Invasive Seagrass and its effects on Juvenile Queen Conch

As invasive seagrass continues to expand and replace native species, populations such as the queen conch are seeing significant changes to their habitat and subsequent negative impact in food source availability. With potential consequence for the resilience of such species in a changing world. A recently published study from St. Barthelemy, St. Eustatius and St. Maarten, worked to understand how native and invasive seagrasses influence juvenile queen conch's development by studying both dietary composition and growth rate.

Queen Conch

The queen conch, or Lobatus gigas, is an iconic species found within the Caribbean, being both economically and socially important (Brownell & Stevely, 1981; Appeldoorn, 1994). Famous for its unique and beautiful shell, along with its role as a popular item in local dishes, this species is heavily fished (Stoner, 1997) and in some areas, pushed to the point of overfished (Stoner et al., 2019). To aid in the restoration efforts of this species, it is often listed as regionally protected and in 1992, it was added to the list of protected species in the Convention of International Trade in Endangered Species of Fauna and Flora (CITES). Adult conchs inhabit a wide variety of environments, including areas of sand, algae and coral rubble (Acosta 2001, Stoner & Davis, 2010). Juvenile conchs prefer a more specific habitat and can normally be found within seagrass beds where they forage for food and are protected from predators (Ray & Stoner, 1995; Stoner, 2003; Stoner & Davis, 2010).

Juvenile Conch Diet

Juvenile conchs have been known to primarily feed on seagrass detritus (or debris), red and green macroalgae, organic material within the sediment and cyanobacteria (Randall, 1964; Stoner & Sandt, 1991; Stoner & Waite, 1991; Serviere-Zaragosa et al., 2009; Stoner et al., 1995). In recent years, invasive seagrasses are becoming much more common throughout the Caribbean (Kairo et al., 2003). This shift in seagrass types can change both food availability as well as the level of protection for juvenile conchs (Willette & Ambrose, 2012). One specific invasive seagrass, Halophila stipulacea, native to the Red Sea, was first observed in Granada in 2002 and can now be found around at least 19 islands within the Caribbean (Ruiz & Ballantine, 2004; Vera et al., 2014; Willette et al., 2014).

The Problem

These shifts from native to invasive seagrasses may have a variety of consequences. For example, there has been a noted decrease in small and juvenile fish around H. stipulacea (Willette & Ambrose, 2012; Olinger et al., 2018). In addition, invasive seagrasses have been known to be much denser, covering most of the sandy bottom leaving little room for conchs to graze (van Tussenbroek et al., 2016). In addition, this dense coverage also limits the amount of light reaching the sediment, further reducing productivity of specimens within the sediment (Hill, 1996; Yang & Flower, 2012)

Stable Isotope Analysis

All living organisms are comprised of a variety of different elements, and these elements can have several forms. When these elements vary from their natural state (balanced number of protons and neutrons) they are called isotopes. Stable isotopes are isotopes which do not decay overtime; therefore, they can be measured and can provide a unique signature to an individual (Hirst, 2018). Since these stable isotopes come from our surroundings, scientists can use this signature to understand where an organism is from. When these isotopes are absorbed by an organism, they change slightly, so by comparing specimen's signatures researches can understand their relationship within the food web.

The Experiment

To better understand the effects of seagrass shifts on juvenile conch's populations a study was conducted which was broken into two different experiments (Boman et al., 2019).

These experiments took place off the coasts of St. Barthelemy, St. Eustatius and St. Maarten. These three islands were selected as they each have varying seagrass species composition, with St. Barthelemy being primarily native, St. Eustatius primarily invasive and St. Maarten being mixed. Both experiments studied juvenile conchs in native, invasive and mixed seagrass areas, and the main objective was to highlight the effects of invasive H. stipulacea on their development. The goal of the first experiment was to better understand the diet of conchs. By defining the isotopic signatures of carbon and nitrogen ($\delta 13C$ and $\delta 15N$) of conchs and their environment, researchers were able to better understand not only their diet, but how the baseline levels of these elements within the study areas are affecting local populations. This baseline data can help highlight areas of pollution, which can also be used to understand its effects on juvenile conch's development. The second part of the study involved collecting juvenile conchs and placing them in an enclosure where measurements could be taken for specific growth rates over a period of time.

The Results

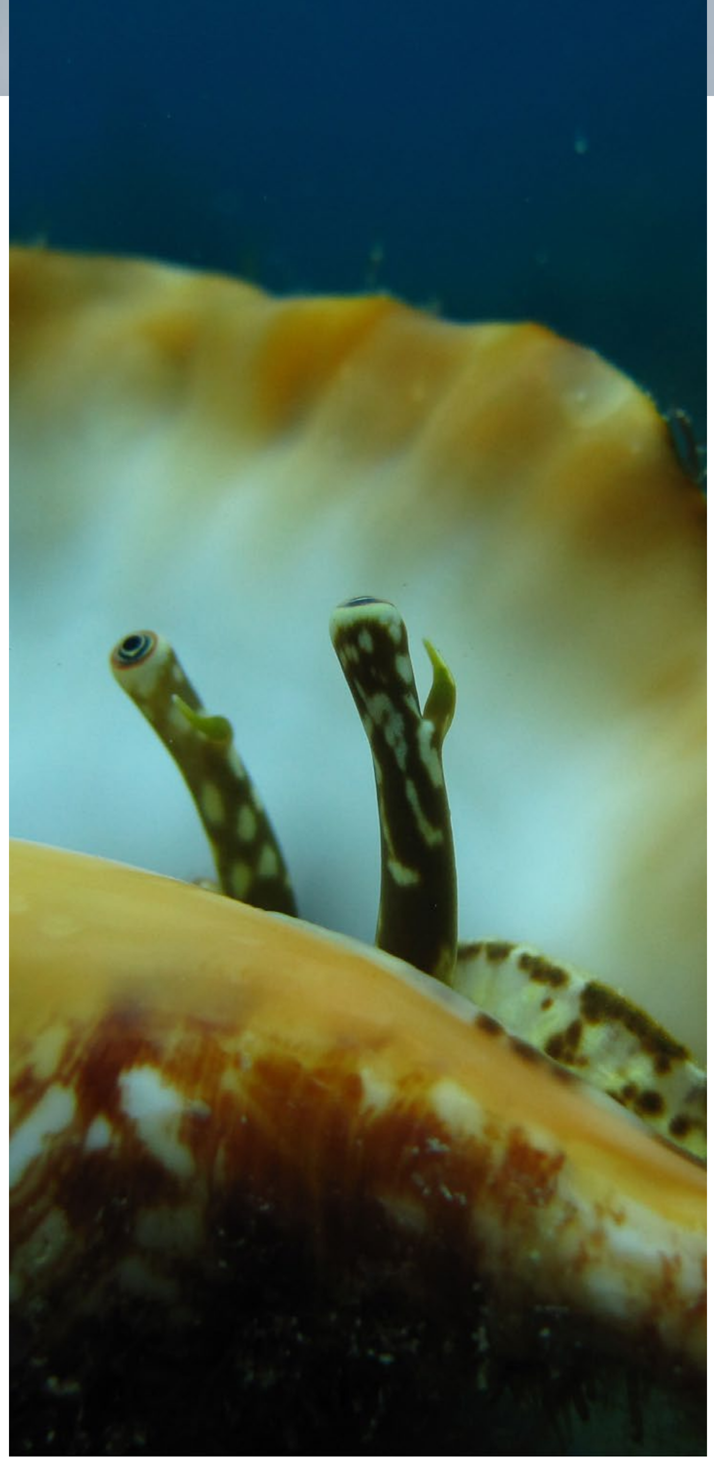
Through stable isotopic analysis, it was determined that the diets between all three habitats were similar, with organic material from the sediment being the primary source of nutrition. Cyanobacteria was only found in St. Eustatius and was determined to have a medium contribution to the diet. Furthermore, seagrass detritus and epiphytes were found to contribute very little to the juvenile conch's diet. An important finding of this study was that although organic material within the sediment was a major contributor to the conch's diet, their isotopic signatures showed variances which matched other unique food items found in each of the sites. This confirms previous research which showed juvenile conchs to be opportunistic feeders (Robertson, 1961; Randall, 1964; Stoner & Waite, 1991).

In addition, enriched values δ15N were found at the sites of St. Barthelemy and St. Maarten when compared to St. Eustatius. This was likely caused by the limited water flow and more anthropogenic nutrient pollution (Tett et al., 2003). Both of these sites were located near outlets from enclosed waterbodies and large hotels (ca. 120 and 650 hotel rooms in St. Barthelemy and St Maarten respectively). The site off St. Eustatius was further from shore and neighboring hotels were significantly smaller (ca. 40 rooms) (E.M. Boman pers. obs). Therefore, this enriched δ15N signature of the conchs located off St. Barthelemy and St. Maarten are likely a result of this anthropogenic pollution.

The growth experiment included 60 juvenile conchs which were collected and placed in six enclosures, three with invasive seagrass *H. stipulacea* and three with a mix of native seagrasses. Originally, the test was to be run for 16 weeks, however, due to a direct hit by Hurricane Irma, the experiment ended after 47 days. In the end, 19 of the conchs from within the native seagrass enclosures measured positive growth, the maximum individual growth being 0.17 mm/d. In the invasive seagrass enclosure, only 5 conchs showed positive grown, with a maximum individual growth being only 0.03 mm/d. Therefore, it was concluded that dense H. stipulacea seagrass beds limit sediment available for grazing and thus limits conch development, which aligns with similar results from a previous study by Stoner & Sandt in 1991.

The Future

The enrichment of δ15N signatures of conchs found within areas of higher anthropogenic pollution demonstrates the role the environment plays in conch's development. It is becoming increasingly more apparent that polluted waters are having long term and lasting affects on the species dependent on these habitats. Furthermore, the lower growth rates of juvenile conchs in invasive seagrasses give us some insight into struggles these, and similar, species may face as the composition of seagrasses within the Caribbean continue to shift. Since this invasive seagrass tends to flourish in nutrient rich waters, as climate change and human expansion continues, we can expect to see invasive species such as these continue to spread. It will continue to be of the upmost importance for researchers and individuals to continue to monitor the situation and to do whatever is necessary to ensure a healthy environment for the queen conch's population to repopulate and stabilize.



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