Marine Larval Ecology Research Experience Part 1 (BIOL 516A) Fall 2010

Syllabus

Instructor: Dr. Brian Hentschel
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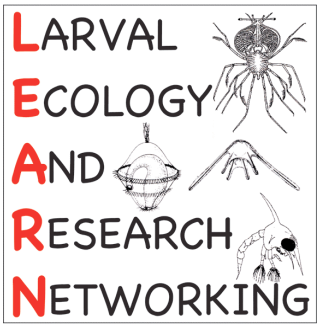
Office hours: Tu: 2:00-3:00 *and* by e-mail appointment

Lecture schedule: M, W: 1:00-1:50
Lab schedule: M: 2:00-4:40 *AND*
50 min TBA each wk

Required text: Young, C.M. 2002. Atlas of Marine Invertebrate Larvae. Academic Press.

Course web site:
https://blackboard.sdsu.edu/webapps/login



Prerequisites

Biol 201B (= Biol 204) & 215.

Innovative Course Concept

This course is part of an innovative integration of teaching and research supported by a 5-yr, $0.5 Million grant from the National Science Foundation: OCE 0548190 "CAREER: Consequences of short-term food variability during the development of marine invertebrate larvae." Students will experience all aspects of scientific research; studying the effects of food variability on the development of invertebrate larvae merely provides the context within which students will develop and refine their research skills. The year-long program is divided into two one-semester courses. The fall-semester course (Biol 516A) will introduce students to the classic knowledge and lab techniques of larval ecology, developing new hypotheses, designing experiments, writing a research proposal, and evaluating proposals in peer-review formats. The companion course in the spring semester (Biol 516B) will be a project-based effort in which teams of students refine proposals, perform guided larval-ecology experiments, and present their results in a variety of formats. Students who enroll in the fall-semester Biol 516A course do not necessarily need to enroll in Biol 516B in the spring, but Biol 516A will be a prerequisite for Biol 516B.

Course Description (Fall Semester)

This fall-semester course will expose students to the diversity of larval forms, introduce various techniques for culturing invertebrate larvae and their foods, and focus students' attention on the ecological consequences of environmental variability during pelagic larval development. Active, collaborative learning strategies will be employed in all aspects of the course. To synthesize their knowledge and apply it in a scientific context, each student will develop a research proposal focused on a larval species of his/her choosing. Students' written proposals will be reviewed anonymously by their peers in written and panel-discussion formats. Teams of students enrolled in the spring-semester course will refine some of the proposals and conduct some of the proposed experiments.

Required Textbook and Additional Readings (Fall Semester)

Young, C.M. 2002. Atlas of Marine Invertebrate Larvae. Academic Press.

This required text provides a comprehensive review of the existing knowledge of marine invertebrate larvae and will be used heavily throughout the fall semester. In addition, the following text is an outstanding guide to methods for culturing diverse invertebrate larvae; its purchase is optional, but strongly encouraged:

Strathmann, M. F. 1987. Reproduction and development of marine invertebrates of the northern Pacific coast. Data and methods for the study of eggs, embryos, and larvae. University of Washington Press.

Many additional readings will be assigned from the primary literature on the ecology of marine invertebrate larvae. In particular, several journal articles will be read and discussed during most Thursday meetings. In addition, Dr. Hentschel will purchase 2-3 copies of the following books and make them available for students to use in the lab and to borrow on an overnight basis:

McEdward, L. 1995. Ecology of Marine Invertebrate Larvae. CRC Press, Boca Raton, FL.

Shanks, A. L. 2001. An Identification Guide to the Larval Marine Invertebrates of the Pacific Northwest. Oregon State University Press, Corvalis, OR.

Course Goals and Student Learning Outcomes

- Students will be able to list and identify the major types of marine invertebrate larvae and describe the major evolutionary relationships among invertebrate animals.
- Students will be able to describe how the major types of marine invertebrate larvae obtain nutrients and food, how they move, and how they develop to later life-cycle stages.
- Students will be able to describe how oceanographic conditions can affect the dispersal of pelagic larvae and the evolution of larval forms and complex life cycles.
- Students will be able to describe the patterns of environmental variability on a variety of temporal and spatial scales in the ocean and list the types of physical processes that contribute to patchiness in the plankton.
- Students will culture phytoplankton and other organisms (e.g., brine shrimp, rotifers) that can be fed to marine invertebrate larvae.
- Students will culture several species of marine invertebrate larvae in the laboratory.
- Students will apply simple mathematical models and descriptive statistics to analyze the growth and survival of organisms in culture.
- Each student will select a larval species of interest and write a formal research proposal focused on testing the effects of environmental variability on the growth and development of that species.
- Students will write constructive peer reviews of research proposals written by two other students.
- Students will evaluate the merits of several research proposals in a panel-review format.
- Students who gain the basic knowledge of larval ecology, draft formal research proposals, and collaboratively evaluate several research proposals will be prepared to conduct some of the proposed experiments as cooperative research teams during the spring-semester course.

Grading

Grades will be based on the percentage of total points earned on the exams, quizzes, and other assignments indicated below:

A = 90-100%; B = 80-89%; C = 70-79%; D = 58-69%; F < 58%

Dr. Hentschel will use plus/minus grading within the upper or lower 2% of each letter-grade category. At his discretion, Dr. Hentschel may modify the percentages for each grade downward if he concludes that the scores should be adjusted based on the class average and general class performance. Please remember that long-standing University policy considers a grade of A to represent exemplary performance, indicative of "outstanding achievement; available only for the highest accomplishment," while a grade of B indicates a "praiseworthy performance; definitely above average." Dr. Hentschel hopes all students will strive to earn As!

Exam 1 (Sep 20)	100 pts
Exam 2 (Oct 27)	100 pts
Exam 3 (Dec 8)	100 pts
Research Proposal (various components)	320 pts
Written Peer Reviews 2 @ 30 pts each	60 pts
Participation in Panel Reviews	50 pts
Participation in TBA Activities	125 pts
Journal Discussion Prep Forms 8 @ 10 pts each	80 pts
Journal Discussion Participation 8 @ 10 pts each	80 pts
Blackboard Quizzes best 2 of 3 @ 15 pts each	30 pts
Participation in one High-School Demonstration	10 pts
EEB Seminar Write Ups 3 @ 15 pts each	45 pts
TOTAL POINTS POSSIBLE	**1100 pts**

Major Assignments

Exams will be a combination of multiple-choice, short-answer, and short-essay questions. Exams will cover lecture material, textbook readings, basic material from journal discussions, and concepts related to skills acquired during laboratory exercises. Make-up exams will consist entirely of essay questions. A student who misses an exam must contact Dr. Hentschel no later than 24 h after the scheduled exam with a written medical excuse or documented emergency to be accorded the privilege of taking a make-up. Any individual student is allowed only one make-up exam during the semester.

Written Research Proposal. Each student will select a larval species of interest and will develop a research proposal focused on testing the effects of food variability on the larval growth and development of that species. The proposal assignment will be divided into several components, including selecting a topic (due Oct 6), writing a preliminary outline (due Oct 25), writing a complete rough draft (due Nov 8), and writing a well edited version that will be graded by the instructor and reviewed by student peers (due Nov 19). After the peer-review process, each student will have an opportunity to turn in a revision of his/her proposal (due during Final Exam period). A detailed set of guidelines on the Research-Proposal assignment will be distributed to students at the beginning of the semester, and several hours of class discussion about developing the proposals are planned throughout the semester (e.g., Sep 20, Oct 18, Nov 1, Nov 22) to guide

students through the process. Briefly, written proposals will be ~ 12 double-spaced pages and must include the following major components:

1) discussion of the background knowledge about the species of interest and the oceanographic and ecological issues related to environmental variability. Citations of relevant primary literature are required.

2) a clear statement of research objectives and hypotheses that will be tested by performing the proposed laboratory experiments

3) a description of the experimental design(s) that will convince reviewers that the experiments can be performed with a reasonable chance of success and demonstrates an understanding of key principles such as replication, independence of experimental units, and appropriate controls

4) an analysis of hypothetical data by graphical and statistical means

5) a synthesis of the importance and implications of the proposed research topic and experiments, including citations of appropriate primary literature

6) a list of equipment and supplies needed to conduct the experiment

7) a timetable of the major activities during the spring semester (e.g., ordering supplies, conducting a preliminary experiment, conducting the main experiment(s), data analysis, writing and preparing presentations, etc).

Written Peer Reviews. To demonstrate the essential process of peer review in science and provide a formative assessment to guide learning, each student will write reviews of two other students' research proposals. Guides on writing effective reviews (e.g., Rosenzweig et al. 1988; Waser et al. 1992) will be discussed in class (Nov 22) before distributing proposals for review. Authors' names will be removed from copies that are reviewed, and peer reviews will be written anonymously. Dr. Hentschel will grade each written peer review for thoughtful content, constructive style, and clarity of grammar and organization.

Participation in Panel-Review Discussions. To synthesize written peer reviews and discuss the merits of different proposals, students will conduct a panel review modeled after the process at many funding agencies (e.g., NSF, NOAA Sea Grant). The format and goals of the panel reviews will be discussed in class (Nov 29) before distributing proposals to panelists. The class will be divided into two panels; each panel will evaluate proposals written by students in the other panel (authorship of the proposals and the two written peer reviews that might assist the panel will be anonymous). Each member of a panel will be required to read every proposal that will be discussed. Each panel will collectively draft a synthesis "Panel Summary" (no more than 1 page) of the panel's evaluation. Each panel also will rank proposals according to the probability of successfully performing the proposed experiments with the larval species selected and the thoroughness of the author's review of the literature pertaining to the species' life history and larval ecology. Dr. Hentschel will observe the panel discussions and assess each panelist's level of preparation and participation (30 points max). Dr. Hentschel also will grade the group-written panel summaries for thoughtful content, constructive style, and clarity of grammar and organization (max of 20 points total assigned equally to all members of the panel).

Participation in Journal-Article Discussions. Eight of the Monday class periods will be dedicated to discussing several journal articles on a specific topic (e.g., Oct 11: Coral Larvae). The class discussions will be set up in a "jigsaw" format. The class will be divided into several groups of 4-5. Each group of 4-5 students will be assigned a different journal article to read.

Before participating in the Monday discussion, each student will complete a brief *Preparation Questionnaire* about the paper she/he read. The preparation form will be on the Blackboard site, and students who complete it by 3:00pm on the Sunday before the discussion will earn up to 10 pts provided they also participate in that week's Monday discussion. Each group of 4-5 students will spend 20 minutes discussing their assigned article and their responses to the questionnaire. Following these initial discussions, one member of each team will be assigned to a new, second group of 4-5 students. Each of the second groups will contain at least one member who read and discussed each of the different articles in the earlier discussions. In the second group, each member will briefly describe the paper he/she read and discussed earlier. By the end of the second set of discussions (25 min), every student will have a basic familiarity with all of the journal articles discussed. By the end of the class period, each member of each second group will complete a brief peer-evaluation form to assess the degree of participation by each group member (each student will assign 0, 1, or 2 participation pts to each member of the group, including themselves). Because participation in these discussions can only occur if a student attends class, *credit cannot be given for any absence during journal discussions*.

Quizzes at the class Blackboard site will be given three times during the semester, before each of the three exams. Each 15-point Blackboard quiz can be completed once during the 6-day period it will be available at the Blackboard site. Each student's best two scores will count toward their final grade. These multiple-choice quizzes will be **open book** (students can use any materials they find helpful). The availability of each quiz will end at 1:00pm the day before each in-class exam (i.e., 24 h before the exam). Do not wait until the last minute to start reviewing for an exam and completing an online quiz! If you experience technical problems with Blackboard, contact the Blackboard helpline: **594-3189** immediately. Technical problems with Blackboard are very rare when using computers in **campus computer labs**. Technical problems are not uncommon if your personal computer has older software. If you have technical problems with a home computer, the Help Staff will ask about your web browser and operating system. **It is each student's responsibility to solve any technical problems so they do not affect more than one quiz score** (which can be dropped without causing any real effect on the total grade).

Participation in High-School Demonstrations. There's an old cliché that a person never really understands something until he/she teaches it to someone else! As part of Dr. Hentschel's effort to integrate research on the ecology of marine invertebrate larvae into science education, students enrolled in Marine Larval Ecology Part 1 and Part 2 will have several opportunities to share their knowledge and experiences with high-school biology and marine science classes.

During the fall semester, teams of 2-3 Bio-516A students will visit a high-school class to demonstrate such laboratory skills as culturing phytoplankton, culturing *Artemia* nauplii, spawning sea urchins, examining live plankton tows, calibrating a microscope to measure small organisms, etc. Each visit to a high school will typically require 2-3 hours, including transit time. Each Bio-516A student is expected to participate in at least one high-school demonstration. Each demonstration is worth a maximum of 10 pts. Dr. Hentschel will consult with each high-school teacher to confirm that all members of a student team participated equally and effectively.

The exact timing of these high-school visits during the Fall semester will be determined during the first few weeks of the semester and will depend, in large part, on the availability of each Bio-516A student's personal schedule and the schedule of classes taught by several participating high-school teachers. The timing of the high-school classes will not coincide with the timing of Bio-516A meetings. Dr. Hentschel will provide a personal note to any professors or employers

who might require an explanation of a student's absence. More importantly, Bio-516A students will have some choice regarding the exact day of a visit to a particular school. Dr. Hentschel anticipates that at total of 6-8 high-school visits might occur throughout the semester. Any Bio-516A student who participates effectively in more than the required one visit, which is likely to be an option, will be awarded 10 extra-credit points per each additional visit.

More information on these high-school demonstrations will be provided during the first few weeks of the Fall semester.

EEB Seminar Write Ups. The goals of this class are to promote active, student-driven learning and to expose students to the process by which scientific research is conducted, rather than just the facts that are the product of scientific research. At most universities, undergraduates' exposure to on-going research is very limited. Dr. Hentschel hopes to change that at SDSU!

On almost every Monday from 4:00-5:00pm in the Biosciences Center, the SDSU Biology Dept invites a speaker to describe his/her research in the field of Ecology & Evolutionary Biology. Topics range from microbes to large mammals and from molecular to global processes. This is an opportunity for students to hear (and meet!) leading biologists from around the country. On all Mondays, class will be dismissed at 3:55pm so students can attend that day's EEB Seminar.

The EEB-Seminar Assignment for Larval Ecology Students:

Students are expected to attend at least 3 of the EEB Seminars. Students are free to choose exactly which seminars they attend. If a seminar is cancelled (on rare occasions this can happen at the last minute), the student must attend another seminar (Don't wait until the last 3 wk of the semester to attend your first seminar!). Dr. Hentschel will share the updated schedule of the EEB Seminars at appropriate times throughout the semester.

For each seminar attended, the student must submit a 2-paragraph write up plus a list of 5 recent journal articles related to the topic. To receive credit, students *must* follow these guidelines:

1) The first paragraph (single spaced, < 300 words) must be a *brief* summary of the seminar (general topic, questions & hypotheses addressed, methods used, main conclusions, etc).

2) In the second paragraph (single spaced, < 400 words), the student will describe his/her original idea(s) concerning similar research that could be done involving marine invertebrate larvae (If a marine invertebrate larva is the focus of the speaker's research, students must describe how similar research could be done on the larvae of a different invertebrate taxon). Original ideas must be explained in some depth (i.e., several sentences), and this paragraph must include at least two parenthetical references to journal articles cited below (see component #3). Within the paragraph, there are generally two ways to cite specific literature. The most common is to include a parenthetical citation at the end of a sentence:

> "Benthic marine invertebrates typically have complex life cycles, most commonly with a pelagic larval phase (Thorson 1950, Strathmann 1993, Pechenik et al. 1998, Pechenik 1999, Hentschel and Emlet 2000)." (The latin "et al." is an abbreviation for more than two authors.)

Instead of citing literature at the end of a sentence, sometimes the phrasing is better if papers by specific authors are cited directly within the sentence:

> "Although Alford and Harris (1988) argued that their results support the model of Wilbur and Collins (1973), I agree with Leips and Travis (1994); the accumulated data show that the timing of metamorphosis becomes fixed during the late portion of the larval phase."

3) Each student must provide complete citations for at least 5 journal articles related to the seminar topic and the student's original idea for applying the seminar to marine invertebrate

larvae. Literature might relate to the taxon of interest, methods, biological significance, etc. *Only papers published since 1997 should be cited, and at least two of the references must relate to and be cited in the student's original idea (i.e., paragraph #2)*. To receive credit, each citation in the list *must* be formatted exactly as in any recent issue of the journal *Ecology,* which the SDSU library subscribes to. For example:

Hentschel, B. T., and R. B. Emlet. 2000. Metamorphosis of barnacle nauplii: effects of food variability and a comparison with amphibian models. Ecology. **81**:3495-3508.

Pechenik, J. A., D. E. Wendt, and J. N. Jarrett. 1998. Metamorphosis is not a new beginning. Bioscience **48**:901-910.

Each write-up will be worth 15 pts (5pts for each of the 3 components). To be graded, a write-up must be submitted to Dr. Hentschel as a MS Word Document *AND* a PDF file via the Digital Drop Box feature of the Blackboard site (in the "Tools" menu). The files should be named with the student's last name followed by an underscore, the seminar speaker's last name, and the file extension ".doc" or ".pdf" (e.g., a student named John Smith who was submitting a write-up of an EEB Seminar presented by Dr. James Estes would name their files **smith_estes.doc** *and* **smith_estes.pdf**). Each write up must be sent to the Digital Drop Box no later than 3:00pm the Friday after the particular seminar. *NOTE:* submitting both a .doc and a .pdf version of the same file via the Bb Digital Drop Box might seem like a pain in the ass, *but* part of this assignment is designed to provide practice and troubleshooting for submitting proposals and Peer Reviews in formats that will facilitate smooth and easy Panel Discussions at the end of the semester. Students are welcome to attend more than 3 EEB Seminars and submit more than 3 write-ups during the semester; the highest 3 scores will count towards a student's overall course grade.

The ***Final Exam Period*** (M Dec 13 1:00-3:00) will be dedicated to a summary discussion of the research proposals and plans for having teams of students enrolled in the spring-semester course conduct some of the proposed laboratory experiments. Students also will be able to turn in a revised version of their written research proposal during this required class meeting.

Lecture, Discussion, and Lab Schedule

Week	Date	Topic(s)	Chapter in Young (2002).
1	M Aug 30	Course Introduction Lab: Use of microscopes & Review of major invertebrate taxa	
	W Sep 1	Lecture: Review of invertebrate phylogenies	
2	*M Sep 6*	*Labor Day Holiday – No Class*	
	W Sep 8	Lecture: Introduction to common larval forms & nutritional modes	1
3	M Sep 13	Lecture: Evolution & ecology of complex life cycles Lab: Examining larvae in natural plankton tows, Culturing phytoplankton.	
	W Sep 15	Lecture: Oceanographic patchiness & pelagic dispersal of larvae	
4	M Sep 20	**Exam 1** Discussion: Developing research proposals Lab: Library skills	
	W Sep 22	*No Class Meeting. Students start searching for literature on research topics.*	
5	M Sep 27	Paper discussions: CLCs in variable environments. Lab: Dissections and anatomy of common invertebrates	
	W Sep 29	Lecture: Echinoderms: Ophiuroidea, Asteroidea, Holothuroidea, Echinoidea TBA: Maintenance of phytoplankton cultures & Microscope image analysis	25, 26, 27, 28
6	M Oct 4	Paper discussions: echinoid larvae Lab: sea urchin & sand dollar spawning, culturing phytoplankton	
	W Oct 6	Porifera & Cnidaria **General proposal topics due** TBA: Maintenance of echinoderm cultures, phytoplankton culture density	2, 3
7	M Oct 11	Paper discussions: Coral larvae Lab: Analysis of echinoid survival & density, phytoplankton growth curves	
	W Oct 13	Lecture: Polychaeta. TBA: Phytoplankton growth curves	12
8	M Oct 18	Paper discussions: Polychaete larvae Discussion: Proposal outlines Lab: Polychaete families, brooding *Spirorbis*, spawning *Phragmatopoma*	
	W Oct 20	Lecture: Gastropoda. TBA: Poly cultures	14
9	M Oct 25	Paper discussions: Gastropod larvae **Proposal outlines due** Lab: Crepidula mating stacks, hatching gastropod egg cases.	
	W Oct 27	**Exam 2** Lecture: Bivalvia TBA: Maintain gastropod veliger cultures	15
10	M Nov 1	Paper discussions: Bivalve larvae. Discuss: 1st draft of research proposals Lab: Spawning mussels & Culturing *Artemia* as food for carnivorous larvae	
	W Nov 3	Lecture: Crustacea. TBA: Feeding cultures of mussels and *Artemia*	17
11	M Nov 8	**Draft proposal due** Paper discussions: Barnacle larvae. Lab: Culturing barnacles or crab larvae	
	W Nov 10	Lecture: Intro to Statistics & Experimental Design TBA: Culturing mussels, barnacles, or crab larvae	
	Nov 12-14	*Western Society of Naturalists Meeting in San Diego (Extra Credit TBA)*	
12	M Nov 15	Paper discussions: Barnacle larvae. Lab: analysis of barnacle or crab cultures: survival & density	
	W Nov 17	*No Class Meeting: Students should work on proposals* TBA: Lab analysis of barnacle or crab cultures: survival & density	
	F Nov 19	**Complete written proposal due in Bb Digital Drop Box by 4pm**	
13	M Nov 22	Paper discussions: crustacean larvae. Discussion: How to write effective peer reviews Lab: analysis of barnacle or crab cultures: survival & density	
	W Nov 24	**Proposals distributed for written peer review**	
14	M Nov 29	Lecture: Predation on invertebrate larvae & larval defenses **Written peer reviews due.** Discussion of panel-review format and goals Lab: Urchin & sand dollar spawning (2nd time)	
	W Dec 1	Lecture: Larval settlement & recruitment (i.e., larvae that graduate!) **Proposals distributed for panel reviews.** TBA: echinoid cultures	
15	M Dec 6	**Panel-Review Discussions of Research Proposals**	
	W Dec 8	**Exam 3** TBA: echinoid cultures	
Final Exam	M Dec 13 1:00-3:00	**Revised written proposals due** Summary Discussion of proposals & upcoming Spring Course	