

Mysid shrimp: A model for research-based laboratories in introductory biology

R.A. Bagnall, R.C. Rosell, D.R. Frohlich. Biology Department,
University of St. Thomas, 3800 Montrose Blvd., Houston, TX, 77006

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ABSTRACT

Americamysis (formerly Mysidopsis) bahia is a small Crustacean that lives in estuaries along the Gulf of Mexico and Atlantic coasts of the U.S. It is a sensitive ecological indicator of habitat quality (EPA approved) and we have used it as a model for undergraduate research. Because it is relatively easy to rear, and is available from Environmental consulting firms around the US that specialize in water quality analysis, we propose to develop the mysid system into an investigative tool for Introductory Biology labs and Intermediate Ecology studies. To date we have had experience with several aspects of mysid biology in an undergraduate research (but not formally instructional) venue: reproductive biology (behavior/isolation, rates, age-specific mortality) and comparison to a congener A. almyra (interspecific hybridization), predation (predators and prey: size, effects of light intensity), and effects of salinity and toxicity (fertilizers, crank-case oil). We are also nearing the completion of a pilot study of A. bahia population variability and have clones of PCR product from mitochondrial DNA markers (12S rDNA, 16S rDNA, cytochrome oxidases I and II) and nuclear markers (18 rDNA, ITS). We propose to develop a series of inquiry based laboratory exercises for Introductory Biology based on physiological, molecular, developmental, behavioral, and ecological studies of mysid shrimp. We will also give students an opportunity to collect and/or examine data using field and laboratory studies of mysid shrimp in ecology, marine biology, invertebrate zoology, evolution and other courses where such data or activities are applicable and useful.

INTRODUCTION

The University of St. Thomas is a small Liberal Arts institution with a student body of approximately 2400. Of those, some 1700 are undergraduates with approximately 65% being female and 32% racial minorities. The freshman class of 1994 illustrates how that trend is growing with 70% being female and 51% minority (29% Hispanic). Twelve percent of incoming freshmen indicated Biology as their major interest in 1994.

Currently our department is composed of approximately 150 undergraduate majors served by 5 full time faculty. We emphasize

zoology and there are no courses taught in plant biology. A large number of our majors are interested in the health professions, but a growing number have become keen to participate in research and are interested in graduate school. Approximately 15 current and former students are involved in research projects in our department. All projects involve some dimension of invertebrate biology and include not only mysids but several whiteflies, plant hoppers, and the Mediterranean fruitfly.

In 1994 we were awarded an Instrumentation and Laboratory Improvement (ILI) grant from NSF which, together with funds committed by our administration, completed a state-of-the-art Molecular Ecology facility. Shortly after the ILI was funded we underwent a departmental review that revitalized our program, established a new curriculum, and solidly grounded our approach to undergraduate education in research and investigation.

BIOLOGY OF MYSIDS

Mysids are small shrimp-like crustaceans in the Order Malacostraca. There are several genera and species that are abundant in bays and estuaries world wide, where they constitute a significant component of ecological communities. Previous studies have indicated that they are often an important food for commercially valuable fish and shrimp. In turn, they consume phytoplankton and zooplankton, as well as benthic algae and detritus. Early juveniles are planktonic, while older juveniles and adults are hypopelagic. They occupy habitats with a variety of substrates, including sand and mud, as well as submerged grass beds.

Mysids are sexually dimorphic, with females developing a conspicuous marsupium in which eggs and larvae are brooded for a period of time. Females also have shorter pleopods (abdominal appendages) than males. The young are released as juveniles, which resemble adult mysids, and after a short time assume the hypopelagic existence characteristic of adults. Mysid shrimp are easily distinguished from other shrimp-like crustaceans by the presence of a bead-like statocyst in the endopod of the uropod. Adult mysids of the genus Mysidopsis (and the newly designated genus Americamysis), which are often abundant in bays and

estuaries, are approximately 6 to 10 mm long, making them easy to see, handle, and maintain in relatively small aquaria.

Americamysis bahia has been a test organism for EPA toxicity testing for more than 15 years, and mysid shrimp have been successfully cultured in the laboratory since the early 1970s. They are easily cultured in simple systems and are very sensitive to environmental toxins. They have a short life cycle (mean lifespan = 90.7 +/- 33.7 days, generation time = 49.4 days), which facilitates studies of sublethal toxicity, in addition to short-term acute toxicity studies. A closely related species, Americamysis (Americamysis) almyra is also widely available, both in culture and in bays and estuaries.

We have successfully maintained both A. bahia and A. almyra at the University of St. Thomas since the mid-1980s, in 30 gal and 10 gal all-glass aquaria with under gravel filters beneath crushed oyster shell. All our cultures have been maintained in artificial seawater (Hawaiian Marine Imports Marinemix) made up with deionized water. We have also had good success maintaining mysids in natural seawater. Our mysids are fed newly hatched Artemia nauplii (1 or 2 days posthydration). We generally replace about 1/3 of the water biweekly, with more complete water changes and extensive cleaning of the tanks as needed (cleaning usually no more than once a year). We have had fewer problems with tank fouling since going to a system of hatching Artemia that involves an approximately hour-long decapsulating procedure that dissolves away the cyst coat with a chlorox-sodium hydroxide wash. The mysids are usually fed once or twice daily.

PAST AND CURRENT PROJECTS

Some of our recent past projects include:

1. A. bahia life table.
2. Effect of salinity on growth and reproduction.
3. Influence of a predator (Cyprinodon) on habitat preference

4. Factors affecting predation rate of A. bahia on Artemia.
5. Effect of light intensity on predation rate
6. Acute toxicity of fertilizer on A. bahia
7. Chronic effects of waste crankcase oil on A. bahia.
8. Interspecific hybridization and reproductive isolation between A. bahia and A. almyra.

Current projects include:

1. A re-examination of morphological similarities between A. bahia and A. almyra using parsimony.
2. Survey of A. bahia natural variability using PCR based genetic markers - see below.
3. Comparison of variability in corporate laboratory populations versus natural populations.
4. Development of mitochondrial and nuclear DNA markers: 12 S and 16S ribosomal DNA, cytochrome c oxidases I and II, 18S ribosomal DNA and an ITS (internal transcribed spacer).
5. Characterizing microbial endosymbionts.

SUGGESTED FUTURE PROJECTS FOR INVESTIGATIVE LABS

Because this system is so easy to manipulate we believe that it can be used as a model in several diverse fields: Physiology, Development, Ecology, Behavior, Molecular Biology, and Environmental Toxicology. With respect to Physiology some interesting projects and demonstrations might be done by examining O₂ consumption and the relative effects of temperature, salinity, light intensity, and sublethal exposure to a host of environmental pollutants. These could involve class or independent projects and might involve comparisons between age classes or brooding versus non-brooding individuals. Likewise, Developmental studies might

examine the effects of the same parameters on developmental rates or gonad development.

Probably one of the richest fields for investigative labs using the mysid model system is Ecology. For example, laboratories could be developed around predation on Artemia nauplii or copepods that include an examination of prey size classes and age classes, rates and/or the effects of numerous physical factors. Also, females brood eggs and we have been interested in studies on reproductive rates and sex ratio and investment. Ecological studies could also be approached from a molecular viewpoint and incorporate studies of variability that utilize RAPDs, fingerprinting, allozymes and make site (bay) or species group comparisons. Allied closely with Ecology are other investigative topics that include Behavior (mating, feeding preference studies and the effects of substrate, salinity, light intensity, predator presence) and Environmental Toxicology (pollutants and water quality).

In conclusion, the mysid shrimp model is a low maintenance, relatively inexpensive system that utilizes commercially available organisms whose biological features are amenable to manipulation. We hope to develop this system for use in introductory biology labs and as a model for sophomore/junior level investigation in Ecology.

Brief Bibliography of Mysid Culture and Basic Biology

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Ward, S. H. 1991. Techniques to enhance laboratory culture of *Mysidopsis bahia*. *American Fisheries Society Symposium* 9:182-191.

RESOURCES

1. To purchase or inquiry about adult mysids:

Aquatic BioSystems, inc.
1300 Blue Spruce Drive, Suite C
Fort Collins, CO 80524

Phone: (970) 484-5091 or Toll-Free 800/331-5916

Fax: (970) 484-2514

Email: absinfo@riverside.com

AquaTox

Phone: 501 767 9120

Hot Springs AR

2. To purchase or inquiry about Artemia:

Aquafauna Biomarine Inc.
P.O. Box 5, Hawthorne, CA 90250, U.S.A.
(310) 973-5275, FAX (310) 676-9387
Professional or Wholesale Sales Only

Aquatic Eco-Systems Inc.
1767 Benbow Court, Apopka, FL 32703, U.S.A
(407) 886-3939, (800) 422-3939, FAX (407) 886-6787
Retail & Professional or Wholesale Sales

Aquavet
2242 Davis Ct., Hayward, CA 94545, U.S.A.
(510) 782-4058, FAX (510) 784-0945
Professional or Wholesale Sales Only

Bonneville Artemia Intl. Inc.
P.O. Box 511113, Salt Lake City, UT 84151-1113, U.S.A.
(801) 972-4704, (800) 274-1047, FAX (801) 972-4795
Retail & Professional or Wholesale Sales

Golden West Artemia
P.O. Box 3593, Salt Lake City, UT 84104, U.S.A.
(801) 975-1222, FAX (801) 975-1444
Professional or Wholesale Sales Only

Kings Aquafeed Supply
101 Kitchener Road 03-30, Jalan Besar Plaza, Singapore 0820
065-2953348, FAX 065-2963580

Prime Artemia Inc.
1042 East Fort Union Blvd. Suite 400, Midvale, UT 84047, U.S.A.
(801) 978-9337, FAX (801) 978-9303

Salt Creek Inc.
946 West 1800 North, Salt Lake City, UT 84116, U.S.A.
(801) 363-0662, FAX (801) 363-0664

Retail & Professional or Wholesale Sales

Sanders Brine Shrimp Company
3850 S. 540 W., Ogden, UT 84405, U.S.A.
(801) 393-5027, FAX (801) 621-3825
Professional or Wholesale Sales Only

San Francisco Bay Brand Inc.
8239 Enterprise Drive, Newark, CA 94560, U.S.A.
(510) 792-7200, FAX (510) 792-5360
Professional or Wholesale Sales Only

3. Useful Websites:

<http://www.epa.gov/ged/search.htm>
<http://www.mdsg.umd.edu/extensionconf/summary.html>
<http://www.aqualink.com/marine/z-atemia.html>
<http://allserv.rug.ac.be/~jdcaluwe/james/courses/hatching/cyst7.html>
<http://allserv.rug.ac.be/~jdcaluwe/james/courses/hatching/cyst20.htm>
http://www.dep.state.fl.us/biology/biol/SOP_HTMLs/Toxicity_Assessment/TA0703.html