Archaeofauna 17 (2008): 157-174

Molluscs in Central Panama: A review

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(Received *21 October 2006*; Revised *7 January 2008*; Accepted *20 June 2008*)

ABSTRACT: Molluscan remains have been used by archaeologists in Panama to reconstruct ancient coastal environments, subsistence strategies and exchange activities at coastal and inland sites. The goal of this review is to summarize some general aspects of mollusc use at sites located on the central Pacific coast of Panama with special reference to (a) their distance from the sea, (b) date of occupation and (c) species diversity and abundance. Ultimately the changing patterns of shellfish use by Pre-Columbian inhabitants show that diversity and abundance in these sites can be linked to their topographic position.

KEYWORDS: MOLLUSC, PANAMA, ZOOARCHAEOLOGY, INTERMEDIATE AREA, NEOTROPIC

RESUMEN: Los restos malacológicos han sido usados por los arqueólogos en Panamá para reconstruir tanto los ambientes costeros antiguos, como las estrategias de subsistencia y las actividades de intercambio de los sitios costeros y los sitios de tierra adentro. El objetivo de este artículo es resumir algunos aspectos generales del uso de los moluscos en sitios localizados en la costa del Pacífico central panameño con especial atención (a) a la distancia de los sitios con respecto al mar, (b) la fecha de ocupación y (c) la diversidad y abundancia de especies de moluscos. En última instancia, los cambios en los patrones de uso de los moluscos por los habitantes precolombinos muestran que la diversidad y abundancia de moluscos en esos sitios están ligados a la posición topográfica de cada sitio.

PALABRAS CLAVE: MOLUSCOS, PANAMÁ, ZOOARQUEOLOGÍA, ÁREA INTERMEDIA, NEOTRÓPICO

INTRODUCTION

Archaeological deposits rich in shell first appear in Panama at a time when there is a deceleration in sea level rise (ca. 7000 BP) (Sandweiss *et al.*, 1998; Bailey & Milner, 2002/2003). Thereafter but prior to 2500 BP differences in stone tools and pottery allow for the identification of a regional cultural tradition. After 2500 BP and based on stylistic homogeneity in its material culture the central Pacific coast area came to be called «Gran Coclé» (Cooke *et al*., 2003; Cooke, 2005). By the 16th century Spanish chronicles report that Parita Bay on the central Pacific coast of Panama was one of the most densely populated areas in Lower Central America (Figure 1). This area was divided among four small chiefdoms from west to east, Parita, Escoria, Natá and Chirú, whose main villages were located along a 35 km wide, semicircular band of floodplains crossed by small rivers that flowed into the bay; each river had/has a prograding delta surrounded by mangroves (Cooke, 1993). The Spanish accounts make constant reference to abundant coastal resources in these villages and they also indicate that the area had markets where Indians exchanged agricultural, marine, and riverine products (De Oviedo y Valdés, 1849-1855; Andagoya, 1913; Espinosa, 1913 [1957]; Jopling, 1993; Cooke & Sánchez Herrera, 2001).

Zooarchaeological research in central Panama has confirmed the Pre-Columbian utilization of coastal resources; such resources included vertebrates and invertebrates for food, tools, ritual and costume objects (Ranere & Hansell, 1978; Cooke & Ranere, 1984, 1989, 1992a, 1999; Cooke, 1988, 1992a, b, 2004a, b; Carvajal Contreras, 1998; Jiménez, 1999; Peres, 2001; Mayo, 2004; Mayo & Cooke, 2005). Relative to the invertebrate/molluscan component, early Panamanian studies focused

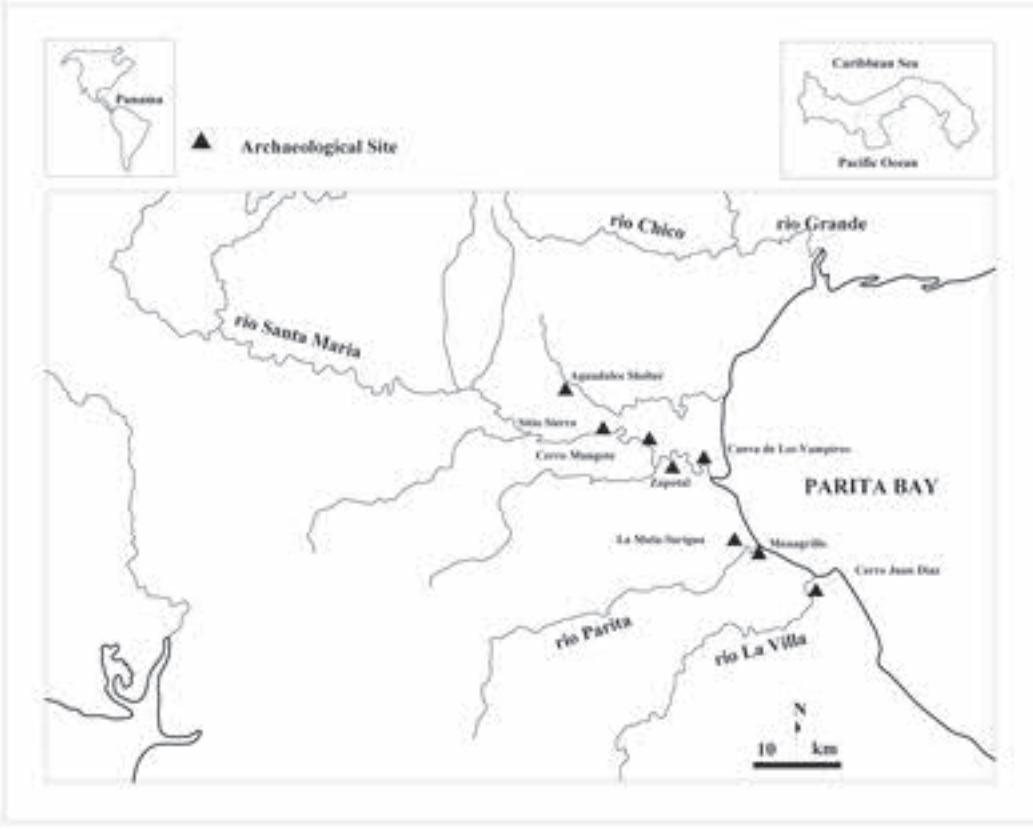

FIGURE 1
Archaeological Sites, Parita Bay, Central Panama.

on shell objects from mortuary contexts (e.g., Sitio Conte [Lothrop, 1937, 1942]).

Later investigators studied middens, such as Monagrillo and Cerro Mangote, with a concern for marine molluscs as food and environmental indicators (Willey *et al*., 1954; McGimsey, 1956; Martín-Rincón & Rodríguez, 2006). It was not until Hansell's (1979) work on mollusc distributions at Monagrillo that archaeomalacological studies became concerned with other aspects of Pre-Columbian societies, such as subsistence strategies, seasonality and site position relative to an active coastline. More recently, Carvajal's shell analysis in a kitchen midden at Cerro Juan Díaz has correlated shellfish taxonomy with their abundance to niche exploitation to cooking and gathering methods (Carvajal Contreras, 1998). At the same site, Mayo (2004) has described a shell workshop in which its inhabitants were manufacturing shell beads. The above kinds of data are useful for estimating how coastal habitats have changed over time and for calculating the distance(s) between resources and consumers. In this paper we describe mollusc use at sites located on the central Pacific coast of Panama with special reference to their distance from the sea, their date of occupation, and the abundance of various molluscan species.

COASTAL GEOMORPHOLOGY

Parita Bay is composed of productive heterogeneous tropical estuaries (see Figure 1 for location). Between May and December the Intertropical Convergence Zone (ITCZ) generates a wet season. In the dry season the ITCZ creates an upwelling of cold, nutrient-rich waters from below the bay's surface. Crabs, fish, molluscs and shrimp depend upon this phenomenon for survival. In the brackish areas along the coast, mangroves create a haven for the above animals with shrimp and molluscs being particularly abundant (Cooke, 1992a).

The distribution of molluscs in a tropical estuary is affected by natural and historical factors, such as changes in the local coastal geomorphology (Day *et al*., 1989). Because coastal geomorphology tends to change rapidly, changes in the diversity and abundance of coastal resources can be linked with the topographical position of each site at the moment of its occupation.

While there have been no detailed geomorphological studies for the central Parita Bay region a seminal study conducted by Temple University scholars in the 1980's has generated a model of Holocene transgression and regression (Clary *et al*., 1984). This model suggests that Parita Bay deltas have been advancing seaward since 4000 BP, or at a time when the sedimentation rate was faster in the central part of the delta (i.e., the Santa Maria River) then on its periphery (i.e., the Grande and La Villa rivers [see Table 1]).

The above model proposes that the progression rate was 0.5 km per 1000 years at the edges of the bay and as much as 1 km per 1000 years in the bay's center. Therefore, archaeological sites would have been either on an active shoreline or embayment at the height of their major occupation or nearer to such then they are today (see descriptions associated with each archaeological site below for more precise distances).

Date BP	Distance from marine environments (km)	Rate of sea advancement	Sedimentation: sea advancement	Coastal mechanisms
10000	> 15	Fast	Slower	Transgression
10000- 8000	15-1.4	Fast	Slower	Transgression
8000-7000	1.4-1.2	Slower	Without movements?	
7000-5000	1.2-5.5	Slow	Faster	Progression
5000-3000	5.5-4.2	Faster	Slower	Transgression
3000-Present	4.2-8.0	Gradual	Faster	Progression

TABLE 1

Chronology of coastline transgression and progression (from Barber, 1981).

ARCHAEOLOGICAL SITES

The molluscan database for this paper comes from 8 archaeological sites located along the Parita Bay in the «Gran Coclé» cultural area (Cooke, 2005). Each is discussed below.

Cerro Mangote is the earliest known preceramic coastal site in the tropical eastern Pacific (McGimsey, 1956; Ranere & Hansell, 1978); it is dated between 7000 and 5000 BP. This small site (0.175 ha) contains lenses of shell and crab claws mixed with large quantities of vertebrate remains. The inhabitants' mixed economy was based on cultivating plants (e.g., maize), hunting (primarily deer and iguanas) and fishing and collecting crabs and shellfish (Cooke & Ranere, 1992b, 1999; Ranere & Cooke, 2003). Fishing concentrated on the marine littoral and seems to have been land-based. Shellfish collecting focused on the mudflats and mangrove fringe. Today the site is located 8 km from the active coastline but was 1-3 km distant at the time of occupation.

Monagrillo is the earliest known ceramic site in the Central American isthmus (4000–2000 BP) (Willey *et al*., 1954; Ranere & Hansell, 1978). The Pre-Colombian inhabitants practiced a mixed economy. They concentrated their fishing on small inshore marine species, such as lookdowns (*Selene* sp.), and thread herrings (*Opisthonema* sp.) and others that prefer turbid waters in estuaries and river mouths, such as threadfin (*Polydactylus* sp.) and Furth's catfish (*Cathorops futhii*). They also took large inshore predators such as white corvine (*Cynoscion* sp.) and a few marine turtles (Cooke & Ranere, 1999). Shellfish species collected frequent sandy beaches or rocky outcrops. In spite of its coastal location Monagrillo's inhabitants consumed maize whose starch grains have been recovered on the edges of grinding stones (Piperno & Pearsall, 1998).

At the time of its initial occupation (4000 BP) this 1.4 ha shellmound was on the strandline of an active beach and next to a small embayment. By 2000 BP it had become surrounded by mangrove and was probably no longer fit for human settlement. Today Monagrillo is located 1.5 km south of the Parita River and the open sea.

Aguadulce Shelter is a 160 square meter rockshelter that was occupied in both Paleoindian (ca. 10,000 BP), preceramic (7000–5000 BP) and ceramic times (5000–3000 BP); it has stone tool and ceramic types contemporary with Monagrillo (Ranere & Hansell, 1978). Pollen, phytoliths and starch grains support the presence of several domesticated plants by early ceramic times, such as leren, arrowroot, squash, bottle gourd, maize, yucca, yam and sweet potato (Piperno & Pearsall, 1998; Dickau, 2005) but grains also indicate that manioc, yam and arrowroot were present earlier (7000-5000 BP) (Piperno *et al*., 2000). Palm fruits (*Elais* and *Acrocom*ia) and nance were also extensively utilized (Piperno & Pearsall, 1998). In addition to land-based animals, the archaeofauna indicates the use of estuarine and mangrove zones to obtain fish, crabs and shellfish (Ranere & Hansell, 1978; Cooke & Ranere, 1989, 1992a, 1999). Presently Aguadulce is 17 km from the sea but would have been approximately 10 km closer at the height of occupation.

Cueva de Los Vampiros occupies an inselberg (Cerro El Tigre) which contains 2 small rockshelters with the major deposits covering an area of ca. 80 m^2. Vampiros dates to ca. 11,500–700 BP; these dates correspond to a pre-agricultural (Paleoindian) and an agricultural occupation. The latter coincides with arrowroot phytoliths (Piperno & Pearsall, 1998). The in situ Paleoindian component lies beneath materials (Pearson, 2002; Pearson *et al*., 2003) which have all indications of being the debris of camps established in order to cure and dry fish (1970 to 700 BP). Fish remains correspond to 99% of the fauna recovered. They include sierra (*Scomberomurous* sp.), needlefish (Belonidae), and green jack (*Caranx caballus*) (Cooke, 1988; Cooke & Ranere, 1999). These deposits also include shell such as *Natica unifasciata*, *Argopecten* sp., *Ostrea* sp. (Cooke & Ranere, 1984; Carvajal *et al*., 2008). Both the Pacific Ocean and the Santa Maria River can be presently seen from the site but it would have been adjacent to the sea at the time of a preceramic occupation.

Zapotal is an early 3.1 ha ceramic coastal shell midden dating between 4000 and 3000 BP; it is presently located 6 km from the prehistoric coastline (Peres, 2001). Numerous archaeologists have conducted surveys on this site, e.g., Willey *et al.* (1954), the Santa Maria Project (Cooke & Ranere, 1984), Giausserand (Cooke, 1995) and Norr (Peres, 2001). Early site occupants consumed ver-

tebrates, such as deer, catfish, thread herring, Pacific moonfish, bumpers and invertebrates, such as Venus clam (*Chione* sp.), oyster (*Ostrea* sp.) and moon snail (*Natica unifasciata*). These species suggest that the preferred habitat of human exploitation was the estuaries in the shallow nearshore waters of Parita Bay (Peres, 2001). The overall depth of the refuse deposits and the similarities in stone and ceramic assemblages to Monagrillo make it likely that Zapotal's population also consumed plants, such as wild *Dioscorea* and cultivars, such as maize, manioc and pepper (*Capsicum*) (Dickau, 2005; Perry *et al*., 2007).

La Mula-Sarigua is the earliest, large (58 ha) nucleated village in central Panama; it is presently located on the north side of the mouth of the Parita River and ca. 1.5 km inland from the coast. It is important to note that this is a multicomponent site with deposits dating from Paleoindian times (ca. 11,000 BP) to contact. Nonetheless, its major occupation is dated to the 3rd millennium BP, a time when there is evidence for population nucleation, use of marine resources such as catfish (*Ariidae* sp.), Pacific bumper (*Chloroscombrus* sp.), and shark.

Vertebrates include deer, armadillo, turtles and lizards. Invertebrate fauna remains include but are limited to oyster (*Ostrea* sp.) and Venus clams (*Chione* sp.) (Hansell, 1988). Paleoethnobotanical data suggest the use of maize, manioc, yam and *Calathea* species (Piperno & Pearsall, 1998).

Sitio Sierra is a 45 ha nucleated agricultural village with round or oval palm roofed houses. The best studied domestic and cemetery features date between 2200 and 1450 BP. In spite of its relative distance from the sea, 70% of Sitio Sierra's fish were marine, such as the lookdown, brassy grunt (*Orthopristis chalceus*), thread herrings (*Opisthonema* sp.) and bumpers (*Chloroscombrus* sp.). This assemblage alludes to the importing of dried and salted fish from coastal regions. Since Vampiros is contemporary with the earliest Sitio Sierra middens, Vampiros may well have been the supplier of such resources (Cooke, 1979; Cooke & Ranere, 1992a, 1999; Isaza, 1993). Over 99% of the macrobotanical remains identified from this site are maize (Cooke & Ranere, 1992b; Dickau, 2005). Today the site is located 12 km from the mouth of Santa Maria River but would have been 9 km distant when occupied (Cooke, 1979; Cooke & Ranere, 1999).

Cerro Juan Díaz presently lies 4 km from Parita Bay but was probably a kilometer closer to the active shoreline when it was first occupied ca. 2200 BP. Covering an area of approximately 200 ha and dating between 2200 and 400 BP the site was used for domestic (habitation) and ritual (burial) activities. Its ecotonal location was surely related to the site's pre-eminence in a small territory. At conquest it was dominated by a lineage whose chief was called «Paris» (Cooke, 1993, 2001; Sánchez Herrera, 1995; Cooke *et al*., 1998; Díaz, 1999; Cooke *et al*., 2000; Cooke *et al*., 2003; Mayo, 2004). Zooarchaeological analysis shows that the exploitation of animals for food in Cerro Juan Díaz was a local activity, e.g., hunting and birding quail, egrets, whistling ducks, doves and small passerines. Iguanas and deer were hunted in wooded savannas and aquatic habitats. The shellfish collection was completed along the littoral and fishing in the tidal river, such as eleotrine gobies, lookdown and thread herring (*Opisthonema* sp.), as well *as* the Spanish mackerel. Intertidal estuary exploitation is represented by catfish (Ariidae), pacific ilisha, bumpers (*Chloroscombrus* sp.) and threadfins (*Polydactylus* sp.). In sandy beaches and deeper water just offshore people collected animals such as Panamain grunt and *Spondylus* (Carvajal Contreras, 1998; Cooke & Sánchez Herrera, 1998; Belanger, 1999; Jiménez, 1999; Cooke *et al*., 2000; Carvajal Contreras *et al*., 2005; Jiménez & Cooke, in press). The dietary mainstay was agricultural products, particularly maize.

MOLLUSC SPECIES: NATURAL HABITATS AND HUMAN UTILIZATION

The mollusc data presented in this paper are based on information reported by various researchers and, consequently, are not completely comparable. For example, some researchers reported minimum numbers of individuals (MNI) based on matching bivalves and others simply counted the total number of valves present (NISP) (Hansell, 1979; Carvajal Contreras, 1998; Belanger, 1999; Peres, 2001). To compensate for this and to enable comparison among the molluscan assemblages we have used the percentage of the weights of total shell of each taxon as reported by each of the researchers.

Based on identifiable habitats of each taxon, shellfish exploitation in antiquity focused on three biotopes; in order of importance they were sandy beach, mangrove-estuary and coral reef/rocks. The following discussion relates the species available to each of their biotopes (Keen, 1971). The intertidal sandy-beach bivalve species are *Tivela* cf. *argentina, Donax panamensis*, *Iphigenia* cf. *altior, Mactrellona* cf. *exolata, Chione subrugosa, Anadara multicostata, Anadara similis*, *Tagelus* sp. and *Tellina* sp.). Species common to the mangrove-estuary biotope are the gastropods *Cerithidea valida, Thais* (s.l.) *kiosquiformis, Natica unifasciata* and bivalves *Protothaca (Leukoma)* sp., *Anadara (Grandiarca)* cf. *grandis, Polymesoda* (s.l.) cf. *boliviana, Anadara* (s.l.) cf. *tuberculosa, Mytella* sp., *Crassostrea* sp. Bivalves such as *Spondylus* spp. and *Pinctada mazatlanica* and gastropods such as *Conus* sp., *Oliva* sp. and *Persicola* sp. are from coral reef/rocks and offshore biotopes. (For a synthesis of ecotonal data see Table 2; for an inventory of species by site see Table 3).

At Cerro Mangote there is a predominance of mangrove, mudflat and rocky low-tide niche taxa (Figure 2). This suggests that humans were exploiting areas closer to the littoral. The high proportions of Crass*ostrea* sp. and *Prothotaca* sp. at the Aguadulce Rockshelter implies that humans focused their shellfish exploitation largely on rocky and mudflat low-tide niches (Figure 3). Vampiros remains show that exploitation focused on mangrove, mudflat and rocky low-tide contexts (Figure 4).

Shellfish exploitation at Monagrillo emphasizes the use of sandy beach and rocky low-tide niches (Figure 5) while those species at Sitio Sierra (Figure 6) were exploited in mangrove, mudflat and rocky low-tide niches. In contrast, populations at Cerro Juan Díaz (Figure 7) emphasized brackish water and sandy beach low-tide zones (Carvajal Contreras, 1998). The high numbers of *Polymesoda* is consistent with this site's location near the mouth of a large river. In both Cerro Juan Díaz and in the upper layers of Vampiros there were high frequencies of *Anadara*.

The predominant shellfish gathered at Zapotal (Figure 8) were *Prothotaca, Chione*, *Natica* and *Ostrea* genera (Peres, 2001). This is similar to that of Cerro Juan Díaz in that both pre-Columbian peoples favored molluscs from brackish water environments in the shallow near-shore waters of Parita Bay.

Pre-Columbian inhabitants at La Mula-Sarigua exploited molluscs from rocky environments in shallow near-shore waters (Figure 9). The invertebrate remains include taxa such as *Anadara*, *Chione, Ostrea*, *Pitar*, C*erithidea*, moon snail, rock snail and other bivalve and gastropods. The

Intertidal sandy beach	Mangrove-estuary	Offshore Coral- reef.
Anadara multicostata (G. B. Sowerby I, 1833)	*Anadara tuberculosa* (Sowerby, 1833)	*Conus ximenes* Gray, 1839
Anadara similis (C. B. Adams, 1852)	*Cerithidea valida* (C. B. Adams, 1852)	*Oliva* sp.
Chione subrugosa (Wood, 1828)	*Crassostrea* sp.	*Pinctada mazatlanica* (Hanley, 1856)
Donax panamensis Philippi, 1849	*Grandiarca grandis* (Broderip & Sowerby, 1829)	*Spondylus* sp.
Iphigenia altior (Sowerby, 1833)	*Natica unifasciata* Lamarck, 1822	
Mactrellona exolata (Gray, 1837)	*Ostrea* sp.	
Tagelus sp.	*Polymesoda boliviana* (Philipi, 1851)	
Tellina sp.	*Prototbaca asperrima* (Sowerby, 1835)	
Tivela argentina (Sowerby, 1835)	*Stramonita haemastoma* (Linnaeus, 1758)	
Tivela byronensis (Gray, 1838)	*Thais kiosquiformis* (Duclos, 1832)	

TABLE 2

Ecotopes of dominant archaeological molluscan species.

Species	Cerro Mangote	Monagrillo	Aguadulce Shelter	Cueva de los Vampiros	Zapotal	La Mula Sarigua	Sitio Sierra	Cerro Juan Diaz
Agaronia testacea		X						
Anadara grandis					X	X		X
Anadara multicostata								X
Anadara obesa		X						
Anadara similis		X	X			X		
Anadara sp.	X		X	X		X	X	X
Anadara tuberculata		X	X		X	X		X
Anomalocardia subrugosa								
Arca pacifica								X
Arca sp.								X
Argopecten ventricosa			X	X				X
Callistoma sp.		X						X
Calyptrea spp.		X						
Cardita laticostata								X
Cardita sp.					X			
Cassis centriquadrata				X				X
Cerithidea mazatlanica	X	X	X			X		X
Cerithidea pulchra					X			X
Cerithidea sp.							X	X
Cerithidea valida	X	X				X		X
Chione obliterata					X			
Chione sp.		X	X	X			X	X
Chione subrugosa	X	X	X			X		X
Conus patricius								X
Conus ximenes			X					X
Corbula nasuta/Corbula obulata			X					
Corbula spp.	X					X		
Cosmioconcha modesta		X						
Crassostrea corteziensis	X	X	X					
Crassostrea rhizophorae	X							
Crepidula incurva		X						
Crepidula marginalis	X	X	X			X		
Crepidula spp.		X			X			
Cymatium wiegmanni						X		
Cypraea cervinetta								X
Donax asper		X	X			X		X
Donax californicus/D. navicula			X					
Donax dentifer		X						X
Donax gracilis		X						
Donax panamensis		X						X
Donax sp.	X				X		X	X
Dosinia dunkeri		X				X		X
Dosinia ponderosa								X
Dosinia sp.				X			X	X
Ellobium stagnalis	X	X						

TABLE 3

Molluscan species present in the Central Pacific sites.

Species	Cerro Mangote	Monagrillo	Aguadulce Shelter	Cueva de los Vampiros	Zapotal	La Mula Sarigua	Sitio Sierra	Cerro Juan Diaz
Euglandina dombertii			X					
Fasciolaria granosa						X		X
Florimetris sp.				X	X			
Hexaplex brassica								X
Hexaplex regius	X							
Hexaplex sp.	X							
Iphigenia altior								X
Isognomon recognitus		X						
Littorina sp.				X				X
Littorina varia	X					X		
Macoma grandis								X
Mactra fonsecana		X	X			X		X
Mactra sp.					X	X		X
Mactra velata								X
Mactrellona exolata								X
Mactrellona sp.								X
Malea ringens	X			X		X		X
Malea sp.							X	
Marginella sapotilla						X		
Melongena patula						X		X
Mytella arciformis	X	X				X	X	
Mytella spp.	X		X	X				X
Mytillus guyanensis								X
Nassarius luteostoma		X				X		X
Nassarius spp.			X					
Natica sp.				X		X	X	X
Natica unifasciata	X				X	X		X
Naticidae			X					
Neorapana muricata								X
Nerita scabricostata						X		X
Northia northia								X
Northia sp.								X
Oliva sp.								X
Olivela volutella								X
Olivella sp.								X
Ostrea columbensis								X
Ostrea conchaphila	X	X						
Ostrea spp.	X	X	X		X	X	X	
Pecten sp.								X
Persicola sp.								X
Pinctada mazatlanica								X
Pitar puytiensis								X
Pitar sp.				X	X		X	X
Pitar tortuosus		X	X			X		
Polinices otis								X
Polinices panamensis								X
Polinices spp.				X			X	

(contin.) TABLE 3

Specie	Cerro Mangote	Monagrillo	Aguadulce Shelter	Cueva de los Vampiros	Zapotal	La Mula Sarigua	Sitio Sierra	Cerro Juan Diaz
Polymesoda anomala								X
Polymesoda boliviana								X
Polymesoda maritima						X		
Polymesoda sp.								X
Prototheca columbensis								X
Prototheca grata			X					
Prototheca sp.				X			X	X
Prunum sapotilla								X
Saccostrea palmula		X						
Solen rudis			X					X
Spondylus calcifer								X
Spondylus spp.								X
Strigilla disjuncta		X						
Strombina turrita			X					
Strombus galeatus								X
Strombus spp.		X				X		X
Tagelus affinis		X				X		
Tagelus dombeii								X
Tagelus sp.	X	X				X		X
Tellina laceridens								X
Tellina sp.				X		X	X	X
Tellina subtrigona								X
Terebra robusta						X		
Terebra sp.		X					X	X
Terebra strigata								X
Stramonita biserialis	X	X				X		X
Thais kiosquiformis	X	X	X		X	X		X
Thais sp.						X		X
Tivela argentina								X
Tivela byronnensis		X				X		
Tivela sp.								X
Trachycardium senticosum		X						

(contin.) TABLE 3

geomorphological and molluscan information indicate that the site's position relative to an active shoreline changed significantly over time from 50 km from the shoreline by 11,000 BP to its present position where an extensive intertidal salt flat sits to its north. The salt flat most likely did not form until sometime after 1200 BP. It presently extends for nearly 2 km seaward where it meets a mangrove-fringed coastline (Hansell, 1988, 1997).

The shellfish collected from the mangrove-estuary biotope were principally of dietary importance. At Cerro Juan Díaz, La Mula-Sarigua and Cerro Mangote, however, there is evidence that some shellfish were collected for other purposes

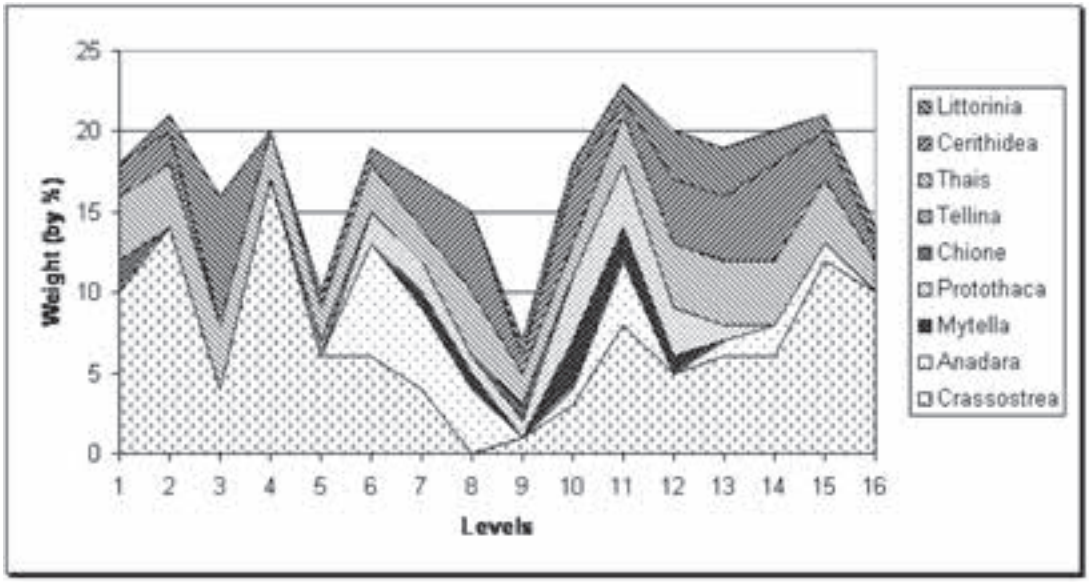

FIGURE 2
Dominant molluscan species by level/time: Cerro Mangote.

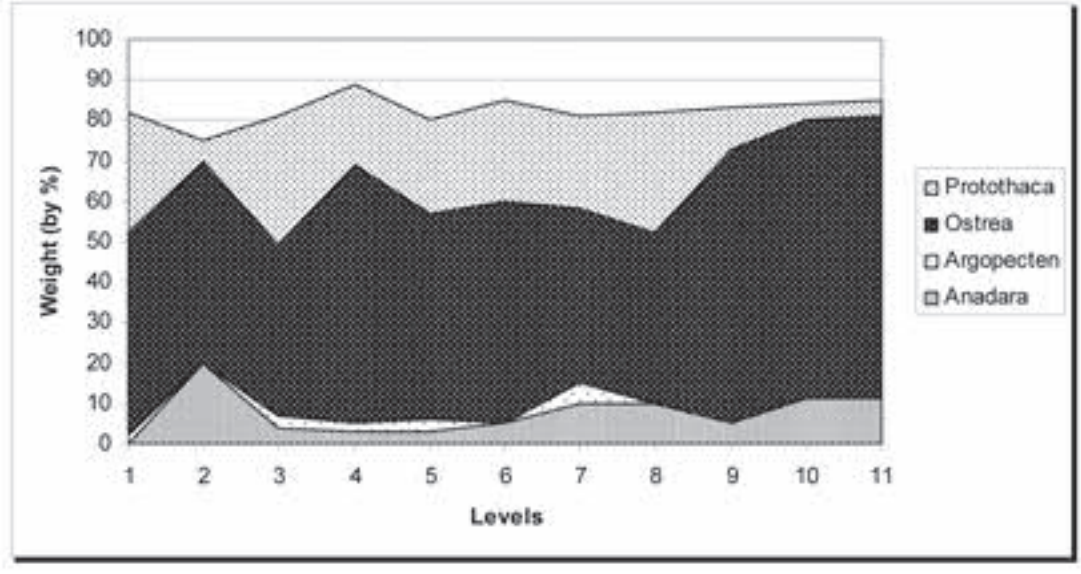

FIGURE 3
Dominant molluscan species by level/time: Aguadulce Shelter.

(McGimsey, 1956; Hansell, 1988, 1992; Cooke & Sánchez Herrera, 1998; Mayo, 2004). For example, the clam *Anadara grandis* was used as a vessel at Cerro Mangote during the Late Preceramic (McGimsey, 1956) and at La Mula-Sarigua during the Middle Ceramic (Hansell, 1988). *Tivela* sp. and *Iphigenia* sp. shells were utilized at Cerro Juan Díaz as scrapers in the finishing of pottery (Carva-

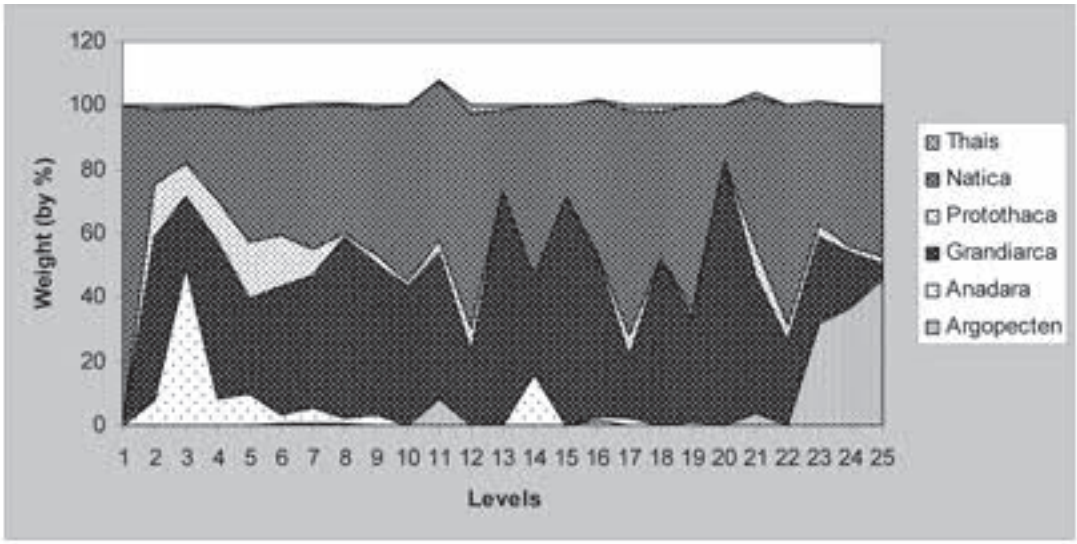

FIGURE 4
Dominant molluscan species by level/time: Cueva de Los Vampiros.

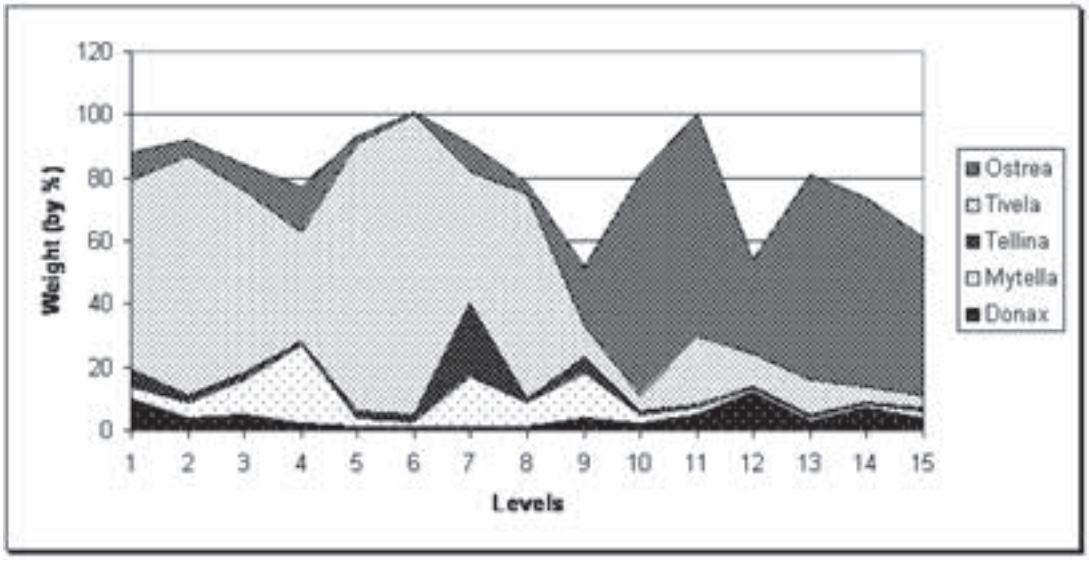

FIGURE 5
Dominant molluscan species by level/time: Monagrillo.

jal Contreras, 1998). The bivalves *Spondylus pinctada* and gastropods *Conus*, *Oliva* and *Persicola* from coral reef/rocks and offshore biotopes were found in association with burials (Cooke & Sánchez Herrera, 1998).

Additionally, Mayo (2004) identified a workshop at Cerro Juan Díaz that specialized in the production of shell jewelry. Spires of *Conus patricius,* flakes of *Anadara grandis* and *Spondylus*, and columella fragments of *Strombus* were encountered.

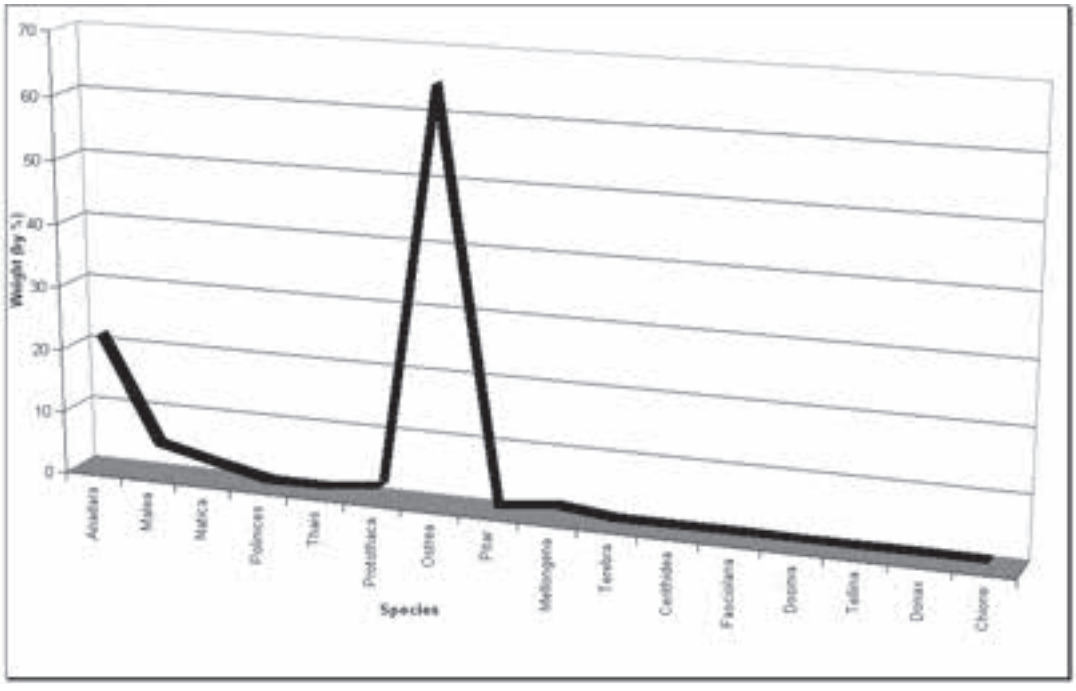

FIGURE 6
Dominant molluscan species: Sitio Sierra.

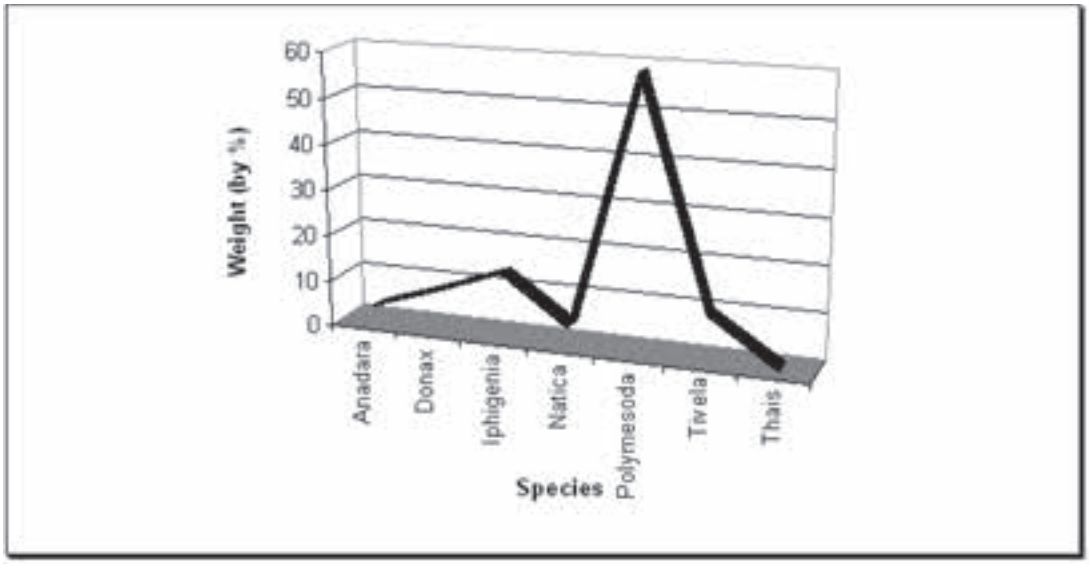

FIGURE 7
Dominant molluscan species: Cerro Juan Díaz.

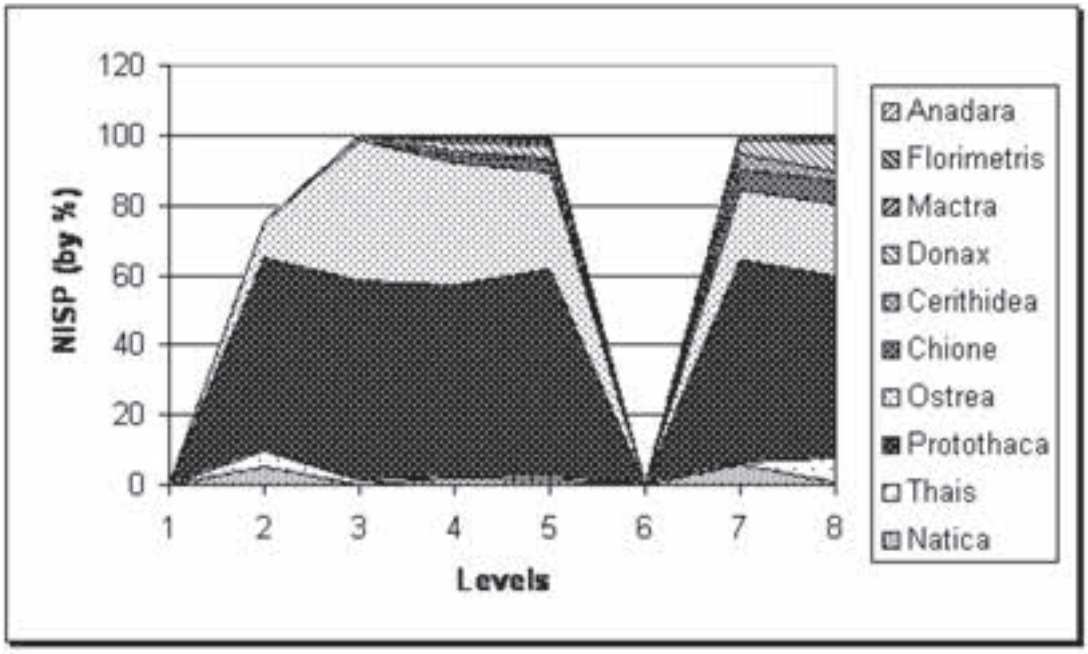

FIGURE 8
Dominant molluscan species by level/time: Zapotal.

In association with the remains of shell jewelry production, there were also abundant stone tools such as scrapers and wedges used to modify this raw material.

In sum, around Parita Bay there is a noticeable difference in the shell species collected for food, used as simple tools and/or manufactured into costume or prestige ornaments. Food species were taken in the nearest available habitats.

DISCUSSION

The above information indicates there is a relationship between mollusc use at sites located on the central Pacific coast of Panama and changes in the distribution of molluscan species through time. It is likely that geomorphological dynamics account for much of the molluscan change as expressed in site: sea distances, dates of occupation, and molluscan species abundance.

The focus on only three niches, such as mangrove/estuary, sandy beach and coral reef/rock habitats, implies that pre-Columbian populations did not have (nor needed) a complicated technology to collect shellfish, with the exception of those species from the coral reef/rock habitats (*Spondylus*). The culling of live *Spondylus* requires diving and the use of a hammer to unfasten the valves from the reef. Since large numbers were used at Cerro Juan Díaz their presence implies boat journeys to coral-fringed islands or trade from perhaps as far away as 50 km (Cooke & Sánchez Herrera, 2001).

The data support the hypothesis that a transformation in shellfish gathering occurred in Parita Bay which was caused by geomorphological changes in the coastline between the occupation of Cerro Mangote (7000 BP) with a high frequency of mollusc species associated with an active beach environment to the beginning of occupation at Cerro Juan Díaz (1800 BP) with a high frequency of mollusc species associated with a low-energy beach environment (Cooke, 1992a). This information further suggests that the mangrove swamp/estuarine environments were extant at least by 7000 BP and the albinas much more limited in areal extent before 3000 BP than today, and in fact may only be 1200 years old in some areas (Clary *et al*., 1984: 55). These changing conditions mod-

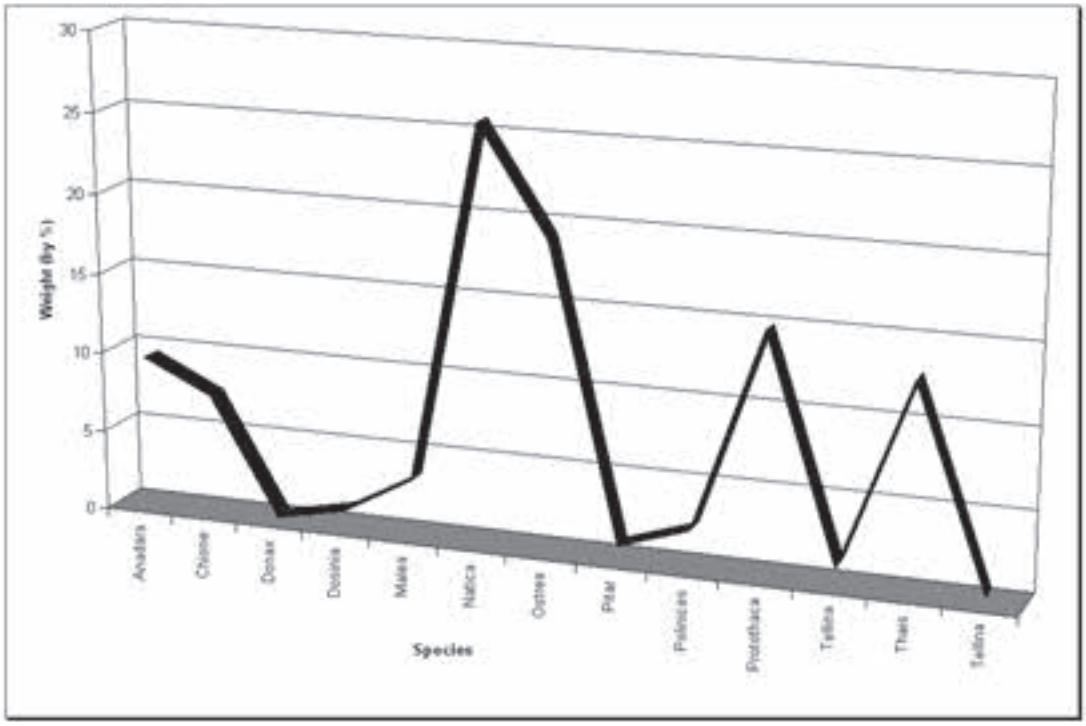

FIGURE 9
Dominant molluscan species: La Mula-Sarigua.

ified the access of certain species such as *Anadara*, *Crassostrea*, *Tivela*, *Ostrea*, *Polymesoda* and *Donax* for Pre-Columbian inhabitants at Cerro Mangote, Monagrillo, La Mula-Sarigua and Cerro Juan Díaz based on molluscan remains.

The above site patterns of shellfish exploitation are confirmed by information gathered from regional surveys conducted by Isaza (2007) and Haller (2004) at La Villa River and Parita River valleys respectively. A common feature documented at all sites in these surveys was the extensive distribution of marine shell middens. An interpretation of these data suggests that coastal interactions and the consumption of molluscs were important parts of the subsistence economy. The analysis of shells from 16 of the surveyed sites from La Villa River identified 93 specimens from the three main biotopes discussed above. In order of importance: all intertidal and mangrove shells were used for food; only a few *Melongena patula*, *Anadara s*p., *Strombus* sp. and *Tivela* sp. specimens displayed signs of being worked. Among the most popular molluscan specimens identified in the majority of sites were *Anadara grandis*, *Tivela, Donax, Natica*, and *Thais*. Offshore or coral reef/rock shells, e.g., *Spondylus calcifer*, and *Pinctada mazatlanica, were* collected for the crafting of personal adornments (Isaza, 2007).

The custom of making collars and beads from seashells has been discovered in many sites on the Azuero Peninsula and along the central coast of Parita Bay (Ichon, 1980; Briggs, 1989). The Cerro Juan Díaz and Playa Venado sites have burials with ornaments from *Spondylus, Pinctada*, *Conus, Oliva* and *Persicola* (Bull, 1949-1961; Cooke, 1997; Cooke & Sánchez Herrera, 1998). And further ethnohistorical sources have noted that shell was used as ornaments, penis sheaths or «trueque» until the Conquest [1](de Oviedo y Valdés, 1849-1855; Jopling, 1993).

[1] Oviedo referred to: Indios Cueva… andaban desnudos, y en su miembro viril un caracol de pescado o canuto de madera, e los testigos de fuera» (pp.110) Jopling mentioned Andagoya about penis sheaths: » los hombres traían sus naturas metidas en

Some scholars have suggested that the use of seashell for jewelry coincided with the rise of maritime trade along the Pacific coast (Hosler, 1998). Others have speculated that they came from the south to Panama looking for *Spondylus* (Masucci, 1995). Hoopes (2005) has suggested that the emergence of the use of shell ornaments, present since 200 A.D, was related to social and demographic changes leading to complexity/hierarchy in Panamanian societies and the expansion of the Gran Coclé Semiotic Tradition, such as those sites of El Indio II (Ichon, 1980), La Cañaza (Ichon, 1980), El Caño (Ladd, 1964), Cerro Juan Díaz (Sánchez Herrera, 1995; Cooke & Sánchez Herrera, 1998; Cooke *et al*., 1998; Cooke, 2001), and Sitio Sierra (Isaza, 1993).

CONCLUDING REMARKS

Current information for Central Pacific Panama suggests that Pre-Columbian communities utilized most of their shellfish for food and that they relied on a few taxa that could be obtained within a few kilometers seaward of habitation. These sites show a predominance of mangrove-estuarine and beach species due to their natural diversity and abundance in the nearby coastal habitats along the Parita Bay. A quite different situation prevailed for the shellfish used for the crafting of personal adornments; they were obtained from subtidal inshore, and coral reef/rock environments.

Additional geomorphologic and other types of studies, such as shell growth incremental and isotope analyses, are necessary in order to clarify the history surrounding each site (Claassen, 1998). For example, at Monagrillo the genus *Tivela* sp. replaced *Ostrea* sp. suggesting that the shellmound was closer to the coastline and to sandy beaches than it is today (Hansell,1979; Clary *et al*., 1984). *Tivela* and *Ostrea* are very specific habitat markers for sandy beach and rocky habitats respectively (Keen, 1971). In Cerro Juan Díaz there were relatively few species associated with a mangrove habitat. Rather the samples indicate the local exploitation of a clear water habitat suggesting that the mangrove was in a different stage of formation than currently. The careful study of species such as *Crassostrea* (prevalent at Cerro Mangote) might provide other kinds of environmental information; this taxon is very sensitive to sudden freshwater floods and sedimentation (Rodríguez-Romero *et al*., 1988).

This brief review summarizes some general aspects of mollusc exploitation and utilization at sites located along the central Pacific coast of Panama. The diversity and abundance of molluscs can largely be linked with the topographical position of the site. In addition the use of «exotic shells» implies that other levels of activities were performed along the Pacific coast.

ACKNOWLEDGEMENTS

This paper was possible, in part, due to the generosity of Richard Cooke (Smithsonian Tropical Research Institute) who supplied us with a significant amount of unpublished data. Diana would also like to thank Irv Quitmyer for inviting her to the Archaeomalacology Meeting at Gainesville. We would also like to acknowledge the helpful grammatical comments of Scott Raymond and Julie-Anne White during earlier versions of this document.

REFERENCES

ANDAGOYA, P.D. 1913: Relación de los sucesos de Pedrarias Dávila en las Provincias de Tierra. Descubrimiento del Océano Pacífico: Vasco Nuñez de Balboa, Fernando de Magallanes y sus compañeros. In: Medina, J.T. (ed.). Tomo II. Imprenta Universitaria, Santiago de Chile.

BAILEY, G. & MILNER, N. 2002/2003: Coastal hunter-gatherers and social evolution marginal or central? *Before Farming* 4(1): 1-15.

BARBER, J. 1981: The influence of Geological Parameters on Man's Early Adaptation to the Coastal Environments of Central Panama. Master's Thesis. Temple University, Philadelphia.

BELANGER, M. 1999: Analyse archeoconchyliologique du Basurero 3 Operation 5, Site Cerro Juan Díaz, Los Santos Panamá. Montreal.

BRIGGS, P.S. 1989: Art, Death and Social Order: the Mortuary Arts of Pre-Conquest Central Panama. B.A.R. (International Series) 550. Oxford.

unos caracoles de la mar de muchos colores y muy bien hechos, y con unos cordones asidos del caracol que se ataban por los lomos: con esto podian correr y andar muy sueltos, sin que por ninguna viase les pareciese cosa alguna de su natura salvo los genetivos, que estos no cabían en el caracol: estos caracoles eran rescates entre ellos para la tierra adentro...» (p. 29).

BULL, T. 1949-1961: An Urn Burial-Venado Beach (Canal Zone). *Panama Archaeologist* 4(1): 42-47.

CARVAJAL CONTRERAS, D.R. 1998: Análisis de cuatro componentes en el Rasgo Ch excavado mediante la microestratigrafía: el caso de Cerro Juan Díaz (Panamá Central). Tesis de Licenciatura. Universidad Nacional de Colombia.

CARVAJAL, D.R.; COOKE, R. & JIMENEZ, M. 2008: Taphonomy at two contiguous coastal rockshelters in Panama. Preliminary observations focusing on fishing and curing fish. *Quaternary International* 180: 90-106.

CARVAJAL, D.R.; DÍAZ, C.P.; SÁNCHEZ, L.A. & COOKE, R. 2005: Fue Cerro Juan Díaz, una aldea Precolombina en el río La Villa, El Pueblo de indios de Cubitá? Memorias del VI Congreso Centroamericano de Historia: 22-26, 2002. Ciudad de Panamá.

CLAASSEN, C. 1998: *Shells*. Cambridge Manuals in Archaeology. Cambridge University Press, Cambridge.

CLARY, J.; HANSELL, P.; RANERE, A. & BUGGEY, T. 1984: The Holocene geology of the western Parita Bay coastline of central Panama. In: Lange, F.W. (ed.): *Recent Developments in Isthmian Archaeology*: 55-83. B.A.R. (International Series 212). Oxford.

COOKE, R. 1979: Los impactos de las comunidades agrícolas precolombinas sobre los ambientes del Trópico estacional: datos del Panamá prehistórico. Actas del IV Simposio de Ecología Tropical. Panamá.

COOKE, R. 1988: Some Ecological and Technological Correlates of Coastal Fishing in Formative Pacific Panama. Proceedings of the Nineteenth Annual Conference. Chacmool, Calgary.

COOKE, R. 1992a: Prehistoric nearshore and littoral fishing in the eastern tropical Pacific: an ichthyological evaluation. *World Archaeology* 6: 1-49.

COOKE, R. 1992b: Preliminary Observations on Vertebrate Food Avoidance by the Precolumbian Amerinds of Panama, with comments on the Relevance of this Behaviour to Archaeolozoology and Palaeoenvironmental Reconstruction. In: Ortiz-Troncoso, O.R. & Van der Hammen, T. (eds.): *Archaeology and Environment in Latin America*: 59-107. Instituut Voor Preen Protohistorische Archeologie Albert Egges van Giffen. Universiteit van Amsterdam, Amsterdam.

COOKE, R. 1993: Alianzas y relaciones comerciales entre indígenas y españoles durante el período de contacto: El Caso de Urracá, Esquegua y los vecinos de Natá. *Revista Nacional de Cultura* 25: 111-122.

COOKE, R. 1995: Monagrillo, Panama's first pottery (300-1200 cal bc): Summary of the research (1948-1993), with new interpretations of chronology, subsistence and cultural geography. In: Barnet, J. & Hoopes, J. (eds.): *The emergence of Pottery: Technology and Innovation In Ancient Societies*: 169-184. Smithsonian Institution Press, Washington, D.C.

COOKE, R. 1997: The Native Peoples of Central America during Precolumbian and Colonial Times. In: Coates, A. (ed.): *Central America: A Natural and Cultural History*: 137-176. Yale University Press, New Haven.

COOKE, R. 2001: Cuidando a los ancestros: Rasgos mortuorios Precolombinos en Cerro Juan Díaz, Los Santos. In: Heckadon, S. (ed.): *Panamá: Puente Biológico*: 54-62. Smithsonian Institute Tropical Research, Panamá.

COOKE, R. 2004a: Observations on the religious content of the animal imagery of the 'Gran Coclé' semiotic tradition of pre-Columbian Panama. In: Jones O'Day, S.; Van Neer, W. & Ervynck, A. (eds.): *Behaviour behind Bones. The Zooarchaeology of Ritual, Religion, Status and Identity*: 114-127. Oxbow Books, Oxford.

COOKE, R. 2004b: Rich, poor, shaman, child: animals, rank, and status in the 'Gran Coclé' culture area of pre-Columbian Panama. In: Jones O'Day, S.; Van Neer, W. & Ervynck, A. (eds.): *Behaviour behind Bones. The Zooarchaeology of Ritual, Religion, Status and Identity*: 271-284. Oxbow Books, Oxford.

COOKE, R. 2005: Prehistory of Native Americans on the Central American Land Bridge: Colonization, Dispersal and Divergence. *Journal of Archaeological Research* 13(2): 129-187.

COOKE, R. & RANERE, A. 1984: The «Proyecto Santa María»: a multidisciplinary analysis of prehistoric adaptations to a Tropical watershed in Panama. In: Lange, F. (ed.): *Recent Developments in Isthmian Archaeology*: 3-30. B.A.R. (International Series) 212. Oxford.

COOKE, R. & RANERE, A. 1989: Hunting in Prehistoric Panama: a diachronic perspective. In: Clutton-Brock, J. (ed.): *The Walking Larder: Patterns of Domestication, Pastoralism and Predation*: 295-315. Unwin Hyman, London.

COOKE, R. & RANERE, A. 1992a: Human influences on the zoogeography of Panama: an update based on archaeological and ethnohistorical evidence. In: Darwin, S.P. & Welden, A.L. (eds.): *Biogeography of Mesoamerica*: 21-58. Mesoamerican Ecology Institute. Tulane University, New Orleans.

COOKE, R. & RANERE, A. 1992b: The origin of wealth and hierarchy in the Central Region of Panama (12,000-2,000BP), with observations on its relevance to the history and phylogeny of Chibchan-speaking polities in Panama and elsewhere. In: Lange, F. (ed.): *Wealth and Hierarchy in the Intermediate Area*: 243-316. Dumbarton Oaks, Washington DC.

COOKE, R. & RANERE, A. 1999: Precolumbian fishing on the Pacific coast of Panama. In: Blake, M. (ed.):

Pacific Latin America in Prehistory: The Evolution of Archaic and Formative Cultures: 103–122. Washington State University Press, Pullman.

COOKE, R. & SÁNCHEZ HERRERA, L.A. 1998: Coetaneidad de metalurgia, artesanías de concha y cerámica pintada en Cerro Juan Díaz, Panamá. *Boletín del Museo del Oro* 42: 57-85.

COOKE, R. & SÁNCHEZ HERRERA, L.A. 2001: El papel del mar y de las costas en el Panamá prehispánico y del periodo de contacto: redes locales y relaciones externas. Simposio Historia Maritima del Pacifico, Costa Rica.

COOKE, R.; JIMÉNEZ, M. & CARVAJAL, D.R. 2000: Alimentos Cercanos, Suntuosidades Lejanas: Aprovechamiento de Vertebrados e Invertebrados en Cerro Juan Díaz, Panamá. 65th SAA Annual Meeting, Philadelphia.

COOKE, R.; SÁNCHEZ, L.A. & UDAGAWA, K. 2000: Contextualized goldwork from 'Gran Cocle', Panama: An Update Based on Recent Excavations and New Radiocarbon Dates for Associated Pottery Styles. In: McEwan, C. (ed.): *Precolumbian Gold: Technology, Style and Iconography*: 154-176. British Museum Press, London.

COOKE, R.; SÁNCHEZ, L.A.; ISAZA, I. & PÉREZ, A. 1998: Rasgos Mortuorios y Artefactos Inusitados de Cerro Juan Díaz, una Aldea Precolombina del 'Gran Coclé' (Panamá Central). *La Antigua* (53): 127-196.

COOKE, R.; SÁNCHEZ, L.A.; CARVAJAL, D.; GRIGGS, J. & ISAZA, I. 2003: Transformaciones sociales y culturales de los amerindios de Panamá durante el siglo XVI: una perspectiva arqueológica y paleoecológica. *Mesoamérica* 24(45): 1-34.

DAY, J.; HALL, C.; KEMP, W. & YANEZ, A. 1989: *Estuarine Ecology*. John Wiley and Sons, New York.

DE OVIEDO Y VALDÉS, G.F. 1849-1855: Historia general y natural de las Indias, islas y Tierra Firme del mar Océano III. Real Academia de Historia, Madrid.

DÍAZ, C. 1999: Estudio Bio-Antropológico de Rasgos Mortuorios de la Operación 4 del Sitio Arqueológico Cerro Juan Díaz, Panamá Central. Tesis de Licenciatura. Universidad de los Andes, Bogotá.

DICKAU, R. 2005: Resource Use, Crop Dispersals, and the Transition to Agriculture in Prehistoric Panama: Evidence from Starch Grains and Macroremains. Ph.D. Department of Anthropology. Temple University, Philadelphia.

ESPINOSA, G.D. 1913 [1957]: Relación del Proceso quel Licenciado Gaspar de Espinosa, alcalde mayor hizo enviado por el muy magnifico señor Pedrarias Dávila desde esta ciudad a las provincias de Nata e Paris y a las otras provincias Comarcanas. El descubrimiento del Océano Pacifico: Vasco Núñez de Balboa, Fernando de Magallanes y sus Compañeros. Editorial Universitaria, Santiago de Chile.

HALLER, M. 2004: The Emergence and Development of Chiefly Societies of the Parita River Valley, Panama. Ph.D. University of Pittsburgh, Pittsburgh.

HANSELL, P. 1979: Shell Analysis: A Case Study from Central Pacific Panama. Master Thesis. Temple University.

HANSELL, P. 1988: The Rise and Fall of an Early Formative community: La Mula-Sarigua, Central Pacific Panama. Ph.D. Temple University.

HANSELL, P. 1992: Resources Accessibility and Control (?): An example from Central Panama. In: Ortiz-Troncoso, O.R. & Van der Hammen, T. (eds.): *Archaeology and Environment in Latin America*: 45-58. Instituut Voor Pre-en Protohistorische Archeologie Albert Egges van Giffen. Universiteit van Amsterdam, Amsterdam.

HANSELL, P. 1997: Reconstructing the Settlement History of La Mula-Sarigua, Central Pacific Panama: Exercises for Studying the Past. Archaeological Applications of GIS: Proceedings of Colloquium II, UISPP XIIIth Congress. Forli, Italy.

HOOPES, J. 2005: The Emergence of Social Complexity in the Chibchan World of Southern Central America and Northern Colombia, AD 300-600. *Journal of Archaeological Research* 13(1): 1-47.

HOSLER, D. 1998: Los orígenes andinos de la metalurgia del occidente de México. *Boletín de Museo del Oro* 42: 3-26.

ICHON, A. 1980: *L'Archéologie du Sud de la Péninsule d' Azuero, Panama*. Études Mésoamericaines Serie II. Mission Archéologique et Ethnologique Francaise au Méxique, Mexico D.F.

ISAZA, I.I. 1993: Desarrollo Estilístico de la Cerámica Pintada del Panamá Central con Énfasis en el Período 500 a.C.-500 d.C. Tesis de Licenciatura, Universidad Autónoma de Guadalajara.

ISAZA, I.I. 2007: The Ancestors of Parita: Pre-Columbian Settlement Patterns in the Lower La Villa River Valley, Azuero Peninsula, Panama. Ph.D. dissertation. Boston University.

JIMÉNEZ, M. 1999: Explotación de Vertebrados Acuáticos y Terrestres por los Indígenas Precolombinos en Cerro Juan Díaz, Los Santos, durante el Período 300-700 d. C. Licenciatura, Universidad Nacional de Panamá.

JIMÉNEZ, M. & COOKE, R. in press: La Pesca en el borde de un estuario neotropical: el caso de Cerro Juan Díaz (Bahía de Parita, Costa del Pacífico de Panamá). Actas del 39 Congreso de Americanistas, Quito.

JOPLING, C.F. 1993: *Indios y Negros en Panamá en los siglos XVI y XVII: Selecciones de Documentos del Archivo General de Indias*. Centro de investigaciones Regionales de Mesoamérica and Plumsock Mesoamerican Studies.

KEEN, A.M. 1971: *Sea Shells of Tropical West America*. Stanford University Press, Stanford.

LADD, J. 1964: *Archaeological Investigations in the Parita and Santa Maria Zones of Panama*. Smithsonian Institution Bureau of American Ethnology Bulletin 193, Washington D.C.

LOTHROP, S.K. 1937: *Cocle: An archaeological study of Central Panama*. Memoirs of the Peabody Museum of Archaeology and Ethnology 7. Harvard University, Cambridge.

LOTHROP, S.K. 1942: *Cocle: An archaeological study of Central Panama*. Memoirs of the Peabody Museum of Archaeology and Ethnology 8. Harvard University, Cambridge.

MARTÍN-RINCÓN, J. & RODRÍGUEZ, F. 2006: Los moluscos marinos de Panamá Viejo. *Canto Rodado* 1: 85-100.

MASUCCI, M.A. 1995: Marine shell bead production and the role of domestic craft activities in the economy of the Guangala Phase, southwest Ecuador. *Latin American Antiquity* (6): 70-84.

MAYO, J. 2004: La Industria Prehispánica de Conchas Marinas en Gran Coclé, Panamá. Tesis Doctoral. Universidad Complutense de Madrid.

MAYO, J. & COOKE, R. 2005: La industria prehispánica de conchas marinas en Gran Coclé, Panamá. Análisis tecnológico de los artefactos de concha del basurero-taller del Sitio Cerro Juan Díaz, Los Santos, Panamá. *Archaeofauna* 14: 285-298.

MCGIMSEY, C. 1956: Cerro Mangote: A Preceramic Site in Panama. *American Antiquity* 22(2): 151-161.

PEARSON, G.A. 2002: Pan-Continental Paleoindian Expansions and Interactions As Viewed from the Earliest Lithic Industries of Lower Central America. Ph.D. University of Kansas.

PEARSON, G.A.; COOKE, R.; BECKWITH, R.A. & CARVAJAL, D. 2003: Update on Paleoamerican Research on the Isthmus of Panama. *Current Research in Pleistocene*: 10.

PERES, T.M. 2001: Coastal Subsistence and Settlement in the Early Ceramic: A Zooarchaeological study from Central Pacific Panama. Ph.D. University of Florida.

PERRY, L.; DICKAU, R.; ZARRILLO, S.; HOLST, I.; PEARSALL, D.M.; PIPERNO, D.R.; BERMAN, M.; COOKE, R.; RADEMAKER, K.; RANERE, A.J.; RAYMOND, S.; SANDWEISS, D.; SCARAMELLI, F.; TARBLE, K. & ZEIDLER, J. 2007: Starch fossils and the domestication and dispersal of Chili Peppers (*Capsicum* spp. L) in the Americas. *Science* 815: 986-988.

PIPERNO, D.R. & PEARSALL, D.M. 1998: *The Origins of Agriculture in the Lowland Neotropics*. Academic Press, London.

PIPERNO, D.R.; ANDRES, T. & STOTHERT, K. 2000: Phytoliths in Cucurbita and other Neotropical Cucurbitaceae and their Occurrence in Early Archaeological Sites from the Lowland American Tropics. *Journal of Archaeological Science* 27:193-208.

RANERE, A.J. & COOKE, R. 2003: Late glacial and early Holocene occupation of Central American tropical forests. In: Mercader, J. (ed.): *Under the Canopy. The Archaeology of Tropical Rain Forests*: 219-248. Rutgers University Press, New Brunswick.

RANERE, A.J & HANSELL, P. 1978: Early Subsistence Patterns along the Pacific Coast of Central Panama. In: Stark, B. & Voorhies, B. (eds.): *Prehistoric Coastal Adaptations*: 43-60. Academic Press, New York.

RODRÍGUEZ-ROMERO, F.; GARCÍA, C. & LAGUARDA, A. 1988: Electrophoretic Patterns Variation in two Oyster Populations of *Crassostrea cortiziensis* from the Mexican Coast. *Anales del Instituto de Ciencias del Mar y Limnología* 15(1): 177-184.

SÁNCHEZ HERRERA, L.A. 1995: Análisis Estilístico de Dos Componentes Cerámicos de Cerro Juan Díaz: Su Relación con el Surgimiento de las Sociedades Cacicales en Panamá (400-700 d.C.). Tesis de Licenciatura, Universidad de Costa Rica.

SANDWEISS, D.H.; MCINNIS, H.; BURGER, R.L.; CANO, A.; OJEDA, B.; PAREDES, R.; SANDWEISS, M.D.C. & GLASCOCK, M.D. 1998: Quebrada Jaguay: Early Maritime Adaptations in South America. *Science* 281: 1830-1832.

WILLEY, G.R.; MCGIMSEY, C.R. & GREENGO, R.E. 1954: *The Monagrillo culture of Panama, by Gordon R. Willey and Charles R. McGimsey*. The Museum, Cambridge.