careful about choosing your advisors in the first place. Most important is their interest in your interests.

Types of Theses

Never elaborate a baroque excrescence on top of existing but shaky ideas. Go right to the foundations and test the implicit but unexamined assumptions of an important body of work, or lay the foundations for a new research thrust. There are, of course, other types of theses:

1) The classical thesis involves the formulation of a deductive model that makes novel and surprising predictions which you then test objectively and confirm under conditions unfavorable to the hypothesis. Rarely done and highly prized.

2) A critique of the foundations of an important body of research. Again, rare and valuable and a sure winner if properly executed.

3) The purely theoretical thesis. This takes courage, especially in a department loaded with bedrock empiricists, but can be pulled off if you are genuinely good at math and logic.

4) Gather data that someone else can synthesize. This is the worst kind of thesis, but in a pinch it will get you through. To certain kinds of people lots of data, even if they don't test a hypothesis, will always be impressive. At least the results show that you worked hard, a fact with which you can blackmail your committee into giving you the doctorate.

There are really as many kinds of theses as there are graduate students. The four types listed serve as limiting cases of the good, the bad, and the ugly. Doctoral work is a chance for you to try your hand at a number of different research styles and to discover which suits you best: theory, field work, or lab work. Ideally, you will balance all three and become the rare person who can translate the theory for the empiricists and the real world for the theoreticians.

Start Publishing Early

Don't kid yourself. You may have gotten into this game out of your love for plants and animals, your curiosity about nature, and your drive to know the truth, but you won't be able to get a job and stay in it unless you publish. You need to publish substantial articles in internationally recognized, refereed journals. Without them, you can forget a career in science. This sounds brutal, but there are good reasons for it, and it can be a joyful challenge and fulfillment. Science is shared knowledge. Until the results are effectively communicated, they in effect do not exist. Publishing is part of the job, and until it is done, the work is not complete. You must master the skill of writing clear, concise, well-organized scientific papers. Here are some tips about getting into the publishing game.

1) Co-author a paper with someone who has more experience. Approach a professor who is working on an interesting project and offer your services in return for a junior authorship. She'll appreciate the help and will give you lots of good comments on the paper because her name will be on it.

2) Do not expect your first paper to be world-shattering. A lot of eminent people began with a minor piece of work. The amount of information reported in the average scientific paper may be less then you think. Work up to the major journals by publishing one or two short - but competent - papers in less well-recognized journals. You will quickly discover that no matter what the reputation of the journal, all editorial boards defend the quality of their product with jealous pride - and they should!

3) If it is good enough, publish your research proposal as a critical review paper. If it is publishable, you've probably chosen the right field to work in.

4) Do not write your thesis as a monograph. Write it as a series of publishable manuscripts, and submit them early enough so that at least one or two chapters of your thesis can be presented as reprints of published articles.

5) Buy and use a copy of Strunk and White's Elements of Style. Read it before you sit down to write your first paper, then read it again at least once a year for the next three or four years. Day's book, How to Write a Scientific Paper, is also excellent.

6) Get your work reviewed before you submit it to the journal by someone who has the time to criticize your writing as well as your ideas and organization.

Don't Look Down on a Master's Thesis

The only reason not to do a master's is to fulfill the generally false conceit that you're too good for that sort of thing. The master's has a number of advantages.

1) It gives you a natural way of changing schools if you want to. You can use this to broaden your background. Moreover, your ideas on

what constitutes an important problem will probably be changing rapidly at this stage of your development. Your knowledge of who is doing what, and where, will be expanding rapidly. If you decide to change universities, this is the best way to do it. You leave behind people satisfied with your performance and in a position to provide well-informed letters of recommendation. You arrive with most of your Ph.D. requirements satisfied.

2) You get much-needed experience in research and writing in a context less threatening than doctoral research. You break yourself in gradually. In research, you learn the size of a soluble problem. People who have done master's work usually have a much easier time with the Ph.D.

3) You get a publication.

4) What's your hurry? If you enter the job market too quickly, you won't be well prepared. Better to go a bit more slowly. build up a substantial background, and present yourself a bit later as a person with more and broader experience.

Postscript

This comment was originally entitled "Cynical aids towards getting a graduate degree, or psychological and practical tools to use in acquiring and maintaining control over your own life." It originated as a handout for the Ecolunch Seminar in the Department of Zoology, University of California, Berkeley, on a Monday in the spring of 1976. Ecolunch was, and is, a Berkeley institution, a forum where graduate students present their work in progress and receive constructive criticism. At the start of the semester, however, no one is ready to talk. This was such a time.

On Friday morning at Museum Coffee, Frank Pitelka, who was in charge of Ecolunch for that semester, asked me to make the presentation on the following Monday. "Asked" is probably a misleading representation of Frank's style that morning. Frank bullied me into it. I had just given a departmental seminar on the Ph.D. work I had done at British Columbia, and did not have much new to say about biology. Frank's style brought out the rebel in me. I agreed on the condition that I had complete freedom to say whatever I wanted to, and that the theme would be advice to graduate students. Frank agreed without apparent qualms. Then I charged upstairs to Ray Huey's office to plot the attack.

I whipped out an outline. Ray responded with a more optimistic and complimentary version (see the following Commentary article), and I wrote a draft at white heat that afternoon. We felt like plotters. We were plotters. There were acts of self-definition in the air. On Monday, I recall that I made a pretty aggressive presentation in which, to emphasize how busy faculty members were, I kept looking at my watch. Near the end I glanced at my watch the last time, said I had to rush off to an appointment, left the room suddenly without taking questions, and slammed the door. They waited. I never came back, but Ray took over and presented his alternative view. Ray told me later that Bill Lidicker turned to him and said, "You mean he's not coming back?" I wasn't. Fortunately, they took it well. They were and are a group of real gentlemen.

I mention these things to explain the tone of our pieces. We would not write them that way now, having been professors ourselves for some years. We never intended to publish them, having regarded the presentations as a one-time skit, but our notes were xeroxed and passed

around, and eventually they spread around the United States. In the fall of 1986 I got a letter from Pete Morin at Rutgers suggesting that we publish the notes. Its survival for ten years in the graduate student grapevine convinced me that there might actually be a demand for them. I had lost my original, and Pete kindly sent me a copy, which turned out to be an nth generation version with marginal notes by a number of different graduate students. On rereading it, I find that I agree with the basic message as much as ever, but that many of the details do not apply outside the context of large American universities.

Ten years later, I have one afterthought.

Publish Regularly, but Not Too Much

The pressure to publish has corroded the quality of journals and the quality of intellectual life. It is far better to have published a few papers of high quality that are widely read, than it is to have published a long string of minor articles that are quickly forgotten. You do have to be realistic. You will need publications to get a post-doc, and you will need more to get a faculty position and then tenure. However, to the extent that you can gather your work together in substantial packages of real quality, you will be doing both yourself and your field a favor.

Most people publish only a few papers that make any difference. Most papers are cited little or not at all. About 10% of the articles published receive 90% of the citations. A paper that is not cited is time and effort wasted. Go for quality, not for quantity. This will take courage and stubborness, but you won't regret it. If you are publishing one or two carefully considered, substantial papers in good, refereed journals each year, you're doing very well - and you've taken enough time to do the job right.

Acknowledgements

Thanks to Frank Pitelka for providing an opportunity. to Ray Huey for being a co-conspirator and sounding board and for providing a number of the comments presented here, to the vast unknown graduate students who kept these ideas in circulation during the last decade,= and to Pete Morin for suggesting that we write them for publication.

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Stephen C. Stearns

REPLY TO STEARNS: SOME ACYNICAL ADVICE FOR GRADUATE STUDENTS

Preface

When Steve showed me the preliminary outline for his talk, my first response was to say, "Steve, this is really cynical, even by your standards. You can't possibly present such a negative view of graduate education." My second response was to draft an alternative outline, which I intended as a direct challenge to Steve's, and which I presented after Steve so rashly stormed out of Ecolunch.

A decade has passed since we performed that amusing skit. In transcribing our old outlines into text, Steve and I have tried to preserve the intentionally argumentative, point-counterpoint format and flavor of our original presentations. We do so, not because we remain convinced that our old views are necessarily correct (I am pleased to note that Steve now recants his views, at least in part), but because we want to emphasize a diversity of views of how to be a graduate student.

Our main point is this: there is no one way to be a graduate student. Each of us is an individual - each of us has individual needs, goals, capacities, and experiences. Advice that is productive for one student may be disastrous for another. So think about these and other views, but don't accept them without question.

Initial Premise

Graduate school provides an opportunity for you to choose from being someone who reads to someone who is read. That is a major metamorphosis, indeed. Not surprisingly, it presents challenges as well as opportunities.

Always Expect the Best

If you anticipate the worst, you are likely to experience it. Instead, develop a positive attitude, decide what you want (T.A. position, research funds. etc.), and then get it. Go outside your university whenever possible for advice and for funds. Don't merely rely on your department or your major professor. In short, be active and independent, not passive and dependent.

Some People Do Care

People are more likely to care about you if you act like a professional (see below) and if you make yourself valuable. Obtain a skill (multivariate statistics, electrophoresis) that you can share. (and of course use yourself). Avoid being used, however.

Seek out and collaborate with fellow graduate students, especially ones who are doing interesting work and who are enjoying it. You are likely to learn far more from graduate students than from your advisor, if only because you have more in common and spend more timewith them. In short, use these interactions as an opportunity to be introduced to different viewpoints and techniques and to become excitedabout your career.

Seek out emeritus or near-emeritus professors, at least ones who are still active. They have a wealth of knowledge and experience, and often have the time and interest to share it. Moreover, they can give you a personal appreciation for the history of your field. Science is an historical activity, and progress in science is often enhanced by an understanding of the past.

On "Exhaustive" Thinking

Thinking "widely and exhaustively" can be mentally exhausting if you aren't academically and emotionally prepared. You may instead make better use of your first year by making up deficiencies in your course background (do so as quickly as possible!). Moreover, some people simply need time before they are ready to think independently. That maturation process can sometimes be accelerated by starting your research with a problem that your advisor "hands you."

Ultimately, however, you must begin to think and do research independently, and you must understand why you are doing a particular project.

On Psychological Problems

Expect them. Everyone will go through periods of intellectual insecurity or stress, most likely in the first year or two. You can often minimize those problems with some simple tricks.

1) Get requirements out of the way as soon as possible. You will be surprised at how much your attitude toward graduate school and your research will improve once you pass all language requirements and qualifying exams. Keep in mind that faculty are inevitably impressed by students who aren't intimidated or slowed down by academic hurdles.

2) Some people simply need time to mature academically. So, fight directives and pressure to complete your Ph.D. in 4 years. You may need to take some extra time or even take a leave of absence. Changing schools or advisors sometimes helps, especially if you can first obtain a Master's degree.

Becoming a Professional

Think of yourself as a professional, someone who will be a biologist for the rest of your life. Start to accumulate a library and reprint collection, develop a computerized list of references and of addresses, attend meetings, meet with visiting seminar speakers, correspond with people working on related problems, send out copies of your articles as they are published, etc.

Treat each project (even a, literature review) as if it is potentially publishable.

Faculty are more likely to treat you as a professional if you act like one. They are a good source of suggestions in this regard. Ask their advice on efficient ways to organize your reprints and reference files, or ask them to recommend key papers (their own, or those of others) that influenced their thinking and careers. Read those papers, then go back and discuss them with the professor. (Note: Many graduate students have not read most of their advisor's papers, or those of other relevant faculty in their department.)

Despite your best efforts (and theirs), the faculty may have a difficult time treating you as a colleague rather than as a student. Therefore, develop contacts outside the department and the university, thereby gaining a new perspective on biology and on your own work. Go on a tour of other universities, meet with faculty and students working in your area, volunteer (if appropriate) to give an informal seminar of your thesis work. If possible, spend a term and take courses at another university (or a field station), especially if a course is special and especially if you are spending your graduate career at one university. These outside contacts not only broaden

your perspectives but may also increase your chances for a collaborative research project, a postdoc, or even a job.

Join appropriate scientific societies, attend their yearly meetings, give papers or posters, get to know your future colleagues. Meetings can be exciting and a chance to find out what is new. Moreover, you get practice at speaking in front of a "foreign' (e.g., non-sympathetic) audience.

On Courses

Never pass up a lecture course from a great professor, even if it is somewhat outside your main area. Seek courses that challenge you to think rather than to memorize. Auditing courses can often be an efficient way to get an overview of a field, at least if you are self-disciplined.

Take short courses that can save you time over the years. Many libraries give instruction on efficient literature searches (see also Smith's book, cited by Steve); and most universities offer introductions to computers, statistical packages, etc. If you don't know these crucial skills already, immediately learn speed typing and word-processing.

On Proposals and Grants

Grant writing is a key skill. Ask professors for copies of their successful grant proposals (perhaps ask them for unsuccessful ones as well!). In other words, find out what makes a good proposal before you start writing; don't waste time 'reinventing the wheel."

Be a scholar. Showing that you know and understand the literature makes a good impression, and it gives you an awareness of the key issues in your field.

Use the working proposal Steve describes as a basis for a real grant proposal. Many societies, governmental agencies (NSF), and organizations give grants to graduate students - ask your major professor and other graduate students for the names of such organizations. Prod your department or advisor to start a permanent file on such grants.

Getting your own grant has important ben-efits beyond simply funding your research. (1) It gives you something to add to your C.V. (2) It helps establish your independence from your advisor and your department. (3) It really impresses your advisor and your committee!

Interactions with Your Advisors

Your advisory committee is there to help you. You can encourage this by taking their advice seriously. If they recommend a paper, read it.Not surprisingly, faculty will be disinclined to give you additional help (and write strong letters of recommendation) if you habitually ignore their advice. Moreover, practice reciprocal altruism - when they ask for your help (to review a paper or perhaps a proposal of theirs), giveit. Seek a symbiotic rather than a parasitic relationship.

On Theses

(Tangent. Even after a decade, I can still hear Steve pontificating the first sentence in this section. His expression, "a baroque excrescence, " is my fondest auditory memory of Berkeley.)

Onward. A thesis shouldn't be the culmination of your research career, but its beginning. You probably never really had your creativity challenged as an undergraduate. Here is your opportunity. Push yourself - you'll respect yourself more than if you are too cautious and try a no-risk project.

Remember that your future research directions need not be constrained by the topic of your thesis. In fact, your thesis experiences may convince you that your interests and talents are elsewhere. Use a Master's-to-Ph.D. switch or a postdoc to change directions, if appropriate.

Publishing

Contrary to widespread opinion, writing and publishing can be fun. More important, the process of writing is a positive learning experience - my understanding of my own research is invariably enhanced while developing a paper or grant proposal.

Writing and publishing aren't always fun, of course, but you can minimize problems by being careful, by organizing your thoughts before you write, by taking pride in crafting sentences carefully, and by having people critically review your papers before you submit them for publication. This review process should be sequential: First, give it at an "Ecolunch." Second, write a draft and have your fellow graduate students and advisor review it critically. Third (optional, but advised), send it to one or a few experts in the field. Fourth, submit the manuscript.

(Having now been an editor of several journals and books, I would add several caveats. Make certain you follow the "Instructions to Authors" for the journal; if you use the wrong format, the editor will suspect that (1) your paper was previously rejected by another journal, or that (2) your work style is casual and not necessarily to be trusted. Also, carefully check the citations in the text against the literature cited section. Check text, tables, and figures for accuracy and neatness. (A paper that is neat and well designed is easy to read.) If you are writing an invited chapter for a book, do your very best to meet all deadlines. Editors cherish contributors who actually meet deadlines and follow instructions.)

Publishing is an important responsibility - you share your insights with others. It is also essential. People occasionally get good jobs or a grant despite a weak or nonexistent list of publications, but the odds, of this happening are slim, indeed.

Although overpublishing is a mistake (as Steve notes), don't be embarrassed by writing one or a few minor papers - ample precedents exist. Moreover, we are often our own worst judge of what is truly significant (see Bartholomew, 1982). (After gaining the benefits of the experience, you can eventually obscure any truly trivial publications by using the following widely used technique -simply change your official "List of Publications" to a "Selected List of Publications" or to a list of "Publications Since 19xx!)

Miscellaneous

Watch for and take advantage of opportunities. If someone is organizing a special field trip, ask if you can go along and help. If there is a job search in your department, look through the applications and learn first hand what makes a good C.V. and what makes a clear

statement of research and teaching interests. (Note: Not all departments permit graduate students to read application files.) Find out your advisor's opinion of the candidates' job seminars. Thus when you start applying for jobs, you will have some idea of what works and what doesn't.

Concluding Remarks

Appearances to the contrary, graduate students need not be oppressed. You actually have as much freedom as you will ever have (except perhaps as a postdoc or during a precious sabbatical), Be positive, not cynical.

Postscript

"Ten years later," I wish to emphasize one comment and then to make one addition. First, do spend time around students and faculty who are doing significant research and who are excited about their careers. In short, surround yourself with good people. Enthusiasm is contagious. Second, learn to respect and to practice the art of getting organized. Thus, be efficient and don't waste time. This will almost certainly enhance your productivity and your enthusiasm for your career.

Acknowledgments

I am of course grateful to Steve Stearns, whose outrageous views prompted this reply. T. Garland, Jr. made useful comments on a draft.

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Perhaps half of the difficulties encountered by graduate students derive from interactions (or lack of interactions) with graduate advisors. All advisors have the benefit of insights from their own experience as advisees, but sample sizes of 1, 2, or 3 may not provide much insight into the intricate details of good advising. Therefore, a discussion of the proper role of advisors is a logical follow-up to recent advice given to graduate students (Huey 1987, Stearns 1987).

Initial Premise: Graduate Students are People

Graduate students can be described by models identifying their many functional and structural roles in research labs, field projects, classrooms, and budgets. However, the most encompassing model of the nature of a graduate student is the humanistic model, encompassing submodels of both physical and psychological well-being. Given this premise, a long list of corollaries can be developed.

Graduate Education = Personal Development

Graduate education is a major step on the staircase of personal development. It has a beginning and, one hopes, an end, but is only a single stage in a longer sere. The graduate advisor can have a large influence on physical well-being by supplying the requisite financial resources, and on psychological development by caring enough to consider the ideas discussed below.

Care about Students

If you don't care about students, you should not agree to serve as anyone's major advisor. You won't enjoy it, the student will be handicapped, and if cosmic justice prevails, your career will not be advanced. If you care, then take the time to think about how you can do a better job.

Provide Clear Maps

The territory of graduate studies has been traversed by thousands of students, but it's a novel experience for each beginning graduate student. The advisor can be of enormous help by providing a clear map of the territory. Such maps come with several overlays.

Each institution has a unique list of hoops each student must pass through, including requirements for coursework, minors, lan-

guages, exams, and the dissertation. Most schools and departments have clear guidelines, but some don't. In all cases, advisors should go over the task map carefully with the student at the beginning of the program, or perhaps even during the negotiation phase the spring before.

The task map overlay needs to include clear expectations of the time for reaching each milestone. The time estimates of course need flexibility, but a clear acknowledgment of the modal time requirements can serve as a reassuring measure of progress, or a warning of growing resistance to progress.

Naive students may expect the maps of tasks and times to explain the framework of their graduate program, but there are hidden dimensions that are obvious to advisors that need to be pointed out. Examples include: interests and personalities of prospective committee members; how to prepare for comprehensive exams; and the need to publish as soon as possible. Insights may be especially helpful on how to develop a healthy and humble professional ego in the face of all the competition and ego games among peers.

The reasons for selecting or omitting specific courses are not the same as in undergraduate territory, and the selection criteria need to be discussed explicitly. Graduate courses (beyond those required by the department) need to be selected on the basis of:

- Filling in critical gaps in the student's knowledge
- Subjects that are difficult to master by independent study (such as biochemistry)
- Formats that involve reading and critiquing current literature

Help Develop Writing Skills

Most graduate students enter their programs with a fair command of English (with the exception of some foreign students), but very few have much experience with science writing. The types of writing courses offered to undergraduates probably provide little insight into science writing. Therefore, it is up to advisors to see that the graduate student is provided with the opportunities to learn to write. In addition to directing them to the usual writing manuals, there are two basic components:

- Provide careful, detailed, and encouraging comments on the student's manuscripts (including many papers before the final dissertation). This can be very time consuming if done well, but is probably one of the most useful tasks an advisor can perform for a student.
- Provide opportunities for the student to critique other manuscripts, including your own and those sent to you to review by colleagues.

Make Thesis Research a Pleasure, not a Terror

The nature of the thesis or dissertation undertaking needs to be clearly communicated to the student. Statements of objectives like, "to make an original contribution to the body of science" can be imposing and worthless. Be clearer. Give reasons such as these, or your own version of these:

- To have your first major experience with performing research be under the tutelage of a great advisor.
- To learn how a research project is conceived, developed, and executed.
- To convince possible employers that you're a better candidate than your competitors.

With these objectives clearly in mind, the graduate student should be well on the way to a positive thesis experience.

Encourage Career Diversity among Students

Keep in mind that the careers of few students follow precisely in the footsteps of their advisors. Be sure students are aware of the wide array of career paths that are open to them, including industry, consulting, and non-university teaching.

Encourage (and Fund) Participation in Conferences

Graduate education prepares students to become peers in a scientific community, and the sooner the student begins to fledge, the better. Attending conferences, presenting papers, and dealing with fellow scientists one-on-one is critical. Take the time to introduce the student to important people with similar interests. I know of no recent graduate who landed a top-notch position upon graduation

who was not already well known in the ecological circle of his or her specialties.

Provide a Map of the Adult World of Grantsmanship

The final map a graduate student needs is the one most often omitted—how to compete for research funds. Let them read your proposals (both successful and unsuccessful), along with the reviews you received. Insist their thesis proposals be written as though they would be submitted to a funding agency, and see that the proposals receive several reviews from fellow students or professors. If possible, involve them in your current proposal writing. (If you are not active in seeking research funds, be sure your students spend time with committee members who are.)

Manage Your Students

Some advisors take a hands-off approach to Ph.D. students, using the sink-or-swim philosophy of letting the student do the entire program as though he or she were already a fully fledged scientist. If this is the sort of advisor you are, never take on a graduate student who does not yet have a Ph.D. Be an active participant in the student's development; tread the fine line between encouraging independence and providing assistance. The optimal amount of assistance, of course, varies with the student, so the best strategy is to discuss this topic periodically in the student's program. Is progress satisfactory? Are there any major stumbling blocks? Does the student need help in setting schedules?

Perhaps the best advice in this category is simply to keep abreast of what the student is doing on a regular basis. This involves having a written plan of study that covers the entire degree program, and frequent updates on current performance (including occasional written progress reports). Remember what's been discussed at these update meetings; few things discourage graduate students as much as an advisor who doesn't remember what was discussed in a conversation a week or a month earlier. (Hint: take notes.)

Be Available for Cosmic Discussions

Much of a graduate education occurs outside the formal structure of courses and thesis research. An advisor who is readily available for discussing ideas wildly unrelated to narrow thesis subjects is a gem. Other graduate students also serve this role, but they can't take the place of an accessible, interested advisor. Take students to lunch—they're poor, they'll appreciate it, it's more fun than eating alone, it doesn't cost much, and can help on taxes.

Encourage Multiple Projects

The dissertation should be the cornerstone of the graduate program, but smaller side projects can add a lot to the structure. They provide diversity in subject matter, opportunities for creating more than one set of hypotheses, and a chance to work on research with other students or professors. Perhaps best of all, small side projects can provide the advisor with answers to small questions that he or she has always wanted to explore but never had the time.

Involve Them in Your Consulting

If you are involved in consulting, your students should have the opportunity to benefit from your diverse activities. Active participation can help them become acquainted with other professionals in the field, provide learning opportunities, and perhaps funds to supplement meager stipends.

Involve Them with Visiting Colleagues, Interviewing Faculty, etc.

This might seem self-evident, but I have heard of many students who have missed the chance to interact with visiting scientists because their advisors didn't think to include them. This is again important both for education, and for developing the professional contacts that are a part of being a full member of a scientific community.

Encourage Them to Work Independently with Other Scientists

If you're a good advisor, your students will assimilate much of what you have to offer long before graduation rolls around. They will learn more if they associate independently with other scientists, and will perhaps be less disillusioned when they realize the limits of your own knowledge.

Discuss these Ideas with Prospective Students

If you discuss these ideas, along with those of Stearns (1987) and Huey (1987), with prospective students, you will have a chance to come to a mutual understanding of expectations, as well as a foundation for evaluation of the student's performance as a budding scientist and your performance as a mentor.

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Commentary

Some Pragmatic Advice to Graduate Students: a Hybridization of Stearns, Huey, and Binkley

As a graduate recently completing a IO-year sojourn in post-baccalaureate study. I thought this forum appropriate to address the recent articles by Steams (1987), Huey (1987), and Binkley (1988) on the complexities of a graduate career. I wish to reemphasize Huey's (1987) statement that there is no single best blueprint for a successful and productive graduate career. I believe, however, that certain elements must be incorporated into any tactical attempt at completing a graduate degree in ecology.

Initial premise

Although implied by Stearns. Huey, and Binkley, I believe that this fact should be made explicit: complete dedication is essential. Anything less than a total commitment inevitably will be counterproductive If you aren't sure whether graduate school is the right choice for you. then it probably isn't. Nothing is more obvious to your major advisor. committee members, and graduate student colleagues than a halfhearted effort. You will alienate everyone if you waste their precious time. Most are willing and eager to help, but it is your responsibility to prove that you merit then assistance.

Hope for the hest but be prepared for the worst

Herein lies the first hybridization. Somewhere between "nobody cares about you" (Steams 1987) and "always expect the best" (Huey 1987) lies cautious optimism. You will learn quickly in your program who can be trusted and who is a bubonic siphonapteran. Trust your instincts. When in doubt, seek the advice of your mentor first, then that of experienced graduate students if necessary. After all. only your major professor can protect you in case of a disaster such as a disgruntled. uncooperative. or offended committee member. Establish trust and candid communication with your advisor as soon as possible; they'll go to bat for you if they're worth their salt.

On psychological problems

As Stearns points out. the pressures Inherent in a graduate career (particularly from deadlines) are enormous. You must be psychologically stable. Emotional problems with your significant other. parents. friends. or pet python will at best delay and at worst ruin your chance for completing your thesis/dissertation.

On financial stability

Unfortunately, this highly sensitive and critically important subject is not given the emphasis it rightfully deserves by either Steams. Huey, or Binkley. Eating and paying rent (and perhaps purchasing the occasional book) are not luxuries; they are necessities. Some graduate advisors and committee members may lose sight of this fact. Financial problems are particularly acute for the contemporary graduate student who often must help support a family. Inadequate funding can exacerbate psychological problems or even force you to quit the program prematurely. I have listed below what I feel is a reasonable priority of methods to obtain funding.

I) Seek grant/fellowship support. If your department has a graduate coordinator. either they or their secretary may have a list of potential sources. If this fails, try the graduate school office of your institution. There is a plethora of possible funding sources. including NSF, NIH, and professional societies; quite often. in-house awards/fellowships are available (albeit highly competitive) from your own institution. You might also shop around your department (especially your mentor) for research assistantships.

2) Teaching assistant stipends. Although this option can provide invaluable assets such as enhancement of teaching skills (and thus your marketability), and it may provide long-term support. be forewarned that it is time-consuming. Furthermore, it probably will take you away from your research considerably more than option I.

3) Seek part-time or. if necessary, full-time employment in an academic setting. Some universities allow graduate students to teach classes such as non-major science courses. A local junior college is another pos-

sibility. Use this option only when ail else fails (and it may). This option is still superior to packing bags at the local supermarket.

Choose your major advisor carefully, before you select your institution

Although Stearns, Huey, and Binkley all stress the imperative of mutual respect between mentor and graduate student. only Steams mentions this most critical precursor: practice preventive medicine. Ask someone you trust. perhaps an undergraduate professor/counselor. about the ability of your prospective advisor to establish productive relationships with graduate students. Travel to their institution on a fact-finding tour. Meet with them personally (a phone call is not the same) and consult as many of their graduate students as possible. Chances are if most of the graduate students are notably disgruntled with their advisor. you may be as well. should you select that program.

Rely on your major advisor for informed guidance

In my opinion, any attempt to "manage your advisor" (Stearns 1987) may be misconstrued as arrogance. Although it is critical to establish your independence (particularly in terms of aggressive. logical thinking), remember one key fact: you become truly independent only after you graduate. Until you have that precious sheepskin framed and on the wall, your career is in their hands. The responsible advisor/committee member will encourage increasing levels of independence as you progress. Inform your major advisor early about your perceived inadequacies and accept their guidance about which courses to take. timetables for completion of qualifying examinations and language requirements, etc. Ask to participate in their research projects. They will welcome the help and you may get a junior authorship out of the deal.

Make yourself visible to the scientific community A.S.A.P.

Publish both quality papers and minor efforts. At this point in your career, even something as trivial as a note (new technique, behavioral observation, range extension. etc.) will familiarize your future colleagues with your name. I am in complete agreement with Huey in that attending conferences. giving papers, and joining professional societies will both hone your skills (e.g., oratorical ability) and enhance your changes of completing your degree and obtaining gainful employment in your chosen profession.

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