Metamorphosis of Queen Conch Larvae is Triggered by Trophic Cues Found in the Nursery Habitats

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ABSTRACT

As conch larvae become physiologically and morphologically mature a cue is needed to trigger metamorphosis. Laboratory experiments show that conch larvae are competent for six days, at which time the larvae must make contact with a benthic cue or lose the ability to metamorphose. Cues from juvenile conch habitats were selected and tested in the laboratory to screen potential inducers. Dilute waterborne solutions of *Laurencia poitei* and *Batophora oerstedi* did not trigger metamorphosis. No evidence was found for gregarious settlement. *Thalassia testudinum* live blades, *Thalassia detritus, Batophora*, and sediment, along with their associated epiphytic assemblage induced 40-80% metamorphosis within 24 hours. Analysis of living and non-living components of macrophytes and sediments indicated that the associated epiphytes are the trigger for metamorphosis. Therefore, conch larvae probably metamorphose in response to trophic cues found in their juvenile habitat. This adaptive behavior may be a mechanism to ensure that larvae are recruited into juvenile habitats to ensure good growth and survival to the juvenile and adult stages.

KEY WORDS: competence, metamorphosis, settlement, *Strombus gigas*, trophic cues.

INTRODUCTION

The queen conch, *Strombus gigas*, hatches as a planktotrophic larva or veliger which spends three to four weeks feeding on phytoplankton while passively being transported with the currents. At competency the veligers are capable of metamorphosis if they make contact with the right cue. Metamorphosis is a morphological and physiological change in development (Scheltema, 1974), the conch veliger loses its velar lobes and takes on a benthic existence (Davis *et al.*, 1990).

Larval metamorphosis is not a random event for many marine invertebrate species, instead it is determined by chemical, trophic, or tactile cues associated with the benthic habitat appropriate for juvenile and adult survival and growth (Crisp, 1974; Scheltema, 1974; Hadfield, 1986; Morse, 1990). In culture, large numbers of competent conch larvae can be induced to metamorphose with a crude extract from a red macroalga, *Laurencia poitei* (Mianmanus, 1988; Davis *et al.*, 1990). However, the concentrations of extract used in hatchery production are not experienced by conch larvae in the field. Benthic cues found in juvenile conch nurseries and dilute waterborne solutes were examined as possible metamorphic cues for queen conch veligers.

METHODS AND MATERIALS

Laboratory experiments were conducted at the Caicos Conch Farm, Turks and Caicos Islands from June to August 1992. Competent veligers were selected from the hatchery for each experimental run. Competency was determined by observing a sample of veligers for morphological characteristics typical for competent conch larvae (foot pigmentation change from orange to green) and from metamorphic "test set" results which used standard *Laurencia* extract (Davis *et al.*, 1990).

Before induction cue experiments were conducted, an experiment was run to determine if newly metamorphosed veligers would induce metamorphosis of the remaining veligers in the treatment containers and thus result in a density-dependent effect (Gotelli, 1990). Six different veliger densities were used (1, 2, 4, 8, 16, 32) with twenty replicates of each. Observations on percent metamorphosis were made 8, 16, 24, and 48 hours after the veligers were introduced into the experimental containers. *Laurencia* extract was used as the metamorphic inducer, however, it was used at 50% the standard dosage (5 mls of extract per liter of seawater). This lower concentration elicited metamorphosis, but avoided a high incidence of induction, this allowed for the possibility of gregarious settlement behavior. This experiment showed that there was no gregarious effect, therefore, multiple larval experiments were justified.

All induction experiments were set up in 300 ml white plastic containers with 25 veligers per container. Six to ten replicates were used for each treatment cue. Filtered seawater was used as a control and materials to be tested as cues were collected on the day of the experiment. Crawling conch which had lost their lobes completely were defined as completing metamorphosis and percent metamorphosis was recorded after 24 hours.

Eight metamorphic cues found in juvenile conch nursery habitats were investigated as possible induction triggers. These cues were: 1) dilute *Batophora oerstedi* extract, 2) dilute *Laurencia poitei* extract, 3) a filamentous red macroalga, 4) *Laurenica* fronds, 5) Batophora fronds, 6) *Thalassia testudinum* blades, 7) *Thalassia detritus*, and 8) sediment with an associated epiphytic mat. The extracts were made by tissue grinding one gram of each alga and filtering the particulates with three liters of water. The algae and other substrates were tested with two to three grams wet weight portions per container.

Following this investigation a group of experiments were set up to look at the living and non-living components of the favored macrophyte and sediment cues. *Batophora* and *Thalassia detritus* were divided into 1) whole blades with epiphytes, 2) whole blades without epiphytes, 3) epiphytes only, and 4) sterilized epiphytes (killing living organisms, leaving organics). Sediment samples were collected from two locations, one in a traditional 0+ year class habitat and the other in a non-traditional juvenile habitat. Sediments with associated epiphytes were tested in three forms: whole, sterilized, and ashed (all organics removed). Approximately 3 grams of macrophyte or sediment were used to prepare each run.

A ten day experiment using the same culture of larvae, was conducted to determine the number of days queen conch larvae are competent. Two metamorphic cues were used, the standard *Laurencia* extract (10 mls of extract per liter of seawater) and *Thalassia detritus* (3 grams wet weight per container). The experiment started with pre-competent veligers (16 days post-hatch) and ended with veligers which produced a very low percent metamorphosis or post-competent veligers (25 days post-hatch). A 24-hour experiment was set up every other day, and metamorphosis was recorded.

RESULTS

The highest mean percent metamorphosis for the screening experiment was achieved with *Batophora* fronds at 62% (±18 SD). The values for percent metamorphosis with other cues were: 52% (±11) with sediment and an associated epiphytic mat, 36% (±13) with *Thalassia* blades, 29% (±16) with *Thalassia detritus*, 19% (±15) with Laurencia fronds, and 11% (±16) with a filamentous red macroalga. No metamorphosis occurred in dilute algal extracts or seawater control treatments.

The living and non-living components of the *Batophora* fronds resulted in a mean metamorphosis of 59% (±7) with epiphytes only, 44% (±21) with whole fronds, 32% (±12) with fronds free of epiphytes, and 14% (±15) with sterilized epiphytes. Results for *Thalassia detritus* were slightly different. Whole detritus produced a mean metamorphosis of 78% (±13), 50% (±24) with epiphytes only, 37% (±13) with detritus free of epiphytes, and 17% (±14) with sterilized epiphytes.

The results with sediment taken from two nursery habitats showed differences in percent metamorphosis, especially for the sterilized sediment. The whole sediment from a traditional nursery ground resulted in a mean of 76% (±7) metamorphosis, 71% (±15) with sterilized sediment, and no metamorphosis with ashed sediment. The sediment from a non-traditional nursery ground resulted in a mean of 48 % (±13) with whole sediment, 12% (±5) with sterilized sediment, and no metamorphosis with ashed sediment.

Queen conch larvae were competent for a six day period. With the detritus cue there was no metamorphosis in larvae 16 days post-hatch. Mean percent metamorphosis increased from 21% (±14) on day 18 to 78 % (±15) on day 23, and decreased to 16% (±8) by day 25. With the *Laurencia* extract cue there was no metamorphosis in larvae 16 days post-hatch. Mean percent metamorphosis for day 18-23 was 76-89% (±14-7) and declined to 3% (±3) by day 25.

DISCUSSION

This study shows that typical juvenile and adult conch foods, *Batophora* and *Thalassia detritus* (Stoner and Waite, 1991) induce metamorphosis. The analysis of living and non-living components of macrophytes and sediment, shows that competent veligers are particularly attracted to the epiphytes associated with these benthic substrata. Other molluscs that exhibit a metamorphic response to trophic cues are the nudibranch *Phestilla sibogae* which preys on the coral *Porites compressa* (Hadfield and Scheuer, 1985) and the red abalone, *Haliotis rufescens*, which grazes on the coralline algae *Lithothamnium californicum* (Morse and Morse, 1984). With conch larvae there may also be a tactile or chemical cue along with the trophic cue, for a high percent metamorphosis occurred with sterilized sediment (high in organics) from a traditional conch nursery.

Several studies have shown that the cue-specificity in larval settlement and metamorphosis contributes to the distribution of recruits in the natural environment (Crisp, 1974; Highsmith, 1982; Morse and Morse 1984; Hadfield and Scheuer, 1985; see Morse, 1990). Conch larvae metamorphose in response to certain cues found in the nursery habitats. It is likely that this is an evolved response which increases the probability of the post-settlement conch finding appropriate foods and/or shelter. Non-random settlement and metamorphosis mediated by specific benthic cues may be at least partially responsible for aggregated distribution in juvenile queen conch.

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