

Signalling Processes Involved in Queen Conch Metamorphosis

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ABSTRACT

Chemical cues are important in the exogenous and endogenous control of metamorphosis in many marine larvae. In most cases, the exact nature of the cue is unknown, and the manner in which larvae receive and transduce cues is not well understood. In order to understand these process in the queen conch, *Strombus gigas*, the role of second messenger pathways in larval metamorphosis were examined. Past work with an artificial inducer of conch metamorphosis, H₂O₂, pointed to the importance of the phosphatidyl inositol signal transduction pathway. The current work focused on this pathway, examining the involvement of tyrosine kinases (TKs), protein kinase C (PKC), and arachidonic acid (AA). Activators of PKC induce queen conch metamorphosis, as does AA. Inhibitors of TKs, PKC, and AA block metamorphosis. These results were used to develop a model for signalling processes involved in the induction of conch metamorphosis and allowed for comparisons with other recognition based systems.

KEY WORDS: Larval metamorphosis, signalling, *Strombus gigas*

INTRODUCTION

In the queen conch, *Strombus gigas*, larval metamorphosis is induced by low molecular weight compounds associated with dominant species of red algae found in conch nursery grounds (Davis 1994, Davis and Stoner 1994, Boettcher and Targett 1996, 1998, Stoner et al. 1996). The free amino acids valine and isoleucine mimic the effects of the natural inducer, and may be recognized at the same sites as the algal cues (Boettcher and Targett 1998). Examinations of the effects of neuroactive compounds and manipulations of external ion concentrations suggest that metamorphosis may be triggered through second messengers, specifically those involved in the phosphatidyl inositol (PI) pathway (Davis et al. 1990, Boettcher et al. 1997, Boettcher and Targett 1998). In this study the role of this pathway in conch metamorphosis was examined by testing the responses of larvae to various blockers and activators of the PI pathway. Changes in the expression and phosphorylation of specific components of the signalling pathway during metamorphosis were also examined. The involvement of tyrosine kinases (TKs), protein kinase C (PKC), arachidonic acid (AA) and Ca²⁺ were specifically addressed

RESULTS AND DISCUSSION

Models for processes controlling the transduction of larval metamorphogenic signals have drawn on those developed for olfactory responses involving primarily the adenylate cyclase/cAMP (AC/cAMP) pathway and the PI pathway (see Morse 1990 and Leitz 1997 for reviews). Preliminary experiments with *S. gigas* indicated that the AC/cAMP pathway was not directly involved in the induction of metamorphosis for this species (Boettcher, unpublished data). These studies along with experiments examining the effects of hydrogen peroxide (Boettcher et al. 1997, Boettcher and Targett 1998) pointed to a role of the PI pathway. In the current study, activators of PKC, including phorbol esters and 1,2 dioctanoyl sn glycerol, were shown to induce queen conch metamorphosis, as was AA. Inhibitors of TKs (genistein and AG82), PKC (chelerythrine chloride and phloretin), and AA (lipoxigenase inhibitors) blocked metamorphosis. Manipulation of calcium concentrations and calcium channel blockers gave mixed results that suggest changes in internal calcium concentrations may influence the induction processes. Using the information provided by these experiments and models applied to other marine invertebrate larval systems (Leitz 1997), a model was developed for signalling during conch metamorphosis.

LITERATURE CITED

- Boettcher, A.A. and N.M. Targett. 1996. Induction of metamorphosis in queen conch, *Strombus gigas* Linnaeus, larvae by cues associated with red algae from their nursery grounds. *Journal of Experimental Marine Biology and Ecology* 196:29-52.
- Boettcher, A.A. and N.M. Targett. 1998. Role of chemical inducers in larval metamorphosis of queen conch, *Strombus gigas* Linnaeus: relationship to other marine invertebrate systems. *Biological Bulletin* 194:132-142.
- Boettcher, A.A., C. Dyer, J. Casey, and N.M. Targett. 1997. Hydrogen peroxide induced metamorphosis of queen conch, *Strombus gigas*: tests at the commercial scale. *Aquaculture* 148:247-258.
- Davis, M.A. 1994. Mariculture techniques for queen conch (*Strombus gigas* Linne) eggmass to juvenile stage. Pages 231-252 in: R.S. Appeldoorn and B. Rodriguez, (eds.) *The Biology, Fisheries, Mariculture and Management of the Queen Conch*,. Fundación Científica Los Roques. Caracas, Venezuela.
- Davis, M. and A.W. Stoner. 1994. Trophic cues induce metamorphosis of queen conch larvae (*Strombus gigas* Linnaeus). *Journal of Experimental Marine Biology and Ecology* 180:83-102.
- Davis, M., W. D. Heyman, W. Harvey, and C. A. Withstandley. 1990. A comparison of two inducers, KCL and *Laurencia* extracts, and techniques for the commercial scale induction of metamorphosis in queen conch, *Strombus gigas* Linnaeus, 1758, larvae. *Journal of Shellfish Research* 9:67-73.
- Leitz, T. 1997. Induction of settlement and metamorphosis of Cnidarian larvae: signals and signal transduction. *Invertebrate Reproductive Development*

31:109-122.

Morse, D.E. 1990. Recent progress in larval settlement and metamorphosis: closing the gap between molecular biology and ecology. *Bulletin of Marine Science* 46:465-483.

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