Lip Thickness of *Strombus gigas* (Mollusca: Gastropoda) Versus Maturity: A Management Measure

DALILA ALDANA ARANDA[1*] and LILIANE FRENKIEL[2]
[1]*CINVESTAV-IPN, Unidad Mérida*
Laboratorio de Biología y Cultivo de Moluscos
Km 6 antigua carretera a Progreso C.P. 97310
Mérida, Yucatán, México
** Corresponding author*
[2]*Archipel des Sciences*
Guadeloupe, Antilllas Francesas

ABSTRACT

The Queen conch *Strombus gigas* is a marine resource of economic, social and cultural importance in the Caribbean countries Total conch production reached 6,520 in 1993 and was reduced to 3,132 tons in 2003. North American market absorbs 80% of this registered production, 17% is exported to the French islands and 3% is consumed in the others Caribbean countries. The high fishing pressure in most Caribbean countries has caused the reduction of the populations of *S. gigas*, forcing to the establishment of regulatory measures. Studies of the reproductive cycle of *S. gigas* are necessary to regulate this resource in the Caribbean region. The present study shows the correlation between the lip thicknesses of *Strombus gigas* versus the reproductive cycle. 700 organisms were sampled at San Andres (Colombia) in 2003; they were sorted in three groups: a) 10 - 17 mm shell total length, without lip; b) Shell total length ≥ 170mm and lip thickness <5mm and c) Shell total length ≥ 170 mm and lip thickness > 5 mm. Samples of visceral mass and gonad were processed by standardized histological methods. Only undifferentiated stages were observed for organisms of 100 - 170 mm of shell length, without lip. Organisms ≥ 170 mm of shell length with a thin lip showed undifferentiated stage throughout the year and a low initial gametogenesis in April-June and October-January, (≤ 20%). The group of shell length ≥ 170 mm and lip thickness > 5 mm exhibits a very different behavior; it undergoes a whole reproductive cycle with gametogenesis during most of the year and spawn in January-February for females and from September to February for males. However mature and spawn stages are very short and represent a low proportion of the population. According to this study, the minimal catch size does not appear as mandatory; the existence of a thin shell lip is neither an efficient criteria of sexual maturity. Only a lip thickness > 5 mm appears as a maturity criteria. Therefore, it appears necessary to introduce this criteria corresponding to a lip that may not be broken by hand, in Caribbean countries regulations. A temporal ban from 1st May to 30 September seems to be well fitted to protect the main reproduction period and to protect the reproductive stock. To be efficient these regulations have to be applied in all the Caribbean countries and to be included in the CITES regulations for exportation. However, the level of protection will depend on a high enforcement of regulations to control exploitation and reduce illegal fishing.

KEYS WORDS: *Strombus gigas*, reproduction, lip thickness, shell length, management

Grosor del Labio de la Concha de *Strombus gigas* Versus su Grado de Madurez Gonádica: Propuesta de Manejo en el Caribe

El Caracol *Strombus gigas* es objeto de una pesquería de importancia económica, social y cultura para todos los países del Caribe. De 1993 a 2003 de acuerdo a CITES el volumen de esta pesquería paso de 6,000 a 3,132 toneladas. De este volumen, el 80% se exporta a Estados Unidos, 17% a las Antillas francesas y sólo un 3% se queda en los países del Caribe para su consumo. La demanda del mercado, ha provocado una sobre pesca sistemática, aplicación de diversas medidas regulatorias y en general un no respeto de ellas. Se requiere un mejor conocimiento de su ciclo de vida y en particular de su reproducción, a fin de proponer medidas que protejan el stock reproductor. Se presenta el ciclo reproductivo de *S. gigas* analizado en un ciclo anual para tres categorías de tallas de longitud de la concha y grosores del labio. a) Longitud sifonal de 100 - 170 mm, sin labio; b) organismos con longitud de la concha ≥ 170 mm con labio. < 5mm y c) organismos con longitud de la concha ≥ 170 mm con labio > 5 mm. Se analizaron cerca de 700 organismos provenientes del archipiélago de San Andrés, Colombia. Las muestras de masa visceral y gónada fueron procesadas con métodos histológicos estandarizados. El grupo de 100 - 170 mm de longitud de la concha y sin labio, presento solo la fase de indiferenciado a lo largo del año. En el grupo de caracoles con tallas de la concha ≥ *170 mm con labio <5mm*, presentaron solo fases de indiferenciado e inicio de gametogenesis de abril-junio y de octubre a enero en porcentajes bajos (≤ 20%). Los caracoles del tercer grupo, de tallas ≥ *170 mm de longitud de la concha con labio > 5 mm* fueron los únicos en presentar un ciclo de madurez gonadal con picos bien definidos de gametogenesis en abril-septiembre y desove en enero-febrero para hembras. En machos, el desove fue de septiembre a febrero. Con base en estos resultados se demuestra contundentemente que el tamaño de la concha no presenta ninguna relación con el grado de madurez sexual para *S. gigas*. Contrariamente el grosor del labio de la

concha si presentó una correlación directa con el grado de madurez de la gónada. Se propone una nueva medida para regular la captura de *S. gigas*, que sería a) grosor del labio ≥ 5mm (que no pueda romperse con la mano) como criterio de desarrollo sexual inicial suficiente y b) un período de veda del 1º de mayo al 30 de septiembre. Estas medidas prácticas y útiles podrían aplicarse en todos los países del Caribe y por CITES para el producto exportado, a fin de proteger el stock reproductor de *S. gigas* en el Caribe y permitir la sustentabilidad de esta frágil pesquería.

PALABRAS CLAVES: *Strombus*, reproducción, madurez, talla, labio, manejo

INTRODUCTION

The Queen Conch *Strombus gigas* (Linné, 1758) is a gastropod of commercial importance in the Caribbean, with a distribution range from Venezuela to Florida and the Bahamas, including the lesser and mayor Antilles.

Strombus gigas is a species of primary economic importance in the Caribbean region. Its importance comes from strong demand for local consumption, the tourist market, and for exportation.

This species represents one of the most valuable benthic resources in the region, exceeded only by the spiny lobster (Alpeldoorn 1994). Since 1998, its catches in the Caribbean region represents US$15 - 20 million (Miller 2000). In 1992, the harvest of conch was 5,554 tons, and in 2002 it was only 3,132 tons. Most of the conch production (80%) is exported to the United States. From 1992 to 2001, a total of 21,649 T of *S. gigas* meat, 2,345, 868 shells, 407,140 specimens and 342 T of live conch were registered for exportation (CITES 2003).

Due to the high fishing pressure that is exerted upon most of its populations several stocks have been reduced to levels where the population can no longer recover (Appeldoorn 1994a), and commercial fishing is no longer feasible. As a result of the high demand, vulnerability, and the overexploitation of local stocks, since 1992 the fishery of this species is submitted to international and local management measures and was included in the Convention on International Trade of Endangered Species of Wild Fauna and Flora. In 1994, it was added to the International Union for the Conservation of the Nature's Red List (IUCN), and in 2002, it was included in Annex III of SPAW (Specially Protected Areas and Wildlife in the wider Caribbean region) as a species that should be used sustainable with management measures in order to protect and to reestablish the stock of this species (CEP 2002, CITES 2003).

Along the Caribbean region, various management strategies are applied to limit exploitation. Strategies that focus on the resource are:

i) Minimum legal size expressed in length, shell lip development, and weight of meat,
ii) Catch quotas,
iii) Temporal fishing bans, and
iv) Reproductive bans.

Strategies to limit fishing effort have been:

i) Limited number of fishermen,
ii) Limited number of conchs per fisherman,
iii) Restriction of capture by depth, and
iv) Restrictions to the use of scuba or hookah diving equipment.

Strategies to protect reproductive stocks or populations in recovery, through the establishment of closed areas to fishing activity and the establishment of Marine Protected Areas (MPAs). However, these management measures do not every time correspond to the life cycle of *S. gigas,* and do not often permit to reestablish the stock of *S. gigas*. The goal of this work was to study the reproductive cycle for three groups of queen conch with different shell length and lip thickness:

i) Conchs of total shell-length of 10-17 mm, without lip;
ii) Conchs of total shell-length ≥170mm and lip thickness <5mm, and
iii) Conchs of total shell-length ≥170 mm and lip thickness >5 mm.

The correlation between the size and lip thickness of *Strombus gigas versus* the reproductive cycle of organisms from these three groups was established.

MATERIALS AND METHODS

Sampling Site

Strombus gigas was sampled from southwestern of San Andres, Colombia (Figure 1) between the 12°32'N 81° 42'W (San Andres island), 12°24'N 81°28'W (Bolivar Cays) and 12°10'N 81°51'W (Albuquerque cays). San Andres is a barrier reef of 32 km long and covers an area of 255 km^2, one of the largest coral reefs in America. Bolivar Cays is located at east southeast of San Andres, It constitutes an area of 10 km of length and encloses four cays. Albuquerque cays, is located to the southwest of San Andres. This Archipelago was declared the Seaflower Biosphere Reserve in November 2000 by UNESCO's Program. Fishermen of Fishingman Place Cove Sea Side cooperative have collected conchs from February 2003 to January 2004 of all the defined types and sizes. Lip thickness, total length of shell and sex were determined. Organisms were sampled monthly and processed by histological methods. A sample of 1 cm^3 of the visceral mass and gonad was dissected from each organism and prefixed 15 days in 10% saline formalin. Then samples was preserved in 70% alcohol with 1% glycerin, until their transfer to CINVESTAV IPN in Yucatan, Mexico, with the relevant data.

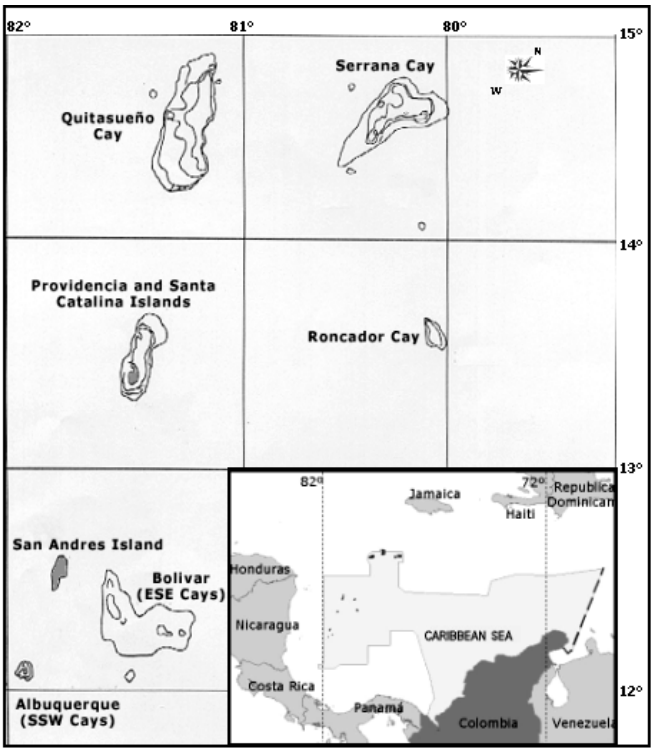

Figure 1. Sampling site of *Strombus gigas* at Archipelago of San Andrés, Providencia and Santa Catalina (SAI), Colombia (Seaflower Biosphere Reserve) (Avila *et al.* 2005).

Histological Methods

The samples were postfixed 7 days in alcoholic Bouin's fixative; rinsed in 70° alcohol; dehydrated in an ascending ethanol series (70°, 96° and 100°); clarified in Clearene®, a clearing-solvent of the paraffin formulated with selected blend of terpenes; then, embedded in Paraplast® (m.p. 56 ºC), a compound of purified paraffin and plastic polymer of regulated molecular weights. Six microns-thick sections were cut with a MICROM HM340E rotary microtome and mounted on glass slides. Sections were stained using Harris's Hematoxylin and Eosin (HHE_2), regressive stain method (Howard and Smith 1983). Tissue slides were examined under 100 and 400x magnifications using a Carl Zeiss MC73A light microscope.

Stages of Reproductive Cycle

The gonad development stages were defined following the microscopic characteristics described by Aldana-Aranda *et al.* (2003 a, b). Gonadic stages described by these authors were reduced at four in this study:

i) *Gametogenesis*, active cell division, mature gametes may or may not be present;
ii) *Mature*, dominance of mature gametes, although some gametogenesis may be present;
iii) *Spawn*, follicles are partially or totally emptied and broken, eggs or sperms are being reabsorbed, phagocytes are present within the follicles;
iv) *Undifferentiated,* gametes nor gametogenic stages may not be identified from the microscopic sections.

RESULTS

Reproductive Stages

Undifferentiated, in both sexes, there are no signs of follicles producing germinal cells. The gonad area was occupied almost in its totality by connective tissue. Numerous dispersed amoebocytes are observed. *Gametogenesis,* follicles producing germinal cells were observed dispersed and occupying ≤25% of the gonad area. In females, ovogonias and oocytes groups at various stages of maturation are observed. In male, spermatogonia and spermatocytes are present. *Mature,* in females follicles reached an average of 266.50 ± 77.15 mm, they have anastomose and their walls are very thin. Eggs filled the follicles, they measured 168.50 ± 20.37 mm with abundant vitelline granules (Figure 2d). Male gonad showed anastomosed follicles and occupies the whole gonadic tissue; their diameter is 114.00 ± 24.51 mm. Sperms are the dominant stage, forming a large mass in the center of the follicles of eupyrene, oligopyrene and apyrene sperms. The vases deferentes are clearly formed and filled with sperm, although some sections may be empty. (Figure 2e). *Spawn***,** in females the follicles are emptied. Connective tissue starts to fill enlarging spaces between follicles. Sparse ovocytes can be detected with disperse vitellum, as well as residual oocytes in process of resorption (Figure 2f). In males the follicles continue to anastomose. Sperms are moved to the testis duct, leaving empty spaces in the follicles (Figure 2g).

Reproductive Cycle of *S. gigas* of Shell Total Length 100-170 mm, Without Lip

Females — Gametogenesis and mature stage were no detected, giving place to a long undifferentiated stage throughout of the sampling period. In this size group, the undifferentiated stage is in fact an immature stage. However in this study immature and post-spawn stages were summarized as undifferentiated stage (Figure 3).

Males — The gonad of males of queen conch with a shell length between 100-170mm without lip, neither reach mature stage nor gametogenesis. The undifferentiated stage is profuse, it was observed throughout of the sampling period without a hint of gametogenesis process. For this size of queen conch, the reproductive cycle is identical for males and females (Figure 4)

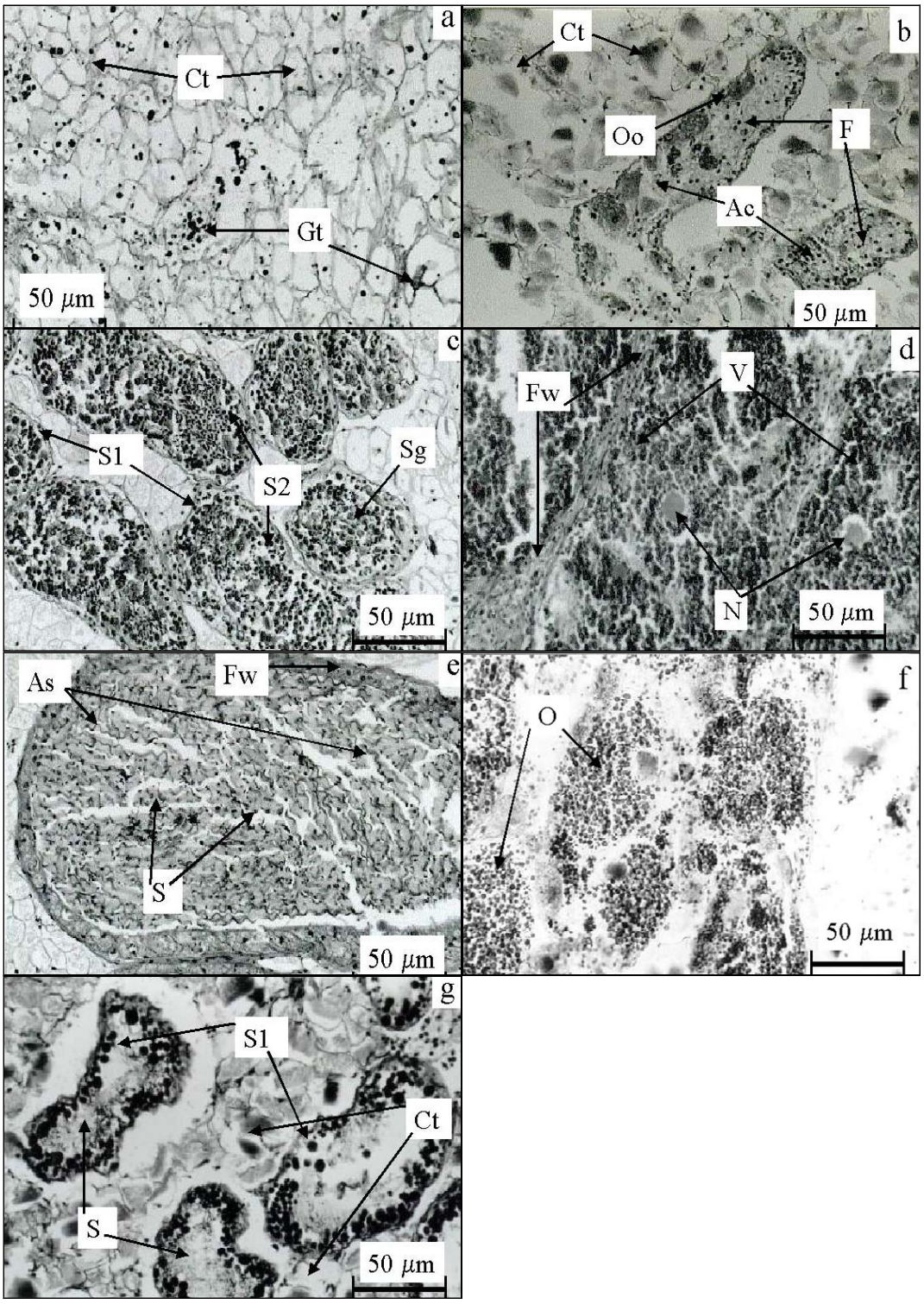

Figure 2. Photomicrographies of *Strombus gigas* gonad. **a)** Rest stage. **b)** Gametogenesis in females. **c)** Gametogenesis in males **d)** Mature females **e)** Mature males **f)** Spawn in females. **g)** Spawn in males. Ac: Accessory cells; As: Atypical spermatocytes; Ct: connective tissue; F: Follicle; Fw: Follicle wall; Gt: Germinal tissue; N: Nucleus; O: Ova; Oo: oocytes; V: vitellum; S: spermatozoids; Sg: Spermatogonias; S1: Spermatocytes; Sd: Spermatides (Aldana Aranda, *et al.* 2003).

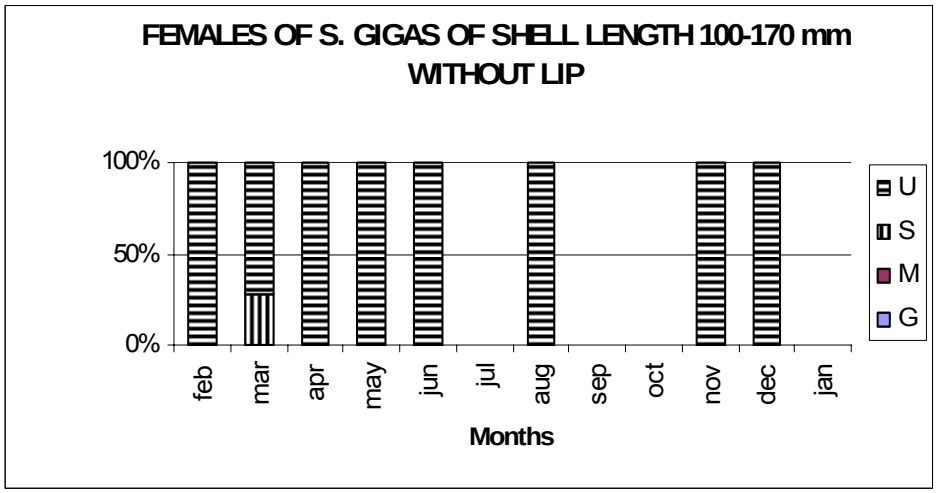

Figure 3. Reproductive cycle of *Strombus gigas* for females with a length shell 100 - 170 without lip in San Andres, Colombia.

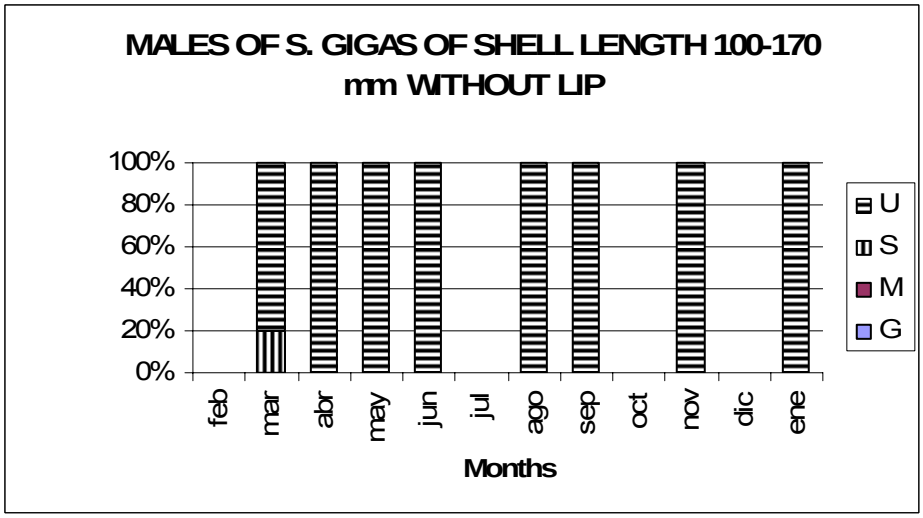

Figure 4. Reproductive cycle of *Strombus gigas* for males with a length shell 100 - 170 without lip in San Andres, Colombia.

Reproductive Cycle of *S. gigas* of Total Shell Length ≥ 170 mm, With Lip < 5mm

Females — Gametogenesis is active from April to June and October-November with percentages ≤ 20%; except in January when this stage reaches 40%. Mature stage was no detected, giving place to a long post spawn and undifferentiated stages throughout the sampling period (Figure 5).

Males — The gametogenesis stage was short and it was only present in the samples in May and June, with a percentage ≤ 10%. Mature stage was not detected throughout the period studied, giving place to a long undifferentiated stage throughout the annual cycle. Few spawn (≤ 10%) was detected in February and March and from November to January (Figure 6).

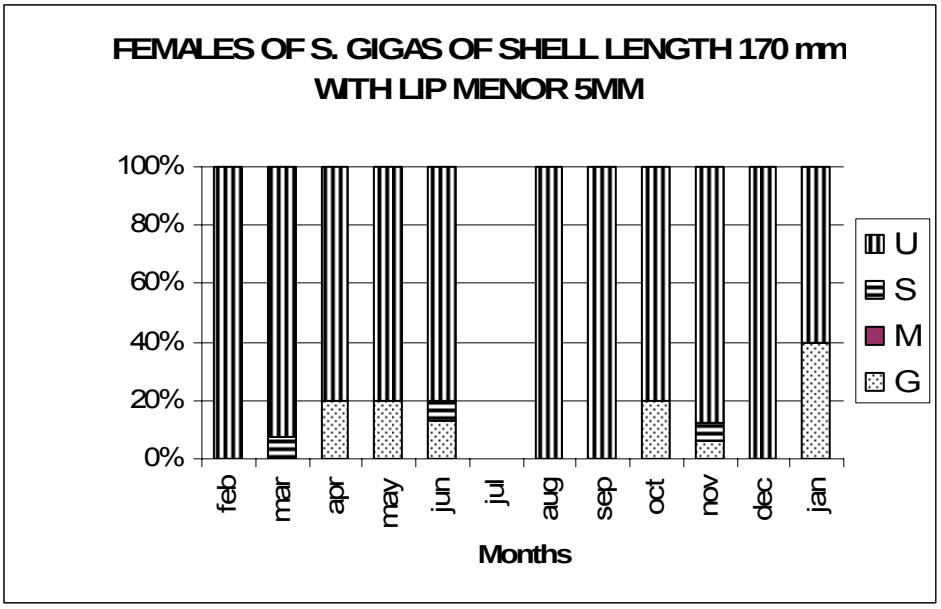

Figure 5. Reproductive cycle of *Strombus gigas* for females with a length shell ≥ 170 with lip ≤ 5 mm.

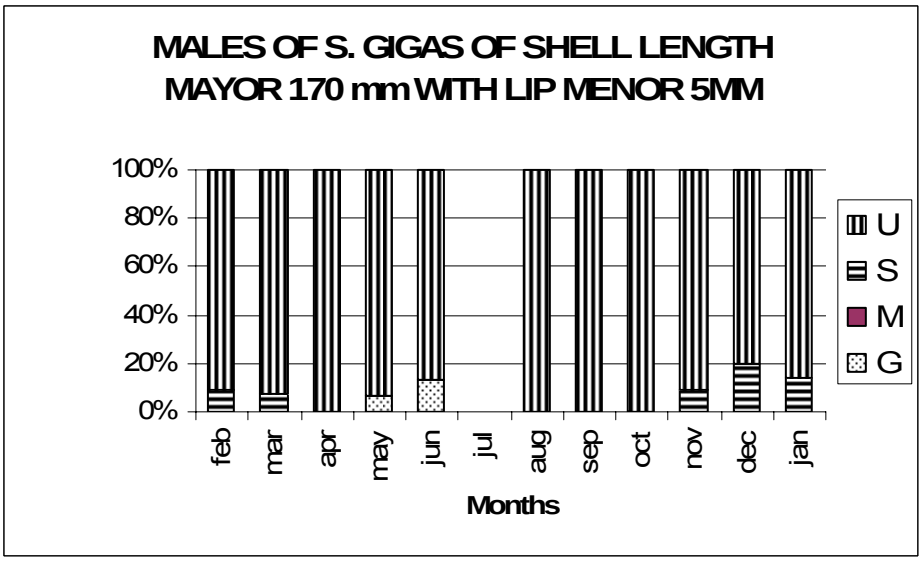

Figure 6. Reproductive cycle of *Strombus gigas* for males with a length shell ≥ 170 with lip ≤ 5mm.

Reproductive Cycle of *S. gigas* of Total Shell Length ≥ 170 mm, with Lip Thickness > 5mm

Females — This group of queen conch of shell length ≥ 170 mm and lip thickness > 5 mm exhibit a very different reproduction pattern than *S. gigas* without lip or *S. gigas* with a lip thickness < 5mm; they showed a whole reproductive cycle with gametogenesis throughout the year. This stage presents a peak between April - August with percentages from 50% to 70%, respectively. In December, the gametogenesis stage was observed for the whole sample. Mature stage was limited to March and April with 20% and 10%, respectively and 20% in September. A peak of spawn stage was detected in February with an average of 60%. This stage was present also at a small percentage ≤ 10% in April and September, giving place to an undifferentiated stage present throughout the sampling period with values from 30 - 70%, except in December and January. The most important stage is clearly gametogenesis, present all the year round whereas the mature stage is quite scarce. (Figure 7).

Males — This group of males of queen conch of shell length ≥ 170 mm and lip thickness > 5 mm exhibited a gonad development pattern different than *S. gigas* without lip or *S. gigas* with a lip thickness < 5 mm. These organisms showed a whole reproductive cycle with gametogenesis present throughout the year, except in June and December. Gametogenesis showed a peak in May and August with values of 75%. A peak of mature stage was detected in June with 67%. Spawn stage was observed in January and February with 30% and from September (60%) to December (Figure 8).

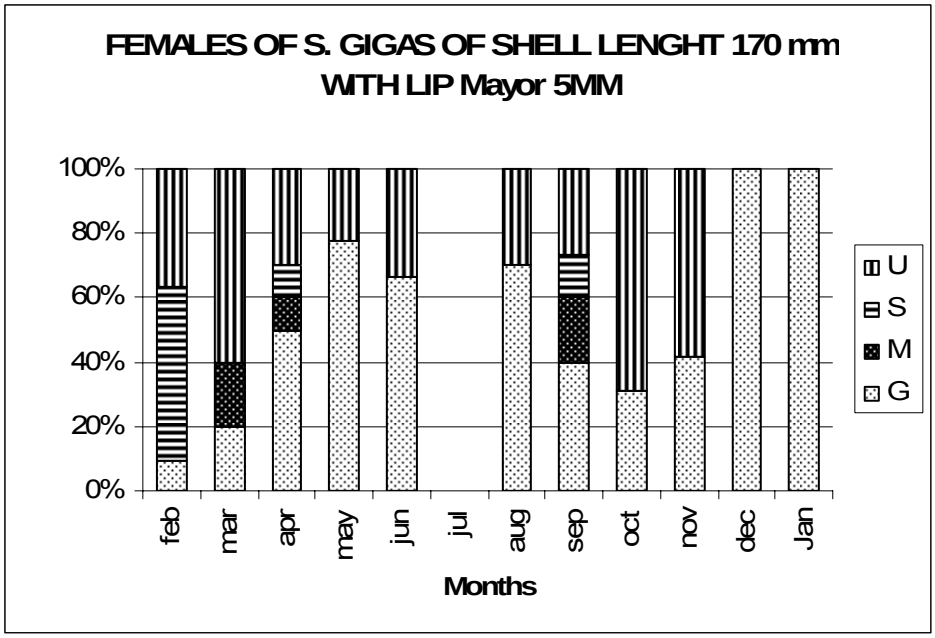

Figure 7. Reproductive cycle of *Strombus gigas* for females with a length shell ≥170 mm with lip › 5 mm.

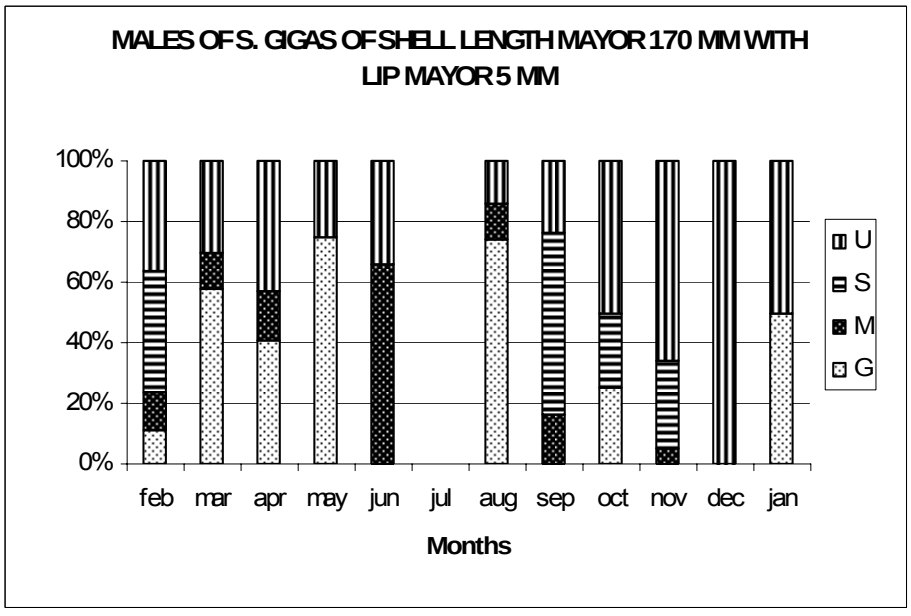

Figure 8. Reproductive cycle of *Strombus gigas* for males with a length shell ≥ 170 mm with lip › 5 mm.

DISCUSSION

The lack of information about the reproductive cycle of *Strombus gigas*, has caught up to the development of successful fisheries management plans throughout the Caribbean. The reproductive season of *S. gigas* has been obtained from observations of reproductive behavior: pairing, copulating, and egg-laying but did not include gonad histological results.

Studies dealing with reproduction of *S. gigas* have been done from the anatomical point of view by Reed (1998) for *S. gigas* and *S. pugilis*. Glazer and Quintero (1998) compared the gonad tissue of *S. gigas* between the off shore and near shore populations in Florida. Delgado *et al.* (2004) examined the gonadic development in transplanted *S.* gigas between off shore and near shore *populations*. Aldana-Aranda *et al*., (2003a, b, 2005) and Avila *et al.*., (2005) described the reproductive cycle in some areas of the Caribbean.

In this work, we studied the reproductive cycle for three groups of queen conch with different shell length and lip thickness:

i) Conchs of shell total length of 10 - 17 mm, without lip;
ii) Conchs of shell total length ≥ 170 mm and lip thickness < 5 mm, and
iii) Conchs of shell total length ≥170 mm and lip thickness >5 mm.

Organisms with a thin lip (thickness < 5 mm) showed undifferentiated stage throughout the year and a low initial gametogenesis in April-June and October-January, (≤ 20%). The group of shell length ≥ 170 mm and lip thickness > 5 mm is the only one to undergo a whole reproductive cycle with gametogenesis during April-September and spawn in February for females and for several months for males. However, the mature stage is very short and with a low proportion for females. It seems more conspicuous for males with a peak in June at more than 60% of the sampled population, but a low proportion during six months and nothing during four months.

Table 1 summarizes the reproductive cycle results from various authors. Aldana-Aranda *et al*. (2003a, b) in Alacranes reef, Mexico observed a long duration with low percentages for the rest and gametogenesis stages; they interpreted the reproductive pattern as a gonad development stage with fast activities . The lack of mature stage was interpreted as no accumulation of ripe gametes. Spawn stage was observed of short duration and low percentage that may be interpreted as an asynchronic spawning period. Post spawn was observed with long duration and high percentage. These results would suggest a reproductive strategy of fast and continuous maturity and spawning, with a fast gametogenic activity without accumulation of ripe gametes through of whole sampling period.

Table 1. Mature stage for *Strombus gigas* established by histological methods. Sampling period, number of simples per month are mentioned.

Sampling area	Sampling period	Number of samples per month	Mature stage E F M A M J J A S O N D	References
Mexico (Arrecife Alacranes) 22º30´ N, 89º40´ W	March-November	20	Ä Ä Ä Ä	Aldana-Aranda *et al.*, 2003a, b
Mexico (Banco Chinchorro) 18º46´ N, 87º20´ W	June-September	20	Ä Ä Ä Ä	Aldana-Aranda *et al.*, 2003a, b, c
Belize (Boca Chica) 17º45´ N, 86º56´ W	January-December	34	Ä Ä Ä Ä Ä Ä Ä Ä Ä Ä Ä Ä	Egan, 1985
St kitts/Nevis 17º05´ N, 62º30´ W	April-December	--	Ä Ä Ä Ä Ä	Buckland, 1989
Colombia (San Andres) 12°32´ - 81°28´ W	January-December	30	Ä Ä	Avila Poveda, 2004
Colombia (San Andres) 12°32´ - 81°28´ W	January-December	10		Avila Poveda, et al 2005
Colombia (San Andres) 12°32´ - 81°28´ W Conchs of ≥170mm shell length and lip thickness >5 mm	January-December	70	Ä Ä	This study

Aldana-Aranda *et al*. (2003 a,b) for *S. gigas* from Chinchorro bank reported gametogenesis and undifferentiated stages long and low. The mature stage was observed in females and males with an average percentage of 35% from May to September. These authors mentioned that the gametogenic period for *S. gigas* presented differences between Alacranes and Chinchorro, even though the gonadic samples were taken during the same period. Therefore it can be ascertained that the reproductively activity was controlled by temperature, photoperiod conditions or bottom characteristics. Egan (1985) for S. gigas at Belize detected mature and spawn stages all-year-round at low percentages.

For *S. gigas* from San Andres, Avila (2004) observed two peaks in April an August. However Avila *et al.* (2005) for organisms sampled at San Andres did not found conchs in mature stage from February to August for an average shell length of 200 mm and little gametogenesis ≤ 10% excepted in March (30%).

These first results would suggest two possible interpretations: a fast gametogenic activity without accumulation of ripe gametes. Organisms from this locality exhibited an undifferentiated stage profuse through the year (Table 2). However Baqueiro *et al*. (2005) for *S. gigas* of Alacranes reef, Mexico and San Andres Colombia, found in the digestive gland a sporozoan infection. Authors cited that this infection could be apparently responsible for the low intensity of gonad maturity registered in these localities.

Table 2. Reproductive Patterns of *Strombus gigas* for Different Sites in the Caribbean
* Conchs of San Andres in this Study

Reproductive Pattern	Locality
Gametogenesis	
1. High gametogenesis	Banco Chinchorro, Mexico- Boca Chica, Belice
2. Low gametogenesis	Arrecife Alacranes San Andres, Colombia
Spawn	
1. Continuos spawn	Boca Chica, Belice
2. Two or more peaks	San Andres, Colombia
3. One short peak	Alacranes, Mexico Chinchorro, Mexico San Andres, Colombia
Gonad of recovery	
1. Minimum or nor postspawn or undifferentiated stages	Chinchorro, Mexico Boca Chica, Belice
2. Fast gonad recovery	Chinchorro, Mexico
3. Mature stage limited or absent	Alacranes, México San Andres, Colombia

In another aspect of this study, a relationship between the reproductive cycle of *S. gigas* and the three classes of conchs without lip, with thin lip < 5 mm and with thick lip > 5 mm was established; where only the thick lipped conchs showed a gonad developed with mature and spawn stages. Buckland (1989) for the conchs of St. Kitt's in 1986 found a spawning season from April to end September with a peak reproduction activity in July and August. This author stated that reproduction activity and mature gonads and spawning were observed only in conchs whose shells had a thick lip. However this author did not stated accurately which neither is a thick lip in millimeters nor described the reproductive stages. Reproductive activity was described by this author only as percentages of the presence of ovary or testis. Buckland giving a qualitative rank between 0 and 4 for thickness of shell lip classes based on the criteria: rank 0, no lip; rank1, lip turning out; rank 2, lip fully formed with no thickness; rank 3, lip fully formed with thickness, no erosion and rank 4, lip fully formed, thick, eroded, bulged, but author did not report these classes of lip in millimeters of lip thickness. Conch with indices of shell lip thickness 2 and 3 had significantly lower percentages of "ovary" or "testis" within the gonad cross sections than conch with lip indices of 4. Only conch whose shell had the thickest lips (lip index 4) were observed breeding and only these conch had ≥ 25% of their gonad area consisting of gametogenetic tissue. Thus, not all lipped conch are sexually mature. Only those conchs with thick, heavy shells are considered able of breeding.

Table 3 summarizes the management measures for *S. gigas* in the Caribbean: areas closed for fishing, temporal bans, catch only by free diving, minimum size of capture, fishing prohibition during the reproduction season, and total closures of the fishery (Theile 2001, Perez 2004). Neither management measures used a minimum thickness lip as criteria for management regulations. Table 4 summarizes the temporal bans in different Caribbean countries.

For fishery management it is useful to know the age at which the females produce the most eggs. With this information, females with the greatest reproductive potential could be protected by regulations, ensuring further recruitment. These studies showed no relationship between the mature and spawn stages with shell length but a conspicuous relationship between thick lipped conch and maturity. Lip thickness appears as a good indicator for a mature conch, thus it could be useful as a management tool to regulate this fishery adequately. From the results presented here, it is possible to recommend for the Caribbean region a minimum catch size, not in shell length but in thickness of shell lip > 7 mm. However, a temporal ban from 1st May to 30 October remains the best way to protect the reproductive aggregations during the main reproductive season.

Besides, an intriguing low gonad development even for really adult conchs makes it necessary a complementary study focusing on the gonad development and the presence of parasites in the digestive gland of *S. gigas.*

A regional cooperation program at the Caribbean level would be necessary to emphasis the environmental factors and current which might influence the reproduction of Queen conchs or their vulnerability to parasites whose detrimental impact may explain the low reproductive success of the species in several remote localities.

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Table 3. Managements measures for *Strombus gigas* by country.

Management measure	Característica de la medida	Country	References
Scuba diving prohibited	-	Martinique	Rathier y Battaglya, 1994
	-	Turks and Caicos	Ninnes, 1994
	-	Belize	Chakalall y Conchrane, 1997
Minimum size	Catch juveniles prohibited	Martinique	Rathier y Battaglya, 1994
	178 mm	Turks and Caicos	Ninnes, 1994
	Catch juveniles prohibited	Bahamas	Glazer y Berg, 1994
	125 mm	Belize	Chakalall y Conchrane, 1997
	180 mm	Grenada	Appeldoorn, 1994
Minimum weight of meat	250 g	Martinique	Rathier y Battaglya, 1994
	250 g	Turks and Caicos	Ninnes, 1994
	28 g	Belize	Chakalall y Conchrane, 1997
Temporal ban	July – September	Belize	Chakalall y Conchrane, 1997
	May – October	Mexico	SAGARPA, 2001
Total ban	1988	Virgens islands	Friedlander *et al*., 1994
	1985	Floride	Glazer y Quintero, 1998
	1978	Bermudes	Glazer y Berg, 1994
	1991	Venezuela	Rodríguez y Posada, 1994
	1988	Mexico (Yucatán)	SAGARPA, 2001
	1988	Mexico (Mujeres, Contoy, Punta Cancún y Bajo Banderas	SAGARPA, 2001

Table 4. Data of CITES, 2003 of temporal bans reported for *Strombus gigas* in the Caribbean (Aldana Aranda, In press).

Country	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Belize							xxx	xxx	xxx			
British	xxx	xxx	xxx	xxx	xxx							xxx
Caiman					xxx	xxx	xxx	xxx	xxx	xxx		
Colombia							xxx	xxx	xxx			
Cuba					xxx	xxx	xxx	xxx	xxx			
Guadalupe				xxx	xxx	xxx	xxx	xxx				
Honduras					xxx	xxx	xxx	xxx				
Jamaica								xxx	xxx	xxx	xxx	
Martinique				xxx	xxx	xxx	xxx	xxx				
México					xxx	xxx	xxx	xxx				
P. Rico							xxx	xxx	xxx			
R. Dom							xxx	xxx	xxx			
T. Caicos							xxx	xxx	xxx	xxx		
Virgins island							xxx	xxx	xxx			
Venezuela							xxx	xxx	xxx			

fixed samples. Laboratorio de Ictiologia of CINVESTAV-IPN, Mérida by its logistic support of histology study. Victoria Patiño Suarez and Teresa Colás Marrufo by histological assistant and analysis of samples. Estrategias reproductivas del Caracol Pala *Strombus gigas* en el Caribe Insular Colombiano, No. 003/april, 2003 (SAI, Colombia and Laboratorio de Biología y Cultivo de Moluscos CINVESTAV-IPN, Mérida, México).

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