

Submit original with signatures + 1 copy + electronic copy to UAF Governance.

See <http://www.uaf.edu/uafgov/faculty/cd> for a complete description of the rules governing curriculum & course changes.

TRIAL COURSE OR NEW COURSE PROPOSAL

SUBMITTED BY:

Department	GPMSL	College/School	SFOS
Prepared by	Sarah M. Hardy	Phone	907-474-7616
Email Contact	smhardy@alaska.edu; cneumann@alaska.edu	Faculty Contact	Sarah M. Hardy

1. ACTION DESIRED (CHECK ONE): Trial Course New Course

2. COURSE IDENTIFICATION: Dept Course # No. of Credits

Justify upper/lower division status & number of credits: **This is an upper division / graduate level course aimed at students with a substantial background in biology and marine science, beyond the level of most lower division students. The course is comprised of 3 hours of lecture per week.**

3. PROPOSED COURSE TITLE:

4. CROSS LISTED? YES/NO If yes, Dept: Course #
(Requires approval of both departments and deans involved. Add lines at end of form for such signatures.)

5. STACKED? YES/NO If yes, Dept. Course #

6. FREQUENCY OF OFFERING:
(Every or Alternate) Fall, Spring, Summer — or As Demand Warrants

7. SEMESTER & YEAR OF FIRST OFFERING (if approved)

8. COURSE FORMAT:

NOTE: Course hours may not be compressed into fewer than three days per credit. Any course compressed into fewer than six weeks must be approved by the college or school's curriculum council. Furthermore, any core course compressed to less than six weeks must be approved by the core review committee.

COURSE-FORMAT: (check one) 1 2 3 4 5 6 weeks to full semester

OTHER FORMAT (specify)
Mode of delivery (specify lecture, field trips, labs, etc)

9. CONTACT HOURS PER WEEK: LECTURE hours/weeks LAB hours/week PRACTICUM hours/week

Note: # of credits are based on contact hours. 800 minutes of lecture=1 credit. 2400 minutes of lab in a science course=1 credit. 1600 minutes in non-science lab=1 credit. 2400-4800 minutes of practicum=1 credit. 2400-8000 minutes of internship=1 credit. This must match with the syllabus. See <http://www.uaf.edu/uafgov/faculty/cd/credits.html> for more information on number of credits.

OTHER HOURS (specify type)

10. COMPLETE CATALOG DESCRIPTION including dept., number, title and credits (50 words or less, if possible):

**MSL 612F Early life histories of marine invertebrates
3 credits Offered Fall
This course will explore the diversity of reproductive strategies and larval forms in marine invertebrates, and consider selective pressures governing the evolution of these forms. Topics include: larval ecology and evolution; environmental constraints on early life-histories; sources of larval mortality; dispersal and recruitment.**

11. **COURSE CLASSIFICATIONS:** (undergraduate courses only. Use approved criteria found on Page 10 & 17 of the manual. If justification is needed, attach on separate sheet.)

H = Humanities N = Natural Science S = Social Sciences

Will this course be used to fulfill a requirement for the baccalaureate core? YES NO

IF YES, check which core requirements it could be used to fulfill:

O = Oral Intensive, Format 6 W = Writing Intensive, Format 7 Natural Science, Format 8

12. **COURSE REPEATABILITY:**

Is this course repeatable for credit? YES NO

Justification: Indicate why the course can be repeated (for example, the course follows a different theme each time).

How many times may the course be repeated for credit?

TIMES

If the course can be repeated with variable credit, what is the maximum number of credit hours that may be earned for this course?

CREDITS

13. **GRADING SYSTEM:**

LETTER: PASS/FAIL:

RESTRICTIONS ON ENROLLMENT (if any)

14. **PREREQUISITES**

These will be required before the student is allowed to enroll in the course.

RECOMMENDED

Graduate standing (600-level) or instructor permission; Invertebrate zoology

Classes, etc. that student is strongly encouraged to complete prior to this course.

15. **SPECIAL RESTRICTIONS, CONDITIONS**

16. **PROPOSED COURSE FEES**

none

Has a memo been submitted through your dean to the Provost & VCAS for fee approval? Yes/No

17. **PREVIOUS HISTORY**

Has the course been offered as special topics or trial course previously? Yes/No

Yes

If yes, give semester, year, course #, etc.:

Spring 2010 (MSL 693)

18. **ESTIMATED IMPACT**

WHAT IMPACT, IF ANY, WILL THIS HAVE ON BUDGET, FACILITIES/SPACE, FACULTY, ETC.

None. Sarah Hardy, the instructor for this course, has been hired by SFOS, and this course will serve as one of the 2 - 3 courses she is required to teach each academic year. No specialized facilities are required for this course.

19. **LIBRARY COLLECTIONS**

Have you contacted the library collection development officer (ffklj@uaf.edu, 474-6695) with regard to the adequacy of library/media collections, equipment, and services available for the proposed course? If so, give date of contact and resolution. If not, explain why not.

No

Yes

During the period when this course was offered as a "special topics" course, continuous communication was maintained with Anne Christie in the BioSci library. Anne has received a copy of the syllabus and tentative reading list, and it was determined that all reading materials needed are available through the library. Special assistance with student research projects will be provided as needed.

20. **IMPACTS ON PROGRAMS/DEPTS**

What programs/departments will be affected by this proposed action? Include information on the Programs/Departments contacted (e.g., email, memo)

The MSL program will be impacted by an increase in the diversity of course offerings available to graduate students. Topics covered will also be of interest to FISH students, particularly for those interested in aquaculture and shellfish resources, and the course will thus also add breadth to the available courses for undergraduate fisheries majors.

21. **POSITIVE AND NEGATIVE IMPACTS**

Please specify **positive and negative** impacts on other courses, programs and departments resulting from the proposed action.

The MSL program has identified a need for this specialized course to serve their graduate students, and thus a faculty position was created for an instructor with expertise in this field to develop just such a course. The course is therefore expected to closely complement the existing course requirements in MSL and address a specific gap within the program. No negative impacts are expected from this course.

JUSTIFICATION FOR ACTION REQUESTED

The purpose of the department and campus-wide curriculum committees is to scrutinize course change and new course applications to make sure that the quality of UAF education is not lowered as a result of the proposed change. Please address this in your response. This section needs to be self-explanatory. Use as much space as needed to fully justify the proposed course.

Understanding the processes that influence survival and movement of larval forms is essential to a wide variety of current issues in marine ecology, particularly in Alaskan waters, including invasive species, climate impacts on species ranges, fisheries resource management, and establishment of marine reserves. This course will give students an in-depth exposure to this important topic, which is currently only briefly dealt with in survey courses, and is thus expected to become a central component of the graduate coursework for marine biology and biological oceanography students in the MSL program.

APPROVALS:

Signature, Chair, Program/Department of: Jert Sutt for Katin Iken Date: 8/23/2010
G PMSL

Signature, Chair, College/School Curriculum Council for: Jert Sutt Date: 8/23/2010
SFOs

Signature, Dean, College/School of: [Signature] Date: 8/28/10
OSMS

Signature of Provost (if applicable) Date:

Offerings above the level of approved programs must be approved in advance by the Provost.

ALL SIGNATURES MUST BE OBTAINED PRIOR TO SUBMISSION TO THE GOVERNANCE OFFICE

Signature, Chair, UAF Faculty Senate Curriculum Review Committee Date:

ADDITIONAL SIGNATURES: (If required)

Signature, Chair, Program/Department of: Date:

Signature, Chair, College/School Curriculum Council for: Date:

Signature, Dean, College/School of: Date:

ATTACH COMPLETE SYLLABUS (as part of this application).

Note: syllabus must follow the guidelines discussed in the Faculty Senate Guide <http://www.uaf.edu/uafgov/faculty/cd/syllabus.html>. The department and campus wide curriculum committees will review the syllabus to ensure that each of the items listed below are included. If items are missing or unclear, the proposed course change will be denied.

SYLLABUS CHECKLIST FOR ALL UAF COURSES

During the first week of class, instructors will distribute a course syllabus. Although modifications may be made throughout the semester, this document will contain the following information (as applicable to the discipline):

1. Course information:

Title, number, credits, prerequisites, location, meeting time
(make sure that contact hours are in line with credits).

2. Instructor (and if applicable, Teaching Assistant) information:

Name, office location, office hours, telephone, email address.

3. Course readings/materials:

Course textbook title, author, edition/publisher.
 Supplementary readings (indicate whether required or recommended) and
 any supplies required.

4. Course description:

Content of the course and how it fits into the broader curriculum;
 Expected proficiencies required to undertake the course, if applicable.
 Inclusion of catalog description is *strongly* recommended, and
 Description in syllabus must be consistent with catalog course description.

5. Course Goals (general) and Student Learning Outcomes (more specific)

6. Instructional methods:

Describe the teaching techniques (eg: lecture, case study, small group discussion, private instruction, studio instruction, values clarification, games, journal writing, use of Blackboard, audio/video conferencing, etc.).

7. Course calendar:

A schedule of class topics and assignments must be included. Be specific so that it is clear that the instructor has thought this through and will not be making it up on the fly (e.g. it is not adequate to say "lab". Instead, give each lab a title that describes its content). You may call the outline Tentative or Work in Progress to allow for modifications during the semester.

8. Course policies:

Specify course rules, including your policies on attendance, tardiness, class participation, make-up exams, and plagiarism/academic integrity.

9. Evaluation:

Specify how students will be evaluated, what factors will be included, their relative value, and
 how they will be tabulated into grades (on a curve, absolute scores, etc.)

10. Support Services:

Describe the student support services such as tutoring (local and/or regional) appropriate for the course.

11. Disabilities Services:

The Office of Disability Services implements the Americans with Disabilities Act (ADA), and insures that UAF students have equal access to the campus and course materials.

State that you will work with the Office of Disabilities Services (203 WHIT, 474-7043) to provide reasonable accommodation to students with disabilities."

MSL 612: Early Life Histories of Marine Invertebrates

Instructor: Dr. Sarah M. Hardy
School of Fisheries and Ocean Sciences
233 Irving II
907-474-7616
smhardy@alaska.edu

Class meeting times: T/Th 3:30 – 5:10
Location: TBA
Office hours: By appointment

Prerequisites: Graduate standing; upper-division undergraduates with permission of instructor. *Recommended:* Invertebrate Zoology or Marine Ecology Field Course

Course Description

This will provide advanced students in marine science with an in-depth look at the reproductive biology of marine invertebrates. We will explore invertebrate reproduction, from the production of eggs and sperm to the successful transformation into the juvenile form, and all steps in between. Throughout this course we will consider environmental constraints on reproduction and larval ecology, and their effects on the evolution of early life-history strategies in the marine environment. The production, movement, and survival of larval forms is a central theme in many current issues in marine ecology, including invasive species, establishment of marine reserves, and impacts of climate change on marine communities. This course thus aims to provide students with a solid understanding of reproductive ecology, and an opportunity to critically examine current research in the field. The course will be structured in a lecture format, but will include regular group discussions of the primary literature.

Learning Objectives

1. Identify typical invertebrate larval forms, become familiar with the classification schemes used to describe larvae, and understand the role of larval forms in defining invertebrate taxonomic relationships.
2. Become familiar with the basic biological processes of gamete production, fertilization, embryogenesis, and larval development in marine invertebrates.
3. Examine the influence of environmental variables on larval development, dispersal and recruitment, and consider the potential effects of these variables on the evolution of marine life-history strategies.
4. Critically evaluate and discuss current research topics in which marine life-history strategies play an important role.
5. Explore current research methods relevant to life-history studies.

Course Policies and Requirements

Check your email regularly, and be sure I have your current contact information throughout the semester. Class information, updates, readings, and changes to the schedule will be distributed via email.

Class participation and active engagement in **group discussions** (including those associated with student presentations—see below) is expected from ALL students. Points for class participation will be applied toward the final grade, as indicated below. Key ideas presented in group discussions can also be expected to appear on exams.

Two **midterms** and one **final exam** will be given during the course. These exams will be written, closed-book, short-answer and/or essay exams, and must be completed during the normal class period. The final exam will include material presented throughout the semester, but will be weighted toward material covered after the midterm.

Homework assignments may be made during the semester. Students are encouraged to collaborate on these assignments where appropriate, but each student will be responsible for submitting his/her own completed assignment at the requested time. Late assignments will not be accepted unless prior approval is obtained from the instructor.

Group Discussions

Plan on discussing as many as two readings from the primary literature during each lecture session at a *maximum*, although we will probably not have time to discuss two readings every class period. Readings will be selected by the instructor, unless otherwise noted, and will be distributed via email a week in advance. All students will be expected to participate in discussions. This process is very important in developing a command of the scientific literature and identifying factors that will make our own writing interesting, effective, and publishable—PLEASE BE PREPARED. When preparing for these sessions, ask yourself the following questions, which we will use as a guide for our discussion:

- Why was this reading assigned? What is the relevance to the lecture topic?
- What is the purpose of the paper? Is the purpose clearly stated? Justified?
- Question/Objective/Hypotheses: Is the question or hypothesis well-stated? Is it relevant to the stated purpose?
- Methods: Are the methods sound? Are they appropriate to the hypothesis stated? What would you do differently? What assumptions are inherent in the methods? Are these assumptions reasonable/acceptable/justified?
- Results: What are the key results? Do they address the stated hypothesis? Was the hypothesis accepted/rejected? Do the figures present the results clearly? Identify figures that are especially useful in conveying the important findings—what do you like about them? What do they tell you?
- Discussion: Do the conclusions follow from the results? Are they presented in a broader context of other work done in the field? Are there broader implications for the field of marine science/biology/fisheries? Are the results relevant in any way to your own work? Are there any major questions suggested by the findings? What would you propose as 'the next step' for this line of research?

- General editorial critique: Was the paper easy to follow? Why or why not? Was there information missing that would have helped clarify any aspect of the study? Did each section of the paper contain the appropriate material? Were the figures clear, useful, and easy to interpret?

Readings

No textbook is required for this course; readings will be assigned from the primary literature. All readings will either be distributed via email, or placed on **eReserves** (<http://eres.uaf.edu/eres/default.aspx>) [**PASSWORD: larvae**]. In addition to required discussion readings, I will provide a general **review paper or book chapter** for each topic wherever possible. These review papers are listed on the lecture schedule below. A **master reading list** organized by topic will also be distributed to you and updated periodically throughout the semester. This list will contain citations for all references provided to you, those cited in lectures and any additional papers of potential interest. If you have trouble obtaining any of these references from the library, let me know and I will help you to obtain a copy.

PLEASE NOTE: You are young professional scientists, and as such, a command of the current literature in your field is essential, as is an ability to allocate your time in the most effective manner. *I will thus expect you to take responsibility for deciding how and where to spend your time on readings.* Here are a few guidelines:

- Readings from the published scientific literature will be discussed in class, as described above. In preparing exam questions, I WILL assume you are familiar with the general concepts and ideas presented in these readings. I WILL NOT expect you to recall detailed information about, e.g., specific figures, etc.
- Review papers may be used in lieu of a text book. How you use them is up to you. If you feel you need a source of additional background reading on lecture topics, skim the reviews for relevant points. If not, consider them an addition to your personal library.
- I will present results and ideas from the relevant scientific literature in lectures, and will provide citations on the slides wherever appropriate. If I mentioned it in class, that probably means I think it is important, so refer to the master reading list if you missed something or want to take a closer look at an original source mentioned in lecture.

Several useful (but not required) **texts** are listed below. These books will be placed on physical reserve at the UAF BioSci Library for the entire semester. An invertebrate zoology text (e.g., Brusca & Brusca) is recommended and should be in the library of all marine biology students; if you do not already own one, you may want to consider a purchase (used copies can often be found for low prices):

Brusca, R.C. & Brusca, G.J. (2003) *Invertebrates*. Sinauer & Associates, Inc., Sunderland, MA, 936 pp.
[This quintessential invertebrate zoology text should be in every marine biologist's personal library! Useful chapters include Ch. 4 on reproduction and larval forms.]

- McEdward, L. (1995) Ecology of Marine Invertebrate Larvae. CRC Press, Boca Raton, 464 pp. [A collection of review papers that summarize many of the topics we will cover in this course. Although these papers are several years old, they are still useful as reviews of the "classic" literature.]
- Gilbert, S.F. (2006) Developmental Biology. Sinauer & Associates, Inc., Sunderland, MA, 817 pp. [A developmental biology text with more detailed information on early embryology, including gene expression, cell communication, and other topics of potential interest.]
- Young, C. M., Sewell, M. A. & Rice, M. E. (2002) Atlas of Marine Invertebrate Larvae. Academic Press, San Diego, 626 pp. [A beautiful illustrated atlas of larval forms organized by phyla, with good general information about the life-cycle of each group.]

Student Presentations: An assignment for a presentation will be made in the first week of the course. The specific topics of these presentations will be chosen by the students with guidance from the instructor. Students are expected to present a general introduction to the chosen topic, and are encouraged to relate the topic to their own research. Presentations will be approximately 30 minutes in length. In addition, students will *assign a relevant paper* on the topic presented, and lead a group discussion on the paper per the usual protocol. We will all provide reviews of each student presentation using a standard form that will be distributed in class. Reviews will be collected by the instructor after each presentation and comments provided to the speaker. If you wish for your comments to remain anonymous, please notify the instructor when handing in your review sheet.

A note about plagiarism: Plagiarism will not be tolerated in any way during this course. All assignments are expected to consist of students' original ideas and/or information from *properly cited* published sources. Students may seek assistance with proper referencing of scientific literature from the instructor as needed.

Grading

Grades will be determined based on the absolute points awarded for the following requirements:

	<u>Possible points</u>	<u>% of total</u>
Class participation (attendance, preparedness, etc.)	50	10
Homework assignments	50	10
Midterm1	100	20
Midterm 2	100	20
Presentation	100	20
Final exam	100	20
Total	500 pts.	100%

Semester grades will be assigned according to the following scale:

A+ 98-100%	A 93-97%	A- 90-92%	
B+ 87-89%	B 83-86%	B- 80-82%	
C+ 77-79%	C 73-76%	C- 70-72%	
D+ 67-69%	D 63-66%	D- 60-62%	F <60%

Support and Disability Services

The Office of Disability Services (203 WHIT; 474-5655; fydso@uaf.edu) implements the Americans with Disabilities Act and insures that UAF students have equal access to the campus and course materials. Students with physical or learning disabilities should contact this office, or the instructor, as soon as possible so that suitable arrangements can be made to accommodate specialized needs.

Lecture Schedule (**Subject to change**):

Week	Date	Lecture Topic	Assignments/Readings
1	9/2	Introductions, Course overview and goals	
2	9/7	Invertebrate zoology review; Classification of life-history modes	Brusca & Brusca Ch. 4; McEdward Ch. 1
	9/9	Embryology review; Generalized larval forms	Nielsen 1998
3	9/14	Origin of complex life cycles: Why are there larvae?	McEdward Ch. 13
	9/16	Diversity of life-history modes	Young et al. 2002 text as needed
4	9/21	Diversity of life-history modes (cont.)	
	9/23	Diversity of life-history modes (cont.)	
5	9/28	Guest lecture (Katrin Iken): Reproduction in macroalgae	
	9/30	Evolutionary transitions in life-history modes	McEdward Ch. 3
6	10/5	Midterm #1	
	10/7	Evolution of brooding	Strathmann & Strathmann 1982
7	10/12	Egg size models	McEdward Ch. 2
	10/14	Larval mortality and selective pressures	Strathmann 2007
8	10/19	Fertilization; gamete competition; sexual selection	Levitan 1998; Yund 2000
	10/21	Special topics: Reproduction in the deep-sea	Young 2004
9	10/26	Maternal investment; Gametogenesis and spawning	McEdward Ch. 5; Marshall et al. 2008
	10/28	Larval diet and nutrition	McEdward Ch. 7
10	11/2	Latent effects of larval experience	Pechenik 2006
	11/4	Larval swimming and feeding; Boundary layer processes	Metaxas 2001
11	11/9	Midterm #2	
	11/11	Special topics: Ocean acidification effects on larvae	Dupont & Thorndyke 2009

12	11/16	Larval dispersal: Physical processes and population connectivity	
	11/18	Larval dispersal, range size, and population effects	Shanks 2009
13	11/23	Guest lecture (Georgina Gibson): Dispersal modeling	
	11/25	Recruitment processes: Larval behavior and habitat selection	Elkin & Marshall 2007
14	11/30	Recruitment and population dynamics	Menge 2000
	12/2	Special topics: Marine protected area design principles	Gaines et al. 2007
15	12/7	Student presentations	
	12/9	Student presentations	
16		Final exam	

Recommended Reading List

Assigned readings are indicated with asterisks (**). Readings available on eReserves are preceded by [R]. The remaining references are suggested supplementary readings that may be of interest, including "classic" papers and citations presented in lectures. *This is a preliminary list that will be updated and revised throughout the semester.*

Useful General Texts

- Brusca, R.C. & Brusca, G.J. (2003) *Invertebrates*. Sinauer & Associates, Inc., Sunderland, MA, 936 pp.
- Gilbert, S.F. (2006) *Developmental Biology*. Sinauer Associates, Inc., Sunderland, MA, 817 pp.
- Nielsen, C. (2001) *Animal Evolution: Interrelationships of the living phyla*. Oxford University Press, Oxford, 563 pp.
- Shanks, A.L. (2001) *An identification guide to the larval marine invertebrates of the Pacific Northwest*. Oregon State University Press, Corvallis, OR, 314 pp.
- Young, C. M., Sewell, M. A. & Rice, M. E. (2002) *Atlas of Marine Invertebrate Larvae*. Academic Press, San Diego, 626 pp.

Embryology and origins of the metazoa

- Chen, J.-Y., Oliveri, P., Li, C.-W., Zhou, G.-Q., Gao, F., Hagadorn, J. W., Peterson, K. J. & Davidson, E. H. (2000) Precambrian animal diversity: Putative phosphatized embryos from the Doushantuo Formation of China. *Proc Nat Acad Sci*, **97**, 4457-4462.
- Degnan, S. M. & Degnan, B. M. (2006) The origin of the pelagobenthic metazoan life cycle: what's sex got to do with it? *Integrative & Comparative Biology*, **46**, 683-690.
- Marshall, C. R. (2006) Explaining the Cambrian "explosion" of animals. *Annual Review of Earth and Planetary Sciences*, **34**, 355-384.
- Nielsen, C. (1994) Larval and adult characters in animal phylogeny. *American Zoologist*, **34**, 492-501.
- **Nielsen, C. (1998) Origin and evolution of animal life cycles. *Biological Reviews*, **73**, 125-155.
- Nielsen, C. (2008) Six major steps in animal evolution: are we derived sponge larvae? *Evolution & Development*, **10**, 241-257.
- Rieger, R. M. (1994) The biphasic life cycle: A central theme of metazoan evolution. *American Zoologist*, **34**, 484-491.
- Sly, B. J., Snoke, M. S. & Raff, R. A. (2003) Who came first--larvae or adults? Origins of bilaterian metazoan larvae. *International Journal of Developmental Biology*, **47**, 623-632.

Diversity and classification of life-history modes

- Bishop, C. D., Erezylmaz, D. F., Flatt, T., Georgiou, C. D., Hadfield, M. G., Heyland, A., Hodin, J., Jacobs, M. W., Maslakova, S. A., Pires, A., Reitzel, A. M., Santagata, S., Tanaka, K. & Youson, J. H. (2006) What is metamorphosis? *Integrative & Comparative Biology*, **46**, 655-661.
- Byrne, M. (2006) Life history diversity and evolution in the Asterinidae. *Integrative and Comparative Biology*, **46**, 243-254.
- Chia, F. S. (1974) Classification and adaptive significance of developmental patterns in marine invertebrates. *Thalassia Jugoslavica*, **10**, 121-130.
- Galley, E. A., Tyler, P. A., Clarke, A. & Smith, C. R. (2005) Reproductive biology and biochemical composition of the brooding echinoid *Amphipneustes lorioli* on the Antarctic continental shelf. *Marine Biology*, **148**, 59-71.
- **Gibson, G. D. & Gibson, A. J. F. (2004) Heterochrony and the evolution of poecilogony: Generating larval diversity. *Evolution*, **58**, 2704-2717.
- Grahame, J. & Branch, G. M. (1985) Reproductive patterns of marine invertebrates. *Oceanography and Marine Biology: an Annual Review*, **23**, 373-398.

- [R] Hickman, C. S. (1999) Larvae in invertebrate development and evolution. *The Origin and Evolution of Larval Forms* (ed. by B.K. Hall & M.H. Wake), pp 21-59. Academic Press, San Diego, CA.
- **[R] Levin, L. A. & Bridges, T. S. (1995) Pattern and diversity in reproduction and development. *Ecology of Marine Invertebrate Larvae* (ed. by L. McEdward), pp 1-48. CRC Press, Boca Raton, FL.
- McEdward, L. R. & Janies, D. A. (1993) Life cycle evolution in Asteroids: What is a larva? *Biological Bulletin*, **184**, 255-268.
- McEdward, L. R. (1995) Evolution of pelagic direct development in the starfish *Pteraster tesselatus* (Asteroidea: Velatida). *Biological Journal of the Linnean Society*, **54**, 299-327.
- McEdward, L. R. & Miner, B. G. (2001) Larval and life-cycle patterns in echinoderms. *Canadian Journal of Zoology*, **79**, 1125-1170.
- Mileikovskiy, S. A. (1971). Types of larval development in marine bottom invertebrates, their distribution and ecological significance: a re-evaluation. *Marine Biology*, **10**: 193-213.
- Rouse, G., Wilson, N., Goffredi, S., Johnson, S., Smart, T., Widmer, C., Young, C. & Vrijenhoek, R. (2009) Spawning and development in *Osedax* boneworms (Siboglinidae, Annelida). *Marine Biology*, **156**, 395-405.
- Rouse, G. W., Goffredi, S. K. & Vrijenhoek, R. C. (2004) *Osedax*: Bone-eating marine worms with dwarf males. *Science*, **305**, 668-671.
- Rouse, G. W., Worsaae, K., Johnson, S. B., Jones, W. J. & Vrijenhoek, R. C. (2008) Acquisition of dwarf male "harems" by recently settled females of *Osedax roseus* n. sp. (Siboglinidae; Annelida). *Biol Bull*, **214**, 67-82.
- Strathmann, R. R., Fenaux, L. & Strathmann, M. F. (1992) Heterochronic developmental plasticity in larval sea urchins and its implications for evolution of nonfeeding larvae. *Evolution*, **46**, 972-986.
- Thorson, G. (1950) Reproductive and larval ecology of marine bottom invertebrates. *Biological Reviews of the Cambridge Philosophical Society*, **25**, 1-45.
- Evolution of complex life-cycles and larval forms; Selective pressures on life-history modes**
- Chia, F. S. (1974) Classification and adaptive significance of developmental patterns in marine invertebrates. *Thalassia Jugoslavica*, **10**, 121-130.
- Collin, R., Chaparro, O. R., Winkler, F. & Veliz, D. (2007) Molecular phylogenetic and embryological evidence that feeding larvae have been reacquired in a marine gastropod. *Biol Bull*, **212**, 83-92.
- Gillespie, J. M. & McClintock, J. B. (2007) Brooding in echinoderms: How can modern experimental techniques add to our historical perspective? *Journal of Experimental Marine Biology and Ecology*, **342**, 191-201.
- Havenhand, J. N. (1993) Egg to juvenile period, generation time, and the evolution of larval type in marine invertebrates. *Marine Ecology Progress Series*, **97**, 247-260.
- **[R] Havenhand, J. N. (1995) Evolutionary ecology of larval types. *Ecology of Marine Invertebrate Larvae* (ed. by L. McEdward), pp 78-122. CRC Press, Boca Raton.
- [R] Hickman, C. S. (1999) Larvae in invertebrate development and evolution. *The Origin and Evolution of Larval Forms* (ed. by B.K. Hall & M.H. Wake), pp 21-59. Academic Press, San Diego, CA.
- Laptikhovskiy, V. (2006) Latitudinal and bathymetric trends in egg size variation: a new look at Thorson's and Rass's rules. *Marine Ecology*, **27**, 7-14.
- McEdward, L. R. (2000) Adaptive evolution of larvae and life cycles. *Seminars in Cell & Developmental Biology*, **11**, 403-409.
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MINOR

Curriculum Committee SFOS

Members: Trent Sutton (Chair)
Katrin Iken
Jeremy Mathis

19 August 2010

Trial Course

Course Number: MSL 612

Course Title: Early life-histories of marine invertebrates

Instructor: Sarah Hardy

First Time of Offering: No

General Recommendations:

The committee was very pleased with the attention to detail that Instructor Hardy maintained while preparing the course form and syllabus. Thank you!

Faculty Senate Form:

Clarify and Address the following:

- It was recommended that for the title, that the hyphen be removed between life and histories
- Please add Christina Neumann's email address (cneumann@alaska.edu) to the email contact line in addition to your email address

Syllabus:

- It was recommended that for the title, that the hyphen be removed between life and histories

EMJLAD 8/19/10

