Does the Age of the Queen Conch Female (*Strombus gigas)* Affect Fecundity and Larval Development?

¿La Fecundidad y el Desarrollo Larval del Caracol Rosa (*Strombus gigas)* son Afectactos por la Edad del Caracol Rosa?

La Fecondité et le Développement Larvaire du Lambi (*Strombus gigas)* Seront-ils Affectés par L'âge du Lambi?

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ABSTRACT

The queen conch, *Strombus gigas*, is a species that is at the base of food webs. As a result, it is a source of food for many species. In addition, it plays an important role in the balance of herbaria (Tewfik 2014, Stoner 1989). I t occupies an important place in the fishing economy as it is the second most economically important fishery in the Caribbean. The impact of climate change on the reproduction and calcification of these larvae is a further negative factor in addition to the problem of stock recovery of this exploited species. Thus, in the face of the scarcity of resources, it is important to put in place appropriate and effective management plans. From this perspective, it is necessary to understand the dynamics of the population and its reproductive pattern. In this respect, an important parameter to take into account is the fertility rate and its variations influenced by environmental and biological factors of the organism, in particular with the season and the age of the females. Insofar as fertility is directly related to the life cycle of the species (Remiz-Llodora 2002, Chamber 1989) and in some countries (Dominican Republic, French West Indies, Martinique and Honduras among others) authorized the capture of conchs deep waters, which correspond to older organisms, noting that they are a non-fertile population (without having scientific data). The objective of this study was to determine if older females are no longer reproductive by determining the influence of Queen Conch female age on fecundity, egg quality and larval quality: Biological criteria may be used in population management and protection programs, especially older females / males.

KEYWORDS**:** *Lobatus gigas*, *Strombus gigas*, queen conch, home-range, displacements, marine reserves

INTRODUCTION

Marine Protected Areas (MPAs) have been created in order to "protect structure, integrity and stability of ecosystems" functioning as a refuge from fishing pressure. Benefits from MPAs as size and abundance increase in species have been largely demonstrated in reserves and adjacent areas. Recent studies focused on reserves dimensions so as to protect properly species in function of their circadian, seasonal and ontogenetic displacements. Larvae of *S. gigas* are effective for restocking programs respecting optimal conditions for larval development. Several studies have been conducted based on long-term displacements, home-range, and migrations of *S. gigas* in function of annual cycles, reproductive seasons, age and sex, site and physicochemical variables along Caribbean. Noguez Nuñez and Aldana Aranda (2014) showed a short-term home-range in function of age and circadian cycle. Purcell and Kirby (2006) demonstrated the relation between speed and weight of sea cucumbers in order to define the size of capture exclusion zones.

Xel Há Park is qualified as a sanctuary for S. *gigas* due to absence of extractive activity for all species. This park showed a population of adult conch and area to reproduction and spawning. (Peel et al. 2011, Santana 2015, Sánchez 2016). Therefore, the aim of the present study was to determine fecundity rate for various ages (sizes) of the Queen conch female, *S. gigas*. Two hypotheses have been proposed:

i) Are old queen conch females still fertile? and
ii) Is the larval development of the old females the same as that of young females?

MATERIAL AND METHODS

Study Site

The Xel-Há inlet is located in the west coast of the Yucatán peninsula in the Mexican Caribbean between parallels 20° 30' and 20°00' north latitude and meridians 87°30' and 87°00' west longitude (Figure 1). This site with a superficial of 10 ha and depth of 0.5 to 4 m. The climate is described as sub-humid with a season called "nortes" from November to February, a dry season from Marsh to May and rainy season from June to October. The tidal regime of the Caribbean sea of Mexican cost is semi-diurnal. The Xel Há Park is qualified as a sanctuary for *S. gigas* with a density superior than 0.5 conch.m^{-2} recommended by Stoner and Sandt (1992) to permit reproductive activity.

The present study was conduct in the mouth zone defined by Peel et al. (2011) and Santana (2015) as a zone of migration and reproduction for *S. gigas.* It is composed of sand bottom with patches of sea grass beds *(Thalassia sp.* and *Halodule sp.),* rocks covering of macro-algae and a few corals.

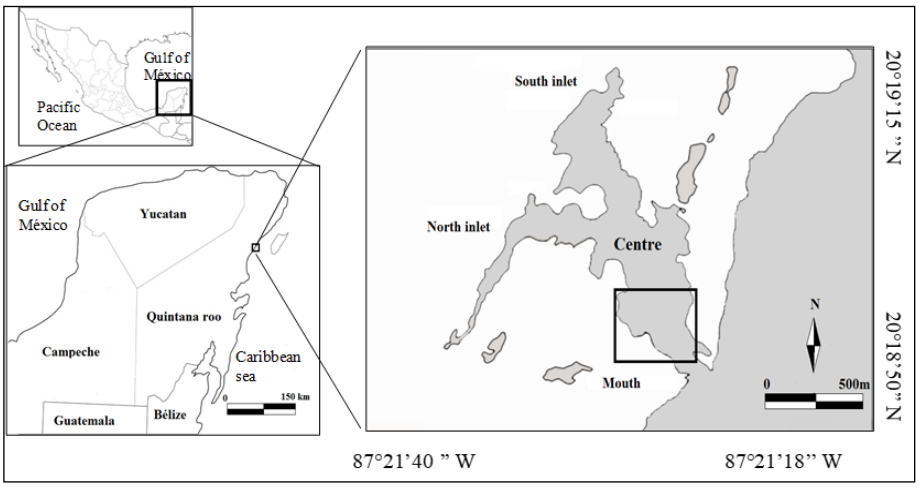

Figure 1. Study site location at Xel-Há Park, Quintana Roo Mexico.

Sampling Conch

A total of 100 females were marked and measured (shell length and lip thickness) with a vernier of 0.1mm precision and weighed with a balance of 0.1g precision. Individuals were then categorized in three classes according its lip thickness (Figure 2). During April to June 2017 the frequency of spawning activity and biomass of eggs spawned was correlated with the lip thickness of females as a fecundity index.

Fecundity Rate

Spawning females were monitored during this period. Spawning is considered ended when the female is detached from the egg line. The eggs were weighed for each female in water. Thus we obtained the weight of eggs spawned for different sizes of lip thickness of females. For each egg mass were sampled five replicates of 10 cm of the cord of eggs. Eggs cordon was placed an incubation unit filled with seawater filtered at 2 µm. To determine fecundity rate, eggs were counted for each cordon. For each replicate and for each female, hatching rate was determined as:

$$\frac{\text{Number of larvae hatched}}{\text{Total number of eggs}} \; x\; 100$$

Egg quality was determined using diameter and area of eggs calculated from 100 eggs for each egg masses.

Larvae Development

The larval growth and calcification rate were used as criterions of the quality of the eggs produced by the conch females of the different sizes/ages.

Each of the samples of the egg masses was cleaned with filtered seawater. Each cleaned egg mass was placed over a 300 µm mesh and kept immersed in a 25-L aquarium with seawater filtered through 2 µm cotton filters. Larvae cultures were maintained at 28 ± 1°C.

*L*arvae were reared according to the method described by Brito-Manzano et al. (1999). Larvae were reared from hatching to 10 days old. Larvae were stocked in 4-L containers. Larvae were fed equal amounts of fresh concentrates of the algae *Nanocloropsis* at a concentration of 1,000 cells/ml (Garcia Santaella and Aldana Aranda 1994, for *S. gigas*). Every two days, 30 larvae were collected at random from each replicate for the observation of growth and to quantified calcium concentration. Each two days veligers were transferred to new containers with fresh seawater filtered at 2 µm cotton filters.

Figure 2. Sizes of reproductive females of conch, *Strombus gigas*. The lip thickness of the conch was used as an indicator of age.

RESULTS

Demography Population

A total of 220 individuals were measured in February 2017. The average of shell length of females was 215±15 mm, with a minimum of 166 mm and a maximum of 235 mm. the lip thickness variate from 11 to Shell length of males variated from 175-206 mm with an average 199±11mm of and lip thickness from 6-31mm with an average of 27 ± 4 mm. A positive correlation was observed between the sizes of lip thickness and the number of egg masses spawned by females.

Fecundity Rate and Embryos

A positive correlations (r = -0.30) was observed between the fecundity rate and the older females that

present shells with a thicker lip of their shells (Figure 3a). Length of spawning time *versus* lipthickness showed that females last on average 300 minutes spawning regardless of their age, using as indicator the thickness of the shell. The biomass of eggs spawned per unit time increased in the older females, with a significant positive correlation (Figure 3b).

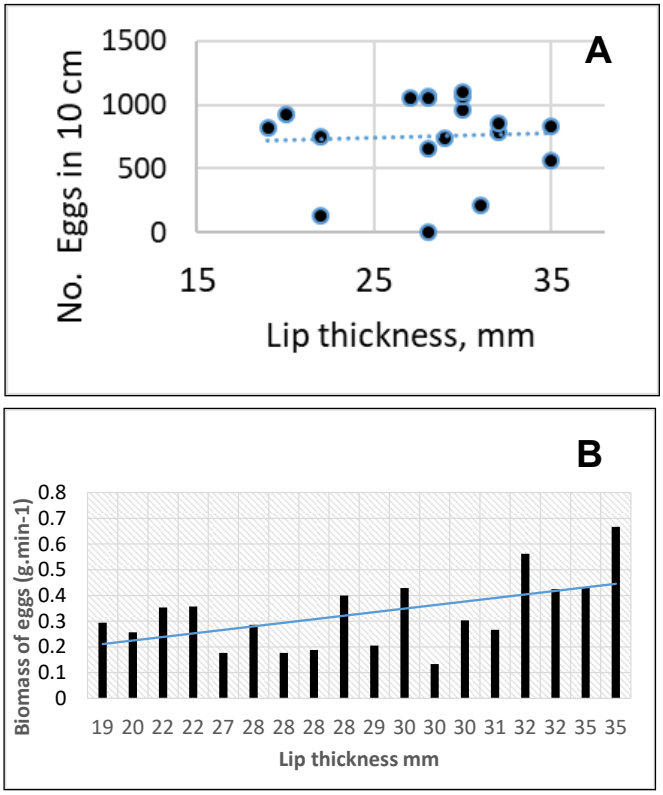

Figure 3. a) number of eggs in 10 cm of the cord of the egg mass for various sizes of females of *Strombus gigas*. b) Biomass of eggs in grams by minute spawned by different sizes/ages of females of conch.

Perimeter of eggs was 315 µm in old females (lip thickness of 35 mm). For youth females (15 mm of lip thickness) the egg perimeter had an average of 200 µm having a positive correlation between size classes of females and the egg perimeter (Figure 4).

DISCUSSION

Until now, reproduction has been studied through observation of reproductive activities or histological observation during oogenesis and spermatogenesis. Also, various factors influencing reproduction were studied.

Nevertheless, there was a correlation between the number of eggs per conch and the lip thickness. Similarly, there was a positive correlation between the amount of biomass produced per minute and the age of females. The delay between fertilization and hatching of eggs of older females was shown to be shorter than that of young females. For the hatching rate, it was faster in older females.

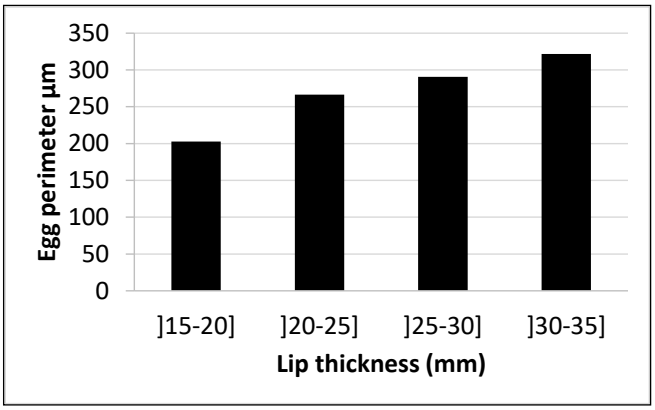

Figure 4. Average perimeter of the conch *(Strombus gigas)* eggs by size classes of the females.

Wendell et al (2003) observed that fecundity rate and the size of the eggs was higher in the older females of mussels. Fecundity was related positively to both length and age, but length was the best predictor. In six species, fecundity increased exponentially with increasing size. These authors do not observe an weak reproductive senescence; however, in all species of mussels studied, older individuals continued to produce large numbers of offspring.

Jakubik and Lewandowski (2007 established the relationship between growth rate, age, mortality and fecundity of the gasteropod, *Viviparus viviparus* . Fecundity was found to depend on the female's size. The size (shell dimensions) did not affect the size of newborn snails; females of different size classes produced offspring of the same shell height (4.0 mm) and width (4.5 mm).

CONCLUSION

The old females of conch are still fertile. The fecundity of the old females was greater than that of the young females. The hatching rate of old females was slightly higher than that of young females. Based in these original results, the old females in general placed in depth waters (30-60m) are contributing to the recruitment of the conch population. For this reason it is necessary to protect this population and not allow more the catch in deep waters with scuba or nets. Possibly this stock permit to conserve the conch population in the Caribbean

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