A REGIONAL STUDY OF CHANGING SUBSISTENCE STRATEGIES AT NEWPORT BAY, CALIFORNIA

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ABSTRACT

A continuing debate exists between Orange County archaeologists on whether or not a regional temporal shift occurred in the dominant shellfish species found in the archaeological sites around Newport Bay, California. With the use of a Geographical Information System, this study examined 153 archaeological sites around Newport Bay and found that a significant regional temporal shift did occur. The dominant shellfish genus procured during Horizon III, Pecten sp., was replaced by Chione sp., as the dominant shellfish genus procured in Horizon IV. Further investigation into the causal factors of this shift reveals that the shift was in response to accelerated sedimentation, a by-product of increased precipitation. The accelerated sedimentation adversely affected the Pecten sp. population, which, in turn, compelled the prehistoric inhabitants of Newport Bay into procuring an alternate food source, the Chione sp.

INTRODUCTION

The focus of this study is the determination of whether or not a shift occurred in the ratio of various species of shellfish found in the archaeological sites around Newport Bay, located in Orange County, California (Figure 1). Many of the estuary/bay shell middens along California's coast experienced a "directional change through time in the proportions among the dominant species within them" (Allen 1981:43) and for years, the local archaeologists working around Newport Bay have debated on whether a shifting of the ratio of shellfish actually occurred. The purpose of this study was to take a regional approach in establishing whether or not shifts occurred in the ratio of dominant shellfish and give possible explanations for these shifts.

Newport Bay was chosen as the study area because: (1) of the voluminous number of sites surrounding the bay (153 archaeological sites can be found in study area, Figure 2); (2) the archaeological sites date from 6495 B.C. to A.D. 1740 (Breschini et al. 1988:21-26), providing sufficient data to study temporal changes; (3) a regional study, examining all the sites in the study area, had not yet been performed on this level.

DISCUSSION

Many archaeologists have developed and tested hypotheses to explain why hunting-gathering societies (such as the prehistoric inhabitants of Newport Bay) had to change their primary food source. Changes in a society's subsistence strategy are usually the result of stresses to the ecosystem. Examples of such stresses are the seasonality of the food's availability, over-exploitation of the food source (caused by increasing population pressures), natural disasters, and environmental changes (climatic and/or geomorphological) (Botkin 1980; Christenson 1980; Dincauze 1987; Earle 1980; Green 1980; Reidhead 1980; Waselkov 1987). When these stresses occur, they tend to increase the cost (in terms of energy expended) of procurement (Thomas et al. 1979:10-13). When a subsistence strategy is no longer cost efficient, then changes need to be made. These changes would include chang-

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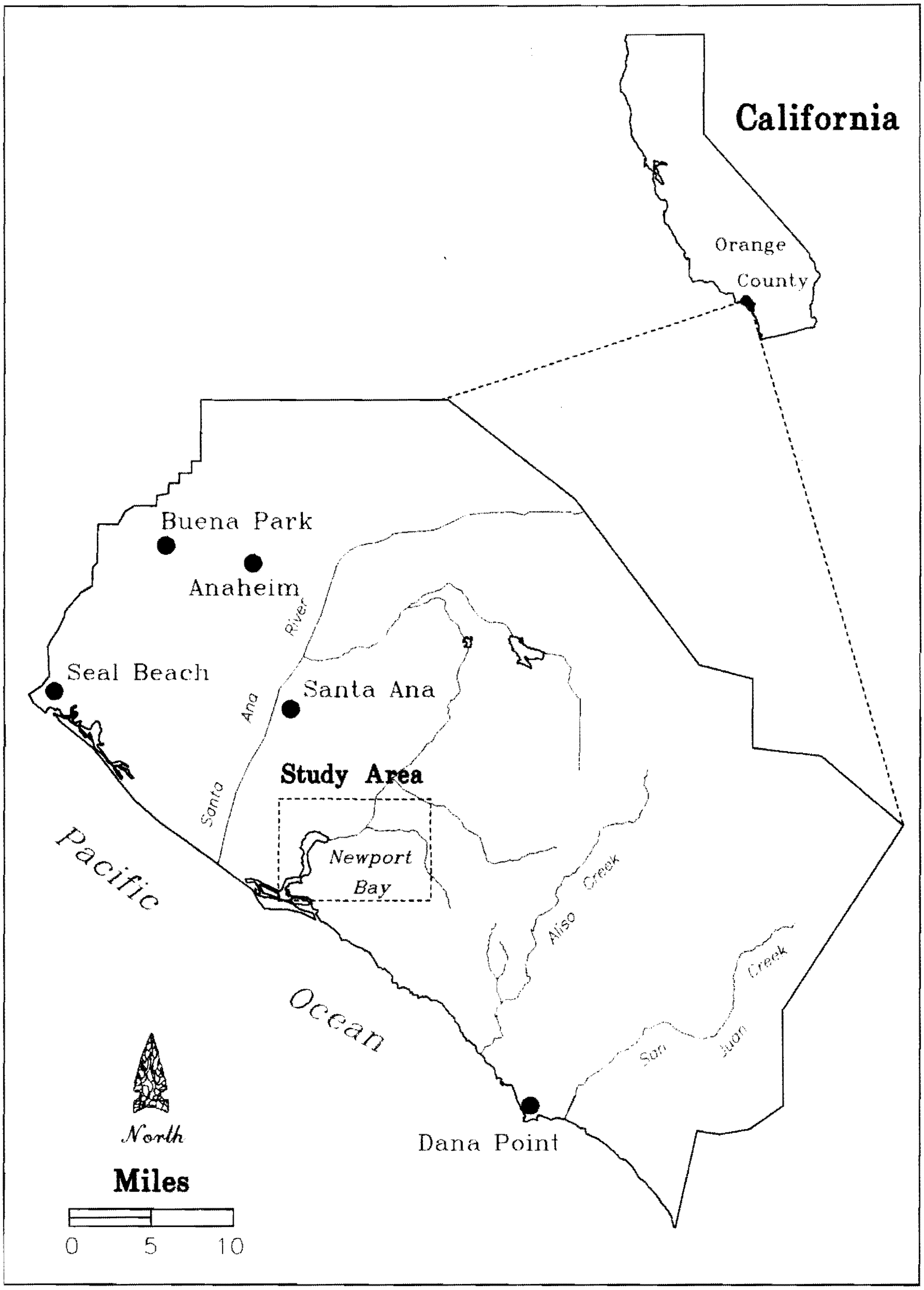

Figure 1. Locational map of study area.

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ing the primary food source and/or adding supplemental food items to the original food source; traveling further to obtain the food source; or moving the base camp to a new location (Thomas et al. 1979:27-34).

Several archaeologists working around Newport Bay have observed shifts in the ratio of shellfish (Allen 1981; Craib 1982; Koerper 1981; Lyneis 1981; Rice and Cottrell 1976). However, these shifts were generally noted, within a site, on a site-by-site basis. A couple of the reports did compare one site against another site (Koerper 1981; Rice and Cottrell 1976), but research had not yet been performed on a regional scale. The shifts observed within these sites, however, suggest that the prehistoric inhabitants did change their subsistence strategy.

To explain the shifts found in the before mentioned sites, these same archaeologists studied the environmental changes that occurred in and around the bay. The archaeologists then attributed the shifts to changes in the bay's ecosystem.

Upper Newport Bay is one of the few remaining natural estuaries in California (Frey et al. 1970:10). An estuary is a semi-enclosed body of water that mixes the salinity of the sea with freshwater of adjoining rivers or creeks. This mixing of salt and freshwater creates a special and unique environment that is constantly undergoing changes in its salinity, temperature, currents, and sedimentation (Reid 1961:69). Life that inhabits this unique environment needs to be able to adjust to these different variables or perish.

Although Newport Bay is an area rich with a variety of mollusks, the recurring species found in the middens are Chione sp. (clams), Pecten sp. (scallops), and Ostrea lurida (oyster) (Koerper 1981:248). Chione sp., Pecten sp., and Ostrea sp. are estuarine animals that inhabit the low intertidal zone of bays and estuaries. Chione sp., Pecten sp., and Ostrea sp. each occupy a slightly different niche within this zone. Chione sp. are mud burrowers that live in the soft sandy mud of the intertidal zone. Even though they are buried in the mud, they are not hard to gather because their burrows are shallow and they can be easily felt with the human foot. Because the floor of the intertidal zone is constantly shifting due to sedimentation carried in by waves or current, the Chione sp. must adjust their position in the substrate (Weymouth 1920:18). Pecten sp., on the other hand, never burrow. They are found lying on the surface of sandy mud flats; however their young do need to attach themselves by a byssus to something sedentary. Therefore, Pecten sp. are found in water where the current is not too swift or else its young would be buried by rapid sedimentation (Weymouth 1920:18). Ostrea lurida are considered fixed bivalves, yet their young are free-swimming. During their spat stage, Ostrea sp. need an area where the tide does not go completely out and leave them exposed or they would smother in the mud (Ricketts and Calvin 1962:216). It is at the end of this free-swimming stage when the oysters use their byssus to secure themselves to a stable object and remain above sedimentation.

I began my research by reading all the site reports available in the study area. Out of the 153 sites, I was only able to produce usable data on 40 sites. The types of usable data I was looking for were (1) what chronological time period did the site fall into and (2) what was the most prevalent shellfish found during that time period. The chronology used for this study is based on William Wallace's (1955) cultural horizons for southern California. They are:

Horizon I:	Early Man	Prior to 5500 B.C.
Horizon II:	Millingstone	5500 B.C. to 3000 B.C.
Horizon III:	Intermediate	3000 B.C. to A.D. 1000
Horizon IV:	Late Prehistoric	A.D. 1000 to A.D. 1782

Although several other chronologies exist for California archaeology, Wallace's chronology was chosen because it is widely accepted and remains influential today as a general framework for southern coastal California prehistory.

The data were transferred to a spreadsheet, and a pattern was immediately noticeable. The results (Table 1) are as follows: Horizon I with 2 sites and Horizon II with 5 sites did not provide a large enough sample to accurately describe temporal

Table 1

Dominant Shellfish Species Occurring in Newport Bay's Archaeological Sites by Time Period

Site Number	Horizon I	Horizon II	Horizon III	Horizon IV
ORA 44		O	PCO	CPO
ORA 53				PO
ORA 57				COP
ORA 64	M	CMP	CMP	
ORA 99 A	O	O		
ORA 106			PCO	
ORA 111				CPO
ORA 116			PC	CP
ORA 119 A		PCMO	PCMO	PCMO
ORA 119 B			PC	OPC
ORA 120		P		
ORA 125				CP
ORA 134			PCO	CPO
ORA 136				C
ORA 166				CPO
ORA 167			P	
ORA 168			P	C
ORA 174			COP	COP
ORA 181				C
ORA 192				COP
ORA 193				OPC
ORA 196			CPMO	
ORA 203 A			CP	
ORA 203 B				C
ORA 203 C				O
ORA 208			PC	
ORA 225			POC	C
ORA 227			POC	OPC
ORA 228			PCO	CPO
ORA 287			PC	CPO
ORA 480				CP
ORA 508 A/B			PC	
ORA 508 C			PC	
ORA 689				OP

M = Mytilus sp.; O = Ostrea lurida; C = Chione sp.; P = Pecten sp.

subsistence patterns. The number of sites found from Horizon III and Horizon IV did, however, increase significantly. Horizon III had 19 sites with usable data; at fifteen of the sites, Pecten sp. was identified as the primary shellfish species and 4 sites had Chione sp. as the dominant shellfish species.

A substantial shift from Pecten sp. to Chione sp. as the dominant species does occur in Horizon IV. There were 17 sites with Chione sp. as the most dominant species, 2 sites with Pecten sp. and 5 sites with Ostrea sp. These figures indicate that there was a significant regional temporal shift in species from the Pecten sp. dominant sites of Horizon III to the Chione sp. dominant sites of Horizon IV. The results also indicate the increasing importance of Ostrea sp. in Horizon IV to the inhabitants of Newport Bay.

This shift in species composition is marked by a change from 79% Pecten sp. and 21% Chione sp. during Horizon III to 71% Chione sp., 8% Pecten sp., and 21% Ostrea sp. (Figure 3). Where these changes in correspondence to the environmental changes in Newport Bay?

The sites of Newport Bay were then mapped on a computer. With the use of a GIS system, the sites could be categorized by the dominant shellfish occurring in Horizon III and Horizon IV and their spatial patterns examined. These sites were then compared to various environmental constituents such as proximity to the bay, differences in elevation and closeness to water drainages. The strongest occurring factor seen through time was that the sites containing shellfish were close to the freshwater drainages (Figures 4 and 5). It is not unusual to find sites near water drainages because of the basic human need for freshwater. This is especially true for village and camp sites, but might not hold true for a shell processing site. At a shell processing site, the shellfish is gathered and shucked near the area where they were obtained, then the shellfish were carried back to the camp site. Because many of the site reports did not, or could not, disclose what type category the site fell into, another explanation was needed to explain the relationship of the sites with drainages.

Most estuarine formation was the result of a drowned river valley (i.e., the submergence of coastal areas by a rise in sea level). The present configuration of existing estuaries, including Newport Bay, is due to the interplay of land topography, runoff water from drainage systems, sediments accumu-

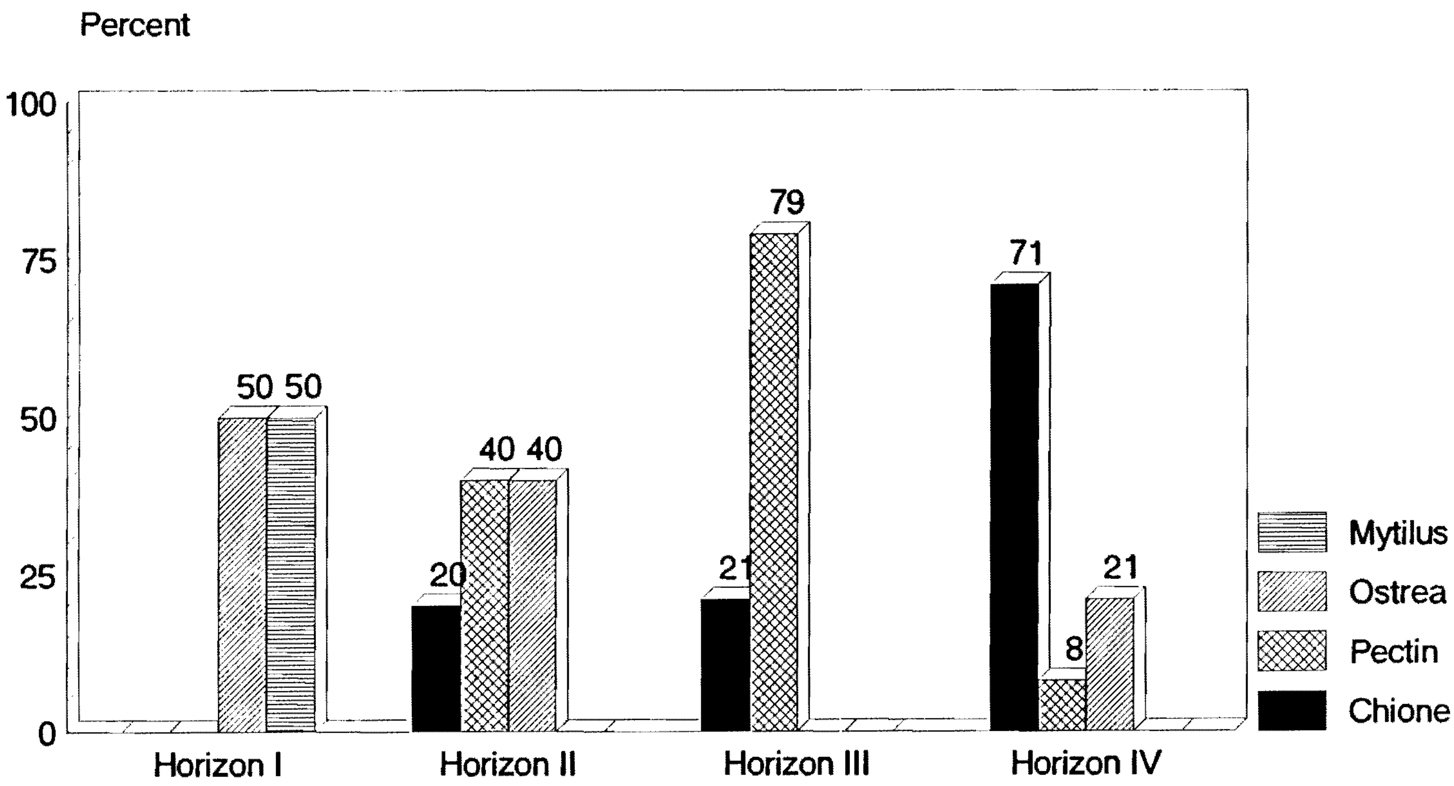

Figure 3. Dominant shellfish distribution by horizon.

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lated from rivers and the ocean, and changes in sea level (McLusky 1971:5-6). The mixture of the salt and freshwater, that is characteristic of estuaries, helps to create a very fertile ecosystem. This unique mixture results in an estuary containing more minerals and nutrients than either the fresh or saline water source could alone (Bickle 1978:8). The balance of life within an estuary is dependent on the interrelationship of many different variables. These include changes in temperature, salinity, currents, and sedimentation. Although the biota living in an estuary can survive minor fluctuations of these variables, elements of the biota might not be able to survive either a long-term alteration or a dramatic short-term event.

Coastal California is considered to be a highly fragile terrestrial ecosystem where the effects of increased or decreased precipitation levels can have critical effects upon the biota (Larson and Michaelson n.d.:12). For example, during periods of decreased precipitation (drought), freshwater supplies to the estuary are decreased. This, in turn, elevates the salinity within the estuary by making the ocean the chief (perhaps only) water source. Increases in precipitation, on the other hand, would expand the flow of freshwater from the various drainages, causing flooding and accelerated sedimentation into the estuary.

In February 1989, Philip de Barros and Owen Davis of the Chambers Group (1990) extracted a 687 cm deep core from a portion of the San Joaquin Marsh for the purposes of making an environmental reconstruction of Newport Bay and its environs (Figure 6). The analysis of the core's sample shows that the water within the bay had episodes where it switched from freshwater to saltwater and back to freshwater again. It suggests that the saltwater periods occurred during either periods of lower precipitation or the diversion of the Santa Ana River (Chambers Group 1990:17). Either incident would have permitted the intrusion of saltwater upstream from Newport Bay.

It would follow then that the periods of freshwater would have been the by-product of increased precipitation, with greater amounts of freshwater running into Newport Bay. This unusually high water runoff would, in turn, carry and deposit a greater than normal amount of sediment into the bay.

The core findings of the Chamber Group were then compared to the known climatic history of California to determine if correlations between past Newport Bay ecosystem changes and periods of increased or decreased precipitation exist (see Figure 6). During the last 10,000 years of California's climatic history, Moratto et al. (1978:148) have identified at least 6 cool/moist intervals each lasting between 400 and 1500 years, separated by 5 warm/dry cycles. Although their climatic chronology does not correlate perfectly against the periods of fresh and saltwater dominance in Newport Bay, some correlation does exist. Periods of saltwater are identified as occurring within a few hundred years of warm/dry climatic periods. The same holds true for the association of freshwater with cooler/wet periods. The information used to create the climatic chronology came from areas in central and northern California and was based on a composite of various studies such as pollen analysis and tree-ring studies. None of the studies cited were performed in Orange County or even in southern California. This could account for the discrepancies at the beginning and ending of each period.

Since estuaries generally exhibit high rates of sedimentation as a consequence of storm frequency it would follow that increased sedimentation would have occurred during the cooler/wetter periods. Undoubtedly, these climatic cycles would have had effects on the biota living in Newport Bay.

Examples of accelerated sedimentation and decreased salinity due to increased precipitation into Newport Bay have been documented in modern times. In his study of seasonal dynamics and its affects on the biota of Newport Bay, Seapy (1981) reports that the sediment level in Newport Bay rose approximately 3 feet during the winter season of 1977-1978. He attributes this increase, which was above normal, to an unusually wet winter, with precipitation equal to 250% of that of a normal year. Low salinities are also recorded for the same time period and

YEARS	Wallace (1955) Cultural Chronology	Dominant Shellfish BY Horizon	Moratto et al. (1978) Predominant Conditions	Chambers Group (1990) San Joaquin Marsh
AD 1782	HISTORIC	?	WARM-DRY	FRESH WATER
AD 1500	HORIZON IV LATE PREHISTORIC	CHIONE	COOL-WET	
AD 1000			WARM-DRY	
AD 500	HORIZON III INTERMEDIATE	PECTEN	COOL-WET	
0			WARM-DRY	
500 BC			MODERATELY COOL-WET	
1000 BC				
1500 BC			VERY WARM-DRY ALTITHERMAL	SALT WATER
2000 BC				
2500 BC			COOL-WET	Fresh Water
3000 BC				SALT WATER
3500 BC	HORIZON II MILLINGSTONE	UNDETERMINED	MODERATELY TO VERY WARM-DRY	
4000 BC				
4500 BC			COOL-WET	FRESH WATER
5000 BC			WARM-DRY	
5500 BC	HORIZON I EARLY MAN			
6000 BC				
6500 BC			COOL-WET	

Figure 6. Reconstruction of Newport Bay's environmental chronology relating to the dominant shellfish species found within the study area.

faunal density were extremely low as well. This pattern of decreased faunal density, undoubtedly, would have also taken place during the cooler/wetter periods identified by Moratto et al.

As before mentioned, Pecten sp. need to attach themselves to something sedentary when they are young. That is why they inhabit areas where the current is not too swift or the young Pecten sp. would be buried by the rapid sedimentation (Weymouth 1920:25). Thus, it is argued that the periods of increased sedimentation caused high mortality rates to the young Pecten sp. population.

Since Chione sp., on the other hand, actively modify their positions in the mudflats, they can adjust more easily to variations in sedimentation than either the Pecten sp. or Ostrea sp. populations. This is probably the best explanation for why they are still living in Newport Bay and the Pecten sp. and Ostrea sp. are extinct.

Nearly all bottom dwelling estuarine animals are restricted to a specific niche within an estuary, including the shellfish discussed in this paper. If environmental changes affecting an estuary are strong and occur for a long duration, the biota of an estuary can become stressed, adversely affecting their population. Some species may, in fact, never recover from this stress. Other species may adapt to the new conditions and become more prosperous. These seem to be the cases for the Pecten sp. and Chione sp.

Due to the complexity of the estuarine systems, it is often difficult to separate different variables and identify which one may have caused a change in the ecology of an estuary. It is, however, the contention of this paper that the main cause for a shift from Pecten sp. dominant sites to Chione sp. dominant sites was the result of increased sedimentation caused by periods of increased precipitation. The increased sedimentation caused stress to the Pecten sp. population, decreasing its availability to the prehistoric inhabitants. To keep up with the food demands of an increasing population, the prehistoric inhabitants had to make a shift to a food source that was more available and cost-effective, the Chione sp.

The emergence of the Ostrea sp. dominant sites during Horizon IV may also be in response to the decline of the Pecten sp. population, but could also be a result of overexploitation due to increasing population pressures and/or be an indicator of microenvironments where the immediate environ was more tolerable for the oysters. However, this can only be ascertained by conducting future research.

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