Preliminary Results of the Abundance of Veliger of *Strombus (Lobatus) gigas* (Linnaeus, 1758) Across the Caribbean Sea

Resultados Preliminares de la Abundancia de Larvas Veliger de *Strombus (Lobatus) gigas* (Linnaeus, 1758) en el Mar Caribe

Premiers Résultats sur L'abondance des Larves Véligères de *Strombus(Lobatus) gigas* (Linnaeus, 1758) dans la Caraïbes

MANUEL SÁNCHEZ CRESPO[1], HAZEL OXENFORD[2], OLIVIER GROS[3], JEANNETTE MATEO[4], JORGE GARCÍA SAIS[5], ALBERTO DE JESÚS NAVARRETE[6], CLAIRE PARIS[7], and DALILA ALDANA ARANDA[1]*

[1]*CINVESTAV IPN Departamento de Recursos del Mar Antigua carretera a Progreso KM.6, A.P.73 Cordemex Mérida, Yucatán 97310 México. *daldana@mda.cinvestav.mx.*

[2]*Centre for Resource Management and Environmental Studies, Univ. of the West Indies, Cave Hill Campus, Barbados.*

[3]*Archipiel des Sciences, FWI, France Université des Antilles et de la Guyane, West, French Island*

[4]*Consejo Dominicano de Pesca y Acuicultura Grupo Jaragua, Inc. Edif. Secretaría de Agricultura. Km 61/2 Carret. Duarte. Los Jardines del Norte c/el Vergel # 33. El Vergel. Santo Domingo, Santo Domingo, Dominican Republic.*

[5]*Caribbean Fishery Management Council 268 Muñoz Rivera Avenue, Suite 1108 San Juan, Puerto Rico 00918-1920*

[6]*El Colegio de la Frontera Sur Av. Centenario km 5.5 Chetumal, Quintana Roo 79000 México.*

[7]*Rosenstiel School of Marine and Atmospheric Sciences, University of Miami, 4600 Rickenbacker Causeway, Miami, Florida 33149 USA.*

ABSTRACT

To compare the abundance of veligers of the queen conch *Strombus (Lobatus) gigas* (Linnaeus, 1758) across the Caribbean Sea during the main summer spawning period for this specie, larvae were sampled in Banco Chinchorro (Mexico), Puerto Morelos (Mexico), Florida and Puerto Rico (USA), Dominican Republic, Guadeloupe (FWI) and Barbados from July to September 2014. Surface plankton samples were collected by oblique hauls with a conical net of 0.5 m diameter and 200 µm mesh size at six stations for each locality, during the full moon at the same hour.

The samples were analyzed following the methodology of Davis et al. (1993) and a two way ANOVA was used to assess the statistical significance of differences among the samples. We found a total of 158 larvae of *S. gigas*. The highest abundance was observed in Barbados during July (18.88 larvae/10 m^3). Abundance of larvae was not significantly different among months. However, significant differences were found among locations. The high abundance of veligers in the Barbados samples suggests that the low density conch population found there may still be capable of providing recruits for downstream populations.

KEY WORDS: Caribbean, abundance, larvae, *Strombus (Lobatus) gigas*

INTRODUCTION

The queen conch, *Strombus (Lobatus) gigas* (Linne 1758), is an endemic gastropod widely distributed in the Caribbean (Stoner 1997). Queen conch stocks have declined significantly throughout the region over the past few decades and as a result of serious concerns for this species, it has been listed in Appendix II of the Convention on International Trade in Endangered Species (CITES) and on Annex 3 of the Specially Protected Areas and Wildlife (SPAW) protocol of the Cartagena Convention. As a consequence, various fishery regulations and management initiatives targeted at rehabilitation and sustainable use of queen conch stock haves now been implemented in most Caribbean countries (FAO-WECAFC-2013).

Many aspects of the biology and ecology of queen conch are relatively well studied in populations from different locations across the region, including the larvae (Davis et al.1993, Posada and Appeldoorn 1994, Stoner and Davis 1997 a, b, de Jesus Navarrete and Aldana Aranda 2000, de Jesus Navarrete 2002). Only recently however, have the reproductive strategies of queen conch populations been compared across populations throughout the Caribbean (Aldana Aranda et al.2014) and no study has examined queen conch larvae simultaneously across Caribbean locations.

Understanding larval supply, settlement and recruitment of species that have a planktonic stage larva is extremely complex, especially when the larval duration is relatively long, so that larvae could drift hundreds of kilometers from their site of origin before settling. When settlement occurs in other national jurisdictions stock management becomes a multinational challenge (Berg and Olsen 1989) and one that requires good information about the sources and sinks of these larvae.

This research adds to the scant knowledge of conch larvae at the scale of the Caribbean Sea by examining density of veligers simultaneously during their summer spawning period.

METHODS

Study Area

The study area covered the Caribbean Sea within the known range of *Strombus (Lobatus) gigas.* Samples were collected from western locations (Banco Chinchorro and Puerto Morelos on the Yucatan Peninsula of Mexico), from northern locations (Florida and Puerto Rico of the US, and Dominican Republic) and from eastern locations (Guadeloupe of the French West Indies, and Barbados).

Sampling Methodology

Samples were collected simultaneously at the seven locations every month from July to September during the full moon at high tide. Six stations were sampled at each of the seven locations: Banco Chinchorro (18.586° N -87.295° W), Puerto Morelos (20.863°N -86.866° W), Florida (25.613° N -80.077° W), Puerto Rico (17.577° N -67.036° W), Dominican Republic (19.905°N -71.635° W), Guadeloupe (16.318° N 61.553° W), Barbados (13.065° N -59.382° W).

Replicate surface plankton tows were made at each station using a conical net that had a 0.5 m diameter opening and 200 µm mesh size. Tows were diurnal and made from a boat travelling for 15 minutes at a mean velocity of 1 m/sec. Plankton samples were preserved in a 5% neutral formaldehyde-seawater mixture (Stoner and Davis 1997 a).

Laboratory Analysis

The entire volume of each plankton sample was sorted for *Strombus (Lobatus) gigas* veligers using a dissecting microscope (X20). Positive identifications of *S. gigas,* larvae were made following the descriptions of Davis et al. (1993) and total number of veligers per sample were counted.

Data Analysis

Veliger density was standardized to 10 m^3, following Davis et al. (1993). Abundance data were analyzed for spatial and temporal variation using a two-way ANOVA.

RESULTS

Larval Density

A total of 158 queen conch veligers were collected from July to September 2014. Most were collected at Barbados (60.13 % of larvae) and 21.52 % were collected at the Dominican Republic location. Larval density varied from 0.0 larvae/10 m^3 at several locations to 6.02 larvae 10 m^{-3} in Barbados (July). Larval densities also varied with month from an average across all locations of 1.18 larvae 10 m^{-3} in July, to 0.45 larvae/10 m^3 in August and 0.58 larvae 10 m^{-3} in September. There were significant differences in veliger abundance among sites (d. f.= 6, F= 18.17, $p \leq 0.001$***) but there were no significant differences among months (d. f.= 2, F= 0.441, $p = 0.6457$) two way ANOVA (Table 1).

DISCUSSION AND CONCLUSIONS

In this study we found considerable variation in conch larvae abundance among locations sampled simultaneously, and an unexpectedly high abundance of larvae at Barbados, where the adult population is known to be very low density (Valles and Oxenford 2012). This suggests that even this depleted population may still be capable of providing recruits to downstream locations. S. gigas larvae were observed from July to September with the highest abundance of larvae being observed in July. This results corroborates the findings of Aldana-Aranda et al. (2003) who observed spawning conchs from June to September for Chinchorro Bank. Likewise Posada and Appeldoorn (1994) found greatest abundance of larvae in July, at Los Roques National Park, Venezuela and Stoner et al. (1996) reported the greatest abundance in June, for the Bahamas.

Table 1. Results of a two-way ANOVA to compare the density of veligers of *Strombus* (*Lobatus*) *gigas*, among months (July to September 2014) and locations (p values < 0.05 indicate, a statistically significant effect on larvae density at the 95.0 % confidence level).

Source of Variation	Sum of Squares	d. f.	Mean Square	F-ratio	Significance Level
Site	56570	7	28284.9	18.1755	**1.245e^{-06}**
Month	1374	2	686.8	0.4413	0.6457
Residual	76254	49	1556.2		

ACKNOWLEDGMENTS

SEP-CONACyT No. 181329. El caracol rosa como indicador de cambio climático en el caribe: acidificacón oceánica y calentamiento. Fondo mixto, CONACyT-Gobierno del estado de Yucatán No.246841: Acciones de mejora al programa de maestría en ciencias con especialidad en biología marina del CINVESTAV-Mérida. Schollarship CONACyT (42410013).

LITERATURE

Aldana-Aranda, D., E. Baqueiro-Cardenas, I. Martinez Morales, A. Zetina Zarate, and T. Brule. 2003. A review of the reproductive patterns of gastropod mollusks from Mexico. *Bulletin of Marine Science* **73**:629 -641.

Aldana Aranda, D., H.A. Oxenford, C. Bissada, M. Enriquez, T. Brulé, G.A. Delgado, I. Martínez Morales, and L. Frenkiel. 2014. Reproductive patterns of queen conch, *Strombus gigas* (mollusca gastropoda) across the Wider Caribbean. *Bulletin of Marine Science* **90**:813-831

Berg, C. J., Jr. and D.A. Olsen. 1989. Conservation and management of queen conch *(Strombus gigas*) fisheries in the Caribbean. Pages 422 - 442 in: J.F. Caddy (Ed.) *Marine Invertebrate Fisheries: Their Assessment and Management.* John Wiley & Sons. New York, New York USA.

Davis, M., C. Bolton, and A. W. Stoner. 1993. A comparison of larval development growth, and shell morphology in three Caribbean *Strombus* species. *Veliger* **36**:236-244.

de Jesús-Navarrete, A. and D. Aldana-Aranda. 2000. Distribution and abundance of *Strombus gigas* veligers at six fishing sites on Banco Chinchorro, Quintana Roo, Mexico. *Journal of Shellfish Res*earch **19**:891-895.

de Jesús-Navarrete, A. 2002. Distribution and abundance of *Strombus costatus* (Gmelin, 1791) larvae and adults at the biosphere reserve: Banco Chinchorro, Quintana Roo, Mexico. *Journal of Shellfish Res*earch **21**:227-23 1.

FAO-WECAFC. 2013. Report of the first meeting of the CFMC/ OSPESCA/WECAFC/CRFM Working Group on Queen Conch, Panama City, Panama, 23-25 October 2012. *FAO Fisheries and Aquaculture Report* **1029**. Bridgetown, Barbados. FAO. 155 pp.

Posada, J. and R.S. Appeldoorn. 1994. Preliminary observations on the distribution of *Strombus* larvae in the eastern Caribbean. Pages 191 - 199 in: R. S. Appeldoorn and Q. Rodriguez (Eds.) *Queen Conch Biology., Fisheries and Mariculture*. Fundacion Cientifica Los Roques, Caracas, Venezuela.

Stoner, A.W., R. A. Glazer & P.J. Barile. 1996. Larval supply to queen conch nurseries: relationships with recruitment process and population size in Florida and The Bahamas. *J. Shellfish Res*. **15**: 407-420

Stoner, A.W. 1997. The status of queen conch, *Strombus gigas*. Research in the Caribbean. *Marine Fisheries Review* **59**:14-22.

Stoner, A.W. and M. Davis. 1997a. Abundance and distribution of queen conch veligers (*Strombus gigas* Linne) in the Central Bahamas: I. Horizontal patterns in relation to reproductive and nursery grounds. *J. Shellfish Res.* **16**: 7-18.

Stoner, A.W. & M. Davis. 1997b. Abundance and distribution of queen conch veligers *(Strombus gigas* Linne) in the Central Bahamas: II. Vertical patterns in nearshore and deepwater habitats. *Journal of Shellfish Res*earch **16**:19-29.

Valles, H. and H.A. Oxenford. 2012. Queen conch (*Strombus gigas*) in Barbados: density, distribution and habitat correlates. *Bulletin of Marine Sci*ence **88**:947-969