Pre-Hispanic Fishery of the Queen Conch, *Strombus gigas*, on the Islands off the Coast of Venezuela

Andrzej Antczak
Maria Magdalena Mackowiak de Antczak

ABSTRACT

This paper examines the pre-Hispanic assemblage of queen conch (*Strombus gigas*) remains recovered during systematic archaeological excavations at the Los Roques Archipelago, 135 kilometers off the coast of Venezuela. Amerindian sailors belonging to different cultures from mainland north-central Venezuela, occupied these islands periodically between A.D. 1200 and 1500.

The data indicate that the pre-Hispanic exploitation of marine animals in this group of islands was focused on the queen conch, which is absent or rare on the mainland coast. This mollusk has been highly coveted by the Amerindian mainland groups as food and as a raw material. The shell was coveted as well as an exotic good and social status marker used in the production of personal ornaments and funerary offerings.

The data discussed here are useful for archaeological reconstruction of economic, social and ideological aspects of queen conch exploitation. These data can be compared to those of modern fishery statistics through interdisciplinary research and will also provide valuable information for the reconstruction of the history of queen conch populations at the Los Roques Archipelago. Finally, it could help determine long-range fishery management strategies and policies of this endangered species.

INTRODUCTION

Archaeological research has indicated that aquatic and marine fishery products were a main source of protein and pivotal for intra-regional trade in several regions of pre-Hispanic America [1]. Archaeologists have provided detailed data on the exploitation of marine resources in pre-Hispanic and early Hispanic times [2–6]. The problems that affect the present-day fishery, such as the biomass

Unidad de Estudios Arqueológicos, Instituto de Estudios Regionales y Urbanos, Universidad Simón Bolívar Apartado 89144, Caracas 1086A, Venezuela. maantczak@usb.ve

reduction of certain economically important species, have rarely been addressed and explained by the investigation of long-term ecological changes induced by anthropogenic and environmental disturbances [7, 8]. To achieve this goal the historical-ecological research in more interdisciplinary and less multidisciplinary terms should be orchestrated [7, 9, 10]. The inclusion of the archaeological data in marine science may be seen as a first step toward such an integrative approach [11].

The interdisciplinary team should be composed of archaeologists, anthropologists, historians and ethnohistorians, marine and fisheries biologists and ecologists, as well as specialists in paleoenvironment and paleoclimate. These individuals would participate in all stages of interdisciplinary research programs within the historical perspective of marine animal populations and their interaction with humans. Such research would permit not only collecting the different threads of data significant in particular spatial/temporal frames, but also to connect all these threads properly into one trans-contextual and trans-temporal model. The fundamental claims of the postprocessual and, specifically, contextual archaeology may be adapted for such an intellectual enterprise. According to the original meaning of the Latin word *contextere* (to weave, to join together), the proposed interdisciplinary contextual approach should connect "the totality of the relevant dimensions of variation around any object". The variable would be, for example, a specific marine animal population, on both local and supra-local scales [12].

In this paper we present the results of our research on the exploitation of the queen conch, *Strombus gigas*, by the occupants of the multifunctional Amerindian campsite located on the tiny island of Dos Mosquises, Los Roques Archipelago, between A.D. 1200 and 1500. The evidence indicates that this resource has been collected by periodic fishermen and by the local population since pre-Hispanic times until the present [6]. Since the 1950s, small-scale artisanal fishery carried out in the archipelago has provided more than 90% of the Venezuelan catch of queen conch and lobsters (*Panulirus argus*). The marine turtles and reef-associated fish have also been exploited in this archipelago although the overall dimension of this fishery has been considerably smaller compared to that of lobsters and queen conch [13]. During the last two decades, the fishery of queen conch and turtles has been banned while the exploitation of fish and lobsters has become strictly controlled.

Some statistical data related to the Los Roques fishery have been available for the last fifty years. The accuracy of these records has increased during the last decades since they became collected routinely. It is noteworthy that the existence and availability of fishery-specific data from the Los Roques Archipelago is quite exceptional within the insular scenario. The data on the fishery carried out on other small islands located off the shore of Venezuela (Dependencias Federales) are poor in quantitative and qualitative terms or absent. The potentially available information is dispersed between the ports of the mainland coast of Venezuela, the neighboring Dutch islands and other islands of the Lesser Antilles where the catch arrived, or corresponds to reports or proceedings of governmental inquiries. In this situation the information should be first collected from dozens of ports scattered across the region. Further, it should be validated, given that the data-registering methods have not only changed through time but, additionally, may be quite different from one port to another and from country to country.

The above discussion indicates that the scholar who aims to reconstruct the long-term history of marine populations and fishery on the small islands of Venezuela is not in as advantageous a position as colleagues in Europe and North America are. They can rely on the potentially useful historical data that was produced during the statistical and proto-statistical periods that lasted for more than one century [7]. On the islands of Venezuela, for the period before 1950 and back to the Spanish conquest, we can only rely on very scant documentary sources limited to accounts of naturalists, buccaneers and travelers. This period roughly corresponds to the historical era of data generation in the northern latitudes [7]. In consequence, to reconstruct the long-term history of marine populations and the ancient fishery and paleoenvironment of the islands off Venezuela, we have to go directly from the modern times and statistically recorded data to the archaeologically generated inferences and natural ecological archives.

In this scenario the main task pertains to the archaeologist. Once gathered, the potential value of the zooarchaeological and paleoenvironmental data for the reconstruction of the history of marine animal populations should be evaluated by interdisciplinary teams that would eventually make it compatible with modern sets of related statistical records. However, despite the early origin of the interest in the archaeological mollusks as sources of data that would be potentially valuable for the reconstruction of the history of marine animal populations [14], the majority of the traditional archaeological analyses of the marine mollusks usually have incorporated only shell artifacts, discussing their functional and symbolic meanings. Until the last two decades approximately, the unmodified shells had been generally specified in the taxonomic lists or, ignored. The interpretation of these taxonomic lists has rarely been attempted [6] In consequence, such lists only give “a report, a facade of scientific accuracy and thoroughness, though in fact their value is quite limited” [15].

To diminish interpretative errors of the marine archaeomalacological fauna, the paleoecological, taphonomical and contextual analyses should be considered an integral part of the process of investigation of archaeological molluscan assemblages. It should be borne in mind that, for example, calculating shells that are not food debris, but would have been erroneously considered as such, undermines not only the reliability of any dietary statistics but may also distort any chain of non-dietary inferences [16, 17].

It has been recognized that discrimination between shell artifact and natural shell is a difficult scientific exercise, especially, when the analysis takes into account the general appearance and macroscopic morphology of the shell alone [18]. However, several contributions have provided methodological devices that aid distinguishing natural and cultural shell deposits [16, 19] and between modification of shells by anthropogenic and natural agents [20–22]. Use-wear analyses have to be done, as well as taphonomy, ecology, and contextual associations of

Figure 1: Location of the Los Roques Archipelago within the Caribbean.

archaeological mollusks have to be exhaustively analyzed and discussed to assure the success of these discriminatory processes.

In this paper, proper distinction between mollusks collected for food, raw material and/or for other purposes (i.e. containers, hearth bases, net sinkers, ritual paraphernalia, curiosities) and those that pertained to the natural sedimentary matrix or were introduced by natural agents to the site, has been of crucial importance. The arbitrary determination of food/artifact, often applied to the archaeofaunal analysis, is replaced here by systematic contextual and analytical discrimination between food, non-food remains and natural objects. We also reconstruct gathering and resource processing techniques that might have been used by the pre-Hispanic visitors to the island [6, 23].

THE NATURAL SETTING

The Los Roques Archipelago is a complex of coral reefs and calcareous sediments on a submarine platform of igneous-metamorphic rocks located between 11° 44' 45" and 11° 58' 36" N and 66° 32' 42" and 66° 52' 27" W. It is a major geographic feature within the chain of islands north of the central coast of Venezuela (Figure 1). With its emerged and submerged areas the archipelago covers about 1500 km^2 [24–26].

The waters of the archipelago are oligotrophic with low concentrations of nutrients and primary production. To explain the existence of a high biomass in waters of such low productivity, it has been argued that the archipelago is a highly efficient system in the recycling of its nutrients with export of only small amounts [27].

The winds on these islands blow from the east and northeast [28] and their velocity oscillates between 18.5 and 46.3 km/h [29]. Tropical storms and hurricanes are quite infrequent phenomena in the area [30]. Only a very small fraction of hurricanes and tropical storms reported in modern times came within 150 km of Margarita Island: "On average, one storm per five or six years may approach the [Margarita] island with sufficient force to affect the beach crest" [30]. The disastrous effects of strong winds from the north and northwest have been reported since 1877 in Los Roques and other adjacent islands [31].

The Guyana Current 'chokes' the Lesser Antilles. Upon entering the Caribbean from the east, it changes into the Caribbean Current, and then into the Gulf Stream. This superficial current flows with variable speed thorough the year from the east to west. According to the Atlas of Pilot Charts [32], the speed with which a boat would move west, by marine currents alone in the area of Los Roques, is about 1.3 knots in February, one knot between February and August, and much slower in September, October and December. The tidal movements on these islands range between 0.2 and 0.4 m and are almost imperceptible [33, 34].

The marine ecosystem of Los Roques, like that of other coral reef systems, is mature and of great complexity, being one of the most evolved within the marine environment [35, 36]. This ecosystem is composed of interdependent communities or biocenosis of intertidal zones, coral reefs, sea grass beds, mangroves and lagoons, and the pelagic environment [37]. The first four communities develop within the benthic realm that is much more diverse in comparison to the pelagic, and clusters more mature and complex communities due to its lesser exposure to random environmental fluctuations [35]. The marine resources of these islands, highly coveted by man, are turtles [38–43], lobsters [44, 45], reef fishes [46–48], and *Strombus gigas* [39, 49–51]. Los Roques and, to a lesser extent, Las Aves de Sotavento Archipelago, sustain large populations of *Strombus gigas*. Its natural density there is among the highest in the Caribbean [52].

THE CULTURAL-HISTORICAL SETTING

The fieldwork on the Los Roques Archipelago, part of the *Archaeology of the Islands of Venezuela* research project and directed by the authors, started in 1982. Extensive excavations in large trenches have been carried out in four of 22 pre-Hispanic sites [6, 23, 53–59]. The site located on tiny Dos Mosquises Island is the source of the data discussed in this paper. It yielded the most numerous and diversified artefactual and zooarchaeological remains and the most complex archaeological contexts of all the islands surveyed and/or excavated in the project (Figure 2). About 50 % of the soil from the excavated sites was dry screened using a one square millimeter metal mesh. The extensive excavations were carried out in levels of 20 cm. Natural/cultural stratigraphical features were also recorded [6]. This site has been interpreted to be a multifunctional campsite, occupied between A.D. 1200 and 1500 by the Valencioid people (the bearers of the Valencia culture) from the north-central Venezuela mainland [56].

The relationship with the marine biologists from the Dos Mosquises Marine Station (Los Roques Scientific Foundation) proved to be of great value in our understanding of the bioecological aspects of local marine resources. We spent several months living with local fishermen, taking notes and building up comparative collections of modern faunas that proved to be indispensable for the identification of over 100,000 zooarchaeological remains recovered during the excavations.

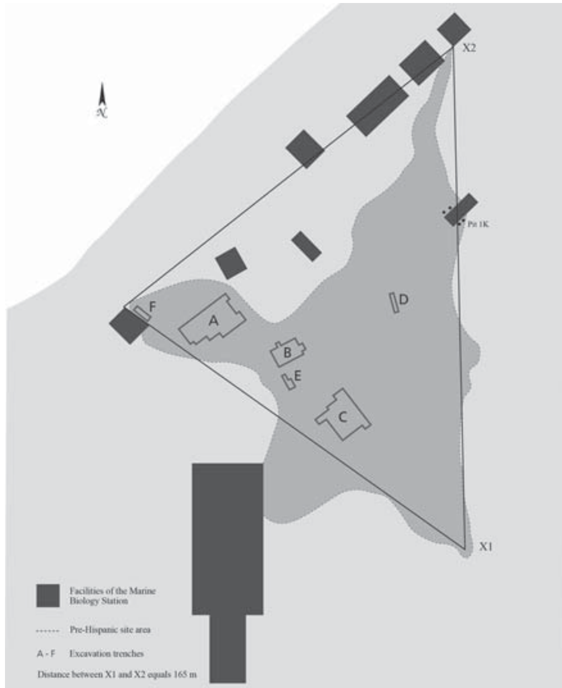

Figure 2: General plan of the excavations at the DM site, Dos Mosquises Island, Los Roques Archipelago.

STROMBUS GIGAS: THE FRUIT OF PARADISE?

A total of 12,672 marine shell specimens have been recovered from the Dos Mosquises Island archaeological site (DM site, hereafter). This number includes 8,549 *Strombus gigas* shells, their fragments and artifacts, which account for 6,696 individuals (Minimum Number of Individuals (MNI, hereafter). This used a quantification standard based on the number of shell apexes or tips. This paper is focused on the analysis of the shells of *Strombus gigas*. Information regarding other marine mollusk remains can be found in the literature [6].

The large protein yields, high densities and reproductive rates, as well as easy access and low risk involved in the exploitation, makes the *Strombus gigas* one of the most attractive food resources for Caribbean societies. The flesh of *Strombus gigas* may be consumed raw, cooked or roasted. If salted and sun dried it may last for 5-6 weeks (Teobaldo Salazar, Felipe Salazar, José Ana Marval, personal communications 1982-85). Apart from its dietary value, the large size of the shell, its external sculpture and physical-chemical properties, are so outstanding in comparison to other locally available shells that the native inhabitants of this region selected it as a 'container' for ideological loads. Large quantities of whole and modified shells, as well as artifacts made out of them, have regularly been recovered from Archaic or preceramic sites of the Caribbean, dating from at least 5,000 years b.p. [60–62]. In several regions this exploitation continued through the Ceramic Period and proto- and historic times [6, 23, 63–65]. Today *Strombus gigas* is still a source of food and craft work for almost 20 Caribbean countries [66], however, its fishing has been prohibited or regulated in many islands of the Caribbean due to its overexploitation [67].

The fisheries of *Strombus gigas* in Los Roques Archipelago stands out in the Caribbean scenario due to its high intensity. Large mega-middens composed of thousands of thousands of shells, scattered on several keys of the archipelago, are direct testimony of the large scale exploitation of this resource in the past. These mega-middens represent, at first sight, thousands of kilograms of meat that have been used for food. The ongoing research indicates that the volume of the pre-Hispanic shell middens at La Pelona Island, in the Los Roques Archipelago, corresponds to the exploitation of about 1,500 kilograms of meat/year between ca. AD 1300 and 1500 [68–71]. The modern middens are no less impressive in volume than their prehistoric counterparts. An average consumption of over 200,000 kg of meat/year was reported in early 1980 in the archipelago [29]. *Strombus gigas* is known at the Los Roques Archipelago as *botuto*. This vernacular name will be used here alternatively with the scientific name.

It is known, from the archaeological record, that *botuto* shells have been used as raw material by the pre-Hispanic inhabitants of north-central Venezuela mainland since the Archaic or preceramic period, 3500 b.c. [72]. Large quantities of whole shells and shell ornaments were reported from the late prehistoric sites in the Valencia Basin [73–76] as well as from the Venezuelan Andes [77, 78], especially from the piedmont area of Quibor [79].

Might the exploitation of the *botuto* in the Los Roques Archipelago have been related and in what way to the web of economic, socio-political and ideological attitudes adopted toward this mollusk by the coastal and inland-located Amerindian societies? Were the Amerindian visitors to these islands exploiting *botuto* for food, as a raw material, or for other unknown, non-functional reasons?

In order to address the above questions some assumptions about the interpretative values of the Dos Mosquises Island *botuto* shell assemblages should first be discussed. The large and solid shell of this gastropod is particularly well suited to resist the adverse action of the majority of natural taphonomic agents operating in the insular environment, especially in comparison to smaller and more fragile shells and bone remains. The probability of archaeological recovery of almost all *botuto* shells that were brought to and discarded in the site during past activities is relatively high. Because *botuto* shells are large and heavy, they are more likely to be found where they had been discarded. When trampled, they do not change their spatial location like smaller artifacts may do, especially in fine insular sand [80]. Scatters and heaps of these shells are the most visible elements of the structure of Amerindian use and re-use of insular space. The mega-middens are a particular monumental heritage of the prehistoric insular landscape.

Even if the deposited *botuto* shell assemblages were mildly affected by diagenetic processes, the material results of brief single historic events cannot be distinguished in their present spatial configurations. The archaeological deposits are, with few exceptions, not ‘snapshots’ of past moments. Therefore, the composition and spatial configurations of the *botuto* assemblages in the DM site cannot match precisely any concrete prehistoric sociocultural system or economic formation [80–83]. These assemblages are a result of sets of different individual and group activities that could tend to overlap from one to another episode of occupation and reoccupation of the site. It should also be remembered that the sites might have been occupied by socioculturally diverse human groups which might have arrived at the islands with functionally and ideologically similar or different purposes, for shorter or longer time spans. In sum, there are many reasons to believe that the majority of depositional sets of *botuto* shells in DM site are overlapping and polythetic [84].

We have assumed that the *botuto* remains in the DM site may mainly be the result of shell discard during or after (1) the flesh extraction, (2) shell working activities, and/or (3) any other unknown activities [85]. Once the flesh is extracted and the shell discarded, no direct archaeological remains of *botuto* consumption practices are left, unlike in the cases of the consumption of mammals, birds or fish. It is our assumption that the loci for the first and second of the above mentioned activities might have been spatially separated during the same occupational episode. Certainly, the shells used in more than one activity might have ended up in the same depositional context [86]. However, using the comparative analysis of statistical figures of spatial distribution of morphologically different/similar shells within and between excavation units and cultural deposits within the DM site, we attempt to determine whether any particular areas of the settlements were used or not for specific tasks during the successive reoccupation of the site [6]. These morphological and distributional data are also used for temporal-spatial comparative intra-site analysis and to infer the functional and symbolic meanings of the shells and their deposits. There are several difficulties in interpreting multivariate spatial patterning. In order to provide some means for interpreting the data, we carried out several experiments and used biological as well as ecological data concerned with modern mollusk populations at the Los Roques Archipelago [6].

Biological and ecological background

The following synthesis of the biogeography, biology, ecology, population dynamics, development and anatomy of *Strombus gigas* is indispensable for understanding the subsequent discussion. Readers interested in more details of this genus are referred to the specialized bibliography [87].

Five species of Strombidae are known in the Caribbean: *Strombus gigas, Strombus raninus, Strombus pugilis, Strombus gallus* and *Strombus costatus*. The area of distribution of *Strombus* spp. comprises Bermuda, Bahamas, South Florida, the Gulf of Mexico and from the West Indies to Brazil [88, 89]. All these species have been reported in Venezuela where *Strombus gigas* is known as *botuto, vaca* or *guarura* [90]. In coastal Venezuela *botutos* may be found, always in low densities, from the Peninsula of Paraguaná to the Peninsula of Paria. In the areas of Morrocoy, Gulf of Cariaco and along the eastern coast, the species has been practically extinguished [91–93]. The largest populations of Strombidae in Venezuela still remain in the archipelagos of Los Roques and

Las Aves de Sotavento, while considerably smaller ones are found in La Orchila, La Tortuga, La Blanquilla and Margarita Islands [94, 95].

All five species of Strombidae are present in Los Roques Archipelago [96, 97], although *Strombus gigas* is, by far, the most abundant [49, 96, 97]. In this archipielago, large areas of sea grass beds, mainly *Thalassia testudinum* and *Syringodium filiforme*, cover an area of about 5400 km^2 with a depth between 0.5 to 1 m [50]. These beds are the ideal habitats of Strombidae. The area on which the collection of *botuto* has traditionally been concentrated is situated along the large interior lagoon of the archipelago [52].

The area that surrounds Dos Mosquises Island is one of the best-studied habitats of *Strombus gigas* in the Caribbean [29, 39, 49, 51, 94, 98]. On the east of the island to a depth of one meter, a 50-m wide strip of *Thalassia testudinum* covers an area of approximately 3400 m^2 (Laughlin and Weil, 1985). The average *botuto* density in this area is between 0.48 to 0.53 individuals per square meter [52]. Given that this zone has been protected from fishing activities by the Los Roques Scientific Foundation since at least 1963, these density values are considered 'natural'. Moreover, toward the northeast of this area, densities of up to 2.1 individuals per square meter were found, which are the highest reported for all the Caribbean [52, 99]. In Cuba, for instance, 0.97 individuals per square meter were reported at Cayo Matías [100].

The reproductive potential of Dos Mosquises' *botutos* is also extremely high compared to other areas of the Caribbean [52]. Dos Mosquises' *botutos* tend to repopulate in relatively short time in overexploited areas. These data clearly indicate that Los Roques Archipelago is an ideal environment for *botuto* development, as may be judged by several remarkable ecological features of their populations that are not found elsewhere in the Caribbean.

Mollusk growth and shell morphology

Strombus gigas is a herbivore that mainly ingests algae, the turtle grass *Thalassia testudinum* and sand [100]. Its post-metamorphic development comprises four stages: juvenile, sub-adult, adult and old [67, 100–102]. Individiuals reach a length of between 7.7 and 11.4 cm after oneo year and 12.7 and 17.8 cm during the next two years [103, 104]. The shell of the juvenile mollusk is thin, fragile and smooth. However, marine animals and non-biotic agents rarely affect it.

Toward the third year of life the mollusk is ready to develop the flared-lip. Its average length may attain 20.3 cm and it may weigh 2.09 Kg, of which as much as 0.9 Kg may be flesh [104]. The shell of this sub-adult individual has well-accentuated, sharp-tipped nodules [100].

In the final stage of the sub-adult phase, the mollusk reaches the maximal siphonal length of up to 30 cm, ceases to grow and begins to produce the flared-lip. This last process may take three to seven months [101, 102]. The fully developed flared-lip is characteristic of a sexually mature adult mollusk [67, 102, 105]. The shell of an adult is more solid and heavier than that of the juvenile. All nodules are completely developed as well as all other elements of the external sculpture of the shell [100]. In Los Roques Archipelago, the adult may attain a length of between 14.5 and 30 cm [52]. Shells larger than 30 cm have not been reported for the Caribbean [106]. The mollusk can live upwards of 20 years [67]. During this time the shell grows in thickness. Due to the natural processes of erosion and abrasion the shell's overall length decreases. As a consequence, the average length of old shells is less than that of younger specimens [67, 101]. These old shells can have an outer lip over 5 cm thick. The whole shell is deteriorated by animals and environment and the nodules are only slightly accentuated and worn [100].

Mollusk processing

The most evident indication of the human use of *botuto* for food is the circular perforation in the spire of the shell. This hole allows introduction of a sharpened artifact so that the tissue that connects the animal to its shell can be cut. By grasping the animal by its operculum and pulling, it may be removed from the shell. This circular hole has been associated generally, though not exclusively, with the aboriginal technique of meat extraction [6, 23, 64, 104, 107]. The elongated, narrow hole, made by a metallic tool such as a machete, has been regarded as a non-aboriginal technique, introduced to the Caribbean by the conquerors [6, 23]. However, systematic and context-sensitive studies of this phenomenon may determine whether all non-circular perforations may or may not be considered non-aboriginal (Figure 3). It has been suggested that the circular hole was made by striking the spire of the shell with the apex of another shell [6, 64, 104]. It may reasonably be assumed that identifiable traces of such an operation should be left on the perforated shell and on the shell used as a 'perforator'.

In order to understand the material and spatial correlates of the 'aboriginal manner' of *botuto* processing for food, Antczak [6] opened circular holes in shells of 50 living mollusks [65]. Old specimens were definitely the worst 'perforators' since the tips of their apexes were thick and rounded. Juvenile shells were too light to be effective against adult and old shells and their apexes were too fragile to endure repeated blows. Adult shells, between 18 and 21 cm in length, were the most effective and durable 'perforators'. In one instance an adult of 25 cm in length, efficiently perforated 23 shells before its apex became round and ineffective.

The location of the opening hole in the spire of the perforated shell must be very precise. Otherwise additional holes are necessary to reach and successfully cut-off the attaching muscle. We assume that some errors occurred mainly because both adult and old specimens that were being perforated might have had thick bunches of algae adhered around their spires, as observed today in living animals, which impeded the recognition of the correct spot.

Thirty minutes were required to perforate 40 shells (5 juveniles, 25 adults and 10 old), remove the soft body of the animal, separate the visceral parts and wash the meat [6]. Once the meat is removed from the shell it must be washed in the sea to remove visceral parts and sand. In consequence, it is suggested that

Figure 3: Two main types of opening holes used in the processing of Strombus gigas mollusks: (top) pre-Hispanic circular ‘perforation’; (bottom) elongated hole left by the metallic tool.

the Amerindian processing areas might have been preferentially located very close the seashore, especially when large quantities of mollusks were processed.

Whole shells

Almost all excavation units at the DM site yielded significantly more perforated than unperforated whole shells (Table I). This indicates that the majority of *botutos* discarded in the site were originally processed for culinary purposes. However, certain figures in Table I call for special attention. How may the highest ratio of perforated shells in the Trench D be interpreted? Given this ratio, as well as the overall structure (low shell heap) and location (on the palaeoshoreline) of the Trench D deposit, this may be considered as an area where Amerindian activities were oriented almost exclusively to the extraction of flesh with subsequent shell discard [6]. This interpretation may also be reinforced by other characteristics of the deposit, such as the highest density of *botuto* shells per cubic meter of the cultural deposit (Table I), extremely low non-*botuto* taxonomic diversity, scarcity of potsherds (all are small, and only four, pertaining to the same vessel, are decorated), and the virtual absence of shell, stone and bone artifacts. However, it should be mentioned that two small hearths, a few plain potsherds, and fragments of turtle carapace and fish vertebrae were found at a depth between 30 and 45 cm toward the base of the midden [6]. Were the lower and upper layers of the midden accumulated by culturally differentiated people and during temporally separated events? Unfortunately, the recuperated pottery is of low diagnostic value and cannot give insight into the homogeneity/diversity and chronology of this deposit. Decorated pottery was not found in the deepest layers and potsherds were not found anywhere in the mid-section of the heap until its top. At the top, four fragments of one pedestal base bowl with incised/punctated decoration were scattered among the shells. The superficial and solitary presence of this vessel invokes too many possible explanations to be of any value for the cultural/temporal determination of processes involved in the heap's formation. However, further analysis of the geomorphology of DM Island and of the structure and composition of the Trench D deposit can shed light on its cultural/natural formation processes and chronology. The evidence indicates that during the early stages of formation of the Trench D deposit (its deeper layers), the Amerindians carried out activities not dedicated exclusively to *botuto* processing, such as food preparation and consumption. If so, then the upper layer(s) composed exclusively of *botuto* shells might have been accumulated later, during one or more episodes of very intense mollusk processing and shell discard. How much later is difficult to determine. In fact, the conspicuous homogeneity of shell morphology through the deposit may suggest that it is, as a whole (upper and lower layers), a result of the discard activities of culturally homogeneous people within a relatively short time.

Table I: Whole, perforated and unperforated *Strombus gigas* shells from Trenches A-F, DM site. Shell type J-Juvenile, A-Adult, O-Old. T-Total.

		Type	Perforated	Unperforated	Total
Trench A	0-20 cm	J	7	3	10
		A	2	2	4
		O	2	-	2
	20-40 cm	J	233	79	312
		A	31	3	34
		O	1	2	3
	T		276	89	365
Trench B	0-20 cm	J	1	1	2
		A	-	-	0
		O	-	-	0
	20-40 cm	J	42	24	66
		A	50	95	145
		O	1	24	25
	T		94	144	238
Trench C	0-20 cm	J	29	49	8
		A	17	22	39
		O	-	2	2
	20-40 cm	J	577	448	1025
		A	697	217	914
		O	227	250	477
	T		1547	988	2535
Trench D	0-20 cm	J	420	23	443
		A	112	2	114
		O	-	2	2
	20-40 cm	J	558	16	574
		A	111	-	111
		O	-	1	1
	T		1201	44	1245
Trench E	0-20 cm	J	2	-	2
		A	-	-	0
		O	-	-	0
	20-40 cm	J	51	12	71
		A	19	2	21
		O	6	2	8
	T		84	16	100
Trench F	0-20 cm	J	5	2	7
		A	-	2	2
		O	-	-	0
	20-40 cm	J	19	9	28
		A	6	1	7
		O	-	-	0
	T		25	10	35

Table II: The natural predators and patterns of their damage to *Strombus gigas* shell.

Predator Phylum/Class	Species	Morphologic type	Shell alteration	Discard pattern	Reference
Gastropoda	*Murex pomum*	All	Drilled	Unknown	[52]
	Fasciolaria tulipa	All	None	Unknown	[108, 109]
Cephalopoda	*Octopus vulgaris*	All	None	Unknown	[110]
		Juvenile	Drilled	Unknown	[**?**]
Crustacea	*Paguristes grayi*	Juvenile	Broken around aperture	Transported	[49]
	Petrochirus diogenes	Juvenile Adult?	Small shells crushed	Unknown	[106, 111]
	Carpilius corallinus	Juvenile	Broken	Unknown	[49]
	Callinectes sapidus	Juvenile	Broken?	Unknown	[111]
	Calappa gallus	Juvenile	Broken?	Unknown	[111]
	Panulirus argus	Juvenile	?	Unknown	[52]
		Juvenile?	Patterned breakage	Unknown	[106]
Pisces	Epinephelidae	Juvenile	Breakage	Unknown	[112]
	Lutjanidae, *Petrometopon cruentatum, Trachinotus falcatus, Lachnolaimus maximus, Balistes vetula, Diodon hystrix*	Juvenile (x<80 mm)	Crushed	Unknown	[49, 52, 106, 113]
	Aetobatus narinari, Dasyatis americana	Juvenile and adults	Crush all the shell	Heaps of crushed shells in water 4-6 m deep	[52, 106, 114]
	Galeocerdo cuvieri	All	Ingest whole shell	Unknown	[106]
Reptilia	*Caretta caretta*	All	Crush	Heaps of crushed shells	[106]
	Eretmochelys imbricata	All	Crush	Heaps of crushed shells	[52]
Mammalia	*Tursiops truncatus*	?	?	?	[106]

Even if we cannot determine whether the lower and upper deposits in the Trench D were or were not contemporary, we can reach some conclusions about the temporal relation between them and the Valencioid deposits located inland. We know that the first shells processed in the area of Trench D, and probably the whole line of the adjacent heaps, were discarded directly on an active palaeoshoreline. Afterwards the coastline protruded eastward from this area (Figure 2). We also know that the deposits situated 25 m to the northeast of Trench D (pit DM/A/1K) gave an uncalibrated radiocarbon date of A.D. 1270 $\pm$ 80. This suggests that the deposits associated with Trench D must have been created earlier than those of Pit DM/A/1K, sufficiently as to allow the formation of about 25 m of land that separates them. However, samples recovered in two pits located close to Trench D and from the bottom of their shell deposits, yielded dates of A.D. 1290-1440 and 1200-1340 (calibrated at 2 sigma). This indicates that the processes of mollusk exploitation in the areas of Pit DM/A/1K, Trench D, and the two mentioned pits, as well as the protrusion of the active seashore, were relatively quick and could have happened in decades rather than centuries. Whether all these shell deposits were a result of activities carried out by the people culturally related to those who left the clearly Valencioid remains in the inland areas of Trenches A-C and E-F, cannot be determined.

We have already mentioned that the upper layers of Trench D cannot be conclusively considered as temporally and functionally separated from the inland Valencioid deposits. However, the homogeneity of the shell assemblage through the entire Trench D deposit, the spatial separation between this Trench and Pit K, and the relation of both areas to the protruding palaeoshoreline, leads us to consider that the whole line of heaps to the north and south from Trench D may be a pre- A.D. 1200 deposition (Figure 2). Furthermore, they may be separated in time from the inland Valencioid deposits, even though all radiocarbon dates in DM site overlap at 2 sigma. For now, the deposits of, and adjacent to, Trench D are referred here as 'pre-Valencioid'.

The *botutos* were processed for food all over the DM site, although with different intensities (Table I). If, however, the shell heaps located in the area of the Trench D and its surroundings are considered as the results of specialized *botuto* processing for food carried out on the paleoshore, how then may other, inland deposits containing shells be interpreted? In particular, we refer to those deposits that contain high proportions of horizontally scattered unperforated shells, characterized by a low density and associated with hearth features, ceramic, shell, stone and bone artifacts. Among them, the *botuto* shells assemblage at Trench B, show particularly anomalous figures such as (1) the highest ratio of unperforated old shells in relation to other trenches, (2) an inverted proportion between perforated and unperforated shells. To address the possible significance of these anomalies we need to have a closer look at the modified shells and discuss additional distributional and contextual data.

Table III: Characteristics and densities (number of items per one cubic meter of cultural deposit) of the *Strombus gigas* shells, shell artifacts and preforms from Trenches A-F, DM site.

Trench	MNI #	MNI density	Unmodified shells density	Modified shells density	Discs density	Worked shell density	Lips density
A	365?	9.7?	9.7	?	0.1	0.2	0
B	245	18.8	18.3	0.5	3.2	10.6	0.15
C	4669	124.5	67.7	57	0.6	0.7	26.9
D	1248	312	311.2	0.75	0.25	0	0
E	125	78	63.7	14.3	1.25	2.5	7.5
F	44?	36.6?	44	?	0	1.6	0
Tot/Av	6696	96.6?	85.7	18.1	1.08	3.2	11.5

Modified shells and fragments

Water-worn fragments as well as freshly-fractured specimens may be found on the insular beaches. We studied a small assemblage of 12 fragments of *botuto* shell that have no evidence of anthropic alteration. These are eight gouge-like and four scoop-like specimens, found in Trenches A and E. They are heavily water-worn on all their edges and surfaces. These specimens are either part of a natural soil matrix or were brought to the site from the beach by the Amerindians. Identical specimens may be found washed ashore on all the beaches of the Dos Mosquises Island. The entire shell may be damaged when trapped within the coral rubble, which moves vigorously during the heavy seas. Some shells may also be crushed, occasionally in large quantities, and discarded with a specific pattern by natural predators (Table II).

The majority of *botuto* predators are able to crush juvenile shells (between 60 and 150 mm in length). However, some, like marine turtles and rays, may crush even adult and old individuals, leaving fragmented shells in shallow waters in regularly structured heaps (Table III). The great majority of modified shells deposits in Dos Mosquises Island are located well inland from the seashore. Their modifications are, almost certainly, of anthropic origin. However, the shells altered by non-biotic processes as well as by the predators may easily be confused with those altered by humans, especially in situations where the modified shells and/or shell fragments are deposited in the modern intertidal zones or palaeoshoreline (i.e. as many in Caribbean Archaic sites).

Selectivity or randomness?

Were the Amerindians selecting certain natural morphological types of shells or collecting them randomly? To answer this question one is tempted to examine whether or not the archaeological shell assemblages match the frequencies of occurrence of the natural morphological types as found at present in their habitats [64]. However, the assumption about the direct relationships between the two sets of data does not have a secure basis upon which to develop archaeological inferences. The pertinent ecological data, even though easily available in the specialized literature [52, 100, 115], were not obtained in studies whose time-depth may be compared to the time archaeologists have to confront. The frequency of the different types in the natural habitat depends on the success of every particular season of reproduction and, therefore, may vary seasonally. The tropical storms, hurricane tails and other natural agents that affect the islands may considerably alter the overall composition of the stock [116] (Table II).

The patterns of type-occurrence may vary spatially from one sub-area to another, even within the same study zone (i.e. Los Roques Archipelago). On the other hand, the deposits of *botuto* shells in Dos Mosquises and in other islands are, almost certainly, not a product of 'flash-in-time' episodes but rather accumulations to which the shells were added, subtracted or reorganized (vertically and horizontally) during successive visits. Even if we could demonstrate that a particular *botuto* heap was created during the duration of one particular visit, the shells that compose it might have been collected in different habitats and during different seasons of the year. For example, is the overwhelming predominance of juveniles in Trench D (Table I) a reflection of cultural selection or of mollusks that were randomly gathered in the site's surrounding waters? It may be argued that these data suggest that the creators of this heap, who probably pertained to the first wave of Amerindian visitors to the island, took advantage of the 'virgin' natural populations of *botuto*. Large and relatively stable through time, aggregations of juvenile mollusks in shallow waters with bottoms covered by *Thalassia testudinum* were reported from many areas of the Caribbean [101, 103, 117]. In the area of Dos Mosquises Island, juveniles inhabit mainly the shallow-water beds between 0.5 and one meter in depth [39, 52]. They could easily be collected there by Amerindians wading in groups or individually, regardless of sex and age [118–120]. Adult mollusks live predominantly in depths between four and eight meters [52] and could be accessed near the shore by an individual diver or by at least a two person team with the use of the canoes. In Alcolado's [100] report, the juveniles accounted for the majority while the adults constituted 33.16% of the total population. In fact, the frequency of occurrence of natural types of *botuto* in Trench D roughly matches those of these modern studies. Given that the shells show great morphological homogeneity along the vertical dimension of the Trench D heaps, our guess is that they may, in fact, represent the results of the exploitation of the virgin *botuto* populations carried out during consecutive events close in time. In other words, the composition of these deposits is probably the result of opportunistic, non-selective gathering. This supposition may still be followed further. It is known that a massive migration of adult *botuto* individuals from the deeper waters, to copulate and deposit eggs in the shallow sandy bottoms, begins in April and lasts for a few consecutive months, each year [52]. The migration of reproductive adults takes them to the same bottoms that, during the rest of the year, are dominated by the juveniles. Were the mollusks from Trench D collected during the months prior to and after the reproductive season, when the juveniles dominated the area?

Regardless of how attractive the above suggestions might be, we should emphasize that the high frequencies of juveniles in Trench D may also be a result of cultural selection because, for example, of the juvenile's more tender flesh or easier-to-perforate shells. Undetermined functional or non-functional reasons might have also influenced the final composition of this shell deposit. Finally, the lack of any functional relationship between the upper segments of the Trench D heaps and other *botuto* shell deposits in DM site are not yet firmly established.

The on-shore deposited assemblages from Trenches A and F, as well as the inland deposit from Trench E, show compositions that, if treated as a whole, also grossly match the natural populations dominated by juvenile individuals (Tables I and IV). Therefore, they may also indicate the opportunistic, non-selective exploitation of the mollusks. However, to determine whether or not the proximity to the seashore is positively co-related to the large quantity of discarded juvenile shells, we excavated four test pits (1 x 1 m) to the north-east of Trench D (Figure 2, 1K-4K), assuming that these shells might have been discarded on or close to the palaeoshoreline. These assemblages yielded very similar proportions of juvenile and adults (116 and 108 respectively). Old individuals and unperforated shells were absent and few of the shells were modified. The lack of unperforated shells and old individuals relates these assemblages to those from Trench D (unifunctional specialized mollusk processing). At the same time the high proportion of adults and the presence of modified shells are similar to the compositions of the assemblages from Trench C (Table IV).

How can we interpret the composition of the assemblages from Trenches B and C, which are distant from the shore? In the latter trench the adults are slightly more numerous than the juveniles and the importance of old individuals is accentuated (Table IV). In Trench B these characteristics are even more emphatic: the adults clearly dominate the assemblage with an important proportion of old specimens. These compositions may be the result of cultural selectivity, for food and/or as a raw material, of the *botuto*. However, it may also be argued that the shells from these deposits were collected precisely during the migrations and congregations of adults during the reproductive phase as previously mentioned. It might have also been the case that the natural populations of juveniles from the inshore shallow waters were overexploited, obliging the Amerindians to dive into the deeper water habitats where the adults dominate. We will discuss these questions in the following section.

Dietary considerations

Even though we still do not know how the contribution of the *botuto* to the diet of the Valencioid visitors to Dos Mosquises Island is precisely related to these of other marine resources (fish, lobsters, turtles, crabs, other mollusks), there is no doubt that it had to be considerable. However, precise determination of this contribution is an unrealizable goal. How can we determine how many unperforated, both whole and modified shells, might or might not have been

Table IV: Distribution of natural morphologic types of *Strombus gigas* whole (W) and modified (M) shells in Trenches B-E, DM site. J - Juvenile; A - Adult; O - Old

Trench	Type	J	A	O	Total
B	W	68	145	25	241
	M	6	3	0	9
	MNI	74	148	25	250
	%	30	50	10	
C	W	1103	953	479	2535
	M	840	1130	164	2134
	MNI	1943	2083	643	4669
	%	42	45	13	
D	W	1017	225	3	1245
	M	0	5	0	5
	MNI	1017	230	3	1250
	%	81	18	0.2	
E	W	73	21	8	102
	M	19	8	1	28
	MNI	92	29	9	130
	%	71	22	7	

considered as food-related items? The overall volume of meat processed for immediate (*in situ*) and/or delayed (preserved and shipped beyond the islands) consumption by the socio-culturally different occupants of the DM site cannot be inferred from the archaeological record. An unknown quantity of mollusks might have been processed beyond the site and DM Island, and their flesh brought to the site for consumption/preservation. Salting and sun drying of *botuto* meat is still a widespread practice among the Los Roques fishermen (information obtained from fisherman, Teobaldo Salazar 1983). It has been demonstrated that it is a successful strategy for storage and transportation of mollusk meat [121, 122], for data about dried *Strombus gigas* export from Turks and Caicos Islands to Haiti). Additionally, the volume of exploited mollusks might have varied from one occupational episode to another as well as from the first stages of the 'discovery' and installation in the Archipelago, to further stages of the explorations and exploitation of the islands' resources. As already discussed, the separation of the deposits that correspond to the different occupational episodes at DM is blurred. Table V shows the remarkable nutritional values of *botuto* meat compared to those estimated for chicken, beef and pork. It is noteworthy that the low frequency of cases of copper-deficiency and poliomyelitis reported among those native Bahamians whose diet was based on *botuto*, was related to its high content of assimilable copper [87, 106].

Table V: Nutritional values of *Strombus gigas*, beef, chicken and pork meats, calculated in dry weight. [1] Data from Fundación CIEPE, San Felipe, Servicio Tecnológico # 16387, analyses contracted by the authors, 21.09.1987. [2] Ministerio de Sanidad y Asistencia Social e Instituto Nacional de Nutrición (1983).

Nutritional information	Unit of measure	*Strombus gigas*[1]	Beef [2]	Chicken[2]	Pork[2]
Protein	%	60.8	74.2	61.4	58.7
Fat	%	1.8	17.8	34.7	37.8
Minerals	%	24.9	4.4	4.0	3.5
Phosphorous	g/kg	3.51	7.3	6.1	7.0
Iron	g/kg	0.13	0.1	0.04	0.06
Copper	g/kg	0.07	-	-	-
Calcium	g/kg	3.84	1.0	0.4	0.2

Using the allometric formula provided by Laughlin and Weil [52] that allows estimating flesh of *botuto* from the siphonal length of its shell, we calculated that 2535 whole perforated and unperforated shells in the Trench C contributed with 266.853 Kg of meat (Table VI). However, it is very suggestive that the mollusks processed in Trench D yielded as much as 18.6% (ca. 131 Kg) of all meat that might have been extracted from shells (based on the total MNI number) in DM site (573.5 Kg.). The volume of *botuto* meat per cubic meter excavated in this purported 'pre-Valencioid' cultural deposit (Trench D) is 46.8 Kg, while in all Valencioid deposits together (Trenches A-C, E, F) it is only 6.9 Kg/m^3. Recently, the estimates of the volume of botuto meat "enclosed" in the pre-Hispanic mega-middens located on La Pelona Island (south of Dos Mosquises) have been published [68–70], confirming the great scale of the pre-Hispanic exploitation of this resource in the Los Roques Archipelago. It is not our intention to go deeper into dietary calculations that will be soon provided by the ongoing research of our project [123]. However, we would like to highlight the potential of such a valuable resource on the economy, social complexity and politics of the prehistoric societies of north-central Venezuela as well as the impact of such a large-scale fishery on natural populations of this mollusk.

For this, let us use some modern ethnographic data to roughly assess the human effort involved in the exploitation of *botutos* and to illustrate the value of these data to the interpretation of the prehistoric realities. Table VII shows the maximum sustainable catch of *botuto* per man/day in different areas of the Caribbean. These figures are not the highest reported in the area since Hesse and Hesse [105] reported that one efficient diver could collect as many as 100 mollusks in half an hour from depths over nine meters in Turks & Caicos Islands. In the shallow waters of Dos Mosquises Island a crew of a boat (3-5 persons) could collect, without diving, as many as 700-1000 mollusks during half a day (this information, which refers to the 1970s, was obtained from *botuto* fishermen (Pablo Mata and Felipe Salazar, 1982-1985). The data indicate that in one day 3-5 men could collect over 300 Kg of highly nutritive meat! For this reason

Table VI: Average, maximum and minimum whole *Strombus gigas* shell (2535 specimens) lengths and weights of flesh from sub-areas A-F within Trench C, DM site. L - Length in centimeters; W - Weight of animal flesh in grams

Shell/flesh	measurements	Average	Maximum	Minimum	Total
Area A	L	18	26.2	8	
	W	88.2	295	13	98456
Area B	L	18.3	24.5	11.5	
	W	87.5	221	24	5865
Area C	L	19.3	24.3	14	
	W	102.2	213	37	9202
Area D	L	19.3	27	10.5	
	W	105.6	338	20	22509
Area E	L	20.4	27.5	10	
	W	126.1	368	19	73640
Area F	L	20.3	27	10	
	W	123.2	338	19	57181

we consider the *botuto* should or can very appropriately be called 'the fruit of paradise'.

The above discussion has a direct bearing on interpretation of the archaeological *botuto* shell deposits; even though it may certainly be argued that the Amerindian *botuteros* were not working to fulfill modern market demand. We will argue that the mollusks specified in Table VII were almost exclusively collected by diving, while the Amerindian populations could have taken advantage of shallow water dense populations, easily accessible by wading. Using the figure of 120 *botutos* as an average one-man catch per day, which is the lowest average reported for modern Los Roques fishery (Table VII), it can be estimated that all the *botuto* shells from the Valencioid deposits within the DM site (MNI=6696) could have been collected by two men in less than a month. However, was such a quantity of mollusks available in Dos Mosquises Island waters?

Botutos may be collected everywhere around the island. However, the ideal habitats, and therefore the major densities of *botutos*, have been reported from sea-grass bottoms toward the southeastern shores. These shallow waters between 0.1 and 1.0 m in depth cover approximately 3400 m^2 [125] with average densities of 0.5 *botutos*/m^2 [39]. This indicates that 1700 mollusks could have been collected from this area by wading on a single occasion. In consequence, all 1245 mollusks from Trench D could have been collected, in theory, from this area during a one-day episode by a few people. The heaps and scattered *botuto* shells in Dos Mosquises Island site are only minor elements of the insular landscape in comparison to the large mega-middens located on other islands of the Los Roques Archipelago. A large part of these middens is undoubtedly of pre-Hispanic origin. In the light of the above considerations, these mega-middens should not necessarily be seen as the products of very long-term successive accumulations resulting from *botuto* fishery. They may be alternatively seen as the

Table VII: Estimated catch of the *Strombus gigas* mollusks per man/day in different areas of the Caribbean between 1960s and 1980s[1]. See Figure 4. [1]All data refers shells collected by diving at the depths of about nine meters. [2] The real yields are larger than shown in this table since during the conversion of the original data the total amount has been divided by the number of crew of the boat despite the fact that not all crew members participate in mollusk collection.

Area	Use of boat	Quantity of collected mollusks	Reference
Los Roques	1 boat	233[2]	[52]
Los Roques	2 boats	250[2]	[52]
Los Roques	1 boat	120[2]	[46]
Grenadines	1 boat?	180[2]	[124]
Turks & Caicos	-	600	[105]
Caicos Bank	?	277	[122]

remains of a relatively short-time intense exploitative effort that should hardly impact the natural populations of this mollusk.

CONCLUSIONS

The examples discussed in this paper indicate that the archaeological reconstruction of prehistoric fishery is a complex and rigorous intellectual exercise that has inherent limitations imposed by the very nature of the archaeological (context-dependant) record. To mitigate these constraints and achieve the goals of the historical ecological nature, the archaeological research should merge since the beginning with its bioecological conterpart in truly interdisciplinary terms.

The above discussion suggests that the pre-Hispanic occupants of the Los Roques islands heavily exploited the extremely dense and vulnerable populations of queen conch. We hypothesize that by the time of the Spanish Conquest the resource could have been depleted. Given that during the 16^{th} - 19^{th} centuries the archipelago was visited sporadically and only by small groups of people [23, 126], the affected mollusk populations would have recovered to pre-contact states. Since the beginning of the 20^{th} century, and especially since the 1950s, small but permanent fishermen populations established in the archipelago exploited the queen conch so intensely that its population was depleted in the early 1980s. These examples raise the question for the potential of the archaeological data for the long-term study of the exploitation of marine populations, especially in those regions of America where reliable statistical data on fishery has only been collected for the last few decades.

We are confident that archaeological data can improve our understanding of the role of marine animals in human history in economic, socio-political, and ideological aspects. Moreover, the interdisciplinary evaluation of the archaeological data, such as that discussed here, would open further archaeological and bioecological interdisciplinary studies that would improve our understanding of the history of marine animal populations and their exploitation in the Carib-

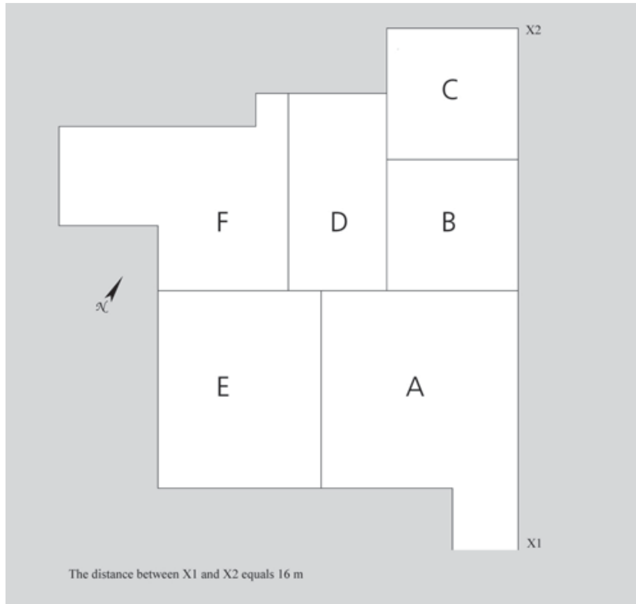

Figure 4: Sub-divisions of the Trench C, DM site, used for the classification of the Strombus gigas shell remains.

bean region. Once an interdisciplinary team validates the archaeological data discussed in this paper and, further, performs the comparative analysis of the pre-Hispanic, colonial and modern fishery statistics, the resulting information would play an important role in long-range queen conch management strategies and policies in the Los Roques Archipelago and adjacent island groups.

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