Comparative Study of Lithic Artifact Composition of Shell Midden Sites Between The Beagle Channel of South America and Okayama Prefecture, Japan

サルティニ　レアンドロ　ダニエル・フェレ　ピラ
SARTINI, Leandro Daniel・FERRE, Pilar

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Comparative Study of Lithic Artifact Composition of Shell Midden Sites Between The Beagle Channel of South America and Okayama Prefecture, Japan.

SARTINI, Leandro Daniel[1] ・FERRE, Pilar[2]

1．OBJECTIVES AND METHODOLOGY

The Beagle Channel (Argentina) and Okayama (Japan) despite being two parts of the world with completely different environments, present the similarity of being large areas with a high concentration of shell middens.

Since they are two completely different environments, the criterion of comparison between these two locations is centered on the lithic assemblages, because they reflect the adaptation to certain environments and resources. Although lithic assemblages, may exhibit variations in their shape, the parameters indicating functionality are the same, so they can be used as universal standard for comparative analysis of archaeological sites anywhere in the world.

One of the main points of comparing these two regions lies into recognizing the variability of use that took place in shell middens in relation to the exploitation of coastal resources in different environmental locations in the past through the composition of their lithic assemblages.

Through the lithic tools our objectives are to understand the functionality in shell midden sites by the settlers in different regions and to find similarities and differences in order to compare the adaptation in different coastal environments, as a means to understand the dynamics of group behavior in the past along the coasts in relation to the resources exploited. From the lithic artefactual point of view, we intend to clarify which activities had greater relevance in these sites.

Shell midden sites were selected for the analysis entitled: 'method of classifying artifacts according to their types' (table 1), based on the analysis method by Suzuki 1981 and complemented by the work of Sawashita 1998 in which the percentage of each type of artifact from each site is calculated. On this set of data, we performed a Multivariate analysis: Principal Component Analysis (PCA) based on grouping artifacts that have the same functionality of use.

As a study object, the lithic materials recovered from different shell sites in the Okayama

[1] Department of Archaeology, Graduate School of Humanities and Social Sciences

[2] Department of Animal Science, Graduate School of Environmental and Life Science

Prefecture were taken. The data comes mainly from the analysis of previous excavation reports in addition, the materials recovered from the excavations of shell midden sites of the Beagle Channel (Tierra del Fuego Province, Argentina) were also used and analyzed in the same manner in order to perform a comparative study with the Okayama Prefecture sites.

Functional categorization	Forms of lithic artifacts
Hunting artifacts	arrowhead, projectile point, stone spear head, point
Fishing artifacts	harpoon, saw shaped stone implement, pick: artifact used in reef of shellfish, stone net sinker (stone weight)
Processing artifacts	blades tools class: flakes with retouching or traces of use are included, tanged stone scraper, scraper class, side scrapper, end scraper, indeterminate form scraper, knife
Deforestation and manufacturing artifacts	polished stone axe
Digging artifacts	chipped stone axe
Cooking artifacts	polishing stone tools class, tatakiishi, hollow stones, concave stone
Tools	pebble tools, hammer stone: artefacts used as tools, stone drill, stone awl, graver (burin), piece esquillee, whetstones

Table 1. Method of classification of the artifacts according to their type.

2. THE STUDY AREA

2.1. OKAYAMA PREFECTURE

2.1.1 ENVIRONMENTAL CHARACTERISTICS AND CHANGES IN THE SEA LEVEL

From a geographical point of view Okayama Prefecture (figure 1), is divided into 3 large areas with great climatic variations: 1-The Seto Inland Sea area, with mild temperatures and scarce annual rainfall (1000-2000 mm). 2-The Inland area, with slightly lower temperatures than those in the previous area, and a slightly moderate annual rainfall. (1300-1500 mm), 3-The Chuugoku Mountains area, with fairly low temperatures and heavy rainfall in winter. The annual precipitation is greater than in the other areas (1600-2000 mm) (Okayama chihou kishoudai 1991).

The coast of the Okayama Prefecture extends for a total of 540 km between the Prefectures of Hyogo and Hiroshima in front of the Seto Inland Sea with the presence of a great number of islands. Surrounded by small hills and mountains, the coastal region presents the Okayama alluvial plain modeled by three main rivers: Yoshii, Asahi and Takahashi. The south area of the alluvial plain extends from east to west to the present bay of Kojima, which in the past was surrounded by the sea forming an island.

Due to this climatic and geomorphological diversity, from an ecological point it is possible to divide the prefecture into 4 ecology areas or ecozones: 1-The Chuugoku Mountains is the area where the 3 large rivers that shape the prefecture originate. It is composed of what are commonly called buna forests, dominated mainly *Fagus crenata, Fagus japonica, Abies firma* and evergreen oak forests（*Quercus acuta, Quercus salicina*, etc）. They are forests that harbor great animal diversity such as various species of birds and mammals like *Ursus tibethanus* and *Servus nippon*. 2-The Kibi Plateau area, its characteristic vegetation is that of transition between the deciduous broad-leaved forest（buna forest）of the Chuugoku mountains area and the evergreen broad-leaved forest of the Seto Inland Sea coast area, that is, evergreen *Quercus* forest（*Q. myrsinaefolia, Q. acuta*）and momi fir forest（*Abies firma*）. In this area there are wetland and reservoir zones that house different species of mammals, reptiles, birds, fish and insects. 3-The Southern plains area, dominated by evergreen broad-leaved forest with species such as *Camellia japonica, Cinnamomum camphora*, and species of the genus *Castanopsis*. In the environment of the Kojima Lake there is a great biodiversity related to the aquatic environments, especially in bird species. 4-The Seto Inland Sea coast area, is the ecozone with less rainfall of the whole prefecture. It was originally dominated by evergreen broad-leaved forest with species such as *Quercus phillyraeoides, Ilex integra* and *Symplocos prunifolia*, although at present, few scattered places are found. The coasts, bays and wetlands of this area form an ecosystem with a rich diversity of species of algae, fish, mollusks, and migratory birds（Okayamaken kankyoubunkabu shizenkankyouka 2013）.

Several environmental changes that occurred in the past can be identified due to variations in sea the level. Based on the analysis of peat layers, in the Okayama plain exist 4 layers that indicate different formation events that reflect the environment of the past（Suzuki 2012, Umitsu 1994）. According to the dating of ^{14}C from the peat layers several events have occurred: 4 periods of stability of the sea level（30000–18000 BP, 11000–8000 BP, 6000–4000 BP and 3000–2500 BP）, 2 transgressive events（18000–11000 BP and 8000–6000 BP）and one regressive event of the sea level（3500–3000 BP）（Suzuki 2012）.

During the last glacial period between 30000–18000 BP, the water level stabilized and it is estimated to have reached a total height between 20 and 100 m inferior to the actual one. Between the 18000–11000 BP, a period of 7000 years, a transgression event occurred in which it is estimated that the sea level ascended approximately 90 m, 16 m below the actual sea level. Between the 8000–6000 BP, the sea level reached a similar height with the current level, since during these 2000 years, the sea level increased approximately 15 m. The period of maximum transgression of the Jomon Period continued between the 6000–3500 BP in which the sea level ascended further, until it reached a height of 3 m above the present one. Soon after that, between the 3500–3000 BP, a small regression event occurred in which the sea level diminished reaching a level that was 3 m below the actual one. Finally, approximately during the 3000-2500 BP a period of relative stability took place, and afterwards, the sea level started to slowly rise until it reached the current sea level (Suzuki 2012)

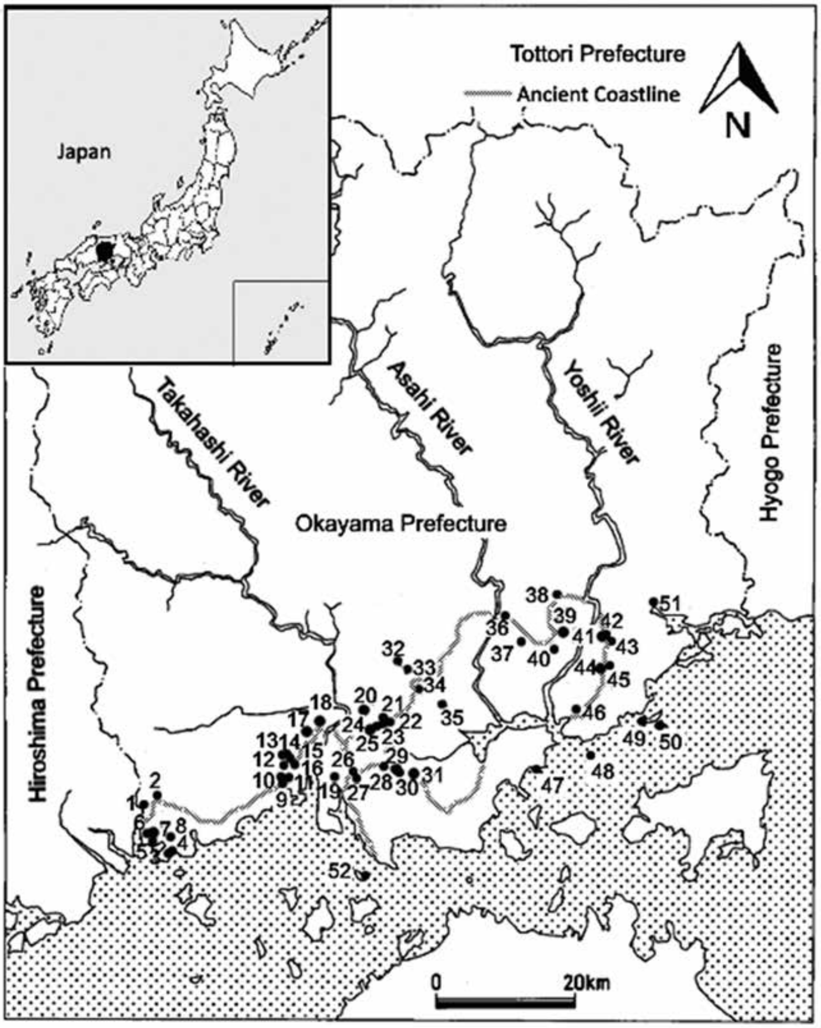

Figure 1. Okayama Prefecture and shell midden sites.

2.1.2. SHELL MIDDENS IN OKAYAMA

Since the dawn of Japanese archeology, Okayama Prefecture has been well known as a concentration region with high shell middens accumulation of the Jomon period. In addition, many of the actually known Jomon ceramic styles of the Setouchi area owe their names to the shell midden sites of the zone. The coastal region of the ancient Kojima Bay possesses the highest concentration of shell middens in all Western Japan. This region also presents one of the oldest shell midden sites of Western Japan and the oldest of the prefecture, the Inushima shell midden site, from the initial Jomon period（Onbe 2009）.

Currently, in Okayama Prefecture a total of 53 sites are known with the following distribution: Setouchi City（7 sites）, Tamano City（1 site）, Okayama City（10 sites）, Kurashiki City（27 sites）, and Kasaoka City（8 sites）. However, these shell middens of the prefecture can be grouped in areas of concentration. Tajima（2015）, groups them into three main areas of concentration. The area 1 is composed by the group of sites of the ancient bay of Kojima, with an estimated extension of 50 km from east to west and 20 km from north to south, with the trend of distribution of sites within the bay concentrated from east to west. The area 2 has the sites of the ancient bay of Kasaoka, which are distributed within a sphere of 10 km. The area 3 is composed by the sites located on the islands. As for the location on the ground, the sites of areas 1 and 2 are distributed mostly on coastal terraces and shoals, whereas the sites of area 3 are located on plateaus of alluvial plains, plateau and low hills of large and small islands.

According to the data obtained from 31 shell midden sites of the Okayama Prefecture, the taxa of the identified shells can be observed in the following proportions: Pacific oyster（*Crassostrea gigas*）32%; blood cockle or blood clam（*Tellitarca granosa*）29%; Japanese basket clam（*Corbicula Japonica*）23%; common orient clam（*Meretrix lusoria*）10% and snails 6%（Tajima 2015）.

２.２. BEAGLE CHANNEL

２.２.１ ENVIRONMENTAL CHARACTERISTICS

The Beagle Channel（figure 2）is located at the southern end of the American continent, at approximately 55° of South latitude. With an approximate length of 180 km, it runs from east to west with a width that oscillates between 4 and 7 km, reason that explains why both coasts are always in sight of one another. The north coast consists on the Big Island of Tierra del Fuego（Isla Grande de Tierra del Fuego）, and the south one on the Hoste and Navarino islands. The coasts are abrupt, with extensive cliffs that separate rocky beaches of generally little extension. The Beagle Channel is a glacial valley that was invaded by marine waters about 8000 years ago（Rabassa et al. 1986）, thus forming a means of communication between the Pacific and the Atlantic Oceans. Parallel to the north coast runs a short distance to a mountain range, the Andes Fueguinos, with altitudes up to 2470 m in Monte Sarmiento and 1470 m in Monte Olivia. The proximity of this mountain range makes abrupt several sectors of the coast and the strip affected by the tides is narrow, with subsequent deepening of the seabed and the areas with plain surfaces are few, very discontinuous, and of limited extent.

We can say that the atmosphere is cold, windy and rainy in the whole area. However, it should be noted that the southern islands serve as a protection against the most direct climatic attacks of Antarctic origin. Therefore, the cold wind and humidity are manifested a little more moderately than in the rest of the area. Another important point is that the large oceanic mass in the vicinity acts as a stabilizing factor and decreases the amplitude of the variants and the climate of the region can be described as "super-oceanic" (Tuhkanen 1992).

From the ecological point of view 3 ecozones can be distinguished: the terrestrial, the littoral and the marine. 1-The terrestrial one consist on Magallean forest dominated mainly by the genus *Nothofagus,* characterized for being a closed forest with little diversity of arboreal species and therefore with scarce diversity of terrestrial mammals and birds, as well as few fishes in rivers of freshwater. 2-The littoral is the most important area, since it presents favorable conditions for human subsistence by receiving the influence of both types of ecozones (terrestrial and marine) with the coast providing the highest biomass. In addition, it also presents favorable conditions of accessibility and predictability for the obtainment of resources (pinnipeds, penguins and mussels, among others). 3-The marine area presents seasonality according to the fauna (fish) fact that differentiates this area from the previous ones.

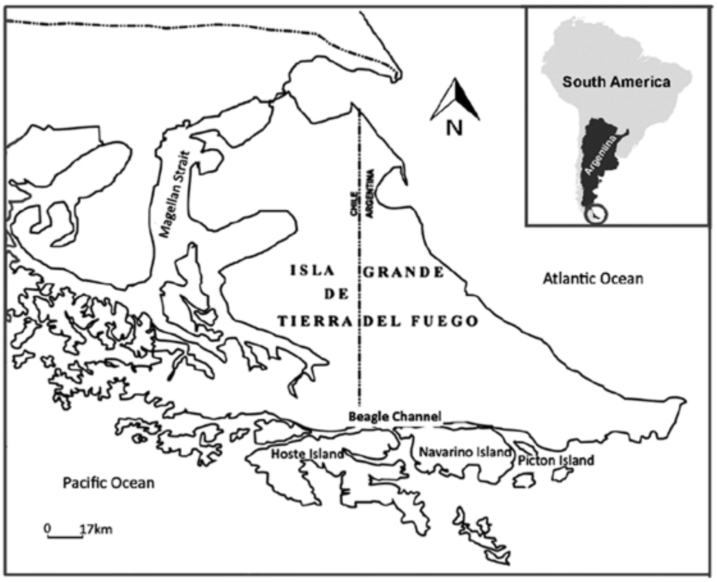

Figure 2. Isla de Tierra del Fuego (Tierra del Fuego Island).

２.２.２. ENVIRONMENTAL HISTORY AND CLIMATE VARIATIONS

During the 6000 years before the arrival of the Europeans, the atmosphere in the Beagle Channel seems to have undergone no major changes, unlike in older times. Geomorphological studies developed along the Beagle Channel and the adjacent spaces; indicate that during the Pleistocene the region was modeled by an intense glacial activity that lasted until approximately the ninth millennium BP in which the current Beagle Channel was traced by a glacier discharge flowing from the Darwin mountain range reaching the Atlantic platform (Heusser and Rabassa 1987; Rabassa et al. 1992).

According to the last great glacial period, two main advances of the glacier were identified whose maximum expansions occurred between 20000-18000 BP (Rabassa et al 1986) and about 11000 BP (Heusser and Rabassa 1987). Subsequently, the resulting water of the fusion of the glacier gave rise to a glacial lake, whose opening to the sea occurred around the 8000 BP. Around 7500 years ago the marine environment was definitely established (Rabassa et al 1986; Gordillo et al 2005).

The glacial-eustatic rise culminated towards 6000-5500 years BP. However, the coastlines formed at the time are today allocated into heights of up to 10 m above the current sea level (Rabassa et al 1992). This is due to a process of coastal elevation, a product of the combined effect of glacio-eustacy in moments immediately after the definitive retraction of the glaciers and of the tectonic ascent towards more recent times (Rabassa et al 1990; Gordillo et al 1992). Two aspects should be highlighted in relation to this paleoenvironment: The first one is that the rate of elevation was not constant over time and it would have been more accelerated in the last 1000 years (Gordillo et al 1992). The second one is that the rise of the coasts was not a continuous process along the entire coastline of the Beagle Channel. To the east of the Lashifashaj River and in Lapataia, the rate of elevation was significantly slower than that recorded in Ushuaia, and even subsidence events have been registered in Sloggett Bay (Coronato et al 1999; Rabassa et al 2004).

Heusser (1989) pointed out that during the first half of the Holocene a moderate and dry warm climate prevailed. In this period the temperature would have been on average up to 2℃ higher than the current ones, while the precipitations would have been about 100 mm below. During the last 5000 years, the climate would have been somewhat cooler and wetter: the summer temperature varied from the current annual average to a maximum of 0.5 ℃ and the precipitations to a maximum of 100 mm. (Heusser 1998).

2.2.3. CHARACTERISTICS OF SHELL MIDDENS

On the north coast there are large numbers of archaeological sites that are distributed from at least Lapataia Bay to Sloggett Bay, except for the section currently occupied by the City of Ushuaia, whose urbanization involved the destruction of many sites. To have more than a few hundred meters within an archaeological site and another one is considered very rare.

A very characteristic archaeological feature of the Beagle Channel regions and its surroundings is the succession of shell middens in the immediate vicinity of the coasts, forming both alignments and small fields that in some cases cover about one hectare. Thanks to ethnographic data from the Nineteenth Century, it was known that these shell middens were closely related to indigenous dwelling places and were primarily constituted by food residues (Orquera and Piana 1999b). The archaeological studies carried out in the region made it possible to confirm these inferences, but applied to a much wider period, which had begun more than 6000 years ago (Orquera and Piana 1999a).

The majority of deposits in the region are shell middens that, in general, have a morphology based on a circular structure of different stratigraphic power according to the case, that surrounds a central depression. These structures are approximately of 3 meters in diameter (although there is high variability) and correspond to cabin bottoms together with an area of accumulation of wastes, residues and perimeter activities that constitutes the proper shell midden subunits. In the center of the structure, at the base of the depression, it is customary to find a home. The perimeter of the circular structure is formed by an accumulation of different layers of waste and sediments that, in turn, fulfilled the function of socket and protected the cabin from the wind (Orquera and Piana 2000). These layers, identified as stratigraphic subunits, constitute the basic unit of formation of these shells middens. Each stratigraphic subunit corresponds to storage episodes of the material (Orquera and Piana 2000), which are not homogeneously distributed throughout the deposit, but correspond to lenses of deposit of the archaeological remains (mainly valves and sediment) that are located in a part of the deposit. These subunits are recognizable from changes in texture, composition and compaction and constitute deposition planes of a few centimeters in thickness. As it is known from the ethnographic record, the great mobility of the Yámana groups (the native people that inhabited the region at the arrival of Europeans) is reflected in the succession of occupation and vacancy events of the deposits. The periods of settlement abandonment are recognized from a thin layer of humus visible on the surface of the archaeological deposit, but especially in the fireplace.

The archaeological sites indicate that the ancient inhabitants of the region took advantage of practically all the stretches of coast available such as still small beaches of a few tens of square meters surrounded by high rocky walls, which explains why the access to these areas was mainly by the sea. Most sites are just a few meters away from the coast and only a few cases are known with more than a kilometer from the current seashore, but in several of them it is necessary to take into account possible displacements of the coastline as an effect of the isostatic-tectonic ascent（Orquera and Piana 1999a）.

According to the majority of the taxa that conform the shell middens of the Beagle Channel we can identify: Mussels（*Mytilus edulis*）70% – 90%; limpets（*Nacella magellanica and Nacella deaurata*）4% – 7%; chitons（*mainly Plaxiphora carmicaelis*）5% and snails（*Trophon geversianus, Xymenopsis muriciformis, Acanthina monodon*）1％ – 4％（Verdun et al 2010）.

3. SELECTED SITES FOR ANALYSIS

3.1. OKAYAMA SITES

Previous reports of Okayama Prefecture sites of the Jomon period were reviewed and based on the information obtained, we selected those sites that presented a good quantity and quality of information about lithic artifacts. In this way, we selected 10 shell midden sites（figure 3 and table 2）, which are: 1-Tsukumo, 2-Suzumimatsu, 3-Satogi, 4-Nishioka, 5-Funagura, 6-Isonomori, 7-Hikosaki, 8-Takehara, 9-Miyashita, 10-Oohashi.

As mentioned above, the land location of most shell midden sites of the prefecture occurs predominantly in coastal terraces, shoals, low hills and alluvial plains. All the sites analyzed in this research are located on low hills, except for Isonomori and Hikosaki which are situated in coastal terraces. Another feature is that the sites prevail in estuaries and marshes. That is, in the mouths of the rivers towards the sea.

However, during the analysis of the reports of the sites we encountered some difficulties, such as the determination of subperiods of artifacts in some sites. This was mainly due to the fact that the reports were very old and, therefore, they were difficult to read and understand. In some reports, the artifacts were not classified by subperiods. In others, the wording was unclear or showed very general descriptions（this is the case of reports such as Miyashita and Oohashi shell middens）.

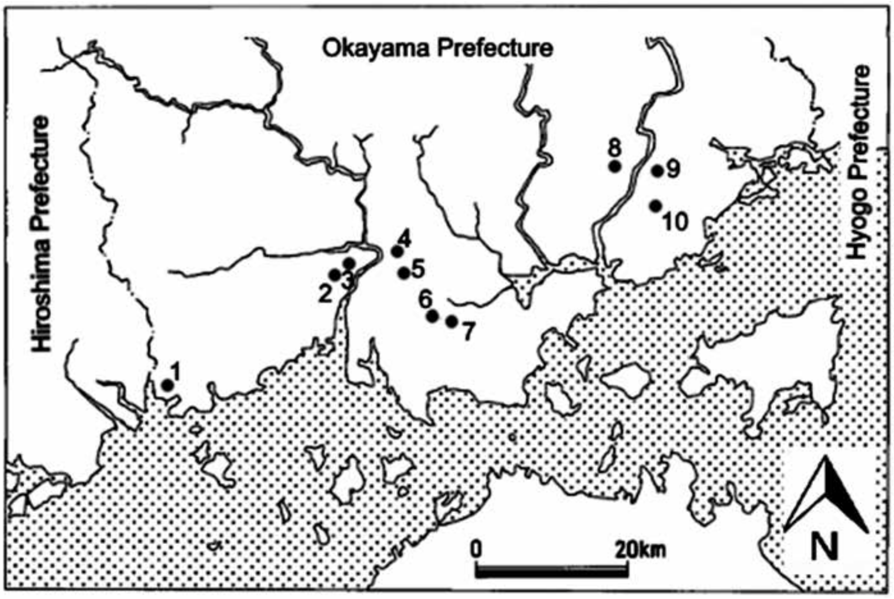

Figure 3. Location of shell midden sites of Okayama Prefecture. 1-Tsukumo 2-Suzumimatsu 3-Satogi 4-Nishioka 5-Funagura 6-Isonomori 7-Hikosaki 8-Takehara 9-Miyashita 10-Oohashi.

Number	Japanese Site Name	Localization	Period	Initial	Early	Middle	Late	Final
1	Tsukumo	Kasaoka City	Initial to final					
2	Suzumimatsu	Kurashiki City	Initial to late					
3	Satogi	Kurashiki City	Early to final					
4	Nishioka	Kurashiki City	Middle					
5	Funagura	Kurashiki City	Initial to late					
6	Isonomori	Kurashiki City	Early					
7	Hikosaki	Okayama City	Initial to final					
8	Takehara	Okayama City	Late					
9	Miyashita	Setouchi City	Early to late					
10	Oohashi	Setouchi City	Early to late					

Table 2. Selected sites for this research in which their location and period are shown. Note: the subperiods marked in black boxes are those that have detailed information of their lithic artifacts by subperiod.

3.2. BEAGLE CHANNEL SITES

As we mentioned previously, along the northern coast of the Beagle Channel (Argentina), from the Lapataia Bay to the Sloggett Bay, the archeological sites appear in large numbers and in a practically continuous manner because of the natural resources extend homogeneously across the bay. However, the archaeological sites of the channel are mostly distributed in three different scenarios of the central and eastern portions of the Beagle Channel, fact that does not indicate that the resources exploited have been different, since as we have seen the resources are homogeneously located to along the whole channel. These three scenarios are: 1- The locality of Lancha Packewaia-Tunel: occupies a stretch of coast with ravine, rocks and woods, with a difficult access to the interior, because it is located in a rocky coastal area of abrupt slope. It includes the sites of Lancha Packewaia, Tunel I, Tunel II, Tunel VII and Tunel XIV. 2- The locality of Shamakush-Mischiuen: The environment is similar to the previous one（cold, rainy and with abundant of woods）but the coast does not possess ravines, and on either side of a rock extends a plain of about 2.5 km of length and 600 m of width. This plain opens into a sea entrance on land that facilitates access to the interior of the mountains in which the decline of the beaches is smooth. It includes the sites of Shamakush I, Shamakush VIII, Shamakush X and Mischiuen I. 3- The locality of Lanashuaia-Imiwaia: Is a littoral environment with gentle slopes and subsoil with muddy substrate; which is located in a landscape with smoother shapes and shortened cuts by deep and narrow bays. Here are located the sites of Lanashuaia and Imiwaia I. Unlike other locations, they are found in a different environmental context in which the smaller angularity of this coast would favor the stranding of cetaceans and sardines and the characteristics of the terrain dominated by low hills and more open forests would also facilitate the human access to the interior of the mountains or the approach of guanacos（*Lama guanicoe*）towards the coast.

The sites selected for our analysis（figure 4 and table 3）belong to these 3 scenarios: Lancha Packewaia, Tunel I, Tunel II, Tunel VII, Shamakush I, Lanashuaia,, Imiwaia I, with one exception Isla el Salmón, This last location differs from the previous ones because it is not situated in the current coast but by the banks of a river that flows into the deep and protected bay of Lapataia. All the sites have been systematically excavated and have very good archaeological information

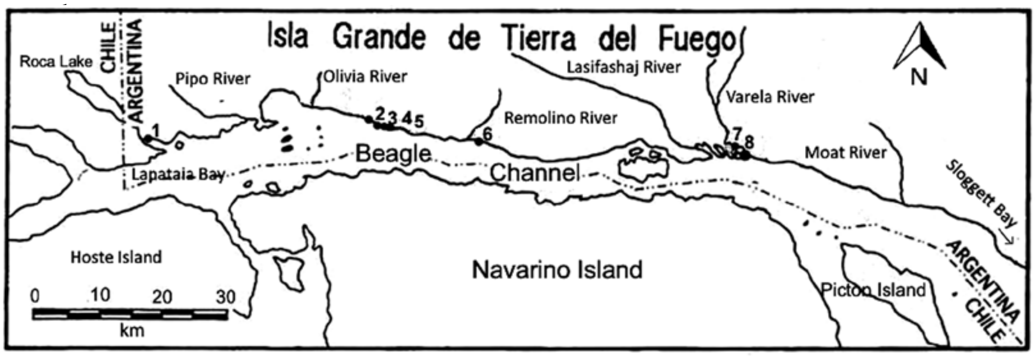

Figure 4. Location of the archaeological sites in the Beagle Channel（Argentina）. 1-Isla el Salmon. 2-Lancha Packewaia. 3-Tunel I. 4-Tunel II. 5-Tunel VII. 6-Shamakush. 7-Imiwaia I. 8-Lanashuaia.

Number	Site	Date	Material	Reference
1	Isla el Salmon	1820±120 BP(AC939)	charcoal	Figuerero Torres and Mengoni Goñalons 1986
2	Lancha Packewaia	4020±70(CSIC 306) −280±85 BP (MC 1064)	charcoal	Orquera et al 1978, Orquera and Piana 1999b
3	Tunel I	6980±100−4600 BP(Beta 2517)	charcoal	Orquera and Piana 1999b, Orquera 2005
		2900−450±60 BP(Beta 4388)	charcoal	
4	Tunel II	1120±90 BP(AC 824)	charcoal	Piana and Canale 1995
5	Tunel VII	100±45 BP(AC 871)	charcoal	Orquera 1995
6	Shamakush I	1020±100 BP(AC1293)	charcoal	Orquera and Piana 1996
7	Imiwaia I	5872±147 BP(AC1397)	charcoal	Orquera and Piana 1996, 1999a, 2000b
8	Lanashuaia	19th Century		Orquera and Piana 1996, 1999b, 2000a

Table 3. Approximate date of each site of the Beagle Channel. The dates are not calibrated.

4. DATA INTERPRETATION AND RESULTS

4.1. OKAYAMA SHELL MIDDENS ANALYSIS

4.1.1. METHOD FOR THE CLASSIFICATION OF THE ARTIFACTS ACCORDING TO THEIR TYPE.

Before proceeding with the analysis, it is important to clarify that the number of sites of the same period and the amount of lithic material recovered from some of them is scarce, so we were restricted for grouping sites of the same period and processing the information. Sawashita (1998) also encountered this complication, however, it should be taken into account that the recovered material does not always faithfully reflect the activities carried out in the past (Schiffer 1976, Clarke 1979), so when analyzing the sites, the results could present some kind of bias.

The lithic artifacts ensemble classification from the excavation reports is shown in figure 5. From its composition we can observe that in the shell middens sites the hunting-fishing-processing activities predominate (Hunting tools 16%-80-100%, Fishing tools 4-57%, Processing tools 3-57%) over other activities such as indicated by the presence of Digging tools (2-3%) that would be important in the obtainment of vegetal raw materials, and Cooking tools (6-14%) which corresponds to the processing of said materials. Also important is the composition of Tools (1-8%) and in some sites the Deforestation tools (1-18%). This high variability in the tool types is showing us the broad spectrum of activities that were carried out in these types of sites.

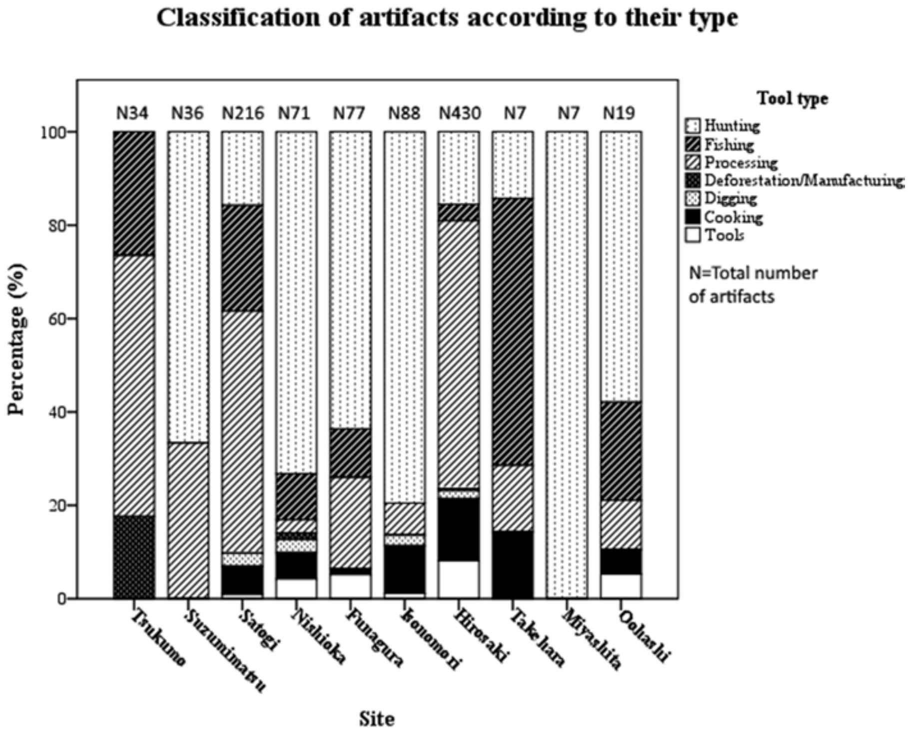

Figure 5. Composition of functional types of Okayama Shell Middens

4.1.2. MULTIVARIATE ANALYSIS. PRINCIPAL COMPONENT ANALYSIS.

Based on the data obtained by the classification of artifacts according to their types (figure 5), we performed a Principal Component Analysis (PCA).

To visualize the relationships between our variables which correspond to the 7 different types of artifacts found in the shell midden sites the PCA grouped the data into 3 new principal components (PC) which explain a 79.98% of the variance of the input data (table 4).

To see what relation our new factors have with the data of origin (tools types) it is necessary to see the table 5. Firstly, in Principal Component 1 (PC1; Axis x), the variable of the Hunting tools is the one with the highest absolute negative value, therefore the smaller the value is, the greater the hunting dependence of the sites is. The highest *positive* value is given by the Processing tools, which indicates sites where prey processing tasks were performed. Secondly, in the Principal Component 2 (PC2; Axis y), the highest *positive* absolute value in the axis is that of Cooking tools, therefore, the greater the absolute value is, one might think that food processing tasks were being carried out. Furthermore, the highest *negative* value is the one of Deforestation and manufacturing tools which would indicate a higher use of these tools and the resources associated.

In the Principal Component 3 (PC3; Axis z) the Processing tools are the variable that has the highest absolute *positive* value, while the highest *negative* value is given by the Fishing tools. We could say that these data of the component 3 are not relevant in our analysis, because making an interpretation of a 3D graph is quite complicated, so, for that reason we decided to use only the first two Principal Components which possess the highest variance and indicate the hunting-fishing-gathering tendencies of the sites, simplifying our 3D Graphic into a 2D one (figure 6).

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2,465	35,213	35,213	2,465	35,213	35,213
2	1,864	26,624	61,836	1,864	26,624	61,836
3	1,270	18,141	79,977	1,270	18,141	79,977
4	,801	11,440	91,417			
5	,393	5,613	97,031			
6	,208	2,969	100,000			
7	4,272E-011	6,089E-010	100,000			

Extraction Method: Principal Component Analysis.

Table 4. Principal component analysis. Eigen value, percentage of variance and Cumulative percentage.

Component Matrix[a]

	Component		
	1	2	3
H1	-,973	-,209	-,023
H2	,659	,046	-,706
H3	,766	,085	,545
H4	,651	-,522	,286
H5	-,102	,665	,305
H6	,218	,844	-,377
H7	-,121	,620	,396

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

H1-Hunting tools
H2- Fishing tools
H3- Processing tools
H4- Deforestation and manufacturing tools
H5- Digging tools
H6- Cooking tools
H7- Tools

Table 5. Principal Component.

The sites situated in the *positive* area of the PC1 axis, correspond with those sites with a greater presence of Processing tools (Tsukumo 56%, Satogi 53%, Hikosaki 57%), suggesting that in these sites the activities of prey processing were predominant with the exception of the Takehara site. To the explain the Takehara shell midden site it is better to use a 3D graph (data not shown) where it is located in the *positive* area of component 3, which indicates a higher presence of Fishing tools which corresponds with what is observed in the bar graph.

Then the 2D graph separates in the *negative* of the Y axis (component 2) those sites with greater presence of Hunting tools (Suzumimatsu 67%, Nishioka 73%, Funagura 64%, Isonomori 80%, Miyashita 100%, Oohashi 58%).

The sites in *the positive* area of the principal component 2 are those that present Cooking tools (Satogi 6%, Nishioka 6%, Isonomori 10%, Hikosaki 13%, Takehara 14%, Oohashi 5%), this factor suggests that in these sites some kind of plant resources were processed. And only one site is located in the *negative* area of PC2 which indicates the use of Deforestation and manufacturing tools (Tsukumo 18%).

According to the analysis of the types of artifacts, we were able to separate the sites into 4 groups, which are linked to certain tasks that predominated over others. The *First group,* located in the quadrant of the positive axis for PC1 and PC2 we can observe that both the Satogi and Hikosaki sites present a great amount of Processing and Cooking tools, which indicate that in these locations which belong to the same period shared similar resources. The *Second group*, in the quadrant constituted by the positive axis of PC2 and the negative axis of PC1 has the sites of Nishioka, Isonomori and Oohashi. All of them present a great amount of Hunting tools and also of Cooking tools, which might be suggesting that those locations were suitable for performing hunting activities. The *Third group*, situated in the quadrant comprised by the negative axis of PC1 and PC2 groups the sites of Suzumimatsu and Funagura, which unlike the previous group, in addition to having a great presence of Hunting tools, they also have a great presence of Processing tools, suggesting that in these sites, hunting and processing activities were carried out. These similarities may also be related to the fact that they belong to the same period. *Fourth group* is that with those sites that could not be grouped, because they share no characteristics with other sites. First, Tsukumo shell midden site could be classified as a fishing-processing site because it has a distinctive characteristic of having a high presence of Deforestation and manufacturing tools. From the point of view of its lithic composition this site suggests to us that the hunting activities are not directly represented in the ensemble, but that indirectly the hunting activities were processed, represented through the Processing tools, which tells us that the hunting activities would be carried out elsewhere. Second, the Takehara shell midden site would be a fishing-processing site and the Miyashita site would be a hunter site. Nevertheless, it should be noted that these sites have very low numbers of artifacts which could be skewing and impeding an adequate analysis of the data.

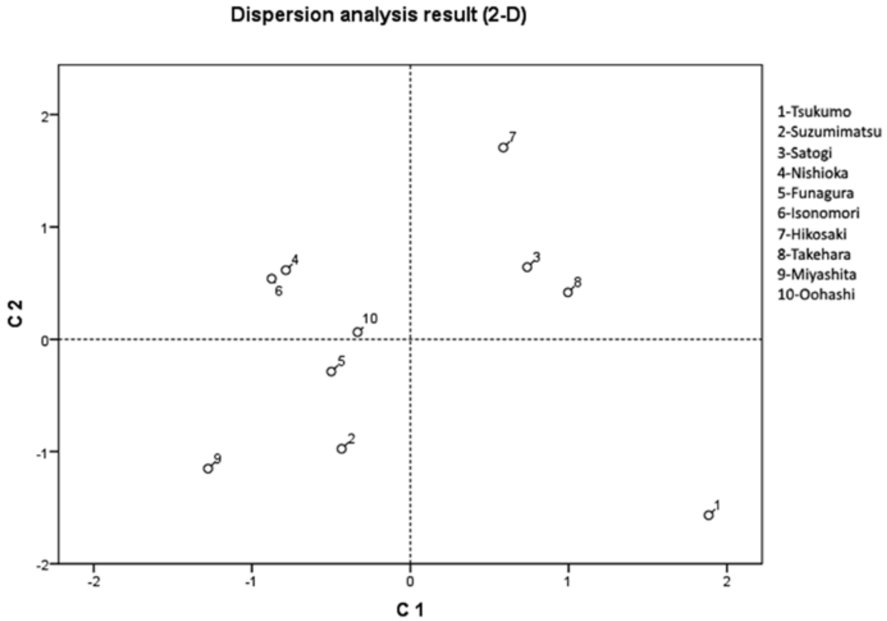

Figure 6. Dispersion analysis result.

4.2. BEAGLE CHANNEL SHELL MIDDENS ANALYSIS

4.2.1. METHOD OF CLASSIFICATION OF THE ARTIFACTS ACCORDING TO THEIR TYPE.

The Beagle Channel artifacts could also be grouped by the methodology of classification of the artifacts according to their type as proposed by Sawashita (1998). The materials analyzed here come from the study by Orquera and Piana (1999a). The shell midden sites of the Beagle Channel presented very good conservation of bone artifacts, so it was a good opportunity to classify them with the Sawashita methodology (1998) for providing complementary information in the analysis of the composition of shell middens artifacts.

In the first place, a graph with the composition of lithic artifacts according to their types was made (figure 7), which grouped the artifacts into 3 types: Hunting tools, processing tools and cooking tools. Secondly, we proceeded to do the same classification with the bone artifacts (figure 8), grouping them into 2 types: Fishing tools and tools. And finally, the lithic and bone artifacts were grouped together into a single classification of artifacts according to their types to obtain more data and to be able to compare them later with the Okayama Prefecture sites (figure 9).

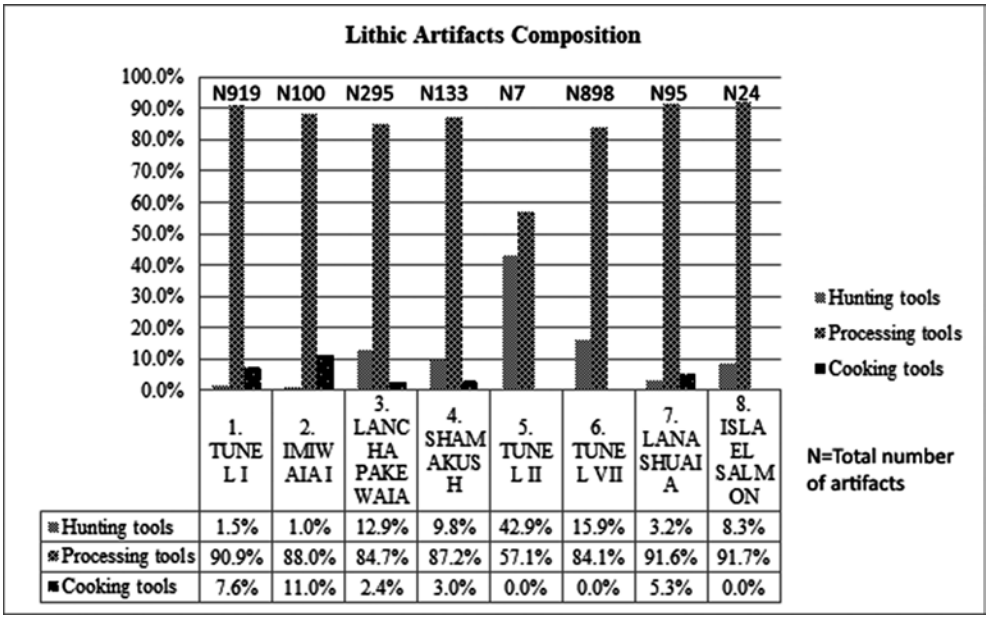

Figure 7. Lithic artifacts compositions.

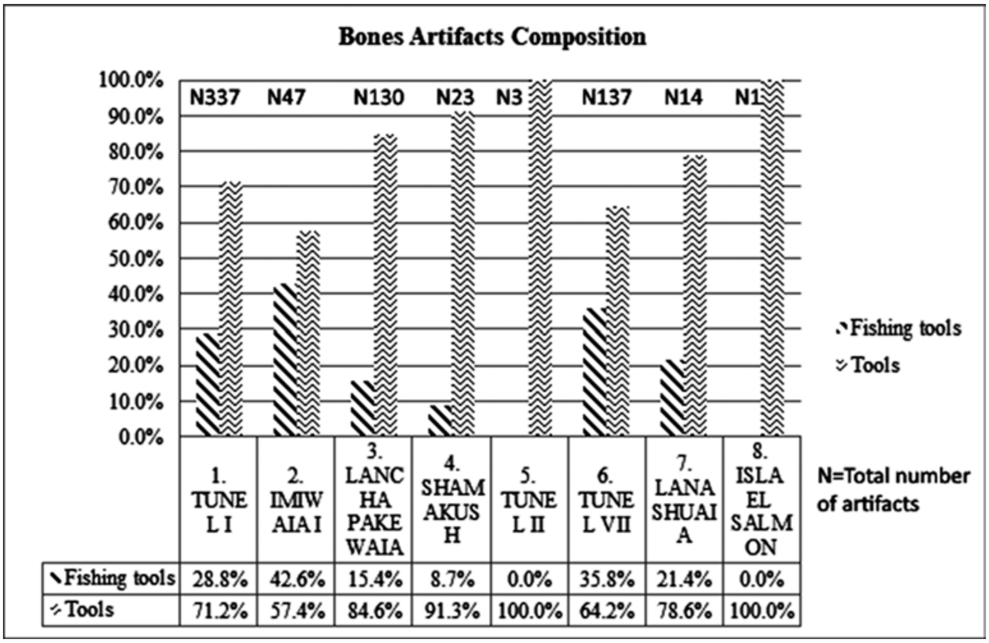

Figure 8. Bone artifacts compositions.

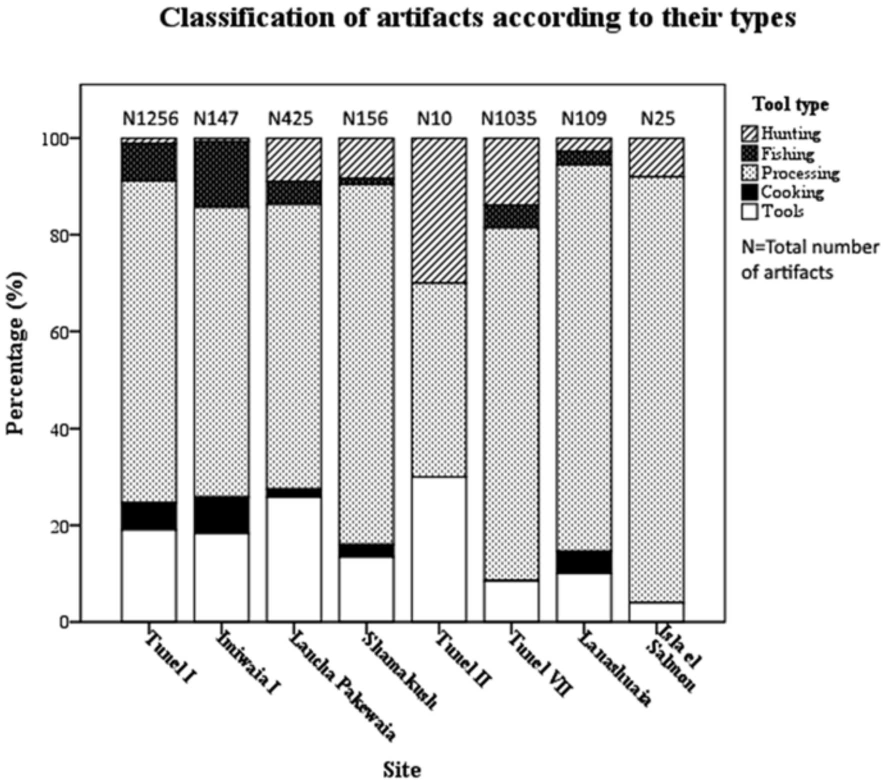

Figure 9. Composition of functional types of Beagle channel Shell Middens (includes bone artifacts and lithic artifacts).

From the analysis of the lithic artifacts composition according to their types (figure 7) it is evident that the processing tools are the ones that predominate in all the sites with percentages that range from 57% to almost 92%. In lesser proportion, as a secondary element of each site, we can consider the Hunting tools which range from 1% to almost 43% of the total of artifacts. Unlike the rest of artifacts, the Cooking tools are only present in 5 sites and have a small proportion that ranges from 2% to 11%.

According to the analysis of the bone artifacts composition according to their types (figure 8), we can distinguish two types of artifacts: Fishing tools, constituted by harpoons, and Tools mainly composed of punch tools, chisels, spatulas and wedges. In relation to the total percentages we can observe the predominance of Tools in all of the locations studied, with values that range between 57% and 100%; while the Fishing tools are only found in 6 sites with percentages ranging from 9% to 43%.

The results of the two graphs with bone and lithic artifacts according to their types were grouped and the percentages were newly calculated. It can be said that in almost all the sites, more than half of the tool composition consists in Processing tools, which is putting a big weight in tasks of prey processing. In relation to this fact, it is also possible to appreciate that the Tools constitute the second most abundant type of artifacts, which would also indicate that in these sites the confection and exploitation of resources also occurred. The third place is occupied by the Hunting tools, fact in accordance to the ethnographic evidence of the Yamanas groups that inhabited the coasts of the Beagle Channel（Orquera and Piana 1999b）; these populations are known for harpooning their preys directly from their canoes in the sea（mainly pinnipeds）and towed to their cabins. This makes sense in terms of the low numbers of Fishing and Hunting tools, and the high percentages of Processing tools observed.

When analyzing the graphs, it can be said that there are no great differences in the lithic assemblages between the sites, because the resources are homogeneously distributed in the environment（Orquera and Piana 1999a）and because in times of human occupation in the Beagle Channel there were no major changes in the environment; and the sites were located approximately in similar environments.

1．FINAL CONSIDERATIONS

From a comparative point of view, it can be said that the Okayama shell midden sites took advantage of a great variability of resources, terrestrial, littoral and marine, not being able to do so in the Beagle Channel sites, which is characterized by a low biodiversity of the terrestrial environment in contrast to the rich estuaries and the mountainous area of Okayama.

A differential factor between these two locations is the positioning of the Okayama Prefecture sites as they are located near the mouths of the rivers, which translates into the use of freshwater and saltwater resources, like in Takehara and Oohashi shell midden sites, in which freshwater Asian clam predominates compared to other shell remains as a constituent of the shell middens.

From the point of view of the artefactual assemblages we could observe that in the sites of the Prefecture of Okayama, the represented artifacts are quite varied which could be reflecting the activities that were carried out according to their environmental location; whereas, on the other hand, the homogeneity of the littoral resources of the Beagle Channel is present practically throughout the year, which is reflected in a similar artefactual composition of the sites. Another difference in the lithic assemblages that stands out in the Okayama shell midden sites is the large number of Hunting tools when compared to the Beagle Channel shell midden sites, in which the

Processing tools predominate. It is known from ethnographic data that the Yamanas groups never installed their camps near the pinnipeds (littoral resource and main food resource of these groups), since any prolonged location of the camps in these sites would have frightened the animals. For this, in the shell midden locations, the topographic conditions usually encountered by the catches are not observed. On the other hand, in the Shell midden sites all the bony constituent elements of the pinnipeds can be represented, which means that the prey was towed to the site in canoes and then processed and consumed. This is clearly reflected in the lithic artefactual assemblages by the great presence of Processing tools. The Okayama shell midden sites could be considered as a multiple activity sites, where mollusk and vegetable collection tasks were carried out together with other activities such as prey processing and tool making. Furthermore, these sites were also a location suitable for the observation of terrestrial preys (wild boars and deer), unlike the Beagle Channel sites where pinnipeds (littoral resource) were the staple food.

Another fundamental difference that arises from the analysis of the classification of the artifacts according to their types is the absence of Digging tools in the sites of the Beagle Channel when compared with those of Okayama, difference that reflects the absence of consumption of vegetal products by the groups that inhabited the Beagle Channel. This lack of vegetable consumption is supported not only by the absence of processing utensils, but also by the ethnographic information and the poverty in edible vegetable elements of the environment (Orquera and Piana 1999b).

Finally, as a conclusion it can be said that, while the environmental characteristics of the Beagle Channel and the Okayama Prefecture were not similar, the shores played a vital role for the human groups in the past. In the case of the Beagle Channel by providing the largest amount of biomass and in Okayama Prefecture by playing an intermediate bridge role in the use and obtainment of diverse marine and terrestrial types of resources.

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