

International workshop on marine invertebrates: Future directions of multidisciplinary research in larviculture

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The culture of invertebrate larvae, either for research, commercial aquaculture or biotechnology, is dependent on a number of important factors. These include providing optimal technological and environmental conditions, adequate nutrition in terms of quantity and quality of the diet for larvae and parent broodstock, disease control and other environmental, physiological and genetic factors.

The larval stage is a critical phase in the life cycle of many species that affects various aspects of developmental success in subsequent life stages (juvenile and adults). A better understanding of the factors involved in larval development, including their role and their importance during development, will allow perspectives for model simulation of responses to changing conditions during larval development and culture. Results from laboratory and field experiments will be essential to model simulation.

A workshop (*International Workshop of Larviculture in Marine Invertebrates*) held in Puerto Montt, Chile from January 7-11, 2002 (Universidad Austral de Chile, 2002), presented a unique opportunity to gather together foreign specialists and Chilean researchers in order to exchange information and experience on marine mollusc, crustacean and echinoderm larviculture. The main objective was to synthesize the different areas of knowledge as a means to better understand the subject. Another purpose of the workshop was to gather national and international experts in several aspects of marine invertebrate larval research in order to provide an opportunity to extend local knowledge and exchange experiences.

The workshop provided an opportunity

for an evaluation of the present status in the culture, physiology and ecology of larvae and postlarvae and implications for the success of juvenile marine invertebrates. Specifically, the major scientific goals during this meeting were:

1. To compare physiological and ecological behavior of larvae and postlarvae of marine invertebrate species under controlled laboratory and field conditions, and to evaluate the implications for larviculture.
2. To understand the major problems and advances in the larviculture of molluscs, crustaceans and other invertebrates.
3. To evaluate the development of larval and postlarval cycles through a model that simulates the production responses to changing conditions in those life stages.
4. To integrate the knowledge achieved in laboratory and field research, combining all disciplines studying marine invertebrate larvae and postlarvae.

Concluding Remarks and Recommendations from the workshop

Four major areas of interest were discussed during the international workshop: (1) Physiology of marine invertebrates, (2) Hatchery culture, nutrition and genetics of marine invertebrate larvae and postlarvae, (3) Abalone larvae and postlarvae culture and (4) Systems approach to studies of production of larval and postlarval of marine invertebrate.

For larvae and postlarvae, we have prioritized the following points for future study:

1. Physiological changes during development should be considered in the context of the whole developmental process since impacts during an earlier phase may not manifest themselves until a later phase. Experiments focused on physiological changes during development should have sufficient temporal resolution to link effects observed during later developmental phases with causes that occurred during earlier phases.
 2. Although there are different indices of larval and postlarval quality, not all indices are representative of larval condition nor are all equally informative for all species. Indices should be tested and cross-calibrated to allow selection of the most appropriate index for each group of animals.
 3. Biochemical and physiological measurements for the quantification of larval and postlarval condition by means of indices require sophisticated equipment and trained personnel. Given that it is difficult for individual groups of researchers to obtain and maintain such equipment and personnel, multidisciplinary groups, both national and international, should share equipment and promote collaborative work through the exchange of scientists and students. Such collaborative groups should also seek funding for equipment and travel.
 4. Since a database on the larval and postlarval physiology of marine invertebrates is lacking, such a database should be established in a format that it is available to all interested persons.
 5. The importance of studies on larval
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physiology within the context of animal production, whether for purposes of commercial aquaculture, re-population of natural habitats, natural resource management or native species conservation, is not recognized by potential funding sources (government and private companies). Efforts should be directed toward the development of effective forms of communication with the various potential funding sources.

The following issues will allow us to have a better understanding on how new technological and biological developments will promote successful cultivation.

1. Continue to focus on the potential for diversification and assess new endemic species for their market potential, functional role in polyculture systems (e.g., bioremediation, nitrogen scrubbers) and/or conservation purpose.
2. Extend nutritional studies on lipids (quantitative and qualitative) to other nutrients (e.g., vitamins, amino acids, carotenoids, nucleotides, minerals, etc.) always using a reference food to allow intercalibration between experiments and laboratories. Also, develop appropriate methods to better quantify food uptake and assimilation in larviculture experiments (for example, develop tracer/marker to assess uptake and assimilation of inert food such as lipid emulsions).
3. Assess the role of the microflora in larviculture systems (e.g., host/microbe interaction, functional role as a food source and as probiotics). At the same time, maintain effort for a better understanding of the immunocompetence mechanisms of aquaculture species, especially in their larval stages.
4. Develop challenge tests with virulent pathogens, evaluating performance and disease resistance of larvae, as a tool to select candidate endemic species for hatchery aquaculture.
5. Determine the genetic diversity of existing and new species for cultivation, developing a genetic database for aquaculture species, and ensure genetic diversity is maintained through good breeding programs (e.g., using

appropriate numbers of parent animals for each spawning event). There is a need to standardize and intercalibrate techniques for the assessment of genetic variability at different levels of the genome.

6. Develop gene banks and gene maps through multinational genome projects. Interdisciplinary cooperation is essential to standardize protocols for producing gene markers (specifically microsatellites) to identify genotypes, individuals, stocks, populations, species, full and half siblings, parents and offspring. All these are required for better management of stocks.

Research priorities on abalone production should focus on the postlarval and early juvenile stages, as well as on the reproductive conditioning of broodstock.

1. Feeding and nutrition studies should include: a) the determination of feeding, nutrition and growth strategies from metamorphosis to a size of 8-10 mm, b) the selection and culture of benthic microalgae of high nutritional quality and 3) the development of cost/effective artificial diets for postlarvae and early juveniles.
2. Pathological studies should be conducted to understand the role of bacterial, parasitic and viral diseases on postlarval survival and performance.
3. Research on the ecology of postlarval culture systems should emphasize the effect of environmental and management variables (e.g., temperature, irradiance, photoperiod, water flow, postlarval densities and thinning procedures, benthic diatoms and feeding strategies, pathogens, competition with other microherbivores, etc.) on postlarval survival and growth. Results from those studies could be incorporated into simulation models to suggest improvements on culture systems.
4. Reliable techniques for broodstock conditioning throughout the year are not yet available for some cultured abalone species (e.g., *Haliotis rufescens*, *H. fulgens*, *H. iris*) and efforts should be devoted to this issue. Studies on the influence of temperature, photoperiod and feeding are especially important.

Systems analysis and simulation can be of great help to answer specific questions and to evaluate both expectations and uncertainties for given phenomena.

Regarding the area of larviculture, the use of system analysis and simulation models to represent energetic balance and growth of larvae and postlarvae of *Argopecten purpuratus* allows us to conclude that:

1. The study of the developmental cycle and production of organisms under laboratory or hatchery conditions should be approached in an integrated way so relationships that are the cause of observed phenomena can be identified and further studies focused on them. This is relevant especially because effects observed in a given developmental stage can have their basis in a previous developmental stage.
2. An appropriate simulation design allows us to evaluate the effect of important management variables on the development of invertebrates and their production, especially those in hatcheries under conditions that have not been previously studied in the laboratory.
3. The use of simulation models is an effective way to contact and communicate with both researchers interested in larval and postlarval development and those that assign funding resources because it provides a common language.
4. Systems analysis and simulation allow us to identify additional conceptual and quantitative information that is needed to improve systems understanding and model predictions.

Considering the previous conclusions it is proposed that:

1. A conceptual model should be developed to represent the different processes involved in the development of marine invertebrates.
2. A workshop should be organized and conducted in which a multidisciplinary group of researchers (economists, physiologists, ecologists, nutritionists, etc.) would discuss the conceptual model and develop a quantitative model for each of the species of interest.

Notes

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