

MEDIA REVIEW

Designing an Effective, Affordable Laboratory Course in Neurophysiology *Crawdad: A CD-ROM Lab Manual for Neurophysiology*

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Sinauer Associates, 1999; \$29.95 ISBN: 0-87893-947-4 CD-ROM

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The *Crawdad* CD-ROM, available in student and instructor versions, is an indispensable resource for anyone planning a laboratory course in neurobiology. *Crawdad* contains guidelines for experiments in crayfish, as well as snail, electric fish, and the freshwater alga, *Chara*. For each of the ten exercises the CD has it all: instructions for setting up the lab, guidelines and videos for all dissections, videos of actual recordings, troubleshooting suggestions, downloadable versions of the manual, vendor contact information, thought questions for students (with answers in the instructors' version), references, and even a calculator for making up solutions.

This all-encompassing audiovisual and written guide, appropriate for seasoned electrophysiologists as well as those who have never touched a microelectrode, serves as a solid foundation for an investigative neurophysiology course. The greatest difficulty is resisting the temptation to use all of *Crawdad's* experiments in your course. Lab courses are usually more successful when students can spend two or three weeks on a project, in which they learn a new technique the first week and select a question(s) to pursue in the subsequent week(s). Such additional time allows the students to plan their experiments carefully, provides them with confidence that second week that, "Yeah, I can do this even though I'm new to electrophysiology", and gives them time to analyze and discuss their results in class with the instructor and their peers. In other words, expanding the amount of time spent on each experiment—focusing on the important skills of learning how to ask a good question, how to find and read the relevant literature, how to interpret data, and how to communicate results effectively—produces a lab course that more closely mimics the investigative process of research labs. The experiments described in the *Crawdad* CD provide a wonderful opportunity to do just that. Each experiment, or "Lab", contains suggested experiments that can be carried out the first week, followed by suggested "Further Explorations" that can serve as the basis of investigative projects in the subsequent week(s). In many cases the suggestions in "Further Explorations" and/or the listed references spawn ideas for very innovative projects. When students have this kind of ownership over their projects, they are much more likely to catch the "data bug"—i.e., the need to come into lab after hours to collect more data to support their hypothesis. Another wonderful aspect of the CD is that it enhances students' independence; they have visual reminders right at their fingertips of how to do the dissections or connect their

recording apparatus, so they need not depend on constant supervision by their instructors. With this kind of independence students have more opportunities to learn the necessary art of troubleshooting in neurophysiology—an important opportunity that few students experience in lab courses.

Crawdad's invertebrate experiments also offer the opportunity to develop another skill that is working its way out of a typical biology or neuroscience curriculum: the skill of microdissection. The crayfish tail is one of the easiest preparations for teaching neurophysiology for several reasons: (1) the nerves and muscles (some of which lie under pigmented landmarks on the epidermis) can be easily visualized with a dissecting microscope; (2) the nerves and muscles can be stained to enhance the visualization (and one of the stains, janus green, is a vital dye); (3) the nerves and muscles withstand the insults of novice electrophysiologists incredibly well (one of my students washed his prep with tap water the first day, and it was not that much worse for the wear!); and (4) the tail contains six bilateral hemisegments, providing 10-12 independent dissection opportunities in each animal. In recent years my students have entered my neurophysiology course with less experience working with their hands, making relatively easy dissections increasingly challenging. The CD helps out a great deal in this respect. Not only does *Crawdad* provide videos of all of the dissections, but the supplementary guide on "Dissection Tips" is a very useful primer for any lab course relying on successful microdissection.

The *Crawdad* CD is an excellent starting place for instructors setting up a new neurophysiology lab, and for instructors using vertebrate preparations in their lab courses who want to switch to invertebrates. I wish that *Crawdad* had been available when I first started teaching my neurobiology laboratory course, because it answers so many of the nuts-and-bolts as well as curricular questions I had at the time, such as: "How do you put together an affordable electrophysiology rig?" and "Are there feasible experiments to do with undergraduates that combine some neuroanatomy and physiology, to get at structure/function questions?" I had the very good fortune to participate in the *Crawdad* workshop at Cornell when Bob, Bruce, and Ron were developing *Crawdad*. The workshop was an enormous help in developing invertebrate-based experiments for my course. The workshop was limited to a small number of participants though, and was only offered three times during summers in the mid-1990s; since then numerous faculty members have

relied solely on the *Crawdad* CD, in conjunction with other available resources, to develop their labs. Such other resources include (but are not limited to): the *Crawdad* web site (<http://www.crawdad.cornell.edu>), the Faculty for Undergraduate Neuroscience (FUN) listserv (fun-l@gettysburg.edu), the FUN newsletter archive (www.funfaculty.org/newsletterarchives.html) and the *Discovering Neurons* text by Carol Ann Paul, Barbara Beltz, and Joanne Berger-Sweeney (Cold Spring Harbor Laboratory Press). Of these, the *Crawdad* CD is probably the most indispensable, particularly for the novice electrophysiologist. This valuable resource is also quite affordable (\$29.99 for the student version, \$49.99 for the instructor's version).

As an instructor who switched from using vertebrate preparations in my teaching lab (e.g., the frog cutaneous pectoris neuromuscular junction, among others), to using the crayfish and snail preparations, I have been very pleased with the change. Not only are the invertebrate dissections far easier for my students to master, but the animals are much less expensive and easier to maintain. In addition, working with invertebrates obviates the need for animal care and use committee approval, reduces student objections to sacrificing animals for research (especially after observing the crayfish aggressively tearing each other limb from limb in their tank), and eliminates the need to oxygenate the tissues. Moreover, the ease and cost efficiency of working with invertebrates make several of the experiments described on the *Crawdad* CD quite amenable for use in demonstrations at local secondary schools.

The *Crawdad* CD-ROM is also extremely useful for instructors with limited (or no) experience in electrophysiology. The first lab on membrane properties, which involves model axons and 9 V batteries, is especially helpful in acquainting students (and perhaps the instructor) with the passive properties of membranes, and with the basic principles of electrophysiological recording. For subsequent "wet" labs, the videos and supporting materials, particularly the appendix on "recording tips," are sufficient for mastering the dissections and recording techniques. One first-year faculty member, a "novice who hadn't touched an e-phys rig in grad school and then found herself teaching neurophysiology" commented, "*Crawdad's* stretch receptor lab is my favorite - there's something conceptually satisfying about the combination of mechanical stretching of the tail, hearing the buzz on the speakers, and seeing the trace on the oscilloscope that allowed my students to understand the response of these neurons to a stimulus they applied with their own hands." Another electrophysiology novice who used the *Crawdad* CD in his neurobiology course comments, "I still don't have a good feel as to how to get rid of noise, but *Crawdad* definitely gave me a lot of possible ideas as to what might be causing noise." In addition to the appendix on how to minimize electrical noise, *Crawdad* contains appendices on how to make affordable suction electrodes, amplifiers, and other electrophysiology equipment – indispensable guides for faculty with limited budgets.

In addition to the passive membrane properties and stretch receptor labs, *Crawdad* describes projects that incorporate concepts covered in a typical neurobiology course. These include experiments on the ionic basis of resting membrane potentials, conduction of action potentials in motor nerve (and related neuroanatomy), firing properties and ionic basis of action potentials in snail neurons, and synaptic modulation and synaptic plasticity at the crayfish neuromuscular junction. Also useful in either a neurophysiology course or in a more general cell biology course is a project in the giant alga *Chara* looking at action potentials and cytoplasmic streaming. Again, all of these labs can serve as the basis for some wonderful discovery-based student projects. For example, two of my students decided to test the hypothesis that the "vital" dye, janus green, which is used to visualize the motor nerves and muscles in crayfish, disrupts synaptic transmission over time; we and others in the *Crawdad* community were beginning to suspect that it does. They designed a project looking at spontaneous and evoked epsps during the application of janus green and found that the dye likely disrupts the release of neurotransmitter (glutamate) from presynaptic terminals and characterized the time course of this effect. Other students have compared glutamatergic synapses at the crayfish neuromuscular junction to those in the mammalian hippocampus. And one surprise to me has been how useful the resting potential lab has been as a first project for students. It not only offers students the opportunity to repeat the classic Hodgkin and Keynes experiments and develop an intuitive feel for the Goldman-Hodgkin-Katz equation, but also leads us to discuss variability in data (theirs versus a data set from the whole class) and the chance to study the consequences of a simple manipulation of their choosing.

Undesirable features of the CD are few. The drawback with the most curricular impact is that the videos are difficult to use as an accessory for lectures. For example, it is difficult (if not impossible) to import the videos into PowerPoint, forcing the instructor to toggle back and forth between PowerPoint and the CD-ROM. An interface drawback is that the video window display is much smaller than the screen size. Furthermore, some users feel that navigating through the CD is somewhat awkward, but can be made easier if a hard copy of the manual is printed out. Some of these shortcomings may be attributed to limitations in technology that existed when Bob, Bruce, and Ron initiated the project in the mid 90s.

In summary, the *Crawdad* CD-ROM and associated faculty workshops constitute a uniquely innovative project that has set a new standard for communicating lab protocols through multimedia. Hopefully *Crawdad* will stimulate the creative juices of others such that additional multimedia lab manuals (and associated web sites) will soon become the norm in disseminating good ideas for undergraduate science education.